Market Effects: Claim Them Now or Forever Hold Your Peace

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ABSTRACT

An energy efficiency program aiming for market transformation can be expected to reach a point at which the net-to-gross ratio (NTG) drops significantly below one. Indeed, reaching such a point can be a sign of success, reflecting a market that can stand on its own.

This paper discusses market effects evaluations of two programs at different stages of the expected cycle of market transformation, both run by the same sponsors in Massachusetts. The first program, for clothes washers, appears to be on the downward side of the cycle—with a low NTG, and addressing a market that has become robust and self-sustaining. The second program, for compact fluorescent lamps (CFLs), is driving many more CFL sales than the program itself is directly responsible for, and has a very high NTG. There are signs, though, that the CFL program may be reaching the height of the cycle, and that a decline in NTG may be imminent.

The sponsors did not claim impacts from the market effects of their clothes washer program when these effects were ascendant and peaking. Having watched the opportunity pass for clothes washers, they do not want to miss another opportunity, and are now claiming impacts from the market effects of their CFL program. This paper, then, makes the case that sponsors should devote resources to assessing market effects early and often in the course of a market transformation program, and, if appropriate, claim impacts from those market effects before they peak and decline.

Introduction

This paper summarizes and examines the implications of research conducted by Nexus Market Research (NMR) to estimate the market effects that may be attributed to the 2006 Massachusetts ENERGY STAR® Appliances Program and the 2006 Massachusetts ENERGY STAR Lighting Program, both sponsored by National Grid, NSTAR Electric, Western Massachusetts Electric, Cape Light Compact, and Unitil (the sponsors). The findings related to appliances, specifically clothes washers, are based on the following:

- Sponsor records of the number of clothes washers rebated in 2006, by CEE Tier
- A random-digit dial survey, to estimate the number of clothes washers sold in Massachusetts
- A survey of Massachusetts consumers who, in previous years, had purchased ENERGY STAR clothes washers using rebate coupons from the sponsors, to estimate expected useful life
- An on-site assessment of households in Massachusetts, as well as data from the 2001 Residential Energy Consumption Study (RECS), to estimate saturation of electric and fossil fuel clothes dryer/water heater combinations

- DOE data, to estimate the average energy use of electric and fossil fuel clothes dryer/water heater combinations, by CEE Tier
- State-by-state tracking of the market share of ENERGY STAR clothes washers sold at major national retailers, conducted for the U.S. Department of Energy by D&R International

The findings related to CFLs are based on the following:

- Records of CFL imports into the United States, from the Department of Commerce
- An on-site retailer survey and bulb count, to estimate sales of CFLs, incandescents, and other bulbs in Massachusetts
- Estimates of CFL sales from other states with active residential lighting programs
- An assessment of CFL sales in Wisconsin and Michigan, conducted by Glacier Consulting

Following Eto, Prahl, and Schlegel (1996), we define market transformation as "a reduction in market barriers resulting from a market intervention, as evidenced by a set of market effects, that lasts after the intervention has been withdrawn, reduced, or changed." One focus of this paper is to help program sponsors decide whether the market is at a point where the program's intervention in the market can be withdrawn, reduced, or changed with a reasonably good chance that market effects will continue. We look at it from the perspective of whether a market transformation program speeds up the market adoption curve.

We define net-to-gross ratio (NTG) as market-level sales minus program-supported sales over baseline sales; when possible (as with clothes washers in the below example), we convert NTG sales to NTG energy savings. This definition takes both participant spillover and nonparticipant spillover into account, so it is possible for NTG to be considerably higher than 1.0; in contrast, definitions that do not count spillover cannot be greater than 1.0 (although they can be less than 1.0 if freeridership is taken into account). Another focus of this paper is to make the case that NTG claims greater than 1.0 may in fact be reasonable.

In this paper, we briefly discuss the evaluators' estimate of clothes washer energy savings that may be attributed to the sponsors' program, as well as the ratio of net-to-gross kWh savings. We follow with a similar discussion regarding CFLs, focusing on sales rather than energy savings. We then discuss the expected trajectory of market effects in a market transformation program, and the points in this trajectory where the sponsors' appliance and lighting programs appear to be. Finally, we discuss the implications for program design, and for estimating and claiming energy savings.[1]

Clothes Washers

The clothes washer NTG estimate considers net energy savings, compared to the sponsors' original gross savings estimate. This NTG estimate uses Virginia as a non-program comparison area for sales, and for energy savings relies on other estimates of annual clothes washer sales in Massachusetts (NMR 2005a), expected useful life (NMR 2007a), appliance saturation (RLW 2006; EIA 2001), and appliance energy consumption (DOE 2000).

