



Water Utility of the Future: A Case Study of Conservation as a Service

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Boston University Institute for Sustainable Energy

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INTRODUCTION

Water utilities serving growing populations in dry climates face challenges in balancing increasing water demand with scarce supplies. New water supply sources are increasingly expensive and require construction of additional infrastructure for treatment and delivery. This poses a challenge for utilities to balance revenues and costs to remain financially viable. As a result, water utilities may face a difficult choice. If the utility chooses to develop new water supplies, they will have to increase their rates. However, they can also choose to assess alternative supply and demand management strategies to match revenues with the increasing marginal costs. Approaches such as water reuse, rainwater or condensate harvesting or harnessing other alternative sources are becoming increasingly widespread. Nonetheless, it is important to continuously assess and implement demand conservation programs, which often prove relatively quick, low-cost and straightforward to implement.

Typically, the first ideas for any water utility to reduce water demand are price signals and education programs. Conventional best management practices for water conservation suggest that water utilities should send price signals by adjusting rates for conservation pricing, offering rebates for water-saving technologies, and educating consumers on water saving behavioral changesⁱ. However, there is a limit to the effectiveness of such programs. Water rates may increase with higher usage, but water demand elasticity is generally low. This makes it difficult to achieve meaningful water conservation, especially in wealthy areas. Water rebate programs often have low participation rates and therefore may not meaningfully reduce water usage, and sometimes may experience rebound effects that reduce water conservation effectivenessⁱⁱ. Education programs may be limited in their efficacy: they may achieve substantial reductions with a small subset of consumers that are reached by the effort, but fail to achieve notable reductions on the utility scale. These solutions either result in consumers facing higher prices or feeling lectured by unsolicited education programs and no guarantees of water conservation. This begs the question, do better alternatives exist?

In our work with New Braunfels Utility (NBU), Boston University's Institute for Sustainable Energy (ISE) recommended a set of water conservation measures that go beyond price signals and education programs. ISE found that efficient conservation opportunities exist in top users and developers in New Braunfels. Our team emphasized the opportunity to develop relations with these water users to achieve the goal of efficient demand reduction in a report to NBU.

BACKGROUND

New Braunfels is a city located in both Comal and Guadalupe counties in Texas and is situated in the northeastern portion of greater San Antonio. The population of New Braunfels is approximately 80,000 people as of 2017 and is estimated to be nearly 85,000 in 2019ⁱⁱⁱ. The median household income in New Braunfels is \$61,618, 7% higher than the United States, and the poverty rate is 9.5% compared to 14% for the US^{iv}. New Braunfels Utilities (NBU) is municipally owned, public joint power and water utility.

In its Water Resources Plan (May 2018)^v, NBU observed that their firm yield water supplies during times of drought are reduced by up to twenty percent. Consequently, the utility considered that sustained population growth rates near 6% per annum may make it difficult to meet water demand in the short term, especially in cases of drought. First and foremost, NBU evaluated supply expansion options in its Water Resources Plan. Subsequently, NBU signed contracts to increase their overall supplies by over 30% within the next 5 years at significantly higher prices than existing water supplies. NBU's long-term strategy to avoid further supply expansions was to set a target to achieve a water conservation target of 120 gallons per capita per day (GPCD) by 2042 (as compared to their current level of 141). In pursuit of water conservation, NBU had already implemented an increasing block rate schedule for water, provided educational materials on their website for water conservation, and offered rebates for water conserving technologies. Moreover, NBU fits perfectly into the description of a water utility in a dry climate that faces increasing water demand along with scarce water supplies with increasing incremental costs. After implementing the water conservation strategies that are part of conventional wisdom (increasing block rate schedule, rebates, education), NBU must seek additional strategies to reduce water demand further to 120 GPCD by 2042.

The Institute for Sustainable Energy (ISE) analyzed NBU's pumping and consumption data and found that

1. Water demand growth was not as fast as NBU anticipated and did not grow proportionally to population growth,
2. The sources of water demand growth are not necessarily the ideal target for water conservation efforts,
3. Water conservation efforts that target top users and developers could prove particularly effective and lead per capita water consumption to the 120 GPCD target by 2030 instead of 2042.

