In-Home Metering of New Refrigerators

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Introduction

PG&E's resource plan relies heavily on energy efficiency programs. Among the various residential efficiency measures promoted by the utility, the refrigerator program accounts for the largest savings. PG&E currently bases its estimates of refrigerator program savings on the differences in expected annual usage between new minimum-efficiency models and those high-efficiency models that receive rebates. This poster describes PG&E's project to meter refrigerators in order to assess the savings predicted by Federal test procedures. In a separate project, PG&E is also evaluating the rebate program's free ridership.

Methodology

In both the pilot and full-scale project, metered data are collected with meters installed at the refrigerator and read during periodic visits to the home. Basic data about the refrigerators (placement and internal temperatures) and homes (occupancy and kitchen temperature) are collected at the time of installation and during these visits. Data from less than a full year are weather-normalized by correlating daily consumption with local weather.

Fresno Case Studies

Twenty new refrigerators were metered in Fresno in 1991. Models from three groups were selected for metering, based on their percentage efficiency improvement compared to 1990 Federal standards: (1) 0-10% more efficient (average: 4%), (2) 10-15% more efficient (average: 11%), and (3) more than 15% more efficient (average: 15%).

A DAC Model TMC-101 meter was installed in the kitchen next to the refrigerator in June 1991. Various data about kitchen temperatures and refrigerator temperatures and characteristics are summarized in Table 1.

The meters retained about thirty days of fifteen-minute consumption data. They were read in three seasons over seven months, covering periods in June, July-August, and November-December. Analysis was restricted to the total of seventy calendar days for which data from all 20 refrigerators were available, to eliminate weather differences as a source of variation in consumption.

Table 1. Characteristics of Monitored Refrigerators

	Adjusted Volume	Δ Temp (Freezer to Room)	Anti-Sweat Heater on	Auto Ice	Lab Annual kWh	Predicted Savings from Standard
Group A (4% group)	22.160	73.2°F	43%	14%	951	4.1%
Group B (11% group)	22.861	71.6°F	29%	71%	895	11.3%
Group C (15% group)	22.156	80.3°F	67%	20%	838	15.4%

Figure 1 shows the size-normalized annual consumption plotted for each refrigerator. Both the low-efficiency (4%) and high-efficiency (15%) groups consumed electricity at rates very close to those predicted by their labels. However, the middle (11%) category consumed substantially more than expected, particularly in the warmer seasons.

As Figure 1 shows, two of the refrigerators in the middle group were particularly high consumers. On-site investigation revealed that malfunctioning ice-makers were the cause in each case. In one case, the ice-maker was functioning even though water had not been connected to the refrigerator. In the other case, the sensor that stops the ice-maker when the ice-bucket is full did not work, so that ice was continuously produced (filling the lower portion of the freezer compartment!).

Sampling for Large-Scale Project

A larger metering project is now underway. The goal of the project is to estimate (in kwh) the difference between the consumption of high and low-efficiency models within 25% with 95% confidence. The preliminary research design calls for metering of 284 refrigerators for periods of three to nine months. Refrigerators would be selected from two groups: standard-efficiency models (as close to minimum 1990 standards as possible) and high-efficiency models (at least 20% above 1990 standards). Models will be selected from the primary size and style categories (e.g., 18-22 cubic feet, top-freezer models), in order to reduce the number of factors that cause variation in energy consumption. Refrigerators in two climate zones would be selected, one with high air-conditioning requirements and another with a mild summer and winter climate. Data collection and analysis are planned to follow the procedures developed in the Fresno project. Results from this project are expected in the fall of 1992.

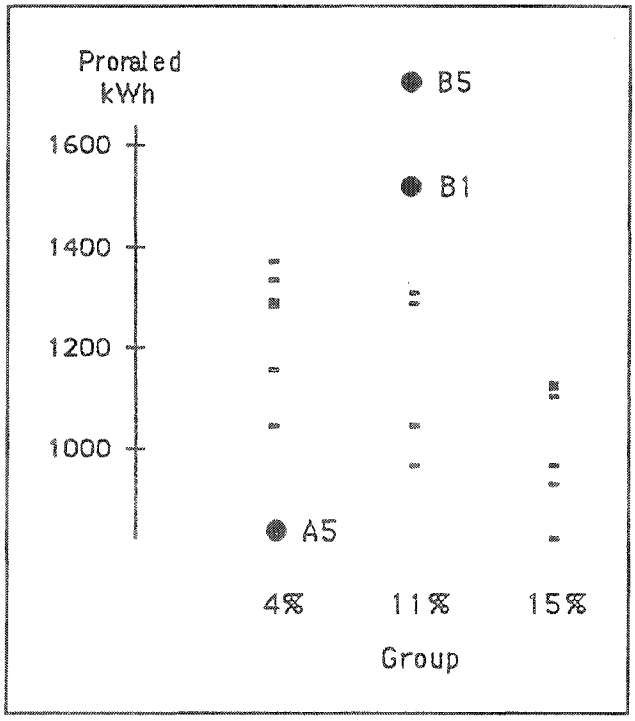

Figure 1. Size Normalized Consumption. Plot shows data for all 20 refrigerators. The data shown is for the first two monitoring periods.

Interpretation

The Fresno pilot did not include enough refrigerators to allow statistically valid conclusions. However, the pilot nonetheless has raised two contradictory possibilities. First, for most models, consumption seems close to the predictions of the Federal test procedures and labels. Since most utilities rely on these labels for their estimates of the energy-savings potential of efficient refrigerators, this preliminary implication is reassuring.

But on the other hand, in a sample of only 20 refrigerators, two turned out to have malfunctioning internal ice-makers. Though the consumption of most models with ice-makers that were metered in Fresno was close to the Federal label's estimate, a malfunctioning ice-maker can substantially increase electricity use, often without raising much concern from the customer. Ice-maker functioning requires further careful investigation.

References

Proctor, J., and G. Dutt. 1992. "Residential Refrigerator Field Metering Project: 1991 Case Studies". RAE-92-Z04, Energy Efficiency Services Department, Pacific Gas and Electric Company, San Francisco, California.