LOW-HANGING FRUIT: THE KEY TO SUCCESSFUL WATER EFFICIENCY PROGRAMS

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INTRODUCTION

People are becoming more aware of the impact their actions can have on the environment and there is a growing movement to try to use our natural resources as efficiently as possible. Water efficiency, which only a few years ago was considered by many water agencies as simply a "feel good" measure, is now considered a legitimate new "source" of water. Improving efficiency is not only good for the environment, it is good for the bottom line as well. But, not all water efficiency measures or programs are equally effective. Some measures have the potential to save large volumes of water but are difficult or not cost-effective to implement; other measures are well received but may result in very little actual water savings (e.g., we have all heard about school presentations touted as a success simply because children are taught to turn off the tap when they brush their teeth).

Developing a new source of water costs money. This is true whether the new source is a supply-side or demand-side alternative. As such, it is important that we spend our money wisely and that we get the "biggest bang for our buck." And, while it is important that we consider the impact our actions will have on the environment, we also need to view our options with a discerning eye. If a water efficiency program is to be successful, it must include measures that are practical and cost-effective, that result in a significant volume of savings, and that are acceptable to a large percentage of our customers.

LOW-HANGING FRUIT

We have all heard the phrase "pick the low-hanging fruit first." It means that you shouldn't expend significant effort trying to achieve difficult goals until you have first achieved all of the easy stuff. Going after the low-hanging fruit first is usually a practical and cost-effective strategy for early success, but it is also a strategy that is too often ignored—at least when it comes to water efficiency programs.

The low-hanging fruit in the water-efficiency orchard are programs or measures that are easy and inexpensive to implement, and that require little or no sacrifice on the part of the homeowner. Any water-efficiency measure that requires a sacrifice (e.g., a change in customer behavior, ongoing maintenance, a high price tag, etc.) on the part of the homeowner is less likely to be successful.

Let's look at the residential customer sector for some examples of low-hanging fruit to reduce water demands. The residential sector is a good place to start because most of us have a firm understanding of how water is used within our own home, and it is within our power to make the changes necessary to improve our current situation (whereas the average homeowner has no control over how much water is used for crop irrigation or power plant cooling).

While some of the measures discussed in this article can be implemented in either new homes or existing homes, new homes offer the greatest opportunity for water savings for a number of reasons: modifications can be made to water supply piping or drain lines without having to tear out existing walls or floors, the homeowner doesn't have to make the financial decision of whether or not to replace a working but inefficient fixture/appliance, the house can be viewed as an entire package vs. the piecemeal approach associated with many retrofit programs, etc.

While the industrial customer sector has thousands of vastly different water uses, the residential customer sector contains only a relatively few different types of water demands. Reducing residential water demands can generally be achieved in two ways: improve the water using habits of the homeowner (often requires some level of sacrifice) or replace inefficient plumbing fixtures and appliances with efficient models (often requires little or no

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level of sacrifice). While making changes in water-use habits, for example, bathing less often, taking shorter showers, not flushing the toilet after each use, etc., can result in water savings, these types of measures are typically considered "soft" because the level of water savings achieved is at the whim of the homeowner, i.e., the homeowner may just as quickly revert back to more frequent bathing or to flushing after each use, etc. So, while behavioral improvements should be encouraged as part of any comprehensive water-efficiency program, it is difficult to accurately predict the level of savings that will be achieved by behavioral modification programs.

This article discusses a number of measures that, in the opinion of the author, do not rely on the homeowner's active participation once the measure has been implemented. As such, these measures require no sacrifice and virtually no behavioral changes by the homeowner, yet they are virtually guaranteed to achieve the expected savings, i.e., these measures are the low-hanging fruit of residential water efficiency programs.

EXAMPLES OF LOW-HANGING FRUIT

0.8-Gallon per Flush Toilets

New toilets in the U.S. must flush with no more than 1.6 gallons of water. There is some expectation that the maximum flush volume will be reduced to only 1.28 gallons by 2014, though this requirement may be limited to residential customers (drain pipes in non-residential buildings often have larger diameters and flatter slopes, both conditions that can reduce waste carry distance). Toilet flushing performance has significantly improved in the last five years, and now new toilet models are being introduced that can flush effectively with only 0.8 gallons of water. This is an important achievement because 0.8 gallons might be the lowest practical flush volume for residential toilets—reducing the flush volume any further than this might increase the risk of having insufficient water to carry waste through the drain lines. In other words, we may *never* see residential toilets flushing with less than 0.8 gallons.

