Potential Best Management Practice: Customer Water Use Messaging

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Summary

Water and energy utilities have historically relied on financial incentives and information dissemination to help customers conserve resources. We are beginning to recognize these actions alone are not enough to motivate consumers to change behaviors. In recent years there have been surges in non-price interventions using behavioral economics that lead consumers to conserve energy. Although many of the behavioral concepts have been implemented in different areas in order to “nudge” consumers to change behavior where they can increase their health, wealth, etc., stakeholders in the energy, and more recently, water markets have started to adopt this new and alternative approach. These social norms messaging programs seem to offer promising ways to affect and reduce resource use among consumers, especially when customers are shown their energy (or water) use is out of alignment with their perceptions, and more importantly, similar households. Recognizing that there are very few studies, pilots or experimentations implemented in water markets, indicates that there is greater opportunity to implement various behavioral concepts in different settings in order to understand what drives consumers’ water consumption behavior and how it can be influenced.

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Introduction

Addressing human behavior as a strategy for efficient use of resources is embedded in most conservation programs and lessons from the social sciences are now being incorporated into the development of behavior-based efficiency programs. The potential contributions from social psychology and behavioral economics for resource efficiency and behavior programs are being used and tested broadly across sustainability and environmental fields. (Vigen & Mazur-Stommen, 2012).

Where economic incentives or financial benefit once dominated conservation programs, Community Based Social Marketing (CBSM) is emerging as an alternative model about behavior change. CBSM incorporates a variety of social marketing "tools" to motivate and engage homeowners to affect desired behavioral changes that lead to energy savings. CBSM strategies incorporate the idea that behavior change happens within a social context that provides motivation and support. For example, customers make decisions based on social cues, self-image, local values and identities. "The tools and framework provided by CBSM are allowing practitioners to build and implement programs that save more energy and are more cost-effective." Some of these behavior changing tools include:

- Commitment – such as a "pledge to save".
- Social Diffusion – refers to how we follow signals from trusted peers.
- Social Norms – refers to the tendency to want to "fit it".
- Prompts – such as signs, or other reminders to take an action.
- Communication – providing relevant and impactful messages in a vivid and personal way.
- Incentives – In the form of financial awards.
- Convenience – Lowering the barrier to taking a perceived inconvenient action[1]

Behavior based efficiency programs recognize and try to account for the difficulties consumers have translating intention into action, especially when the discussion is about energy efficiency, and more recently, water use efficiency. Consumers do not always know or cannot identify the best action that may lead to the highest returns and this leads to failures in decision-making, inaction or low returns for their perceived "high" efforts. Consumers also have difficulty making a choice when there are too many options. For instance, Iyngar and Lepper's (2000) study shows that more shoppers make a purchase of a jam when they are presented with six choices than when they are presented with 24 choices. This choice overload is especially true when it comes to information regarding energy efficiency; there are a lot of sources that suggest numerous actions to be taken in order to conserve more energy and each identifies/prioritizes different actions to be taken.

Most social norms based research has been conducted on consumption rather conservation. For example, when consumers learn that seven out of 10 people choose one brand of automobile over another, or that teeth-whitening toothpaste has become more popular than regular toothpaste, they are getting information about social norms. Social norms have also been used as a

[1] http://www.aceee.org/files/pdf/presentation/cbsm-webinar.pdf

behavioral tool to reduce the choices consumers are facing when they make a decision or are converting their intention to an action.

Customer use messaging is part of the larger field of behavior-based programs, and messaging that includes a social comparison is particularly effective at changing people's behaviors. Informing customers about how their use compares to similar households is referred to as social norms messaging and has become an accepted way to influence the conservation of natural resources. Behavioral economists assert that in the absence of price signals, policymakers can change peoples' behaviors by harnessing their natural inclination to conform to social norms. For natural resources, such as electricity and water, "if an individual is presented with credible information that they consume more than their neighbors and such consumption is socially undesirable, the individual will seek to change his or her behavior." (Ferraro, et al., 2011)

> *"When individuals learn what the commonly accepted ways of behaving in a group is, they tend to align their behavior closer to the norm."* (Ignelzi, 2013)

Social comparisons have been shown effective in a variety of other fields such as alcohol and drug use (Perkins & Berkowitz, 1996), voting (Gerber & Rogers, 2009), and environmental awareness (Goldstein et al., 2008). These studies show individuals validate the appropriateness of an action or thought through comparison to others. For resource conservation, this is important for several reasons. Consumers who want to change their behavior will not do so purely for pro-environmental purposes, rather, they would like to see tangible changes in their bill and in their social comparisons (Ferraro et al., 2011).

Two types of social norms have been identified in comparative usage programs: descriptive norms and injunctive norms. Descriptive social norms refer to the observance or perception of the behaviors taking place around you; doing what everyone else does. An injunctive social norm takes into consideration whether a behavior will be approved of or not. The social norms based programs highlighted in this report incorporate both of these approaches for natural resource conservation.

Studies on comparison have also shown the level of comparison has an impact on the consumer. For example, when the social comparison is between the consumer and all the other people in the country, or state, there are virtually no savings. However, when the comparison is between the consumer and actual neighbors or people from the same town, the comparison mattered and social pressure resulted in much more significant savings. This suggests identification with a group of people increases both trust of the group members and the social pressure that the group can exert (Mani et al., 2013).

In another study where door hangers were left at 271 homes in San Marcos, California, with different, randomly assigned energy conservation messages, door hangers that compared a given household's energy demand to that of their neighbors led to 10% more energy demand reduction than door hangers that gave only energy conservation tips. Research in energy and other fields suggest that social norms affect individual actions by providing guidelines as to what is acceptable or "normal" behavior. Social norms designs also intend to reduce the search cost of the useful and effective information that are available to adopt conservation behavior (Nolan et al., 2008).

Noting that over three-quarters of Americans think of themselves as environmentalists (Mackoy et al., 1995), many businesses employ pro-environmental messages to encourage conservation. For example, many hotel chains encourage consumers to reuse their towels, which provides obvious environmental benefits such as less water and energy use but also has economic benefits for the hotel in the form of reduced labor, water, energy and detergent costs. In their 2008 study, Goldstein et al., sought to determine if including descriptive norms (how most people behave in a situation) would be more effective than the standard pro-environmental approach. In their first experiment, they designed two different messages to engage hotel guests in a towel reuse program. Utilizing a towel reuse sign, the first message employed the standard environmental message, focusing guests' attention on the importance of environmental protection. The second message, a descriptive norm message, informed guests that the majority of other hotel guests participated in the towel reuse program. Both towel reuse signs provided information about the benefits of participating in the program, such as the amount of water and energy saved.

What the study found is that the descriptive norm message resulted in significantly higher participation (44.1%) in the towel reuse program than did the environmental protection message (35.1%) demonstrating that hotel guests were more motivated to reuse their towels when they learned that most other guests had done the same. They conducted further studies to investigate whether guests who learn the descriptive norm for their particular room were more likely to participate in the towel reuse program than guests who learn the same descriptive norm for the whole hotel. When guests in a particular room number were told that previous guests to that room number had participated in the program, towel reuse went up to 49.3%.

These studies have motivated an increased interest in designing policy interventions that target energy demand and measure the responsiveness of consumer behavior to these interventions. Energy consumption and investment in energy efficiency involve consumer decision-making and behavioral economics can provide new perspectives for understanding how individuals respond to choices, make decisions and take action to change their behavior.

For the purposes of this report, we will focus mainly on programs that employ social norms as the means to change customer behavior. Energy utilities have been utilizing behavior-based programs for almost a decade and therefore, the majority of the research on behavioral interventions in resource conservation has been conducted with energy utilities. An extensive list of behavior change intervention strategies have been identified and incorporated into the efficiency programs in the energy sector; for a thorough discussion of the components of a behavior-based program, please refer to Residential Behavioral White Paper.

Behavior-Based Efficiency Programs in the Electric Sector

Economists and policymakers have relied on relative prices as the primary driving force on energy demand. However, the drain on public funds is one drawback to price-based approaches to energy conservation. For example, subsidies for energy efficient durable goods draw the majority of public energy efficiency funding in the United States. As a result, interest in non-price energy conservation programs has increased (Allcott, 2011). Harnessing the attributes of human sociability, CBSM programs can motivate behavior change beyond what financial incentives can sustainably affect (Vigen & Mazur-Stommen, 2012).

Managing energy use through technology can reduce the amount of active decision-making on the part of the consumer, but it does not eliminate the role of behavior. To that end, in 2008 energy utilities began to incorporate large-scale residential behavioral programs to reduce energy use. To comply with a 2012 mandate from the California Public Utilities Commission all the California investor-owned utilities have initiated behavior programs that employ comparative energy usage (Ignelzi et al., 2013).

Non-price energy conservation programs incorporate insights from the behavioral sciences and are evaluated via randomized control trials (RCT) (Allcott, 2011). The use of RCT design is important to measuring the outcomes of these behavioral interventions. This involves studying a group of people selected at random to receive the "treatment" or intervention and a control group who does not receive the treatment. RCTs are quantitative, comparative, controlled experiments where results can be analyzed with statistical tools.