DATA INSIGHTS

The ISE began its analysis of NBU's meter level water use data by breaking it into end-use groups using billing codes: residential, commercial, public (any water use that the city is responsible for), and other. Understanding the relative portions of end-use is critical for effective water conservation planning.

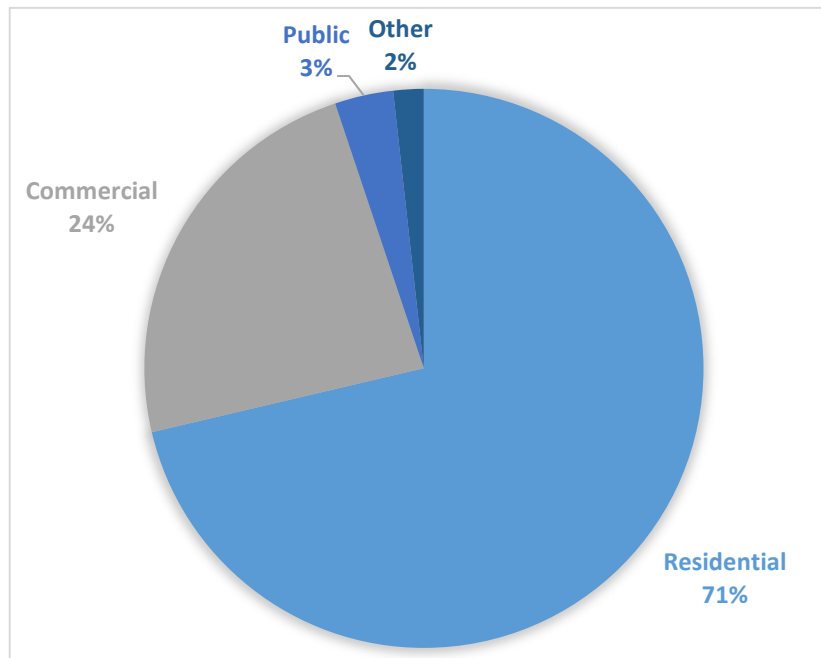


Figure 1: Disaggregation of Water End Use

Figure 1 shows that residential water demand constitutes 71% of total water demand, but this segment is divided among thousands of accounts. Therefore, any water conservation program targeting this group would need to be universal in nature. Rebates, pricing changes, and broad educational programs can apply here but are not always effective. Instead, ISE opted to find the low hanging fruit for water conservation, leading to the investigation of the distribution of water demand by percentile. Understanding the distribution of demand can also be helpful in water conservation planning, as it can answer the question of just how much of the water demand comes from top users.

