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Massachusetts Electric and Gas Program Administrators

Methods for Measuring Market Effects of Massachusetts Energy Efficiency Programs

November 14, 2014

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Part of the Special and Cross-Cutting Evaluation Program Area

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1. INTRODUCTION

Most evaluations in Massachusetts have estimated net savings at the program level based on program-tracked savings alone. However, program-tracked savings reflect only part of the savings that may be attributed to programmatic activity; programs may also result in spillover savings and market effects on the positive side, and may include free ridership on the negative side. The next section defines the terms more fully, but *free ridership* is tracked savings that would have occurred without the program but involved support by the program; *spillover* is savings resulting from program influence without direct program support; and *market effects* are savings resulting from long-term structural changes to the market. Past market effects research has proven able to measure these untracked program-attributable savings and thus properly credit the Program Administrators (PAs) for driving changes in the market. The Massachusetts PAs have recently pursued a limited number of market effects studies—including the 2010 market effects study of C&I High Bay Lighting,[1] the ongoing Market Effects Baseline study for LEDs, the Residential New Construction Net Impacts Study,[2] and, a few years ago, the Statistical Analyses of Penetration of ENERGY STAR-compliant Appliances.[3] Historically, though, market effects savings from Massachusetts programs have infrequently been counted in program evaluation. Some reasons for this include the focus on near-term savings, the complexity of assessing market effects when taking a participant-focused approach, and an incomplete understanding among stakeholders of what market effects are and how they can be measured.

In recognition of these issues, the PAs and the Energy Efficiency Advisory Council have commissioned this study. This document draws on the literature on market effects measurement for energy efficiency programs and has the following aims:

- To describe concepts important to understanding and measuring market effects and associated savings
- To help the PAs identify when they should consider measuring market effects by describing the conditions likely to produce substantial market effects
- To identify conditions allowing measurement of savings from market effects
- To delineate and describe the range of methods available to measure market effects and provide guidance for selecting among them when planning for evaluation

It is worth noting from the outset that it takes more time to accrue measurable market effects than to accrue savings directly from program participants. This should be taken into account when planning for evaluation of market effects.

[1] KEMA 2014, *HBL Market Effects Study,* http://ma-eeac.org/wordpress/wp-content/uploads/High-Bay-LIghting-Market-Effects-Study-Final-Report.pdf.

[2] NMR 2014, *Massachusetts New Construction Net Impacts Report, http://ma-eeac.org/wordpress/wp-content/uploads/Residential-New-Construction-Net-Impacts-Report-1-27-14.pdf.*

[3] Summarized in Wilson-Wright *et al.,* 2005 “Front-loading Marketing: Assessing Cumulative Effects of ENERGY STAR® Appliance Promotions on State-by-State Market Penetration Levels,” http://www.iepec.org/conf-docs/papers/2005PapersTOC/papers/079.pdf.

2. OVERVIEW OF MARKET EFFECTS

2.1 KEY CONCEPTS

In this section, we describe some key concepts for understanding market effects for Massachusetts programs going forward.

What is free ridership? "Free riders are those who adopt an energy efficient product or service who would have adopted it without the intervention."[4]

What is a "market"? The "market" in "market effects" refers to the system of demand and supply for a product or service, including the "market actors" involved in producing, selling, and consuming the product or service.

What is a market effect? A market effect is "a change in the structure of a market or the behavior of participants in a market that is reflective of an increase in the adoption of energy-efficient products, services, or practices and is causally related to market intervention(s)."[5]

What is spillover? Spillover is "the energy savings associated with energy efficient equipment installed by consumers who were influenced by an energy efficiency program, but without direct financial or technical assistance from the program. Spillover includes additional actions taken by a program participant as well as actions undertaken by non-participants who have been influenced by the program."[6]

What is the relation between market effects and spillover? According to Prahl et al.,[7] market effects constitute one of the four types of spillover, which may overlap. Examples of each can be found in Appendix B. The four types are:

- Inside spillover: When additional program-induced actions are taken at the participating site.
- Outside spillover: When a market actor participating in the program initiates additional actions that reduce energy use at other non-participating sites.
- Non-participant spillover: When actors not participating in the program are induced to take action.

[4] Sebold, F. D., Fields, A., Skumatz, L., Feldman, S., Goldberg, M., Keating, K., and J. Peters, "A Framework for Planning and Assessing Publicly Funded Energy Efficiency," Study PG&E-SW040, 2001, accessed July 9, 2013, http://library.cee1.org/sites/default/files/library/1235/412.pdf. Page 5-23.

[5] Eto, J., Prahl, R. and J. Schlegel. 1996. "A Scoping Study on Energy-Efficiency Market Transformation by California Utility DSM Programs." Paper prepared for the California Demand-Side Measurement Advisory Committee. July. Accessed August 22, 2014 from http://emp.lbl.gov/sites/all/files/lbnl%20-%2039058.pdf. Pg. 9.

[6] New York Department of Public Service. November 2012. "Evaluation Plan Guidance for EEPS Program Administrators." Update #3. Appendix F. Albany NY. Pg. xiv.

[7] Prahl, Ridge, Hall & Saxonis. 2013. Pg. number not specified.

- Market effects: "Spillover savings that reflect significant program-induced changes in the structure or functioning of energy efficiency markets." [8] Some examples of these changes are:
  - Increased availability of efficient technologies through retail channels
  - Reduced prices for efficient models
  - Build-out of efficient model lines, and an increase in the ratio of efficient to inefficient goods sold or practices undertaken in the market. Within energy efficiency, this ratio is known as market penetration or market share.

What is the baseline? The baseline in this context is *naturally occurring market adoption* or the *counterfactual*—what would have happened in the absence of the program.

2.2 WHEN TO EXPECT SIGNIFICANT MARKET EFFECTS

Not all programs or sets of programs targeting a given market are likely to generate enough market effects such that evaluators can measure them above the "noise" of other causal factors of outcomes in the market *and* such that the additional savings from the effects warrant the cost of measurement. For this reason, program administrators need to give careful thought to whether a specific program is likely to result in substantial market effects before spending resources on a market effects evaluation plan and related measurement.

- Programs are more likely to result in substantial market effects under the following conditions: The savings per transaction are small, but the transactions are numerous. (There is an exception to this. Where there are significant market failures for the product or service, such as the price not reflecting externalities, or imperfect information or imperfect competition, there may be substantial market effects with big savings per transaction. The Home Performance market, which is effectively being created from scratch with the help of energy efficiency programs, is an example of such an exception.)
- The program strategies in use are likely to result in market changes. For example, the programs target *markets* rather than program participants; they aim to change energy use through changing what happens among upstream market actors, rather than focusing just on end-users of equipment or services, and they may involve providing education or information in order to change practices or decision making that affects energy consumption.[9]
- A significant proportion of market actors have been touched by the program.
- The product or service that the program addresses offers significant non-energy benefits, such as increased comfort, increased home value, or reduced maintenance.

[8] Prahl, R., Ridge, R., Hall, N. and W. Saxonis. 2013. "The Estimation of Spillover: EM&V's Orphan Gets a Home." In Proceedings of the 2013 International Energy Program Evaluation Conference. Chicago, August 13-15. Accessed November 11, 2014 from http://www.iepec.org/conf-docs/conf-by-year/2013-Chicago/095.pdf.

[9] NMR Group, Inc. 2013. *A Review of Effective Practices for the Planning, Design, Implementation, and Evaluation of Market Transformation Efforts*. CALMAC Study ID PGE0330.01.

Some strategies that may increase the likelihood of generating substantial market effects include the following:

- Working within the market structure to leverage market forces to achieve program goals. This requires researching the market to understand factors such as the different commercial interests in the market; market actors' work habits; who has power in different transactions; and who is hurt by or benefits from the introduction of new products, services, or methods.
- Finding market allies who are willing to work with the program.
- Getting market ally input into program design.
- Sharing risks with market actors and using upstream market actors—such as manufacturers, distributors, or installers—to influence the "downstream" adoption of products and services by end-users.

It is possible to design programs in order to maximize market effects. Programs designed to maximize market effects are often referred to as *market transformation* programs. The 2013 report *A Review of Effective Practices for the Planning, Design, Implementation, and Evaluation of Market Transformation Efforts*[10] describes planning steps for maximizing market effects based on a review of the market transformation literature and interviews with administrators of strategic market transformation programs. See this report for more information about program design to maximize market effects.

