Water Consumption Efficiency of Toilets & Shower Heads in Davis: Old Davis (Cambridge House) vs. New Davis (Sycamore Lane Apartments)

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Abstract

The efficiency of household water consumption varies with the age of the home. Generally, older buildings have a lower water efficiency use due to differences in technology compared to the water efficiency in newer buildings today. There is expected to be a difference in the quantity of water consumed as a result of the differences in water efficiencies between the older (built around 1970) and newer (built in the 2000's) apartments in Davis, California. A cost-benefit analysis will be conducted in order to determine if installing efficient bathroom fixtures such as newer shower heads and toilets is an economical form of reducing water consumption and saving money. Through this project, the hypothesis mentioned before will be tested through a case study of older (Cambridge House) and newer (Sycamore Lane Apartments) apartment complexes in Davis, California where we will investigate and compare the differences in water use in bathrooms through the use of toilets and shower heads.

The study will measure the water flow rate from shower heads and the gallons of water used per flush for toilets from the older appliances at Cambridge House and the more efficient appliances at Sycamore Lane Apartments over the course of one week. From the observations and data collected, results were calculated that revealed the quantity of water used in older apartments is twice as much as the quantity of water used in newer apartments. These indicated that the water bill for residents in Cambridge House is also twice as much as the water bill that residents at Sycamore Lane Apartments receive, thus validating our hypothesis that the Cambridge House apartment could save money on billing by updating its technology to the standards of Sycamore Lane Apartments.

Introduction

We are looking at efficiency in household bathroom water use in different parts of Davis, California. The older part of Davis generally will have lower water use efficiency due to old appliances. These appliances sometimes also include leaking pipes, dated technology, and inadaptable units for water saving. The newer part of Davis, have upgraded their bathroom appliances to include the newest efficient technologically advanced appliances. We will compare a bathroom in the newer part of Davis to a bathroom in the older part of Davis and determine if there is a difference between the two in water efficiency and water conservation. The study will measure the flow rate and efficiency of the appliances and calculate the quantity of water used per week. The cost of water use per apartment is then compared.

Toilets and showerheads in the two different areas use different amounts of water. The difference in water use between the bathroom in an older apartment and a new apartment in Davis will lead to differences in water bills. We are investigating if the different bathrooms will have a significant water bill difference and if switching old appliances for newer ones will save water and money. In this hard economy many people want to save money. It can be hard to pay for new appliances when the immediate effects are not necessarily seen. Our case study shows that installing newer appliances helps the consumer save money on the water bill, and also become more water efficient. It will also be helpful for contractors and apartment builders to understand the advantages of using new appliances. The case study demonstrates that effective use of technology through installing new appliances helps water planning and management.

Objective

The main objective of this project is to determine if switching from older showerheads and toilets to newer appliances will save water and money. First, the group members will collect field data through the estimation of the total amount of gallons of water used per day in the shower and through flushing the toilet. After observation, the amount of water used in the older apartment will then be compared to the newer apartment. In the second step, we will compare the value of each apartment's water bill per month using the current water rates in Davis, California. Lastly, we will determine if switching over to new appliances in the older apartment will be cost effective compared to doing nothing.

Hypothesis

We expect there to be a difference in the quantity of water consumption between the older and newer apartments in Davis, California. Our goal is to determine if the cost-benefit analysis will support our hypothesis: installing efficient bathroom fixtures is an economical form of reducing water consumption and saving money. After developing this hypothesis we felt that looking at the efficiency of different toilet and showerheads would be appropriate to see if our hypothesis made sense. In order to do this we looked at the Home Depot website to see various brands of bathroom fixtures and how efficient they were.

