Installing Water-Conserving Technologies to Reduce Water Usage in San Francisco

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Section A01

Abstract

California is currently suffering through an unprecedented drought. To counteract this harsh reality, Governor Jerry Brown enacted a new executive order to reduce water consumption in urban areas by 25% (Fimrite et. al, 2015). San Francisco, being an integral part of Californian urban life, serves as a prime template to evaluate whether or not this new order is feasible in terms of water usage. Cities throughout the state are required to meet different reductions based off of their current water usage per population. San Francisco, with its current fairly efficient water use, is only required to meet an additional 8% reduction (SWRCB, 2015). This report will give a quantitative evaluation of three different methods of reducing urban water use in an average home in the city. To reach our overall objective, we will use the costs of the different appliances and their respective efficiencies to calculate a cost-effective method to meet the water consumption reductions. We aim to find a way for families to meet this new requirement by spending the least amount of money. The three different methods we will be comparing are: replacing old showerheads with more efficient heads, replacing old toilets with low-flow toilets, and installing new, water-conserving faucets. The costs of implementing each of these methods in compliance with the 8% reduction will be compared to find the most cost-effective choice. The result of this analysis will help consumers reduce water usage, while saving the most amount of money.

Introduction

Beginning in 2012, California has weathered one of the worst droughts in the state's history, forcing the state to implement measures to reduce water consumption and promote water conservation. These measures have targeted different areas, including urban cities like San Francisco by recommending, and later mandating, reductions in water use. Many of these reductions must be met through monetary means, such as buying new water-saving technologies. In order to meet these reductions, families will need to make adjustments to their homes and lifestyles. One deterrent for families to make these changes are the costs associated with the new appliances. By calculating the different costs of purchasing different water-saving technologies, we hope to find the most cost-effective way to meet the new water consumption reductions.

Objective

The objective of our project is to find the most cost-effective way for a home in San Francisco to meet the 8% reduction of water consumption through installing new, water-conserving appliances. We will compare the costs associated with the three different scenarios and compare these values to find the least expensive method. As part of the cost, we will be taking into account labor and installation costs with the cost of purchasing the new technology. We will begin by calculating how many gallons of water will needed to be saved per person and then find which method is cheapest to meet those reductions.

Data Sources

According to the State Water Resources Control Board (SWRCB), the San Francisco Public Utilities Commission (SFPUC) will need to make an additional 8% cut from its 43.5 R-GPCD (residential-gallons per capita day), which was measured from July-Sept 2014 (SWRCB, 2015). The mandated 8% cut would equate to be 3.6 residential-gallons of water

per capita day. The SWRCB based their calculations off of 2013 and 2014/2015 water levels of the SFPUC. This value will act as our main reduction goal to meet through implementing and comparing different and varying water-conserving technologies.

We will also be obtaining data about average water usage, from shower to faucets, from Professor Samuel Sandoval-Solis' Exercise 2 (Sandoval-Solis, 2015). Since San Francisco is fairly environmentally friendly in its use of water, we will be using the conservation scenario efficiencies in the Exercise as the standard scenario for our study. We did this because the R-GPCD for the conservation scenario was 47 R-GPCD, which is very similar to the 43.5 R-GPCD of San Francisco.

We gathered all of our pricings for new water-saving technologies from the Home Depot website, and made sure that all of the technologies that were chosen were certified by the EPA's Water Sense partnership program ("Indoor Water Use," 2015). Our water-conserving faucet, from Glacier Bay, will cost a total of $29 and has a flow rate of 1.5 gallons-per-minute (Home Depot, 2015). Our water-conserving showerhead, from Delta, costs $12 and also has a flow rate of 1.5 gallons-per-minute (Home Depot, 2015). The water-conserving toilet, also from Glacier Bay, that we are using costs $98 and has a flush flow rate of either 1.1 or 1.6 gallons-per-flush (gpf), depending on the type of flush; it was averaged to 1.27 gpf for the toilet efficiency (Home Depot, 2015).

