Chapter 8. The Future Potential for Water Conservation

The analyses in Chapter 7 establish the cost-effectiveness of quantifiable water conservation measures for two water agencies in Southern California. The case studies discuss the potential for the water agencies studied to meet the 20% reduction in water consumption by 2020. But both the ability of water agencies to meet their 20 x 2020 targets through the BMPs recommended by the State and the ability of the BMPs to further reduce water use beyond 2020, which is likely to be necessary due to climate change, depend on the extent to which the BMPs have already been implemented in the districts by the baseline period, or to their level of saturation within the district. The level of saturation of specific water-conserving plumbing devices or appliances is important for meeting 20% by 2020 targets, since the level of saturation is a major means for water districts to demonstrate that they have fulfilled the CUWCC requirements for specific BMPs. For example, to demonstrate that they have met BMP 2, Residential Retrofits, with respect to low-flow showerheads, water agencies can demonstrate either that 75% of single family and multi-family residences built before 1992 have such low-flow showerheads or that the agency has distributed or directly installed such low-flow showerheads to 10% of single and multi-family residences built before 1992 (CUWCC 2012). 1992 is the reference year because Federal standards for low-flow showerheads, faucets and toilets were adopted in 1992.[1]

Factors Influencing Saturation Rates

Two major factors influence the saturation of water-conserving devices and appliances, the natural replacement rate or turnover of such devices, and the national, state and local codes requiring more water-conserving devices.

To develop its 20% by 2020 water conservation targets, the state of California used the turnover rates for the following devices and appliances presented in Table 8.1.

[1] However, the standards went into effect at the beginning of 1994.

Table 8.1. Selected Devices or Appliances and their Turnover Rates

Device or appliance	Average Life-span	Turnover Rate per Year
Showerheads	10 years	10 %
Residential Toilets	25 years	4%
Residential Clothes Washers	14 years	7%
CII Toilets	20 years	5%

Source: California State Water Resources Control Board (2008)

Changes in Federal and California state codes mandated that only efficient showerheads, faucets and toilets could be sold as of the beginning of 1994 (California Code of Regulations, Title 20, Chapter 2) and state regulations required that beginning in 2007 only high-efficiency clothes washers be sold[2] (California State Water Resources Control Board 2008). Taking their natural replacement rate and the code requirement into account[3] by 2010, LFSHs had likely surpassed the 75% saturation rate in the metropolitan region. This is the reason that LFSHs were not listed as a major water conservation measure in agencies' 2010 urban water conservation plans. Residential toilets, on the other hand, with a 25 year lifespan, may still require some active conservation policies on the part of agencies, such as LADWP, where the predominant majority of the housing stock pre-dates 1992. Using the turnover formula, in 2012, the percentage of inefficient toilets in areas, such as Los Angeles, could have been as high as 40%. However, LADWP, beginning in the 1990s, had a very aggressive conservation effort. LADWP's program included the free distribution of ultra-low flush toilets (ULFTs), which replaced 1.27 million inefficient toilets with ULFTs . ULFTs are toilets that use between 1.28 to 1.6 gallons per flush (gpf), in contrast to the older toilets that use 3.5 to 5 gpf. In addition, in 1998 the City of Los Angeles enacted an ordinance that required property owners to install water efficient devices before closing escrow. As a result of these efforts, LADWP quickened the conversion of inefficient toilets with water-conserving toilets, so much so that by 2006, LADWP stopped its rebates for ULFTs, reporting that 90% of the stock of inefficient toilets had been

[2] After 2007, in California, high efficiency clothes washers are to have a maximum water factor of 8.5 per machine. Water factor is a measure of the amount of water used per cubic foot of laundry. This is in contrast to traditional washers that have a water factor of 12.0 or more. After 2010, State standards reduce the water factor, requiring a water factor of 6.0 for clothes washers. Note the diminishing returns from successive technological innovations in this area.