Private companies such as Opower, Tendril, Aclara, and C3 have all developed behavioral efficiency programs for the energy sector. Most program designs share the same features including:

- Implementation using an experimental design, where homes are randomly assigned to treatment or control groups;
- Target thousands of utility customers (large scale programs);
- Provide customers with an analysis of their historical consumption, energy savings tips, and energy-efficiency comparisons to neighbor homes; and
- Typically implemented by outside vendors (Mazur-Stommen and Farley, 2013).

Opower Home Energy Reports

As the market leader, Opower engages with more than 90 utility partners in North America, Europe and Asia. Since the launch of large-scale Home Energy Report programs in 2008, millions of electricity customers across the United States have received Opower's personalized Home Energy Reports.[2] The reports provide education and encourage the customer to save energy with behavioral changes (e.g., turning off lights or adjusting thermostats), upgrading home appliances, and improving their home's envelope (e.g., windows and insulation). Home Energy Reports are several-page letters with two key components: 1) Social Comparison Module that shows customers their energy use in comparison to their most efficient neighbors in similar households (the descriptive norm) and categorize the household as "great", "good", or "below average" (the injunctive norm) (Figure 1); 2) Action Steps Module that provides relevant energy conservation tips.

[2] www.opower.com

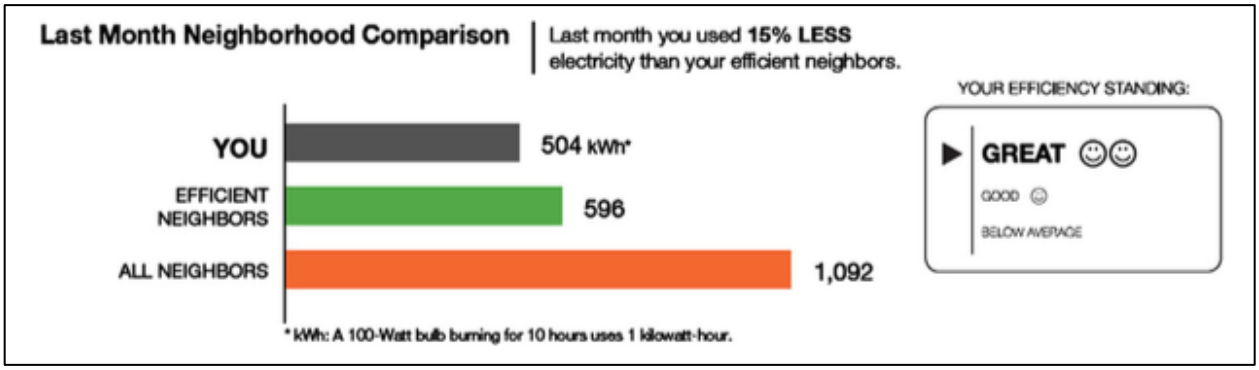


Figure 1. Example of Opower Home Energy Report (Allcott, 2011).

Most Opower Home Energy Report programs have been implemented in randomized control trials, which yield unbiased and robust estimates of electricity savings and provide credible evidence of program effects (Khawaja and Stewart, 2014). Allcott (2011) evaluated the series of Opower programs run before the end of 2009 this included nearly 600,000 households, constituting one of the largest randomized field experiments in history. These randomized control treatment designs, which rely on an opt-out option to allow customers to decline participation, include a treatment group who were mailed Home Energy Reports, and a Control group that did not receive HERs. Depending on the utility, HERs were mailed monthly, bimonthly, or quarterly. Some utilities opt to have letters sent each month for the first several months of the program with a decreasing frequency thereafter.

Two forms of attrition were noted, moving and opting out. The probability of moving over the life of each experiment ranged from 5% to 20%. Energy bills were not observed after the resident moved. The percentage of residents who opted–out ranged from .1% to 3.3%; the reasons cited included, comparisons were unfair or inaccurate or that the reports were a “waste of resources.” When participants opted out, their utility bills were still observed (Allcott, 2011).

Early studies indicate that after treatment begins, the treatment effects take several months to ramp up to something approximating a steady state, and Home Energy Reports appear to have constant or increasing effects as they are repeatedly delivered over the first two years of treatment. However, energy savings were found to persist if the stimulus that elicits the behavior (the HERs) continues. If the stimulus ceases, then savings decline substantially (Ehrhardt-Martinez et al., 2010).

Opower conducted a survey to determine what activities actually affected the decrease in energy usage. Asking customers in the Treatment group to self-report what they had changed as a result of receiving HERs, some reported adding weather-stripping, improving insulation or servicing their air conditioner. However, the most frequently reported changes included day-to-day behavioral modifications such as turning off the lights, unplugging electronics, and adjusting thermostats.

Behavior-Based Water Use Efficiency Programs

Water managers can benefit by incorporating lessons learned from the behavioral programs utilized by the energy sector. Behavioral water use efficiency is not readily understood by those outside the social sciences and differs from the standard approach of hard measures such as showerheads, faucet aerators, toilets, etc. that have dominated water conservation since the 1990's. This report provides examples of vendor designed messaging programs some of which require extensive data analytics, but also included is an example of an effective behavioral program that had a single, one-time message.

Based on information from the energy sector, using behavioral messaging to reduce water use looks promising. Water utilities have typically relied on providing customers with information usually found on their water bill. However, there are two reasons why the average water bill may not work for conservation: 1) Consumers do not generally understand water usage units (ccf) on water bills; and 2) Average water bills are low compared to other utility bills.[3] In a 2014 study, (Attari) participants were asked what unit of measure they are most comfortable identifying as a way of measuring water use. Approximately 73% of respondents stated gallons were their preferred metric when discussing water use, because "…most Americans make decisions about gallons of liquid nearly every day (e.g., buying gasoline or milk)."

Additionally, consumers tend to believe their water use is in alignment with the general population, but recent studies show most people's perceptions about how much water they use are incorrect (Allcott, 2011). When customers are shown a comparison, such as with social norm messaging, it resonates with them. In addition to this comparison element, social norms based programs reference the social norm that draws attention to accepted behaviors.[4]

Although customer water use messaging programs are relatively new to the water sector, recent pilot programs, such as WaterSmart Software's Home Water Reports, seem to indicate these programs may be effective. Once customers are shown their water use is out of alignment with their perceptions, and more importantly, similar households, they are motivated to make changes. This echoes the findings from Allcott (2011) that suggest untreated households believe their energy usage is closer to the norm than it actually is; and treatment causes households to update their beliefs about social norms. In other words, when consumers are shown that their energy use is outside the "norm" they will make changes to their consumption.

Behavior-based water use efficiency forms the basis for programs such as WaterSmart Software's Home Water Reports. This design of behavior-based conservation programs relies on the same research behind Opower's Home Energy Reports, (i.e., when customers are shown their water use compared to their similar neighbors, they tend to be motivated to conserve).

[3] Dominique Gomez, AWE Webinar, November 18, 2014
[4] Ibid

Messaging Programs in the Water Sector

Messaging programs focus on customers reacting to information that is of interest to them in a way that influences their mindset, prior assumptions/habits, etc. (Ignelzi et al., 2013). Research for this report found a handful of vendor-designed water use messaging programs currently available as well as some non-vendor designed pilot programs. The technologies used in these programs have the goal of engaging the customer and encouraging them to be active participants in the management of water use.

WaterSmart Software's Home Water Reports, modeled after Opower's Home Energy Reports, is currently the most prevalent in the water industry; however, other types of programs that employ behavioral approaches also exist. The use of data analytics (collecting, organizing, and analyzing data to discover patterns) is what makes social norms based efficiency programs different from what has previously been used for water conservation. Although there are various types of messaging as previously discussed, this report focused on social norms and comparison.

