The Next Generation of Data-Driven Demand Management
Long-Range Planning for Revenue Stability

Abstract
Water utility executives are faced with new realities which require them to reassess the tools they use to support mid and long-term financial decisions. Emergent cloud-based data platforms, specifically designed for the challenges faced by water suppliers, represent a new, critical element to improve decision-making. Data insights applied to utility management strategies will help meet the challenges of demand management and revenue control when fully integrated with water supply and infrastructure replacement planning. Utility managers can achieve the sustainability and affordability objectives they desire through the practical application of data analytics.
Introduction

THE U.S. WATER INDUSTRY

The U.S. Water industry is complex and diverse. Each organization and management structure is relatively unique, ranging from municipalities of single cities or counties, to private utilities and even water districts encompassing entire interstate regions. Nationwide there are nearly 54,000 community water systems. The industry does not employ standard communication approaches with end-users, as each program is directed by varying officials and managers. As one of the most capital intensive ($6.84 of investment to earn one dollar of revenue) sectors of cities (with water related services twice as capital intensive as electricity and three times as gas), and historically low water prices and associated revenues, venture capital and private equity has been reluctant to deploy dollars in the water industry.

The industry is also facing a near-term future of growing demand. From 2015 to 2019, the U.S. is projected to have a population growth rate of 2.4%, with just under half of the states with higher growth rates reaching up to 7.5%. Much of that growth is occurring in arid urban regions where the cost for new water supplies is rapidly climbing as traditional supply sources have already been tapped. For water utilities, that means more customers, more water demand, and more infrastructure development needs.

In addition to new infrastructure, the nation is facing a different crisis: That of replacing existing infrastructure. In 2002, the EPA projected a daunting $335 billion gap to replace and update America’s entire aging drinking water infrastructure in the next 15 years. Now the estimate for underground water pipes replacement over the next 20 years including sewer and storm systems is much larger. A recent U.S. Conference of Mayor’s estimate placed a combined need for all assets including growth at up to $4.8 trillion. With over 240,000 water main breaks in 2013 and an engineering grade of D from the American Society of Civil Engineers (ASCE), the U.S. wet infrastructure is at a critical crossroads, requiring this hidden issue to become a public discussion at all levels.
The current situation is unsustainable and a different approach is needed immediately.

WATER EXECUTIVES FACING NEW REALITIES

Against a backdrop of decreasing supplies, growing demand, and the need for massive infrastructure investment, the U.S. water industry also finds itself at the dawn of a revolution in data-driven water management practices, definitions, and applications. This transformation builds on the tradition of water resource supply and protection planning while facing new realities. Asset failure continues to occur due to deferred investments, population shifts, unfunded environmental mandates, utility knowledge loss and skill shortages, water supply variability, increased public scrutiny on utility spending, changing financial markets, and continued cost increases. The current situation is unsustainable, and a different approach is needed immediately.

Misalignment of water supply and demand is one of the greatest environmental concerns from coast to coast, from informed citizens to finance managers to elected officials. Drivers of this distress include climate change, population growth, regulations, demand variability (complicated by changing weather patterns and water saving efforts), ownership, and transfers. Water utility managers are expected to know not only the per-capita demand of a growing and changing population but also how to protect existing customers from water shortages due to natural or man-made emergencies. In the past few years these have included contamination, drought, earthquakes, and algae blooms.

Engineers are tasked with the evaluation of infrastructure needs including replacement and repair schedules. They must assess asset and capacity needs and, through master planning efforts, strive to achieve sustainability goals while building more resilient water systems. Finance professionals are expected to understand costs and how they will impact rates and revenues, while simultaneously addressing the affordability concerns of the customer base. Even wastewater utilities that have historically been unconcerned with water supply issues are now forced to deal with the costly effects of lower flows from water demand management efforts, the complexities of reuse planning, and new regulatory water quality requirements.

