National Efficiency Benchmarking Study for Residential Central Air-Conditioning

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ABSTRACT

The National Efficiency Benchmarking Study is an independent, nationwide assessment of energy efficiency programs and their impacts on the sale of residential central air conditioning equipment. The study investigates trends in sales and market share of residential central air conditioning units by efficiency level (SEER/EER) for utility service territories across the United States. The study examines sales trends in locales where there has been intense utility or agency sponsored program activity, and compares these trends to areas of less aggressive or no program activity.

The National Efficiency Benchmarking Study incorporates data from over 900 equipment dealers, distributors and manufacturers in 30 regions nationwide, and matches it to utility program information to provide utilities with the relative impact of their energy efficiency programs. The study looks across regions to understand the dynamics of residential air conditioning markets.

Introduction

Despite the presence of numerous energy efficiency programs around the United States, quantitative evaluations of these programs have been an expensive prospect focused exclusively on individual regions. Many studies are conducted to satisfy the requirements of State regulatory bodies and are focused primarily on cost recovery rather than best practices in program design. With increasing fuel prices and the advent of legislatively-mandated integrated resource planning targets in some States, it is important for utilities to review what are most efficacious practices in program design so that they can maximize the savings achievable from their programs. Quantec's first National Efficiency Benchmarking Study attempts to assist utility program planners and evaluators in doing just that.

This first benchmarking study, to be released in early 2008, focuses on residential central air conditioning equipment. Central air conditioning is a major contributor to the summer system coincident peak load in many areas of the United States, and reducing demand on the power system during this season is a critical priority for many utilities. Therefore, many utilities provide incentives to repair or replace aging, less-efficient equipment, or provide incentives to residential customers who don't just replace their aging, less-efficient or non-functional equipment, but provide additional savings by installing new, premium-efficiency units that exceed minimum equipment codes.

The National Efficiency Benchmarking Study is designed to enable program administrators evaluators insight into such questions as:

- How does our territory rank relative to other territories, with and without programs, in sales of high efficiency residential central air conditioners?
- Are program impacts extending beyond the number of units for which we are providing incentives (i.e., is the program creating spillover)?
- What would happen to high efficiency central air conditioning sales in our territory if we did not run a program, or if we modified the program?

- What are the opportunities for utilities and manufacturers to co-brand or co-market rebate programs?
- What can we do to optimize our existing program, and what components should we include in designing a new program?
- Are manufacturer and program rebates complementing each other, or to what extent are they excessive or redundant?

The study covers three unique areas of analysis not typically included in energy program evaluation efforts: Benchmarking, Baseline, and Best Practices.

Benchmarking

The National Efficiency Benchmarking Study is designed to provide utilities with an independent, nationwide assessment of energy efficiency programs and their impacts on the sale of residential central air conditioning equipment. The study investigates trends in sales and market share of residential central air conditioning units by efficiency level (SEER/EER) for utility service territories across the United States. The study examines sales trends in locales where there has been intense utility or agency sponsored program activity, and compares these trends to areas of less aggressive or no program activity to allow utilities to assess the effectiveness of the various elements included in their programs. Utilities are able to benchmark the effectiveness of their programs in promoting high efficiency equipment sales relative to other programs similar to theirs as well as to other programs across the United States.