[3] The formula used to estimate the rate of inefficient devices remaining is the following:
$x_t = x_0 (1 - r)^t$, where x_0 is the number of inefficient devices at the start, r is the turnover rate, and t is the number of years, and x_t is the number of inefficient devices remaining in year t (California State Water Resources Control Board 2008). The saturation rate from natural turnover in cases where a change in code requires more efficient water conserving devices would be, $sc_t = 1 - (1-r)^t$, where sc stands for saturation rate based on code changes and natural turnover rates.

replaced. Note that LADWP as of 2012 still provides rebates for High Efficiency Toilets (HETs) for residential customers. HETs are toilets that reduce water used by about 20% below ULFTs, with 1.28 gallons per flush or less. This latter illustrates how technological innovation can expand the opportunities for conservation within a decade, since the ULFTs introduced in the 1990s averaged 1.6 gpf, while the HETs introduced in the 2000s reduced the gallons per flush further by at least 20%. For clothes washers, based on their natural turnover rates, without active rebate programs from LADWP, the percentage of non-water conserving clothes washers could be as high as 75% in 2012, but by 2020, based solely on their turnover rate, the percentage of inefficient clothes washers would decline to 42%. These examples show the importance of changes in federal, state, and local standards or ordinances to achieve water conservation objectives. At the same time, they also show that, for devices or appliances with long life spans, active efforts on the part of the water agencies are important to quicken the attainment of water conservation goals.

Another factor that influences saturation rates for residential sector BMPs are household moves. The rate of household moves, especially for single family housing where the moves are often accompanied or preceded by remodeling or the purchase of new appliances (as illustrated in the Los Angeles and Huntington Beach case studies), is an indirect indicator of the turnover rate of inefficient appliances such as toilets. Thus, in cities, such as Huntington Beach or Los Angeles, where the residential turnover rate from 2000-2010 was over 50%, the actual replacement rate of inefficient toilets was likely to be higher than a rate based solely on the natural turnover rate.

Orange County Saturation Study

Saturation rates are not easy to establish empirically. Empirical studies require surveys and site visits. In the Metropolitan Los Angeles Area, only one major saturation survey has been conducted for Orange County by the Metropolitan Water District of Southern California and the Municipal Water District of Orange County. The 2002 Orange County Saturation Study focused on low-flow showerheads (LFSHs) and sought to answer two major questions: the extent to which saturation of LFSHs occurred uniformly across the county, and the extent to which saturation of LFSHs had reached the 75% required to meet BMP 2 target for both single and multi-family households in the county. The study results strongly indicated that, at least in Orange County, countywide results provided good estimates of retail water agency saturation rates. The other major finding from the study was that the saturation rate for LFSHs in the county for single family households in the winter of 2000 had not reached 75%, but was closer to 67% and the multi-family saturation rate ranged between 53% and 66%. Note that the natural replacement of inefficient showerheads in 2000[4] was 62%. Thus, the finding of 67% saturation rate for single family was 5% points above what would have been expected absent active efforts

[4] The actual effective date of the 1992 Federal standards was the beginning of 1994, thus, we can calculate the percentage of inefficient showerheads remaining or the saturation rate of efficient showerheads at the end of 2000 based on 7 years of natural turnover.

from the water agencies. The multi-family saturation rate obtained by the Orange County Study was even closer in alignment with the natural replacement rate calculation. This suggests that water agency efforts were not very effective in hastening the adoption of LFSHs in the County, especially in the case of multi-family households.

Another objective of the Orange County study was to identify the use of other indoor water-using devices in pre-1992 units, in particular ultra-low flow toilets (ULFT). As noted above, since 1994, only ULFT have been sold in the state of California. The county sample of Orange County households indicated that roughly 48% of all toilets in single-family housing units were ultra-low flush (ULFT) models. The saturation of ULFTs among multi-family dwellings, comprised largely of apartments, lagged behind at about 38%. Part of this difference is explained by the reasons given for replacing these types of devices. Occupants of single-family dwellings were much more likely to report having replaced showerheads and toilets during a remodeling project or, in the case of toilets, because they obtained a ULFT through a utility-sponsored program. Occupants of multi- family dwellings, on the other hand, were more likely to report that their showerheads and toilets had been replaced only because the old ones had failed. The lower saturation of water-efficient devices among multi-family dwellings, and the fact that multi-family households were less likely to report participating in utility-sponsored retrofit programs, suggests several possibilities. Multi-family households may have been less aware of the existence of utility-sponsored programs. They may also have faced greater barriers to program participation than occupants of single-family units. Note that the saturation rate of ULFTs based solely on the natural replacement rate in 2000 should have been about 25% for both single family and multi-family housing. The higher saturation rates obtained by the OC survey suggest more effective conservation programs on the part of the water agencies.

Outdoor Water-Conservation Devices

Outdoor water use accounts for about 40% of LADWP's water use and 60% of CVWD's residential use, and represent a large target of opportunity for water conservation in the region. Residential water use, especially single family residential, makes up a large proportion of outdoor water use and residential uses amount to from 66-69% of the water use of the three water agencies studied. Outdoor water use can be reduced by both water conservation devices, such as weather-based irrigation devices and pop up rotating nozzles, as well as landscape ordinances and landscape education and water pricing to reshape user behavior.