Table 1. Customer Water Use Messaging Programs in the Water Sector

Program Name	Social Norms	Data Analytics	Random Control Trials	Average Cost	Interactive Portal
WaterSmart Software Home Water Reports	Yes	Yes	Yes	$1-$6 per household	Yes
Alliance for Water Efficiency Home Water Calculator	Yes	Yes	No	Free to AWE members	Yes
MuniApp for Water Utilities	No	No	No	$7,500-$15,000	Yes
DropCountr	Yes	Yes	Yes	$10,000	Yes
Droplet Technologies	Yes	Yes	No	$15,000-$30,000	Yes
North Marin Water District	Yes	No	No	N/A	No
Cobb County Water Systems	Yes	Yes	Yes	N/A	No

WaterSmart Software Home Water Reports

By combining behavioral psychology, big data analytics, and cloud computing, WaterSmart Software seeks to assist water utilities to better educate their customers about how much water they are using. WaterSmart Software has the ability to collect large amounts of water consumption data that provides the opportunity to offer customized, water-saving

recommendations and targeted communications regarding investments, incentives, or other important utility messages.[5]

WaterSmart Software currently contracts with 32 water agencies throughout the United States, mostly in the Southwest. Home Water Reports (HWRs) (Figure 2) provide residential customers with information about their household water use, including:

- Their current water use compared to their past water use
- Average water use of similar households
- Average water use of the most-efficient similar households

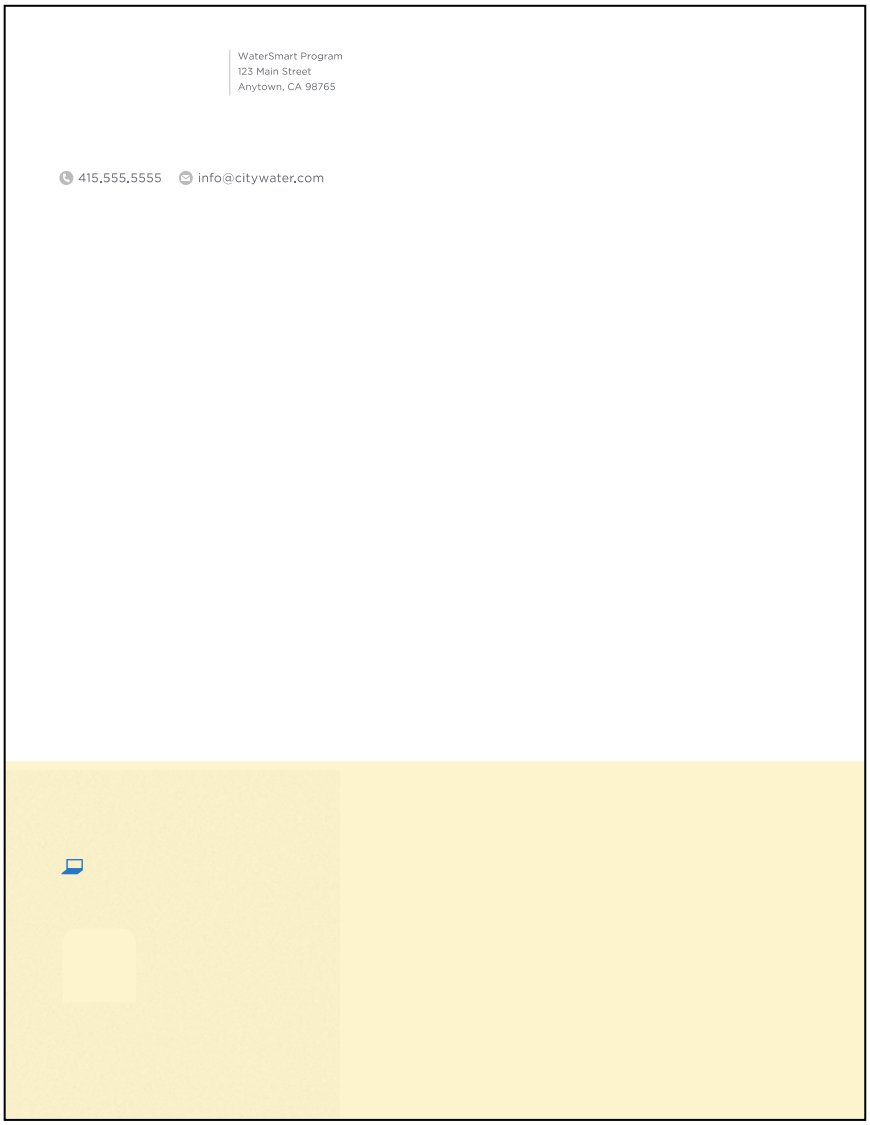


Figure 2. Example of WaterSmart Software Home Water Report (www.watersmart.com)

[5] www.watersmart.com

Based on consumption data and property assessment records, the goal of the personalized reports is to motivate and enable customers to use water more efficiently.

Approximately 1-2% of customers receiving WaterSmart Software Home Water Reports call their water provider. These calls are generally a result of customer's disbelief of their water use.[6] This coincides with studies that show customers tend to underestimate their water use (Attari 2014). These types of calls tend to taper off after about 60 days. However, WaterSmart Software trains the water agency call center staff on what types of questions to expect from customers receiving HWRs for the first time, and how to respond to questions about the reports. To help alleviate high call volumes, depending upon the number of reports being sent by the water agency, the schedule of reports being sent out is rotated.

Successful implementation of WaterSmart Software does not require the water purveyor to have Automated Metering Infrastructure (AMI). However, agencies with AMI technology can offer their customers greater disaggregated data and analytics. For example, automatic leak detection is possible, outdoor water use, and individual appliance (i.e., toilet, faucet, dishwasher, etc.) can be more easily identified. Approximately 10% of water purveyors utilizing WaterSmart Software have AMI, which parallels the percentage of AMI across the water industry.

Home Water Reports are delivered via mail or email, depending upon the water agencies access to email addresses and customer preference. Currently, customers are not provided with the opportunity to choose delivery method of HWRs. A random sample is selected for treatment and electronic reports are delivered if email addresses are available. WaterSmart Software studies have found an approximately one-half percent difference in water savings based on the two delivery methods; with paper reports providing a slightly higher rate of water savings.

Formatting for Home Water Reports is standard but does offer some level of customization. The water purveyor determines the recommendations that are included in the report, the frequency of reports, and any additional messaging to customers. The HWRs are designed to move consumers along in complexity. For example, the first set of reports begin with simple messaging and recommendations, as the consumer engages more with the Program, the messaging becomes more specific and interactive. Customers can report back on recommendations they plan to implement and then report on actions, based on the recommendations, they have completed. This interaction allows for more complex recommendations, which can include a variety of indoor and outdoor water use behaviors and devices, suggestions on when to water, turf replacement and installation of native species.

WaterSmart Software provides both web based and mobile customer Portals for a more detailed analysis of water use and water-saving recommendations. Approximately 30-35% of customers take advantage of this feature. Customers are invited to log on and revise their household data for more accurate savings and usage estimates.

The water utility Dashboard serves as an engagement platform where all communication with customers can be recorded. The Dashboard also allows the utility to "push" messaging to

[6] Jeff Lipton, personal communication, November 25, 2014

customers. These push messages can go beyond water efficiency and provide customers with whatever types of messages the utility needs to convey.

Early studies show that WaterSmart Software seems to be a relatively low cost option for water efficiency. Initial savings for customers receiving HWRs compared to those who do not is 5% reduction in water use. In general, more affluent households use more water and also demonstrate higher savings levels, however the numbers vary from region to region and additional studies are needed.[7] Customers who receive HWRs are three times more likely to engage in other water agency programs, and 70% of homes that receive communication through HWRs reduce their water use.[8]

With avoided energy and water costs, the financial benefit to the water utility is important, providing water agencies with the potential to downsize their infrastructure and extend the life of their system. The cost of the WaterSmart Software HWRs depends upon the features and the implementation design selected by the water utility. Determining the number of customers reached is based on the water utility's needs and budgets. The EBMUD program followed a typical pattern, with an initial small roll out and then expansion of the program to more customers.

East Bay Municipal Utility District (EBMUD) WaterSmart Software Pilot Program

The East Bay Municipal Utility District's (EBMUD) year-long WaterSmart Pilot program was the first relatively large-scale Social Norms Based (SNB) efficiency program implemented by a large urban water utility. Funded by the California Water Foundation and WaterSmart Software, the Pilot was developed as a controlled experiment including an independent evaluation. Having identified leveraging information and communication technology to provide water management services as a long-term strategy for water conservation in their 2011 Water Conservation Master Plan, when presented with the opportunity to participate in this Pilot study, EBMUD saw an opportunity to try something new. [9]

WaterSmart Software Home Water Reports (HWRs) are customized reports similar to Opower Home Energy Reports. WaterSmart Software utilized existing EBMUD water use and customer data (i.e., household attributes such as yard size and number of occupants) to create individualized reports. The HWRs track customers' water use, provide comparisons to other similar users, and recommend tips to conserve. Reports were delivered to customers via mail or electronically on a bi-monthly basis to coincide with billing cycles (Mitchell et al., 2013).

From June 2012 through June 2013, approximately 10,000 homes in EBMUD service territory were provided Home Water Reports. The pilot was comprised of two experiments: the Random Group, which represented EBMUD's overall service area; and the Castro Valley Group, a more homogenous selection (Table 2). The goal of this experimental design was to explore whether

[7] Jeff Lipton, personal communication, April 9, 2015
[8] Dominique Gomez, AWE Webinar, November 18, 2014
[9] Mike Hazinski, personal communication, December 9, 2014

treatment effects differed when HWRs were provided to an entire community with similar characteristics as opposed to randomly selected households across a service area (Mitchell et al., 2013).

In both the Random Group Experiment and the Castro Valley Group Experiment, households were selected to either a treatment group or a control group. Those in the treatment group received HWRs and those in the control group did not. For a detailed description of the EBMUD Pilot, please refer to *Evaluation of East Bay Municipal Utility District's Pilot of WaterSmart Home Water Reports* (Mitchell et al., December 2013).

