It All Comes Down To the Baseline – Estimating Market Transformation Effects

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Introduction

Quantum Consulting (QC) has developed an accurate and straightforward method for estimating market transformation of energy efficient measures. This effort began in 1996 with an evaluation of Florida Power and Light's (FPL's) residential and commercial/industrial energy efficiency incentive programs. FPL has been implementing some of the largest demand-side management (DSM) programs in the country over the last 10 years. These programs have had a significant effect on transforming the market for many residential and nonresidential energy efficient products and services, including heating, ventilation, and air conditioning (HVAC), lighting, insulation, window treatments, and duct repairs. We believe this to be the largest and most comprehensive market transformation study to be conducted to date.

Although qualitative evidence of market transformation readily exists, quantifying these effects in terms of energy or demand savings has, historically, been notoriously difficult. This was the problem QC faced, and after three years of extensive research and analysis, QC is confident in both our methods and results.

The difficulty in quantifying market transformation for any given energy efficiency program is that these programs have been in existence for many years. Over these years, the regional equipment stock has been affected by the supply-side effects of these energy efficiency programs. For this reason, a vital piece to the puzzle of measuring market transformation is estimating the baseline energy consumption. In other words, what is the demand and energy consumption that would have occurred in the absence of the program? Since FPL's incentive programs have been in place for over a decade, it would be extremely difficult to develop a baseline using only data collected within FPL's service territory, since it is very probable that the programs have affected the market.

Utilities have been implementing energy efficiency programs across the nation for over a decade now. As these programs have matured, the focus of evaluation has evolved from measuring first-year gross savings to measuring the long-term effects of market transformation. QC and Florida Power and Light have developed this approach, which provides a cost-effective means for evaluating these effects. Our method is unique in that it measures market effects for end-users in terms of actual kW demand. However, an important limitation to keep in mind is that the model cannot determine if the affects are sustainable. We believe this paper will be of interest to utilities across the nation, as market transformation becomes the primary objective of energy efficiency programs.

Market Baseline Territory Selection

The key element of our approach is the use of an appropriate comparison territory service territory to act as the baseline. Since this comparison territory's purpose is to represent what would have occurred in FPL's service territory if no energy efficiency programs were ever offered, it is important that it be as similar to FPL in all facets but one, a general lack of any type of energy efficiency program.

There are several important aspects to consider when identifying candidate comparison territories. The most important of these include utility size and region, customer information, DSM activity, climate data, and general demographics and/or firmographics. The data sources required to make an appropriate selection are discussed below.

Candidate Utilities

The first step in selecting candidate territories is to develop a list of utilities with similar qualities as the utility to be examined. In the case of FPL, we selected several large public utilities in the South, including Florida Power Corporation, Georgia Power, Duke Power Company, Carolina Power and Light, Entergy (Gulf States, Louisiana, and New Orleans), Houston Light and Power, and Texas Utilities. In order to develop an appropriate list of candidate comparison utilities, an extensive data search must be conducted to obtain both general and specific information on public utilities in the United States.

Customer Information

Customer information for each specific utility can be obtained from the United States Department of Energy (DOE). As the statistical agency of the DOE, the Energy Information Administration's (EIA) main function is to "provide policy-independent data, forecasts, and analyses to promote sound policy making, efficient markets, and public understanding regarding energy and its interaction with the economy and the environment." EIA's web site provides a wealth of data that is essential to the process of selecting a baseline territory. It also enables the downloading of sector-specific tables at the individual utility level that detail class of ownership, number of consumers, revenue, sales, and average revenue per kWh.

DSM Activity

In addition to customer information, it is vital to collect information on DSM activity. An excellent source for this data is available from the EIA, in the report titled "U.S. Electric Utility Demand-Side Management," prepared by the Coal and Electric Data and Renewables Division, Office of Coal, Nuclear, Electric, and Alternative Fuels. This report presents comprehensive information on DSM activity in the United States at the national, regional, and utility levels. It also contains information on energy savings, peak load reductions, and cost information for specific utilities. DSM program information is provided at the energy efficiency and load management program level for residential, commercial, and industrial sectors. Since this report is a complete listing of all DSM activity in the U.S., the exclusion of a utility from the report implies that the utility has no DSM activity.