It is unsurprising that, to utility finance professionals, conservation has been synonymous with revenue loss, potential decreases in credit rating, and higher capital costs. Revenue erosion has led to budget cuts that impair the ability to invest in preventive maintenance programs to extend asset life. Reduction in maintenance budgets has resulted in premature asset failure, driving up capital costs. This downward fiscal cycle can result in the inability to control or forecast revenue, and greater uncertainty concerning water usage. In this context, conservation can distort the price elasticity of demand.
and create pressure to rebalance the fixed and volumetric components of water rates to help reduce revenue variability.

But that view of improved water-use efficiency is outdated. Better control over water demand improves forecasting capabilities and moderates variability. This creates greater financial control and improves both short and long-term prospects for more efficient operations, greater customer engagement, and reduced future capital requirements (Figure 2).

**FIGURE 2. Data Analytics and Behavioral Efficiency offer an opportunity to shift paradigms**

<table>
<thead>
<tr>
<th>OLD PARADIGM</th>
<th>NEW PARADIGM</th>
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<tbody>
<tr>
<td>Expensive, slow, supply-side solutions</td>
<td>Cost-effective, rapid data-driven demand-side solutions</td>
</tr>
<tr>
<td>Volumetric rate structure</td>
<td>Decoupled rate structure</td>
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<tr>
<td>Silent provider of service</td>
<td>Treat customers as partners</td>
</tr>
<tr>
<td>Mass communications</td>
<td>Targeted, personalized communications</td>
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<tr>
<td>Reduced water delivery erodes revenue</td>
<td>Demand management slows rate increases</td>
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**Changing the Paradigm of Demand Management**

**DATA IS THE NEW GOLD**

As the science of water demand management becomes a baseline component of supply management, reliable and timely data emerges as a key ingredient. The evolution of data collection and analysis is redefining water efficiency, leading demand management to center stage.

In order to successfully reduce infrastructure costs via water demand management, data must be collected, monitored, and analyzed at a sufficient level of detail for engineering teams to modify assumptions concerning pipe and facility capacity. These analyses must occur at both the customer level and the utility operations level. Utilities need tools that enable dynamic modeling and sensitivity analysis, based on large, real-world data sets. To be most useful, these tools should be visual, intuitive, and support effective communication with key stakeholders such as board members, regulators, and end-use consumers.
New analytic software has increased the connectivity between system information and service programs (Figure 3). However, data, as a utility management input, is still plagued by disjointed sources that can be very painful to integrate. Utilities can be swamped with data streams from supervisory control and data acquisition (SCADA), meter data management (MDM), customer billing, rebate programs, customer information systems (CIS), global information systems (GIS), customer relationship management (CRM), and more. Supply-side efforts have made use of various applications, but the majority of utilities lack sophisticated tools for demand-side analyses. Spreadsheets are subject to limitations and errors, lack data security, and are time-consuming to generate. This makes it difficult to visualize demand patterns and credibly forecast future operational and capital budgets.

The Water Environment Research Foundation’s Blueprint vision\textsuperscript{10} for individual water utilities states, “Successful users of state-of-the-art technology and information use cost-effective advanced solutions to provide customers with the best service possible.” These solutions support strategic imperatives that allow “utilities to use technology to effectively meet challenges of efficient operation, exceptional service, and meaningful public engagement.” This data intelligence needs to empower customers while informing long-term strategy for infrastructure planning and rate design.

Accurate and comprehensive data is also critical for benchmarking. Benchmarking in the water industry has proven effective in comparing reliability, sustainability, and program performance outcomes. “The tools are important for documenting past performance, establishing baselines...
for gauging productivity improvements, and making comparisons across service providers. Rankings of the cost-effectiveness of various water utilities can inform policymakers, those providing investment funds (multilateral organizations and private investors), and customers. In addition, if managers do not know how well their organization or division has performed (or is performing), they cannot set reasonable targets for future performance.”

“Benchmarking has become a key tool in the water industry to promote and achieve performance targets for utilities. The use of this tool for performance improvement through systematic search and adaptation of leading practices has expanded globally during the past decade.”

As with accurate demand forecasting, water utilities that are better able to understand their baseline will be able to make more effective decisions on investments and policies in the future to ensure the utility’s ongoing success.

The challenge is to fully integrate demand management into long-term water supply and infrastructure replacement planning. To meet this challenge, the collection, analysis, and interpretation of data at the utility and customer level needs to fundamentally change.

