Residential DSM: Program Transition from Planning to Maturity

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In New England, the Collaborative process, which began in 1987, has now completed a full cycle of program design, field implementation, and finally evaluation. The unique features of the collaborative programs included a high level of utility investment, comprehensive treatment of each customer, and a strategic delineation of target markets.

Substantial program delivery has been completed for many of these programs. The opportunity exists to not only review the impact of those programs but also to look at the critical assumptions at each stage. These will be presented for two programs: Energy Fitness and Single Family Electric Space Heat.

The first stage of program development was the program design stage. Assumptions concerning technical opportunities, program costs, measure costs, savings, participation rates and many other factors were established and incorporated into program designs.

The second stage was actual field implementation. This stage packaged the program designs into operational components, selected contractors, identified customers, marketed and delivered measures. In almost all cases, these were fully funded by the utility. The paper will review the actual costs, participation rates, estimated savings, and technical opportunities achieved during initial program implementation.

Lastly, the process and impact evaluations are beginning to show the accuracy of the assumptions at each stage. The lessons learned from one of the most ambitious residential DSM investment planning and implementation strategies in the country will be presented.

Introduction

This paper attempts to look at two program designs which were developed during the collaborative negotiations in New England and identify the transition points for each program. The author was directly involved in both program design and implementation for several utilities and therefore does not bring an uninvolved or neutral perspective to this work. Rather, this paper attempts a first hand retrospective of the efforts to design and implement these programs over the past five years.

The design stage lasted from 1986 until 1989 while the implementation stage continues from 1990 to the present. The generic designs which evolved from the collaborative were implemented by several utilities in New England and this review will attempt to focus on the common points among them instead of focusing on the specific programs of any one utility. This paper concentrates on the programs which were both designed and implemented by CSG since the data availability is most complete for these programs.

The comprehensive review of each program is not possible within the scope of a single paper and will not be carried out. Instead the focus will be on a more in depth analysis of one program and the extrapolation of the program transition points to another program. The electric Space Heat Program, which has the longest history and the most available information is reviewed in detail. The program was originally designed in a collaborative process between several community groups and New England Electric System (NEES) in 1987-1988. Subsequently, this program was incorporated into the more comprehensive collaborative which included Conservation Law Foundation and others in 1988.

The other program is the Energy Fitness Door to Door conservation program. This was designed as part of the collaborative negotiations between 1988-1989 and implemented by four utilities in 1990-1991. Since field implementation and impact data are limited, these programs will be reviewed to illustrate the importance of program transition stages.

DSM program evaluation is frequently carried out within a snapshot time frame but program design and implementation are dynamic processes. Process evaluations and

impact evaluations are conducted to analyze a program during a specific time of operation, usually six months to a year. Each approach looks at a facet of program implementation but does not fully capture the critical transition points in a program as they unfold over a multi-year time frame.

There are multiple program transition points which can be identified. First is the program design phase where planners use assumptions and available data to simulate program operations and prepare a program design. Second, is field implementation. The transition from program design to operational programs results in staff and contractors attempting to follow the concepts created in the design phase. Third, there is a transition stage during the first year of operation where market place realities are incorporated into program implementation. The final stage is when a program reaches operational maturity. At this stage procedures and measures can be fine tuned based on both formal and informal evaluation feedback.

An evaluation (either process or impact), which documents the first year of a program's operation, may present the average of three very different program stages. In the first program stage, the attempt to implement a design concept with specific staff and contractor (as well as sub contractor) capabilities will result in program adjustments from the initial design. In the second stage, the adjustment of the program to the needs of actual program participants may result in further modification, which may produce another version of the same program. During the first year, the third stage is achieved as the program reaches maturity in eight to twelve months. Since procedures are in place and staff/contractors are reaching the full extent of their capabilities, the program may then operate on a very different level.

Several program transitions will occur after the first year of operation. The fourth level of program operations may be achieved when the program receives the results of any formal or informal evaluations and carries out additional modifications and adjustments. Finally, a fifth program transition stage is achieved when new products or technologies, which result in new savings opportunities, have been successfully introduced into the marketplace. For point-of-sale programs or those that incorporate significant new technology development, this stage will generally require between two and four years. A good example is the pending introduction of compact fluorescent bulbs, which are low THD, High Power Factor and electronically ballasted. These products required four or five years of utility programs before convincing the industry that there was a market for this technology.

Narrowly defined or static evaluations which do not incorporate an understanding of these program transition points will inevitably result in analysis which does not accurately reflect the true long term performance or potential of a particular DSM program.

Electric Space Heat Programs in New England

The initial electric space heat program was designed in 1986-1987 with the objective of targeting comprehensive utility investments towards high kwh use space heating households where the maximum savings opportunities would be present. The initial design was carried out with very little field experience in the country to draw on for technical potential or design feature input. (The Hood River project results were not known to the participants until late 1987.) Detailed description of the initial program design and the results of the field implementation of the pilot stage of the program by NEBS, CET and CSG (which was operating under the name of Community Energy Partnership) was presented in a 1990 ACEEE paper by Bob O'Brien (NEES), Dave Jacobson (NEES), and Laura Dubester (CET).

Several key areas of program design which will be reviewed at each transition stage are:

1. Incentive structure
2. Profile and rate of measures installed or projected for installation
3. Projected or achieved savings for those measures
4. Installed costs for each measure and total costs per household
5. Program delivery procedures including contractor structure, technical assessment procedures and administrative oversight
6. Calculated administrative costs for each household

These six critical features of a program can reflect the changes at transition stages of implementation. The transformation of each program component at each stage of implementation can illustrate these program evolutions.