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[1] The implications as stated do not necessarily represent the views of program sponsors.

Virginia offers no incentives for energy-efficient clothes washers. It is also a state with median household income ($50,028) that is higher than the U.S. average, and close to that of Massachusetts ($52,713). (U.S. Census 2006) Given that sales of ENERGY STAR-qualified clothes washers are associated with higher incomes (see, for example, NMR 2005a), we therefore treated Virginia as the baseline: what would have happened in Massachusetts in the absence of an appliances program.[2]

According to the DOE market share data, 46.86% of clothes washers sold in national chains in Massachusetts in 2006 were ENERGY STAR-qualified, compared to 33.20% in Virginia. (D&R 2007) That means that the total number of ENERGY STAR-qualified clothes washers in Massachusetts was 57,562, compared to a baseline of 40,775—a difference of 16,787 units.[3] Unfortunately, the DOE appliance market share data do not distinguish among CEE tiers. However, since 96% of the sponsors' rebates went to units with MEFs[4] of 1.8 or higher, it seems reasonable to assume that most of these 16,787 incremental units were 1.8 MEF or higher. The average rebated unit had an MEF of 2.02.

On this basis, the evaluators estimated that the per-unit lifetime net savings are 3,074 kWh attributable to all program years (from 1998 through 2006), and—based on previous research conducted for the sponsors (NMR 2005b)—1,445 kWh attributable to the 2006 program year. For the entire program, the estimated net savings are 89,403 MWh attributable to all program years, and 42,020 MWh attributable to the 2006 program year.

The sponsors' 2006 lifetime gross savings estimate, based on per-unit savings estimates and the number of units rebated, was 153,932 MWh. Given a market-level lifetime net savings estimate of 42,020 MWh, then, the evaluators' estimate of the net-to-gross ratio is 42,020 MWh divided by 153,932 MWh, or 0.27. If the effect of previous years' programs on 2006 clothes washer sales had not been considered, the estimated NTG would be 89,403 MWh divided by 153,922 MWh, or 0.58—still well below 1.0.

These market-level estimates do not distinguish between participant spillover and non-participant spillover, but they are both accounted for in the difference between actual and baseline. Freeridership (including partial freeridership) is part of the baseline and hence does not need to be calculated. In self-reports, participating consumers could conceivably overestimate their freeridership, because they could easily think they would have bought a given model in the absence of the rebate without knowing how much the program had done to make that model available to them. It could also be argued that self-reporting tends to underestimate freeridership, partly because of "gaming" the ability to get a reduced price. In any case, nonparticipant purchasers of qualifying units cannot reliably estimate the influence of the program on their purchases—for example, one influence could have been the greater availability of qualifying units, making their purchase a more viable option.

It is also likely that some of the net savings are not captured with the market-level approach used here. For example, just as we attribute some of the savings associated with efficient clothes washers sold in 2006 to program efforts in previous years, so is it likely that the 2006 program efforts will contribute to savings in subsequent years—savings that have not yet

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[2] See later paragraphs for a summation of reasons why this comparison area approach provides an imperfect baseline.

[3] Based on an estimate of 122,828 clothes washers sold in Massachusetts in 2006; 46.86% of that equals 57,562; 33.20% equals 40,775.

[4] MEF is "Modified Energy Factor," a measure of efficiency for clothes washers provided by DOE. A higher MEF means a more efficient clothes washer.

been credited to the program. Also, we used clothes washer sales in Virginia, a state with no substantial ENERGY STAR appliance program, as a baseline. It is likely that sales of efficient clothes washers in Virginia have been affected by program efforts in Massachusetts and other active states, thus increasing the baseline and erroneously reducing the net savings. Clothes washer manufactures cater to national markets; they don't produce "regional" products. Therefore demand stimulated in states working through national entities such as ENERGY STAR and CEE to pool market influence on national manufacturers is likely to affect sales in states with no program activity. For example, we found that in 2006 ENERGY STAR-qualified clothes washers at all CEE tiers were nearly equally available at national chain stores in Massachusetts and Virginia (NMR 2007a).