Table 2. EBMUD WaterSmart Pilot

	Total Sampling Population	Size of Treatment Group	Size of Control Group
Random Group	3,286	1,710	1,576
Castro Valley Group	9,300	8,000	1,300

For the EBMUD Pilot, the Home Water Reports used injunctive norms to communicate to participating households how they were doing. As previously discussed, injunctive norms involve people's perceptions of what behaviors are approved of or disapproved of by others. For example, households that used less than the 20th percentile of their comparison group were told they were doing "Great", and received a smiley face emoticon. Households within the 20th to 55th percentiles were told they were doing "Good", and received an emoticon with a neutral expression. Households above the 55th percentiles were instructed to "Take Action" reinforced with an emoticon with a worried expression.

One of the primary questions the Pilot study sought to determine was, "Would this SNB efficiency program result in measurable water savings?"

Indeed, the Pilot study found measurable water savings in both experimental groups. Water savings achieved in the Random Group were 4.6% and water savings for the Castro Valley Group were 6.6%. This is important because it corroborates the results of WaterSmart estimates of 5% water savings.

The Pilot study also found water savings to be greater in the households with higher water use. Households in the top quartile of water use, saved on average, 1% more than other quartiles. This suggests that if a water agency does not plan to provide HWRs to all customers, they should focus on providing reports to the top water users.

Estimates for saved water ranged between $250 and $590 per acre-foot. According to the independent reviewers, even at the upper-end of cost ranges, the unit costs are less than the cost of most other water demand management and new water supply options which indicate SNB efficiency programs could provide very cost-effective water savings.

Also important to this study was to determine if water savings varied based on how reports were delivered. There are a number of considerations when determining whether to send customers paper or electronic HWRs, such as the cost of delivering paper or email reports, the availability of customer email addresses, and the avoided cost of saved water. This Pilot found that reports delivered on paper via mail saved about 1% of mean household use more than households receiving electronic reports delivered via email.

EBMUD acknowledges their Pilot needs to be implemented under a wider variety of conditions and therefore, this study may not be representative of statewide customers. As more SNB efficiency programs are developed and studied, a better understanding of achieved savings statewide will emerge. Additionally, further studies will raise confidence in the methodology.

The Pilot also focused on two additional questions:

1. Would households receiving HWRs be more likely to participate in additional water agency programs?

    a. The Pilot study determined that households receiving HWRs were 6.2 times more likely to participate in audit programs and 1.7 times more likely to participate in rebate programs than those households not receiving reports.

2. Did receiving Home Water Reports increase customer knowledge and awareness of water consumption and efficiency?

    a. Although households that received HWRs viewed them as providing useful information on how to use water efficiently, the reports did not seem to improve the household's knowledge about how much water they actually use. The tendency to underestimate daily water use was the same between control and treatment groups. Because the treatment group saved water, this finding suggests that the ability to accurately quantify water use is independent of behavioral changes that result in water savings.

Providing customers with more and sustained water use information may eventually help customers come to a better understanding of their actual water use. Utilizing the Customer Portal may be one tool to accomplish this. The WaterSmart Software program gives customers the option of logging on to the Customer Portal, an interactive tool that allows customers to input and make any appropriate changes to their household data. When the customer updates household data, a revised comparison report is generated. The customer can also report water conservation actions they have taken, plan to take or actions they do not plan to take. This allows for greater customization in the recommendations to these customers. Over 10% of the customers in the Pilot who received Home Water Reports logged on to the customer portal. EBMUD would like to drive that percentage up, and the now-available mobile version of the Customer Portal may be a new tool to accomplish that.

Utilizing software services is a new way of doing business for water purveyors and EBMUD had to extensively modify an existing contract template provisions for the sensitivity of the data

transfer and intellectual property protections required for this Pilot program. Just as it is to all utilities, ensuring the security of customer data was critical, and EBMUD's data security review and a third party security assessment added months to the program launch. Once contracts were in place, there was an initial one-time data dump to WaterSmart Software of all EBMUD's 325,000 single-family customers. Each business day, metered consumption data for approximately 8,000 single-family households is uploaded to WaterSmart Software, providing an on-going data feed.

Another challenge to utilizing software services is incorporating the software company's outreach materials with existing water agency branding and collateral materials, to ensure consistency. EBMUD wanted to make certain that all materials appeared to come directly from the water agency. Although the content of the WaterSmart Home Water Reports is customizable (i.e., recommendations and messaging to the customer is determined by the water agency), the formatting of reports is standard. Therefore, there were limits to how customizable the HWRs could be.

Accompanying the WaterSmart Software is the Water Utility Dashboard tool, an online utility-facing interface. Program analytics allow the District to track program performance including water savings analysis, changes in water use, top water users and spikes in water use that may indicate leaks. The Dashboard allows tracking of all customer activity and provides a picture of each customer's water consumption. EBMUD was able to track all communication with customers, including calls and emails. Having a variety of functionalities, the Dashboard was reported to be quite useful.[10]

East Bay Municipal Utility District found that this Social Norms Based efficiency program elicited reactions from customers and not all reactions were positive. The District reported that there were some customer calls as a result of receiving HWRs, but relatively few. These calls were typically a result of the injunctive norms; customers generally feel like they use the right amount of water and being told they use more than similar households can create a negative reaction. Customers are given the opportunity to opt out of receiving HWRs and the opt out rate was less than one percent.

For future programs, EBMUD will look for ways to maximize the benefit of messaging customers while minimizing the negative responses. EBMUD plans to expand the SNB efficiency program experiment to various groups of customers with different norm messaging, eliminating the use of injunctive norms to certain groups in the first messaging.

Social Norms Based efficiency programs are a new way to engage customers. For resource conservation it is an evolving product and science, but early studies show SNB efficiency programs may prove to be a relatively low cost intervention to reach a large number of customers. Using automated messaging allows for more engagement with customers; and EBMUD feels it could eventually become a resource for customers. The Customer Portal could allow customers to manage their water use by being able to frequently check in on their water consumption.

[10] Mike Hazinski, personal communication, December 9, 2014

"Leveraging information and communication technology responds to how people expect to get information now."[11]

Alliance for Water Efficiency Home Water Calculator

The Alliance for Water Efficiency (AWE) offers members free basic access to their Home Water Calculator. Designed for single-family residential water use calculations, customers of member agencies can log onto the calculator and answer four simple questions to launch the calculator. Customers can then work their way through the application to refine their estimates for household water usage. Indoor water usage calculations are based on information from the Residential End Uses Study conducted by the Water Research Foundation and the answers provided by the customer, such as number of people in the household, and the year the home was built. Outdoor water needs and projected use are calculated with evapotranspiration data from the United States Geological Survey. When the customer enters their zip code, information on outdoor water use is pulled from the database of zip codes within the calculator.

After the customer answers a series of questions, they are provided an output report that can be very specific if the customer answers all the questions. The calculator compares the customer to average as well as efficient homes in their zip code. The report also includes various tips on water efficiency based on the answers provided in the calculator.

Water agencies have the option of customizing the Home Water Calculator to allow for more robust and accurate information to the water consumer. Customization includes AWE member name and logo on the calculator as well as hosting service and updated ET data for the zip codes within the member agency service territory. Tips to rebates and links specific to the water agency are also provided to the user. Google analytics helps the member water agency determine how many customers are using the calculator in their service territory, provide for more in-depth integration with billing data, and provide more customization of any water agency data they are interested in incorporating into the calculator. The customization option gives the look and feel of being on the water agency website and makes it easier for the customer to stay on the water agency website after visiting the calculator.

The Home Water Calculator is free to Alliance for Water Efficiency members, but if a water purveyor chooses to customize the application, there is a one-time customization fee of $9,500 and a $6,000 annual calculator licensing and hosting fee.[12]

The Alliance for Water Efficiency has a variety of ideas for how this calculator can tie in to other efficiency programs. With customization, a water agency could design a neighborhood competition, school or classroom competitions, or use it as a first step in offering retrofit incentives or prizes. One example of how a water utility can utilize the Home Water Calculator is the Region of Waterloo, Ontario, Canada.

[11] Ibid
[12] www.a4we.org/webinars/aspx

The Region of Waterloo (includes the cities of Cambridge, Kitchener and Waterloo) in Ontario, Canada is utilizing the Home Water Calculator as a first step for their self-designed Pilot program scheduled to launch in Spring 2015. The Pilot will include direct water use messaging to customers. The program will encourage highest water users to log on to the Home Water Calculator and complete the self-audit. Direct mail letters informing customers about their water use compared to the neighbors, their city, and the region as well as tips for conserving water will follow. Highest per capita users will qualify for a home consultation from water agency staff. The goal for the Region of Waterloo is to bring per capita water use down to 43.6 US gpd by the year 2025.[13]

MuniApp for Water Utilities

Specifically designed to function on a mobile device, mobile applications may be considered the next technological advancement in customer convenience. "The essence of a mobile app is to take the information and functionality the utility currently makes available to its customers on its website and to reconfigure it to a more user-friendly visual and functional experience, specifically adapted for the mobile environment" (A. Soviero 2014).

