Quantifying Events in a Parallel Universe: Four Case Studies of Estimating Baseline for Market Transformation Programs

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ABSTRACT

This paper presents four case studies that offer methodological approaches and lessons learned that can be applied to the evaluation of market transformation initiatives nationwide. Evergreen Economics conducted the assessments for four Northwest Energy Efficiency Alliance (NEEA) market transformation initiatives: high efficiency televisions, residential lighting, heat pump water heaters and high performance homes. The methods Evergreen Economics used to estimate net market effects included analysis of market data, analysis of secondary data sources, and in-depth interviews with market actors and program staff.

Naturally occurring market baseline cannot be measured but only estimated because it is a counter-factual – an empirically based estimation of what the regional market would have looked like without NEEA's intervention. The case studies illustrate that traditional evaluation and research methods may be used to estimate what would have happened in the market in absence of the intervention.

Introduction

The Northwest Energy Efficiency Alliance (NEEA), established in 1997, is a non-profit organization funded by the Bonneville Power Administration, Energy Trust of Oregon and more than 100 Northwest utilities on behalf of more than 12 million energy consumers. NEEA collaborates with its funders to accelerate market adoption of energy efficient products, services and business practices through regional market interventions that:

- Expand energy efficient product availability
- Increase demand for energy efficient products
- Expand market capability via education, training and technical support
- Develop emerging energy efficient technologies
- Advance the development of more stringent codes and standards

NEEA and its regional partners fund a variety of initiatives. NEEA's current portfolio includes programs that address existing buildings, commercial real estate, lighting, healthcare and information technology in the commercial sector and efficient homes, televisions, desktop personal computers, heat pump water heaters and ductless heat pumps in the residential sector. NEEA also implements initiatives in the industrial sector, supports the adoption of increasingly stringent codes and standards, develops emerging technologies and offers coordination and information-sharing services to its regional partners.

NEEA's initiatives are designed to effect structural market changes that increase the supply of and demand for energy efficiency products, services and business practices. NEEA's market transformation programs deliver long-term energy savings as a result of increased and

accelerated market adoption of those products, services and business practices. While utility program evaluations rely on customer enrollment and meter data analyses, NEEA's market transformation program evaluations must rely on estimating the increase in market adoption that results from its market interventions, and multiplying that by per unit energy savings. In order to calculate the increase or change in market adoption, NEEA must track actual market adoption and estimate what would have occurred absent its intervention (i.e., naturally-occurring baseline). These estimates are rolled into an Alliance Cost Effectiveness (ACE) model, which is periodically updated by NEEA's planning and implementation teams and then independently assessed by evaluators.

NEEA presents its cost-effectiveness assumptions to its funders on at least an annual basis, where estimates are scrutinized.

Approach

NEEA engaged Evergreen Economics (Evergreen) to provide independent assessment and, in some cases, development of parameters used in its ACE models for many of its initiatives. This review and assessment is typically conducted as one task associated with a broader market progress evaluation report (MPER). NEEA's baseline assessments are intended to provide transparent, accurate, replicable estimates with a modest budget. These efforts typically rely on available secondary data, as well as limited primary research. The goal of these baseline assessments is not to achieve a measure of reality—that would be fruitless since the task is to estimate what did not occur. Rather, the goal is to identify a reasonable and efficient approach to estimating the naturally-occurring baseline that is fairly straightforward and defensible.

Below we describe four case studies. The first two are for initiatives that had already been launched when NEEA hired Evergreen to develop or assess its planning estimates of baseline market adoption – compact fluorescent lamps (CFLs) and high efficiency televisions. The next two are for initiatives that are in the planning stages – heat pump water heaters and high performance homes. The two types of case studies illustrate that it is easier to collect data before a market intervention begins—because current market penetration data is easier to procure than past market data, and because market actor forecasts are unbiased by any market change that has already occurred as a result of the intervention. After a market intervention is underway, it is more challenging to acquire reliable baseline forecast data, requiring creative use of secondary data sources and triangulation of results.

CFL Case Study

Introduction

NEEA launched its consumer lighting market initiative in 1997 to advance consumer awareness and use of compact fluorescent lamps (CFLs) and fluorescent light fixtures throughout the region. Its earliest projects addressed such market barriers as high first cost; lack of product availability; lack of consumer awareness; incompatibility of CFLs with existing fixtures, dimmers, timers and photocells; performance problems; poor aesthetics of energy-efficient lighting products; and consumer dislike of fluorescent technologies by providing financial incentives to manufacturers; retailer education; marketing and mass advertising; and branding.