Weather-based irrigation devices and pop-up rotating nozzles, which are major devices currently in use by the water agencies to meet BMP targets represent relatively new technology and studies of their potential for water savings vary widely (U.S. Dept. of Interior Bureau of Reclamation 2008). A recent study recognizes that although many experimental studies have found that weather based irrigation devices can reduce water use by 40-70%, larger pilot scale projects indicate savings of 10% or less (Dukes 2012). CALGreen, the new State Building Code that went into effect on January 1, 2011, does require weather or soil-moisture based irrigation controllers for new construction or remodeling (CALGreen 2010, Title 24, Part 11, 4.304.1). But

there are no state standards that apply to the sale of such irrigation devices.[5] Thus, agencies cannot count on the natural replacement rate of such devices to eventually meet conservation goals for existing development. Outside of new construction and redevelopment, the widespread adoption of outdoor water conservation devices in existing development will need to rely on agency incentives, educational efforts, and water pricing.

The potential for water agencies to reduce their per capita water use to meet 20% by 2020 targets through outdoor water use varies not only by land use, but also, in single family residential areas, by the density or the size of the lots. For example, since most of CVWD's territory is single family residential with on average larger lots than the City of Los Angeles, a smaller percentage of single family households equipped with water-conserving outdoor devices could yield a proportionately greater amount of water conserved per household, and thus CVWD has a greater opportunity to reduce its per capita water use through outdoor water devices for residential customers and regulations than LADWP or Huntington Beach.

Meeting 20 x2020 Water Conservation Targets and Conservation Potential beyond 2020

The water agencies studied, as indicated in Chapter 6, are very likely to meet their conservation targets by 2020 to a large extent because they used options, allowed by the State, to select their baselines based on high water use years. As Table 2 makes clear, the 20% by 2020 per capita targets that agencies established are all higher than their per capita water use in 2010, admittedly a wet year during a recession. Wet years primarily reduce the amount of water that households and businesses use outdoors. The reduction of water use in wet years thus highlights the importance of outdoor water use in customers and agency water budgets, and the opportunities for savings.

[5] AB 1881, the Water Conservation and Landscaping Act (Laird 2006) required the California Energy Commission to hold rulemaking hearings to establish standards for water conserving irrigation devices. The CEC held such hearings, but ruled on July 29, 2009 to suspend rulemaking. After reviewing the available information, CEC determined that there was insufficient technical data and analysis to support standards or labeling for water-saving urban outdoor irrigation devices. (CEC 2009)

Table 8.2 Water Agencies Water Use in 2010, and 20 x 2020 GPDC Targets

Agency	2010 Water Use in gpcpd	Baseline gpdc for setting Agency 2020 target	Gpcpd Target for 2020	% Difference between 20 x 2020 Target and 2010 gpcpd
LADWP	117	152	138	15%
CVWD	215	285	228	6%
Huntington Beach	124	159	137	10%

From the percentage difference between the targets the water agencies set for themselves and their actual per capita water use, it is reasonable to assume that water districts can reduce their water use to at least their 2010 level beyond 2020 through outdoor water and CII conservation programs. We can assume just on this basis, see the last column in Table 2, that LADWP can reduce its water use by 15% beyond 2020, and Huntington Beach by 10%. Of the 3 agencies studied, with a 6% difference, CVWD seems to have the least potential for more savings. But this is related to the predominance of single-family residential in the district as discussed in Chapter 6. The district's potential for reducing residential outdoor water use is significant in the future through outdoor use conservation programs.

Saturation Rates by 2020

Even in the absence of State legislation (AB 407 2009) that requires that inefficient plumbing fixtures be replaced by 2020 (discussed in Chapter 2), most indoor water saving devices, such as HETs, and washers for single family residential households were likely to be close to a saturation point of 75% by 2020. AB 407 will ensure that by 2020, water efficient plumbing fixtures will exceed this saturation rate in the pre-1994 building stock, by requiring compliance for all types of buildings by 2019. However, without the AB 407 mandate, saturation rates would not likely have reached 75% for indoor CII uses, and the water agencies studied, especially LADWP, are focusing their rebate programs on the CII sectors. Since the CII sectors in the 3 agencies studied represent about 1/3 of the water consumption for the agencies, the total indoor water conservation potential from these sectors will likely be less than it has been for the residential sector.