MuniApp for Water Utilities is a mobile application that allows simple, but adaptable two-way communication between the water provider and the customer, and is currently in use in the Florida cities of Lake Worth, and North Miami.

Utilizing the same information that the water customer sees on the website, MuniApp provides that information to the customer via the mobile app. The mobile app does not require direct access to water agency's customer data, rather, MuniApp provides the data that is presented on the water agency's website customer account display to the mobile device. The advantage of the mobile app is that it provides information to the customer on the go and much sooner than their bill can. Although AMI is not necessary to utilize MuniApp, if the water agency has AMI, the customer can receive daily meter reads.[14]

An advantage for the water agency is the mobile app's ability for quick communication via "push" notifications. For example, push notifications can inform customers that their bill is available, provide reminder notices of upcoming bill due dates, permissible outdoor watering days, service disruption notices, etc. These push notifications are customized and directed though a dashboard provided by MuniApp. The push notifications can be to an individual customer, all of the customers on a street or to specific geographic regions within the agency's service territory.

After downloading the app, the customer uses their online username and password to logon to the mobile application. The water provider logo and four buttons appear on the homepage:

[13] Steve Gombos, personal communication, December 28, 2014
[14] DJ Soviero, personal communication, November 25, 2014

1. Current Balance – allows the customer to see their current bill and make payments.

2. Consumption History – shown as a bar chart and is preset to one year of billing history. If more usage history is available, the customer is given the option to change the parameters of how much consumption history they see.

3. Settings – provides history of utility push notifications to customers, language choice and feedback to MuniApp.

4. Report a Problem – Connects the customer directly to preset email recipients at the water agency and provides a direct dial to present the agency's customer service phone number.

Figure 3: MuniApp (www.muniapp.net)

Templates are available to help customers monitor their consumption and develop consumption targets. Notifications can be generated when customers are reaching their targets.

The main features of the mobile app are shown below (Table 3), for more detailed information visit www.muniapp.net.

Table 3. Features of MuniApp's Mobile Application

Feature	*Water Agency Perspective*	*Customer Perspective*
Revenue	Sends statements, late payment and shutoff notifications.	Receive and view bills, provides mobile payment options.
Resource	Notify customers of permissible watering days, high consumption, usage restrictions.	Displays usage data, calculates target reductions.
Communication	Provide consumption data and other custom notifications to customers to guide usage.	Constant/immediate way for customer to contact water provider.

MuniApp recently developed a program called MuniApp Direct for the City and County of Sao Paolo, Brazil in which the customer can monitor their usage without the utilities involvement. MuniApp Direct will show customers how to locate and read their meter and allow customers to choose the consumption reporting periods to better monitor usage.

MuniApp is currently seeking a water agency in California willing to Beta test the mobile application. Steps for water agency implementation include:[15]

[15] Anthony Soviero, personal communication, January 6, 2015.

- MuniApp demonstration
- Four-page licensing agreement
- MuniApp available for download by customers (approximately 3-6 weeks)
- One hour training session for water agency personnel to learn how to utilize the Dashboard
- Annual licensing agreement and fee is required
- Application maintained on vendor server, not on utilities server

Dropcountr

Dropcountr is a mobile and web application water management system that helps utilities and customers understand and better manage their water. The Dropcountr mobile app, which can be downloaded to a customer's mobile device, makes clear how many gallons of water the customer uses and puts it into a social context, comparing the customer's water use to average water use as well as similar households.

After downloading the mobile application, the customer logs on and is asked a series of questions that helps build the customer profile and provides an email address for the utility. This customer profile, which includes such information as the number of people living in the home, and the number of bathrooms, is used to develop a customized water budget. Customers are also provided actionable items to help them meet their water budget and compare them to similar profiles.

For the water utility, Dropcountr CLEAR is a meter data management tool that aggregates customer data so the utility can easily see high use customers, trends in water use, customers who have participated in rebates, etc. This information allows the utility to "message" their customers appropriately based on the applicable message or information for a particular customer, for example bill pay, rebates, water restriction and emergency messages are sent and received instantly.[16] These messages are sent through email or "push" notifications. Dropcountr helps utilities deliver customized drought and water budget messages instantly. Push notifications can also alert the customer to any abnormal water usage that may indicate leaks.

Dropcountr currently has two California water utilities signed on for one-year pilot programs. The City of Folsom will target high water users, whereas, Purissima Hills Water District (Los Altos Hills) will be providing the application to all customers. After the one year pilot, Dropcountr will conduct customer satisfaction surveys, and monitor whether this program is successful in helping drive customers to other utility programs.

Dropcountr is offering a standard four-month pilot to interested utilities. The flat fee for this pilot is $10,000 and includes the app, monthly home water reports to 5,000 customers via email, and emails or push notifications regarding available rebates, incentives or other water agency programs. In this scenario, if the utility has 30,000 customers, 5,000 customers will be the test

[16] www.dropcountr.com

group and 25,000 will constitute the control group. They can also send varying messages and test the impact each type of messaging has on customer behaviors.

The goal is to provide transparency for the customer, helping them better understand their water usage and what programs and information are available to them. The goal for the water agency is to save staff resources. Customer service calls can be reduced regarding bill questions, and driving customers to online billing saves the water utility money.
There is approximately a two-week turnaround after contracts are signed for the water agency to launch Dropcountr. The water utility provides as much data as it has available to Dropcountr's secure servers and they will utilize that data for analytics. Dropcountr will work with water utility staff to customize the outreach materials that are sent to the customers. By email or direct mail, customers will be notified once or twice prior to program launch, and again after launch to encourage household enrollment in the program.[17]

Droplet Technologies

Droplet Technologies works with water agencies in an effort to conduct conservation programs in the most effective way. With their "Reach Across the Meter" philosophy, they aim to assist water utilities to engage their customers, turning them into partners in the management of water.

In addition to providing turnkey platforms for programs such as Turf Replacement, rebates, vouchers and efficiency evaluations, Droplet Technologies makes available to water utilities licensed software with a monthly fee. The software, which has elements that are customizable, allows Droplet Technologies to be as adaptable as possible to meet the needs of the water agency.

The software provides customers with a portal capable of providing both social norms based messaging and water budget messaging. Customers can communicate valuable information with the water agency, such as number of persons per household, total irrigated area and steps toward efficiency. Customers can also view their current and historical use as compared to a water budget or allocation-based rate structure, as well as similar customers in their area. The Portal offers a full spectrum of social norms based messaging that is optionally integrated with water budget information. The more granular the data, the more accurate the social norms messaging will be. In addition, the information input by the customer and agency, allows the software to drive customers to programs most likely to benefit the customer.

Depending upon the water agency, billing information/meter reads are uploaded either in real time, weekly, or monthly. When collecting data from water utilities there is always concern with confidentiality and level of security, Droplet Technologies security meets and exceeds all federal guidelines.

Droplet Technologies is currently working with five large wholesale water agencies including California Water Service, California American Water, Western Municipal Water District,

[17] Dustin Cady, personal communication, December 9, 2014.

Golden State Water Company, and Castaic Lake Water Agency. Each of these agencies may be utilizing a different aspect of the services offered by Droplet Technologies.

Average cost for programs ranges from $15,000 to $30,000 per year. The on-boarding process is approximately 1-2 months.[18]

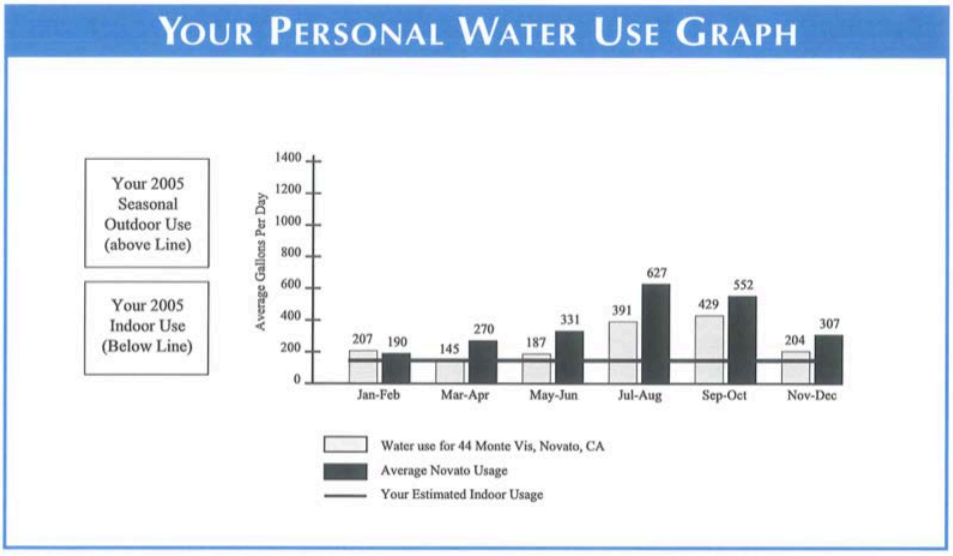
Non-Vendor Implemented Programs

Recognizing that not all water utilities have the budget to incorporate vendor-designed programs into their suite of conservation programs, we felt it important to highlight a self-designed program and opportunities where water utilities may partner with academia.