The possibility also exists that these net savings estimates are too high. For example, if the expected useful life is lower than estimated (14.6 years, based on a logit analysis reported in NMR 2007a), then consumers may replace broken units with even more efficient units when the federal standards change, and not all expected savings will be realized.

Compact Fluorescent Lamps

We developed two estimates of the net CFL sales[5] that may be attributed to the Massachusetts Residential Lighting Program. The first estimate relied on state-level sales from selected states with active programs, including Massachusetts, along with national CFL shipment data. We subtracted sales in areas with active programs from total national sales (from U.S. Census 2007, adjusted to eliminate non-residential sales), and treated the per-household CFL sales level in the remaining states as the baseline for per-household sales in Massachusetts. We used this approach for the 2005 and 2006 program years, allowing analysis of changes from year to year. The second approach, followed only for the 2006 program year, used a single-state comparison area—Michigan—based on work conducted by Glacier Consulting, which involved comparison of per-store sales in Wisconsin and Michigan for the same national or regional chains (Glacier 2007).

Based on a retailer survey and shelving stock assessment, we estimated that market-level sales of CFLs in Massachusetts in 2006 were between 10,426,466 units and 12,904,727 units (NMR 2007b). With the national comparison area approach, we estimated that 2006 baseline sales per household ranged from 1.05 to 0.94. Multiplying these estimates by the number of households yields total Massachusetts retail CFL baseline sales of 2,565,028 to 2,307,726. Baseline sales are defined as the number of CFLs that would have been sold in the absence of program sales. The higher 2006 baseline estimate (1.05) assumes fewer market-level CFL sales in Massachusetts and other active program areas; the lower 2006 baseline estimate (0.94) assumes higher market sales in program areas. National sales are constant. We divided the resulting sales by the total number of households in states with no programs to obtain annual baseline estimates.

As noted earlier, the difference between the baseline estimate and the estimate of market-level sales is the net program effect. Freeridership is "below the line" in the baseline estimate (and not calculated), while both participant spillover and nonparticipant spillover are "above the line" in the net program effect estimate (and calculated together, not separately). In

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[5] This estimate is net sales rather than net savings. The Massachusetts sponsors are currently conducting studies to provide updated inputs to derive savings estimates, including installation rate, wattage displacement, hours of use, and measure lifetime.

Massachusetts, the net program effect, or the CFL sales attributable to the program (directly and indirectly) ranges from 7.9 to 10.6 million CFLs, depending on the estimate of total market sales. The NTG is calculated as the ratio of market-level CFL sales minus baseline sales over program sales. The magnitude of the NTG estimate indicates the level of sales that can be attributed to the program. The 2006 Massachusetts NTG ranged from 2.43 to 3.28.

Wisconsin Focus on Energy used the state of Michigan as a comparison area for the state of Wisconsin to estimate the effects of its 2006 program (Glacier 2007). The NTG for this program was fairly low, at 0.81. The evaluators believe this is primarily due to Wisconsin's reliance on coupons rather than markdowns/buydowns, resulting in relatively low growth in Wisconsin market sales between 2005 and 2006—24%, compared to 65% to 104% in Massachusetts, and 63% in the U.S. as a whole. However, it is also possible that the comparison area methodology itself has some effect on the lower NTG. Our national comparison area approach effectively used non-program areas for comparison; the program areas we used were New England (Massachusetts, Connecticut, Rhode Island, Vermont, New Hampshire, Maine), New York, Wisconsin, California, and the Northwest (Washington, Oregon, Montana, Idaho)—states that, taken together, have higher than average incomes. We have found (e.g., NMR 2007b) that higher-income households tend be buy more CFLs than those in lower-income households. It therefore may be that people in the remaining, lower income states—largely in the Southeast based on population, but also the Southwest, the Great Plains, and the Mountains—buy fewer CFLs than those in non-participating upper Midwestern states like Michigan, thus making the baseline lower and the NTG higher.

We believe that Michigan serves as a good comparison area for Massachusetts, as a northern state with similar income levels and demographics. This approach provides a more conservative NTG estimate than we find using a national comparison area and may better reflect what would have happened in Massachusetts in the absence of a program.

The Wisconsin study estimated baseline or naturally occurring sales of 1.66 CFLs per household. Multiplying this estimate by the number of households results in baseline CFL sales of 4,057,673 in Massachusetts. This baseline yields net program effects ranging from 6.4 to 8.8 million CFLs, depending on the estimate of total market sales. The NTG ranges from 1.97 to 2.74.