NEEA's initiative began targeting retailers in 2000 (by providing salesperson training as

well as advertising and marketing support) and shifted its focus to manufacturers in 2005, coordinating an annual regional manufacturer buy-down promotion from 2005 through 2007. Total regional sales of Energy Star CFLs exceeded 18 million lamps by 2007. NEEA subsequently concluded that additional support of the Northwest lighting market was no longer necessary and ceased its active interventions in the market in early 2008 [KEMA 2008]. Since then, Bonneville Power Administration, Energy Trust of Oregon and the investor-owned utilities continued to fund upstream CFL programs in the region to capture resource acquisition opportunities. NEEA has engaged an evaluation contractor each year to continue to track the market and update cost-effectiveness assumptions, including estimates of baseline market sales.

Approach

NEEA conducted an annual review of its cost-effectiveness assumptions for CFLs as part of its yearly Market Progress Evaluation Report. The evaluators used net effects estimation techniques that were being used in other regions of the country to estimate baseline CFL market shares and sales for the Northwest. There is a direct relationship between a program's net effects and baseline: total market – baseline = net effects. To estimate baseline sales for 2008, the evaluation compared per capita sales of CFLs in non-program regions that were being compiled for a California Upstream CFL Market Effects Study [Cadmus et al 2010] to per capita Northwest CFL sales. Evaluators attributed the difference between the two to the program efforts of NEEA and its utility partners.

While this method yields estimates of a program's cumulative impact on the market, it excludes program impacts that may have occurred nationally or globally. For example, baseline sales (e.g., in Michigan or other non-program areas at the time) were likely influenced by NEEA's market interventions, which included partnership with national retailers and manufacturers. If the program influences retailers and/or manufacturers with whom it engages to develop a consistent national strategy, then the method described would discount total program market effects. For that reason and also that few non-program areas remained as more states began implementing energy efficiency and upstream CFL programs, this method was not used to estimate the 2009 and 2010 Northwest baseline. Instead, evaluators assumed that the rate of growth in baseline is equal to the rate of change in the total market, a trend observed from 2007 to 2008.

Results

Table 1 below presents baseline estimates gathered from five states by year. The first column indicates the region in which the program operated, the second column the baseline region that was studied where no program was in effect. In all cases, the baseline region was selected to match the program area demographically. The third column cites the source of the baseline estimate. The final three columns present the baseline per capita CFL sales estimate by year. The last two rows of the table show the simple average and annual rate of change in the average that we calculated across the various estimates.

Table 1. Baseline CFL Sales Estimates, 2005-2007

Program Region	Baseline Description (e.g., Region)	Source of Baseline Estimate	Baseline Estimate (CFLs per household)		
			2005	2006	2007
Wisconsin	Michigan	Wisconsin Focus on Energy CFL Market Study	1.0	1.7	3.2
British Columbia	North and South Dakota	Direct and Market Effects of BC Hydro's 2006-2007 Residential CFL	-	1.3	-
Massachusetts	U.S. Excluding Program Areas	Massachusetts program CFL net effects assessment: results memo (average of high and low estimate)	-	1.0	-
New York	U.S. Excluding Program Areas	NYSERDA program CFL net effects assessment: report appendix	0.5	-	-
California	Based on California net-to-gross supplier surveys and meta-analysis of other net effects studies	DEER CFL Net-to-gross report/2004-2005 California Single-Family Rebate Program Evaluation/ 2007 RMST	0.3	0.5	1.5
Average			0.6	1.1	2.4
Annual Rate of Change in Average			-	84%	113%

Source: Cadmus et al 2010

Table 2 below presents estimates of national Energy Star CFL retail sales by year provided by annual CFL Market Profiles prepared by the national Energy Star program's contractor, D&R International (column b). In 2008, we observed that change in total market sales from 2006 to 2007 (column c) mirrored the change in baseline during that same time period (column e). For 2008 through 2010, there were no baseline estimates available, and we used the growth in the national market (column c) as a proxy for growth in baseline (the change in column d). The final two columns (f and g) combine census estimates of the number of Northwest households with the baseline estimate (column d) for the Northwest CFL baseline. When subtracted from estimates of Northwest total CFL sales, baseline estimates yield estimates of regional net market effects.