When looking at the website there was actually a designated section for water saving toilets. The brands and prices varied of the toilets varied from $100 to almost $900. Besides the price variation, there was also a gallons/per flush variation of the toilets, from 1 gallon/per flush toilets to 1.6 gallons/ per flush toilets. The first brand that looked to be efficient that could be installed in the older apartments in Davis (specifically, Cambridge House), was a KOHLER Cimarron 2-Piece Elongated Toilet. The listed price of the KOHLER Cimmaron Toilet was $248. This particular toilet was said to be

highly efficient because it's gallons/per flush (GPF) was 1.28. Another possibility of an efficient toilet according to the website was the KOHLER Wellworth Classic 2-Piece Pressure Lite Elongated Toilet. This toilet's listed price was $331.19 and its gallons/per flush was 1.0. The Wellworth Classic toilet cost more than the Cimmaron toilet, but its gallons/per flush was 0.28 lower than the Cimmaron. The following is a chart with several toilet brands listed along with their prices and gallons/per flush.

Toilet Brand/Name	Price	Flow Rate=Gallons/Per Flush
KOHLER Cimmaron 2- Piece High Efficiency Elongated Toilet	$246	1.28 GPF
American Standard Concealed Trapway Cadet 3 Flo-Wise 1-Piece	$268.60	1.28
KOHLER Wellworth Classic 2-Piece Pressure Lite Elongated Toilet	$331.19	1.0 GPF
KOHLER Santa Rosa Comfort Height Compact Elongated Toilet	$422.10	1.28 GPF
KOHLER Gabrielle Comfort Height Compact Elongated Toilet	$501.97	1.28 GPF
KOHLER San Raphael Comfort Height 1-Piece Elongated Toilet	$702.90	1.0 GPF
KOHLER Reve 1-Piece GPF High Efficiency Dual Flush Elongated Toilet	$846.80	1.6 GPF

After looking at the website for Home Depot it is evident that the efficiency of the toilet varies as does the cost of the toilets. The older apartments in Davis do not need to necessarily install the most expensive toilet thinking that it would be the most efficient. In reality, the apartments could install a 1.28 gallons/per flush toilet for $248 instead of buying a toilet with the exact same 1.28 gallons/per flush toilet, but for $660.50. They could save a value of $412.50 by choosing the cheaper toilet that has the same gallons/per flush as the more expensive toilet.

The efficiency of showerheads was a bit more challenging to determine. So we looked at the Department of Energy homepage to find some information about what makes a showerhead efficient. According to its website, a showerhead is considered efficient if it has a flow rate of equal to or less than 2.5 gallons/per minute (GPM). An interesting bit of information that we learned was that there are two different types of showerheads. There are aerated showerheads and laminar-flow showerheads. Aerating showerheads form a misty spray by mixing air with water. Laminar-flow showerheads form individual streams of water. Before 1992, there were showerheads that had flow rates of 5.5 gallons/per minute. Therefore older apartment complexes such as Cambridge House in Davis need to update their showerhead fixtures to become more efficient.

After discovering what a showerhead's flow rate needs to be in order to be considered efficient we went to back online to the Home Depot homepage to see what types of showerheads had low flow rate. One possible option of a low flow showerhead was the Delta 1-Spray showerhead with 2.5 gallons/per minute flow rate. The cost of this showerhead was $33.95. Another possible option for an efficient low flow showerhead was the Delta 1- Spray Chrome Showerhead with a 1.5 gallon/per minute flow rate. The cost of this showerhead was $16.65. The following is a summary table of different efficient showerheads with their listed prices as well as their flow rates.

Showerhead Brand/Name	Price	Flow Rate=Gallons Per Minute (GPM)
Delta 1-Spray Showerhead	$33.95	2.5 GPM
Delta 1-Spray Chrome Showerhead	$16.65	1.5 GPM
Delta 3-Spray Showerhead	$10.80	2.5 GPM
Delta Arios	$34.98	2.0 GPM
Speakman Anystream Eco 4-Jet	$26.22	1.5 GPM

After looking at the Home Depot website once again there is a difference among showerhead prices and flow rates. There are some showerheads that are less expensive than others and also have a lower flow rate. Therefore they can be considered to be more efficient. The apartment complexes could get a showerhead with a 1.5 gallons/per minute flow rate and save $17.30 when compared to a 2.5 gallons/per minute showerhead.

