Journal of Environmental Management 128 (2013) 683–689

Contents lists available at SciVerse ScienceDirect

Journal of Environmental Management

journal homepage: www.elsevier.com/locate/jenvman

Water conservation quantities vs customer opinion and satisfaction with water efficient appliances in Miami, Florida

Mengshan Lee*, Berrin Tansel

Civil and Environmental Engineering Department, Florida International University, 10555 W. Flagler St., Miami, FL 33174, USA

ARTICLE INFO

Article history:
Received 26 November 2012
Received in revised form
14 May 2013
Accepted 23 May 2013
Available online 10 July 2013

Keywords:
Sustainability
Water conservation
Water use behavior
Water use efficiency measures
Residential customers
Synergistic effect

ABSTRACT

During 2006–2007, Miami-Dade County, Florida, USA, provided incentives for low income and senior residents in single family homes for retrofitting with high efficiency fixtures. The participating residences were retrofitted with high-efficiency toilets, showerheads, and aerators. In 2012, a telephone survey was conducted to evaluate the satisfaction of the participants and the associated effects on water conservation practices. This study evaluates the attitudes and opinions of the participants relative to water use efficiency measures and the actual reduction in water consumption characteristics of the participating households. The participant characteristics were analyzed to identify correlations between the socio-demographic factors, program satisfaction and actual water savings. Approximately 65.5% of the survey respondents reported changes in their water use habits and 76.6% reported noticeable reduction in their water bills. The analyses showed that the satisfaction levels of the participants were closely correlated with the actual water savings. The results also showed that satisfaction level along with water saving potential (i.e., implementation of water efficiency devices) or change of water use habits has provided positive synergistic effect on actual water savings. The majority of the participants surveyed (81.3–89.1%) reported positive attitudes for water conservation incentive program and the benefits of the high efficiency fixtures.

1. Introduction

Water conservation is recognized as a critical factor for water demand management (Baumann et al., 1998). The water demand management strategies can be broadly divided into three major categories as economic, technological and behavioral (Brooks, 2006; Saurií, 2003). Demand management strategies such as water metering, rebate/retrofit programs for high efficiency devices, water efficiency labeling, water conservation or education programs, and leakage control have been proposed and/or implemented for various applications (Inman and Jeffrey, 2006). Recently, the water demand management focus has shifted to residential customers by implementation of programs that are designed to encourage voluntary water conservation either by altering water use behaviors or utilizing water use efficiency fixtures (Lee and Tansel, 2012; Lee et al., 2011a; Syme et al., 2000).

Residential households are considered to have the potential for significant water and energy savings (Willis et al., 2010). The U.S. EPA and Federal Energy Management Program (FEMP) identified water efficiency Best Management Practices (BMPs) for indoor water use fixtures such as toilets, showerheads and washers (Mayer et al., 1999; Vickers, 2001). The strategies for promoting use of water efficiency fixtures have been successful in some communities resulting in up to 35% of indoor water savings (Balbin et al., 2010; Inman and Jeffrey, 2006; Lee et al., 2011b; Mayer et al., 2004). Recent studies have reported that water conservation behaviors may pose significant influence on water conservation quantities (Gilg and Barr, 2006; Kolokytha et al., 2002; Millock and Nauges, 2010; Randolph and Troy, 2008; Russell and Fielding, 2010).

Water conservation behaviors can be divided into two major categories as (1) efficiency behaviors, and (2) curtailment behaviors (Gardner and Stern, 1996). Efficiency and curtailment behaviors refer to on-off behaviors (i.e., installing high efficiency fixtures) and conservation actions (i.e., reducing time for showering), respectively. Stern (2000) reported that the major causes of water conservation behaviors as attitudes, beliefs, habits or routines, personal capabilities and contextual force. Russell and Fielding (2010) observed that committed water conservation behavior was consistent with the theory of planned behavior that user usually posed positive attitudes to water conservation, perceived social support (i.e., personal norms) and behavioral control. Socio-demographic characteristics, on the other hand, are usually

* Corresponding author. Tel.: +886 423590121x30045/39; fax: +886 423594276.
E-mail addresses: mlee011@fiu.edu, mengshanlee@thu.edu.tw (M. Lee).

0301-4797/$ – see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.jenvman.2013.05.044

considered as proxies for personal capabilities (such as knowledge and skills) or contextual factors (physical infrastructure and technical facilities in the household) in facilitating water conservation behaviors (Stern, 2000). Socio-demographic and psychological determinants are expected to provide an essential basis for examining the nature of water conservation behaviors. There is a need of exploring the interrelationships between social and psychological variables and water conservation (Campbell et al., 2004).