Table 2. National Energy Star CFL Retail Sales and Northwest CFL Baseline Sales Estimates, 2008-2010

(a)	(b)	(c)	(d)	(e)	(f)	(g)
Year	National CFL Sales (000s)	Percent Change in National Sales	CFL Baseline (CFLs per household)	Change in CFL Baseline	Northwest households (000s)	Northwest CFL Baseline (000s)
2005	76,500	-		-		
2006	138,800	81%	1.1	84%		
2007	297,800	115%	2.4	113%		
2008	244,500	*-18%*	2.0	**-18%**	5,060	9,960
2009	232,000	*-5%*	1.9	**-5%**	5,131	9,580
2010	303,900	*31%*	2.4	**31%**	5.171	12,700

Sources: Cadmus et al 2010, ECONorthwest 2010, KEMA and Evergreen Economics 2011
Note: italicized estimates were used as a proxy for the bold estimates

Implications

The method used to estimate 2008 Northwest baseline CFLs relied on available methods and data. For 2009 and 2010, the secondary data was limited, and the evaluators developed a reasonable and simple approach to estimate baseline. These approaches are consistent with NEEA's desire for transparency, replicability and accuracy and met the scrutiny of its funders. The approaches also met the tight budget and schedule constraints. In 2009, NEEA could have tried to develop baseline estimates by using the methods used in prior years in other regions – e.g., identifying an area similar to the Northwest that did not have a program. However, the evaluators identified a major limitation to that approach: the cumulative effect of upstream programs nationwide had likely impacted the national market such that CFL sales in other areas now reflected spillover effects that would be impossible to determine. Such methods would not be useful for NEEA since its definition of market effects includes spillover. Instead, the evaluators used methods that were appropriate given the methodological constraints and the context. The method could be easily updated over time, using a consistently available data source.

High Efficiency Television Case Study

Introduction

NEEA launched a high efficiency television initiative in early 2009 in conjunction with related West Coast utility efforts (known collectively as the Business and Consumer Electronics or BCE program). Meanwhile, the national Energy Star program and the California appliance standards were evolving to improve the efficiency of televisions, and television technology was changing to accommodate material and input improvements (as is typical in the lifecycle of many manufactured products). NEEA engaged Evergreen Economics researchers in early 2011 to develop estimates of market share for two periods: the period before the program was launched and the "historical period" from when the program was launched through the end of 2010 when the research was launched. We looked at four different tiers of televisions: Energy Star 3.0 + 15%, Energy Star 3.0 + 30%, Energy Star 4.1 and Energy Star 5.1, determining what would have been and what would be growth in market shares for efficient televisions in each of these categories in absence of NEEA's market interventions.

Approach

      The approach consisted of a market assessment – development of total and program sales for the period prior to intervention and the "historical period" for the Northwest and nation – and attribution assessment – interviews with television suppliers and industry experts to estimate attribution shares for each time period and tier. Energy Solutions developed estimates of sales data, using program data provided by the implementer, QDI Market Strategies, using extrapolation to fill data gaps. Evergreen researchers developed a framework of influence for the program – including NEEA, other West Coast utilities, national Energy Star program and natural technology advances and then conducted interviews with market experts to estimate attribution shares for each influencer by time period and tier.

Results

      The research results suggested that there were many overlapping factors that influenced the change in market share that occurred since the initiative launched. NEEA was a major contributor to two of the major influence factors: the BCE program's impact on national supply of efficient televisions and the increase in television ENERGY STAR specifications. Other factors were California appliance standards and technology innovation.

      Table 3 below shows the attribution shares allocated to each factor by tier during the historical period, after the initiative was launched. Factors are broken down by contributor in the table, with the total shares for each tier summing to 100 percent (across columns a through i). The final column sums the shares for columns with NEEA influence (columns a, d and i). Energy Star brand specifications and the BCE program influence declines as California appliance standards and natural technology innovations (mainly improvements and broader use of LEDs for backlighting) start to impact the market for the Energy Star 4.1 and 5.1 tiers.

