Lower Water Bills

The City of Los Angeles Shows How Water Conservation and Efficient Water Rates Produce Affordable and Sustainable Use

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CALIFORNIA WATER EFFICIENCY PARTNERSHIP

Alliance for Water Efficiency

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Introduction

The Los Angeles Department of Water and Power (LADWP) provides water service to residents of the City of Los Angeles, California. LADWP has been a leader in water efficiency, conservation, and recycled water for decades. In addition to water conservation programs, LADWP has also implemented efficient water rate structures based on marginal costs, and bills customers with a fully volumetric rate and no service charge. Its innovative strategies related to water efficiency and conservation and rates over the years beg the question, "What would the economic impact on bills have been in the City of Los Angeles if none of these activities occurred?" "Are rate payers better off?" The relationship between conservation and water rates is not always well understood. Many water professionals and customers are perplexed by rate increases when system-wide water use has gone down, and blame water conservation and efficiency as the culprit for higher rates.

This white paper argues that this causality needs to be reversed: Higher water rates in a tiered structure send an intentional price signal to customers about the cost consequences of consumptive choices. Water rates that communicate cost consequences to customers provide the information basis for informed choices about efficient water use. Implementation of efficient water rates, efficient plumbing standards, and long-term conservation programs have lowered utility operating costs in the short and long term. This ultimately lowers the cost burden on water customers. This paper explores this dynamic by evaluating the costs that have been avoided by LADWP's water efficiency and conservation efforts, and the impact on customer bills.

The City of Los Angeles implemented water rate reform in 1992 that incorporated conservation pricing (tiered water rates), conservation programs, and the concept of marginal/incremental cost pricing set to the cost of recycled water. (The City selected recycled water as the least cost incremental water supply source.) Environmental advocates were instrumental in the passage of this rate reform. The City also advocated for national water efficiency standards that were incorporated as plumbing fixture standards (for low-flow shower heads and 1.6 gallon per flush toilets) in the National Energy Policy Act of 1992. California water agencies, including LADWP, also invested money in public media campaigns to advocate for wise water use. Further, California has experienced historic drought conditions in recent years and the City is currently implementing extraordinary conservation measures.

The City recently developed a water marginal cost of service model to set conservation water rates as a continued path to sustainable and affordable rates. The use of marginal cost of service is a progressive methodology in water planning and rate design in contra-distinction to average embedded methods. The existence of the City's marginal cost of service studies affords a method to measure the economic costs that were avoided by conservation efforts, both by rate design and direct programs such as rebates. The City performed the equivalent of integrated resource plans for water, which provided estimates of incremental supply costs that supported the water marginal cost study. Using the marginal cost study the City adopted the residential four-tier water rate design shown in Table1 (next page).

Table 1: LADWP Residential Water Rates Fiscal Year 2015-16

FY 2015-16	
Schedule A	$/HCF
Tier 1	$4.45
Tier 2	$5.41
Tier 3	$6.31
Tier 4	$7.91

This is the payoff from more than two decades of efficient water rates and investments in conservation.

This paper sets out to answer the question, "What would have been the economic impact on bills in the City of Los Angeles if none of these activities occurred?"--that is, if conservation had never happened. This is the payoff from more than two decades of efficient water rates and investments in conservation.

The paper provides a technical estimation of the economic benefit of conservation efforts over the last twenty-six years by using avoided marginal costs to value the savings. Historical roots of this analysis can be found in the public purposes of (Dupuit, 1844) and the institutionalist literature on avoided costs and efficient utility pricing (Boiteux, 1949).

The City's water department lies within the Los Angeles Department of Water and Power (LADWP), which is a joint water and electric department of the City of Los Angeles.

