LIPA's Commercial Construction Program: Demonstrating Initiative Influence along the Road to Transformation

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ABSTRACT

Market transformation program theory is predicated on the introduction of specific stimuli into a marketplace to influence the rate of adoption of an efficient technology or practice. Unfortunately, the full degree of measurable influence leveraged by these stimuli often does not occur until several years after introduction. It is uncommon in the non-residential market to conduct longitudinal studies of market behavior, yet assessing broad measures of market activity over time is critical to assessing the effectiveness of program stimuli and ensuring program strategies provide the intended results in the target market.

In a recent theory-based study of the Long Island Power Authority's (LIPA's) Commercial Construction Program, the challenges associated with measuring the influences of a commercial new construction/major renovation program required collecting and analyzing a wide range of data over a three-year period, all referencing a comprehensive characterization and baseline study of the construction market conducted in 2000/2001. This paper explores the combined use of qualitative survey-based research and quantitative on-site data to develop defensible indicators of market transformation.

Ultimately it was determined that there is strong evidence that the Commercial Construction Program is inducing a positive change in the efficiency of the target markets. Specifically, data suggest that there were early signs of increased adoption of energy efficient practices and equipment, with a reasonable level of attribution to the LIPA initiative. As a result of this study, we conclude that a self-reported behavioral approach to non-residential market effects studies can provide an effective way of assessing early market effects of programs like the Commercial Construction Program.

Introduction

The LIPA Commercial Baseline Study was concluded in 2001 and comprised a diverse set of data collection activities that included in-depth interviews (68), quantitative interviews with market participants (239), and on-site equipment inventories of Long Island buildings (163). The Commercial Construction Program Market Impact Study, conducted by RLW, was begun in early November 2002, and included two primary phases of activity, both of which were intended to update metrics calculated in the original 2001 baseline study. The new work also provides indicators of early transformation effects in the new construction, renovation, remodeling, and equipment replacement markets. These phases included performing surveys with market actors followed by site visits to recently constructed or substantially renovated buildings. These new activities were designed to provide a targeted exploration of people coming into contact with the program followed by a more conventional update of baseline market activity. These phases are further summarized below.

- Phase 1 of the Commercial Construction Program Market Impact Study was comprised of a qualitative survey of market participants who have directly experienced the program in some way. This activity focused explicitly on the extent to which there are signs of lasting market changes among this subset of the general population of market participants.
- Phase 2 of the Commercial Construction Program Market Impact Study was comprised of a full scale update to the baseline on-site building survey results. This activity was staged after Phase 1 and served as a more traditional broad update of the baseline.

In this report, we focus primarily on the Phase 1 results. The primary reason for this is because the two phases together produced more findings than can be covered in a paper of this length. Therefore, the Phase 2 results presented here were limited to those that provide confirmation of Phase 1 results. Another reason is that we believe Phase 1 was more unusual than Phase 2, and the approach and results have more interesting implications for other non-residential market effect studies.

Underlying Principles of the Market Impact Study Design

Since its inception in the Fall of 1999, LIPA's Commercial Construction Program has aimed at shifting current design and construction practices on Long Island to achieve greater energy efficiency in the new construction, renovation, remodeling, and equipment replacement markets. The Commercial Construction Program is a market transformation[1] program designed to affect specific changes in the behavior of end-users, vendors, contractors and design professionals (such as architects, HVAC engineers and lighting designers). This study was designed around the premise that showing early effects of the program on the market depends on two requirements: (1) measurement of the market changes via surveys with market actors and in observed practices on-site and (2) assignment of credit (causality) to the initiative.

A primary challenge encountered in the measurement of market changes was to assess them early in the program cycle. Specifically, it was believed that the first signs of permanent, significant change due to the program were likely to be seen among the subset that directly experienced the program. Significant shifts in their behavior would likely be masked if the study examined the entire market participant population. Therefore, the measurement of market change was made in two principal ways:

- First, based upon the belief that lasting behavioral changes on the part of firms in direct contact with the program are likely to be leading indicators of market effects, we designed survey question batteries that allowed self-reporting of changes in behavior that are due to the program or other influences.
- Second, through the identification of baseline metrics appropriate for assessment, we sought to collect data from the targeted program-contact group to compare these data with similar data obtained from the general market population in the original market baseline study.