Climate Information

Another essential piece to this puzzle is identifying the annual cooling degree days for the specific area of the utility. Cooling degree days provide an indication of the climate for specific locations throughout the U.S. Because of the effect of climate on the installation of energy efficient equipment, it is important for the comparison baseline utility to have comparable degree days. These

data are collected by the National Oceanic and Atmospheric Administration's (NOAA) Climate Prediction Center (CPC).

Demographic and Firmographic Data

The data needed to make demographic and firmographic comparisons are provided by the United States Census Bureau. The Census Bureau data allows demographic and firmographic comparisons at the county and state level. The demographic data pertinent to this analysis that can be obtained include: population, education, labor force, income and poverty, retail sales per household, energy consumption per capita, and homeownership rates. Firmographic data available at the four digit Standard Industrial Classification (SIC) code level are number of employees, annual payroll, and total establishments.

Baseline Area Selection

Once all of this information is collected and tabulated into a matrix, comparisons need to be made in order to select the best available baseline service territory. For the FPL project, the three Entergy utilities in Louisiana, Entergy Gulf States, Entergy Louisiana, and Entergy New Orleans, were selected as the baseline territory. After the selection, it is of vital importance to contact the appropriate manager at the selected utility to verify the nonexistence or relatively low amount of DSM activity.

Louisiana was selected based on the following criteria:

(1) Verified by Entergy management, Entergy Louisiana and Entergy New Orleans have not offered rebate programs since at least 1992 and Entergy Gulf States phased out their rebate programs in 1994. This is also confirmed by the EIA data that can be reviewed in Table 1.

(2) Louisiana is in a region [Southwest Power Pool, (SPP)] of very little DSM activity as compared to FPL [Southeastern Electric Reliability Council (SERC)]. Total residential peak load reduction for the SPP area was 381 MW in 1996 as compared to 5,307 MW in the SERC area. This is an indication that Louisiana has been fairly isolated from DSM influences from nearly utilities.

(3) Entergy's average revenue per kWh (in cents) is in the same range as FPL's (7.59, 7.72 and 8.25 for Entergy vs. 8.04 for FPL).

(4) Louisiana has the most similar climate of all the candidate utilities to FPL (as similar as can be found) with 2,655 cooling degree days as compared to 4,198 cooling degree days for FPL.

(5) Residential demographics (prepared by the U.S. Census Bureau) in both states are surprisingly similar. Median household income in Louisiana is $27,949 vs. $29,745 in Florida. Retail sales per household in Louisiana is $24,271 as compared to $25,688 in Florida.

Table 1. Utility Information

Utility	Peak Load Reductions (MW 1996) Res	C/I	En. Eff.	DLC	Other LM	Avg Rev/kWh (cents)	CDD per Year	Total Customers	Res Cust (% of Total)	Median HH Income*	Retail Sales per HH*
Florida Power & Light	**1,240**	**765**	**1,126**	**879**	**0**	**8.04**	**4,198**	**3,550,742**	**89%**	**29,745**	**25,688**
Florida Power Corp.	1,343	81	291	1,156	326	8.39	3,427	1,292,057	88%	29,745	25,688
Georgia Power	**38**	**67**	**54**	**52**	**0**	**7.69**	**1,667**	**1,730,887**	**88%**	**34,099**	**24,643**
Duke Power Co	**70**	**25**	**96**	**0**	**0**	**7.85**	**1,582**	**1,816,565**	**85%**	**31,979**	**23,698**
Carolina Power & Light	**346**	**829**	**539**	**136**	**498**	**7.31**	**1,417**	**1,108,633**	**84%**	**31,979**	**23,698**
Virginia Power	80	13	91	0	14	8.12	1,348	1,842,539	89%	39,211	26,958
Commonwealth Edison	30	204	18	15	201	11.39	752	3,395,802	91%	39,554	24,727
Entergy Gulf States	**0**	**0**	**0**	**0**	**0**	**8.25**	**2,655**	**310,543**	**87%**	**27,949**	**24,271**
Entergy Louisiana	**0**	**0**	**0**	**0**	**0**	**7.72**	**2,655**	**616,015**	**88%**	**27,949**	**24,271**
Entergy New Orleans	**0**	**0**	**0**	**0**	**0**	**7.59**	**2,655**	**189,608**	**90%**	**27,949**	**24,271**
Kentucky Utilities	17	35	10	0	42	4.55	1,288	427,478	83%	32,413	23,021
Louisville Gas & Electric	0	53	1	0	52	5.98	1,288	349,845	88%	32,413	23,021
Houston Light & Power	**64**	**36**	**100**	**0**	**0**	**8.42**	**2,700**	**1,522,793**	**88%**	**32,039**	**24,665**
Texas Utilities	**555**	**706**	**968**	**0**	**294**	**7.83**	**2,603**	**2,367,911**	**88%**	**32,039**	**24,665**

