Measurement and Verification Guidance Document
Project Summary

CalWEP and the UC Davis Center for Water-Energy Efficiency will be collaborating on a Measurement and Verification Guidance Document Project, also known as the Evaluation of Urban Water Conservation Programs: Standard Methods for Measurement & Verification of Water Savings Project. The purpose of the project is to develop a guidance document outlining the different methods that can be used to verify the water savings of various water conservation and efficiency programs.

After extensive review and approval by the CalWEP Research and Evaluation Committee and two task forces, the CalWEP Board of Directors voted in early September to approve for CalWEP to begin fundraising for the project. **The goal is to raise $140,000**.

Background
In 2014 and 2016, the Department of Water Resources sponsored a Water Energy Efficiency Grant Program, which provided funding for water efficiency programs that would save water and water-related embedded energy. Funds for the grant programs came from proceeds of the California Air Resources Board's Cap and Trade Program.

CARB requested that the DWR grants be evaluated for savings. However, during the grant solicitation and award contracting process, the requirement to evaluate water and energy savings was not required. As a result, the measurement and verification of such savings was not planned for in most of the grantee programs.

UCD CWEE is currently in contract DWR to evaluate the water and energy savings of a portion of DWR's 2014 and 2016 grants. In collaboration with CalWEP, UCD CWEE will leverage their work evaluating DWR's grants to develop a measurement and verification guidance document.

Problem/Need
Without planning for the measurement and verification of water savings of an efficiency program prior to implementation, accurate quantifications of the savings achieved under the program would be difficult to assess. This can be due to an insufficient number of program participants, a lack of required data, and other factors. Furthermore, without consistent measurement and verification methodology, it would be challenging to compare water savings between different programs in order to determine the most impactful program.

Solution
Upfront planning for conducting evaluations of efficiency programs with a focus on consistent measurement and verification will help yield accurate estimates of savings achieved. The guidance document produced under this project will outline how to design or plan for a verifiable study of a program, data needs and limitations given data availability, and different evaluation approaches that include experimental and non-experimental methods. The goal is to develop measurement and verification guidance that is streamlined, easy to follow, feasible to implement, and geared towards water utilities.

Additional Background (Provided by UC Davis):

The UC Davis Center for Water-Energy Efficiency (CWEE) is in contract with the Department of Water Resources (DWR) to evaluate the water and energy savings of a portion of the 2014 and 2016 DWR Water Energy Efficiency Grant Program. The program provided funding for the installation of water efficiency measures that aimed to save water, and water-related embedded energy savings. The program was funded by the proceeds of the California Air Resources Board's (CARB) Cap and Trade Program through the appropriated Greenhouse Gas Revolving Fund. Once the 2016 grants were awarded, CARB requested that the DWR grants be evaluated for savings through the measurement and verification (M&V) of program participants' pre- and post-implementation data at the customer level using water and energy consumption data. Evaluation of grantee conservation programs was not required during the grant solicitation or award contracting and, therefore, planning for M&V was not included in most of the designs of the grantee conservation programs.

Unfortunately, without planning for evaluation prior to rolling out conservation programs, accurate estimates of the savings achieved by the various conservation measures could not be produced for many of the funded programs. In some cases, there was incomplete participant data, often due to unwillingness of data owners to share data. In other cases, the number of treatments was insufficient to produce a precise estimate of the water and energy savings. Even in programs with many treatments and complete data, CWEE could only quantify the savings using retrospective studies instead of rolling out randomized control trials, the gold standard in measuring the effect of implementing different treatment measures. Instead, with upfront planning and a focus on M&V included in the roll out of new programs, it will be possible to consistently produce accurate estimates of the realized savings achieved by conservation programs going forward. Perhaps most importantly, with more precise savings estimates from each conservation program, and more consistency in M&V approaches across conservation programs, it will increasingly become possible to better select the most impactful programs and target them where they will have the largest savings.

Project Motivation

To measure the water savings achieved by efficiency measures, an M&V evaluation compares the actual water consumption for the program participants to the hypothetical amount they would have consumed if they never received the efficiency measures. The main difference between various M&V methods is the different assumptions that are required to construct this hypothetical amount of water, which then result in different levels of accuracy in measured savings that result.

The most accurate savings estimates will come from experimental studies. Experimental studies, by definition, add some level of randomness to either who receives the treatment of efficiency measures and/or when they receive them. This may involve randomly encouraging some households to participate in an efficiency program and/or randomly setting the dates for when participating customers will receive their upgrades. This process requires more upfront planning, but also significantly benefits the evaluation process. The methods used to evaluate experimental studies are often much simpler than those used to evaluate non-experimental studies and require far weaker assumptions. Consequently, experimental studies will be more accurate and provide a higher level of confidence in the results.