Data Sources

- http://www.homedepot.com/webapp/catalog/servlet/Search?storeId=10051&langId=-1&catalogId=10053&keyword=showerheads&Ns=None&Ntpr=1&Ntpc=1&selectedCatgry=SEARCHALL#/?c=1&Nao=72

- http://www.homedepot.com/webapp/catalog/servlet/Navigation?storeId=10051&langId=-1&catalogId=10053&N=5yc1vZbzbdZ1z139et#/?c=1&1z139et=1z139et&Nao=120

- http://energy.gov/energysaver/articles/reduce-hot-water-use-energy-savings

- http://public-works.cityofdavis.org/Media/PublicWorks/Documents/PDF/PW/Water/Utilities/utilityBillDetails.pdf

- https://smartsite.ucdavis.edu/access/content/group/9fa03a66-c713-4cbf-8c6b-59bce0ec23a3/Exercises/Ex_2/Ex_2_Wat.%20Demand%2C%20Water%20Conserv%20_%20Eff.pdf

Methods and Assumption

The methods for calculating our data took a week to complete. Thaleena and Tal both recorded data the same week from their apartment complexes. Thaleena lives at Sycamore Lane Apartments (New Davis) while Tal lives at Cambridge House (Old Davis). In both cases, the data is for an apartment which has two people living in it.

In New Davis, Thaleena and her roommate recorded every time they used the toilet or the shower. For the week of November 12th thru November 18th, the toilet was flushed a total of 70 times. Different toilets use different amounts of water per flush. The toilet in new Davis was a Briggs China Toilet and it used 1.8 gallons of water per flush. This number was then multiplied by 70 to see the total amount of gallons used per week by the toilet. The total amount of gallons of water used per week by the toilet was 126. During this same 1 week period, the shower was used for a total of 154 minutes. This value was calculated using stopwatches while showers were being taken. The showerhead for New Davis was a Niagara showerhead. We had already determined that the flow rate for this showerhead

was 2 gallons of water per minute. This value was then multiplied by 154 (total shower use) to get 308 gallons of water used per week by the Niagara showerhead.

In Old Davis, Tal and her roommate also recorded each time they used the toilet or shower. For the week of November 12th thru November 18th, the toilet was flushed a total of 63 times. The toilet being used was a gerber toilet. Since this was older than the Briggs China Toilet, there was more water used per flush. Every time Tal and her roommate flushed the toilet, 4 gallons of water were used. When multiplying 63 (number of flushes in week) by 4 (gallons of water used per flush), it was determined that a total of 252 gallons of water was used per week. This is more than twice as much that was used at New Davis. During this one week period, Tal and her roommate also recorded data on shower use. The shower was used for a total of 105 minutes for the week. The flow rate for the showerhead was 7 gallons of water used per minute. When multiplying the shower use by the flow rate, it was determined that 735 gallons of water was used per week. Once again, Old Davis used more than twice as much water for showers as New Davis.

The different values we received for the data from Old Davis and New Davis was what we expected. Older buildings tend to have a lower water use efficiency than newer buildings. After looking at our data it was determined that New Davis does in fact save water when it comes to showerheads and toilets.

Calculation/Results

We analyzed the costs of a scenario in which the Old Davis apartment updates its technology to the standards of the New Davis apartment. To obtain the costs, we calculated the cost of water based on the amount of water used. For this analysis we used our collected data on the average gallons per week used by the subject toilets and showerheads, and a sample water bill provided by the Davis Public Works Department. A summary of the cost-benefit analysis can be found in the table below.

	Total gallons per week	Total gallons per 2 months	CCFs per 2 mo.	Cost of water use per 2 mo.
Old Davis (East)	987	7,896	10.56	*$15.83*
New Davis (North)	434	3,472	4.64	*$6.96*

