Using Program Theory and Logic to Improve Design and Likelihood of Real Market Change: Experience with a State Public Benefits Program

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ABSTRACT

Portfolio-level and program-specific theory and logic modeling activities are currently being performed within the New York State Research and Development Authority (NYSERDA) for their **New York Energy-$mart℠** Program. This paper provides details on the theory and logic efforts that have evolved during an ongoing assessment of over 30 interrelated energy-efficiency and renewable-resource programs.

These activities are helping NYSERDA to describe critical program activities within a broader context of the markets it is targeting. They help describe how the portfolio of programs works together to achieve overarching goals and confirm and identify logic elements and underlying theories. In addition they can identify high priority measurement indicators and researchable issues for tracking performance, market changes, and assessing causality. Results from these activities are also providing NYSERDA's implementation staff with real-time insights and feedback on the effectiveness of their programs, recommendations for modifications to better align activities with desired goals (given current driving and restraining forces), and an improved "performance story" to explain their programs to partners and stakeholders.

Samples of the methods used, logic-diagrams created, logic-elements identified (*i.e.*, target markets, barriers, program activities, outputs, short, intermediate and long-term outcomes, external influences), potential measurement indicators, and researchable issues are provided.

Finally, the paper summarizes results and lessons learned about logic modeling in general, and more practically with a focus on describing how these theory-related activities are being used to help develop energy-efficiency policies, program designs, market assessments and implementation improvements that will maximize abilities to achieve lasting change.

Summary of the New York Energy $mart℠ Program

The **New York Energy $mart℠** Program was established through a regulatory Order issued by the New York State Public Service Commission (PSC) in January 1998 and commenced implementation on July 1, 1998.[1] In total program consists of over 30 separate initiatives, and multiple sub-components, working in four major program areas as follows: (1) Commercial and Industrial Energy Efficiency; (2) Residential Energy Affordability; (3) Low-

[1] PSC Case No. 94-E-0952, *Opinion and Order Concerning System Benefits Charge Issues,* Issued and Effective January 30, 1998. The Program is currently scheduled to run through June 30, 2006.

Income Energy Affordability; and (4) Research and Development (R&D - including renewable and combined heat and power). Collectively, the portfolio of **New York Energy $mart℠** Program initiatives is being implemented to achieve four overarching public policy goals.[2]

Overview of Program Theory and Logic Activities Performed

The design of each of NYSERDA's energy efficiency and R&D public benefits programs is based on specific assumptions about how energy efficiency and renewable resource markets operate. These designs have been developed through thoughtful assessment with input from multiple stakeholders and include consideration of the barriers that inhibit participation in the markets, and who the market actors are that occupy and influence the programs and the markets. Each program is designed according to a "logic" that dictates the path the program will take from inception, to creating market effects, to achieving public policy goals and objectives. The program analyses discussed in this paper describe how the development of program-specific theory and logic models and **New York Energy $mart℠** portfolio-wide and sector-level logic models (including the R&D group of programs) were conducted to identify critical logical pathways and make underlying assumptions explicit. Following are some brief definitions and discussion of the key program-and portfolio-level theory and logic activities performed.

Program Theory vs. Program Logic

Program theory identifies the assumptions underlying each program and describes how the program fits within a broader market context. In addition, program theory shows how the program is expected to work and identifies the intended outcomes. NYSERDA staff requested that both program theory and program logic be developed. These terms are increasing used interchangeably as developers of logic models more formally define and test the theories that underlie their models. John Gargani in "A Historical Review of Theory-Based Evaluation"[3] argues that the increased popularity of theory-based evaluation over the past 30 years with both evaluators and funding agencies has spawned the development of numerous varieties or *brands* of theory based evaluation, each with its own history, terminology, and features, and that "logic models" are a combination of two other brands of theory-based evaluation.