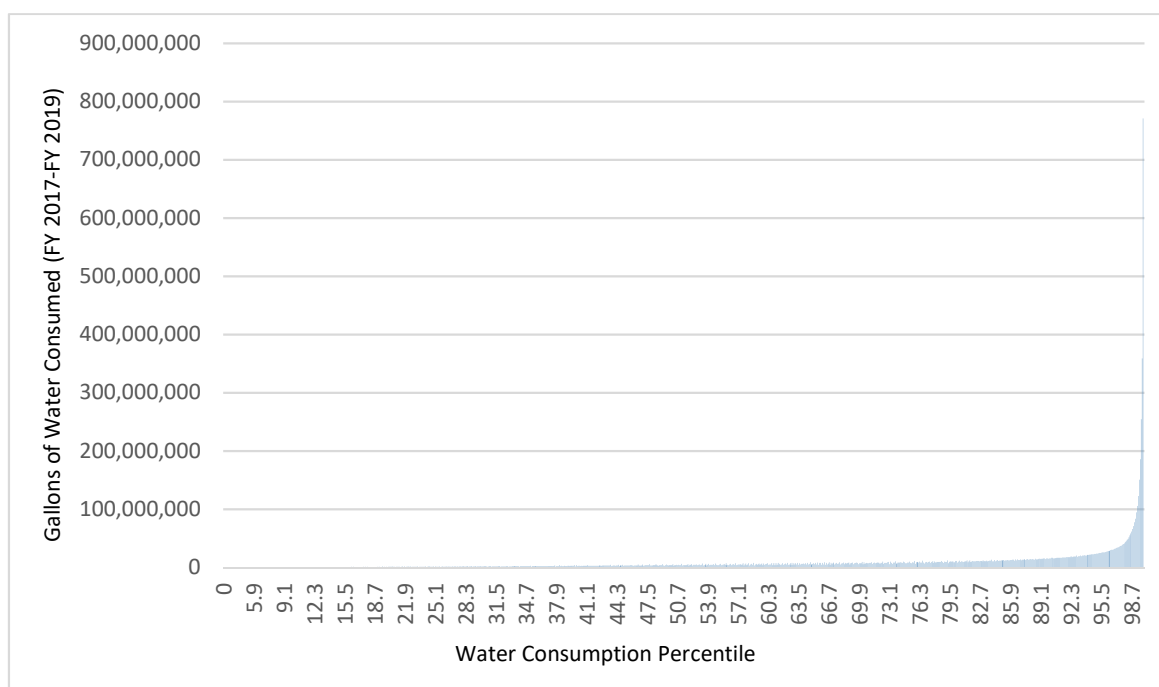


Figure 2: Water Use by Percentile shows top-heavy distribution of water use

Figure 2 plots the amount of water consumed by each 0.1% percentile grouping of all accounts over combined fiscal years 2017-2019. The y-axis lists the combined annual consumption (in gallons) for accounts in each 0.1% percentile group. The 0.1% percentile represents the total usage of 0.1% of accounts with the least usage, and the 99.9% percentile represents the total usage of 0.1% of accounts with the most usage. This visualizes the top-heavy nature of water consumption in the New Braunfels Utility service area, and the importance of focusing NBU's resources on targeted demand conservation strategies for high-percentile accounts. Overall, the top 1% of water users represent 27% of the total water demand. These top 1% of water users represent only a few hundred accounts, meaning that water conservation programs focused on this group could be much more targeted, customized, and effective.

The larger the portion of water consumption that comes from top users, the easier water conservation becomes by targeting these top users. Instead of asking tens of thousands of residential accounts to reduce water usage by 10%, it is much more straightforward to ask a few hundred accounts to reduce water usage by 30% to achieve the same total reduction. In fact, ISE provided NBU with a list of accounts with the highest consumption, and NBU found that relatively easy yet notable demand reductions could be made with some of these top users. Some of the top users were commercial users who simply irrigated their lawns every day and could reduce overall usage by double-digit percentages. Other top users were wastewater treatment plants, which could reduce water use by 75% at a facility by implementing a more water-efficient wastewater treatment process. These top consuming accounts not only make up a large portion of total water use but also have potential for large efficiency gains. These are the low hanging fruit for NBU's conservation programs.

The final piece of important information is the identification of top users, so that broad guidelines for water conservation can be established.

