Prematurely Reducing Program Support May Produce Negative Market Effects

Kristin Landry and Amul Sathe, Navigant
Marina Geneles, PECO

ABSTRACT

This paper finds that inconsistent program support disrupts market progress and limits market transformation. Specifically, this study used a "market model" to examine the adoption of CFLs in PECO's residential lighting market.[1] The market model method presented here estimates total market effects (including both participant and non-participant spillover) by examining the entire CFL market over a 20-year historic period. This method involves aggregating many pieces of available market data, modeling what the CFL market would have done in the absence of the utility's CFL programs, and comparing it to actual market conditions measured by the utility's evaluation teams over time. The analysis shows that PECO's CFL programs were instrumental to moving the market forward in their territory. After strong performance in program years one and two (2009 and 2010), PECO had to reduce spending for their CFL programs because they had met their targets, and the overall market responded by significantly reducing CFL installations. Had PECO been incentivized to continue their CFL programs and the savings they were achieving, CFL saturation would likely have continued to outperform gross program activity, resulting in a continued net-to-gross ratio greater than one from positive market effects. The sudden reduction in program support hindered market transformation and resulted in negative market effects. This indicates that the program began incentivizing efficient equipment installations by a section of the market that was influenced by market actors other than the utility. These installations represent additional free riders rather than new adoptions. These findings lead to the conclusion that support for consistent utility programming is essential to transforming the market. Furthermore, a market transformation framework for programs, rather than a resource acquisition target, is likely to be more successful at achieving a market environment in which the adoption of the efficient equipment is self-sustaining.

Introduction

This paper describes quantitative evidence for negative market effects resulting from prematurely ending support for an energy efficiency program through an analysis of PECO's compact fluorescent lamp (CFL) incentive programs. In a regulatory structure that does not incent utilities to exceed program savings targets, PECO's CFL programs hit their target savings well before the deadline. The resulting reduction in program support disrupted market progress and resulted in negative market effects and ultimately a lack of market transformation. The methodology for the market transformation model used for this analysis is already captured in *Using Market Models to Evaluate Market Effects/Transformation of Multi-year Energy Efficiency Programs* (McDonald, Sathe, and Landry 2014).

[1] PECO is the largest electric and gas utility in Pennsylvania, serving approximately 1.6 million electric customers and over 500,000 gas customers (PECO 2016).

The following sections describe the regulatory structure constraining PECO's program, the performance of PECO's CFL program, and the analysis demonstrating the fallout of reduced program support. The paper concludes with recommendations for PECO and other utilities as well as a review of strengths and limitations of the market transformation modeling method.

Glossary

Some of the terminology used here is unique to net-to-gross (NTG) analysis as a whole, and some is unique to the market transformation model methodology. This methodology focuses on installations of efficient equipment as this directly correlates to energy savings.

- Net-to-gross ratio (NTGR) – The ratio of net program activity to gross program activity.
- Naturally occurring baseline (NOB) – Reflects the installations of an energy efficient measure that would have happened if the utility intervention never occurred (going all the way back to the inception of a utility program). NOB is the counterfactual to the formation and continued operation of utility programs.
- Free ridership – Energy efficient equipment installations discounted through a utility program and that are also part of the naturally occurring baseline. These installations of the energy efficient equipment would still have occurred in the absence of the formation and continued operation of the utility incentive program, but do take advantage of discounts from the utility when the program is offered.
- Naturally occurring non-participants (NONP) – The portion of the NOB that are not free riders. These installations of energy efficient equipment would have occurred in the absence of a utility incentive program and do not take advantage of program discounts even when they are available.
- Program-influenced participants (PIPs) – The installations of energy efficient equipment that result from the utility program, taking advantage of discounts in the process. These installations are incremental to the NOB.
- Spillover – Spillover accounts for the additional installations of energy efficient equipment by a customer, without a program discount, after a customer has already purchased a discounted product.
- Positive market effects – Consist of untracked installations (installations occurring without a discount from a utility) of energy efficient equipment; untracked efficient equipment purchases include spillover and program-influenced non-participants.
- Negative market effects – Additional free riders that result when a program is incentivizing efficient equipment installations without reaching new adopters. These installations detract from the NONPs.
- Net Program Impact – Consists of the sum of PIPs and market effects.
- Gross Program Activity – Consists of the sum of PIPs and free riders.