**FOCUSING ON WATER DEMAND**

Where do water utilities turn when faced with low aquifer levels and precipitation variability? Historically, when utilities needed more water, dams and reservoirs were constructed, and new wells were drilled. But these approaches are no longer viable in many parts of the country: water providers face historically low water levels in aquifers, as well as decreased surface run-off. Recycled and desalinated water are increasingly being pursued, but these projects take years to develop, are expensive, and only address a modest portion of supply needs.

These factors push water providers out of their comfort zone and force them to consider new approaches. This leads to more emphasis being placed on the demand side of the equation (Figure 4).

Water demand is normally tracked at the utility, system-wide level. But to better manage demand and improve forecasting capabilities the focus shifts to where water is being consumed: at the customer level. New forecasting models that include controlled demand management capture data throughout the entire water value chain and incorporate all inputs, outputs, and stakeholders’ water use actions. The long-term result includes a dynamic and holistic data-driven picture that supports improved asset allocation and decision-making. Such capabilities “help save energy, improve dynamic pricing ability, monitor water quality, extend infrastructure longevity, and reduce capital expenditures by managing peak demand.”
THE BENEFITS OF WATER DEMAND MANAGEMENT

When considering updating or replacing current water treatment plant infrastructure, demand reduction is a high value alternative to procuring new water supply resources. In addition to helping balance mismatches in supply and demand, short-term benefits include:

- Lower operations and maintenance (O&M) costs
- Lower energy expenses
- Lower treatment costs
- Deferred or downsized capital projects
- Greater system reliability
- Reduced rate shock
- Higher credit ratings
- Lower interest rates for municipal bonds

Short-term demand reduction is usually associated with drought, natural disasters and economic crises where real results are needed as quickly as possible. Improved water-use efficiency moves beyond those conditions to offer substantial long-term benefits. Water-use reductions over a 20-year time horizon can help optimize demand management policies while creating new virtual water supplies (Figure 5). These approaches have been shown to significantly slow down rate hikes in some utilities14 and have yielded substantial avoided operational and capital costs (Figure 6). Additionally, investments in efficiency have improved demand forecasting and increased revenue control.15

LONG-TERM BENEFITS OF WATER-USE EFFICIENCY

Demand management over a 20-year time horizon creates new virtual water supplies.
Because of these benefits, utilities across the nation are increasingly investing in demand management programs. Simultaneously, we see an increase in the number of organizations calling for improved water efficiency as a cost-effective source of supply such as the Alliance for Water Efficiency, Waterwise, and the U.S. Water Alliance. Even when demand-reduction is not a specific agency need, utility managers are increasingly honing in on demand management best practices as an integral component of Integrated Regional Water Management Plans.

**INFRASTRUCTURE COST SAVINGS: A COLORADO CASE STUDY**

Improved demand management helps reduce operational and capital costs and allows utilities to more easily fund current and future projects without rate shocks while mitigating affordability issues. According to a recent study in Colorado, utilities were able to significantly downsize rate increases through demand management practices.\(^\text{14}\) The study analyzed water use behavior and utility policies since 1980, projecting utility costs to the present day, had demand management never been introduced. The results were startling.

According to the City of Westminster’s findings, an additional 7,295 AF would have been needed to meet rising demand. As new water sources in the Colorado Front Range are priced at an astonishing $30,000 per acre-foot, the council calculated savings in capital investments to be $218.85M. Demand reductions particularly affected Peak Season water production, saving the city approximately $130M in additional treatment costs. Wastewater treatment savings of roughly $20M were realized.