Scientific Methodology to Estimate the Economic Value of Conservation Savings

The study sets forth what would have happened to water demand and water costs in the City of Los Angeles in the absence of efficiency-oriented rates and conservation programs. It uses the following steps:

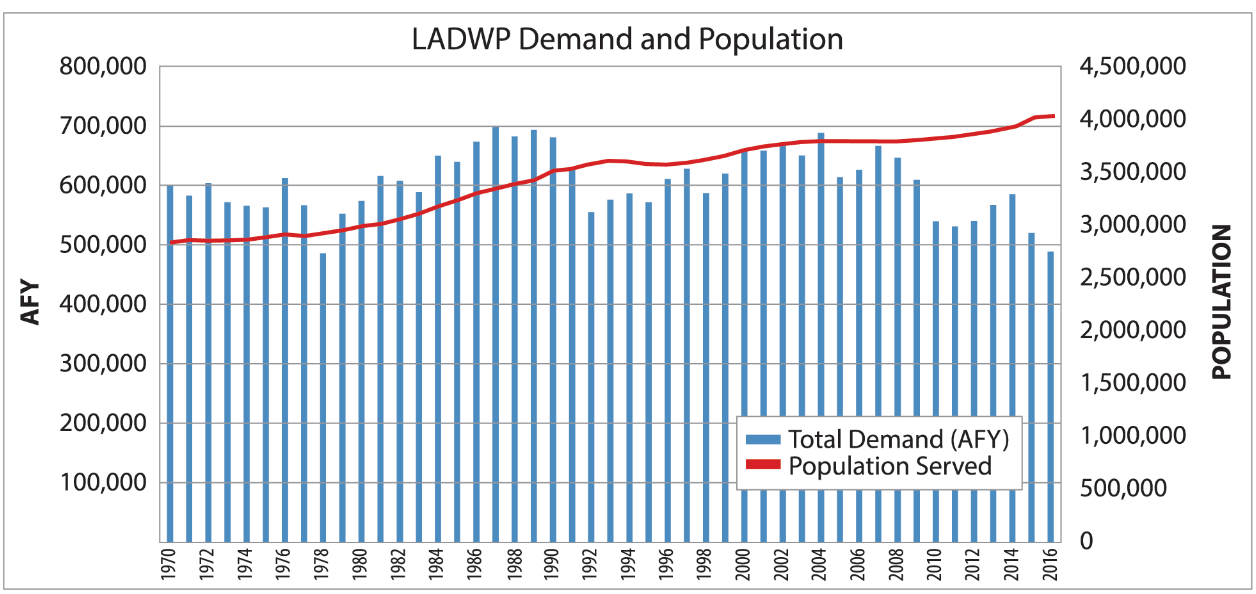
1. Estimate water demand at a constant per capita level (no conservation) and compare to the actual water demand historic path.
2. Estimate short-run marginal costs (O&M), taken from the City's marginal cost model.
3. Estimate long-run marginal costs (supply), taken from the City's marginal cost model.
4. Assess the impact on water revenue requirement and rates, both with and without conservation.

Note that the frame for this economic calculation is bound by the LADWP service area. It is likely that LADWP-sponsored conservation efforts produced benefits outside its service area; outside-of-area benefits are not calculated in this white paper. Similarly, LADWP-sponsored state-level efficiency standards, which have repeatedly set the stage for national water efficiency standards (Vickers, 2001, AWWA M54, 2017), are not separately broken out in the valuation.

Water Demand: With and Without Conservation

To determine the effect of conservation on water demands, annual population (persons) and system water demand (acre-feet per year, AFY) were examined for 1974 to 2016. Chart 1 illustrates annual water demand in acre-feet and the population served by LADWP.

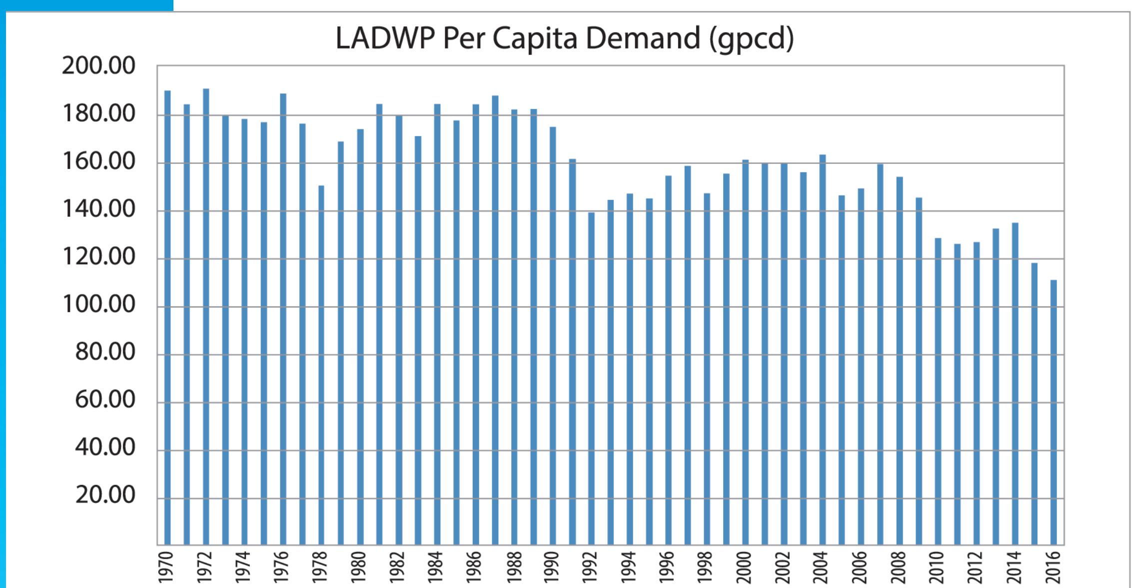
Chart 1: Historic LADWP Population and System Water Demand



