Energy Savings from Moulton Niguel Water District Water Efficiency Programs

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Environmental Problem

Water's density and specific heat capacity make it energy intensive to move, treat and heat: in California, these activities account for 19% of the state's overall electricity use and 10% of its greenhouse gas (GHG) emissions. Despite the well-established link between water use, energy use, and GHG emissions, few studies have examined the energy savings and avoided emissions that result from programs that reduce household water use by installing water-efficient devices.

Project Objectives

Objective 1

Quantify energy saved and GHG emissions avoided through water savings associated with five of Moulton Niguel Water District's residential rebate programs: high-efficiency clothes washers (HECW), high-efficiency toilets (HET), weather-based irrigation controllers (WBIC), rotating sprinkler nozzles (RSN), and turf removal (TURF).

Objective 2

Develop a framework that other water providers can use to conduct similar analyses on their own rebate programs.

Findings

The majority of water savings were realized through the HECW and HET programs, as they had high levels of participation and per-device water savings. Embedded energy remained relatively constant throughout the study period (2010-2019), and was largely composed of energy use during transport via the State Water Project (SWP) and Colorado River Aqueduct (CRA). Embedded GHG emissions decreased significantly over the course of the study period, from a peak of 691 $kgCO_2e$/acre-foot (AF) in 2012 to a low of 425 $kgCO_2e$/AF in 2017. Past rebate participation most heavily influenced the rate of accumulation of total energy and GHG savings, whereas savings in a given year were more affected by that year's embedded energy and GHG factors. **Ultimately, district-level water savings of 4,087 AF during the study period translated into energy and GHG savings of 10,497 MWh and 2,678 metric tons CO_2 e, respectively, across MNWD's water supply chain.**

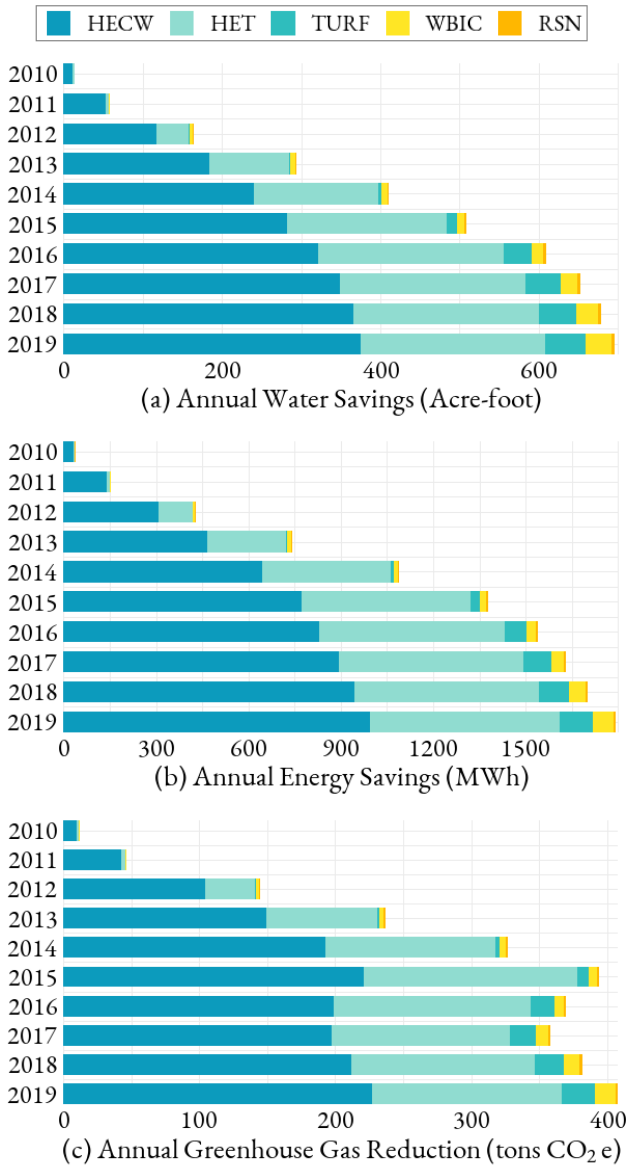

Figure 1. These three graphs present the annual water savings (acre-foot, AF), energy savings (megawatt-hour, MWh) and greenhouse gas emissions reductions (metric tons CO_2 equivalent) associated with the selected rebate programs from 2010 to 2019, respectively.