Source: Energy Information Administration, NOAA Climate Prediction Center, and U.S. Census Bureau

*These data are at the state level.

After the selection of an appropriate market baseline area, the next step is to collect and analyze the necessary data to calculate market transformation effects. The method is discussed in the following section.

Estimating Market Transformation Effects – Net Benefits Analysis Method

Energy-efficiency programs are designed to both increase the efficiency of the installed equipment and accelerate the adoption of targeted technologies and/or actions among all customers. It is the extent to which the program succeeds in meeting these objectives that determines net program benefits.

In addition to directly increasing the likelihood that program participants will purchase targeted equipment, energy-efficiency programs indirectly affect nonparticipant purchase patterns. This is accomplished through cost reductions, improved performance, increased availability, and enhanced awareness (and therefore perceptions) of targeted equipment. For both participants and nonparticipants, an energy-efficiency program can affect either the efficiency or the timing of equipment purchases. Efficiency is affected when participants (directly) and nonparticipants (indirectly) are induced by the program to purchase higher efficiency units than they would have installed in the program's absence. Timing is affected when participants and nonparticipants are encouraged by an energy-efficiency program to replace old, inefficient equipment sooner than they would have without the program—even if the new equipment does not meet program requirements.

QC's approach allows net impacts to be identified as either efficiency-based or accelerated adoption-based. The details of this approach are discussed below.

Demand without the Program

The starting point for net impact calculations is the estimation of demand in FPL's service territory in the absence of the program. This is estimated as the sum of the demand of customers who make equipment changes (replacer demand) and the demand of those who keep their existing equipment (other demand). This is illustrated in the upper left graphic of Figure 1.