> Logic modeling can be viewed as the marriage of theory-driven evaluation and logframe analysis [used intensively by international development programs]. It sits between the academic and management worlds, intended to promote the standards of academic research while meeting the needs of program administrators. … The academic tradition of logic models began with the recommendation by Weiss (1972) that evaluators use program theory to strengthen evaluations. As ensuing papers, articles, and books further developed the notion of program theory, a distinction was

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[2] The PSC's 4 overarching public policy goals are: (1) Improve system-wide reliability and peak reduction through end-user efficiency actions; (2) Improve energy and access to energy options for under-served customers; (3) Reduce environmental impacts of energy production and use; and (4) Facilitate competition to benefit end-users.

[3] Gargani, John "A Historical Review of Theory-Based Evaluation", University of University of California, Berkeley, draft paper, Fall 2003.

> made between global social science theories (theories with a capital "T") and local beliefs (theories with a small "t"). At some point, the terms *theory* and *logic* began to be used to distinguish these two conceptions of program theory. (Gargani 2003, 40-41)

Gargani (2003) concludes that the logic model concept is relatively new and many issues are unresolved. One of these is the tension between the need for technically sound methodologies, which can be expensive, and the staffing, funding, and workload realities that constrain nearly all service agencies. McLaughlin and Jordan (2004)[4] write that Rogers et. al. (2000)[5] and Birkmayer and Weiss (2000)[6] present examples of theory-driven evaluations, but report that while theory-driven evaluation is conceptually sound, it is rare to find good examples in practice.

In the work done for NYSERDA, we use "program theory" to describe the more formal, academic description and analysis of the theory, and "program logic" to describe the program staff's view of the logic based on their considerable expertise and stakeholder involvement. Individual program-level theories are determined using multiple sources of information, such as Program Managers' and implementers' first hand experience with the program and its design; evaluation studies of similar programs or market characteristics; and existing theories in sociology, economics, and other social sciences, such as theories of marketing, market structure or technology diffusion. As appropriate, this larger view of the market might include an examination of prior work on market information flow and market product flow.

Program theory includes a description of the issue the program addresses, factors thought to be reasons causing the issue (e.g., market barriers), and which of those factors are addressed by the program and why. The theory describes the choice of target customers and the hypothesized activities, outputs and sequence of outcomes. These outcomes also include potential contributions and impacts that individual programs may have at the portfolio-level (*i.e.*, the linkage to overarching public policy goals of the **New York Energy $mart**^{SM} Program).

In program theory, the driving and restraining forces that make up the context of the program are explained. These forces are often termed as the antecedent factors and mediating factors. Antecedent factors are present as the program gets underway. Mediating factors are those outside of the program that might mediate the success of the program during implementation. Thoughtful consideration of these factors can help to identify risks, unknowns, and potential weaknesses within the program theory such that recommendations for experimentation or modifications to program design can be made.

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[4] McLaughlin, John A., and Jordan, Gretchen B., "Chapter 2: Logic Models," in *Handbook of Practical Program Evaluation,* 2nd Edition, Wholey, J., Hatry, H., and Newcomer, K., Eds., Jossey-Bass, 2004. See also: McLaughlin, John A., and Jordan, Gretchen B., "Logic Models: A Tool for Telling Your Performance Story," *Evaluation and Program Planning*, Elsevier Science: New York, Vol. 22, Issue 1, February 1999, Pp. 65-72.

[5] Rogers, Patricia J., Petroscino, Anthony, Huebner, Tracy A, Hacsi, Timothy A. (2000). "Program Theory Evaluation: Practice, and Problems," *New Directions For Evaluation*" Number 87, Fall, Jossey-Bass, pp. 5-13.

[6] Birkmayer, J. D. and Weiss, C. H. (2000). Theory-Based Evaluation in Practice: What do we learn? Evaluation Review., vol.24, # 4, pp 407-431.