### FIGURE 6. Deferred capital costs for new supply and storage avoids significant interest expenses

<table>
<thead>
<tr>
<th>System Size (Connections)</th>
<th>Number of Systems</th>
<th>Estimated 20-Year Capital Need ($M)</th>
<th>Average Investment per System ($M)</th>
<th>Annual Interest on 20-Year Bond at 3.5% ($M)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 100,000</td>
<td>426</td>
<td>$145,100</td>
<td>$340.61</td>
<td>$11.92</td>
</tr>
<tr>
<td>3,301–100,000</td>
<td>8,787</td>
<td>$161,800</td>
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<tr>
<td>&lt; 3,300</td>
<td>42,322</td>
<td>$64,500</td>
<td>$1.52</td>
<td>$0.05</td>
</tr>
</tbody>
</table>

Source: Capital investment estimates from 2002 EPA Drinking Water Infrastructure Needs Report

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**CITY OF WESTMINSTER SAVED WITH DEMAND MANAGEMENT**

- **$591 M** in capital expenses
- **$1.2 M** in operating costs
Overall, through consistent demand management programs, the City of Westminster was able to avoid over $591.85M in costs for new capital investments in water source supply and infrastructure. The study also found that the utility saved on average $1.24M in yearly operating costs. The study also analyzes these costs and their repercussions on water and wastewater rates, as well as tap fees. Combined water and sewer bills would be 91% higher than they are currently, jumping from $655 to $1,251 annually had 1980 water usage levels continued without demand management. Similar results were found for tap fees, whose rate would have increased by 99% had conservation never been introduced.

The report admits, “Each water system is unique, so the results from Westminster may not be applicable to everyone. Utilities could perform a similar analysis to see the real value of conservation. However, the $590 million dollar cost associated with the additional 7,295 AF of demand reveals the significant hardship associated with expanding water resources supply and wastewater treatment infrastructure in today’s environment.”

Utilities are increasingly adopting rate structures that place more weight on **fixed costs** rather than variable operating costs.

It is a hardship for the utility, but also for the customer, to keep up with rates that are increasing at an alarming rate. “Water and wastewater rates have increased faster than the Consumer Price Index (CPI) over the past 15 years”16 (Figure 7). Managing the public response to rate increases has taken on growing significance in recent years as utilities grapple with the double

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**FIGURE 7. The increases in water costs continue to exceed the Consumer Price Index**

Source: IPU-MSU based on BLS data.
edged sword of rising infrastructure costs and decreasing demands.” Although rates may still increase, they will do so significantly more slowly when demand management programs are in place. Utilities are increasingly adopting rate structures that place more weight on fixed costs rather than variable operating costs. Demand management programs funded by monthly fixed costs of utility water and wastewater rate structures allow utilities to fully capitalize on avoided costs as well stabilize revenues by emphasizing predictable fixed costs.

WATER AND ENERGY DEMAND MANAGEMENT

Much of the work on water demand management is built on earlier studies relating to energy demand management. The gradual shift from simple to complex technologies, from distributed to centralized systems, and from free good to economic resource has typified both commodities.

Over the past 20 years the energy industry has undergone a transformation. A trend toward increased decoupling of electricity consumption and rates in favor of fixed capital recovery margins has largely eliminated disincentives toward improved efficiency. This has created a new industry for “energy efficiency”, leading to a boom in technology innovation and yielding benefits for utilities, industry vendors, and consumers. Utilities have transformed the grid system, turning it into the “smart grid” equipped with GIS and smart meters measuring real time data.

Developments in the water industry have begun to parallel energy market trends with customer engagement programs leveraging the full benefits of smart metering data technologies. With demand management a growing priority in the water sector, increased control over water use is required for predictable and sustainable revenue flows. As with the energy industry, coupling advanced data analysis with customer engagement solutions will allow the water industry to achieve similar results. Advanced Metering Infrastructure (AMI) promises time and use rate charging with near perfect allocations of peaking and energy costs by water source. With ingenuity and drive, the water industry can make significant headway in efficiency, return on investment, and transparency.
POPULATION DEMANDS ON WATER SOURCES
Population growth compounds water utility constraints, driving them to search out alternative water sources. As urbanization continues, metropolitan areas seeing the greatest increase in population tend to be in regions of the world with the least amount of potable water. While per capita water consumption has continued to decline in most parts of the world, demands on limited supply sources in the most populous cities leads utilities to search for new solutions to the growing supply-demand imbalance.