2.3 PROGRAM-FOCUSED APPROACH TO MEASURING NET SAVINGS FROM MARKET EFFECTS

With some exceptions, Massachusetts evaluations have typically estimated program savings by subtracting free ridership from, and adding inside or outside spillover to, program-tracked savings.[11]

The traditional formula[12] for calculating a net-to-gross (NTG) ratio at the program level is as follows:

$$NTG = 1 - FR + SO$$

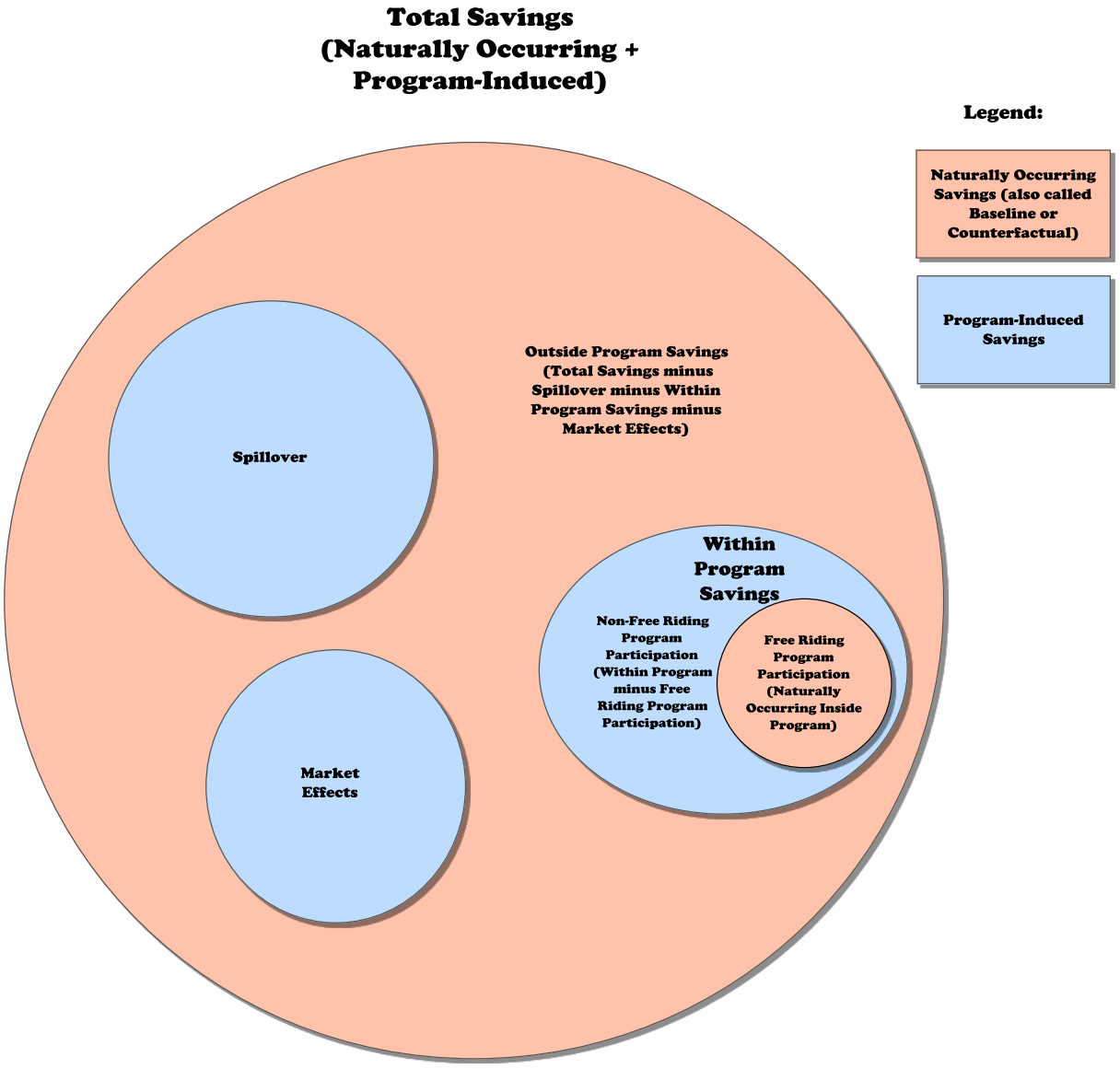
Some practitioners have argued that this traditional equation—and the ways in which free ridership (FR) and spillover (SO) are typically measured—underestimate market effects.[13] This has led some evaluators to modify the above equation by treating market effects as an add-in, as follows:

[10] NMR Group, Inc. 2013. CALMAC Study ID PGE0330.01.
[11] For more information about this approach, see Schlegel, J. 2013. "Issues and Reflections on Net Savings." Presentation made at NEEP EM&V Forum Annual Public Meeting, December 13. Accessed February 18, 2014 from /sites/default/files/resources/Issues%20and%20Reflections%20on%20Net%20Savings.pdf.
[12] FR=Free ridership. SO=Spillover.
[13] Mahone and Hall, "Proceedings of the ACEEE Study on Energy Efficiency in Buildings" (2010).

NTG = 1 – FR + SO + ME

This approach typically defines market effects as separate from spillover, as depicted in Figure 2-1. This program-level approach to net savings estimation emphasizes separating the components as much as possible.[14]

Figure 2-1. Participant-Focused Approach to Net Savings Estimation



A major problem with treating market effects as separate from spillover in this manner is the difficulty in avoiding double counting. While a program is operating, there is likely to be some

[14] NMR Group, Inc. 2013.

spillover that is not market effects, such as breakage (customers intending to cash in a rebate, but never doing so), [15] or participants taking additional actions outside the program that reduce energy use, but as a direct result of program participation. Much spillover, however—including most, if not all, spillover that occurs after program activity is eliminated or reduced—is difficult to distinguish from market effects. For example, savings due to changes in stocking practices in response to a program can and have been counted as spillover; it also seems to be a change in the structure and functioning of the market, and therefore constitutes a market effect. The overlap is considerable, but spillover is the more general term and appears to encompass market effects at the conceptual level, even though, in practice, savings measured with market effects approaches can be greater than those measured with a focus on limited types of spillover.