Annual water demand fluctuates due to factors such as weather variation and cyclical economic conditions. As can be seen in Chart 1, population is clearly trending upward.

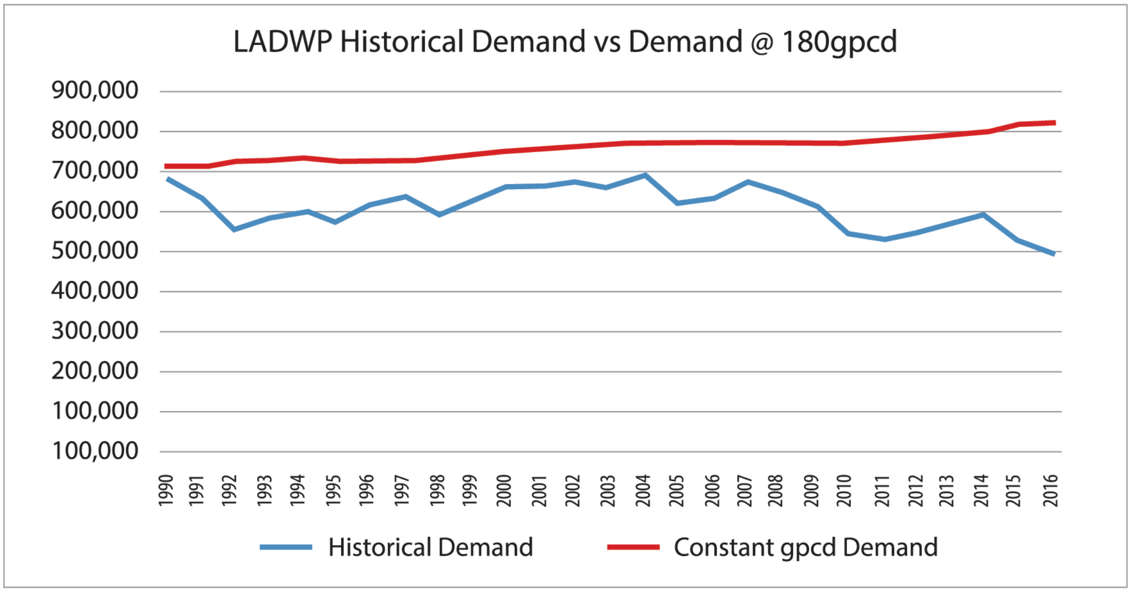
The period of study when significant conservation programs and tiered rate structures occurs from 1990 to the present. To better determine the effect of conservation starting in the 1990s, the data displayed in Chart 1 were converted to gallons per capita per day (gpcd), effectively taking the population trend out of the data. The resulting gallons per capita per day are displayed in Chart 2.

Chart 2: LADWP Gallons per Capita per Day



If one examines the gpcd for the decade before the 1990s, the water demand per person averages 180.2 with limited variation. After 1990, the demand drops below 160 gpcd never to rebound. The analysis uses the difference between the actual annual system water demand from 1990 to 2016 and holds the gallons per capita per day constant at the 180.2 level times the population. This is illustrated in Chart 3.