At least two models of 0.8-gallon single-flush gravity toilets have already met the flushing performance criteria established by the U.S. EPA's WaterSense program, i.e., they flush more than 350 grams[1] of waste in a single flush. By installing only 0.8-gallon per flush toilets in new homes the savings (vs. homes with 1.6-gallon models) would equal about 4.0 gallons per capita per day or gcd (5 flushes/capita/day × 0.8 gallons/flush savings) with absolutely no effort or sacrifice required by the homeowner. In fact, there is a good chance that the homeowner would not even realize that they are flushing with only 0.8 gallons. What's more, the marginal cost associated with supplying and installing 0.8-gallon toilets in all new homes is minimal.

Efficient Clothes Washers

The benefits associated with efficient clothes washers are well known, but that doesn't stop them from being included in this list of low-hanging fruit. Clothes washing is one of the largest indoor water uses in the residential customer sector. Homes with a typical top-loading washer have clothes washing demands of about 15 gcd. Efficient front-loading washers, which have been popular in Europe for many years, currently use about 40% less water and 50% less energy (they spin the clothes faster, meaning less time in the dryer)—and they are getting even more efficient. The biggest problem with front-loading washers is that they cost more than top-loading models (often $200 to $800 more). Even with a higher marginal cost, however, the market is clearly moving to embrace front-load washers (recent estimates are that almost one-third of washers currently sold in the U.S. are front-loaders).

A water savings of 40% equates to a volumetric savings of about 6 gcd, again with no effort or sacrifice required by the homeowner. In fact, most homeowners actually prefer front-loading washers. But be careful about offering minimal rebates towards the purchase of front-loading washers, however. Rebates of $50 or $100 may not be sufficient to persuade a consumer to select a front-loading washer vs. a top-loading model. Programs with minimal rebate levels may include a large percentage of free riders.

Hot Water Recirculation Systems

One of the most common sources of wasted water in the home is related to the wait time as hot water travels from the hot water tank to the fixture. For

[1]About 3/4 of a pound.

example, people typically turn on the shower and then let the water run down the drain until it reaches an appropriate temperature before they begin their shower. New homes are often equipped with a single lever shower activator along with a pressure- or temperature-balancing valve to avoid sudden temperature changes in the shower that may occur when someone flushes a toilet or begins to wash clothes. With these types of valves the homeowner cannot control the flow rate to the showerhead (the flow is always "full"); they can only control the temperature.

Almost all new homes are equipped with 2.5 gallon per minute (gpm) showerheads. Assuming that 2 people use the ensuite shower each day and the wait time for hot water to reach this shower is 60 seconds, the savings would be about 5 gallons per day per household.

If we also consider water wasted at the bathroom lavatory sink, other showers within the home, and at the kitchen sink while waiting for hot water to arrive, a reasonable estimate of total water wastage due to hot water wait times may be about 8 gallons per household, or about 2 gcd based on a family of four.

Hot water recirculation systems are only really suitable for new construction because they require a dedicated return line from the furthest fixture back to the hot water tank and a small pump to circulate the water prior to the hot water event. Note, the author does not recommend retrofit-type systems (e.g., for existing homes) that use existing cold water supply lines as hot water return lines. The author installed one of these systems in his own home and then experienced increased wait times for cold water.

The cost associated with installing a hot water recirculation system (pump and piping) in a new home is estimated to be approximately $250. Not only is there no sacrifice required by the homeowner, most homeowners *prefer* the option of having instantaneous hot water at their showers and faucets.

Efficient Showerheads

The current showerhead maximum flow rate standard in the U.S. is 2.5 gpm. While it is technically possible to produce showerheads with flow rates of 0.5 gpm or less, there are two limiting factors that make this type of scenario unpractical: 1) it is unlikely that shower performance levels (ability to clean) at extremely low flow rates would meet consumer expectations, and 2) the risk of thermal shock when a toilet is flushed or a clothes washer fills increases as flow rates decrease even if the home is fitted with pressure- or temperature-balancing valves (these values are generally not tested at flow rates less than 2.0 gpm).