2.4 MARKET-FOCUSED APPROACH TO MEASURING NET SAVINGS FROM MARKET EFFECTS

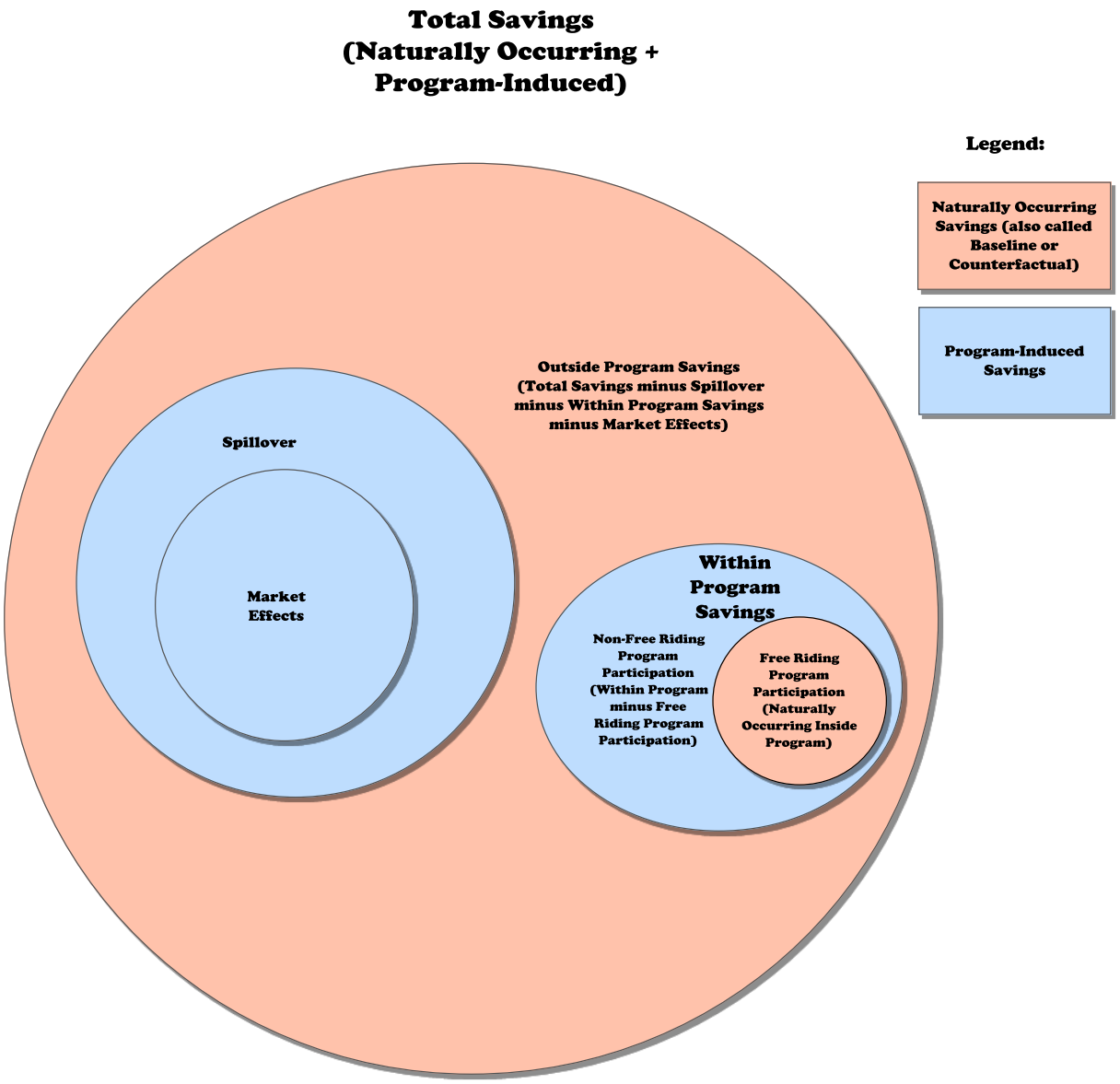
A market-focused approach, depicted in Figure 2-2, requires the estimation of "naturally occurring" savings, also called the baseline (savings that would have happened with or without the program) to be subtracted from the total energy-efficient activity in the marketplace with the program. From a practical standpoint, the measurement focus of this approach is the baseline versus what happened over time at the market level. Market effects and spillover are calculated together, which avoids the double-counting problem inherent in adding a market effects savings estimate to a traditional net savings estimate, as depicted above in Figure 2-1. The simplified formula is as follows:

NTG = (total savings – naturally occurring savings) / within-program savings

Because it focuses on the market, not the program, this approach tends to capture more savings than the participant-focused approach, thus providing PAs with more of the credit for the savings achieved by their programs.[16]

[15] Jolson, M., Weiner, M. and R. Rosecky. 1987. "Correlates of Rebate Proneness." Journal of Advertising Research, 27 (Feb-March), 33-43.
[16] NMR Group, Inc. 2013.

Figure 2-2. Market-Focused Approach to Market Effects



3. MEASURING AND EVALUATING MARKET EFFECTS

Ideally, measurement of market effects would be taken into consideration in conjunction with program planning. However, the methodological framework discussed in this section can be used to aid Massachusetts program administrators in evaluating market effects from legacy programs that may have already affected the markets in which they operate. Many of the planning steps described here can also be used with legacy programs.

3.1 THEORY-BASED EVALUATION

Theory-based evaluation assesses programs according to the program team's predefined theory of how and why the program should work, or the "program logic"—that is, "the chain of events from intervention to changes in the amount of efficient products produced/consumed and the resulting energy savings."[17] At a high level, this involves:

- Developing a sound understanding of the market in which the program operates or is to operate. This may include a visual model of the market.
- Developing a narrative, or a visual description or "logic model," of the program actions and how they are expected to lead to changes in the market for the product or service the program promotes. The program logic model should include the short-, intermediate-, and long-term outcomes that are expected to result from program activities. Some of these outcomes reflect significant program-induced changes in the structure or functioning of energy efficiency markets that will lead to savings, and so are market effects.
- Developing indicators by which to measure the outcomes if they cannot be measured directly, establishing baseline measurements for each indicator, and conducting periodic research to track progress toward the outcomes.[18]

Historical tracing is a subset of theory-based evaluation. It "involves the careful reconstruction of events leading to the outcome of interest, for example, the launch of a product or the passage of legislation, to develop a 'weight of evidence' conclusion regarding the specific influence or role of the program in question on the outcome." The methods used include the following:

- "Compiling, comparing, and weighing the merits of narratives of the same set of events provided by individuals with different points of view and interests in the outcome.
- "Compiling detailed chronological narratives of the events in question to validate hypotheses regarding patterns of influence.

[17] Sebold, F. D., Fields, A., Skumatz, L., Feldman, S., Goldberg, M., Keating, K., and J. Peters, "A Framework for Planning and Assessing Publicly Funded Energy Efficiency," Study PG&E-SW040, 2001, accessed August 22, 2014 from http://library.cee1.org/sites/default/files/library/1235/412.pdf.

[18] NMR Group, Inc. 2013. "A Review of Effective Practices for the Planning, Design, Implementation, and Evaluation of Market Transformation Efforts."

- "Positing a number of alternative causal hypotheses and examining their consistency with the narrative fact pattern.
- "Assessing the consistency of the observed fact pattern with linkages predicted by the program logic model."[19]
- "Identify[ing] and weight[ing] the relative contribution of factors or programs affecting a single but complex outcome, such as legislation or regulatory ruling.
- "Identify[ing] and weight[ing] the relative contribution of factors affecting decisions made by a small number of individuals or organizations, e.g., standard setting.
- "Identify[ing] and weight[ing] the relative contribution of factors affecting growth in market share, especially where direct questioning of decision makers is difficult."[20]

A limitation of historical tracing is the heavy reliance on the analyst for judgment and transparency, as there is no formal basis for assessing the relative contributions of multiple factors to market outcomes.[21] This limitation can be limited by relying on the judgments of multiple analysts, including possibly an expert panel.

Theory-based evaluation is useful both for assessing savings from past market effects from established programs (retrospective evaluation), and for laying the groundwork for future assessment and documentation of market effects (prospective evaluation). *Retrospective* theory-based evaluation allows evaluators to make a qualitative, retrospective case for market effects—assuming that the evaluation finds that the outcomes occur more or less in the order predicted by the program logic model and are logically linked to program activities. The point of *prospective* theory-based evaluation is to establish an initial baseline of key indicators so that later retrospective studies can assess attribution through changes in the key indicators.

Theory-based evaluation is both an important planning tool for market effects measurement and a qualitative method by which to determine if market effects have resulted from program efforts. For this reason, it should serve as the framework on which *all* market effects evaluations are based, regardless of the specific analytical method that is ultimately used to establish quantitative attribution of market effects for a particular program. Indeed, Rosenberg and Hoefgen suggest that all attribution of market effects be done in conjunction with theory-based evaluation or "historical tracing," noting that it serves "as a sanity check on quantitative analyses of program attribution."[22] Indeed, it is difficult to make a credible case for any quantitative estimate of market effects if a credible *qualitative* case—through theory-based evaluation—cannot be made; hence, both components are necessary.

Implementing theory-based evaluation to measure market effects requires advance planning. If this planning can be done in conjunction with program planning, it can reduce the cost of measurement while increasing its accuracy. Below are the key activities to undertake when planning for the measurement of market effects from energy efficiency programs.

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[19] Rosenberg & Hoefgen. 2009. 78.
[20] Rosenberg & Hoefgen. 2009. 79.
[21] Ibid.
[22] Rosenberg and Hoefgen, "Market Effects and Market Transformation," 80, 100.