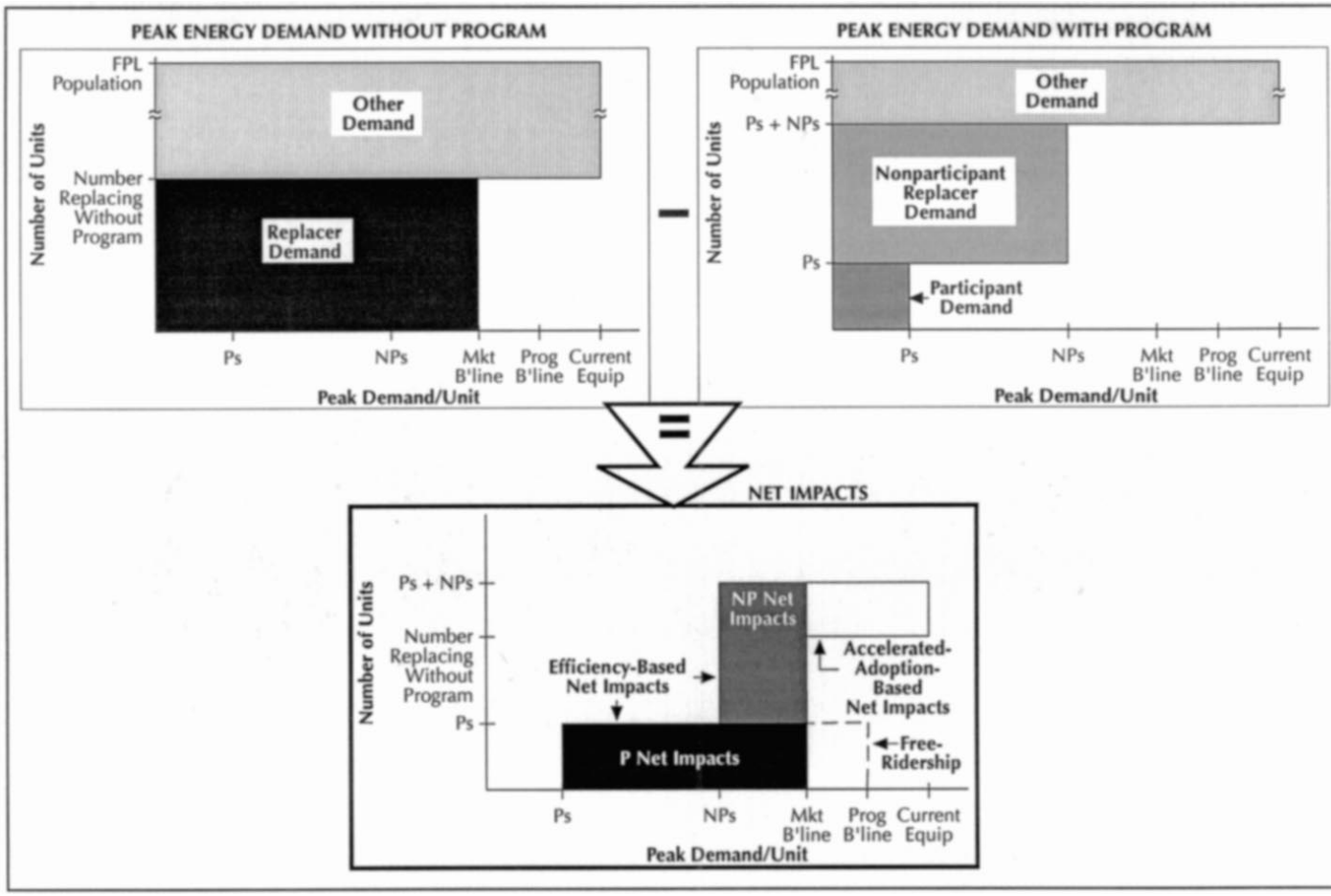

Figure 1. Residential HVAC Program, Net Impacts

Since demand in the absence of the program cannot be observed with existing customers, the number of replacing customers and the equipment they install is estimated from data collected in the market baseline territory. Demand for customers who make an equipment change is calculated by multiplying the number of units installed (the replacement rate) by the peak demand for those units that would have been purchased in the absence of the program (the market baseline). Both the replacement rate and the market baseline are estimated from the observed actions of customers in a no-program service territory that is otherwise similar to FPL's.

Demand for other customers—those with existing equipment who would make no changes without the program in place—must also be quantified. This demand is calculated by multiplying the

number of existing units in FPL's service territory (less the number replaced) by the peak demand per unit of the existing equipment.

Demand with the Program in Place

Demand in FPL's service territory with the program in place is the sum of the demand of participants (participant demand), nonparticipants who make equipment changes outside the program (nonparticipant demand), and customers who keep their existing equipment (other demand). This is illustrated in the upper right graphic of Figure 1.

Estimates of energy demand with the program in place reflect what actually occurred, so each of these components can be calculated based on observed customer actions. The demand of participants is calculated by multiplying the number of participant units by the peak demand per unit of participating equipment. The demand of nonparticipants who replace equipment is calculated by multiplying the number of nonparticipant units adopted by the peak demand per unit of replaced equipment. Similar to the no program case, demand for other customers—those with existing equipment who made no changes without the program in place—is calculated by multiplying the number of existing units in FPL's service territory (less the number replaced by participants and nonparticipants) by the peak demand per unit of the existing equipment.

Net Program Impact

Net program impact is the difference between demand with and without the program in place. This is illustrated in the lower graphic of Figure 1. As mentioned earlier, this analysis allows program net impacts to be identified as either efficiency-based or accelerated-adoption-based.