Regulatory Structure

The Pennsylvania regulatory framework does not reward energy efficiency savings beyond program targets. In 2008, Pennsylvania's governor signed into law Act 129, which required electric utilities to achieve cumulative energy efficiency savings of 1 percent by May 31, 2011 and 3 percent by May 31, 2013. Peak load also had to be reduced by 4.5 percent by May 31, 2013 (PA PUC; Neumann, Gunn, and Lysyuk 2014). Under Act 129, PECO is only

allowed to spend up to 2 percent of annual revenue to meet its energy efficiency savings targets. Program spending beyond this cap cannot be recovered in rates unless approved on a separate case basis (Neumann, Gunn, and Lysyuk 2014).

PECO's CFL Program Performance

PECO launched their CFL programs in 2009 with great success in a market that was ready for the utility's intervention. The continued success in 2010 was overwhelming and resulted in achieving the regulatory target and the limits of the program budget years ahead of schedule, forcing PECO to scale back in 2011. Figure 1 shows that the following years continued to have limited program support.

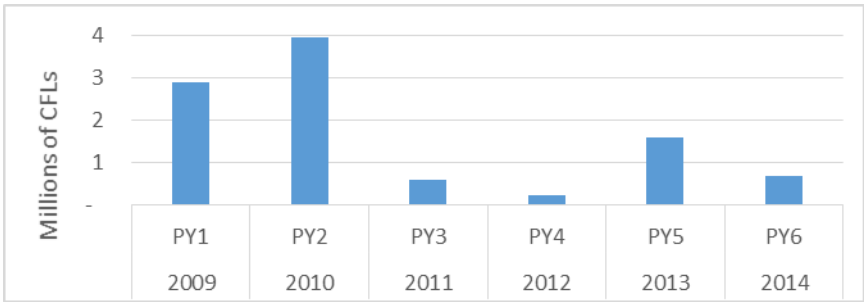

Figure 1. PECO program annual CFL sales. *Source:* Navigant analysis.

The Analysis

This analysis provided quantitative evidence for how PECO's CFL programs affected market transformation in their service territory.

The Challenge of Estimating Market Effects for Multi-year Programs

The CFL Market Model uses multiple years of data on CFL program activity and national market activity to estimate net-to-gross ratio (NTGR), market effects,[2] and free-ridership associated with PECO's CFL programs. Multi-year program influences are not accounted for in most NTG methods, and spillover is often ignored due to the challenges of its estimation. This method addresses these limitations by using saturation[3] rather than annual sales data to account for program influences that carry over from year to year.

Traditional evaluation protocols are not designed to handle market transformation programs and can mistakenly count multi-year program effects as free riders, significantly decreasing a program's NTGR. For example, consider a customer who has purchased and installed CFLs for the last four years. In the first year, the customer was influenced to begin purchasing CFLs by a utility's program marketing, education, and discounted pricing. The customer continued to purchase discounted CFLs in the second, third, and fourth year based on

[2] The term market effects (as used in this paper) consist of untracked installations (installations occurring without a discount from a utility) of energy efficient equipment; this includes spillover and program-influenced non-participants. See glossary for other definitions.

[3] Saturation refers to the percent of installed stock. Example: a house with 50 lamps total, 5 of which are CFLs, has a CFL saturation of 10%.

their new knowledge and acceptance of CFLs. If a survey was conducted in the program's fourth year, the customer would likely report that they would have purchased the CFL even if the utility program was not active in that year. Traditional evaluation approaches would conclude that this customer was a free rider[4] and thereby part of the naturally occurring baseline (NOB) (as illustrated in Figure 2). In contrast, this CFL Market Model reports this participant's activity as program-influenced.

Figure 2 illustrates the framework to examine multi-year program influences. Traditional evaluation methodologies attempt to quantify free-ridership and use this to subsequently estimate the NTGR. These analyses rarely attempt to estimate the NOB. The NOB is meant to reflect what would have happened if the utility intervention had never occurred, going all the way back to the program's inception. Estimating free-ridership of a widely-adopted technology in a single program year (long after the program start) often results in an overestimate of free-ridership as described by the example in the previous paragraph. In extreme cases, the calculated value for free-ridership may be larger than the actual NOB (which in reality cannot happen by definition) and effectively deducts savings from program-influenced participants (PIPs). Thus, directly estimating the NOB is a preferred approach for evaluating the NTGR.

A market transformation framework for programs goes even further by estimating the NOB and measuring total market activity against this counterfactual to gauge the success of a program, without regard to the various influences that create the additional market segments shown in Figure 2. The market transformation framework is designed to create a system-wide change such that the adoption of the efficient equipment becomes self-sustaining without the support of utility programming.