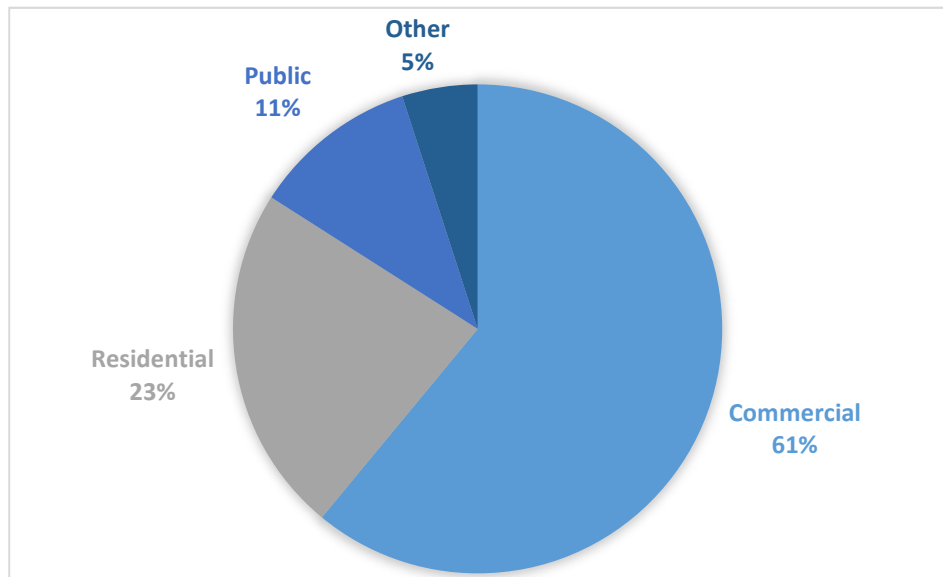


Figure 3: End Use for Top 1% of Accounts show top users are mostly Commercial

From figure 3 above, the top 1% of users are mostly commercial and industrial users, making up 61% of the water demand of the top 1% of users. Further insights can be drawn from a higher resolution disaggregation of end-use water demand among the top 1% of users.

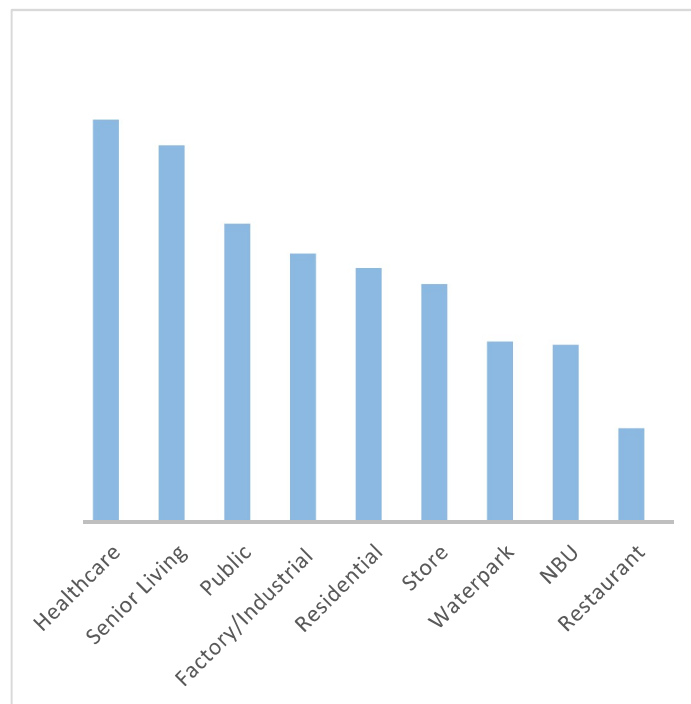


Figure 4: Water Use by Type shows the most water-intensive commercial businesses

NBU's largest water users are healthcare facilities, senior living homes, and public city-owned parks and other facilities. While some water use in these facilities is strictly necessary, wasteful water use through inefficient or outdated fixtures and lawn irrigation is quite common across such commercial applications. Simply informing facilities of potential solutions can go a long way in conserving water without compromising outcomes for users of these facilities. These data inform utilities on how to best target top users and approach reduction of their water consumption.

The ISE identified key insights to draw from these data. First, the top-heavy nature of the usage distribution indicates that top users are significant contributors to overall demand. Second, top users were typically commercial users that focus on profits and are particularly interested in reducing costs, including those from water usage. In turn, ISE recommended that NBU understand the types of businesses that are top consumers so that it can develop effective rebates and water conservation measures for these customers.

WATER CONSERVATION AS A SERVICE

The consensus among literature on water conservation is that although water prices are inelastic (a 10% increase in water price results in a low single-digit percent reduction of demand)^{vi}, price conservation programs outperform non-price conservation programs (including education programs)^{vii} on key metrics such as cost efficiency^{viii}. However, rebates for water conservation technologies may not be as effective due to the rebound effect^{ix}.

The modest effect of rebates was observed in NBU's data on rebates, where participation rates were small and water conservation was estimated at 0.14% of total demand. NBU also has an increasing block rate schedule and ongoing water conservation education efforts online, and despite these efforts and rebates, NBU's GPCD is near the median for cities in Texas, suggesting these programs are not particularly effective. It is clear that NBU needed a more targeted approach.

With NBU facing increasing costs and being forced to choose between increasing water rates and demand conservation, there is an opportunity to move beyond price signals and education efforts through water conservation as a service. The central premise is that water utilities can increase customer satisfaction by providing customized water conservation aid that can save businesses and residential customers money. The key insight ISE emphasized to NBU is that it can accomplish water conservation as a service by targeting top users (which tend to be a significant portion of overall water demand and are often inefficient water users) through an outreach and customized rebate program.

