Cost–Benefit Analysis of Onsite Residential Graywater Recycling: A Case Study on the City of Los Angeles

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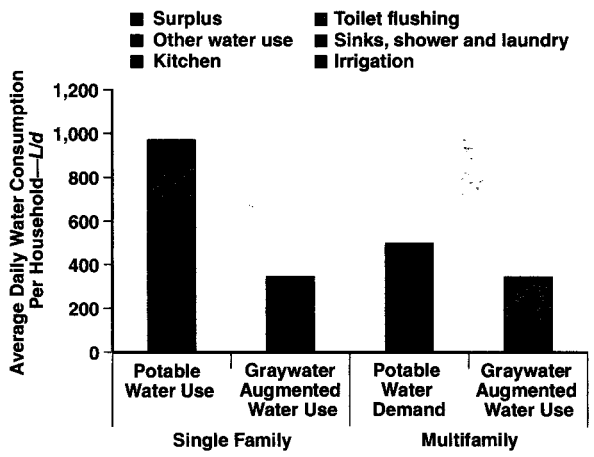
The City of Los Angeles, Calif., has a population of 4.1 million but has limited local water resources, instead relying mainly on imported water (approximately 86% of the total water supply). A small fraction of the city's water supply (only about 1%) is from recycled water. Low use of recycled water mainly results from a lack of distribution infrastructure. As a result, approximately 76% of the city's effluent is released into the Pacific Ocean. Because about 68% of the approximately 685 × 10^6 m^3/y of total water supply is for residential purposes, onsite graywater recycling would enable the city to increase its water recycling capability and capacity as well as improve water sustainability and drought resilience.

Graywater is defined as domestic wastewater from handwashing sinks, showers, bathtubs, and washing machines; kitchen wastewater is excluded from the definition of graywater in some regions, such as California. Graywater reuse without treatment is generally encouraged only for subsurface irrigation to minimize human exposure to pathogens. In California, above-ground graywater recycling is allowed only when effluent meets disinfected tertiary standards. The treatment costs for meeting such requirements encompass capital, operations and maintenance, and building-retrofitting costs. High treatment costs favor onsite graywater treatment in high-density multifamily homes but impede the adoption of onsite graywater treatment in low-density residential housing such as single-family homes. Lowering treatment costs will provide shorter payback periods and broader economic implications for onsite graywater recycling in residential homes.

FIGURE 1 Potential reduction in potable water demand achievable with onsite graywater recycling in single-family and multifamily homes in Los Angeles, Calif.



METHODS AND MATERIALS

This study evaluated the cost and benefits of graywater recycling by establishing potential indoor and outdoor water consumption in residential homes using publisheed indoor water use surveys as well as land and water consumption data. A cost–benefit analysis of onsite graywater recycling for end users was performed by estimating the average costs of treatment and retrofits along with savings from water conservation. In addition, a cost–benefit analysis of onsite graywater recycling for water and wastewater agencies was performed by comparing the costs and carbon footprint size of recycled graywater with other water sources.

CONCLUSIONS

This study shows that graywater recycling can increase Los Angeles' ability to reduce potable water consumption and lower water supply demand and treatment-related energy demand. The estimated available graywater in the city is equivalent to approximately 25% of its water supply. Graywater recycling can reduce Los Angeles' potable water consumption by 27% for a single-family home and by 38% for a multifamily dwelling (Figure 1). With 10% of the population participating, the city would be able to reduce water supply demand and treatment-related energy demand by 43,000 MW·h/y, reduce potable water demand by 2%, and reduce wastewater treatment load by 3%. This study also shows that amending local building codes to require new construction to include plumbing that diverts graywater for direct reuse or treatment would greatly facilitate onsite graywater recycling by lowering or eliminating costs related to building retrofits.

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