During 2006–2007, Miami-Dade County, Florida invited low income seniors and other qualifying low income residents in single family homes built before 1996 to participate in the High Efficiency Fixture Retrofit Program. The participating residences were retrofitted (free of charge) with up to two high-efficiency toilets, up to two high efficiency showerheads, a maximum of two bathroom faucet aerators, and a kitchen faucet aerator. The expected water savings, as detailed in Table 1, for the installed high efficiency showerhead, aerator and toilet were 28, 9.3 and 34.7 gallons per household per day (GPHD), respectively (Lee et al., 2011b; Mayer et al., 2004). The purpose of this study was to assess the water conservation quantities and associated effects (e.g. satisfaction level and change of water use habits) of the participating customers in the High Efficiency Fixture Retrofit Program. A telephone survey was used to collect feedback from the participants. The survey results were analyzed to identify the correlations between the water conservation quantities, changes in habits and satisfaction levels of the participating costumers.

2. Methodology

2.1. Sample description

The High Efficiency Fixture Retrofit Program was first started in late 2006 with total of 271 senior or low income households with average 2.3 occupants in the households. These participants are living in houses with characteristics of average 2.7 bedrooms, 1.5 bathrooms and adjusted building footage of 130 m^2 (Lee et al., 2013). In urban area of Miami-Dade County with total population of about 2.59 million people (estimated in 2012), approximately 14.2% of the total population is seniors (persons who are over 65 years old) and 17.9% of the total population is persons below poverty level from 2007 to 2011. The average number of occupants in a household in Miami-Dade County from 2007 to 2011 is 2.93 people (U.S. Census Bureau, 2013).

Household water demand reduction for High Efficiency Fixture Retrofit Program participants ranges from 18.8% (for survey participants) to 23.8% (for all participants) within three years of implementation, whereas the reduction for customers participate in other high efficiency appliances rebate programs is only approximately 14.5% (Table 2). This can be partly due to the differences in family composition, life style, and the quantity of water saving devices installed (Lee et al., 2013). The declining trends in household water demand for all program participants demonstrated the success of implementation of water conservation practices.

Table 1
Description of high efficiency fixtures used in the senior and low income full retrofit program.

Fixtures	Water use rate	Water saving potential (GPHD[a])	Installed fixtures (unit/household)	Maximum number of fixture installed (unit/household)
Toilet	1.28 GPF[b]	34.7[d]	1.4	2.0
Showerhead	1.5 GPM[c]	28.0[d]	1.4	2.0
Aerator	1.5 GPM[c]	9.3[e]	2.0	3.0[f]

[a] GPHD: gallons per household per day.
[b] GPF: gallons per flush.
[c] GPM: gallons per minute.
[d] Lee et al. (2011b).
[e] Mayer et al. (2004).
[f] 2 for restrooms and 1 for kitchen.

2.2. Survey procedure

The survey participants were randomly selected from the participating households in the High Efficiency Fixture Retrofit Program ($n = 271$) since the first year of the project implementation in fiscal year 2006–2007. Stratified random sampling method was applied in selecting survey participants for representing the total population. The survey group was first ranked by their water consumption data (from highest to lowest) and divided into subgroups with different water consumption ranges to ensure that participants with different water consumption characteristics are included in the survey. In total, 121 participating households were selected for the survey. The survey was conducted by telephone using a questionnaire. The questionnaire included questions in the following four categories:

1. Water-using-related socio-demographic characteristics (i.e., address, gender, number of occupants in household, education levels of occupants, verification of the number and type of water use efficiency fixtures still in place at the residence);
2. Customer satisfaction (i.e., ease of application process, scheduling of appointment, installation process, and use of product);
3. Effects of the project (i.e., change of water use habits, monetary savings on water bill, recommendations to others on water saving devices, and, interest in trying new water saving devices); and
4. Awareness of the program (i.e., obtained information from television or radio, awareness of other water conservation programs from MDWASD, and, knowledge of water conservation programs from other organizations).

The survey results were recorded and entered into an excel format for further analysis. Full responses were received from 64 households surveyed out of 121 attempted, which corresponds to 52.8% response rate.

2.3. Data analyses

The potential water savings in relation to the number of high efficiency fixtures installed in the participating households were evaluated using an index based water saving potential. The water saving potential of each household was evaluated on a scale of 1–3. As shown in Table 3, the customers with water saving potential index of 3 had a maximum of two high efficiency showerheads, two high efficiency toilets and three high efficiency aerators. A

Table 2
Household water demand changes of surveyed participants in comparison with other program participants within the community.

Participants (mean, GPHD[a])	Base year	1st year	2nd year	3rd year
Survey participants ($n = 64$)	198.7	188.2	191.5	161.3
HEFRP average ($n = 271$)[b]	203.9	197.4	184.9	155.3
REBATEs average ($n = 1829$)[c]	259.5	248.9	231.3	222.0

[a] GPHD stands for gallons per household per day.
[b] High efficiency fixture retrofit program (same as SLIFR program in Lee et al., 2013).
[c] Customers participated in either toilet, showerhead or clothes washer rebate programs (Lee et al., 2011a, b).