Implications

The Massachusetts sponsors began offering rebates for ENERGY STAR clothes washers in 1998, and Figure 1—based on DOE's ENERGY STAR market share data from national chains—clearly shows the program had an effect from the beginning. In early 1998, the ENERGY STAR clothes washer market share in Massachusetts was virtually the same as that in Virginia; by 1999 it was twice as high. By 2006, however, it was only about 40% higher proportionally, indicating declining effects over time. While the sponsors did not estimate the NTG in 1999, we speculate that it would have been much higher than the 0.27 NTG estimated for 2006.

Figure 1. ENERGY STAR Clothes Washer Market Share in National Chains
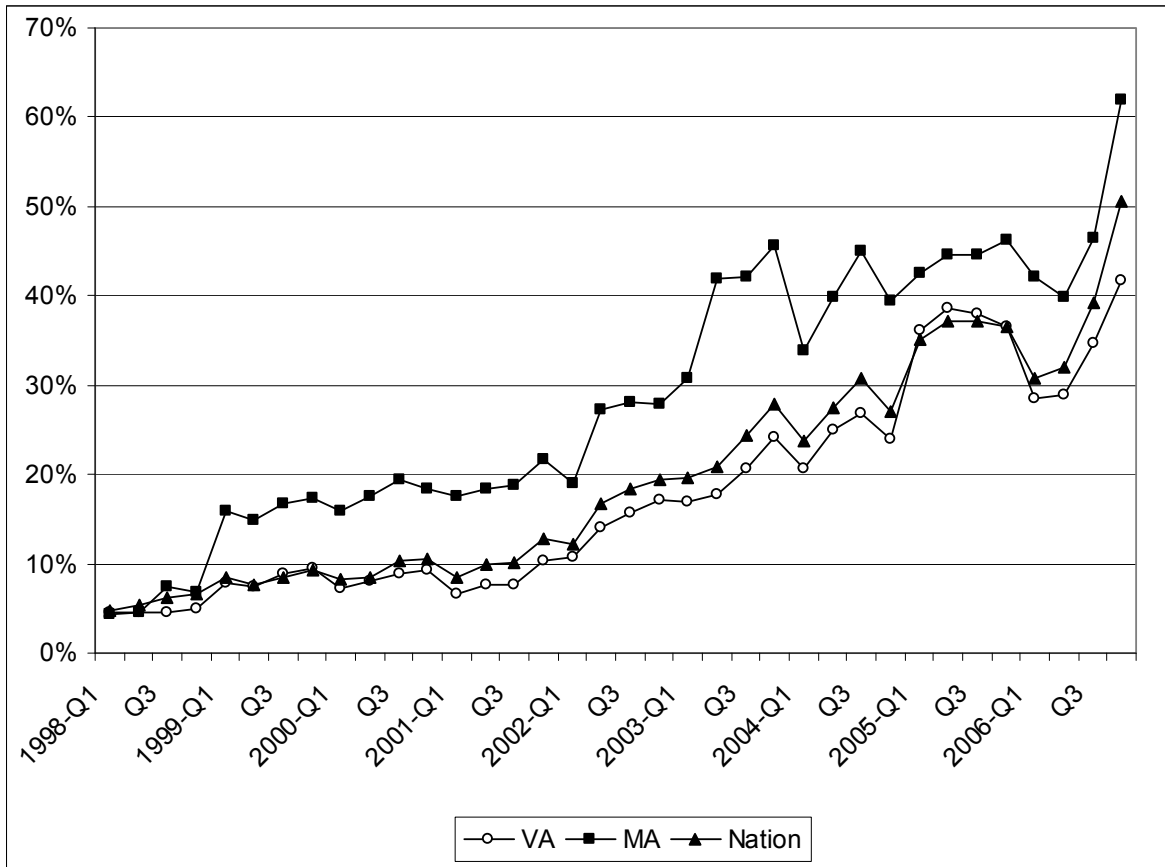
Source: D&R (2007)

Massachusetts sponsors, as a group, also began promoting CFLs in 1998, although some individual sponsors had begun in the early 1990s. In contrast to sponsors' clothes washer effort, the CFL program shows a rising NTG in 2006—from 1.37-1.41 estimated for 2005, to a conservative estimate of 1.97-2.74 for 2006 using the single-state comparison approach, or 2.43-3.28 using the national comparison approach, which had also been used in 2005.