Based on current industry best practices, program logics include the following elements:

- Key program resources/inputs (program funding, internal and contractor staffing, sources and magnitudes of leveraged funding/partnerships, etc.);
- Activities (internal and contractor program implementation tasks, outreach/marketing and delivery mechanisms, etc.);
- Customers and partners (who the program works for and with – customers receive products and services directly from the program and its partners, and change behavior or take action that translates into program outcomes);
- Outputs (internal and implementation contractor services, products, training/support being provided to target customers or market actors, etc.);
- Outcomes (short, intermediate, and longer-term anticipated results/benefits/market changes from program activities – many of which come directly from the program's stated measurement indicators and appropriate/targeted portfolio-level goals and objectives), including how these contribute to overarching policy goals;
- Any perceived external influences (recognizing the influence that market actors, barriers, other **New York Energy $mart**SM programs, state, regional and national activities or circumstances, etc., may have on a program's logic); and
- Drawn from the logic, measurable indicators and explicit, researchable issues.

Program-level theory and logic deliverables typically include a logic model diagram (discussed in more detail below) showing the logical relationships among the program elements. Program theory and logic modeling helps identify relevant research activities that might be helpful in indicating how evaluation results may be used for tracking progress toward key goals. Identifying and tracking appropriate program outputs and outcome indicators can provide valid evidence of program success and causal relationships operating within the program.

A program-level logic model maps relationships among the inputs, activities, outputs and outcomes that constitute a program and identifies key program-specific researchable issues and indicators for measuring program success (*i.e.*, supporting progress toward achieving public policy goals). In addition, the logic model makes explicit who the program's customers are and what external influences could impact the program. Figure 1 provides an example of a program-level logic diagram.[7]

Portfolio-Level Analysis

A portfolio-level analysis describes the activities, outputs, and outcomes associated with a portfolio of programs, and identifies theories and implied logical links at a higher level of abstraction that are working together to achieve key goals. The analysis also identifies measurement indicators, researchable issues, and potential external influences that can help guide planning evaluation activities to track the portfolio's short, intermediate and long-term success. Portfolio-level theory and logic deliverables focus on broader policies, issues and goals

[7] This diagram is based on initial program analysis work done in early 2004 for NYSERDA's *Keep Cool* Program. The *Keep Cool* Program seeks to reduce summer peak in NY's residential sector leading to improved customer load management, improved system-wide reliability, and a transformed residential room air conditioner market.

(beyond consideration when looking just at an individual program) and how implementation of the portfolio of programs is addressing these items, including an assessment of the overarching program's niche within this broader perspective. At the portfolio-level, the essence of the program as a whole is described from various stakeholder perspectives through a diagram or series of diagrams and associated text. An important element of a portfolio-level assessment is the identification and documentation of where programs are working toward common goals (including identification of which programs are working together and how). Modeling the logic of a portfolio of programs helps define common activity groups and delivery mechanisms and common customer and partner groups.

The portfolio-level theories and logics focus on hypothesized synergistic impacts that multiple programs may be having on the PSC's overarching public policy goals. One of the primary differences between the portfolio and program-level assessments is the additional insights gained of portfolio impacts on overall decision-making practices by major sector areas. These insights, coupled with the goal of creating an energy efficiency ethic in New York, represent important elements that portfolio-level assessments can address to help describe the theories and logic associated with changing marketplaces for efficiency in New York.

Methodologies and Sample Outputs

In addition to the program theory and logic activities which are the subject of this paper, NYSERDA's **New York Energy $mart^{SM}** Program evaluation efforts included more traditional process and impact evaluations of individual programs and significant market characterization, assessment and causality research. Separate evaluation assistance contractors were hired by NYSERDA to perform these activities. It has been important throughout all of NYSERDA's evaluation efforts that work plans, interim and final results be shared and coordinated amongst and between all contractors.[8]

To maximize the sharing and usefulness of information, and to avoid duplication of evaluation contractor efforts, three basic activities were conducted for NYSERDA during 2003 and 2004 for the purpose of developing program and portfolio-level theory and logic models. First, program summaries were developed for all of NYSERDA's **New York Energy $mart^{SM}** programs. Activities performed in development of the program summaries consisted mainly of secondary research to identify program-specific information. Numerous data and document sources were reviewed to collect program-specific information on overarching goals, target audiences and current market data, measures promoted/services provided, delivery mechanisms, current measurement indicators, integration with other programs, etc.