It should be noted, however, that on outcome, the primary focus of the study was on the self-reported influence and not the direct comparison of results. Subsequent to this initial phase we sought to assess and update actual practices, observed during on-sites, to provide confirmation of the self-reported changes. One primary challenge recognized early in this study was that if and when structural change was observed, it would be very difficult to attribute the change to LIPA's initiative. Besides rebates and other utility interventions, many other factors such as new energy codes in New York State and new technology developments also affect markets. While it was noted that the LIPA-sponsored initiative

[1] Formally, we believe market transformation can be defined as when a program or initiative induces a lasting change in the structure of an energy product, service market, or the behavior of market participants, that results in greater adoption and penetration of energy-efficient technologies and practices.

may be contributing to these other factors, the specific assignment of utility attribution was problematic. To overcome this issue, this study sought to assess the program's impact through market participant self-reports. A series of questions that solicited recent changes in behaviors, followed by respondents' own report of specific elements that influenced the changes, was used. LIPA's influence was explored when appropriate.

Phase 1 Methodology

The primary tasks associated with this initial phase of the study included the development of a sample design and selection, the development and performance of phone surveys with various market actor groups, and statistical analysis of the survey results. Each of these discrete tasks is discussed below.

Sample design. The sample frame for the phone survey was developed through an iterative process that included: the compilation of customer and contractor contacts from the program tracking system, the collection of seminar attendee lists, and the development of a list of the one-on-one contacts established and maintained by LIPA implementation personnel. Once the population sample frame had been assembled for each market participant and end-user group, sample quotas were established in each group and firms were contacted randomly to complete surveys. The final sample frames, population sizes, and completions are provided in Table 1.

Table 1. Market Participant Phone Survey Final Sample

Sampling Group	Total in Sample Frame	Total Completions
Design Professional: Architect	50	17
Design Professional: HVAC Engineer	79	25
Design Professional: Lighting Designer	92	18
Builder/Developers	58	13
Lighting Contractors	38	11
HVAC Contractors	52	17
Total	369	101

Survey Development and Implementation. In the phone survey, data collection forms were preliminarily based upon the instruments from the baseline study. The explicit program theory, developed very early in the program's history, specified various market effects of the program that were hypothesized as occurring in specific time frames. In the process of selecting indicators for assessment, it was decided to limit them to those expected to change in the first three years of the program. This was done to prioritize indicators likely to show the most movement since program inception. However, it was also noted that the self-selection bias inherent in surveying organizations in contact with the program, as well as small sample sizes, would likely diminish the import of the direct comparison of Phase I study results to the baseline results. In addition, there was concern about the potential to statistically determine significant differences between the baseline and updated indicators. Consequently, while questions that mimic the baseline data collection were retained in varying degrees, more importance was placed on the additional questions that gathered self-reported behavioral changes and self-reported attribution of those changes.

Key questions were added to the phone survey designed to gather self-reported data regarding behavioral changes that market participants in direct contact with the program may have undergone in the last two years. Surveyors also asked respondents to cite influences of the reported changes. These questions were added to pursue relatively long-lasting behavioral changes, as opposed to one-time only

effects that are the focus of resource acquisition impact studies. Questions were carefully designed to avoid leading the respondent into identifying LIPA as the cause of any behavioral change, with open-ended questions being asked first, followed by questions specifically probing LIPA influence. This last round of questions proved to be the most important as it specifically assessed the role of the program in the noted changes.

Analysis. The results of the phone survey data were analyzed to provide levels of self-reported behavioral changes and any associated causality or attribution of those changes. Central to this assessment was a thorough understanding of the market stimuli or interventions that the program has implemented since inception. The program staff has initiated interventions to various degrees with all market actors, including information directed at end-users, developers/builders and design and technical assistance professionals. The specific behaviors and stimuli asked about were driven by the program theory. A brief comparison of the updated values was made to the baseline to qualitatively illustrate differences between the 2002 program-contact population and the 2000 overall population of market participants.