The rising NTG for CFLs reflects the rapid growth of market-level CFL sales in Massachusetts from 2005 to 2006. While national CFL sales experienced a very healthy growth rate of 63%, from 100 to 163 million (excluding non-residential applications), Massachusetts sales grew even faster. Our estimated range of 10.4 to 12.9 million market-level CFLs is 65% to 104% higher than the 2005 estimate of 6.3 million CFLs. However, it must also be noted that baseline estimates of CFL sales are also much higher than in 2005. Baseline CFLs per household in 2005 ranged from 0.14 to 0.19 or from 0.71 to 0.76, depending on assumptions about national sales. In 2006, baseline CFLs per household ranged from 0.94 to 1.05 under the national comparison area approach and 1.66 under the single-state approach using Michigan as a non-program comparison area. These CFL figures are summarized in Table 1.

Table 1. CFL Sales and NTG

	2005	2006
Market-level sales		
Massachusetts	6.3 million	10.4-12.9 million (65%-104% increase)
U.S.	100 million	163 million (63% increase)
Sales per household		
Massachusetts	2.59	4.25-5.27
Baseline—national baseline approach	0.14-0.76	0.94-1.05
Baseline—single-state baseline approach	NA	1.66
Massachusetts NTG		
National baseline approach	1.37-1.41	2.43-3.28
Single-state baseline approach	NA	1.97-2.74

We do not believe the sponsors' lighting program will continue to see such high net-to-gross ratios far into the future. At a national level, CFL sales showed dramatic growth beginning in 2006 and accelerating in 2007, as shown in Figure 2. Given the growing identification of CFLs as an emblem of "doing one's part" to address environmental issues and global warming, the efforts of parties like Wal-Mart,[6] and pending legislation to phase out inefficient lighting, we expect more CFLs to be sold in non-program areas. This will continue to raise the baseline and eventually lower net-to-gross ratios, which at some point will fall well below 1.0. As is the case with clothes washers, increasing CFL sales in non-program areas are very likely affected by the efforts of those with active programs, such as the Massachusetts sponsors. As is also the case with clothes washers, programs run in past years continue to have an effect on current sales—an effect we quantified for clothes washers, although we were not able study the issue for CFLs. The NTG reaching 0.27 (or even 0.58 when the effect of past programs is not considered), as with clothes washers, indicates that past program efforts alone may be sufficient to propel sales in the future, and that the market may have been largely transformed.

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[6] Wal-Mart committed to selling 100 million CFLs in 2007, and met the goal by September (Wal-Mart 2007).

Figure 2. National CFL Sales and Shipments
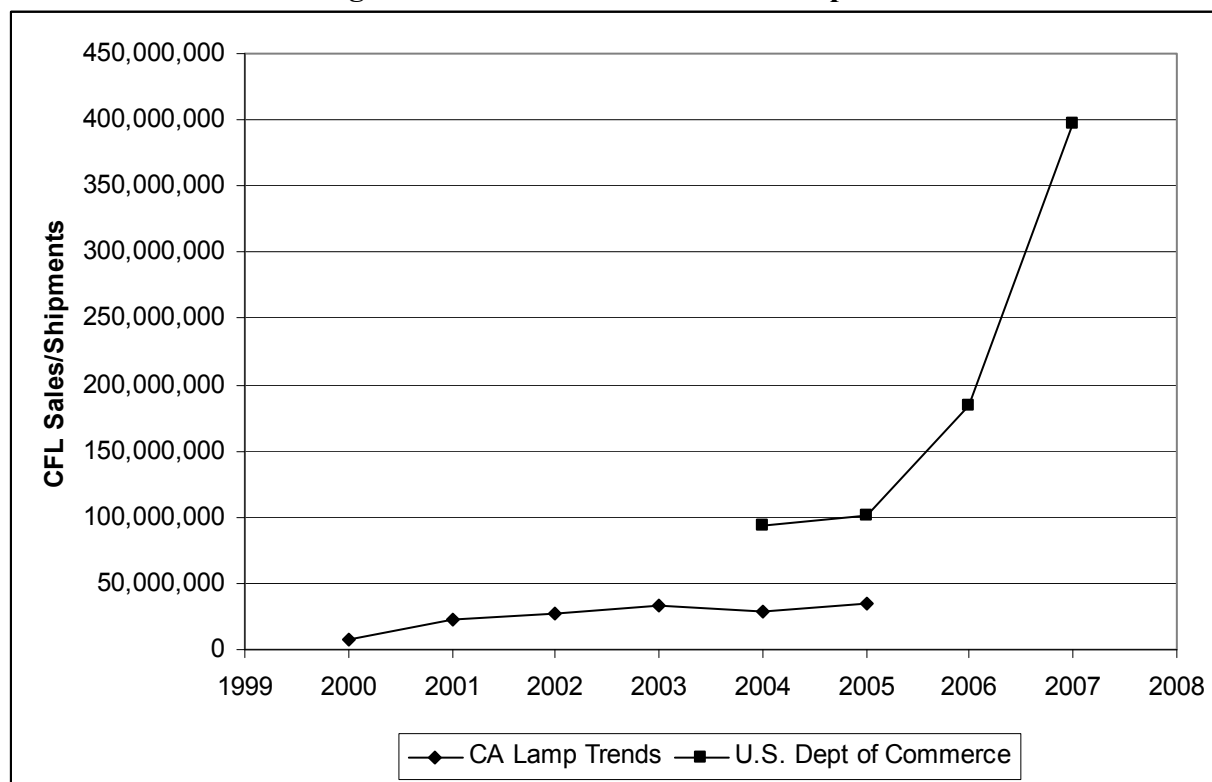
Sources: Itron (2006), U.S. Department of Commerce (2007)