A second activity entailed the development of preliminary logic models for a few selected programs, to describe key elements (inputs, activities, customers, outputs, outcomes and potential external influences), to create an initial logic diagram, and to identify researchable issues and potential program measurement indicators. These preliminary logic models were developed specifically as an interim product to provide insights to NYSERDA's other evaluation

[8] An overall evaluation assistance contractor was hired by NYSERDA to ensure such coordination and to provide report development and other critical support.

assistance contractors during development of their own **New York Energy $mart**^{SM} program market characterization, assessment and causality research plans. [9]

Development of full program and portfolio-level theory and logic models represented the third and primary program analysis activity. An overview of the methodologies used when developing these detailed program-specific and portfolio-level models is presented in the following section.

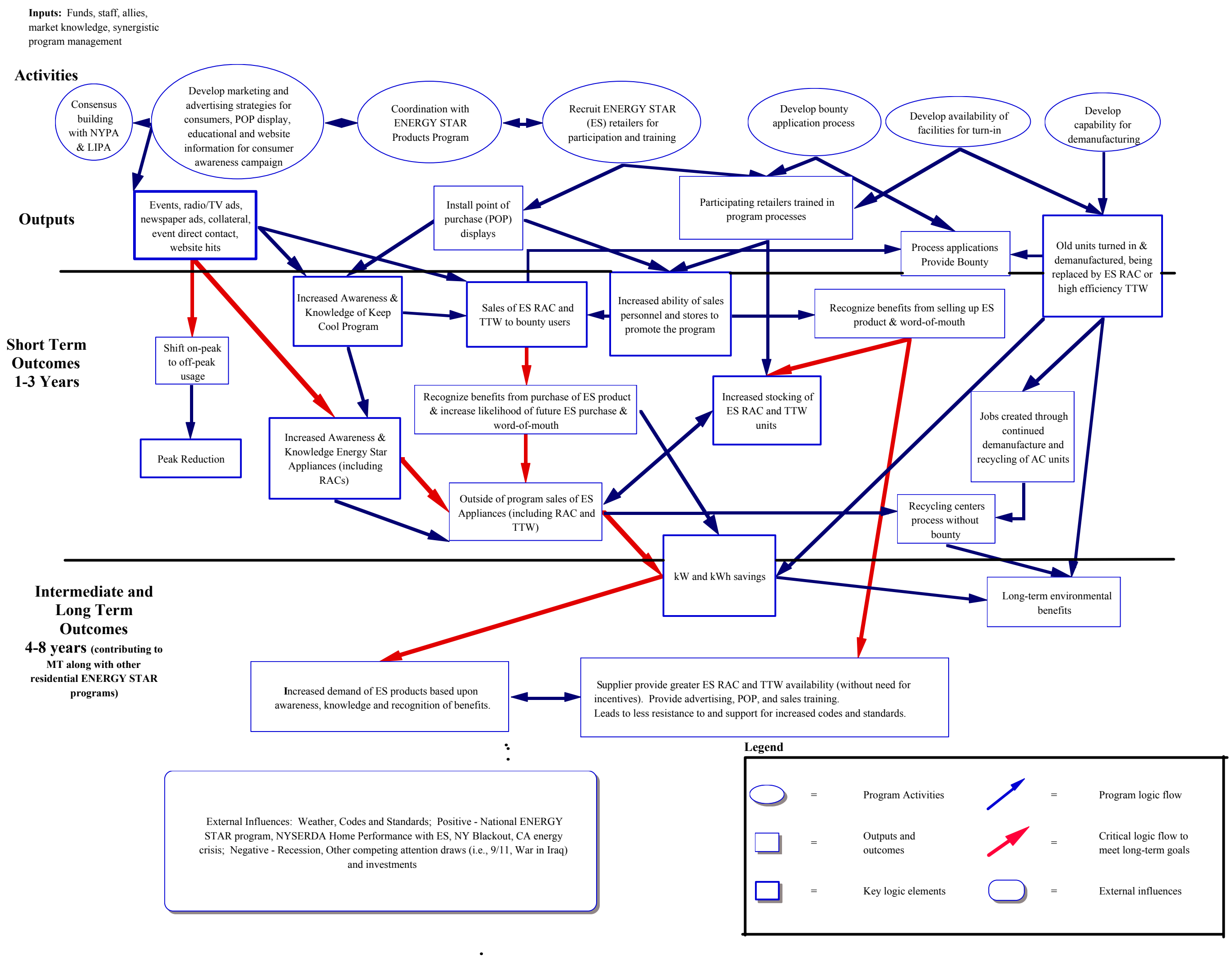
Full Program-Specific Theory and Logic Model Development Methodology