Identify the markets that the program targets. Identification of the market should include the market actors up and down the supply chain. For example, in the 2012 Massachusetts Joint Statewide Three-Year Electric and Gas Energy Efficiency Plan, the Residential New Construction program plan describes the market actors as comprising homebuilders/ developers, contractors, architects/designers, trade allies, HERS raters, homebuyers, realtors, code officials, and appraisers/mortgage bankers. [23] Note that neither end-use loads nor potential program participants are part of this listing. It is important to identify the market actors because they are critical to measuring market effects.[24]

Characterize the market. In order to identify possible market effects from the program, it is critical to have an accurate understanding of the market as well as the actors in it. This understanding is developed by carrying out a market characterization study. Typical elements of good market characterization studies include consideration of the following:[25]

- Market size
- Technology performance
- Supply-side structure and operation, including key groups of actors, how decisions are made, where value is added, and how prices are set
- Current supply channels for specific products
- Consumer behavior
- Perceptions of market actors of product advantages and barriers to adoption
- Customer segmentation
- Incremental cost of the efficient product or service over standard ones
- How savings could be measured.

A strong market characterization study increases the likelihood both that the program strategies will lead to desired market responses and that later market effects evaluation will assess the right effects. A program designed based on a characterization of the market that does not reflect the actual market conditions or behavior of market actors will lead the program to adopt activities based on faulty assumptions about how the market operates, thereby reducing the likelihood of success. A good market characterization looks at the entire supply chain and the different categories of market actors being engaged by the program to affect the market.

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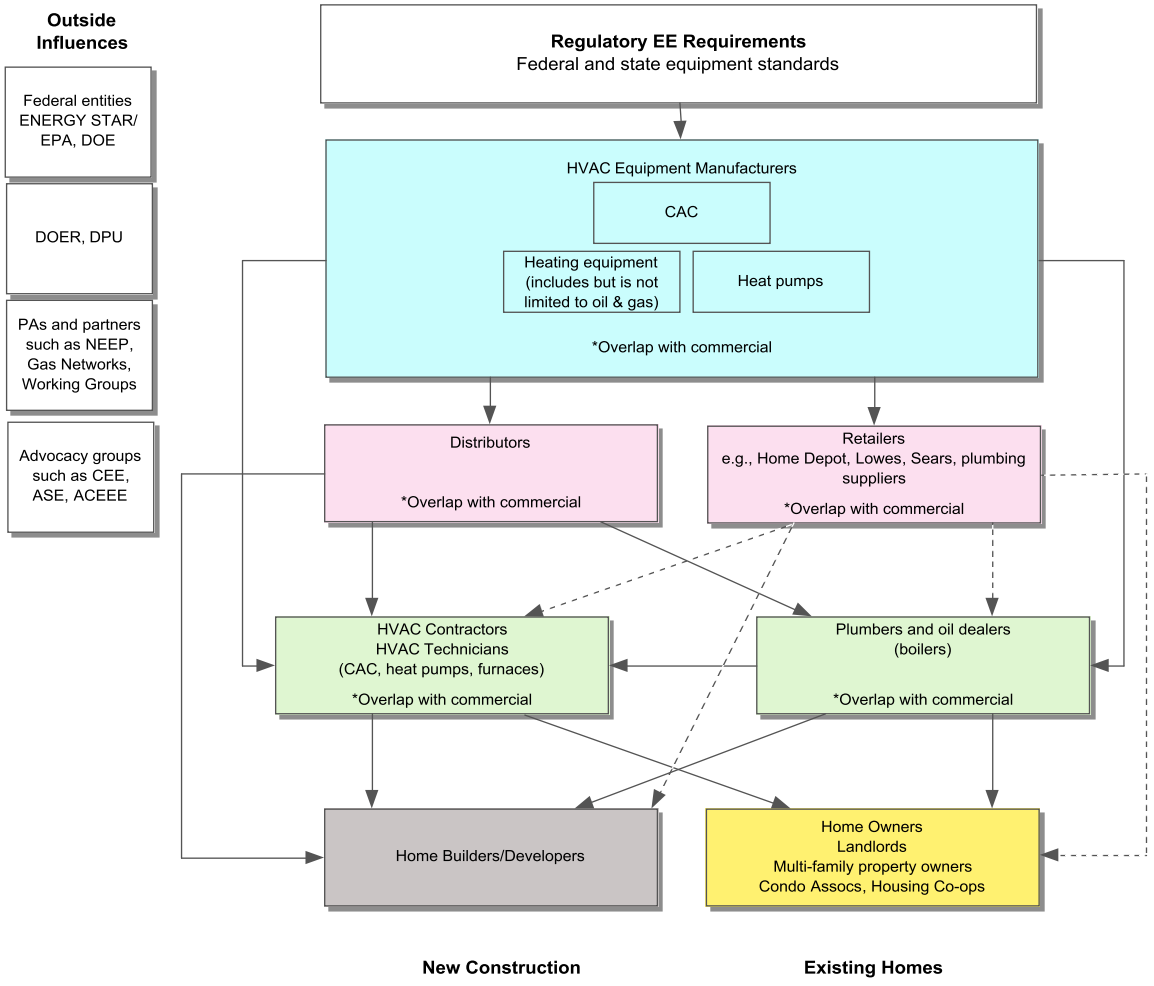
[23] Massachusetts Joint Statewide Three-Year Electric and Gas Energy Efficiency Plan. November 2012. Accessed August 30, 2014 from http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0CCAQFjAA&url=http%3A%2F%2Fwww.mass.gov%2Feea%2Fdocs%2Fdoer%2Fenergy-efficiency%2Fstatewide-electric-and-gas-three-year-plan.pdf&ei=dyICVNqXE4-8ggS2roLoDA&usg=AFQjCNHeaevCwaNf1RiGQgnULYb5coim0w&bvm=bv.74115972,d.eXY.

[24] NMR Group, Inc. 2013. "A Review of Effective Practices for the Planning, Design, Implementation, and Evaluation of Market Transformation Efforts."

[25] Based on Rosenberg and Hoefgen, "Market Effects and Market Transformation."

Develop a market model. In addition to helping program planners understand how the market works, the market characterization study will ideally include a market model. A market model is a graphic representation of how the various market actors interact throughout the distribution channel for a given technology. The market model can to help program planners and staff identify gaps in the program's activities and ensure that they have a good grasp of the structure and functioning of the market. The market model also helps them to better identify linkages between marker actors and leverage points between the market and the program.[26] Below is an example of a model of the residential HVAC market developed for the Massachusetts program administrators.

Figure 3-1. Market Model—Residential HVAC



Source: NMR Group, Inc., & Tetra Tech, Inc. 2014. "Program Design Review of Targeted Markets." Memo delivered to National Grid, June 18.

Tell a story (the program theory). Develop a coherent theory—that is, the "program theory" or "program logic" that describes how the program actions are expected to lead to desired

[26] Ibid.

outcomes. The theory should be clearly linked to the description of the market. As Sebold et al. explain, "Articulating the program logic ensures that the activities, resource investments, and evaluation efforts fit with and focus on the core assumptions and causal hypotheses of the planners and policymakers."[27] The program theory should:

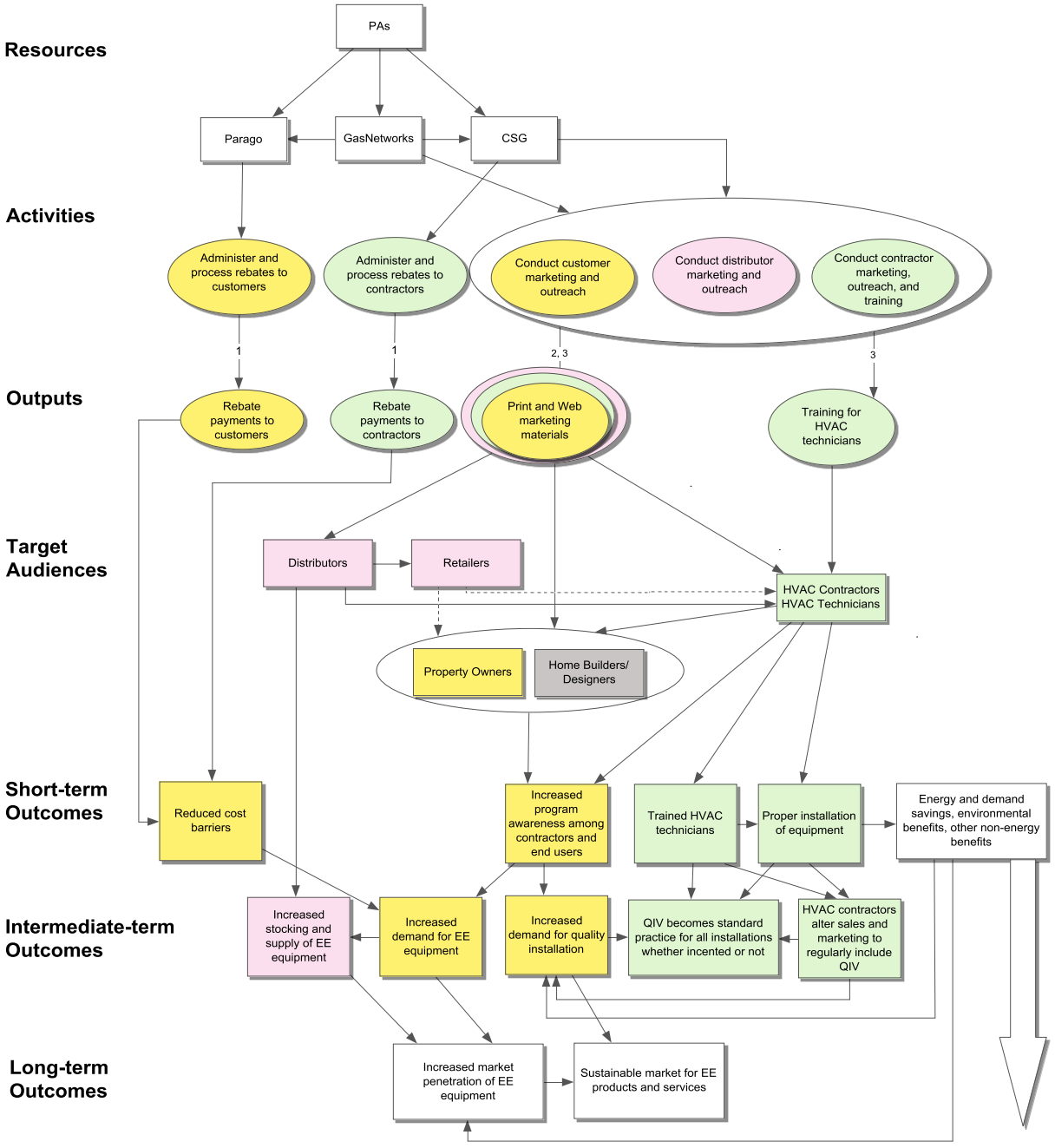
- Describe the market
- Lay out the rationale for the intervention
- Lay out the expected effects of the intervention
- Describe the strategies to be implemented and the logic of their theory
- Describe the resources to be applied
- Note places where there might need to be program transitions (e.g., modifications, where there would be success or failure).[28]

Develop a logic model. According to Rosenberg and Hoefgen, "Program logic models are graphic representations of the causal links between program activities, short-term responses to those activities among market actors, and longer-term market effects." Logic models serve as tools for understanding both the causal relationships among program activities and expected outcomes and the feedback loops and interconnections among various program components (such as resources, activities, and outcomes).[29] Each element in the logic model must be linked directly or indirectly to desired outcomes. However, just drawing an arrow between two boxes does not guarantee that the causal link shown in the model is actually logical or defensible, so the logic model alone is not enough. The program theory needs to provide an explicit justification of why and how the program efforts will lead to the desired outcomes.[30]

[27] Sebold *et al.*, "A Framework," 4-2.
[28] Sebold *et al.*, "A Framework . . . "
[29] Rosenberg and Hoefgen, "Market Effects and Market Transformation," 48.
[30] Keating, "Guidance on Designing and Implementing," 14.

Figure 3-2 below is an example of a program logic model.

Figure 3-2. Logic Model—Cool Smart Program[31]



Source: NMR Group, Inc. & Tetra Tech, Inc. 2014. "Program Design Review of Targeted Markets." Memo delivered to National Grid, June 18.

[31] Excluding ductless heat pumps.

Establish indicators tied to expected market effects outcomes. Work with the evaluation team to establish indicators for each of the market effects outcomes identified in the logic model. Ideally, the indicators should be selected during the program planning phase. In the more common case of planning market effects evaluations for existing programs, practitioners should take into consideration the data that have already been collected by the program or previous evaluations, as some of these may be able to serve as indicators for some of the expected outcomes, with the added benefit of providing historical information to help with retrospective evaluation. The indicators selected will ideally be tracked over time through regular market assessments.[32] Table 3-1 shows an example of outcomes and market effects indicators from the Massachusetts C&I Upstream HVAC Program. It may be helpful to categorize outcomes and related indicators into key areas that many programs try to influence, such as awareness, availability, attitudes/perceptions, pricing, sales, and energy savings.

Table 3-1. Selected Outcomes & Related Indicators for the Massachusetts C&I Upstream HVAC Program

C&I Upstream HVAC Program	Prospective (baseline)		
Outcomes	**Indicators**	**Data Source**	**Timing**
Distributors become aware of program and are willing to participate	Distributors say they are aware of program	Distributor survey	Annually beginning Q4 2014
		Phone calls, emails, and site visits	April 2013–present
	Distributors say they are interested in participating	Distributor survey	Annually beginning Q4 2014
	Distributors sign up for program	Program records	Quarterly beginning Q1 2014
		Signed Distributors' agreement	April 2013–present
Distributors' sales forces trained in program	Number of distributor staff members trained in program	Program records	Quarterly beginning Q1 2014
	Number of distributors whose staffs are trained in program	Program records	Quarterly beginning Q1 2014
Greater emphasis by distributors on selling qualifying equipment due to opportunity for higher project margin from incentives	Emphasis on energy efficiency and qualified equipment in distributors' sales efforts	Distributor survey	Annually beginning Q4 2014

[32] NMR Group, Inc. 2013. "A Review of Effective Practices for the Planning, Design, Implementation, and Evaluation of Market Transformation Efforts."

C&I Upstream HVAC Program	Prospective (baseline)		
Greater effort by distributors' sales staff to sell qualifying equipment	Distributors say their sales staff is increasing efforts to sell qualifying equipment	Distributor survey	Annually beginning Q4 2014
Increased sales of qualified product under program auspices	Program-supported sales	Program records	Quarterly beginning Q1 2014
		Program records	Monthly
Reduced first cost of qualifying equipment to customers when some portion of incentive used for this purpose	Distributors say they are passing on some portion of incentive to customers	Distributor survey	Annually beginning Q4 2014
Increase in program participation as program encourages competition for sales among distributors	Distributors sign up for program	Program records	Quarterly beginning Q1 2014
		Program records	Major distributors in 2013; smaller potential participants ongoing
Greater stocking of efficient equipment by distributors	Counts and %s of qualifying and non-qualifying equipment in stock	Distributor survey	Quarterly beginning Q1 2015 (data starting Q1 2012)
Increased market penetration of EE equipment	Counts and %s of qualifying and non-qualifying equipment sold	Distributor survey	Quarterly beginning Q1 2015 (data starting Q1 2012)
		HARDI data	Quarterly data beginning Q1 2013
		Program records	Monthly
Energy and demand savings, environmental benefits, other non-energy benefits	Quantification of savings stemming from market effects	Described in "Recommended Methods for Assessing Market Effects of HVAC Programs" (1)	2017 (retrospective)
Sustainable market for EE equipment	Sustainability assessment	Multiple sources	2017 (retrospective)

(1) NMR Group, Inc., & Tetra Tech, Inc. 2014. “Recommended Methods for Assessing Market Effects of HVAC Programs, Interim Version." August 11.

The data requirements of a particular program's market effects indicators will vary depending on the program theory. This method is often based on a mix of qualitative and quantitative data. It often includes market sales data as a long-term indicator of market effects. The approach requires a sound understanding of the market or markets in which the program operates. The story of how the program should affect these markets needs to be based on sound logic. The progress indicators selected for each outcome need to be appropriate to the outcome, and it must be possible to obtain the relevant data.

Identify baselines. The market characterization should include measuring the baseline for the product, equipment, or service against which to assess future market effects attributable to the program. Market effects evaluation is most efficient when practitioners and evaluators give thought to the market model, program theory, logic model, and associated indicators as part of planning for the market characterization study. This will increase the likelihood that most or all of the market effects indicators that will need to be tracked have baselines established as early as possible. The market characterization may also include a forecast of how the indicator would be expected to change over time without market intervention.