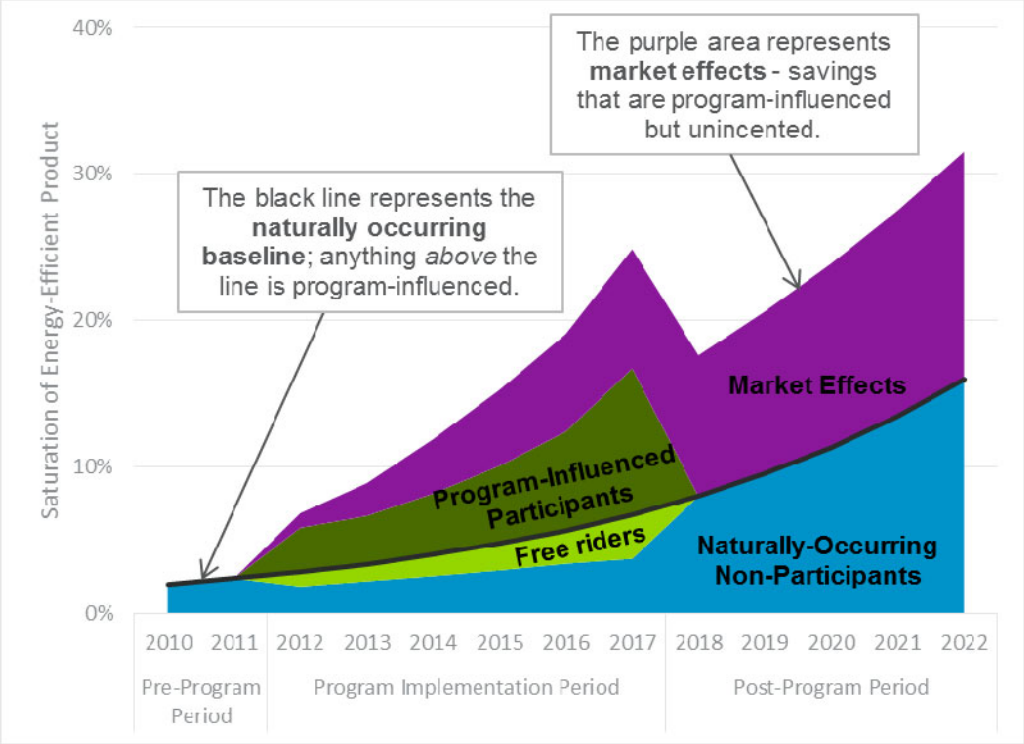

Figure 2. Generic framework for examining multi-year program influences. *Source:* Navigant analysis.

[4] A few programs do grant partial credit for these savings after the first program year.

Method

Navigant's market model approach to develop a comprehensive net-to-gross[5] (NTG) estimate for CFLs is more fully explained in *Using Market Models to Evaluate Market Effects/Transformation of Multi-year Energy Efficiency Programs* (McDonald, Sathe, and Landry 2014). In summary, Navigant used Bass diffusion curve modeling (a widely accepted equation for the rate of adoption of a new technology) and a stock turnover model to forecast the saturation that would have existed in PECO's service territory in the absence of the program. This counterfactual was compared with data reflecting actual saturation of CFLs in PECO's territory. The result is an NTG estimate that accounts for the long-term, cumulative effects of the program on the market since its inception in 2009.

The CFL Market Model is an analysis that estimates the NOB of CFL activity in PECO territory as a preliminary step in the estimation of the NTGR. Ideally, the following steps would be taken to estimate the NOB and NTGR of CFLs in PECO territory:

- Obtain CFL annual sales data within PECO territory from 1990 to 2014.
- Split CFL annual sales data into two sets:
    - CFL sales from 1990-2008 (prior to PECO programs)
    - CFL sales in 2009 and beyond (after PECO programs came into effect)
- Use 1990-2008 CFL sales to project the sales of CFLs in 2009 and beyond. This forecast represents CFL activity absent any PECO program influence (i.e., the NOB).[6]
- The difference between actual CFL sales and the NOB, divided by the number of CFLs discounted by PECO, when summed over the life of the program, yields an estimate of overall NTGR for the life of the program.