A hypothetical example may be helpful, as depicted in Figure 3. Suppose a program in its first year is responsible for all sales of a given efficient technology in the program area, based on the fact that a non-program or baseline area has no sales; if the program did not exist, there would be no sales. From a sales perspective—that is, without considering actual vs. expected savings—the NTG is 1.0. Beginning in the second year, the program starts affecting the local market, even while the non-program market is developing to a lesser extent, and the NTG increases through year six, to a high of 3.1. After that, however, both the local and the non-program markets continue developing, with non-program sales catching up as the market becomes transformed; thus the NTG falls below 1.0 by year ten, and to 0.0 by year 12.

Hence one function of an effective market transformation program is to accelerate the market adoption curve. We are suggesting that the pattern, not the timing or the numbers, applies more broadly. Specifically, for the examples used in this paper, we are suggesting that, as of 2006, the Massachusetts ENERGY STAR Appliances program, with a NTG of 0.27, was well along the downward slope of the NTG curve, and that the Massachusetts Residential Lighting Program, with a NTG of at least 1.97, was at or near the peak. Based on the rapid development of the national CFL market, as discussed above, we further suggest that the NTG for the lighting program has either started to decline or will do so soon, and that the decline will occur over a fairly short period.

Of course, these expectations are subject to other factors, such as the development and introduction of new technologies, which could start the cycle over again, or changes in codes and standards, which could accelerate it. There are also at least two additional caveats to these expectations. First, an assumption underlying the oversimplified pattern depicted in Figure 3 is

that market penetration of efficient technologies in both the program area and the comparison area will follow the standard S-shape curve, and that in both areas it will reach a limit near 100%. If manufacturers and retailers were to change their strategies abruptly and fundamentally, or if prices were to increase substantially, the expected S-shape curve might not develop. Even with out such fundamental supply-side changes, the market penetration could level off at a lower level in the comparison area. It is also possible that the NTG could fall relatively slowly—particularly, again, if the curve in the comparison area should level off before that in the program area. All of these—the development and introduction of new technologies, changes in codes and standards, changes in strategy on the supply side, and long-term lag in market development in non-program areas—are possibilities for the CFL market.