Due to the perceived complexity and lack of standards or guidance[1] in the water industry on how to perform or plan for M&V activities, programs are either not evaluated or evaluated using a variety of different methods and designs. If programs are evaluated, it is often done using non-experimental methods. These methods compare households to themselves to estimate water consumption before and after the households receive the efficiency measures, and sometimes are compared to other similar households that did not participate in the program. Often, these non-experimental methods must impose unreasonably strong assumptions to account for the fact that participants select to be treated, and to a certain extent, choose when to receive treatments. Consequently, it is often difficult to place much confidence in the resulting savings estimates.

Ultimately, non-experimental programs are simpler to implement but more difficult to evaluate. While, non-experimental methods are sufficient in some cases, the lack of confidence in the resulting estimates, and the lack of consistency in estimation approaches makes it difficult to compare between water supply utilities or to understand the likely effects if the same type of program was rolled out again. These inconsistent evaluation methods across the California water suppliers prevent the sharing and translation of knowledge in a sector that would greatly benefit from leveraging the funding of their peers to advance water efficiency in California.

Project Objectives

The development of the M&V guidance document will include three primary objectives:

1. Provide guidance surrounding the data requirements to conduct effective M&V analyses. This will include:
   - How to determine the minimum number of participants in order to detect an effect of a certain size.
   - What data will need to be obtained, for example:
     - Will water consumption need to be observed within non-participating homes, and if so, how many?
     - How long before and after the treatments occur will water consumption need to be observed?
     - How do these requirements vary with the frequency of the data observed (e.g., monthly billing data vs. AMI data)?
     - Will additional information about households be required (e.g., square footage, number of bedrooms/bathrooms)?
     - What weather data will be needed (e.g., temperature, precipitation, evapotranspiration) and at what data resolution?
2. Provide a succinct overview of the main methodologies for conducting retrospective M&V analyses for non-experimental programs that have already been rolled out. This overview will be targeted towards a broad audience seeking to gain a clear understanding of the statistical approaches and empirical strategies.
3. Provide guidance surrounding the design and implementation of water efficiency programs in advance of implementation to ensure that subsequent M&V analyses will result in accurate (i.e. unbiased) and precise estimates of the resulting water savings. This includes identifying what questions are possible to answer given available data and how and when to combine results from multiple studies to obtain a better understanding of how savings differ across programs and with customer characteristics (e.g. demographics, climate, season, building/lot features, etc.). Much of

[1] Some M&V guidance documents do exist but includes work that is either outdated, complex and cumbersome, or oriented to the energy efficiency sector.

the focus will be on providing guidance surrounding simple, viable approaches to introduce randomization in the timing of treatments.

Project Tasks

Task 1 – Collaboration with CalWEP

- Coordinate with CalWEP and the Research & Evaluation Committee to understand the items members would benefit from including in the guidance document
- Present at and attend Committee meetings as needed
- Coordinate with the Committee during a draft review of the guidance document and incorporate the Committee's feedback for tailoring the document to water suppliers and CalWEP members.

Task 2 – Development of an M&V Guidance Document

- Conduct literature review and summary on recent methodological advances
- Develop discussions and guidance on the following:
  - The basic types of M&V approaches including deemed, calculated, and measured, and their associated assumptions and accuracy
  - Gather a reference section or bibliography of priority methods for deemed, calculated, and measured methods
  - Generate some examples of using calculated vs. measured methods and a discussion on the differences
  - Detailed data requirements, per type of M&V approach
  - What types of questions can be answered given data availability? Organize the results per the availability of data and the questions that can be answered
  - The types of non-experimental and experimental measured strategies
  - Internal and external validity of different approaches
  - How to compare results from similar programs from different water utilities
  - Best practices in how to collaborate and coordinate studies across different water utilities
  - Extra design considerations for evaluating multi-family and commercial sector programs.
- Generate and showcase examples using actual and/or simulated data
- Deliver a draft document for review and discussion with the CalWEP Committee. Perform revisions as needed and submit a final deliverable.

Timeline

Most of the work will be performed in the summer quarter which correlates with the time available for the professors involved to perform the work. The entire project may be completed in 6-12 months depending on when the project begins. An updated timeline can be submitted once the project is contracted.