This ideal analysis is not possible because reliable CFL sales data within PECO territory from 1990 to 2014 are unavailable. Thus, Navigant developed an approach to estimate the NOB and NTGR using reliable data that are available. The available data include:

- CFL annual sales in the U.S. from 1990 to 2014 (U.S. ITC)
- Residential CFL saturation in the U.S. from 2008 to 2010 (DOE 2009, 2010, and 2012)
- PECO program-discounted bulbs sold from 2009 to 2014
- PECO territory residential CFL saturation in 2010 and 2013

Navigant used these data to estimate the NOB and the NTGR. The bass diffusion model used to forecast the NOB was calibrated to national data for 1990-2000 (the time period before market actors began to influence CFL adoption). The stock turnover model accounts for the number of homes, the number of bulbs per home, the rate at which CFLs go into and come out of storage, CFL measure life, and CFL bulb price, as well as how each of these changes over time. Navigant does not distinguish between the various types of CFLs (standard vs. specialty) in this

[5] Net-to-gross (NTG) ratios are estimated to determine the portion of sales of energy-efficient products that can be attributed to the program or market intervention.

[6] This model inherently includes the influence of all non-PECO programs. The PECO NOB represents the NOB that would occur in PECO territory if PECO programs did not exist but other CFL programs did exist. PECO NONPs is the portion of the NOB that represents what would happen if absolutely no programs for CFLs existed, anywhere.

analysis. Rather, this analysis groups all types of CFLs together into one category of bulbs for consistency with national saturation data.

Figure 3 presents a framework for understanding the components of the NTGR, put into the terms used in this analysis. While gross saturation can be estimated from program tracking data, net saturation must be calculated using information about the NOB and market effects. The NOB includes free riders and naturally occurring non-participants (NONPs). In this NTG analysis for PECO's CFL programs, Navigant applies CFL saturation information (as opposed to annual CFL sales) to the framework in Figure 2. Transforming sales data into saturation data allows for the examination of NTG under a longer-term market transformation framework.

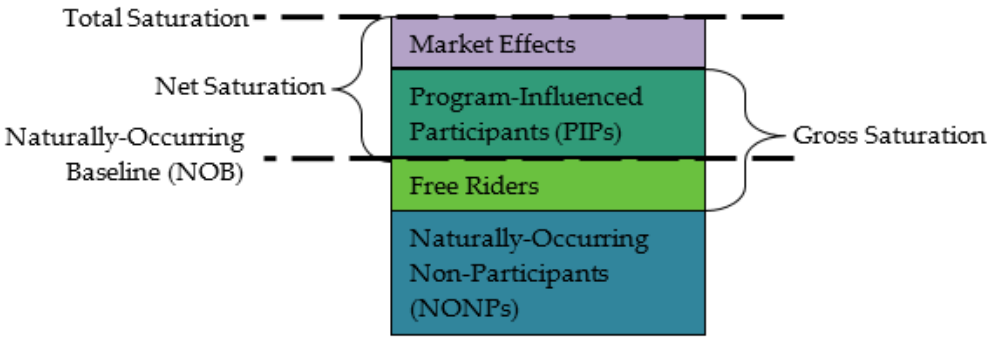

Figure 3. Generic framework for net-to-gross terminology. *Source:* Navigant analysis.

Results

Figure 4 displays these market segments over the life of PECO's programs. It illustrates PECO CFL program gross saturation (gold line) stacked on top of the PECO NONPs projection (black line) to allow for a visual correlation that matches up with the framework presented in Figure 3. What does not match the original framework is that the effect of gross program savings when stacked on top of the projected NONPs rises above the total saturation of CFLs in PECO territory (purple triangle). Mathematically, this results in negative market effects, and PECO PIPs account for only 5.7 percent saturation (9.9 percent plus the negative 4.2 percent market effects). This means that PECO programs in 2013 were incentivizing this "negative market effects" segment as free riders who would otherwise have been PECO NONPs (below the black line).