Mother nature plays a role in declining precipitation rates and rising temperatures directly affecting the volume of snowpack that normally melts into our sources of surface water. Groundwater accounts for 25% of total water needs in the domestic, agricultural, and industrial sectors in the US. Over half the population relies on groundwater as a primary drinking water source. Decades of poor management of groundwater sources (much due to agricultural usage) have depleted reserves while climate change patterns are resulting in alarming declines of groundwater recharge rates.

Recent discussion related to water stress, particularly in the Western United States, has focused on drought. However, what we’re experiencing is not primarily a drought problem. It’s a growth problem.

INCREASING COSTS OF NEW WATER SOURCES
What other options exist when current sources are depleted or unavailable? Many utilities are buying raw water from other water providers, but at very high cost. Other options include recycled or reclaimed water that requires additional treatment depending on the initial quality and its targeted end use. Desalination is yet another option. California’s coastline recently saw construction of the nation’s largest desalination plant in Carlsbad, after almost 6 years of government permit negotiating. Customers will be paying up to $2,257 an acre-foot for the water. An agency which provides water to 3.1 million people in San Diego County, signed a 30-year contract agreeing to buy at least 48,000 acre feet a year. This affects everyone’s water bill, not just those receiving water directly from the plant. Average customer bills in the county will go up $5 to $7 to pay for the $1 billion project. For context, the project is projected to provide 7% of demand for San Diego County.
THE COST OF REDUCING WATER DEMAND VS. NEW WATER SOURCES

California’s updated 2014 Water Plan discusses how to maximize investments in data collection through utility and customer side analytics technologies, which is identified as a best practice.

“In addition to using conservation rate structures to incentivize water conservation, some water suppliers are using a new behavioral approach to affect demand management. Based on insights from psychological research, behavioral water efficiency programs inform consumers of prevailing social norms, such as the average water use of neighbors, to drive conformity to a more efficient standard. This comparison creates a social framework in which water conservation is seen as highly valued by residents of a community.

The effectiveness of behavioral water efficiency programs has been tested in several communities, including in an East Bay Municipal Utility District pilot project. In this pilot, residents received Water Reports with information about their water consumption, the consumption of similar households, and personalized recommendations on ways to save. The yearlong pilot project involved 10,000 homes and a randomized control group.

Households that received Water Reports reduced their water use from 4.6% to 6.6%, were more likely to participate in utility audit and rebate programs, and reported higher levels of customer satisfaction.

The unit cost of saved water was between $250 and $590 per acre-foot, with a mid-point cost of $380 per acre-foot.”

As outlined by AWWA in their Water Resource Manual, industry best practices for Water Use Efficiency have included water surveys, residential plumbing retrofits, system water audits, leak detection and repair, metering with commodity rates, native plant landscaping, high efficiency washing machines, low flush toilets, and school education programs. These “water efficiency programs” costs range from $465 to $980 per acre-foot but are only utilized by a small percentage of customers. (Figure 8)

Demand management has a cost and a yield like any potential water resource, so a cost-benefit analysis should be performed before implementing programs. The AWWA offers a 10-step development process to do so. Integrating a demand management program as part of a larger Water Management Plan can provide the best perspective on potential savings, avoided costs, and appropriate measures to benefit all stakeholders.

In 2010, The Water Research Foundation (WRF) published a report based on utility surveys called Water Conservation: Customer Behavior and Effective Communications. The objective of the study was to evaluate the
relationship between water efficiency behavior of residential customers and communication approaches that seek to influence that behavior.

Forecasting demand management results can be very difficult. Changes in precipitation patterns, household size, landscaped area, and other variables can lead to wide-ranging estimates. The WRF survey results identified a number of important factors that influence per-capita water demand. Different conservation programs yield various results: equipment and fixture changes provide long-term savings; demand impacts of low-water use landscaping and managed irrigation are more difficult to predict; and consumption changes tied to rate design depend on a variety of factors unrelated to price, such as household income, number and age of occupants, and irrigable land area. Of course all of these factors impact revenue forecasts.

The use of data can help utilities to better target customers who will benefit the most from demand management programs. As benchmarking is used to inform utility planning and decision making, the same approach has proven effective in influencing customer consumption behavior. Customers require household-based comparison information to make informed decisions and persistently reinforce behavior change.