Phase 1 Key Findings

There were three ways that each type of market actor came into contact with the program. Some were contacted directly by LIPA staff, some attended seminars, and some received rebates. It is important to note that those who came into contact with the program through the receipt of a rebate and reported behavioral changes, may be reflecting just on the impacts of the rebate. Because of the one time nature of rebate influenced behavioral changes, they were captured separately from what are considered lasting behavioral changes attributable to seminars and direct LIPA contact.

Tables 2, 3, and 4, present key findings for each technology type and market participant group, based on the telephone data collection. They show the number of projects or units each group reported being involved in during 2002, the percent who reported increasing their use of a high efficiency practice for that technology, and the proportion of them who reported their change in behavior was due to LIPA. The final column shows only those respondents influenced by LIPA that were not involved in a rebated project.

As an example, in the first row of Table 2, builders and developers contacted in the survey reported overseeing 165 HVAC projects in 2002 on Long Island. Among respondents, it was reported that 20 of these projects had an increase in the level of efficiency of HVAC installed. For 15 of the 20 projects, increased use of high efficiency HVAC was attributed to the influence of LIPA's Commercial Construction Program. The final column shows the number of projects where the influence was either from a seminar/group session or a one-on-one contact (and not rebates) – for the builders/developers, this remains at 15. It should be noted that not all groups were asked about all measures, depending upon the amount of activity each group was anticipated to have with each of the technologies examined, in addition to whether the group was asked about the technology in the baseline study.

The level of attribution to LIPA ranges from 2% of lighting units installed by lighting contractors to 16% of projects reported by developers and design professionals. Additional analysis was performed to establish where the first influences were found.

Table 2. Initiative Influence on HVAC Design and Specification among Participating Market Actors

Technology	Respondent Group	Projects/ Units of Respondents in 2002	% That Use High Efficiency And Increased Their Use of High Efficiency	...And LIPA Influenced the Increase of High Efficiency	...And LIPA Influence Was Not Rebate
HVAC Equipment	Builder/Developers	165 projects	20 (12.1%)	15 (9.1%)	15 (9.1%)
HVAC Equipment	HVAC Engineers	370 projects	91 (24.6%)	91 (24.6%)	60 (16.2%)
Chillers	HVAC Engineers	150 projects	35 (23.3%)	35 (23.3%)	35 (23.3%)
HVAC Project Total		**685**	**146 (13.2%)**	**141 (12.8%)**	**110 (10.0%)**
Air-Cooled Chillers	HVAC Contractors	100 units	50 (50.0%)	0 (0.0%)	0 (0.0%)
H_2O-Cooled Chillers	HVAC Contractors	200 units	40 (20.0%)	0 (0.0%)	0 (0.0%)
Unitary A/C	HVAC Contractors	1,550 units	189 (12.2%)	120 (7.7%)	0 (0.0%)
HVAC Unit Total		**1,850**	**279 (13.6%)**	**120 (5.9%)**	**0 (0.0%)**

Table 3. Initiative Influence on Motor Specification among Participating Market Actors

Technology	Respondent Group	Projects/ Units of Respondents in 2002	% That Use High Efficiency And Increased Their Use of High Efficiency	...And LIPA Influenced the Increase of High Efficiency	...And LIPA Influence Was Not Rebate
Motors	Lght Designers	20 projects	20 (100.0%)	20 (100.0%)	20 (100.0%)
VFDs	Builder/Developers	95 projects	15 (15.8%)	15 (15.8%)	0 (0.0%)
VFDs	HVAC Engineers	140 projects	40 (28.6%)	40 (28.6%)	20 (14.3%)
Motor Project Total		**255**	**94 (12.1%)**	**75 (9.7%)**	**40 (5.2%)**