The program would function as such: 1) NBU would identify top users in a given time period, 2) NBU would conduct outreach to these customers to help analyze their water use and offer recommendations/customized rebates for specific water conservation measures, 3) NBU could estimate for the customer how much they would save on their water bill from the recommended

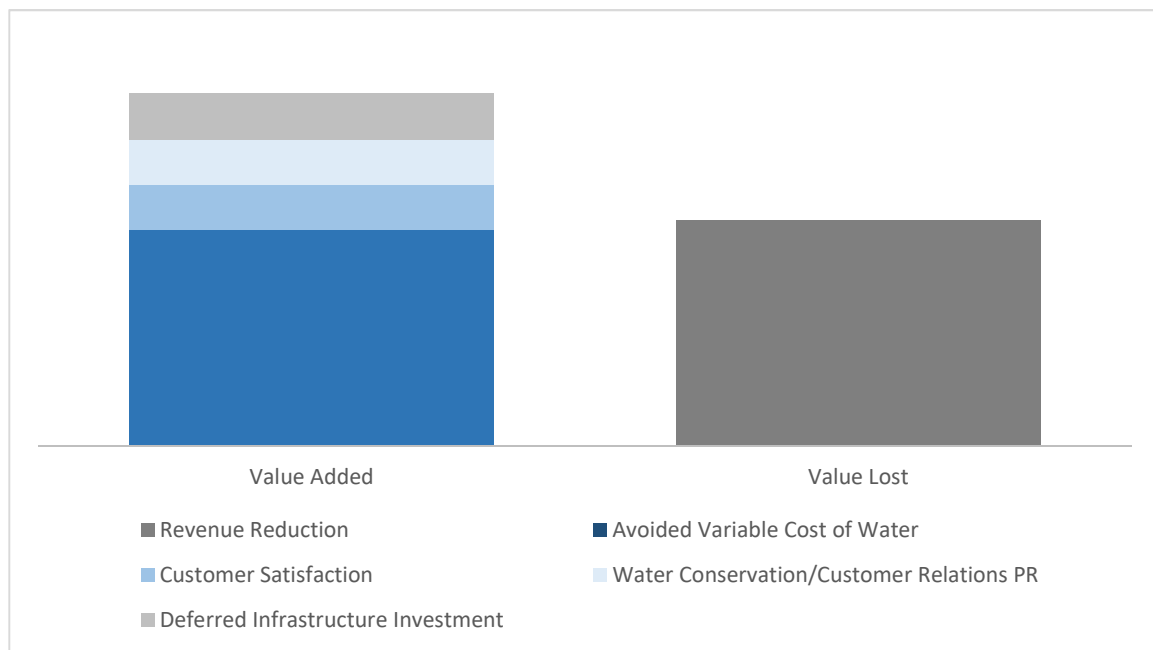


Figure 5: Illustrative Graph of Value Proposition of Water Conservation for a Water Utility

actions. Such active engagement would ensure that top users seriously consider water conservation and will likely result in high positive response rates. This outreach would lower customers' water bills and increase their satisfaction. While the utility may lose some revenue, it would also avoid significant variable costs. Likewise, it would benefit from increased customer satisfaction, improved public relations by meeting water conservation targets, and deferred infrastructure investment. Moreover, lost revenues from water conservation are more than offset by general growth in water demand, meaning that utility revenues will still increase over time (see Figure 5 for an illustration of potential costs and benefits).

ISE also outlined a methodology for NBU to estimate an outreach program budget based on the variable cost of water. The method is as follows:

- 1) NBU needs to estimate and/or assume what it believes to be a reasonable percentage reduction that can be made each year over a certain period. Estimates suggest that it is reasonable to assume that a 15% reduction in water consumption can be made through outreach efforts for top users over a period of 15 years.
- 2) With a yearly percentage reduction, NBU can estimate the number of gallons to be saved through outreach efforts.
- 3) From there, NBU can multiply the number of gallons saved each year by the variable cost of the water source utilized in each year and discount the budgets for future years to present-value.
- 4) The resulting net-present value is the maximum budget for the outreach program – as long as NBU spends less than the budget, its outreach and retrofit efforts are profitable.