Table 3. Summary of Attribution Shares During Historical Period (April 1, 2009 – December 31, 2010), by Tier

| Tier | BCE Program Incentives | | ENERGY STAR Brand/Specs | | | | TV Manufacturer and Retail Stocking | | TV Retail Promo-tions | |
	(a) NEEA	(b) Other BCE Sponsors	(c) National	(d) NEEA	(e) Other BCE Spons-ors	(f) Other	(g) California Appliance Stds	(h) Techn-ology Improve-ments	(i) NEEA	NEEA Total
1	0%	34%	20%	0%	20%	10%	0%	15%	0%	0%
2	27%	3%	18%	0%	18%	9%	0%	15%	10%	37%
3	5%	14%	11%	5%	5%	5%	10%	35%	10%	20%
4	5%	14%	11%	5%	5%	5%	10%	35%	10%	20%

Source: ECONorthwest, 2011

Figure 1 shows the change in market share during the historic period, broken out by NEEA's influence (or net market effects) and the naturally occurring baseline market share (which includes all the other factors that influenced the market). This figure combines the information from Table 3 with the change in market share by tier during the historic period. Each column is a tier, and represents the change in market share that occurred from the time the initiative launched through the end of 2010. For the first tier, market share increased 14 percent since NEEA launched its initiative, but all of that change would have happened in absence of the initiative. For tier 2, the market share increased 44 percent since NEEA launched its initiative, with NEEA responsible for 16 percent of the increase (or 37% of the total increase from Table 3). Tier 3 market share increased 69 percent, with NEEA responsible for 14 percent of that increase and tier 4 market share increased 21 percent with NEEA responsible for 4 percent of the increase (or 20% of the total increase for both tiers from Table 3 above.)

Figure 1. Change in Market Share During Historic Period for High Efficiency Televisions
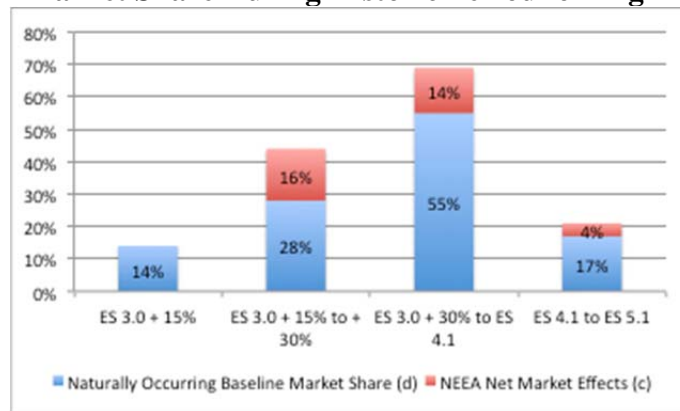
Source: ECONorthwest, 2011

Implications

Evergreen Economics' analysis provided NEEA with an estimate of baseline market share based on qualitative interviews. Prior to Evergreen's research, NEEA had access to program data through its contractors, QDI and Energy Solutions, but the data offered no information about what might have happened absent the NEEA/BCE intervention. The addition of qualitative interviews, conducted with stakeholders who were provided with the sales data, provided a first cut at the order of magnitude of NEEA's market impact. NEEA later decided, however, that this qualitative approach was not sufficiently robust and defensible—particularly considering the significance of the TV initiative in NEEA's portfolio.

NEEA subsequently identified a more objective data source upon which to base its baseline market share estimate: a detailed industry forecast published by Display Search in Q3 2008. This forecast represents what industry experts projected prior to NEEA and utility intervention in the market. NEEA's 2012-2013 market progress evaluation efforts will attempt to increase the level of analytical rigor applied to determining the impact of NEEA's intervention by applying quantitative analysis to determine the initiative's impact on sales of the most efficient televisions.

Heat Pump Water Heater Case Study

Introduction

NEEA finalized "A Specification for Residential Heat Pump Water Heaters Installed in Northern Climates Version 4.0" in late 2011 in conjunction with utilities and other agencies across the northern U.S. This specification provides beyond-Energy Star performance requirements for heat pump water heaters intended to be installed in latitudes north of 40 degrees [NEEA, 2011]. NEEA is working in conjunction with manufacturers to develop products that meet the Tier 2 level of the specification – the level that NEEA believes adequate for installation in the Northwest's climate. NEEA engaged with Evergreen Economics researchers in the summer of 2011 to document the history of the heat pump water heater market in the Northwest [Evergreen Economics, 2011]. Subsequently, NEEA is planning on doing extensive baseline research for this technology, and engaged with Evergreen Economics researchers to develop estimates of current market share for two specifications of heat pump water heaters: Energy Star and Tier 1. We are also conducting a current market share assessment for Tier 2 products to document installations prior to an initiative, but still resulting from NEEA's efforts to develop the Tier 2 specification and their work with manufacturers to develop a product that meets the specification. An additional related effort is an assessment of baseline market share in future years for Tier 2 heat pump water heaters. This market research will help NEEA in its efforts to develop baseline market share estimates in subsequent, larger-scale research projects.