With respect to outdoor water saving devices, neither residential nor CII outdoor water devices are likely to reach 75% saturation point by 2020. In the absence of State or Federal standards for outdoor irrigation devices (which would drive conversion through natural turnover rates), it is likely that such devices could yield substantial water savings beyond 2020. In addition, as we have experienced with ULFT and HETs, there are likely to be innovations in devices and appliances that will yield greater water savings in the future to meet climate change

challenges to the region's water supply. Thus, we can conclude that there will be significant opportunities to reduce outdoor water use beyond 2020. However, there are no studies that estimate the remaining potential of water conservation devices for outdoor water use beyond 2020.

Water-efficient New Construction

As discussed above, the combination of federal and state standards for water efficient plumbing fixtures will ensure that inefficient plumbing fixtures will be replaced in the pre-1994 building stock by 2019. CALGreen, the new State Building Code requires that new construction and remodeling incorporates water-efficient plumbing fixtures. In addition, CALGreen also identifies two voluntary sets of standards, Tiers 1 and 2, which localities can adopt to obtain more ambitious water conservation targets of 30, 35 or 40% for new buildings (CALGreen 2010, Title 24, Part 11, Sections 304-306). This means that all new construction and remodelings would need to meet the requirements of the code, and will be automatically meeting the 20% reduction in water use target. From the standpoint of the State's 20 x 2020 conservation target, CALGreen, ensures that the indoor plumbing fixtures in new development meets this target, and AB 715 and SB 407 do the same for the existing building stock.

Outdoor water use in new construction will also be impacted by CALGreen. As indicated above, CALGreen also mandates weather or soil-moisture based irrigation controllers (CALGreen 2010, Title 24, Part 11, 4.303.1-4.304.1). Also important for outdoor water use in new construction will be the local efficient landscape ordinances required by California AB 1881, which were adopted in January, 2010. Such ordinances apply primarily to new development, including residential development with irrigated areas larger than 5,000 feet, and existing landscapes larger than 1 acre. The ordinances assign water budgets to landscapes, and determine annual water allowances based on landscape area, local evapotranspiration rates, and the water needs of different plants. As a result, outdoor water use in new developments will be more water efficient than existing development. This makes clear that the future opportunities for outdoor water savings will be in pre-2011 residential and CII uses, in particular, in low-density residential uses.

New Opportunities for Conservation beyond 2020

CALGreen also provides further opportunities for water savings. Neither the City of Los Angeles nor Huntington Beach, have adopted the more water efficient voluntary Tiers 1 or 2, which can yield 30-40% water reductions instead of the mandatory requirements which are expected to reduce water use in new construction by 20%. In the future, cities can adopt Tier 1 or 2 standards and obtain greater indoor and outdoor water savings.

Our discussion of the potential of conservation measures to reduce water use beyond 2020 is not complete without an examination of the potential for water metering and water conservation pricing. The three water agencies analyzed have 100 % metered accounts. However, both LADWP and CVWD have mixed water accounts with significant irrigation use.

For example, LADWP has over 60,000 mixed accounts that could be supplied dedicated meters for outdoor water use (LADWP 2008). For new non-residential development, CALGreen requires separate meters for indoor and outdoor water use for development with landscaped areas beyond 1,000 square feet (CALGreen, 5.304.2). But for water agencies with significant low-density residential development, separate meters for indoor and outdoor water use may be an important future initiative.

Both CVWD and LADWP have increasing block (based on tiers) volumetric pricing, which meet the requirements of BMP 4, Metering with Commodity Rates. However, as discussed in the case study chapters, CVWD tier prices do not vary significantly enough to provide a strong economic signal, and LADWP's pricing structure relies on water budgets that provide larger tier budget allotments for residential lots with larger areas. Huntington Beach relies on a uniform rate structure, which complies with CUWCC requirements for the BMP, but which does not provide a clear economic signal to consumers. Thus, there is likely room for water conservation in the service areas of these agencies through pricing structures with improved inclining block features. According to Griffin's review of the literature (2006), the price elasticity of water use is in the range of 0.35 to 0.45. This means that a 10% increase in water price is likely to reduce water use by 3.5%-4.5%. This is not an insignificant effect, part of which can be better through improved conservation pricing.

In the future, if we were to combine both metering and water pricing by requiring separate water meters for indoor and outdoor water use for all types of accounts, including single family residential, it would enable differential conservation water pricing for indoor vs. outdoor use. This proposal goes beyond CALGreen's policy that requires separate meters for nonresidential new construction. A combination of separate meters for indoor and outdoor use for all accounts and improved conservation pricing could provide an effective, and perhaps, a less expensive strategy to reduce outdoor water use for *existing uses* instead of relying on water agency rebates and other programs. Note that both CALGreen and the 2010 landscape ordinances based on the State's Model Water Efficient Landscape Ordinance are primarily focused on new developments.