While the market effects indicators will vary depending on the nature of the market and the product or service, some are nearly always applicable: market share for energy-efficient products and services, the saturation of such products or prevalence of services; the price of energy-efficient products or services compared to less efficient alternatives; their availability; market actors' perceptions, knowledge, and possibly awareness of the products or services; and, ultimately, net energy and demand savings.[33] These are all indirect indicators that can help build up a preponderance of evidence to make the case that the market has changed because of program activity.

As mentioned earlier, it takes more time to accrue measurable market effects than to accrue savings directly from program participants. This should be taken into account when planning for evaluation of market effects.

3.2 ESTIMATING NET SAVINGS STEMMING FROM MARKET EFFECTS

Theory-based evaluation is critical for making a credible case that market effects have occurred as a result of program activity; it does not result in estimates of energy savings. It can, however, provide guidance about the market actors and mechanisms by which market effects are expected to occur, and hence help in the design of a quantitative study. Insofar as the quantitative study focused in this way measures net savings stemming from market effects, then the theory is validated.

The literature on market effects points to four general methods of estimating net savings stemming from market effects:[34]

1. Supply-side market actor self-reported counterfactual analysis[35]

[33] Ibid.
[34] NMR Group, Inc. 2013. "A Review of Effective Practices for the Planning, Design, Implementation, and Evaluation of Market Transformation Efforts."
[35] NMR Group, Inc. 2013. "A Review of Effective Practices for the Planning, Design, Implementation, and Evaluation of Market Transformation Efforts."

2. Cross-sectional analysis, which may include time-series data
3. Forecasting or retrocasting the non-intervention baseline
4. Structured expert judgment.

The attribution measurement methods described here are often found used in conjunction with each other in a single study.[36] For example, in a review of attribution approaches used for the evaluation of market effects from a selection of strategic market transformation programs across four different program administrators, NMR Group found multiple attribution approaches applied in studies of 11 of 12 of programs assessed.[37] Three recent studies of HVAC market effects examined for the Massachusetts PAs were each found to use at least three of the approaches described above.[38]

To estimate net savings, all of these approaches require the following:

- Estimating the size of the market (efficient and non-efficient) in the baseline and current periods
- Identifying changes in market actor behavior
- Measuring gross savings at the market level
- Establishing the baseline for savings, also referred to as "naturally occurring savings" or the counterfactual, which is the savings that would have occurred in the absence of the program
- Estimating net savings, which is the gross savings at the market level minus the baseline.

Supply-side market actor self-reported counterfactual analysis. With this approach, evaluators ask upstream market actors about free ridership (naturally occurring within-program savings) and spillover through surveys or in-depth interviews. Evaluators subtract (for free ridership) or add (for spillover) these self-reported estimates to the in-program gross savings to estimate net savings. (Note that this approach cannot be used with end-users, as they cannot answer questions about non-participant spillover in a meaningful way.)[39]

Market actor self-reported counterfactual data involve a number of threats to validity. These include the ability of market actors to recall sales or shipments; the accuracy of their reports as to the influencing factors for customers as a whole; ensuring that a representative sample of the targeted market actors is surveyed; the possibility of market actors gaming their

[36] Hoefgen, Lynn. 2010. "Choosing the Right Tools: How Different Markets and Programs Call for Different Approaches to Estimating Net Savings." In *Proceedings of the 2010 International Energy Policies & Programmes Evaluation Conference.* Accessed July 29, 2014 from http://www.iepec.org/conf-docs/papers/2010PapersTOC/papers/043.pdf.

[37] NMR Group, Inc. 2013. "A Review of Effective Practices for the Planning, Design, Implementation, and Evaluation of Market Transformation Efforts." Calmac etc.

[38] NMR Group & Tetra Tech. 2014. "Recommended Methods for Assessing Market Effects of HVAC Programs, Interim Version." August 11.

[39] NMR Group, Inc. 2013. "A Review of Effective Practices for the Planning, Design, Implementation, and Evaluation of Market Transformation Efforts."

answers to ensure that the program continues; market coverage and weighting; and the accuracy of the actual and hypothetical activities reported by market actors. Biases inherent in self-reporting of the counterfactual can be minimized by using well designed surveys with good set-up questions and validating and calibrating scoring systems.[40]

Cross-sectional analysis. This approach involves identifying one or more comparison groups that will be tracked along with the program area. The comparison group serves as the "baseline" for the program area, and the evaluator subtracts savings in the baseline area from market-level savings in the program area to estimate net savings. The comparison group could be either a randomly assigned control group or a quasi-experimental group. The subjects in a quasi-experimental group are not randomly assigned; instead, they are selected for collective characteristics that are similar to those of the program group. Cross-sectional analysis can be performed using sales data, survey data, or both.[41] Survey data may involve sales estimates or multiple field studies of targeted measures and practices conducted over several years in the program area and one or more comparison areas.

Sales data must include sales of standard-efficiency products or equipment, not just efficient equipment, and it must be possible to differentiate between them in the data. Another important factor is the existence of appropriate comparison areas.[42] Assessing the availability and comprehensiveness of market sales data and appropriate comparison areas should be part of the market effects evaluation planning process.

Comprehensive sales data allows for some of the most rigorous market effects evaluations. Unfortunately, reasonably comprehensive market-level sales data are not readily available for most types of products and equipment addressed by energy efficiency programs. Lack of sufficiently comprehensive sales data results in the need for triangulation through the use of multiple methods.[43]

Possible sources of market sales data are:

- Sales or shipment data provided by industry associations or by mandate of federal government
- Shipment data from manufacturers (either actual data or self-reported)
- Sales data from regional buyers and distributors (either actual data or self-reported)
- Sales data from retail store managers or contractors (either actual data or self-reported)
- End-user data (self-reported purchases).

In some cases, market sales data may be available for purchase, such as lighting data via CREED or HVAC data via HARDI and D&R. Such data typically do not cover every possible sales channel, and this needs to be taken into consideration in the analysis. In the many

[40] KEMA, Tetra Tech & NMR Group. 2011.
[41] NMR Group, Inc. 2013.
[42] Ibid.
[43] Ibid.

cases in which true market-level sales data are not readily available, it may be possible to develop a reasonably comprehensive set of market-level sales or shipment data by asking enough manufacturers, regional buyers and distributors, or some combination, for the data. Alternatively, self-reported sales obtained by methods such as vendor surveys may collect "best guess" estimates of sales volumes and shares from a sample, then use sampling weights and other measures of size (such as employment) to expand the survey responses to the full market. In some cases, "end-users' self-reported purchases can provide market data if the participant sample is sufficiently large and representative of the market. Self-reported purchase estimates can be obtained through telephone surveys or through on-site data collection. For example, studies evaluating lighting programs have used bulb purchase and socket saturation data from on-site visits to customers' homes because they have been found to be more reliable than self-reported estimates from telephone surveys."[44]

Cross-sectional analysis requires the use of comparison areas. Comparison areas need to be similar to the program area. Factors that can limit the extent to which two or more areas can be compared include the existence of similar programs in the comparison area, unique market characteristics in one or both areas, climate differences, and significant demographic differences, to name just a few. While some of these differences can be controlled for in statistical models if multiple comparison areas are available, this is not always possible.

That said, the comparison area need not be exactly comparable to the area of study interest. What is necessary is to construct a credible baseline for the area of interest based on the comparison-area data, possibly with a set of systematic adjustments. An example is to express sales data in terms of sales shares to control for differences in total size of the two areas. Shares may even be calculated separately by segment, if the information is available, to allow adjustment for a different segment mix between the areas.[45]

Cross-sectional comparison uses statistical modeling to describe pre-program conditions, or what conditions would be like in the absence of a program, in program and multiple comparison areas. Models of this type have been successfully developed well into program implementation without prior data collection. Some examples include models of market share of ENERGY STAR appliances in the Northeast and CFL sales in program areas across the nation. It is also possible to develop time series cross-sectional analysis of changes over time among different groups, either as a simple comparison or using statistical modeling.[46]

In addition to the challenges described above, there are risks inherent to completing comparison-based approaches. These include:

- Not being able to obtain the required sales data, especially if they are to be provided voluntarily by vendors

[44] NMR Group, Tetra Tech & KEMA. 2011. "Cross-Cutting Net to Gross Methodology Study for Residential Programs – Suggested Approaches." Study prepared for the Massachusetts Program Administrators. July 20.
[45] KEMA, Tetra Tech & NMR Group. 2011.
[46] NMR Group, Inc. 2013. "A Review of Effective Practices for the Planning, Design, Implementation, and Evaluation of Market Transformation Efforts."