Approach

The planned approach consists of a market assessment – development of total sales of Tier 1 and Energy Star HPWHs for the current period for the Northwest – and a forecast assessment – interviews with water heater suppliers and industry experts to assess market share for Tier 2 heat pump water heater sales in the future. NEEA plans to conduct a more robust forecast of market share for both Tier 1 and Tier 2 products in subsequent research efforts.

Both the market and forecast assessment rely on approximately 10 in-depth interviews and developing and populating a simple spreadsheet algorithm. The market share assessment will incorporate Residential Building Stock Assessment (RBSA) data when it becomes available in order to corroborate and support the assessment with quantitative data. The market share assessment also relies on a review of related literature. There are no available results as this project is currently underway.

Implications

In 2011 NEEA formalized stage-gate process for its market initiatives, which it calls the Initiative Life Cycle (ILC) process. The ILC process calls for NEEA to assess the naturally occurring baseline market adoption for new initiatives in conjunction with the "assessment and validation" stage of the ILC that follows the "concept approval" stage gate (Figure 2). For the heat-pump water heater initiative, NEEA has already secured a bold performance specification for measure qualification, and the baseline market share forecast will be finalized before further significant market intervention. Where the performance specification strives to push the market

forward, the baseline assessment will support net market effects measurement after the initiative is launched.

Figure 2. NEEA's Initiative Life Cycle (ILC) Process

Source: NEEA
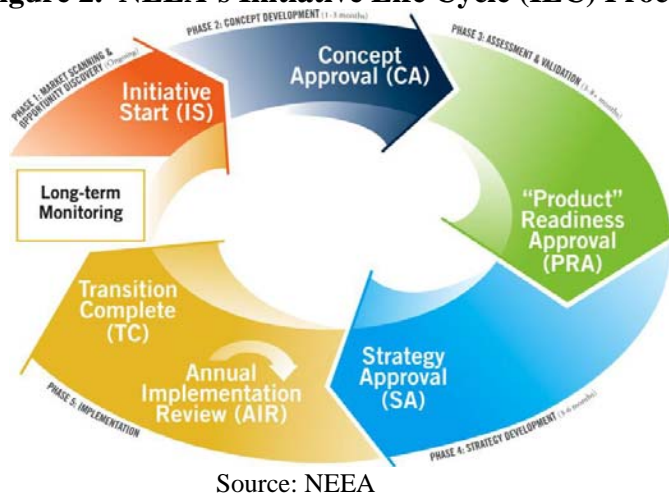
NEEA's process also calls for an evaluability assessment early in the ILC. Evergreen's baseline assessment research will also identify data gaps, market actors unknown to the program staff, and a method for assessing market effects in the future. This information is critical for a program committed to transforming a market – and documenting such transformation. NEEA's ILC will ensure that baseline and evaluability assessments are performed prior to full program implementation for all new initiatives.

High Performance Homes (New Construction) Case Study

Introduction

NEEA first launched the Northwest Energy Star Homes program in 2004. Recently NEEA created a specification for a "High Performance Home," loosely defined as homes that deliver twice as much energy savings as Northwest Energy Star homes, based on a preliminary performance specification (as opposed to prescriptive paths). While performance-based specifications allow for increased customization and control by the builder, they are harder to identify in a market assessment for one main reason: there is no straightforward checklist of measures by which to compare. That said, NEEA indicated that High Performance Homes generally have certain characteristics that separate them from other energy efficient homes (e.g., triple-pane windows) [Stephens, 2012].

NEEA engaged with Evergreen Economics researchers in regards to the Northwest Energy Star Homes program in 2004 [ECONorthwest, 2005]. In 2012, NEEA engaged with Evergreen to estimate current market share and forecast baseline market share for High Performance Homes in the Northwest without program intervention. Although NEEA has yet to launch an initiative for High Performance Homes, the current assessment will provide a baseline for future efficient home incentive programs. In addition, NEEA will be piloting a metering study of 10-15 newly constructed High Performance Homes over the course of a year.