Efficiency-based net impacts exist if the program causes participants and/or nonparticipants to install higher efficiency equipment than they would have in the absence of the program. Participant efficiency-based net impacts are the number of participating units multiplied by the difference between the market baseline peak demand per unit—the efficiency of equipment that would have been installed without the program—and the peak demand per unit of equipment installed through the program. Nonparticipant efficiency-based net impacts are of the number of nonparticipating units multiplied by the difference between the market baseline peak demand per unit and the peak demand per unit of equipment installed outside the program.

Accelerated-adoption-based net impacts exist if the program stimulates an increase in the number of units replaced in a given year. They are the difference between the number of replacements with and without the program, multiplied by the difference between the peak demand per unit of the equipment currently in place and the peak demand per unit of the market baseline.

Free-ridership is the product of the number of units that would have been installed without the program and the difference between the program and market baseline peak demand per unit.

Components of Net Benefits

Redefining the previous discussion in terms of more "traditional" program evaluation, net program benefits are the sum of net participant impacts (gross impacts less free-ridership) and free driver impacts, as shown in Figure 1.

The magnitude of net participant impacts is determined by the number of participants, the efficiency of participant installed equipment, and the program and market baselines. The first two of

these parameters are obtained from FPL's participant database. Therefore primary data collection efforts are concentrated on the market baseline efficiency is the key determinant in the calculation of net participant impacts.

The magnitude of free-driver impacts depends on both the relative replacement rates among FPL nonparticipants and customers in the baseline area and on the efficiency of equipment installed by each group. Since all of these parameters are based on primary data collection from a variety of sources, it is important to triangulate and verify the consistency of the results

Surveys

FPL Canvass Surveys

Over the past two years, approximately 15,000 FPL nonparticipating customers have been surveyed. These surveys were designed to obtain data on the frequency and efficiency of nonparticipant actions.

Baseline Area Canvass Surveys

Approximately 15,000 baseline area customers have been surveyed over the past two years. These surveys were also designed to obtain data on the frequency and type of replacement actions in the non-program service territory. In addition, follow-up mailers were completed by those customers who mentioned an equipment change, to gather data such as HVAC nameplate information (which provides capacity and SEER rating).

Contractor Surveys

Contractors and trade allies were contacted and surveyed in order to cross check the efficiency data collected from customers. These surveys were completed with participating and nonparticipating contractors in FPL's service territory and with contractors in the market baseline area.

Manufacturer Interviews

The largest HVAC equipment manufacturers were interviewed to obtain information on equipment and marketing trends.

Secondary Data

In addition to primary data collection, a thorough secondary data search was conducted to support findings from the above data and to further investigate market trends.

Results of the FPL Residential HVAC Evaluation

The method described above of measuring net program benefits was used in the evaluation of FPL's Residential HVAC Program.[1] Results of this analysis indicate that both measurable accelerated adoption and efficiency based impacts are occurring.

The first data to be examined are installations if FPL's service territory and the market baseline area (vertical axis of Figure 1). These data are plugged directly into the vertical axis of the graph shown in Figure 1 above. Figure 2 shows that HVAC equipment purchases among single family detached houses in FPL's service territory are very similar to purchases in the baseline market. The slightly higher replacement within FPL service territory suggests only modest accelerated adoption impacts as the program encourages customers to early replacement of older, less efficient equipment.