- Transformation of the market for the product, equipment, or service is well underway (typically, "once national market shares begin to exceed 25 to 30 percent")[47]
- Lack of appropriate non-program areas as more and more organizations begin to administer energy efficiency programs across the US[48]
- The non-program comparison area may have been influenced by other areas' programs, resulting in a conservative estimate that understates program impacts.

The validity of results from comparisons depends on factors such as the degree of comprehensiveness of the market sales data, the ability to construct non-program baseline from pre-program and/or comparison-area market coverage, where on-site data are collected, verification of measures by on-site auditors (if on-site data are collected), accuracy of respondent recall, the ability to construct the non-program baseline from comparison-area market coverage, market coverage and weighting, and market actor gaming and recall of sales or shipments.[49]

Forecasting or retrocasting the non-intervention baseline. With this approach, evaluators develop a statistical model to estimate how the market would behave over time without the intervention of the program. A model that develops an estimate for a future date is called "forecasting." A model that develops an estimate to describe pre-program conditions is called "retrocasting." The forecast or retrocast estimate is compared with the actual behavior of the market with the intervention in order to estimate net savings.[50]

Some examples of this approach are as follows:

- Using an estimate of the average efficiency resulting from current customer decisions about equipment, products, or practices as the "current-practice baseline" and the equipment, products, or practices promoted through the program as the counterfactual. The difference is the savings caused by the program, with no further adjustments. The Pacific NW's Regional Technical Forum, Indiana, and Delaware consider the savings using current practice as the baseline to be—or be very close to—net.[51,52]
- Using prior market trends to estimate a natural adoption curve that describes how the market would behave without intervention and using it as the baseline (retrocasting). This was the approach taken for a recent study for DTE Electric, which used diffusion modeling and stock turnover modeling to estimate a naturally

[47] Rosenberg & Hoefgen 2009: p. 103.
[48] Rosenberg & Hoefgen 2009.
[49] KEMA, Tetra Tech & NMR Group. 2011.
[50] NMR Group, Inc. 2013.
[51] NMR Group, Inc. 2013. "A Review of Effective Practices for the Planning, Design, Implementation, and Evaluation of Market Transformation Efforts."
[52] Ridge, R., Baker, M., Hall, N., Prahl, R., and W. Saxonis. 2013. "Gross Is Gross and Net Is Net: Simple, Right?" In *Proceedings of the International Energy Efficiency Program Evaluation Conference.* Accessed August 27, 2014 from http://www.iepec.org/conf-docs/conf-by-year/2013-Chicago/094.pdf#page=1.

occurring lighting baseline to an earlier year, and compared it to actual socket saturation data to estimate the net impacts of DTE Energy programs.[53,54]

A threat to validity with the current-practice baseline approach is that the non-participant energy use baseline might be lower than measured due to market effects from previous years of energy efficiency programs. This is especially likely if the market is quite small and programs have been running for some time. Also, participants who self-select into the program may be predisposed to purchasing the efficient equipment prior to participation.[55] A threat to validity with retrocasting the baseline is that it depends on assuming that what would have happened fits the "natural" adoption curve, which is subject to numerous other influences and rarely conforms to the ideal.[56]

Structured expert judgment. This involves identifying a team of experts who review information on the market for the energy-efficient product or service. Each individual on the team then answers questions about the baseline conditions in the market and supplies their answers to the evaluation team. The evaluation team compiles all the responses from the experts and returns the full set of responses to each expert on the panel. The panelists may then revise their estimates based on the insights of their colleagues. The collective insights of the panelists are used to develop baseline estimates, or to develop qualitative assessments of attribution.[57] While this is a qualitative method, it may involve asking panelists to make quantitative estimates, depending on the data available to them. For example, in the Residential New Construction Net Savings study,[58] a Delphi panel reviewed baseline studies conducted in 2004 and 2011, along with extensive program and market data, to develop estimates of the counterfactual; the evaluators then modeled the counterfactual energy usage based on the panel's judgment.

Structured expert judgment requires comprehensive market data for panelists to review, or multiple estimates derived through other methods. A strength of this method is that it "allows experience from other contexts to be applied to situations in which all feasible methods may have substantial threats to validity. Expert judging also allows adjustments to be made, albeit subjectively, for some of these threats. A particularly useful role for structured expert judging is to develop a 'consensus' estimate to consolidate results from multiple estimation methods."[59]

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[53] Cadmus, Navigant & NMR Group. 2014. "Michigan CFL Net-to-Gross Advisory Panel, Final Report." April 14. Accessed August 27, 2014 from http://www.michigan.gov/documents/mpsc/ntg_report_2014_453678_7.pdf.

[54] NMR Group, Inc. 2013. "A Review of Effective Practices for the Planning, Design, Implementation, and Evaluation of Market Transformation Efforts."

[55] Ridge, R., Baker, M., Hall, N., Prahl, R., and W. Saxonis. 2013. "Gross Is Gross and Net Is Net: Simple, Right?" In *Proceedings of the International Energy Efficiency Program Evaluation Conference.* Accessed August 27, 2014 from http://www.iepec.org/conf-docs/conf-by-year/2013-Chicago/094.pdf#page=1.

[56] We'll add the citation for this statement to the next draft.

[57] NMR Group 2013.

[58] NMR Group 2014, *Residential New Construction Net Savings Report,* Study prepared for the Massachusetts Program Administrators and the Energy Efficiency Advisory Council.

[59] NMR Group, Tetra Tech & KEMA. 2011. *Cross-Cutting Net to Gross Methodology Study for Residential Programs – Suggested Approaches.* Study prepared for the Massachusetts Program Administrators. July 20. Pg. 4.

This approach requires high quality, comprehensive information to provide to panel members, and cooperation from a knowledgeable panel.[60] Rosenberg and Hoefgen,[61] two recent Massachusetts studies of net-to-gross methodology,[62,63] and papers by Hoefgen[64] and Ridge et al.[65] all offer insights about the methods listed above and guidance in selecting among them. This section, especially Table 3-2, summarizes the guidance from these documents.

[60] NMR Group, Tetra Tech & KEMA. 2011. "Cross-Cutting Net to Gross Methodology Study for Residential Programs – Suggested Approaches." Study prepared for the Massachusetts Program Administrators. July 20.

[61] Ibid.

[62] NMR Group, Tetra Tech & KEMA. 2011. "Cross-Cutting Net to Gross Methodology Study for Residential Programs – Suggested Approaches." Study prepared for the Massachusetts Program Administrators. July 20.

[63] KEMA, Tetra Tech, KEMA & NMR Group. 2011. "Cross-Cutting C&I Free-Ridership and Spillover Methodology Study Final Report." Study prepared for the Massachusetts Program Administrators. April 18.

[64] Hoefgen, Lynn. 2010. "Choosing the Right Tools: How Different Markets and Programs Call for Different Approaches to Estimating Net Savings." In *Proceedings of the International Energy Policies Programmes Evaluation Conference*, Paris, France. Accessed August 21, 2014 from http://www.iepec.org/conf-docs/papers/2010PapersTOC/papers/043.pdf#page=1.

[65] Ridge, R., Baker, M., Hall, N., Prahl, R., and W. Saxonis. 2013. "Gross Is Gross and Net Is Net: Simple, Right?" In *Proceedings of the International Energy Efficiency Program Evaluation Conference.* Accessed August 27, 2014 from http://www.iepec.org/conf-docs/conf-by-year/2013-Chicago/094.pdf#page=1.