Approach

Similar to the heat pump water heater study, the planned approach consists of an assessment of current and future market penetration. The market assessment relies on quantitative data obtained from 4-5 residential construction experts throughout the Northwest (some of whom run "green" or energy efficient homes programs). It will also incorporate data from the Northwest Residential Building Stock Assessment (RBSA) when it becomes available in order to corroborate and support the data from residential construction experts with quantitative additional data. The forecast assessment relies on qualitative information collected from the same experts regarding residential new construction trends in their respective regions. Forecasting is complicated by the fact that the definition of a High Performance Home includes a percent energy savings above code. Since code changes over time, and future code is not simple to predict, it is difficult for residential construction experts to predict future baseline market penetration. They are estimating market share above a moving target.

There is not a lot of existing market research for homes that meet NEEA's specification for a High Performance Home, and thus we do not plan to include a literature review to inform our assessment. Should our in-depth interview research uncover pertinent literature, we plan to include any findings into our overall assessment. This study is also currently underway, and thus there are no results at this time.

Implications

The implications of this study are in line with the implications of the heat pump water heater market share study. NEEA is looking to answer future evaluation questions through pre-intervention studies of the High Performance Home market. Our study's goal of documenting the market share of these homes prior to intervention by NEEA allows for a more accurate understanding of the likely impacts of the initiative on the Northwest market. Furthermore, it provides similar ancillary benefits as mentioned above – in fact, we have already identified data gaps and potential issues with the way energy efficient homes agencies have historically documented performance. Home performance is taken into account when determining ratings or scores (e.g., LEED designation or HERS scores), but they are not thoroughly or consistently documented in databases. Rather, in many cases, only the final score or rating is included in the databases, which makes assessing homes based on performance specifications tricky; many of the homes' *performance* or *physical* characteristics are not documented in the databases at all. While this data gap makes assessing market share difficult, it is still better to address this issue prior to intervention, and easier to assess baseline forecast market share at this time despite the existing data gaps.

Conclusions and Recommendations

The case studies described in this paper offer examples of how a regional market transformation organization estimates the market impact of its initiatives. Traditional gross and net savings approaches are not appropriate given the context. NEEA determines cost-effectiveness of its initiatives by developing estimates of naturally occurring baseline – what would have happened in absence of the market intervention, and subtracting that from total regional market penetration.

There are benefits to estimating baseline forecast market share prior to initiative implementation, especially if there is market data available. Even in the absence of available market data, it is easier for market actors and experts to assist in estimating *current* and future market share, as opposed to recalling market share of years past and estimating how much of the current market penetration would have happened without the intervention. Another benefit of conducting independent market baseline assessment during the onset of program activities is the ability to assess the initiative's evaluability based on available data sources and identification of data tracking needs (e.g., metrics, sources, etc.).

Finally, we offer the following lessons based on our experience assessing baseline and net market effects for NEEA (and for other program sponsors):

- Consider the context first when devising methods for estimating net market effects and baseline – e.g., definition of net market effects (whether cumulative market effects may be considered in a current program year, should spillover be included or excluded, and if it may be included must it be estimated separately from net market effects); standards for transparency, replicability and accuracy; schedule and budget; the level of scrutiny that methods and results will be given and the regulatory environment

- Consider early in the program planning process baseline and net market effects measurement– allowing sufficient time to identify the potential data sources and methods that might be used

- Include in program planning early documentation of the theory of how net market effects are likely to be produced, with estimates of what the growth in baseline is expected to be, and identification of any other market drivers that might impact baseline

- Weigh each potential method based on its limitations and cost – an ample budget doesn't necessarily justify spending more when a less costly approach can be used to generate a reasonable estimate

- Rule out any methods that are not consistent with the theory of the program – e.g., if the program was designed to generate cumulative market effects and leverage other regional and national related efforts, then a method that excludes spillover and cumulative impacts is not appropriate

- Combining quantitative market data with qualitative market expert input can be a very useful way to understand the market, its influences and develop ballpark estimates of influence and net market effects – though that approach may not meet stricter criteria for determining net impacts

- Many program administrators could benefit from working together across states and regions to obtain more robust data and develop consistent methods that could be used to measure the net market impacts of market transformation programs

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