Activities performed in this area consisted mainly of the following items:

- Data Collection: The majority of which was completed during development of the Program Summaries, and supplemented by review of other potentially relevant documents.
- Issue Description: Based on a more thorough review of the Program Summaries and the underlying documentation supporting specific summaries in order to identify the issue the program is designed to address.
- Preliminary Logic Model Elements Definition: Included initial attempts at identifying the inputs, activities, customers, outputs, outcomes and potential external influences of the program.
- Preliminary Logic Model Diagram Construction: Transposed key logic model elements into a series of boxes, circles and arrows to identify preliminary logical relationships among the elements. Included procurement and incorporation of NYSERDA Program Manager feedback to identify holes or fill in missing information and links, leading to a revised logic model diagram and identification of researchable issues and associated program measurement indicators.
- Theory Write-ups: Preliminary logic model diagrams were supplemented with additional information from research that identified key findings from potentially relevant non-NYSERDA-specific market/marketing and economic research and sociological studies. Relevant findings were then incorporated into a formal textual document that summarized key theories and logical relationships of the program(s) being analyzed.
- Theory/Logic Model Verification: This stage included active solicitation of input from NYSERDA Program Managers through a workshop setting. Results were incorporated into revised theory write-ups and included recommendations to highlight potential areas for further evaluation or market research that could help position specific program elements to better achieve key goals.

[9] Ideally, theory and logic models would be developed for programs prior to their implementation in the field so they can influence program design and allow the program to build cost effective evaluation and performance monitoring into the program plan.