To collect the labor costs of installing our new technologies, we used estimations by Homewyse.com, which tabulates the average installation cost of different areas. We used 94101 as the zip code to be representative of San Francisco. The average labor cost to install a faucet is $81.85/hour (Homewyse, 2015). The average labor cost for the

installation of a toilet is $79.72/hour (Homewyse, 2015). The average labor cost to install a showerhead is $63.70/hour (Homewyse, 2015).

Methods and Assumption

We looked at the most cost-effective method that would reduce water consumption in San Francisco by 8% to meet the mandate set by Governor Brown. In order to determine what method of conservation was most cost-effective, we needed to first determine the price and water efficiency of the different bathroom technologies. These devices were water efficient showerheads, toilets, and faucets. When choosing technologies, we made sure that they were all EPA-certified Water Sense products.

In our calculations, we first determined the costs that one would incur from purchasing the water saving devices. These costs were the sum of both price to purchase the new devices and the price of labor to install the devices. The next step of our calculation included determining the amount of water saved by each device. We would use this new efficiency and compare it to the efficiencies of the existing and current technologies, including faucets, showerheads and toilets. We would then find the cost per gallon saved of each technology and whether or not the act of installing the technology would meet the 8% reduction goal.

One assumption that we made when determining the amount of water reduction was the average usage of the technologies. We assumed that on average people used their faucets for about six minutes a day, showered a total of ten minutes a day, and flushed their toilets about four times a day (Sandoval-Solis, 2015). These assumptions are critical to our calculations as they allow us to calculate the exact quantity of water usage between existing technologies and efficient devices, which are needed for the 8% reduction in water

consumption. If water usage were to change, the quantity of devices needed to meet the reduction would also change, ultimately affecting the total cost incurred from purchasing the devices. In doing these calculations, we also assumed that people would purchase bathroom devices that are the least costly, but would also improve efficiency.

Calculation/Results

Step 1: Calculating the population served by SFPUC & 8% reduction in gallons per capita

- *Total Water Saved* (from 2014/2015 to 2013):
  = 20,365,410,000 -18,717,900,000
  = *1,647,510,000 gallons*
- *Percent Saved* (compared to 2013):
  = 1,647,510,000/20,365,410,000
  = *8%*
- *Residents served by SFPUC:*
  = (Total Water Population / # days) ÷ # Resident-gallons per capita day
  = 18,717,900,000 gallons / 245 days = 76,399,591.84 gallons/day
  = 76,399,591.84 gallons/days ÷ 45.4 R-GPCD
  ≈ *1,682,810 residents*
- *# Gallons to be saved*:
  = July - Sept 2014 R-GPCD x Percent Reduction
  = 45.4 R-GPCD x 8%
  = *3.63 R-GPCD*

Step 2: Calculating the cost of achieving the 8% reduction

	Scenario	Efficiency	Cost of Installation ($)	Cost of Purchase ($)	Average use per day
1	Standard Showerhead	2.0 gallons/minute			10 minutes
	Standard Toilet	1.8 gallons/flush			4 flushes
	Standard Faucet	1.8 gallons/minute			6 minutes
2	Water-Conserving Showerhead	1.5 gallons/minute	$127.4/2 hours	$12	10 minutes
	Water-Conserving Toilet	1.27 gallons/minute	$175.4/2.2 hours	$98	4 flushes
	Water-Conserving Faucet	1.5 gallons/minute	$163.7/2 hours	$29	6 minutes

	Scenario	*Gallons/Day* = (Average use per day * Efficiency)	*Gallons/Day Saved*	*Cost of achieving 8% reduction*
1	Standard Showerhead	2.0 gallons/minute x 10 minutes = *20 gallons*		
	Standard Toilet	1.8 gallons/flush x 4 flushes = *7.2 gallons*		
	Standard Faucet	1.8 gallons/minute x 6 minutes = *10.8 gallons*		
2	Water-Conserving Showerhead	1.5 gallons/minute x 10 minutes = *15 gallons*	20 gallons – 15 gallons = *5 gallons/day*	$127.4+$12 = *$139.40*
	Water-Conserving Toilet	1.27 gallons/flush x 4 flush = *5.08 gallons*	7.2 gallons – 5.08 gallons = *2.12 gallons/day*	$174.4+$98 = *$272.40*
	Water-Conserving Faucet	1.5 gallons/minute x 6 minutes = *9 gallons*	10.8 gallons – 9 gallons = *1.8 gallons/day*	$163.7+$29 = *$192.70*