In nearly every case, demand management results in lower costs to utilities and end-use customers than procuring new marginal supply sources. While managed demand never entirely substitutes for new water supplies, a portfolio approach featuring demand management to address marginal supply requirements has repeatedly proven the least expensive option.
Forecasting the Future

THE INFRASTRUCTURE INVESTMENT GAP

In a two-part Water Research Foundation study, a forum of utility managers discussed key trends impacting the industry. The primary study\(^28\) researched and analyzed four categories of environmental, technological, economic, and societal/political trends with topic areas ranging from climate change, to rate of technological adoption, to customer and community relationships.

One of the trends projected to influence utility sustainability is the nation's aging water infrastructure and overall capital needs. As stated earlier, estimates for investment in water infrastructure are projected to be as much as $4.8 trillion dollars nationwide through 2028\(^8\). Of the twenty utility managers surveyed, most commented that this daunting capital need had “gotten the best of them these past 5 years.” The strategy development discussion called for aggressive capital improvement plans highlighting the importance of incorporating the following practices:

1. Careful coordination between the utility and all stakeholders
2. Creating and adhering to a methodology in prioritizing projects, and
3. Greater coordination between engineering and finance departments.

Yet even with strict adherence to coordination practices, it is still unclear how utilities will finance infrastructure improvements over the next two to three decades. New sources of capital in addition to traditional municipal bond financing are needed, and concerns over financial stability in the face of uncertain future demand and revenue makes that prospect even more challenging.

SHIFTING WATER DEMAND

Demand for water across different socio-economic segments of the country is changing over the next two decades. Residential demand for water is expected to decline due to changes in utility, stakeholder, and individual behavior. Industrial water use will also likely see a decline due to improved efficiency practices and technologies, along with migration of large industries to non-U.S. markets. Conversely, increases in water demand are likely in the energy industry due to expansion of thermo-electric power and fracking activity.\(^28\)

The USGS recently released a study confirming that water use estimates for 2010 reported withdrawals at the lowest levels since 1970. 2010 estimates were also 13% less than 2005 usage rates, which is curious in light of a 4% population increase during the same period.\(^29\) Water demand is also affected by social changes, such as a heightened concern over water quality, and
geographic population shifts. Population shifts to the Southern and Western regions of the country leads to excess capacity in the North and East while challenging current capacity of the utilities in the nation’s western half.

The most successful efforts to deal with these changes in consumption patterns have focused on better understanding trends and developing proactive strategies to address future challenges. “The main challenge with this trend appears to relate more to uncertainty in predicting usage than the actual decline.” There is a prevailing concern of an “unknown bottom.” This trend has influenced what utilities are requiring of their customers and has “dominated the utility-customer relationship.” Water suppliers are attempting to recover lost revenue by adding decoupled surcharges to bills, and customers are increasingly dissatisfied with paying more for less water.30

OUTDATED FORECASTING MODELS

These changes in water consumption patterns have an impact on the business model of utilities. Due to revenue uncertainty from unpredictable customer consumption, many utilities are revamping their rate design to increase fixed charges and reduce the volatility of variable volumetric charges. This approach effectively decouples revenues from water consumption charges. Accurate demand forecasting models are necessary for decoupled rate structures to succeed, and help utilities optimize system operations, plan for future water purchases or system expansion, and predict future revenue.

There are several ways to forecast demand; one particularly basic and popular method31 is to simply multiply current per capita water consumption (GPCD) by expected future population. However, as indicated by the USGS statistic, this is a highly inaccurate forecasting model. According to a study by the Pacific Institute32, although water demand forecasting accuracy is improving, utilities have traditionally over-estimated water use, leading to a tendency to build excess system capacity. Utilities must consider a wide range of variables when predicting customer behavior such as new legislation, conservation programs, media messages, climate change, changes in cultural values, and demographic shifts. By considering a more comprehensive set of factors when forecasting demand, utilities are able to improve financial stability and protect favorable bond ratings.