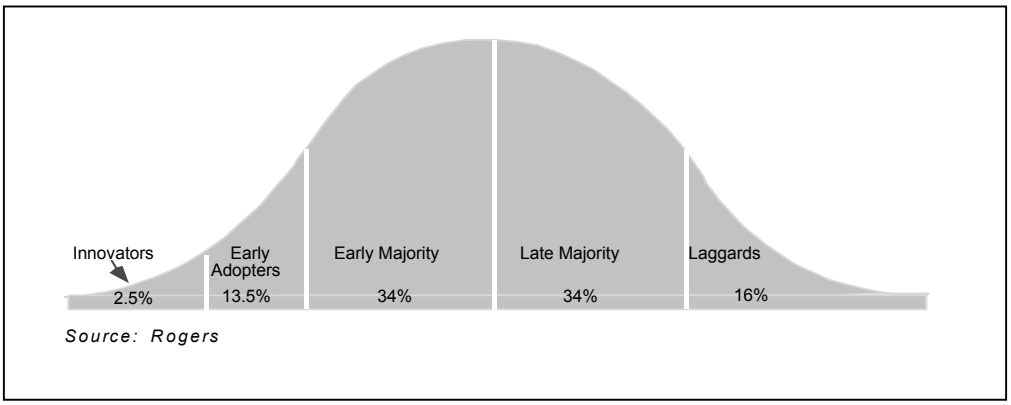
Table 4. Initiative Influence on Lighting Design and Specification among Participating Market Actors

Technology	Respondent Group	Projects/ Units of Respondents in 2002	% That Use High Efficiency And Increased Their Use of High Efficiency	...And LIPA Influenced the Increase of High Efficiency	...And LIPA Influence Was Not Rebate
Compact Fl.	Builder/Developers	140 projects	14 (10.0%)	6 (4.3%)	6 (4.3%)
HID Fixtures	HVAC Engineers	110 projects	33 (30.0%)	20 (18.2%)	0 (0.0%)
HID Fixtures	Lght Designers	435 projects	75 (17.2%)	21 (4.8%)	0 (0.0%)
Lght Controls	Builder/Developers	140 projects	35 (25.0%)	35 (25.0%)	35 (25.0%)
Lght Controls	Architects	305 projects	181 (59.3%)	112 (36.7%)	62 (20.3%)
Lght Controls	HVAC Engineers	110 projects	65 (59.1%)	40 (36.4%)	0 (0.0%)
Lght Controls	Lght Designers	435 projects	200 (46.0%)	20 (4.6%)	0 (0.0%)
Linear Fl.	Builder/Developers	140 projects	57 (40.7%)	57 (40.7%)	57 (40.7%)
Linear Fl.	Architects	305 projects	108 (35.4%)	54 (17.7%)	54 (17.7%)
Linear Fl.	HVAC Engineers	110 projects	49 (44.5%)	49 (44.5%)	28 (25.5%)
Linear Fl.	Lght Designers	435 projects	195 (44.8%)	62 (14.3%)	0 (0.0%)
Single Lamp Fixtures	Architects	305 projects	47 (15.4%)	47 (15.4%)	47 (15.4%)
Single Lamp Fixtures	HVAC Engineers	110 projects	48 (43.6%)	48 (43.6%)	28 (25.5%)
Single Lamp Fixtures	Lght Designers	435 projects	112 (25.7%)	39 (9.0%)	0 (0.0%)
Lighting Project Total		**3,515**	**1,219 (31.9%)**	**610 (16.0%)**	**317 (8.3%)**
HID Fixtures	Light Contractors	2,650 units	1,250 (47.2%)	750 (28.3%)	750 (28.3%)
Lght Controls	Light Contractors	64,500 units	450 (0.7%)	400 (0.6%)	400 (0.6%)
Linear Fl.	Light Contractors	25,000 units	1,200 (4.8%)	0 (0.0%)	0 (0.0%)
Single Lamp Fixtures	Light Contractors	14,000 units	1,225 (8.8%)	800 (5.7%)	800 (5.7%)
Lighting Unit Total		**106,150**	**4,125 (3.9%)**	**1,950 (1.8%)**	**1,950 (1.8%)**

Examining Aggregate Levels of Influence by Market Participant

The market theory of the Commercial Construction Program rests on early adopters providing momentum to expand program effects. The diffusion of innovation theory provides a way to represent and interpret results for each market actor population affected by the program. In the diffusion of innovation theory, the first 16 percent to adopt a technology or practice are generally considered to be the innovators and early adopters (innovators are 2.5% while early adopters are 13.5%). This "standard adoption curve" is further illustrated in Figure 1 below.