→ *The only technology that would meet the water-reduction mandate by itself would be the water-conserving showerhead. It would save a total of 5 gallons/day from the switch. The water-conserving toilet would conserve 2.12 gallons/day, while the faucet would save 1.8 gallons/day. These, by themselves, would not meet the mandate set by Governor Brown. The most probable reason for this could be that the existing technologies used by San Franciscans are already very conserving. To meet the mandate, however, the toilet and faucet could be installed together to reach the 3.6 gallons/day requirement. They would save 3.92 gallons/day together.*

Step 3: Calculating the cost-effective ratio of the technologies

- Showerhead:
  = $139.40 / 5 gpd
  = *$27.88 per gallon saved*
- Toilet:
  = $272.40 / 2.12 gpd
  = *$128.49 per gallon saved*
- Faucet:
  = $192.70 / 1.8 gpd
  = *$107.05 per gallon saved*
- Toilet & Faucet:
  = ($272.40 + $192.70) / (2.12 gpd + 1.8 gpd)

= *$118.65 per gallon saved*

→ *Installing a showerhead would be the best option, have a total of $27.88 per gallon saved. Installing a toilet and faucet, both of which do not meet the 3.6 gpd reduction individually, would have a total of $128.49 per gallon saved and $107.05 per gallon saved, respectively. If the toilet and faucet were installed together, they would meet the water reduction requirement and also cost $118.65 per gallon saved.*

Conclusions

After calculating the cost of each appliance and the efficiencies associated with them, we were able to find the cheapest method of water reduction from the three technologies that we focused on. Our calculations found that installing new showerheads would be the most cost-effective method when comparing the three options. We found that the showerhead would cost $27.88 per gallon saved. A faucet would cost $128.49 per gallon saved, followed by a toilet, which would cost $107.05 per gallon saved. To meet the 8% reduction with a toilet and faucet, they must be installed together to save a total of 3.92 gallons/day. They would have a cost of $118.65 per gallon saved.

In general, stricter reductions, such as a full 25% reduction, can be made through a combination of these technologies. This would be highly effective and could be implemented with relative ease. If all three technologies were installed, 8.92 gallons per day could be saved at a cost of $67. 77 per gallon saved. Mandatory water reductions are important to our project and in general as there are no real incentives to saving water. By mandating a water reduction, Governor Brown has made maintaining current levels of water usage not an option. This mandate will prove to be beneficial in responding to the drought that we are currently experiencing. As proved in this paper, there are many easily obtainable actions that can be made, like replacing a few household items, which can lead to quite large reductions in water use.

Recommendation/Limitations

This analysis is limited by multiple factors. Firstly, as a general analysis of water reductions, this report is limited to the city of San Francisco. San Francisco is unique in its lack of agriculture, as well as its current position on the forefront of environmental issues as it has already taken the initiative to reduce water usage. Cities also vary greatly from what their economies and citizens value, so analyses should be done specific to the city of interest. We are also limited by our assumptions; not every household will have the same conditions, use the same technologies, or use the technologies for the same periods of time. This makes this type of analysis even more specific in nature. Average values can only predict so much. In terms of limitations, prices can vary in the present and future due to fluctuations. This will affect the best and most cost-effective option. For example, if a faucet becomes cheaper to install in the future, it could overtake the showerhead as the best option. Presently, our analyses find that the showerhead is the best option with the current prices that we gathered. To make the best analysis, we recommend using location and city specific and temporally updated values for calculations.

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