Background

Moulton Niguel Water District (MNWD) serves over 170,000 customers across six cities in Orange County, CA. Approximately 85% of these customers are residential. Southern California Edison (SCE) and San Diego Gas & Electric (SDG&E) supply energy to MNWD's 16 lift stations and three wastewater treatment plants.

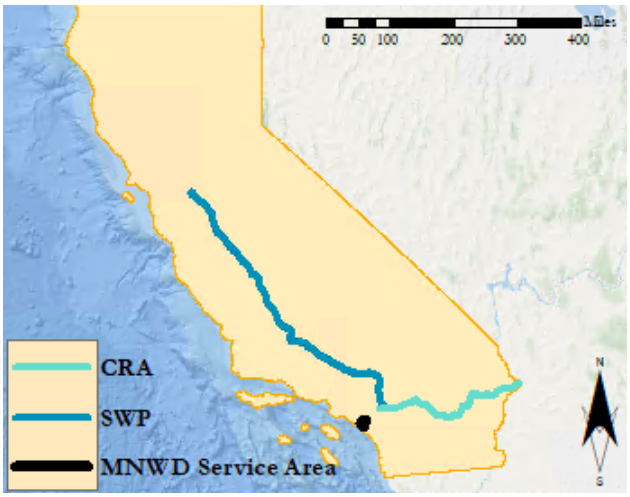

Figure 2. All the water supplied to MNWD's residential customers comes from the State Water Project (SWP) and the Colorado River Aqueduct (CRA), purchased from the Metropolitan Water District of Southern California (MWD).

Methods

A 2015 University of California, Riverside study of MNWD's rebate programs provided water savings estimates for the selected rebate programs. Internal system audits conducted by MNWD were used to account for system loss and calculate avoided water imports. Embedded energy values were developed for MNWD's potable water supply and wastewater effluent using SCE and SDG&E facility energy use data, and source water embedded energy values provided by MWD. Utility-specific emissions factors were applied to energy use data to find embedded emissions. Finally, avoided water use, embedded energy, and embedded emissions results were translated into energy saved and emissions avoided at the program level using rebate invoice data.

Framework

After quantifying program-level savings from MNWD's rebate programs, a framework for repeating this analysis on other rebate programs was developed. The framework distills established methods used in Objective 1 into a set of fundamental equations usable by other water utilities. These equations allow calculation of embedded energy and emissions factors and the quantification of program-level water, energy, and emissions savings. They are applicable to a broader range of rebate programs in service areas with water supply portfolios different from MNWD's. The framework also includes basic recommendations for data management and key factors for consideration during analysis.

Impacts & Conclusions

The results demonstrate that energy savings and avoided emissions resulting from water saved through efficiency programs can be quantified. This quantification offers utilities an opportunity to:

- understand which rebate programs yield the highest co-benefit savings and invest resources accordingly.
- include rebate programs in tracking progress towards energy efficiency, emissions reduction goals.
- collaborate with energy providers on cooperative rebate programs designed to reduce water use, energy use, and GHG emissions.

Recommendations

The approach taken in this study and defined in its proposed framework can be improved in several ways:

- Improving data management and sharing best practices will streamline the calculation of embedded energy and emissions factors.
- Regular data curation and standardization of methods for controlling for confounding factors will increase the accuracy of savings calculations.
- Techniques for capturing spatial and temporal variability of water savings, embedded energy, and embedded GHG emissions should be further investigated.
- Repeating this analysis will help identify procedural barriers to cooperative rebate programs that can be addressed with state-level policy changes.

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