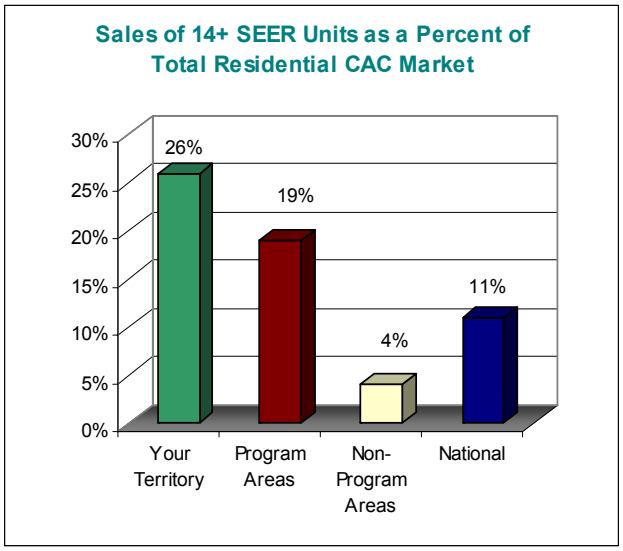

Figure 1. Sample Graph of Equipment Sales by Program Comparison

Baseline

While utility programs typically rely on the number of incentives paid as a starting point for estimating program impacts, it is widely understood that actual impacts may vary due to both naturally occurring adoption (free-ridership) and spillover. Self-reported assessments for both of these factors usually obtained from follow-up telephone or mail surveys inherently carry a potential for bias and uncertainty.

The Residential Central Air-Conditioning Report uses a regression model to estimate baseline sales of efficient units that would have occurred in absence of any program (Figure 2). This approach is the most effective way to truly account for all program effects, and is only possible because of the study's nationwide data collection effort.

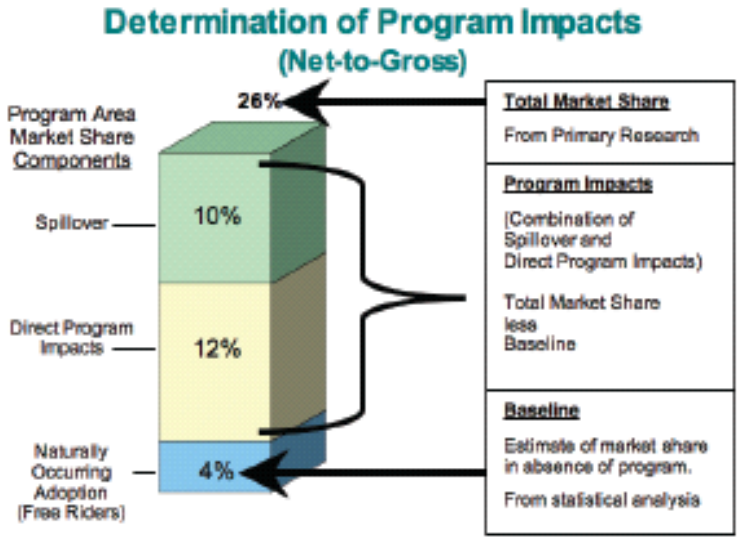

Figure 2. Calculation of Program Baseline

Best Practices

The analysis also seeks to identify best practices for program design based on empirical analysis of the market share data, and examining the most effective program features for increasing sales. This component supports forward-looking program design and provides administrators with information on optimal incentive levels, incentive structures, marketing techniques, and other program features. By comparing numerous programs across the country, this study identifies and ranks the relative impact of different market factors.

The Best Practices analysis considers program design elements such as customer incentives, dealer incentives, advertising, bill inserts, web page promotion, and sizing/installation requirements. In addition, the analysis considers the impacts of local or regional electricity rates, the availability of manufacturer rebates and tax credits, regional climate data and current economic conditions as well as other factors such as green building trends, average home size and average income and education levels of the local population.

Evaluation Focus and Methodology

To address the researchable issues, Quantec has collected information through primary and secondary data sources. Primary and secondary data collection activities include telephone surveys of over 900 equipment dealers, distributors and manufacturers nationwide, program data provided by participating utilities, and program database analysis.

- **Dealer/distributor telephone surveys**: Quantec conducted surveys of over 900 air conditioning equipment dealers and distributors. The survey asks dealers and distributors

questions about the sales of equipment by SEER in their sales territory as well as questions about sizing tools, certification of installers, and brands of equipment sold.