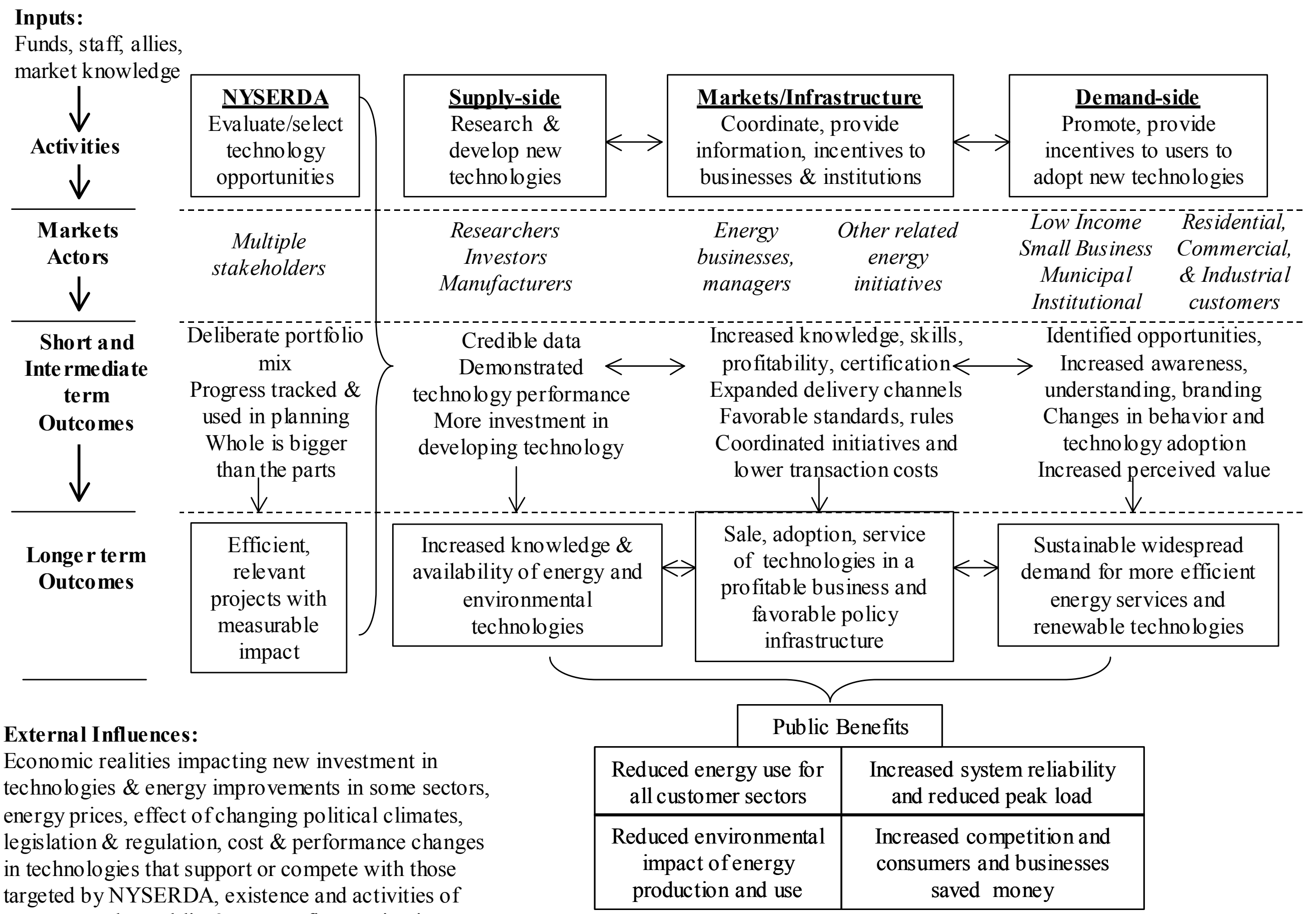
Figure 1. Sample DRAFT Keep Cool Program-Level Logic Diagram



Portfolio-Level Theory and Logic Model Development Methodology

Portfolio-level theory and logic activities involved an iterative process that entailed both bottom-up and top-down approaches. Constructing a logic model for NYSERDA's **New York Energy $mart**^{SM} portfolio required defining program thrusts and strategies that linked separate activities and outputs to the larger more long-term, desired outcomes (*i.e.*, building from the bottom-up). It also tried to capture synergies among programs, groupings by goal areas, markets, and targeted groups (*i.e.*, a top-down approach). Figure 2 provides a sample of a portfolio-level logic diagram based on an early 2004 draft of the **New York Energy $mart**^{SM} portfolio program theory and logic model.

Figure 2. Sample DRAFT New York Energy $mart℠ Portfolio-Level Logic Diagram



External Influences:
Economic realities impacting new investment in technologies & energy improvements in some sectors, energy prices, effect of changing political climates, legislation & regulation, cost & performance changes in technologies that support or compete with those targeted by NYSERDA, existence and activities of numerous other public & non-profit organizations promoting similar objectives

Summary of Results and Lessons Learned

Table 1 presents a list of the specific **New York Energy $mart**℠ program and portfolio-level theory and logic models that were developed during the first year of this evaluation effort.

Table 1. Program and Portfolio-Level Assessments Conducted (Year 1)

Sector	Program/Portfolio Name
Residential Sector	Keep Cool Program (full logic model) Assisted Multifamily Program (full logic model) ENERGY STAR Products (preliminary logic model)
Commercial/Industrial	Commercial New Construction (full logic model) Existing Buildings (preliminary logic model)
Research and Development	End-Use Renewables Wholesale Renewables
Portfolio-Level Assessments	**New York Energy $mart**℠ Portfolio-wide (preliminary) R&D Programs Portfolio (preliminary logic model)

Among the multitude of individual implementation activities being conducted through the programs assessed in Table 1, targeted researchable issues were documented to make explicit important underlying assumptions on the most significant program elements that could impact specific activities abilities to lead to anticipated outcomes. Following are examples of two of these researchable issues: [10]