OVERCOMING UNCERTAINTY

These trends can be summarized by one word: Uncertainty. “In fact, the new threat to fiscal performance may lie in uncertainty. These uncertainties will likely require a suite of strategies to mitigate and master the most probable and consequential trends and their associated risks. Utility responses to
uncertainties, risks, costs, and innovative opportunities will help shape public perceptions of water utilities and their leaders and in turn, shape the state of the industry. But modern data analytics technologies can be used to address areas of uncertainty.

The University of Twente in the Netherlands published a study reporting on each country in the world and their unique water footprint. U.S. water consumption was calculated to be 1,053 billion cubic meters in 2014. This amount of water was produced and distributed by over 50,000 different non-transient water systems across the nation. It is interesting to note that, according to the EPA, only 8% of water utilities service over 82% of U.S. population. This is yet another indication of ongoing trends toward urbanization that stress the relatively few systems serving a vast majority of the population.

In the face of these challenges, water industry professionals are seeking out innovative practices to increase sustainability and productivity. Demand management as an effective new source of marginal supply is topping the list of best practices in many regions.

**IMPROVING REVENUE CONTROL**

Water supply planners are not able to make prudent and cost effective estimates unless customer water demand becomes more consistent. Price elasticity of demand is distorted by conservation messaging which leads to further revenue uncertainty. Revenue projections use billing information derived from meter consumption data and water rates. Improved data reliability and sophisticated interpretation is critical to improving forecasts and capturing cost savings. This is done by avoiding high peaking factors and pipe sizes from engineering assumptions. Infrastructure replacement planning activities that incorporate an integrated investment planning process with more accurate demand projections inevitably lead to lower long-term system costs.

An integrated approach grounded in data analytics and customer engagement takes the short-term revenue gap from demand management programs and leverages it for longer-term, cost saving investment strategies.

**DEMAND MANAGEMENT VIA CUSTOMER ENGAGEMENT: A CALIFORNIA STUDY**

We have already established the beneficial cost of behavioral efficiency programs in the context of other marginal water supply options, but there are additional advantages to managing water consumption by directly engaging end-users.
As discussed earlier, East Bay Municipal Utility District (EBMUD) tested behavioral efficiency in a pilot program of residential Water Reports developed by WaterSmart Software. An independent study found a 4.6%–6.6% decrease in water use in the treatment group compared with the control group. Personalized information on the Reports encouraged high users to cut back, while nudging already-efficient homes to maintain their current level of use. The study found that households with water usage in the top quartile saved the most, while the lowest water users’ consumption did not increase in response to social norms. These findings indicate that Water Reports can be used as an effective tool to target the most volatile segments of demand, thereby stabilizing revenue.

Empowering customers to take action improved the utility-customer relationship. Water Reports were found to be statistically significant in their ability to influence customers to take part in utility programs such as audits and rebates. Customers who received reports were 2.3 times more likely to participate and up to 80% more likely to score EBMUD as “Excellent” in “giving useful tips and tools needed to use water efficiently.” These findings have been further supported by WaterSmart’s own surveys, which have seen a 36% increase in customer satisfaction from Water Reports.

DEMAND MANAGEMENT AND ASSET MANAGEMENT PLANNING

According to a study by the California Urban Water Conservation Council, all utilities should consider demand management in an overall water asset management plan because of its substantial financial benefits. Based on the study’s findings, utilities implementing demand management practices are reaping extensive avoided costs and saving hundreds of thousands of dollars per year. The study characterized direct avoided costs into four categories: short run, long run, non-water, and total avoided costs. Short run avoided costs are primarily marginal costs such as expenses for purchased water, energy, and treatment chemicals.

Long-run avoided costs are fixed costs such as big capital investments in water distribution infrastructure, treatment plants, and other upfront startup systems. Most long-run avoided costs derive from infrastructure investments that can be deferred and/or downsized through demand management. Costs were further analyzed by assignable vs. joint costs (i.e. costs that are incurred by a single system element vs. several elements combined). While numerical projections vary depending on data quality and accounting, the overall trend in avoided cost savings through improved demand management is clear.
DIRECT AVOIDED COSTS OF IMPROVED EFFICIENCY
The CUWCC study suggests that costs projected by the accounting approach often underestimate the actual price tag of investments and operating expenses due to three key factors:

1. Projections are done using depreciated historical costs instead of current replacement cost
2. Retained earnings and system development changes in the rate base are usually excluded
3. Projections on water scarcity are often unrealistic

To overcome these shortcomings, the Council suggests more accurate estimates of direct avoided costs for utility demand management practices. “The estimation of a water utility’s avoided supply costs begins with baseline assumptions about the future supply and infrastructure investments that would be made and the manner in which the system would be operated in the absence of conservation.”