- **Program data**: Quantec has analyzed detailed information on program activities provided by participating utilities on a confidential basis including participation levels, detailed budgets, and program design elements.
- **Program database analysis**: Quantec has assembled publically available data about current energy efficiency programs nationwide and analyzed the data to create comparison groups of programs with similar characteristics. In addition, databases of utility service territories by zip code and national weather data have been assembled.

Quantec plans to update the study annually.

Evaluation Model

The regression modeling approach for this study builds upon the previous work of Rosenberg (2003) and Wilson-Wright et al. (2005) in evaluating ENERGY STAR® promotions. The National Efficiency Benchmarking model looks for a relationship between central air conditioning sales and active program participation while controlling for program incentive amounts, program loan amounts, and the cost of the air conditioning units. Because some of the zip code[1] regions don't have any programs, they act as the base case to which Quantec compares those areas with extensive programs.

The data gathered during the dealer and distributor telephone surveys by utility regions and county data are expanded into zip codes. In addition to the survey data, data from the DSRE database is also used to obtain program information for all AC loan and rebate programs in the US.

Quantec obtained data from the U.S. Census Bureau providing population, number of households, household income, number of homes, number of occupants, owner/renter status, and urban/rural percent information.

From the DOE's Energy Information Agency, Quantec obtained utility-level data of average residential electric rate. This data is expanded to zip code level by mapping zip codes to utilities using a database obtained from PLATTS.

The weather data obtained from NOAA's National Climatic Data Center includes long-run temperatures for many stations in the U.S. Quantec mapped each zip code to its nearest normal weather station.

The form of the model is:

$$AC\_Sales\_per\_household_z = \alpha + \beta_1 LRCDD_z + \beta_2 RESELECRATE_z + \beta_3 MAXINCENTIVE_z + \beta_4 MAXINCENTIVEPERTON_z + \beta_5 AC\$Ton_z + \beta_7 LOAN\%_z + \beta_8 LOANAMT_z + \beta_9 LOANINT_z + \beta_{10} RURAL_z + \beta_{11} OWN + \varepsilon_z$$

where, for zip code z,

- $AC\_Sales\_per\_household_z$ is the total AC sales either overall or at a certain SEER level normalized by number of households in zip code z.
- α is the intercept represents average baseline sales
- $LRCDD_z$, is the annual daily cooling degree days (base 65) for the zip code

[1] Note that throughout this study that a zip code (42000+ in the USA) actually refers to 30000 standardized ZCTAs (zip code tabulation area) used by the Census Bureau, because there are a lot of sparsely-populated zip codes.

- $RESELECRATE_z$ is the average residential rate in $/kwh in the zip code
- $MAXINCENTIVE_z$ – Average maximum utility incentive amount in the zip code
- $MAXINCENTIVEPERTON_z$– Average maximum utility incentive per ton in the zip code
- $AC\$Ton_z$ is the average cost of each equipment per ton in the zip code
- $LOAN\%_z$ is the maximum loan amount as % in zip code z
- $LOANAMT_z$ – is the maximum absolute $ loan amount in zip code z
- $LOANINT_z$ – is the average loan interest rate in zip code z
- $RURAL_z$ is the average rural percentage in each zip code
- OWN_z is the percentage of homes that are owner occupied in the zip code
- ε_z is the error term

The above model form represents only a general case for total sales. The model is also run for specific SEER sales levels, as well as combinations of SEER levels.

Future Directions

In coming years, Quantec will issue annual updates to the central air conditioning study, as well as expand the offering of reports to cover additional measures. Measures discussed for inclusion in future reports are: compact fluorescent bulbs and fixtures, residential heat pumps, residential furnaces, residential hot water, commercial HVAC, commercial hot water, motors, compressed air, and renewable energy programs.

To expand upon either the service territory customized or national overview reports, some participating utilities have also included expanded telephone survey questions, calculation of program energy and demand savings, and engineering validation of the assumptions behind the deemed savings values.

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