- New Construction Program (NCP – example): Implicit within the NCP logic is the assumption that achieving the goal of market transformation depends on designers changing their design practices as a result of participation in the program. The logic model highlights that the combination of technical assistance and stipend incentives provided to A&E firms and the active involvement of program-recruited Outreach Project Consultants lead to changes in the frequency or number of energy efficiency measures and strategies suggested by A&E firms in non-program buildings designed by the A&E firms. The model assumed in this research issue is summative for these various actions (TA + stipend to A&E + OPC involvement = more measures in non program buildings designed by participating A&E firms). The program premise is that the TA + stipend + OPC is the means by which A&E firms learn enough to be able to apply the ideas on their own to projects that don't have technical assistance or incentives from the program. If it is found that the program's current outreach to designers is not resulting in designers changing their practices, then refinements may be needed.
- Keep Cool Program (example): A key element of Keep Cool is the replacement (turn in) of old, operating AC units with new more efficient units, thus reducing the overall energy usage (especially during summer peak periods in New York). It is implied within the logic that the program's recycling efforts cause there to be fewer RACs in the secondary market. The Keep Cool Program thereby reduces energy and demand usage as more, new RACs are purchased at higher efficiency levels than the efficiency levels in the secondary market. Without turn-in of the old units, these less efficient RACs will likely find their way into other rooms in the same house, in use at family or friends homes, or for sale in the secondary market, thus increasing kWh usage and summer peak demands. It will be important therefore, to confirm that the program's recycling efforts are in fact reducing the number of RACs in the secondary market. If it is found that, as a result of program advertising, more air conditioners (albeit ENERGY STAR® units) are being purchased than otherwise would have occurred, then anticipated energy and peak period savings benefits may be impacted.

Results to date, including the logic model diagrams, researchable issues (examples of which were presented above) and associated short, intermediate and long-term measurement indicators are helping NYSERDA's evaluation and program implementation staff to identify

[10] It is important to note, that due to the dynamic nature of NYSERDA's programs and their long-standing focus on continual program improvement, a majority of the issues identified during this project are either in the process of being assessed, or are no longer valid since program changes may subsequently have been incorporated. Also, as part of this project, the usual list of measurement indicator categories (*i.e.*, reduced barriers, sustainable changes in behavior developed, increased sale of energy efficient equipment and products, energy and cost savings created, lowered peak electricity demand, increased share of renewable generation in the market, quantifiable non-energy benefits created) were verified and customized for NYSERDA's portfolio and program-specific activities.

more specifically what needs to be investigated, other relevant research that might be helpful in certain program design areas, and ways that evaluation results can be used for tracking progress and developing program refinements. Specifically, many of the researchable issues and measurement indicators identified through the preliminary and detailed logic modeling efforts being done for NYSERDA have already been (or are being) incorporated into **New York Energy $mart**[SM] program market characterization, assessment and causality, and process evaluation contractors' work activities so that results can be used to validate or provide useful insights regarding key hypothesized relationships. Exactly how these subsequent evaluation findings will be received by NYSERDA's program staff and incorporated into future program enhancements is yet to be fully known. However, by involving program staff in the development and vetting of these program logic models and making their underlying program activity-to-outcome assumptions explicit, the likelihood of buy-in, acceptance and utilization of evaluation results will be greatly increased.

Conclusions/Lessons Learned About Logic Modeling and Its Catalyst for Program Change

When developing program and portfolio-level theory and logic models for NYSERDA, the envelope of current best industry practices was often pushed to improve practices where appropriate and achievable within existing contractual timing and budget limitations.[11] One example of an improvement in practice was to ensure that the logic models were viewed in a dynamic manner. This was done by involving program staff in development of the logic models, by including discussion of external influences, and by including identification of researchable issues. Truly dynamic logic models are quite useful because they can inform and are informed by changes that occur in program goals, delivery, and context over time and as more is learned about the program theory. Such dynamic logic models can really only occur, however, with full program manager ownership so that changes in the logic model can be made as lessons are learned in the field and as key hypothesized relationships are tested by evaluators. Although the logic models developed thus far for NYSERDA were done in a collaborative manner, more active program manager involvement and ownership would be desirable. As results from market assessments of these key relationships and measurement indicators become available, it is expected that increased program manager ownership and benefits will be achieved.