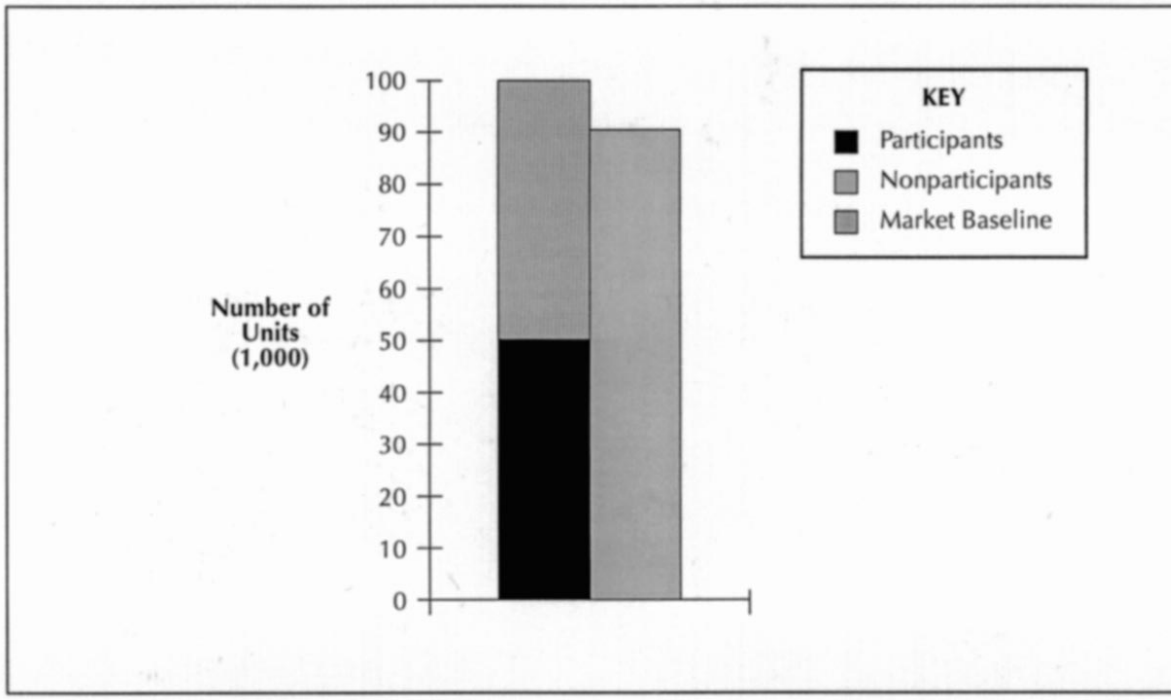

Figure 2. CAC Replacement Rates, 1998

The next step in analyzing the efficiency of units installed in FPL's service territory and the baseline market (horizontal axis of Figure 1). As can be seen in Figure 3, participant average efficiency levels are much higher than nonparticipant levels. Additionally, the efficiency of nonparticipant purchases in FPL's service territory are slightly higher than in the market baseline area. This suggests that while the majority of efficiency based impacts will be from participant installations, a small amount will originate from the nonparticipant installations.

[1] Actual numbers have been altered to protect FPL's confidentiality agreement.