The first column contains the total gallons per week, an addition of the gallons used by the showerhead and toilet for each apartment. The total gallons were *987 gallons and 434 gallons* for the Old and New Davis apartments, respectively. The city of Davis issues water bills to residents every 2 months, corresponding to one period of water usage. Therefore, we multiplied our total gallons per week by 8, to get the total gallons per 2 months. These values were *7,896 gallons/2months and 3,472 gallons/2months* for the respective Old and New Davis apartments. The city of Davis calculates the total water bill using CCFs, a billing unit based on cubic feet. For the calculations, 1 CCF is equal to 748 gallons. To determine the number of CCFs used per 2 months, we divided the total gallons per 2 months by 748 gallons. This calculation yielded *10.56 CCFs/2months and 4.64 CCFs/2months* in the respective Old and New Davis apartments. Our final step was to obtain the cost of water for these 2 months. The city of Davis uses two tiers to bill residents for water. The first 36 CCFs used in 2 months have a rate of $1.50/CCF, and the rate above 36 CCFs is $1.90/CCF. Since we did not have greater than 36 CCFs, we multiplied the CCFs per 2 months by the $1.50 rate. This calculation gave us the final cost of water for the Old and New Davis apartments, *$15.83/2months and $6.96/2months* respectively.

The results of these calculations show that the cost of water per 2 months is about twice as much for the Old Davis apartment. By subtracting the two water costs per 2 months, we obtain the savings if the Old Davis apartment were to update its technologies to the standard of the New Davis apartment. The savings amount to *$8.87/2months*. This outcome is most likely due to the differences in flow rates of the toilets and showers, as the Old Davis appliances used two to three times the amount of water. Since we calculated a cost per 2 months, we converted this to a cost per week. This conversion allowed us to compare the cost to our original data that was collected per week. The results of this conversion are a cost of water use equal to *$1.98/week and $0.87/week* for the Old and New Davis apartments respectively. Leading to a savings amount of *$1.11/week* if the Old Davis apartment were to update its technologies to those of the New Davis apartment. Nevertheless, there is still a significant difference between the costs of water use of the Old and New Davis apartments, as the cost of water for the Old Davis apartment is *2.27* times higher than the New Davis apartment.

Conclusions

The results highlight the differences between water efficiency and water conservation. Water efficiency refers to the technology involved in water usage, which in our case is the showerhead and toilet. The differences between the flow rates of the showerheads and gallons per flush of the toilets reference the water efficiency. In contrast, water conservation refers to the behaviors involved in the

consumption of water. Therefore, taking a shorter shower would reduce the usage of water and would improve water conservation.

There were large differences in both the showerhead flow rate and the gallons used per flush for the toilets between the Old and New Davis apartments. The more efficient technology of the New Davis apartment led to lower water usages, which led to a lower gallon per week usage. In comparison, the Old Davis apartment had less efficient technology, which led to higher water usages and a higher gallon per week usage. The correlation between the technology efficiency and water consumption suggest that our hypothesis is valid, that the Old Davis apartment could save water money on billing by updating its technology to the standards of the New Davis apartment. However, when we look at the quantity of the savings from the cost analysis, water efficiency has less of an impact than we originally thought. Since the savings between switching from the Old Davis appliances to the New Davis appliances are around one dollar per week, there is little incentive to invest the money to achieve such a small level of savings. Therefore, we suggest that water conservation plays a larger role in reducing water usage. Based on our research and calculations, we predict that reducing the amount of water consumed through behavioral changes can greatly lower the cost of water in monthly billing. A change in behavior, such as taking a shorter shower, has the potential to have a large impact on water usage. As an area of further study, we would measure the impact shorter showers has on water usage and the monthly billing rate. Furthermore, we would see if the savings from water conservation are greater than the savings from using more efficient technology.

Recommendation/Limitations

Our water cost analysis was limited by the amount of available information. We calculated benefits of investing in a new technology based on the money saved on the amount of water used per 2 months and per week. However, we would have liked to do a full cost-benefit analysis if not limited by available information. We believe the main limitation is that we chose to analyze apartments and not homes, which have more access to billing information. The water bill from the City of Davis Public Works Department was most likely for a home, and not an apartment in Davis. We used this sample water bill for the dollar rate of water use because the water bill we had for a Davis apartment was not applicable. Davis apartments are billed for water based solely on square footage; therefore they have the same cost of water regardless of the amount of water they use. In a Davis apartment there is little incentive to reduce water uses with more efficient technology because the water bill will not change based on decreased water uses. Therefore, the input costs cannot be recovered by savings in water billings due to the fixed water bill calculated with square footage.

References

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