The question that must be answered is how these factors might change due to demand reductions. “Over a specific time horizon, expenditures are projected using proven demand forecasting methods taking into account population growth, industrial sector development, weather patterns and other factors. The rate at which different prices will increase over time must also be accounted for.” Existing system components are assessed and new additions are planned.

Next, over the same time horizon, expenditures are calculated incorporating estimated demand changes. System components whose costs are expected to decrease because of the demand reduction are said to be operating “on the margin.” This second cost projection is said to be the marginal operating and capacity cost. Direct avoided costs are separated for peak and off-peak seasons. Utilities will save the most money and water during the peak-season affected by demand management; however, other short-term avoided costs can be seen during off-peak season. System simulations that try to more closely predict system response are most accurate in estimating marginal costs. The study offers specific formulas and input charts for utilities to accurately estimate their individual direct avoided costs to determine the economic benefit of demand management programs.
On average, utilities can save up to $684/AF by engaging in demand management programs that lead to lower operational costs as well as deferred and downsized capital projects. As can be seen in Figure 9, when a new additional water source is required (year 2024), the avoided costs almost double.

Cost projections will multiply in the year a new source is introduced. This projection varies according to the price of the new water source. Many traditional sources of water are no longer available and thus prices for incremental water sources are often extremely high.

How does a utility begin to capitalize on such savings? Implementation of the proper demand management program is required. Most Best Management Practices found in the demand management category cost between $465-$980/AF to implement and maintain, which makes a behavioral water efficiency program leveraging Water Reports an extremely competitive investment at $250-$590/AF.

LEAK DETECTION: A UTAH EXAMPLE

The methodology of the CUWCC study also accounts for regular water system losses when calculating marginal costs and direct avoided costs. Therefore, mitigating demand-side losses is a strategy to increase savings. Utility officials in Park City, Utah reported a favorable statistic for WaterSmart Software’s automated leak resolution system. “In the first three months of the program, the platform delivered over 150 leak alerts to residents, 70% of which were closed within ten days of the notification.”
A New Future

The application of data analytics to demand management, integrated with financial and infrastructure planning is an emerging framework for water utility executives. From this new perspective, utility managers can engage stakeholders by providing a data-rich communications environment. This data translates into insight and increasingly transparent board and council meetings, more informed rate approval processes, and empowered customers. A more robust data environment means increasingly credible consumption and financial forecasts, greater stability of financial resources, and less costly access to capital. Utilities are able to realize direct avoided costs while creating data-driven justifications for new projects that align with actual consumption needs, informed through controlled demand management.

Data rich communication tools for demand management offer an effective way to reach out to individual customers. This approach ultimately helps the utility of the future build a partnership with customers that yields greater consumption management through information technologies, data insights, and behavioral science that communicates the true value of water.

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Endnotes


ABOUT THE AUTHOR

Gregory M. Baird is president of The Water Finance Research Foundation and specializes in long-term financial planning, infrastructure asset management and capital funding strategies for municipal water utilities. He served as a municipal finance officer in California and as the CFO of Colorado’s third largest utility—overseeing all financial aspects of a $150 million water, wastewater and storm drain operation and $2 billion capital program. Mr. Baird has issued more than $1 billion in municipal debt and has had county treasury oversight responsibilities of over $900 million. Mr. Baird serves on the AWWA Sustainable Infrastructure, Rates and Charges and Asset Management committees. He founded the Utility Finance Forum (UFF) for the Government Finance Officers Association (GFOA) and advises the GFOA Economic Development and Capital Planning Committee on water utility and asset management issues. He is widely published and presents on utility infrastructure asset management and integrated finance issues for the U.S. and Canadian water and wastewater industry.

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