North Marin Water District

North Marin Water District (NMWD), a small agency with 21,000 accounts located in northern California, utilized comparison messaging as early as 2000. Included in their newsletter to customers was an element comparing customer water use to an "average home" in their service territory (Figure 3). This messaging also pointed out when water use was considered "out of line" with the norm. In 2009 NMWD ceased mailing this information to customers in an effort to reduce the size of the newsletter and save on printing and mailing costs. They continue to provide messaging on water bills comparing the previous two years of water use, and the information is now available online.

North Marin Water District did not conduct any controlled studies to prove water savings from this type of messaging.[19]



[18] Jon Daniel & Ken Pollard, personal communication, December 10, 2014
[19] Ryan Grisso, personal communication, February 17, 2015

Figure 4. Example of North Marin Water District Water Use Graph (www.nmwd.com)

Research seems to suggest academia has an interest in studying the potential for behavioral nudges, and these studies are becoming more numerous. Nudges can help biased individuals make "better" decisions without impacting unbiased people. Considering that biases may also exist as a result of inattention, low-cost interventions, such as nudges, can help consumers make optimal choices. A few examples include:

- Cobb County Water Systems/Georgia State University
- E2eProject, Hunt Allcott, Department of Economics, NYU and Judd Kessler, Wharton Business School
- Water Conservation and Spatial Peer Effects, Alrwais, O., Capra, M., Hilton, B., Park, J. and Rustamov, G. Department of Economics, Claremont Graduate University.
- University of California Merced Water Battle
- Irvine Ranch Water District/University of California Irvine Water Battle

Cobb County Water System

In the midst of an extreme drought in 2007, Cobb County, Georgia sought ways to educate their customers in an effort to reduce water consumption. In conjunction with Georgia State University, Cobb County Water System (CCWS), an agency of the county government that distributes water to approximately 170,000 residential customers, implemented a randomized control trial in which households were assigned into one of four treatment groups. The goal of the program was to assess the impacts of different conservation messages on residential water use.

CCWS staff determined that if the messaging could reduce water consumption by 2% during the 2007 summer water season (June-September), it would be deemed cost-effective.

The program design utilized a one-time mailing on CCWS letterhead to single-family, detached households. Customers were randomly selected to receive one of the following three treatments:

1. Technical advice - provided households with an "information only" message that listed ways to reduce water use (Appendix A)
2. Weak social norm message – augmented Treatment 1 and asked customers to act on the enclosed tip sheet and "do their part" to protect the region's water resources.
3. Strong social norm message – augmented Treatment 2 with a comparison of the household's water use to the median county household water use for a five-month period and included the percentile in which the household fell during this period. For example, it stated their consumption compared to their average neighbors consumption (Figure 4).

Your own total consumption June to October 2006:	**52,000 gallons**
Your neighbors' average (median) consumption June to October 2006:	*35,000 gallons*
You consumed more water than 73% of your Cobb County neighbors.	

Figure 5. Example of CCWS Strong Social Norm Message (Ferraro, P.J. & Price, M.K., 2009).

Each treatment group consisted of approximately 11,700 households. The remaining customers (approximately 71,600 households) received no treatment and constituted the Control group. Water bills were evaluated during and after the message delivery months. The results found that households receiving the weak social norm message reduced summer water consumption by approximately 2.7%, and households receiving the strong social norm message reduced water use by 4.8% compared to households in the control group. Ferraro et al., (2009) found that the effects of the two norm-based messages were immediately detectable the month after treatment, and up to four months after the treatment. They further report that by December 2007, there was no detectable effect from the weak social norm message, but the strong social norm message's treatment effect could still be detected in summer of 2009, two years after the message was delivered (Ferraro et al., 2013).

A study of the longer-term impacts of this normative messaging program found treatment effects persisted four years after the messages were sent. This has an impact on the cost effectiveness of the program and can help draw conclusions about the treatment effects. In 2007, CCWS felt the program was cost effective around $0.58 per thousand gallons saved. With the persistence of the effects detected in this longer term study, the cost per thousand gallons reduced is more than 50% lower ($0.28 per thousand gallons reduced) (Bernedo et al., 2013).

Bernedo et al., (2013) assert their analysis provides some evidence that persistence in the treatment effects from normative messaging that includes social comparisons reflect habit formation. This assertion is based on their observance of non-detectable treatment effects in treated households where the treated customers have moved. Because they compare households where treated customers have moved to households where treated customers have not moved (name on the water bill stayed the same over the four year study period), they assert that the savings can be attributed to the creation of new habits or adoption of mobile technologies rather than changes to capital stock in the home.

> "*The treatment effect disappears when the treated customers disappear.*" (Bernedo et al., 2013)

CCWS was surprised and unprepared for the reactions from customers receiving Treatment 3 with the strong social norm message. Although it was not an evaluative measure of the customers' water use, rather it simply stated how much water they used compared to what their neighbors used. Customers that phoned felt CCWS should have phrased the message in a more positive way. For example, if the letter stated "You use 50% more water than your most efficient neighbor", customers wanted the water provider to state it more positively; "You use 50% less

water than your less-efficient neighbors." CCWS received the most feedback calls from the most efficient customers, as they felt insulted and "called-out" by the water utility. The volume of calls was such that CCWS set up a hotline so calls went to the GSU professors, as the utility couldn't field them all. This was a one-time mailing (not on-going), so the calls lasted only one month.[20]

CCWS stated this SNB messaging program got customers attention and resulted in water savings beyond any previous program. If they were faced with another serious drought, they would certainly utilize this type of conservation program again, realizing today's customers may not have as strong of a reaction to the messaging as they did in 2007 because they are more accustomed to receiving this type of comparison messaging from electric utilities and in general, have more access to usage information. Today's environment may evoke a different response because customers have more information now.[21]

It is important to note that the treatment effects associated with the strong social norm message for this example are most likely being realized through changes in outdoor watering. CCWS customers do not generally have in-ground automatic sprinkler systems, so it may be difficult to parallel these savings for California or the western US in general (Ferraro et al., 2013).

University of California Merced Water Battle

In 2010 Martin Figueroa, a student at UC Merced, thought it strange there were energy competitions on campus, but no focus on water conservation. With help from campus leaders, Figueroa partnered with a start-up company to develop an online water-monitoring dashboard that incorporated social networks, educational concepts and real-time water use and introduced the UC Merced Water Battle. Using Aquacue's Barnacles, small electronic devices that attach to water meters, provides the opportunity for students to monitor real-time water use, accessible from the Internet.

During the month long competition, students are encouraged through behavioral messaging to take shorter showers, flush less, wash only full loads of laundry and not to let the faucet run. The messaging includes posters, flyers, a Facebook page, weekly meetings, etc.[22] The messaging behind the competition is designed to teach behaviors people can easily practice. In the 2013 competition, the residents saved 44,000 gallons just by changing their behaviors. The 2014 competition included a new dashboard allowing everyone to see which hall was saving the most water on any given day, how much water was saved overall, and whether the system had detected any leaks on campus that needed repairs (UC Merced, University News, October 1, 2014). This has become an annual competition on campus. Water savings are not tracked after the monthly competition ends.

Irvine Ranch Water District – UC Irvine Water Battle

[20] Kathy Nguyen, personal communication, January 7, 2015
[21] Ibid
[22] Taylor McAdam, personal communication, February 26, 2015

Using the model from UC Merced, Irvine Ranch Water District (IRWD) introduced the Water Battle program to UC Irvine in 2013. IRWD was interested in determining if using real-time water use data along with competition could produce long-term water savings. Using social media, email blasts and word of mouth help increase awareness about the competition.

IRWD and UCI shared the cost of installing individual dorm meters, which were approximately $40 per meter. Initial start-up time was considerable, including an agreement between the water district and the University, installation of the meters, Barnacle, and the dashboard. IRWD staff report having a "champion" on campus is critical to the success of the program. Although water use declined during the competition, IRWD did find the savings were not sustained after the competition ended.[23]

The E2e Project

As the incorporation of behavioral programs continues in the utility sector we can expect to see more pilot programs developed. One such example is: The E2eProject, "Using Opt-In Programs to Target Home Water Conservation: A Pilot Experiment." As described in the project plan, traditionally utilities have offered reports, such as Opower's Home Energy Reports, and WaterSmart Software's Home Water Reports, on an opt-out basis, this inevitably involves sending reports to many households that do not want to receive them. In this pilot, the authors seek to determine if customer satisfaction, targeting, and cost-effectiveness can be improved by utilizing an opt-in program instead.