Figure 3. Hypothetical Program Market Effects
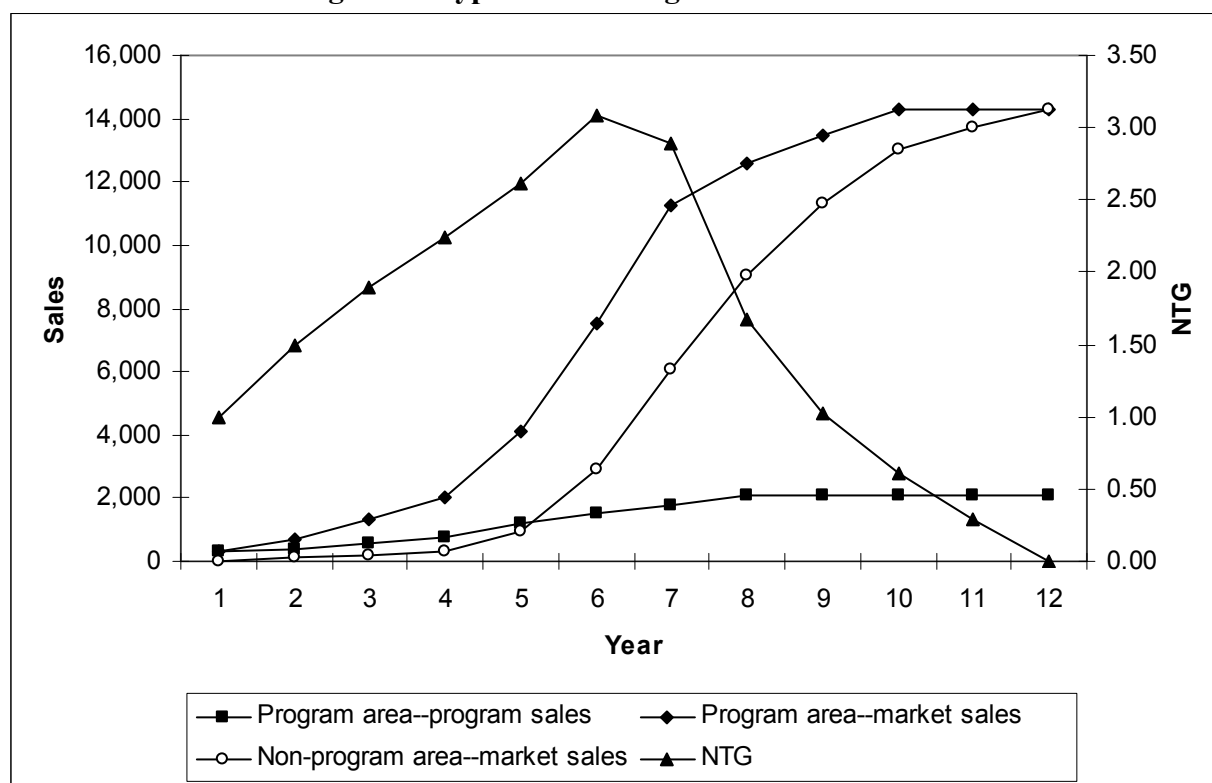
This analysis leads to three recommendations for efficiency programs. The first recommendation is to consider scaling back or revising market transformation programs once the NTG falls substantially below 1.0 (meaning that the program may be getting less savings than expected), and to consider scaling back or revising all programs—even resource acquisition programs—well before the NTG gets close to 0.0 (meaning that the program is getting no savings at all). Of course, cutting back or eliminating programs would be subject to other findings indicating market transformation, such as decreases in incremental prices, greater availability in a wide array of channels, increased consumer awareness, increased commitment by manufacturers, and a summative analysis of whether the market is sustainable on its own.[7]

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[7] See, for example, Hoefgen, Li and Feldman (2006).

The second recommendation is to claim savings from market effects when they can be shown to exist, thus making programs more cost effective and helping to secure their funding.

The third recommendation—necessary for following the first two—is to monitor market effects and net-to-gross ratios so that managers and regulators will know the impacts of their programs. Program managers should begin monitoring and claiming market effects early in a program cycle, while the effects are still positive. The sponsors of the Massachusetts programs only recently began quantifying and claiming market effects—that is, beyond freeridership and participant spillover. With clothes washers, these efforts began after most of those market effects had taken place. With CFLs, it appears that the sponsors have begun claiming market effects at or near their peak. Program managers should also continue to monitor throughout the program cycle, given the possible interruptions in or possible exceptions to the S-shape curve outlined above, which could confound expectations. With CFLs, one possible interruption is the pending legislation to phase out inefficient lighting; another is the ongoing development of new efficient lighting technologies, such as LEDs. While it may be that the final transformation of the lighting market cycle is imminent, it may also be that a new cycle is about to begin, or has already begun.

Conclusion

The concept of market transformation assumes that a program intervention can accelerate the market adoption of a product or technology. There is evidence that Massachusetts sponsors' promotion of efficient clothes washers and CFLs may in fact have helped speed up the adoption of these products in Massachusetts, based on comparisons with sales in other areas where no programs are in place.