Figure 1. Typical Size of the Product Adoption Groups[2]



The factors used in the calculation of program influence on the behavior of each market participant group are presented in Table 5. Column A shows the population sizes of each market participant group[3]. Column B presents the number of participants by type in the market. Column C is the quotient of columns A and B and shows the approximate percentage of each group's population that has participated in the program. Column D shows the survey sample sizes of each market participant type. Column E presents the number of respondents within each group reporting LIPA was at least a partial influence on their increased use of at least one energy efficient technology. Column F is the quotient of columns D and E and presents the percent of each group's sample that reported LIPA's influence on their increased use of at least one energy efficient technology. Column G is the product of columns C and F and shows the percentage of each group's population that has been influenced by LIPA to increase their use of at least one energy efficient technology.

[2] Rogers, Everett. (1995). Diffusion of innovations. Fourth edition. New York, NY: The Free Press.
[3] Regional Economic Research, Inc., *Long Island Power Authority: Commercial and Industrial Baseline Study, Volume 2.* May 2002. p. 2-13.

Table 5. Calculation of Program Influence on Participant Behavior

Column Label	A Population from Baseline Report	B # in Program Participant lists from LIPA	C % of Population that has Participated in the Program	D Survey Sample Size	E # of Sample Points Reporting Program Influenced Positive Behavior Change	F % of Sample Reporting Program Induced Positive Behavior Change	G % of Population Positively Influenced by Program
HVAC Contractors	901	52	5.8%	17	4	23.5%	1.4%
Lght Contractors	622	38	6.1%	11	3	27.3%	1.7%
Builder/Developers	729	58	8.0%	13	4	30.8%	2.4%
Architects	316	50	15.8%	17	5	29.4%	4.7%
HVAC Engineers	149	79	53.0%	25	10	40.0%	21.2%
Lighting Designers	131	92	70.2%	18	9	50.0%	35.1%
Total	**2,848**	**369**	**13.0%**	**101**	**35**	**34.7%**	**4.5%**
Calculation	-	-	**B/A**	-	-	**E/D**	**C x F**

Figure 2 illustrates the approximate level of change attributed to the program among each of the types of professionals/market participants contacted as calculated in Table 5. The bottom bar of the figure presents, in linear form, the standard product or behavior adoption curve presented in Figure 1. In this bar, the percentages associated with the typical adoption of a new product or practice is shown, extending from the innovator segments to the laggard segments. In other words, the first 2.5% of a given market to adopt a particular behavior or product are called 'Innovators', the next 13.5% are called 'Early Adopters", etc. The remaining six bars show the approximate level of influence of the program among the actor type population on Long Island, dissected by the thresholds of each adoption phase. Lighting designers and HVAC engineers have shown a high level of behavioral change while architects and builder developers have shown moderate change. Due to uncertainties associated with changes that may have happened to population sizes since the baseline study, the possibility of self-selection among those designers who chose to respond to the survey, and the moderate level of responses among respondents, we believe this figure provides a general sense of the level of influence of the program so far.