This program design would begin with a population of at least 40,000 households, a control group of approximately 12,000, who would not receive reports, and a treatment group of approximately 26,000 would receive one or two "introductory" Home Water Reports introducing them to the program and its value, and include an opt-in card. If the household opts to continue receiving reports (six reports over the next year), they are asked to pay some small fee for receiving the report. The authors hypothesize that customers who are willing to pay for the reports may be more responsive to the information provided, perceive more value and feel more committed since they have paid for the reports (Allcott & Kessler, 2014). This pilot is currently being conducted with an energy utility, but the authors would like to work with a water utility as well.[24]

Water Conservation and Spatial Peer Effects in Turf Removal

This pilot study aims to examine the long-term impact of turf removal programs and whether the adoption of a native landscape by one household generates diffusion or contagion within a locality. That is, do neighbors mimic early adopters of turf removal programs? There is some evidence that diffusion matters in conservation. A 2014 study on the spatial and temporal patterns of diffusion of residential solar photovoltaic (PV) systems, concluded that the primary determinants of the observed patterns of diffusion of PV systems in Connecticut were peer effects. In other words, neighbors do mimic.

[23] Amy McNulty, personal communication, December 3, 2014
[24] Hunt Allcott, personal communication, January 16, 2015.

The authors believe there are important similarities between solar PV adoption and turf removal programs, the adoption of both are highly visible and consistent with evolving social norms. Using GIS data, the authors are interested in studying the spatiotemporal patterns of the adoption of native landscapes within neighborhoods in California. Determining whether or not patterns of diffusion are consistent with spatial peer effects, could lead to important implications for both policy and marketing of such conservation programs.

Short-term and Long-term Conservation Potential and Cost Effectiveness

Determining the conservation potential and cost effectiveness of behavioral programs in the water sector is difficult because it is a very new approach to water conservation. We can, however, look to the energy sector to draw conclusions about behavior-based conservation programs. Allcott, who has done extensive research on the topic, asserts that many of the lessons learned from energy savings studies would translate and be relevant for water too.[25]

There is a growing body of research exploring the effects of social comparisons on conservation, and results from these studies suggest "providing households with Home Energy Reports that include social comparisons leads to significant reductions in average monthly energy use." These comparison reports have been shown to produce an average of 2-3% reduction in energy use as they encourage those with above average energy usage to save (Ferraro et al., 2011). When evaluating HER programs it is important to recognize these programs can differ along a number of dimensions, such as:

- Type of fuel targeted for savings (electricity or natural gas)
- Program populations (e.g., high-energy users, electric-heat customers)
- Report frequency (the number of reports per home, per year)
- Duration of treatment (length of time since the first reports were received)
- Report contents (Khawaja and Stewart, 2014)

Khawaja and Stewart (2014) reviewed the savings from HER programs running three or more years, while customers were receiving reports (in-treatment savings) as well as after reports stopped (post-treatment savings). Electricity savings per home increased over the first three or four years of treatment relative to a control group.

Three savings phases became evident during treatment:

1. Savings increase rapidly during the first six to 12 months of program participation as utility customers assimilate HER information and begin to conserve energy.
2. Over the next 12 to 24 months, savings continue but at a lower rate than during the first 12 months (this is the period where customers start to form energy-savings habits).
3. In program years 3 and 4 savings maintain or increase at a very slow rate as customers continue to receive reports that reinforce conservation habits. "There is no evidence to

[25] Hunt Allcott, personal communication, January 15, 2015.

indicate that average savings decrease in later treatment years because customers tire of or stop paying attention to the reports."

Determining how long the effects of the messaging last (post-treatment savings) is an important measure of the cost effectiveness of HERs. In the absence of empirical results, energy analysts had assumed zero persistence of treatment effects, i.e., once messaging stopped, there would be no detectable effects of the treatment and thus, no more savings (Allcott & Rogers, 2014). The most common approach in the energy sector in determining cost-effectiveness is to apply a one-year effective life for each year households receive reports. Khawaja and Stewart (2014) argue this is a flawed approach as it ignores the fact that while savings decay (a reduction in savings relative to what occurred while participants received HERs), they do not end abruptly when reports stop.

A study of post-treatment savings from HERs sent for a six-month duration found the savings persisted for two months after the last treatment, then decreased significantly. Within five months of delivery of the final report, 83% of electricity savings had dissipated (Allcott, 2013). Additional research is necessary to fully understand the optimal program design for desired effects, however, the optimal program design may be to continue sending reports long enough for people to develop habits, then reduce the frequency with which reports are sent. If intervention stops after two years, consumers are not fully habituated and continued treatment still has substantial incremental effects (Allcott and Rogers, 2014).

In a review of HER programs running for three or more years Khawaja and Stewart (2014) summarized the findings from four separate post-treatment savings studies. Findings include:

1. HERs typically result in significant electricity savings. Opower Home Energy Reports have savings of 1.5% to 2.5% per year.
2. Electricity savings increase during treatment years one and two and then level off in subsequent years.
3. HERs continue to generate savings after households stop receiving reports.
4. Two types of savings can be identified during treatment: avoided savings decay and additional or new savings.
5. Accounting for post-treatment savings will improve program cost-effectiveness in the first and second year of the program.
6. For cost effectiveness estimates, utilities should apply a 20% savings decay rate per year.

Energy conservation programs are generally compared on a basis of program implementation cost per kilowatt-hour of electricity saved. Opower's Home Energy Reports have been reported to have cost-effectiveness ranging from 1.3 to 5.4 cents per kilowatt-hour which is comparable to traditional energy efficiency programs. A second comparison is to calculate the energy price changes that would induce the same changes in demand. Studies show the effects of sending Home Energy Reports are equivalent to an 11% to 20% short-run price increase or a 5% long run price increase. "Taken as a whole, these effects are remarkable: simply sending letters can significantly and cost-effectively affect energy use behaviors." (Allcott, 2011).

Recent studies suggest the persistence of savings effects is greater than initially thought. Studies from the energy sector provide some evidence that persistence in the treatment effects seen from social norms messaging that includes social comparisons reflect habit formation when the intervention continues long enough to provide customers the time to create new habits (Bernedo et al., 2013) (Allcott & Rogers, 2014). “Short treatment periods do not provide sufficient time for utility customers to form these habits” (Khawaja and Stewart, 2014).

However, analysis from the 2007 Cobb County Water System behavioral intervention program reports a surprisingly persistent effect even though households received only a single message. Researchers found the effect detectable four years after the intervention where savings were detectable suggesting the intervention worked through both short-lived behavioral adjustments as well as longer-lived adjustments to habits or physical capital (such as investments in new water saving technology (Bernedo, et al., 2013).

The persistence effect for the Cobb County Water System program increases cost-effectiveness of the program. The original estimate for the CCWS social norms program was $0.58 per thousand gallons reduced, but adjusting for the persistence of the intervention lowered the cost to $0.28 per thousand gallons saved. This represents for policy makers a low cost way to reduce residential water consumption (Bernedo, et al., 2013). When persistence of effects of the intervention is determined, the program was more cost-effective than previously expected and costs dropped by more than 50%.

Initial water savings estimates for East Bay Municipal Utility District’s WaterSmart Home Water Reports pilot program are approximately 5%. These savings equate to a unit cost of water saved ranging between $250 and $590 per acre-foot for reports delivered by email and between $290 and $570 per acre-foot for paper reports.

Statistical Reliability

Increasingly utilities have begun implementing behavior-based programs to elicit savings, instead of merely claiming savings. There are numerous studies in residential energy markets but water utilities have just started to implement and study these programs. As discussed throughout the paper, only a handful of programs provide statistical inference to the larger population and help understand consumption behavior. This is mainly due to a lack of proper guidelines for a randomized control trial (RCT) approach. “A program must have external validity so that its conclusions are transferable to the population at large” (Sergici and Faruqui, 2011). Considering the amount of time and resources invested in these programs, following the general principles of RCT approach would prevent possible waste.

Another approach providing a broader understanding of consumer’s consumption behavior is to have high frequency data or Automated Metering Infrastructure (AMI). The widespread use of AMI in the energy sector provides the opportunity for using more granular data and better analytics. The hourly, or even shorter, interval consumption data can provide important insights not only for program administrators, utilities, and regulations, but also consumers. As discussed

by Armel, et al. (2013), consumers would receive even further tailored feedback, and personalized recommendations about energy efficiency actions based on the consumers' behavioral patterns.

With only two studies available for behavior-based programs in the water sector, it is difficult to draw conclusions on the reliability of the data. Evidence from the Cobb County Water System's randomized control trial showed water savings when customers were provided a strong social norm message, as did the independent review of East Bay Municipal Utility District's Home Water Reports Pilot. Data gathered in this independent study was in line with WaterSmart Software's other studies. To have confidence in the statistical reliability of behavior-based programs will require additional randomized control trials and "…confidence in the data will come with time."[26]

[26] Ken Pollard, personal communication, December 10, 2014.