Chart 3: LADWP Actual System Water Demand and Projected Constant GPCD in AFY



Water Marginal Cost Estimates: Short and Long Run

For over two decades, the City has utilized marginal cost principles to inform water rates. The City was one of the first to implement an increasing tiered rate structure in the United States. In the last year, the City has updated its marginal cost model in anticipation of instituting a new four-tier rate structure. The current marginal cost model summarized by major functional categories is shown in Table 2 in 2013 US dollars per Hundred Cubic Feet (HCF).

Table 2: Water Marginal Cost by Functional Area (LADWP 2014 MC Study, 2013 US$)

Marginal Unit Cost By Function	MC	Units
Transmission		
Los Angeles Aqueduct Annual Cost (Plant)	$ 0.08	$/HCF/annual
Supply		
Supply (O&M)	$0.31	$/HCF/annual
Supply (Plant)	$0.81	$/HCF/annual
Purchased Water/Long-Run Marginal Supply Cost	$3.63	$/HCF/annual
Adder for Bay Delta Conservation Plan Delta Fix, Cap n Trade	$0.29	$/HCF/annual
Local Pumping	$0.11	$/HCF/annual
Water Quality & Regulatory		
Water Quality & Regulatory Capital	$1.40	$/HCF/annual
Water Purification (O&M)	$0.19	$/HCF/annual
Distribution		
Distribution Storage Plant	$0.18	$/HCF/annual
Distribution Storage O&M	$0.09	$/HCF/annual
Distribution Plant	$1.16	$/HCF/annual
Distribution O&M	$0.42	$/HCF/annual
Customer Service, Billing	$0.34	$/HCF/annual
A&G	$0.40	$/HCF/annual
Total Marginal Cost	$9.40	

The total marginal cost across all functional categories was $9.40/HCF (Hundred Cubic Feet) in 2013 US dollars. Only a portion of these costs are affected by per capita volumetric conservation: supply, treatment and local pumping. Table 3 describes the subset of marginal costs affected by the assumed per capita conservation that sums to $4.25/HCF. The short-run water marginal cost was $267.83 (2013 US$) per acre-foot, the long run $1,582.28 (2013 US$). Short-run marginal costs were derived from a General Ledger analysis of actual historical year costs. The long-run marginal supply cost was set to the marginal cost of recycled water, adjusted for distribution system loss (i.e., each acre-foot of delivered supply requires more than one acre-foot produced).

Table 3: Water Marginal Costs Affected by Per Capita Volumetric Conservation (2016 US$)

Marginal Unit Cost By Function	MC/unit	Short-Run	Long-Run	Source Notes
	$/HCF/annual	$/AFY	$/AFY	
Supply (O&M)	$ 0.31	$133.34		MC derived from General Ledger analysis of actual historical year costs
Long-Run Marginal Supply Cost	$3.63		$1,582.28	MC of Recycled Water from UWMP $1500/AF (ad. for 5.2% system loss)
Local Pumping	$0.11	$49.60		MC derived from General Ledger analysis of actual historical year costs
Water Purification (O&M)	$0.19	$84.90		MC derived from General Ledger analysis of actual historical year costs
Total	$4.25	$267.83	$1,582.28	(2013 $)
Total		**$275.36**	**$1,626.74**	(2016 $)
Adjusted for inflation using the California All Urban Consumer Price Index for Los Angeles				

Avoided Cost Impacts With and Without Conservation

Given the water marginal cost estimates and the difference in water demand attributed to the study period of 1990 to 2016, the value of water saved can be assessed. The short and long-run water marginal cost estimates in 2016 US dollars are multiplied by the water demand difference. Table 4 shows the resulting sum over the study period for both short and long-run marginal costs is $7.71 billion in constant dollars (2016 US$). For comparison purposes, operating revenue for LADWP from 1990 to 2016 was $21.19 billion in constant dollars (2016 US$). Thus, actual customer bills would have increased an average of 36.4% (~=$7.71/$21.19) to pay for the additional costs caused by constant per capita consumption. Equivalently, one can state that reductions from constant per capita demand—induced by efficient water rates and conservation—produced an average 26.68% (~=$7.71/($7.71+$21.19)) reduction in customer bills over this period. Table 4 provides a summary of this computation.