Figure 2. Level of Program Influence on Participant Behavior

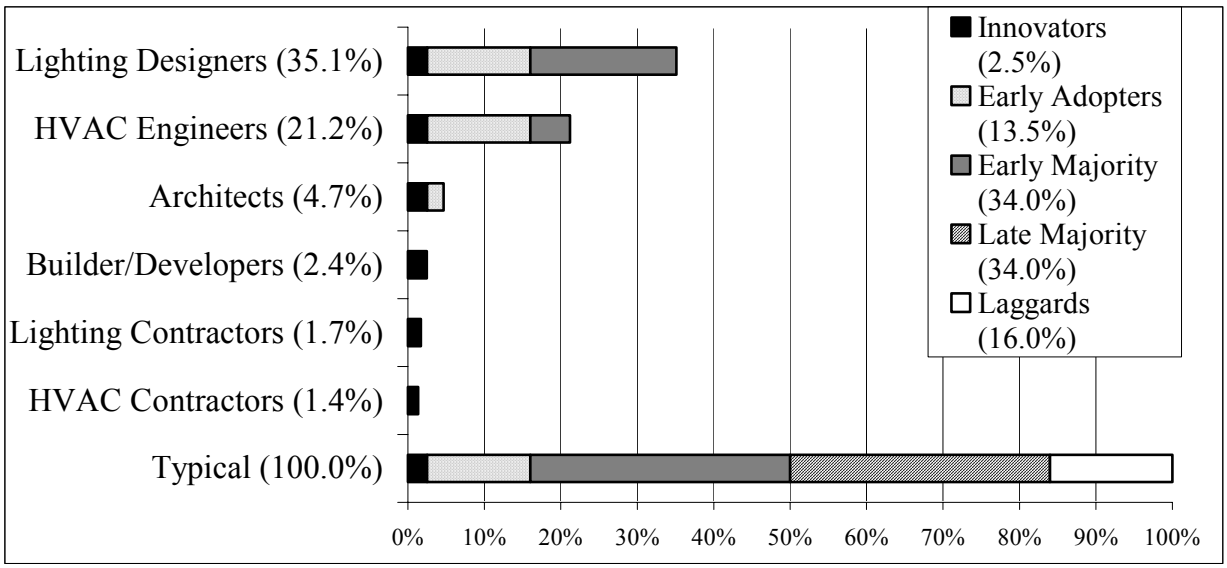


Table 6 presents the market participant types contacted as part of the initial study and the three primary means by which customers came into contact with the Commercial Construction Program. Within the table, the overall percent of the sample that both experienced a change in a desired behavior and was influenced by LIPA is provided. The three columns to the right of the table show the means by which they came into contact with the program.

Nearly 20% of the 101 respondents became involved with the program through one-on-one contact with LIPA personnel and also reported a desired behavioral change attributable to the program. One-on-one contact appears the most successful avenue for causing desired behavioral changes in market participants. The majority of architects, lighting designers, builder/developers, HVAC engineers and HVAC contractors who reported increases in desired behaviors did not receive a rebate. Indeed, 29.4% of architects, 30.8% of builder/developers, and 17.6% of HVAC contractors reported increases in desired behavior changes due to other program interventions.

Table 6. Program Elements Generating Influence

Actor Type	Sample That Reported LIPA Influenced Change	....in Contact with the Program Through…		
		LIPA 1:1 Ctc	Rebate	Seminar
Architect (n=17)	29.4%	29.4%	0.0%	0.0%
HVAC Engineer (n=25)	40.0%	8.0%	16.0%	16.0%
Lighting Designer (n=18)	50.0%	33.3%	16.7%	0.0%
Builder Developer (n=13)	30.8%	30.8%	0.0%	0.0%
Lighting Contractor (n=11)	27.3%	0.0%	27.3%	0.0%
HVAC Contractor (n=17)	23.5%	17.6%	5.9%	0.0%
Overall (n=101)	34.7%	19.8%	10.9%	4.0%

Phase 2 Methodology and Findings

Phase 1 of the Market Impact Study was followed by Phase 2, in which on-site surveys were conducted. These surveys were performed to update baseline market indicators based upon actual installation practices. Phase 2 is not the focus of this paper, but instead is used as a secondary source of information in the indication of program effects.

The sample frame for the on-sites was divided into new construction and major renovation – it focused on the three largest building types being built or renovated on Long Island: retail buildings, offices, and schools. The new construction site population and sample selection was based upon LIPA billing data - unique new meter sets between January 1, 2002 and September 29, 2003. The renovation population and sample selection was based upon information from two sources: an F.W. Dodge database of Long Island renovation projects and a Reed Construction Data (RCD) database (formerly Construction Market Data) of activity between January 1, 2002 and December 31, 2003.

In both sample designs, the Dalenius-Hodges technique[4] was used to create three strata from which to sample for each of the three building types. These strata were based upon the project valuation (in dollars) for renovation sites and electricity consumption (in kWh) for new construction sites. This range of business types; retail buildings, offices, and schools, was limited to make the study more manageable. In addition, it should be noted that this number of business types limits the ability of using the Phase 2 results to confirm or disconfirm the results from the larger number of business types

[4] *Sampling Techniques.* William Cochran, John Wiley and Sons. 1977. This technique calls for sorting by the field of interest (in this case, annual energy consumption) in ascending order and determining the strata cut-points so that the standard deviation in each strata is approximately the same.

represented in Phase 1. A total of 163 on-sites were performed in Phase 2, which consisted of 81 new construction sites and 82 renovation sites.