Conclusions and Recommendations

This paper reviews existing studies using behavior-based interventions and programs to motivate customers to reduce energy and water consumption. A diverse set of case studies is reviewed and the effectiveness of their methodology is assessed in order to determine which strategies are effective in changing behavior. This review paper is important and timely in its effort to consolidate the existing literature and provide recommendations for future study design, especially for water conservation programs. However, studies that lack RCT design could lead to biased outcomes and effects not being properly measured, preventing the opportunity to scale the outcome of the programs. Thus, the design of any behavior-based program or intervention for water utilities becomes very important. The traditional assumption that providing information would be sufficient to extract savings ignores cognitive limitation, decision heuristics and environmental factors. Studies from both energy and non-energy fields suggest that consumers have limited attention, time inconsistency and are affected by the social environment. For water purveyors there are underused behavioral factors that need to be investigated in order to better understand consumption behavior.

> "*Taken as a whole, these effects are remarkable: simply sending letters can significantly and cost-effectively affect energy use behaviors."* (Allcott, 2011)

Although more studies are needed, social norms messaging appears to be an effective tool for moving consumers toward conservation of resources, especially when a comparison is made between the consumer and their closest neighbors. The interventions, in the form of Home Water Reports or similar mailings, motivate customers to change their behaviors. The messaging, however, must be presented in terms that are easily understood and provide recommendations that are easy to implement, quantifiable, and contain a limited number of choices. Water agencies may consider how to include a comparison message, such as that used in the Cobb County Water Systems program, on their monthly water bills as a way to "nudge" consumers to save water.

Cost effectiveness studies seem to suggest that social norms messaging programs, when done with the right treatment time frames, can reduce energy and water use, and are cost effective. However, generally "these programs are often evaluated in one-year cycles, where the program costs for that year are compared to econometric estimates of energy conserved in that year" (Allcott and Rogers, 2014). These estimates ignore the possible diffusion effect or spillover effect to the following year(s).

With a larger customer base, the energy sector can more economically utilize vendor implemented behavior programs, but for the water sector, where small water purveyors are common, vendor implemented programs may be cost-prohibitive. Economies of scale could be utilized by partnering with surrounding water agencies to employ programs such as WaterSmart Software Home Water Reports or other programs mentioned in this report. There are, however, opportunities for water purveyors to collaborate with universities to design and deliver social norms based messaging programs. When designing water use messaging to deliver conservation messages to customers, it makes more sense to employ "…social science research and theory rather than business communicators' hunches, lay theories, or best guesses in crafting persuasive appeals." (Goldstein, et al., 2008).

Opower has conducted surveys across the U.S. and internationally and have discovered what they call "The Five Universal Truths about Energy Consumers". [27]

1. Utilities are not meeting customer expectations
2. Everyone wants lower bills
3. People look to utilities for energy information
4. Customers value personalized energy insights
5. Everyone wants to know how they measure up

Assuming these Five Universal Truths apply to water consumers as well as energy consumers, providing information such as Home Water Reports, or other comparison data is a potentially powerful tool for the water sector. In addition to providing information on comparison use, these messaging programs go beyond unidirectional transfer of information and passive recipients and seek to foster a relationship between the utility and the customer in hopes that deeper and more regular interactions occur and that customers are more willing to participate in other utility programs (Mazur-Stommen & Farley, 2013).

Customer water use messaging with a social norm component represents an opportunity for water purveyors to provide information to customers that helps them recognize if their use is in line with the average water use for similar households. Recognizing that people want to do what is "normal" these behavioral nudges can be effective in reducing water use.

[27] www.opower.com/fivetruths

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Appendix

Appendix A: Cobb County Water Systems Tip Sheet

Simple Ways to Reduce Water Consumption

Outdoor Water Use

Did You Know?
In summer, household water use can double. Reducing outdoor water use is easy, better for your yard, and can be done without making big changes to your yard or lifestyle.

- **Fix leaking sprinklers, spigots and hoses.** One broken sprinkler can use an additional 100 gallons in a typical 10 minute watering cycle.
- **Raise your lawn mower blade to at least 3 inches.** This encourages grass roots to grow deeper, shades the roots and holds soil moisture better than a closely clipped lawn.
- **Water your lawn with only one inch of water every seven to ten days** (less often if we've had rain). Overwatered lawns and plants grow shallow roots and are more likely to die in periods of drought.
- **Don't water between 10 am and midnight.** The water evaporates before plants can use it.
- **Use a low-flow nozzle on your hose.** Using a standard nozzle on your hose to wash your car or plants can require hundreds of gallons more water than a low-flow nozzle.
- **Mulch!** Using pine straw, bark chips or ground hardwood mulch on the roots of plants and trees helps the soil retain water.
- **Use plants appropriate for our climate.** Ask your local nursery about drought-tolerant plants and trees appropriate for Georgia. See next page for more information.
- **Do not use a hose to clean your driveway or sidewalk.** Use a broom instead and save hundreds of gallons of water.

Toilets, Faucets, Showers and Washing Machines

Did You Know?
A showerhead or faucet leak of one drop per second adds up to 2,700 gallons/year!

- **Fix toilet leaks:** This can save you thousands of gallons of water each year!
- **Turn off the bathroom faucets when brushing and shaving:** Save up to 3,000 gallons/year!
- **Don't use your toilet as a wastebasket.**
- **Replace your old toilet.** If you have a pre-1993 toilet, you can save more than 16,000 gallons per year by purchasing a high-efficiency model (1.3 - 1.6 gallons per flush). Unlike the first generation of low-flow toilets, new models reduce water use without sacrificing performance.
- **Replace your old faucets and showerheads.** High-efficiency sink faucets (1.5 gallons per minute or less) and accessories (like aerators) can reduce this standard flow by more than 30 percent without sacrificing performance.
- **Take short showers rather than baths:** Taking a five-minute shower uses 10 to 25 gallons as opposed to 30 – 70 gallons for a bath. If you take a bath, stopper the drain immediately and adjust the temperature as you fill the tub.
- **Run full laundry loads** or use the appropriate load size selection on the machine.
- **When you replace your old washing machine, purchase a high-efficiency washing machine** that uses less than 27 gallons of water per load.

Everywhere You Look, You'll Find Another Easy Way to Reduce Water Consumption

Detecting Hidden Leaks

To detect hidden leaks:

- Read your water meter before and after a two-hour period when no water is being used. If the meter does not read exactly the same, you probably have a leak. To download a guide to reading your meter, please visit water.cobbcountyga.gov/files/meterhowto.pdf *

To tell if your toilet has a leak:

- Place a drop of food coloring in the tank; if the color shows in the bowl without flushing, you have a leak in the tank.
- To see if the leak is coming from the flush valve, shut off the water supply to the toilet. Mark the water level on the inside of the tank with a pencil. Check the water level in 10 or 20 minutes. If the water has fallen, you know the flush valve is leaking.
- If the water seems to run constantly in the toilet, your refill valve may be leaking. In this case, the tank overfills and the excess water runs into the overflow pipe and into the bowl.

For more information and repair tips, Ace Hardware has an excellent FAQ section, as well as installation guides, in the Projects & Solutions section of their website: www.acehardware.com/info-home/. Home Depot also has guides in the Know-How section of their website at homedepot.com.

Advice on Proper Yard Watering

Cobb County provides instructions on proper yard watering

- Call 770-419-6244, or
- Download the guide at water.cobbcountyga.gov/files/IrrigationAudit.pdf

ConserveWater Georgia offers plenty of information, tips, and creative ideas.

- Download their WaterWise Landscaping &Watering Guide at www.conservewatergeorgia.net/pdf/water-wiseguide.pdf.

Find the right plants and trees for your yard!

- Online guides to appropriate plants and trees for Georgia can be found at:
  -georgiagaces.caes.uga.edu Search for "drought-resistant" (georgiafaces.caes.uga.edu/getstory.cfm?storyid=1165)
  -www.marshalltrees.com Go to "Educational Information," then "Trees During Design & Development." The "Tree Selection" section has a link for "Drought Resistance" (www.marshalltrees.com/articles.asp?p=2&id=26&cid=0)

How you design your landscape is also important. Check out the following guides:

- http://www.conservewatergeorgia.net/pdf/medc_water_saving_tips_new_landscape.pdf
- http://pubs.caes.uga.edu/caespubs/pubcd/B1073.htm.

Audit Your Usage

To help you learn more about how much water you are using in your home, Cobb County has a quick, 2-page home water audit that you can complete: http://water.cobbcountyga.gov/files/wateraudit.pdf. By completing this questionnaire and submitting it to the Water Efficiency Program, you may qualify for FREE water saving devices and water efficiency information.

*Any documents on-line that have a ".pdf" extension require Adobe Reader. You can download it for free at: http://www.adobe.com/products/acrobat/readstep2.html

For More Information Visit: water.cobbcountyga.gov/efficiency.htm

Example of Cobb County Water Systems Tip Sheets (Ferraro, P.J., & Price, M.K., 2009).