Savings Estimation Methods for Energy Efficiency Programs: A Half-Hour Guide

Kansas Corporation Commission
Workshop on Energy Efficiency
March 25, 2008

Marian Brown
Manager of Measurement & Evaluation
Energy Efficiency Division
Southern California Edison

Why Measure Energy Efficiency Program Savings?

- Metering the un-metered resource
  - Measured savings for resource planning
  - Measured benefits from reduced pollution/GHG
  - Accountability for ratepayer dollars and shareholder reward
- Improve programs
  - More accurate savings estimates for measures
  - Increased energy savings from better design
  - Basis for future EE program funding

Types of Programs and Impact Evaluations

- Resource Acquisition Programs –
  - Create direct energy savings
- Education/Information Programs
  - Create indirect energy savings
- Market Transformation Programs
  - Create long-term changes in product availability, cost and features, plus customer awareness, understanding and purchase behavior

Direct Energy Savings

- Program participation is defined as purchasing or adopting the energy efficiency measures.
  - That's how rebate and direct installation programs work.
- So the first job is to estimate the energy savings achieved from those adoptions (called gross energy savings).
- Then the follow-up question is in which cases the program caused the purchase/installation/adoption (net energy savings; attribution; net-to-gross ratio).

Indirect Energy Savings

- The program activity is intended to influence a decision to adopt efficiency measures,

  rather than require it as a condition

  for participation.
  - Examples: Energy audits, energy efficiency training, education, information, market transformation.
- So the evaluation must first determine whether the program did indeed lead to adoption of energy-efficient measures (attribution/net-to-gross ratio).
- Then, it must estimate what the resulting energy savings were.

Estimating Gross Energy and Demand Savings

For Both Direct and Indirect Savings Programs

The Two Basic Approaches

Statistical Billing (Energy Use) Analysis

- Simple billing analysis normalized for weather
- Regression analysis
- Multi-stage regressions (can include net savings analysis)

Engineering Measurement and Analysis

- Pre-post measurements and engineering algorithms
- Pre-post building energy simulation models

Sometimes, the two approaches are combined.
We try to include economic/behavioral effects wherever possible.

Which Measurement & Analysis Method to Use for the Energy Savings?

- Methods range from simple and direct to complex and indirect and sometimes combined.
- More complex methods generally require more detailed data and higher cost.
- Guidelines for good measurement/analysis:
  - The *Model Energy Efficiency Program Impact Evaluation Guide* covers both billing analysis/regression methods and engineering methods, plus net savings methods.
  - IPMVP (*International Performance Measurement & Verification Protocol*) is a widely recognized standard for engineering measurement and analysis approaches.

Billing Analysis Tends To Be Preferred When:

- Both pre- and post-retrofit billing data are available.
- Expected energy savings are large enough to be statistically observable in a billing analysis (at least 10% of total usage; depends on several factors).
- Analysis can include large numbers of participants that are reasonably homogeneous.
- Inclusion of a comparison or control group allows for behavioral change corrections and/or simultaneous estimation of net savings

Engineering Measurement & Analysis Tends To Be Preferred When:

- No pre-installation billing data are available (e.g., new construction).
- Expected energy savings are a small fraction of total energy usage.
- Program has a small number of participants or unique measures.
- Program itself includes substantial engineering analysis that can be built on.

Using a Sample to Estimate Program Savings

- Choosing when to use a sample:
  - Can you get good enough data for the whole population of participants? (And what is the whole population?)
  - Or should you gather more detailed and accurate data for a good sample?
- Questions to ask to assure reliable results from a sample:
  - Is it unbiased (or properly weighted to be unbiased)?
    - Non-response bias (do some groups respond at lower rates?)
    - Survey selection bias: Did it exclude relevant groups from the sample?
      - *Can you think of some examples?*
  - Does it give the needed level of precision?
    - Depends on sample size and variance in the population.
      - *How far off can an estimate be and still be useful to you?*

A Key Question: What Would Energy Use Be in the Absence of the Program?

- We can measure energy use before the program.
- We can measure energy use after the program.
  - But how much of the change was due to the program?
- Conventionally, we look at this question in two dimensions:
  - One related to gross energy savings;
  - One related to attribution and net energy savings.

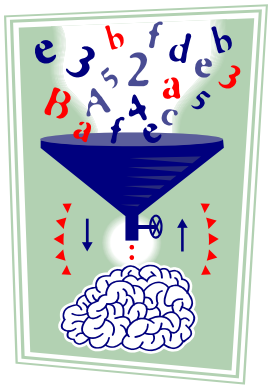
Gross Energy Savings Baseline

- What technology/behavior choice was being made?
  - Pure retrofit: Early replacement or add-on
    - Then savings is prior energy use minus new energy use
  - Replacement on burnout or new construction (lost opportunity market)
    - Then savings is efficient equipment energy use minus usage of a standard efficiency new measure

Determining Attribution, the Net-to-Gross Ratio, and Net Energy Savings

Attribution:

What energy savings are the result of the program, rather than other influences?



Indirect Savings Programs

- Attribution is the first question for audit, training, education, marketing, and market transformation programs.
  - Step 1: Who was actually exposed to the program?
  - Step 2: How many of those exposed to the program activities changed their behavior in energy-saving ways?
  - Step 3: Of those who changed, how much of the changes were due to the program rather than other influences?
  - Step 4: Estimate the energy savings of those changes identified as due to the program.

Direct Savings Programs

- Attribution is usually the second question asked for rebate and direct install programs.
  - Step 1: How much energy did participants save?
  - Step 2: What fraction of participants' changes were due to the program, rather than other causes?

The Traditional Direct Savings Approach: The Net-to-Gross Ratio

- = The fraction of the apparent program energy savings that are truly the result of the program
- Example:

  Program pays rebates to 100 customers who install high efficiency windows and claims the energy savings of these 100
- Sources of difference for apparent vs. actual:
  - Free riders

    20 of these customers were already planning to do this without the rebate offer.
  - Spillover

    10 neighbors also install these windows because of their installing neighbors' recommendations, but don't get the rebate.

Measurement Methods for the Net-to-Gross Ratio (and their Key Difficulties)

- Self-Report Survey
  - Minimize bias towards self-credit for decisions
- Regression Analysis Comparison of Participants and Non-Participants
  - Identify a comparable group of non-participants
- Market Baseline
  - Find data for proportion of efficient sales before and after program, for the program region and a comparison region

When the Traditional Net-to-Gross Approach Doesn't Work

- When one or more related programs have long-term effects on a market, estimating free riders and even some short-term forms of spillover misses the major, long-term sources of savings due to the program(s).
- Then, we need to monitor how the market itself changes over time and try to determine how much of the change is due to the programs.
- The next presentation will discuss the measurement of programs with these types of market transformation effects.

Attribution Estimation is Difficult and Imprecise. Can't We Just Skip It? No!

- We can't just pretend a substantial effect doesn't exist, because it's hard to measure.

- We must pay attention to how much difference the program makes, both for:
  - Accountability to ratepayers; and
  - Picking the right measures and the right programs to maximize cost-effectiveness.