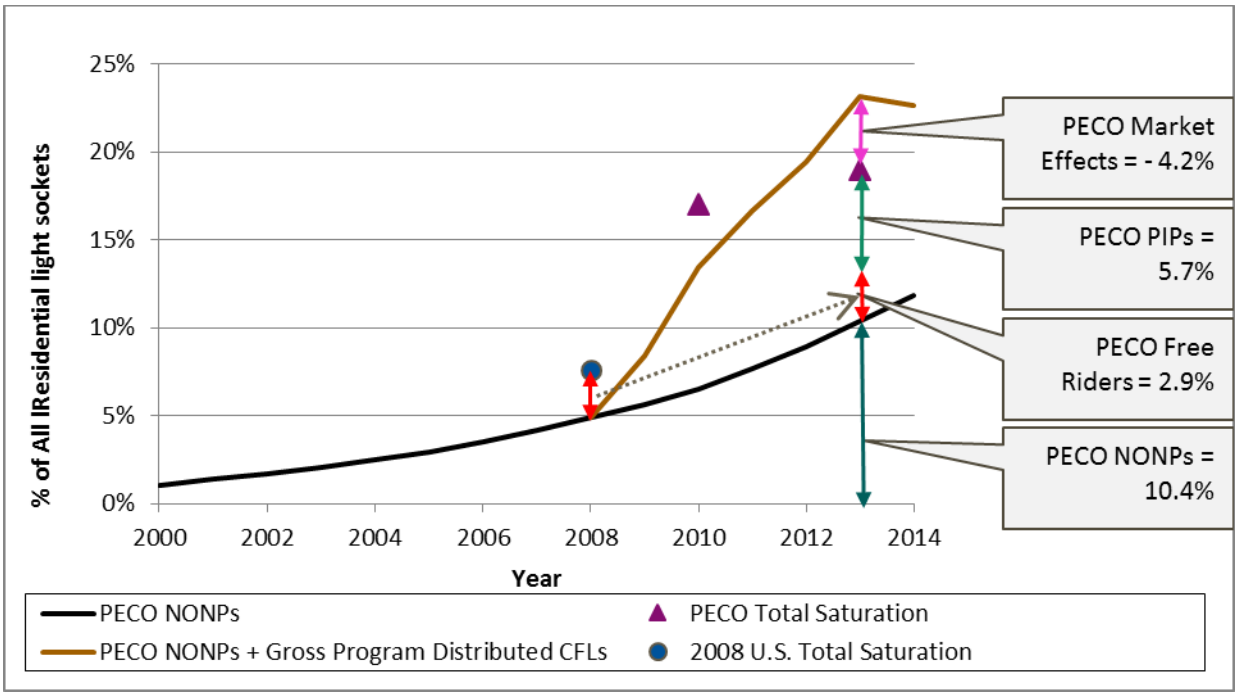

Figure 4. PECO CFL saturation components as related to NTGR terminology. *Source:* Navigant analysis.

Figure 5 illustrates the analysis for 2010. Total saturation in 2010 is greater than the gross program activity plus the NONPs. This illustrates that PECO programs were having a greater impact on the market than could be accounted for by program bulbs alone over the first two years of programming.

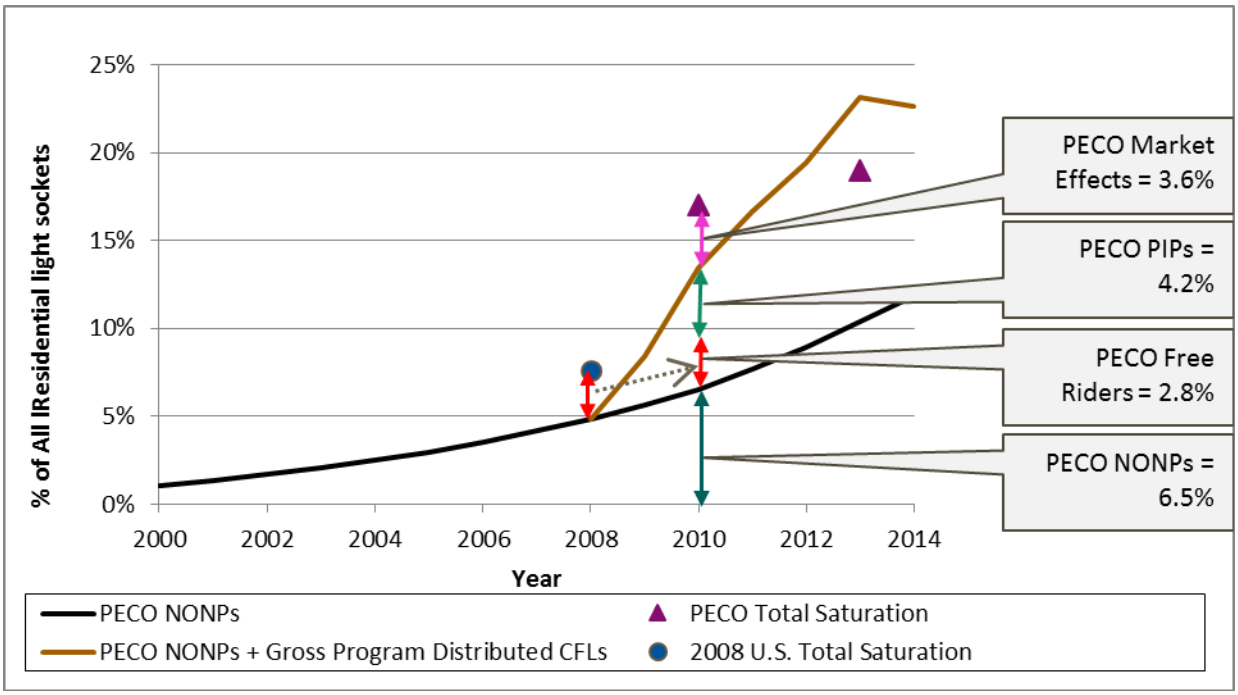

Figure 5. 2010 PECO CFL saturation components as related to NTGR framework. *Source:* Navigant analysis.