While some people may be happy with the performance levels of showerheads operating at less than 2.0 gpm, the author recommends that municipal programs focus on 2-gpm showerheads to avoid any possible liability associated with thermal shock and to ensure that consumers are happy with the performance levels—showerheads are easy to remove and replace if the homeowner is not happy with them.

The average duration of a shower is approximately 7 minutes and the average person takes about 0.75 showers per day (not everyone showers every day). Switching from a 2.5 gpm unit to a 2.0 gpm unit could save approximately 3.5 gcd and, if a high quality showerhead is used, there is no sacrifice required by the homeowner. The marginal cost associated with the purchase of low flow showerheads is minimal.

Efficient Faucets

There are typically two types of faucets found in the home: bathroom (lavatory) faucets and kitchen faucets. Kitchen faucets are very often used to fill sinks, pots, containers, etc.—activities that are volume related vs. flow rate related. The fill times of volume related demands will increase if flow rates are reduced, a situation that would not be embraced by most homeowners. Many industry experts believe that it is neither practical nor useful to require flow rates on kitchen faucets to be less than 2.2 gpm.

Lavatory faucets, on the other hand, are not generally used to fill containers. Studies have shown that reducing the flow rate of lavatory faucets can reduce water demands. The maximum allowable flow rate for all non-residential lavatory faucets in the U.S. is 0.5 gpm. It is expected that this flow rate would also be acceptable in residential applications if it were not for the fact that lower flow rates result in increased wait times for hot water to reach the fixture. While some minimal water savings would almost certainly be achieved with the installation of

0.5 gpm lavatory faucets (or aerators) in new homes, the use of such devices would be considered far more practical if the home is also fitted with a hot water recirculation system that would essentially eliminate the wait time for hot water.

The per capita volumetric savings associated with this measure would be expected to be about 1.0 gcd with no effort or sacrifice required by the homeowner. The marginal cost associated with the purchase of low flow aerators is minimal.

Efficient Humidifiers

Many new homes in colder climates are fitted with furnace-mounted whole-home humidifiers. Most of these units are flow-through fixtures, i.e., water is supplied to the unit via a solenoid valve controlled by the operation of the furnace and the desired level of relative humidity in the home. Water trickles down a mesh or "honeycomb" while air passing through the mesh "picks up" moisture on its way to the home. This type of system avoids having standing water in the humidifier that can lead to health problems because water flowing over the mesh is either evaporated or is discharged down the drain. Unfortunately, at least from a water efficiency point of view, more than 90% of the water supplied to this type of humidifier is often discharged down the drain.

An efficient humidifier can waste less than 5% of its total water supply down the drain. The author installed an efficient humidifier in his own home during the winter of 2007 and measured an average savings of 50 gallons per day (the savings actually varies slightly from day to day). It is important to note that these savings would only be associated with homes that currently have (or would have when they are constructed) a flow-through humidifier, and the savings only occur during winter months when humidifiers typically operate.

Based on an occupancy rate of 4 persons per home, the per capita savings associated with installing an efficient humidifier is about 12.5 gcd. What's more, with some models there is no need to change the humidifier media (no sacrifice). Not only does the homeowner save water but also the time and costs associated with humidifier maintenance. The marginal cost associated with the purchase of an efficient humidifier is approximately $100.

UNRIPE FRUIT

Graywater reuse and rainwater harvesting systems that provide at least a portion of indoor water demands are two potential water-efficiency measures garnering quite a bit of press lately. While there isn't space to present a long-winded discussion of these two systems here, I will say *you need to do your research!* These types of systems can often have payback periods of 20 years or more.

The effectiveness of a rainwater harvesting system depends on many elements: annual precipitation rates, frequency and duration of rainfall events, roof area, storage volume, area of landscape, and others. Rainwater harvesting systems should not be confused with rainbarrels. Rainbarrels, which typically hold between 25 to 100 gallons, are often just too small to be very effective as water efficiency measures. In many areas, the best use for captured rainwater is irrigation—no special permits are required, the water quality is suited for irrigation purposes, and irrigation helps to replenish the ground water systems, but there are also systems that use captured rainwater for indoor uses such as toilet flushing or clothes washing. There is some question regarding how the water agency should be compensated for collecting and treating rainwater discharged into the municipal sewer system. Typically residential sewer charges are based on the volume of water purchased by the homeowner but, since homeowners do not pay for rainwater, there is no way for the water agency to quantify the volume of rainwater sewage produced by each home. Perhaps water agencies will require rainwater systems to be metered in some way if they are connected to a home's indoor plumbing. Rainwater harvesting systems can potentially save huge volumes of water—but only in areas with lots of evenly distributed rainfall. For several reasons, including the relatively small geographical area in which these types of systems are suitable and the potentially long payback period, the author does not consider rainwater harvesting systems to be a particularly low-hanging fruit at this time.