This framework allows for the development of a budget for a given target of water savings. It is also useful to determine when it is advantageous from a cost perspective to pursue additional demand conservation efforts rather than supply-side infrastructure upgrades.

Another potential group to which water conservation as a service can apply is real estate developers. Real estate developers tend to irrigate the lawns of properties they develop with no regard for water, often incurring fines due to watering ordinances. NBU could offer consultation to real estate developers to help them reduce overhead costs from overwatering lawns and watering ordinance fines. In the same consultation session, NBU could also offer incentives for installing water efficient fixtures, which will benefit both the end-user of the property and ensure lower water consumption.

Eventually, the water utility of the future will be able to provide customized rebates and recommendations to all of their customers. This will be done through software that analyzes smart meter data and customer interface software that displays customized water conservation recommendations and rebates for technologies along with a customer's billing data.

CONCLUSION

Over the next few months, NBU will continue to implement efforts to curb water demand from top users while also providing them with a water conservation and bill reduction service. NBU is also evaluating meetings with real estate developers and software that can analyze smart meter data and recommend water conservation strategies to customers. Such software will cut down on outreach effort costs and enable customized solutions to be distributed to all water utility customers. These efforts will help NBU achieve their water conservation targets of 120 GPCD at least 12 years earlier than anticipated, defer infrastructure upgrades, and will also aid in avoiding expensive variable costs of water, therefore eliminating the need for drastic rate hikes. Finally, large customers will see their water bills reduced. NBU and ISE will continue to evaluate the success of this strategy over time.

This strategy of water conservation as a service can be applied at any water utility but is especially applicable in those utilities that face increasing water costs that require rate increases or water conservation. A proper implementation strategy should start, as this case study does, with an analysis of the utility data of water users and identifying the top tranche of users. Next, water utilities should engage in outreach and evaluate the inefficiencies in water usage among the top users, and then offer both behavioral suggestions and customized rebates for retrofits.

ISE recommends that pilot programs for water conservation are implemented to allow for more data to be collected and analyzed. Moreover, implementing and evaluating software that can analyze smart meter data and make water conservation recommendations automatically is also a critical next step. By analyzing the data from these pilots, best practices can be developed as a framework for water utilities that are transitioning into the water utility of the future.

ENDNOTES

ⁱ Best Management Practices for Municipal Water Users. Texas Water Development Board, 2013, [www.twdb.texas.gov/conservation/BMPs/Mun/doc/MunMiniGuide.pdf?d=3510.554 99992799](http://www.twdb.texas.gov/conservation/BMPs/Mun/doc/MunMiniGuide.pdf?d=3510.554%2099992799).

ⁱⁱ Gillingham, Kenneth, et al. "The Rebound Effect and Energy Efficiency Policy." SSRN Electronic Journal, Sept. 2015, doi:10.2139/ssrn.2550710.

ⁱⁱⁱ "New Braunfels, Texas Population 2019." World Population Review, 2019, worldpopulationreview.com/us-cities/new-braunfels-population/.

^{iv} "New Braunfels, TX." Data USA, datausa.io/profile/geo/new-braunfels-tx.

^v 2018 Water Resources Plan. New Braunfels Utility, 2018.

^{vi} Olmstead, Sheila M., and Robert N. Stavins. "Comparing price and nonprice approaches to urban water conservation." *Water Resources Research* 45.4 (2009).

^{vii} Campbell, Heather E., Ryan M. Johnson, and Elizabeth Hunt Larson. "Prices, Devices, People, or Rules: The Relative Effectiveness of Policy Instruments in Water Conservation 1." *Review of policy research* 21.5 (2004): 637-662.

^{viii} Inman, David, and Paul Jeffrey. "A review of residential water conservation tool performance and influences on implementation effectiveness." *Urban Water Journal* 3.3 (2006): 127-143.

^{ix} Gillingham, Kenneth, et al. "The Rebound Effect and Energy Efficiency Policy." SSRN Electronic Journal, Sept. 2015, doi:10.2139/ssrn.2550710.