A snapshot of the data for 2010 is shown in Figure 6 and for 2013 in Figure 7. These visualizations show the positive market effects in 2010 as in the original framework and then the way negative market effects are representative of additional free ridership in 2013, decreasing the saturation associated with NONPs.

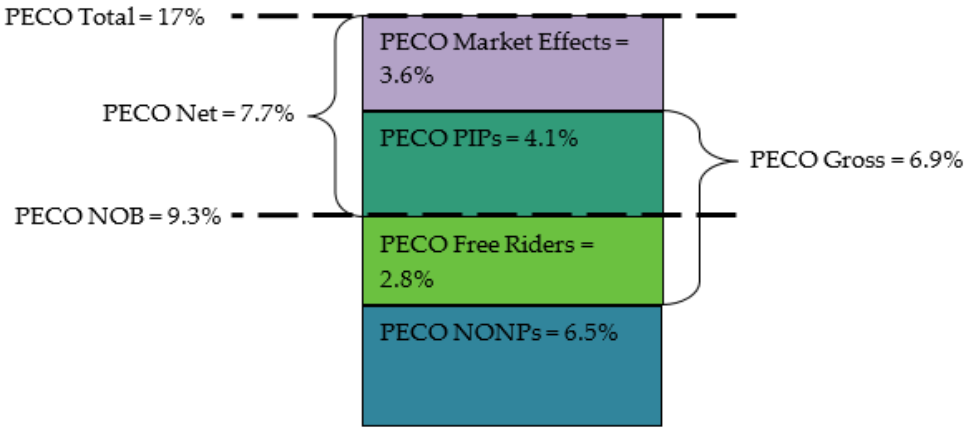

Figure 6. 2010 PECO territory CFL saturation results. *Source:* Navigant.

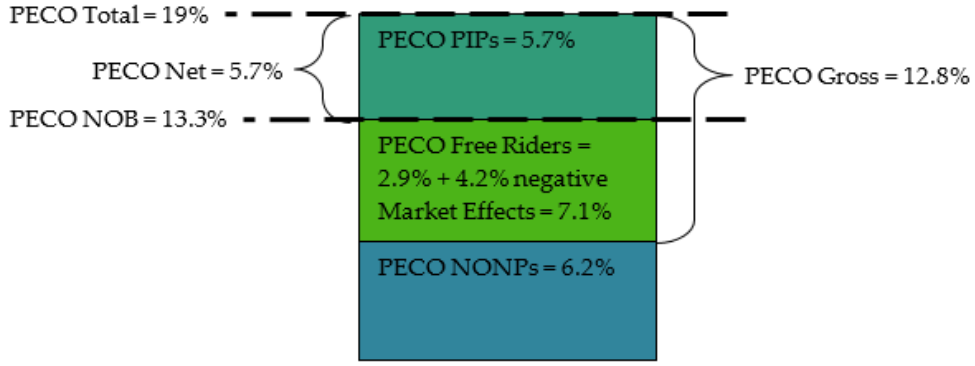

Figure 7. 2013 PECO territory CFL saturation results. *Source:* Navigant.

The NTGR components, expressed in saturation percentage points, are translated into ratios common to NTG analyses in Table 1. This method estimates a free-ridership of 40 percent for 2010 with 52 percent market effects resulting in a 111 percent NTGR. (Numbers do not appear to add up due to rounding). These values are reflective of cumulative PECO program activity from 2009 and 2010. Therefore, 40 percent of the cumulative CFLs that were discounted by PECO's programs in those two years would have been installed in the absence of the program and are considered free riders. Meanwhile, PECO's CFL programs influenced the installation of additional un-discounted CFLs (equal to 52 percent of the CFLs discounted by PECO in 2009 and 2010); this is PECO's effect on the local market for CFLs. Some of these un-discounted CFLs may be counted in traditional NTG research as participant spillover, while others would be purchases by non-participants influenced by the program and typically missed in CFL NTG

research.[7] The net activity generated by PECO's CFL programs is thereby equal to 111 percent of PECO's gross CFL activity in the program's first two years.