As of 2006, the market adoption of efficient clothes washers appeared largely to have taken place, with sales in the baseline area beginning to catch up with those in Massachusetts. As a result, the NTG had fallen substantially below 1.0—meaning that the program was achieving less savings than it was directly supporting.

In the case of CFLs, as of 2006, market adoption appears to have been accelerating faster in Massachusetts than in non-program comparison areas. Accordingly, the NTG was considerably greater than 1.0—meaning that the sponsors' program was responsible for more CFL sales than it directly supported. With geometric increases in sales nationally and the active promotion of CFLs by major players like Wal-Mart, however, it is likely that the curve is nearing its peak and that the NTG will begin to decline fairly soon.

Market transformation, early in a product cycle, involves greater sales and savings than a program promoting that product is directly responsible for, and later on it entails less sales and savings. Given that a rising and then declining NTG can be expected, it is incumbent upon sponsors to measure the market effects of their programs both early in the program cycle so that positive effects can be demonstrated and claimed, as well as later in the cycle so that the proper time to end or curtail program support can be identified.

References

[D&R] D&R International. 2007. *Resources for Appliance Manufacturers and Retailers*. http://estar7.energystar.gov/index.cfm?c=manuf_res.pt_appliances. Washington, D.C.: Department of Energy.

[DOE] Department of Energy. 2000. *Final Rule Technical Support Document (TSD): Energy Efficiency Standards for Consumer Products: Clothes Washers*, http://www.eere.energy.gov/buildings/appliance_standards/residential/clwash_0900_r.html. Washington, D.C.: Department of Energy.

[EIA] Energy Information Administration. 2001, *Residential Energy Consumption Survey*, http://www.eia.doe.gov/emeu/recs/recs2001/hc_pdf/appl/hc5-9a_ne_region2001.pdf. Washington, D.C.: Department of Energy.

Eto, J., R. Prahl, and J. Schlegel. 1996. *A Scoping Study on Energy-Efficiency Market Transformation by California Utility DSM Programs*. Berkeley, Calif.: Lawrence Berkeley National Laboratory.

[Glacier] Glacier Consulting Group, LLC and Ralph Prahl Associates. 2007. *Comprehensive CFL Market Effects Study, Final Report*. Madison, Wis.: State of Wisconsin Department of Administration Division of Energy.

Hoefgen, L., A. Li, and S. Feldman. 2006. "Asking the Tough Questions: Assessing the Transformation of Appliance Markets." In *Proceedings of the 2006 Summer Study on Energy Efficiency in Buildings*, 10.14-10.25. Washington, D.C.: American Council for an Energy-Efficient Economy.

Itron. 2006. *California Residential Efficiency Market Share Tracking: Lamps 2005*. Southern California Edison: Rosemead, Calif.

[NMR] Nexus Market Research. 2005a. *Market Progress and Evaluation Report (MPER) for the 2004 Massachusetts ENERGY STAR Appliances Program*. National Grid: Northborough, Mass.

[NMR] Nexus Market Research. 2005b. *Statistical Analyses of Market Penetration of ENERGY STAR-Compliant Appliances*. National Grid: Northborough, Mass.

[NMR] Nexus Market Research. 2007a. *Estimates of Net Impact of the 2006 Massachusetts ENERGY STAR Appliances Program, Clothes Washer Component*. National Grid: Northborough, Mass.

[NMR] Nexus Market Research. 2007b. *Market Progress and Evaluation Report (MPER) for the 2006 Massachusetts ENERGY STAR Lighting Program*. National Grid: Northborough, Mass.

[RLW] RLW Analytics. 2006. *Final Market Potential Report of Massachusetts Owner Occupied 1-4 Unit Dwellings*. NSTAR: Westwood, Mass.

U.S. Census. 2006. *American Communities Survey*. http://factfinder.census.gov. Washington, D.C.: U.S. Department of Commerce.

U.S. Census. 2007. *U.S. Imports of Selected Merchandise*. http://www.census.gov/foreign-trade/reference/products/index.html. Washington, D.C.: U.S. Department of Commerce.

Wal-Mart. 2007. "Wal-Mart Surpasses Goal to Sell 100 Million Compact Fluorescent Light Bulbs Three Months Early." http://walmartstores.com/FactsNews/NewsRoom/6756.aspx. Bentonville, Ark.: Wal-Mart Stores, Inc.