Table 3-2. Factors for Consideration in Selecting Among Market Effects Measurement Methods

Attribution Method	Data Source	Types of data collected	Data Description	Analysis	Data Requirements	Validity: Depends on—	Data collection issues	Typical Cost or Complexity
1. Supply-side market actor self-reported counterfactual analysis	Retail store managers and contractors, manufacturers, distributors	Post Hoc self-reported counterfactual, collected by telephone survey or in-depth interview. May also be based on market sales data.	Promotional activity and sales (or shipments) with and without program. May be % increase or decrease in sales instead of sales data.	Weighting and/or averaging	Sales or Shipment Data of reasonable quality available; data can be allocated to MA reasonably well; Reliability and Validity of Survey Responses	Market actor gaming and recall of sales/shipments; market coverage and weighting; accuracy of supplier-reported actual and hypothetical activities	Accuracy of supplier's report on factors influencing customers as a whole; Ensuring a representative sample of suppliers	Low
2. Cross-sectional analysis of sales or purchase data	Sales/shipment data provided by industry groups or, ideally, mandated by the federal government	Comprehensive market sales data for program area and comparison area	Sales of efficient and standard equipment in program and non-program areas over time	Weighted/averaged area-to-area comparison, or statistically derived baseline	Comparable markets in other areas for which data can be obtained; Sales or Shipment Data of reasonable quality available; data can be allocated to MA reasonably well	Degree of comprehensiveness. Truly comprehensive sales/shipment tracking systems have never been available; if they were, validity would likely be greater than with any other method	With voluntary efforts, some parties often don't cooperate, leaving major holes in data. No mandatory comprehensive tracking system has ever existed.	Low if data are available, High or not possible if data need to be developed
	Manufacturers & Regional buyers and distributors	Market sales/shipment data	Sales of efficient and standard equipment in program and non-program areas over time	Weighting and/or averaging		Ability to construct non-program baseline from pre-program and/or comparison area market coverage	Often some key suppliers don't cooperate, "holes" need to be plugged	Low
	End-users/decision makers	Self-reported purchases	Self-reported purchases in a specific period, along with other behaviors, attitudes, and characteristics, in program and non-program areas	Weighted/averaged area-to-area comparison, or statistically derived baseline	Comparable markets in other areas for which data can be obtained; Reliability and Validity of Survey Responses	Verification of measures by on-site auditors and accuracy of respondent recall; Ability to construct non-program baseline from comparison-area market coverage	Requires considerable effort to assure consistency of data collection protocols across on-site auditors	High

Attribution Method	Data Source	Types of data collected	Data Description	Analysis	Data Requirements	Validity: Depends on—	Data collection issues	Typical Cost or Complexity
3. Forecasting or retrocasting the non-intervention baseline	Market actors such as retail store managers and contractors, manufacturers, distributors; market and program sales data; non-participating customers	Market or self-reported sales or shipments and current practice data	Customer self-reports about equipment, products, or practices or site data; sales of efficient and standard equipment	Weighting and/or averaging and modeling	Sufficient verified variables available about the market in question and about current decision-making and practices to develop an accurate current practice baseline	Forecasted baseline based on a model, not data; market coverage and weighting; market actor recall of sales/shipments; participant self-selection bias	Often some key suppliers don't cooperate, "holes" need to be plugged	Medium
		Market or self-reported sales or shipments and other retrospective or prospective market data	Current actual sales of efficient and standard equipment and modeled counterfactual sales; may also include site data	Modeling	Sufficient verified variables available about the market in question to develop a reasonably accurate model to estimate market behavior	Retrocasted baseline based on a model, not data; Market coverage and weighting; Market actor gaming and recall of sales/shipments	Often some key suppliers don't cooperate, "holes" need to be plugged, program may not have clear participants and non-participants	Medium
4. Structured expert judgment	Various	NTG estimates from multiple methods, or judging by weight of evidence	A variety of data are supplied to panelists; market sales data may be among the data supplied.	Delphi process	Comprehensive market data for panelists to review, or multiple estimates derived through other methods	Well documented methods, Effective iteration process, Panelists' expertise and commitment; Quality and comprehensiveness of information presented	Cooperation from a knowledgeable panel	Depends on quality of input methods

Sources: Based on "Cross-Cutting Net to Gross Methodology Study for Residential Programs," [66] "Cross-Cutting C&I Free-Ridership and Spillover Methodology Study Final Report," [67] Rosenberg & Hoefgen[68] and Ridge et al.[69]

[66] NMR Group, Tetra Tech & KEMA. 2011. "Cross-Cutting Net to Gross Methodology Study for Residential Programs – Suggested Approaches." Study prepared for the Massachusetts Program Administrators. July 20.

[67] KEMA & NMR Group. 2011. "Cross-Cutting C&I Free-Ridership and Spillover Methodology Study Final Report." Study prepared for the Massachusetts Program Administrators. April 18.

[68] Rosenberg, M., and L. Hoefgen, "Market Effects and Market Transformation: Their Role in Energy Efficiency Program Design and Evaluation," California Institute for Energy and Environment, 2009, accessed July 10, 2013, http://www.calmac.org/publications/Market_Effects_and_Market_Transformation_White_Paper.pdf.

[69] Ridge, R., Baker, M., Hall, N., Prahl, R., and W. Saxonis. 2013. "Gross Is Gross and Net Is Net: Simple, Right?" In Proceedings of the International Energy Efficiency Program Evaluation Conference. Accessed August 27, 2014 from http://www.iepec.org/conf-docs/conf-by-year/2013-Chicago/094.pdf#page=1.

APPENDIX A: FURTHER READING

Eto, J., Prahl, R., and J. Schlegel. 1996. "A Scoping Study on Energy-Efficiency Market Transformation by California Utility DSM Programs." Paper prepared for the California Demand-Side Measurement Advisory Committee. July. Accessed August 22, 2014, from http://emp.lbl.gov/sites/all/files/lbnl%20-%2039058.pdf

KEMA and NMR Group, Inc. 2011. "Cross-Cutting C&I Free-Ridership and Spillover Methodology Study Final Report." Study prepared for the Massachusetts Program Administrators. April 18.

NMR Group, Inc. 2014. Massachusetts New Construction Net Impacts Report. http://ma-eeac.org/wordpress/wp-content/uploads/Residential-New-Construction-Net-Impacts-Report-1-27-14.pdf

NMR Group, Inc. 2013. A Review of Effective Practices for the Planning, Design, Implementation, and Evaluation of Market Transformation Efforts. CALMAC Study ID PGE0330.01.

NMR Group, Inc., Tetra Tech, and KEMA. 2011. "Cross-Cutting Net to Gross Methodology Study for Residential Programs – Suggested Approaches." Study prepared for the Massachusetts Program Administrators. July 20.

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Sebold, F. D., Fields, A., Skumatz, L., Feldman, S., Goldberg, M., Keating, K., and J. Peters. "A Framework for Planning and Assessing Publicly Funded Energy Efficiency." Study PG&E-SW040, 2001. Accessed July 9, 2013, from http://library.cee1.org/sites/default/files/library/1235/412.pdf

APPENDIX B: EXAMPLES OF SPILLOVER AND MARKET EFFECTS

Inside spillover. Say you own a small office building. You recently participated in your utility's commercial lighting program, and as a result you now have high efficiency lighting and controls installed in commonly used parts of your building—but they are not everywhere in the building. You have an electrician at the building doing some unrelated work. While the electrician is there, you instruct her to install some more high efficiency lighting in a few less-used areas of the building because you think you'll be able to save more if you eventually install high efficiency lighting equipment throughout your building. You do not apply for a rebate for the extra equipment, because you figure you've been through the program and probably can't get another rebate. The savings from your actions are **inside spillover**.

Outside spillover. Let's say you have a second office building that didn't participate in the lighting program, and the electrician will also be doing some work in the other building. You ask her to install some high efficiency lighting and controls in that building too—and don't apply for a rebate. The savings from this is **outside spillover**.

Non-participant spillover. You're really pleased with the high efficiency lighting and controls installed in both your buildings. You brag to another building owner about how you saved money from the lighting. That building owner has to have some fixtures replaced in his building. Because of what you told him, he decides to go ahead and install some high efficiency lighting and lighting controls instead of replacing like with like. Savings from the building owner's actions are **non-participant spillover**.

"Breakage" is another example of non-participant spillover. Breakage occurs when a customer receives a rebate check but does not cash it.

Market effects. An example of **market effects** in the commercial lighting market is lighting distributors choosing to stock more high efficiency lighting equipment in response to program-induced changes in the structure and functioning of the commercial lighting market.