The 2013 numbers reflect a different balance. This method estimates a 2013 free-ridership of 56 percent (23 percent free-riders plus the 33 percent negative market effects) resulting in a 45 percent NTGR. (Numbers do not appear to add up due to rounding.) These values are reflective of cumulative PECO program activity from 2009 through 2013. Therefore, 56 percent of the cumulative CFLs that were discounted by PECO's programs over this time period would have been installed in the absence of the program and are considered free riders. The net activity generated by PECO's CFL programs is equal to 45 percent of PECO's gross CFL activity in the first five program years.

Table 1. Final calculated values for PECO, 2010 and 2013

	Saturation Percentage Points		Ratio (to Gross)*	
	2010	2013	2010	2013
Gross Activity	6.9%	12.8%	1.00	1.00
Net Activity	7.7%	5.7%	1.11	0.45
Free Ridership	2.8%	2.9%	0.40	0.23
PECO Market Effects	3.6%	- 4.2%	0.52	- 0.33

Numbers may not add up due to rounding. *Source:* Navigant.

Conclusion

The analysis of these two market snapshots reveals the effect of PECO's strong initial programs years followed by reduced program support. The market as a whole responded by slowing almost to a halt (2 percent growth in CFL saturation over the 3 years from 2010 to 2013). This demonstrates that PECO's programs were instrumental to moving the market forward in their territory from 2009 to 2010, and when programs were scaled back, the overall market responded by significantly reducing CFL installations. Had PECO continued their CFL programs and the savings they were achieving, CFL saturation would likely have continued to outperform gross program activity. The resulting NTGR would then have remained above one due to positive market effects.

The promise of the first two years of PECO's CFL programs was hindered by a lack of support thereafter. Without strong PECO programming, the market reverted to pre-program growth rates, which were even slower than the growth of the expected naturally occurring baseline at the time. This indicates that the PECO program was unable to transform the CFL market, as the saturation growth rate spurred by the program in 2009 and 2010 proved unsustainable with reduced program support. The intermittent nature of PECO's program support disrupted market progress and hindered the program's ability to create lasting transformation.

[7] Participant spillover only accounts for the additional purchases of non-rebated CFLs after a customer has already purchased a discounted CFL. Traditional measurement of participant spillover does not account for non-rebated CFL purchases that were independently made without a customer ever purchasing a discounted CFL.

Recommendations

PECO's experience with their CFL programs provides lessons learned not only for the programs analyzed, but for all utilities with incentive programs for energy efficient equipment. Below we provide recommendations first for PECO, then for other utilities to consider.

PECO

The CFL market in PECO's territory still lags behind the national market; the national market reached 22.8 percent CFL saturation in 2010 (Navigant 2012). Without renewed support for these programs, PECO's territory may continue to fall further behind the national market as CFL saturation growth rates may remain low (as observed from 2010 to 2013). As the lighting market continues to evolve, PECO still has opportunities to influence and transform the market:

- **Continue to incentivize CFLs until CFL saturation reaches higher levels.** PECO territory CFL saturation in 2013 fell short of the national average CFL saturation. With higher regulatory targets, PECO could continue to rebate CFLs until PECO territory saturation at least matches national saturation.
- **Focus lighting market transformation efforts going forward on LEDs.** LEDs have long measure lives, better lighting quality, the ability to dim, as well as other favorable features that appeal to residential customers. With a large incandescent base in PECO territory, the opportunity for installing LEDs, and the resulting savings, could be immense. In states with high CFL saturation, Navigant has observed that the potential for LEDs can be low due to the small incremental savings of LEDs replacing CFLs as well as the long life of CFLs, which decreases the likely number of installation opportunities.

Other Utilities

Any utility attempting to transform the market for energy efficient technologies can improve their chances of success by learning from PECO's experience.

- **Consistent programs are key to achieving market transformation.** Residential lighting programs – and likely other programs as well – should aim for consistency from year to year. Customers are more satisfied when they can rely on programs over time.
- **Promote regulatory structures that reward savings beyond set targets.** Pennsylvania's "all stick and no carrot" regulatory environment prompted the abrupt reduction in CFL programs that disrupted the market's transformation. A regulatory structure that doesn't penalize utilities for overachieving will promote successful programs over the long term.
- **Reform programs to a market transformation framework.** While resource acquisition programs can achieve market effects, they are less effective at generating self-sustaining adoption of efficient equipment than programs taking a market transformation approach.