Graywater reuse systems were developed in response to the fact that not all of our water demands require potable water quality. Residential graywater is the water discharged from showers, clothes washers, bathroom sinks, and bathtubs. With a little filtering and cleaning graywater can be reused in the home—typically for toilet flushing or landscape irrigation, though sometimes even for clothes washing. Water discharged from toilets or kitchen sinks is referred to as blackwater and cannot be reused in the home without going through some serious treatment.

Graywater systems are best suited for new construction where it is relatively easy to install collection and supply piping. In existing homes you will need to reroute the appropriate drains to the graywater collection tank and install new water supply piping to your toilets (and/or clothes washer or landscape irrigation system).

Remember that you are producing and using graywater each day, so your system needs to be sized appropriately. It doesn't make sense to install a large tank and collect 100 gallons of water each day from your bathing and laundry if you only use 20 gallons each day to flush your toilets. And this brings up an interesting fact—graywater systems are more cost-effective when used in conjunction with inefficient plumbing fixtures! For example, a family of four with an inefficient clothes washer and inefficient showerheads may produce 100 gallons of graywater each day. If the home has 3.5-gallon toilets and each person flushes five times per day, the volume of water that can be saved each day is 70 gallons (4 persons × 5 flushes/day × 3.5 gallons/flush). If another family of four has an efficient clothes washer and showerheads, as well as high-efficiency toilets (HETs) flushing with only 1.28 gallons, they may produce only about 60 gallons of graywater each day and the volume of water that can be saved is only 25.6 gallons (4 persons × 5 flushes/day × 1.28 gallons/flush). Using these examples, if the home with inefficient fixtures saves about $150 per year, the home with efficient fixtures will save only about $55 per year. Given that even a very modest graywater reuse system may cost about $2,000 to supply and install, payback periods can be significant.

Don't get me wrong; I am in no way opposed to graywater reuse. In fact, because graywater offers such a huge potential for water savings, I believe that someday the use of these systems in new homes will become mandatory. Currently, however, because of the long payback period and the cost and labor associated with operating and maintaining these systems, the author does not consider graywater reuse systems to be a low-hanging fruit at this time.

ROTTEN FRUIT

Tankless water heaters (sometimes called on-demand or instantaneous systems) are often identified in ads or on the web as saving water vs. the traditional storage hot water tanks. The truth is that tankless systems *do NOT save water.* In fact, tankless systems tend to use *more* water than traditional hot water tanks. In a typical tank system, hot water is provided by the tank the instant there is a hot water demand (though it still takes time for the hot water to arrive at the fixture). Tankless systems, on the other hand, supply cold water for a few seconds until the unit "heats up" so there is an even longer wait time for the hot water to arrive at the fixture. What's more, there is a minimum flow requirement for most tankless systems, i.e., a low flow demand (such as the type that might be used when shaving) might not be sufficient to engage the tankless heater to provide hot water. Tankless systems are often marketed as providing an endless supply of hot water, possibly prompting people to take longer showers and use even more water. The author does not recommend including tankless hot water systems in water-efficiency programs.

CONCLUSION

People are becoming more aware of how important it is to use our limited natural resources wisely. Municipalities and water agencies need to react to this growing awareness by carefully selecting which water efficiency measures to include in their programs. It is no longer acceptable to implement programs based on "gut feelings" or inadequate research. The most effective water efficiency measures are cost-effective, embraced by the customer (no sacrifice), easy to implement, and are able to achieve significant levels of sustained water savings. Measures with all of these attributes are considered to be the low-hanging fruit in the water efficiency arena and should be targeted first to help ensure the success of your municipal program. Luckily, even more examples of low-hanging fruit are being developed each year as technology continues to advance.