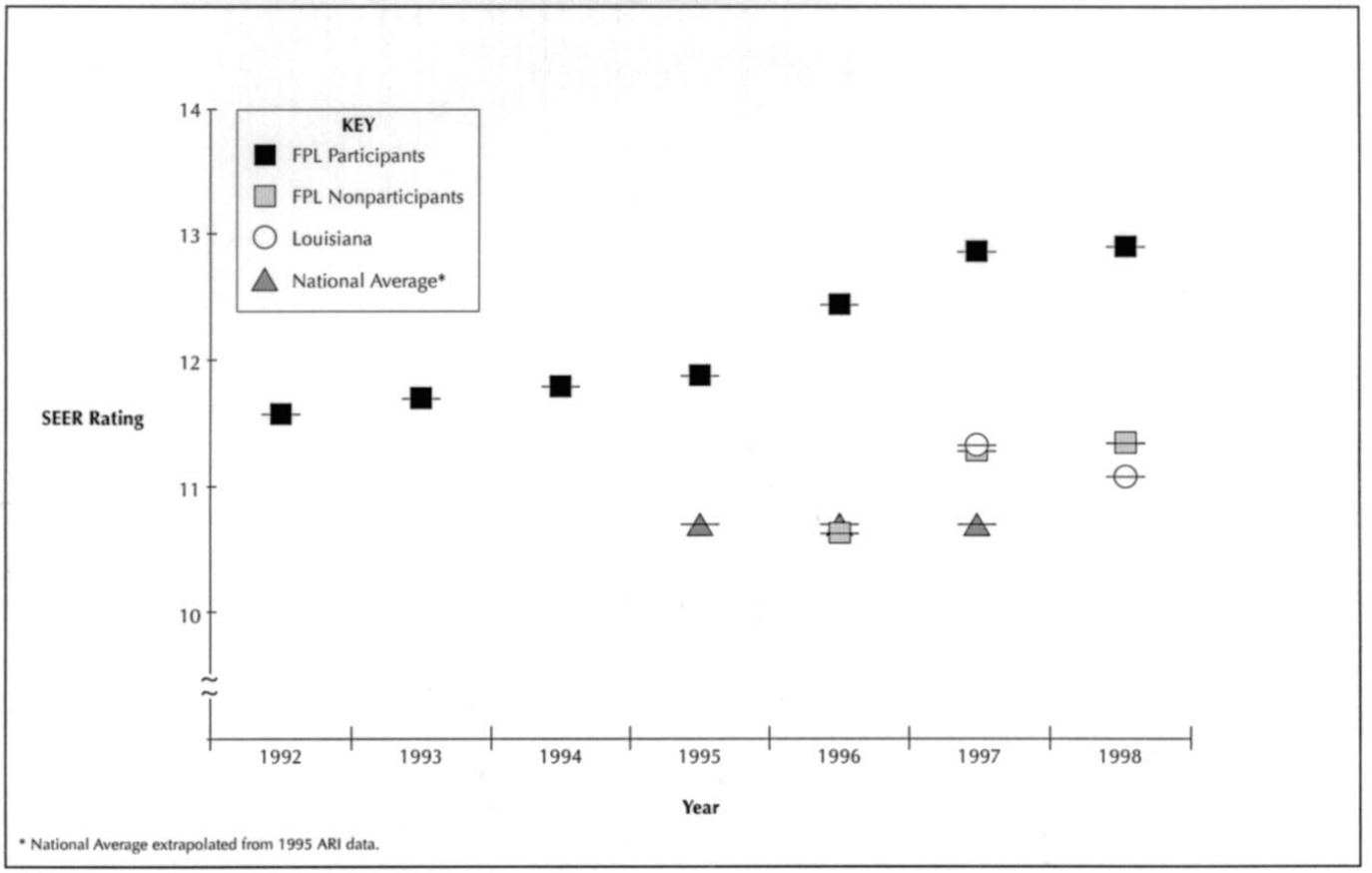

Figure 3. FPL and Market Baseline HVAC Replacement Efficiency Over Time, CAC and CHP Components.

Further, purchases outside FPL's program have ranked above the national average and have been increasing over time. Data collected through canvass surveys indicate an average efficiency of 11.3 SEER in 1998 for nonparticipant purchases within FPL's service territory. Data on efficiency levels in Louisiana also show above average efficiency levels relative to the national average. For Louisiana the average is 11.1 in 1998. The average efficiency for Florida as well as the baseline area is above the national average of 10.9 SEER. However, the national average contains new construction (the mailer data do not) and the average is calculated with all 50 states, almost all of which have far fewer cooling degree days than Florida and the baseline state.

Net benefits are then estimated by combining installation and efficiency information both in and outside FPL's service territory. This is illustrated in Figure 4.