Table 4: Estimate of Economic Benefit of Conservation 1990 to 2016

Calculation Step	Short-Run Avoided Costs Real 2016 US $	Long-Run Avoided Costs Real 2016 US $	Total
Marginal Cost (2016 US$/AF)	$275.36	$1,626.74	$1,902.09
Marginal Cost multiplied by the Demand Difference, Summed over 1990-2016 (2016 US$)	$1,116,280,476	$6,594,712,331	$7,710,992,807
Summed Operating Revenue 1990-2016 total (2016 US$)			$21,192,930,837
Percent Bill Reduction, 1990-2016			26.7%
Marginal Cost times Demand Difference, Summed over 1990-2016; Timed Value Adjusted (@ 3.186% real discount rate)	$1,600,448,745	$9,455,060,179	$11,055,508,924

To arrive at an absolute dollar amount, the time stream (1990-2016) of avoided costs in Table 4 were adjusted to reflect the time value of money. A dollar saved in 1990 could have been invested using the real interest rate of 3.19% (financial assumptions in the LADWP Marginal Cost study) resulting in a higher value in 2016. The real interest rate is derived from the LADWP cost of capital (5.25%) and inflation rate (2%) that were the financial assumptions used in the LADWP Marginal Cost Study.[1] The standard present value formula is applied by year to the avoided costs. The sum of the time value adjusted savings over the study period across short and long-term avoided costs is $11,055,508,924. In other words, an estimate of the present value of savings in water supply, treatment and pumping since 1990 is on the order of $11 billion (2016 US$).

1 An exact formula for the real discount rate can be derived from the Fisher Equation: $r=(n-i)\div(1+i)$ where r is the real discount rate, n is the nominal discount rate, and i is the expected inflation rate. Hanke and Wentworth pointed out material problems to using an additive approximation ($r \approx n-i$) to real interest rates in water resource cost-benefit analysis.

Summary

This paper sets out to answer the question, "What would have been the economic impact on bills in the City of Los Angeles if water rate reform and water conservation had never happened?" Customer bills have been reduced from what they would have otherwise been due to the costs of avoided water supply. Readers should note that this study has focused only on the avoided costs of water supply. Wastewater/stormwater revenue and avoided costs have not been examined in this study, but other studies (Fiske and Chesnutt, 2010) have shown wastewater avoided costs were at least as large as the water supply only costs. Therefore the overall bill savings of both water, wastewater, and stormwater costs from conservation could have been twice as high as the magnitude of the summed water supply costs of $11 billion (2016 US$), a significant sum.[2] Thus, our estimate of a 26.7% real reduction in water supply costs constitutes a lower bound on total water avoided costs as it does not include the effects on customer wastewater bills.

The use of marginal cost of service is a progressive methodology (Boiteux, 1949; Kahn, 1991) in water planning and rate design in contra-distinction to the sole use of average embedded methods. Both are allowed under American rate design standards (AWWA, 2017).[3] The marginal cost of service, by measuring and communicating the forward-looking economic costs avoided by demand reduction to customers (whose value Dupuis explicated in 1844), has the advantage of both reducing customer bills and avoiding rate shock (AWWA, 2017). Full cost water pricing using marginal cost methods

2 We also note that wastewater avoided costs are more involved and must include the complications from reduced volumetric flow. See the CUWA white papers on the topic, "Adapting to Change: Utility Systems and Declining Flows" November 2017. We note that LADWP appears to have successfully adapted. http://cuwa.org/pubs/CUWA_DecliningFlowsWhitePaper_11-28-17.pdf

3 Both methods are, in fact, still needed. Average-embedded costs still form the basis for determining revenue requirements and marginal/incremental cost methods inform the appropriate price signal in a rate design. See Chesnutt, T.W., et al., (2014) Building Better Water Rates in an Uncertain World, A Water Rates Handbook, Appendix A: Costing Methods.

communicates cost consequences to customers; Customers respond to this price signal. The City of Los Angeles has a long history of water rate innovation, implementation of large scale water-end-use efficiency programs, and has established the political feasibility of instrumental uses of water rates to modulate scarcity and improve customer affordability. The summed avoided water supply costs of $11 billion (2016 US$) reduced customer water bills by 26.7%, improved the long-term water sustainability of Los Angeles, and constitutes a meaningful sustainability payoff from two and a half decades of water conservation efforts and efficient water rates.

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