Another improvement was the use and development of new and better ways of diagramming the program and portfolio-level logic models. Specific enhancements included adding customers and participants to the logic model along with identifying timing of events and impacts, designated critical pathways, and potential external influences. Showing customers in the logic modeling (because it is their changes in behavior and action that leads to outcomes) and

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[11] In addition to New York, energy efficiency programs in California, Wisconsin, Maryland and other states in the U.S. are currently using logic models, and in Canada the logic model has been used routinely for all federal programs, including R&D and Technology Deployment for more than 20 years. For more examples of energy R&D logic models and the logic modeling process see the following publications: Beschen, Darrell and Jordan, Gretchen, "Planning for Evaluation of the U. S. Department of Energy's Energy Partnerships/Climate Change Programs," *Proceedings: National Energy Program Evaluation Conference 1995*, SAND 95-1086C, 1995; Jordan, et al. (1997a, 1997b); and Teather, G. and Montague, S (1997). "Performance Measurement, Management and Reporting for S&T Organizations -- An Overview." *Journal of Technology Transfer*, 22:2.

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including them explicitly helps program managers to think through what some call the "miracle in the middle". Designating critical pathways helps to show the importance of portions of the logic, whether that is because a large amount of funds are expended there or because without that step, other activities or events cannot occur. As mentioned earlier, including external influences, which many but not all do, helps to document the assumptions on which the program was planned (the static logic), and if these change, the logic will change.

A third improvement relates to the use of a textual description of the logic diagram, and the specification of researchable issues and associated measurement indicators at the time the logic is formulated. This is a very good practice and often is not done due to time and resource constraints. Doing so helps both evaluators and program staff to think through the logic. This is also important for accountability.

Finally, more thorough explication of the program theory has been incorporated, adding to the usefulness of the logic models for planning and evaluation purposes. Through this effort, the most relevant social science theories were discussed in detail with NYSERDA program staff to help validate key assumptions underlying specific program implementation activities. In certain cases, it was found that slight adjustments in program focus (or delivery approach) could better align activities for success (e.g., targeting "change agents" when selecting projects for funding within NYSERDA's Commercial New Construction Program could accelerate progress toward achievement of the program's market transformation objectives).

A number of challenges arose and limitations were identified during the development of these activities, the most important of which (some we new to begin with, so just verified) are summarized below:

- Few logic models have been done for research and technology development/deployment programs.
- Capturing multiple stakeholder perspectives and distilling a great deal of documentation onto a single sheet to describe the essence of an individual or portfolio of programs can be extremely difficult.
- Small changes in logic modeling can have significant meaning. An iterative process to arrive at a common understanding is important.
- Verifying the appropriateness and accuracy of key theory and logic flows requires data and time. It requires the collection of critical baseline data, followed by careful monitoring of direct program activity outputs and short, intermediate and long-term outcome indicators.
- The validity of specific program logic elements, although reasonable at a particular point in time, can change based on both internal and external circumstance (influences) and how programs mature over time. It is therefore important to include tracking of such critical circumstances as part of the program's regular monitoring process.
- Developing theory and logic models for programs prior to their implementation in the field can be the most effective way to influence program design and can allow the program to build cost effective evaluation and performance monitoring into the program plan. However, the development of such models after program implementation has already begun can still serve an important validation role (testing of key hypothesized

activity-to-outcome relationships and confirming and adding to existing performance measures).

Valid evidence of program success and causality can be provided by identifying and tracking indicators along the logic chain and completing evaluation studies that have been focused by the theory and logic efforts. Should results from actual field tracking reveal that activities are not yielding anticipated results, NYSERDA will be effectively informed and positioned to make program-level and portfolio-wide modifications to better align activities for goal achievement.

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