The on-site data collection form was modeled after the form used in the baseline study to gather detailed information on lighting, motor, and HVAC systems. The final version of the form facilitated the collection of equipment types, efficiency levels, and operating characteristics for the systems of interest. A battery of questions, similar to the one used in Phase 1, was used to assess LIPA's influence on the decision to install the observed equipment. Other general building information was also gathered through the survey, including building size and hours of operation. All on-site surveys were performed with the decision-maker for each project, either at the time of the visit or over the phone following the visit.

Final comparisons to the baseline on-site findings were made and self-reported attribution from site contacts detailed the reasoning behind the decision to install particular equipment found on-site was reported. Phase 2 also provided an opportunity to assess changes in installation practices since the baseline study.

Due to the difference in the targeted data collection points between the two phases of work, it is difficult to definitively reconcile Phase 1 and Phase 2 results in this paper. Phase 2 results suggested encouraging and meaningful movement of most metrics toward positive outcomes. Further, in many cases, LIPA was the reason for the decision-maker's choice in the level of efficiency. In looking at specific technology results in Phase 2, lighting generally moved in a positive direction despite having experienced some negative changes in rebate eligibility since the baseline was established. Motors and HVAC both experienced fairly substantial movement since the baseline study as well, and all three technologies had modest attribution to LIPA Commercial Construction Program influences. These results are broadly consistent with the fact that lighting designers and HVAC engineers reported the highest level of behavioral change due to the program in Phase I. So while not designed to provide direct support for the Phase 1 results, Phase 2 does provide some degree of confirmation that the Phase 1 self reports of increased use of efficient technologies is evident among the technologies observed and business types visited.

Conclusions

There is strong evidence that the LIPA Commercial Construction Program is inducing a positive change in the new construction and major renovation market place on Long Island. In looking at the market actors noted to be most influenced in the initial study phase as well as the increased installation of energy efficient equipment since the baseline study, there emerges a consistent pattern of market effects induced by the program.

Data from Phase I suggest that there are early signs of increased adoption of energy efficient practices and equipment, with a reasonable level of attribution to LIPA's Commercial Construction Program. Lighting designers and HVAC engineers have shown the greatest amount of desired change attributable to the program and are exhibiting adoption levels consistent with the 'early majority' phase. Architects and builder/developers show moderate change, and HVAC and lighting contractors show only marginal changes with adoption levels attributable to the program still within the 'innovators' phase.

To put these results in context, it seems reasonable to assume that design professionals have an interest in attending seminars and one-on-one meetings with LIPA to keep up with efficiency trends and practices, and to obtain continuing education credits. One might expect builder/developers and contractors to be more resistant to changing their building practices to incorporate efficient technologies because of the time needed to become familiar with them and the risk associated with adopting practices that are not 'tried and true'. We believe the Phase 2 results -- the observed installation practices in the

field -- suggest that the self reports of improved energy efficiency practices provided by the actors in Phase 1 are genuine and are producing a real impact on building efficiency.

In considering program impacts on influencing market players, it is apparent that different market participants attributed changes in behavior to different program stimuli. Architects, lighting designers, HVAC contractors, and builder/developers appear to respond best to one-on-one contact with LIPA personnel; lighting contractors respond well to rebates and similar program incentives, and HVAC engineers respond to both rebates and seminars. Overall, one-on-one contact between implementation staff and market participants is the most effective program stimulus.

We also conclude that a self-reported behavioral approach to non-residential market effects studies can provide an effective way of assessing the early market effects of programs like the Commercial Construction Program. Historically, assessments of market effects relied on pre/post comparisons of market-wide indicators, often yielding uncertain results due to the difficulty of achieving good sampling precision, the multiplicity of causal agents at work, the tendency for non-residential new construction markets to change relatively slowly, and the difficulty of fully replicating work conducted years earlier. We believe this study demonstrates that obtaining self-reports from market actors coming into contact with a program is an effective way to evaluate early market effects, and that this approach can be effectively combined with a later assessment of change in market-wide indicators.

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