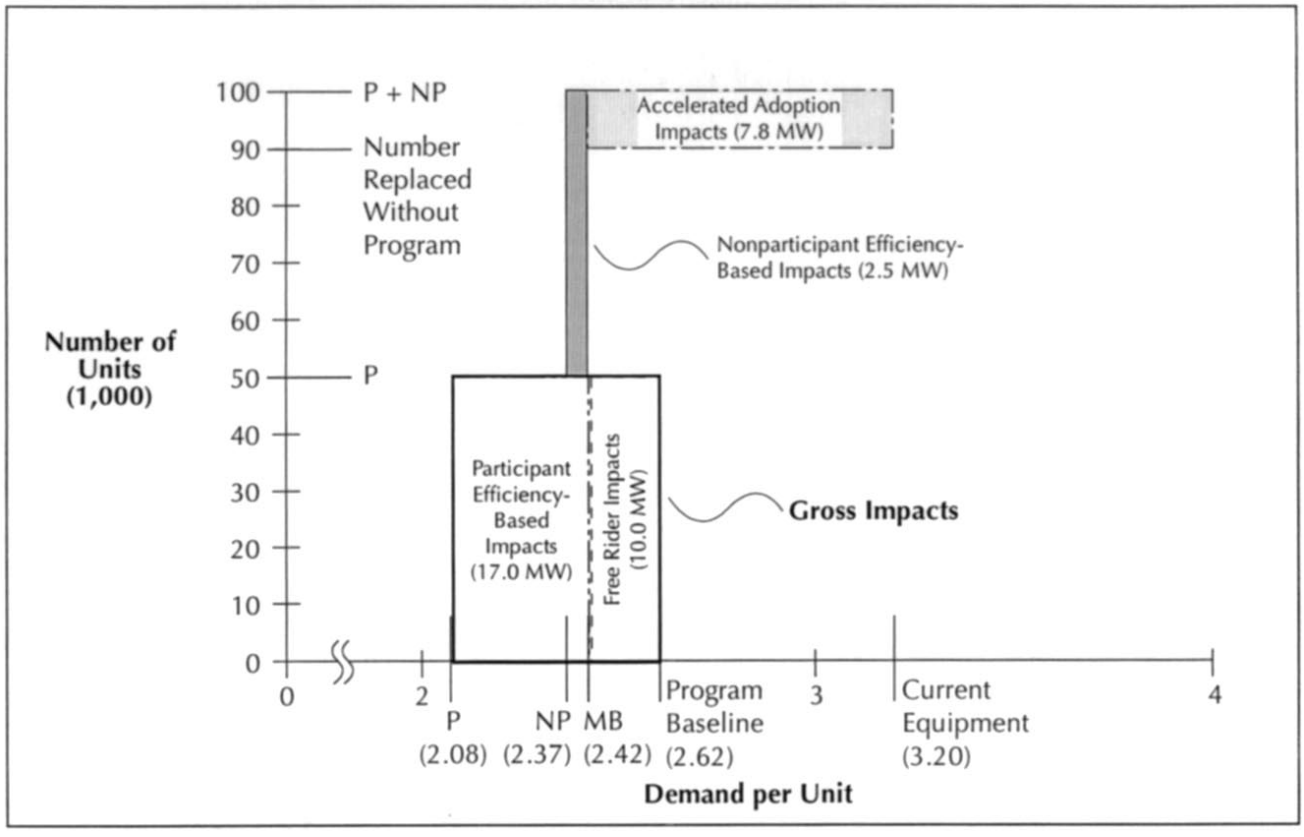

Figure 4. 1998 CAC Net Impacts

The majority of the 19.5 MW efficiency-based net impacts come from participant installations (17.0 MW). However, the finding that average nonparticipant SEER levels in FPL service territory are slightly higher than in Louisiana indicates that nonparticipant efficiency-based net impacts exist. These nonparticipant net impacts are estimated to be 2.5 MW. This finding suggests that market transformation is occurring in the FPL service territory.

Gross program impacts for the program are approximately 27.0 MW for 1997. However, comparison with a baseline replacement rate yields a free-ridership estimate of over 40 percent, reducing participant efficiency impacts to 17.0 MW.

The baseline area has a slightly lower replacement rate than FPL with the program, which results in some accelerated adoption impacts of 7.8 MW for 1997. Combining the gross impacts with free ridership and the accelerated adoption impacts gives net impacts of 27.3 MW for the program. This is virtually identical to gross impacts of 27.0 MW and yield a net-to-gross ration of 1.01.

Conclusions

Based on the above analysis method, there is evidence of market transformation to higher efficiency HVAC equipment as a result of FPL's incentive program. A significant finding in our research was that FPL's HVAC Program is capturing a large share—about 50 percent—of the market. While the majority of the net impacts were participant based, a small amount was observed for nonparticipants. This finding of nonparticipant net impacts implies that market transformation effects exist. Most importantly, these effects can be measured quantitatively over time.

It should be noted that measuring the sustainability of these effects was not included in the scope of this study. True market transformation means lasting impacts even when the incentive program goes away. While the scope of this study did not center on the CADMAC approach, it will attempt to include some of their methods in the future so as to investigate the sustainability of the market transformation.

The use of the baseline area has allowed the measurement of both the demand and supply side effects of FPL's energy efficiency incentive programs. The success of this method depends upon estimating what would have occurred in the absence of the program.