Strengths and Limitations

Every method used to conduct a NTG analysis has both strengths and limitations; this method is no exception.

The key strengths of this approach include:

- The method accounts for multi-year program influences. Traditional evaluations can overestimate free ridership by having a single-year view as opposed a multi-year view that considers the full history of program influences on current program participation. This method estimates the NOB as opposed to just relying on free-ridership to account for multi-year program influences.
- The use of saturation accounts for the multiple cumulative effects of program influence. Most NTG estimates focus only on the program effects during the year in which the analysis is conducted. Those estimation methods do not account for the fact that program activity in one program year will affect market activity in the next program year. Using saturation to reflect how program impacts accumulate allows PECO to claim savings in later program years for those participants influenced by the program since its inception. Further, a focus on saturation facilitates a complete accounting of non-discounted bulbs installed, which are otherwise underrepresented in standard NTG values.
- The use of saturation more accurately reflects the timing of program impacts, taking into account bulbs that first go into residential storage. Though sales data reflect when bulbs are purchased, studies have shown that a large number of bulbs first go into storage in the home. Using saturation shifts when savings are claimed from the time of purchase to when the bulbs are actually installed and in use. This method allows for proper accounting of CFLs in storage where other methods may penalize NTG for CFLs that are not installed in the year they are purchased.

The key limitations of this approach include:

- The assumption that 100 percent acceptance occurs for a CFL when CFL price per bulb equals the price of an incandescent bulb allowed for the creation of a payback acceptance curve based on price elasticity data. A 50 percent willingness adjustment was made to account for qualitative considerations because while the longer expected life of a CFL and incremental energy savings translate into cost savings, these are not the only factors in residential light bulb purchasing decisions. So, even when the retail price of a CFL is equal to that of an incandescent bulb, factors like technology familiarity and brand recognition interfere with the rational decision presented by the economics.
- In translating sales to saturation, the stock turnover model must assume what percent of CFL sales go into the residential sector as opposed to the commercial sector and remove those attributed to the commercial sector. For the U.S., Navigant assumes 94 percent of CFLs sold go into residential homes, with the remaining 6 percent going into small businesses (based on customer survey results) (KEMA 2010). When translating PECO program sales into saturation, the commercial program bulbs were removed prior to analysis. Navigant assumes that 92 percent of CFLs sold in PECO territory went into the residential sector (Navigant 2013). These assumptions account for small businesses purchasing upstream rebated bulbs from retail outlets and installing them in their commercial facilities.
- The assumption that CFL saturation in PECO territory before PECO programming is equal to the average U.S. CFL saturation. This assumption results in a higher free ridership than if national program influences are said to have not fully penetrated PECO's

territory and influenced CFL purchases. Given the market lag in PECO's territory as compared to the national average, this is a conservative assumption.

References

DOE (United States Department of Energy). 2009. *CFL Market Profile: March 2009.*

—— . 2010. *CFL Market Profile: Data Trends and Market Insights.*

—— . 2012. *2010 U.S. Lighting Market Characterization.*

KEMA. 2010. *Final Evaluation Report. Upstream Lighting Program, Volume 1*. California Public Utilities Commission, Energy Division.

McDonald, C., A. Sathe, and K. Landry. 2014. *Using Market Models to Evaluate Market Effects/Transformation of Multi-year Energy Efficiency Programs.* International Energy Policy & Programme Evaluation Conference.

Navigant. 2012. *2010 U.S. Lighting Market Characterization.* U.S. Department of Energy. http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/2010-lmc-final-jan-2012.pdf

—— . 2013. *Quarterly Report to the Pennsylvania Public Utility Commission (Preliminary Annual Report) For the Period March 2013 through May 2013, Program Year 4, Quarter 4. Appendix B.*

Neumann, R., R. Gunn, and M. Lysyuk. 2014. *Regulatory Update: Regulatory Regimes and Effective Energy Efficiency Programs (Across Fifteen States) and Potential Improvements.* Washington, DC: American Council for an Energy-Efficient Economy. http://aceee.org/files/proceedings/2014/data/papers/8-214.pdf

PA PUC (Pennsylvania Public Utilities Commission). "Act 129 Information." Accessed March 2016. www.puc.state.pa.us/filing_resources/issues_laws_regulations/act_129_information.aspx

PECO Energy Company. 2016. "We are the largest electric and natural gas utility in Pennsylvania." https://www.peco.com/ABOUTUS/WHOWEARE/Pages/ServiceTerritory.aspx

U.S. ITC (United States International Trade Commission). http://dataweb.usitc.gov/.