Overall, given the likely remaining potential by 2020 of water efficient appliances for indoor residential (through the adoption of CalGreen's Tier 1 or 2 building code options) and CII sectors and outdoor water conservation through irrigation fixtures, as well as through the future improvement in the efficiency of such devices, and adding the potential savings of separate meters and improved water conservation pricing, we speculate that, at least, for the water agencies studied, such efforts could yield another 20% of total water savings by 2035.

Findings

Saturation Rates Determine the Potential Contribution of Best Management Practices to Conservation. The extent of implementation to date and in the future or the saturation rate will determine the extent to which water agencies can meet the targets set for 2020 and beyond.

Saturation Rates are Influenced by Federal or State Mandates and Natural Turnover Rates. State mandates for water efficient devices or practices establish a date after which more efficient devices are sold or practices are mandated. Such a date can be used, in conjunction with natural replacement rates of devices or appliances to determine the saturation rate of quantifiable efficient devices within a district.

The Efficiency of Water Saving Devices can Increase over Time, with Decreasing Returns. Technological innovation has increased the efficiency of some devices and appliances, such as showerheads, toilets and washing machines. For example, more efficient toilets have decreased their water use from the traditional pre-1994, 3.5 gallons per flush, to the Ultra-Low Flush Toilets, post-1994, with 1.6 gallons per flush, to the current High Efficiency Toilets, using ≤ 1.28 gallons per flush. Note that the percent water savings from the second innovation is smaller than from the first innovation.

Orange County Saturation Study Provided Insights on Saturation Rates among Single and Multi-Family Households in the Region. The OC Saturation Study was an early (2002) and sole empirical study of the saturation rates in region for water conserving showerheads and toilets. The Study conducted surveys and site visits, 7 years after the implementation of federal mandates for the sale of water efficient devices. Saturation rates among single-family households were higher than for multi-family households for both water efficient showerheads and toilets, suggesting the need to tailor agency rebate and education to multi-family properties.

Outdoor Water Use Represents from 40-50% of Total Water Use among Agencies Studied with Great Potential for Savings. Potential savings in this area can be achieved through agency rebate programs for installing water saving irrigation devices and from regulations. Water agencies in the metropolitan area are increasing their financial rebates for pop up rotating nozzles and weather-based irrigation devices. CALGreen, California's new building code, in effect since January 1, 2011, requires weather-based or soil-moisture based irrigation devices for new construction. However, no federal or state standards for irrigation devices have been established. Since no standards for such devices have been established, natural turnover rates cannot be relied upon to reduce the number of inefficient devices. Only agency efforts will improve the efficiency of outdoor irrigation of existing uses, residential and CII.

CALGreen, California's New Building Code will Reduce Indoor Water Use of New Construction by 20%. The new Code requires that water efficient devices in new construction reduce water use by 2020. As the economy improves through the end of the decade new

construction will help reduce water agencies per capita water use. In addition, State law required that California cities and counties adopt water efficient landscape ordinances for new construction by January of 2010. The use of these new landscape ordinances to review development proposals will also contribute to reductions in water use.

Through a Combination of Saturation Rates and State Requirements, the pre-1994 Building Stock will Contain Water Efficient Plumbing by 2020. Through natural replacement, new state laws, and water agency efforts, most indoor residential devices will be water-efficient by 2020. As it is, water agencies are offering fewer rebates for indoor residential devices and concentrating their efforts on other sectors.

Room for Improving Water efficiency in the CII Indoor and Residential and CII Outdoor Sectors Through 2020. Water agencies studied are currently concentrating their efforts on these sectors.

Agencies likely to Meet their Conservation Targets by 2020 due to the Favorable Baselines they Established. Favorable baselines will likely permit water agencies to meet their 20 x 2020 targets without great effort, which implies that they can achieve significant water savings beyond 2020. CVWD with its larger lot residential zoning is most constrained in increasing water savings requiring active agency effort to reduce outdoor water consumption in both residential and CII sectors.

Greatest Conservation Potential beyond 2020 will likely Remain in Outdoor Water Use. It is likely that agencies can meet additional 20% reductions in per capita water use beyond 2020 through conservation efforts in residential outdoor use, and in CII indoor and outdoor water use through more efficient devices. In addition, the water agencies studied could also achieve water savings beyond 2020 by adopting more efficient water conservation pricing, by metering indoor and outdoor water uses, and finally by setting differential rates for indoor and outdoor water consumption.

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