Competing Risk Models for Estimating Measure Life

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Introduction

Pacific Gas and Electric Company (PG&E) and Quantum Consulting (QC) recently evaluated the expected measure life of residential refrigerators that were rebated in 1996 and 1997 under PG&E's Residential Energy Efficiency Incentives (REEI) Program. PG&E defines the expected measure life as the median number of years that the refrigerators installed under the program are still in place and operable. In order to estimate the median expected life, classical survival analysis was employed, consistent with many other similar studies being conducted nationally for all varieties of end uses and sectors. Where this study differed, however, is in its approach to applying survival analysis techniques to retention analysis. This poster presents results that were obtained by implementing competing risk models to estimate the effective useful life of energy efficient refrigerators.

Research Methodology

According to PG&E's definition of retention, a measure must be "in place and operable", meaning that it must still be in working condition and operating within PG&E's service territory. Therefore, there are two distinct cases where a unit is no longer considered to be "in place and operable": (1) if the equipment failed, (2) if the unit has been moved outside of PG&E's service territory. Each of these two events has a different underlying distribution of occurrence. For example, it is likely that equipment failures occur very late in life, and have a distribution with an increasing rate of failure over time. For new refrigerators, it is common for participants to take their unit with them when they move, possibly outside of PG&E's service territory. As a unit becomes older, it is less likely that the owner would take the unit during a move, resulting in a decreasing removal rate over time. Therefore, it is likely that units that are moved outside of PG&E's service territory will have a significantly different distribution than equipment failures. For this study, we utilized classical survival analysis techniques to develop competing risk models, which are survival models that allow for multiple types of events. Due to the relatively short time period between purchase and this evaluation, very few of the rebated refrigerators had failed. Anticipating this problem, participants were also surveyed for failure information regarding their old refrigerator that was replaced by the rebated unit. Failure information for the old refrigerator and removal information for the rebated refrigerator was analyzed for this presentation.

Research Results

This poster presents results that were obtained from the model. First, survival functions are presented for each event (failures and removals) individually. These are accompanied by their respective hazard functions (the rate at which events occur). The individual event distributions are followed by a combined distribution that was the result of implementing the competing risk model. This methodology for estimating the effective useful life for energy efficiency measures can be applied to any type of equipment for any sector.