This paper is based on information submitted to NEBS in the design of the pilot program and the DPU filing which resulted from the initial negotiations with six Massachusetts utilities. Although there were some differences between these data sources as a result of timing, the

similarities were the result of the same design team being involved. Information on later stages of implementation and field delivery come from the experience of CSG implementing programs for NEBS and Boston Edison.

Incentives

The initial planning team projected that there would be a significant demand by customers for cost sharing of investments as the result of the option to upgrade items such as window replacement, lighting fixtures or other measures. In addition, the initial plan incorporated a maximum incentive based on kwh per square foot of heating costs, which resulted in the requirement for customer cost sharing in some cases. It was also projected that a full 33% of the customers visited by the program would accept only the simple measures installed at the time of the visit. It was anticipated that customers would reject contractor installed measures, which required additional inconvenience and additional costs.

At the contracting stage, the incentive structure was modified to incorporate full utility payment for all cost effective measures. This modification reduced customer cost sharing and increased participation rates of cost effective follow-up measures too close to 100%. At the field implementation stage, it was discovered that customer option upgrades were not occurring at significant rates which facilitated program administration and lowered costs.

Measures, Installation Rates, Costs and Savings

The most dramatic changes in the program through the design and implementation stages have been in the availability of measures and rate of installation. These have changed as the result of contractor capability improvements, improved product availability and actual field identified measures contrasting from theoretical projections.

Tables 1 and 2 provide a description of some of the changes at each stage.

The information in Tables 1 and 2 clearly indicate that over the first three years of program design and operation the package of measures, costs, and projected savings changes significantly. The target audience was the same but the range of available measures and their costs changed dramatically.

The reasons for these changes were varied. The primary change in air sealing costs and rates of installation resulted from changes in program delivery structure. The changes in installation rates for insulation resulted from the actual field conditions in the target market compared with projections. The additional lighting measures were the result of a wider range of bulb and fixture options and increased skill in installation. Finally, the addition of measures such as duct sealing, attic hatch and stairwell covers, a/c covers, and other measures were the result of the identification of new products or installation opportunities.

The initial savings projections were that the space heat program would be able to save 2500 kwh annually. A total investment of between $1,500 and $1,600 in measures and $200 in program delivery costs was projected. Although the measure costs were less, the initial field implementation indicated that the delivery costs were much higher than anticipated due to the delivery structure and utility data requirements. The delivery costs were adjusted upward to $350 per household, and the measure costs decreased to an average of $750 based on the projection that upwards of 1/3 of the households would not complete follow-up sub-contractor measures, which were recommended. The full scale implementation record is that actual delivery costs were less than $275, and measures installed averaged approximately $850 per household.

The decrease in measure costs from the original projections to initial field implementation resulted from a significant decrease in window measures installed and a decrease in air sealing costs. The increase in measure installation costs from the initial field stage to the second field stage are the result of increased rates of major measure installations per household (90% compared to 66%). This was the result of increased incentives and reduced customer cost sharing.

The savings estimate was revised from the initial projection in the planning stage of 2,500 kwh to 1,500 kwh per year at the contracting and increased to 1600 kwh per year based on estimates from a random sample selection of customers served. These were engineering estimates, since hard measured data is not yet available for 1991.

Program Delivery Structure

There were several significant changes in delivery structure during program transition from planning to implementation stage. These changes included the following:

- Customized technical assessments and approval of measures were replaced with pre-approved measures based on average savings and existing conditions. This dramatically reduced technical assessment costs.

Table 1. Measures Projected (rate)

	Stage 1 1988-89 Planning (st.)	Stage 2 1990 Pilot (actual)	Stage 3 and 4 Implementation 1991 (actual)	1992 (est.)
1. Air Sealing	80%	60%	86%	85%
2. Attic Insulation	50%	55%	65%	65%
3. Hatch Insulation	50%	50%	44%	40%
4. Attic Stair Covers	None	None	24%	30%
5. Basement Insulation	04%	04%	12%	12%
6. Window Measures	60%	21%	8%	8%
7. Thermostats	50%	8%	07%	08%
8. Lighting				
Bulbs/Hsld.	2	4	5	5.5
Fixtures/Hsld.	.4	.2	.14	.15
9. Water Measures	50%	70%	74%	75%
10. Duct Measures				
Sealing Leaks	None	None	None	08%
11. Attic Fan Covers	None	None	None	05%

- The two visit system of technical assessments, which included air sealing and then additional sub-contractor measures, was replaced with a single technical assessment/air sealing visit. This allowed for air sealing in larger numbers of homes without requiring additional inconvenience to the customers.

- Sub-Contractor air sealing was replaced with direct delivery of air sealing as part of the core program visit. This was due to inadequate numbers of air sealing contractors and unsuccessful efforts at stimulating contractors to enter the marketplace. As a result, the cost of this measure decreased 50%.

- The program structure has evolved to incorporate new measures. This includes duct sealing, window quilt applications, lighting fixtures, and other measures which require specialized visits and crews.

- Revised cost effectiveness standards, staff incentive systems, and quality control procedures are producing significant changes in second year measure installations and savings projections. Total air sealing results, more measures installed and other improvements are incorporated into the program at its mature implementation state (year 4 of planning and operation).

Electric Space Heat Program Stages: Summary

The electric space heat program was designed during the collaborative negotiations in 1987-1988; began pilot field operation in 1989; implemented full scale field operations in 1990, and adjusted the program over time to accommodate new products and techniques. There were five distinct phases of program development which resulted in different estimates of impact, cost and cost effectiveness. The lessons from this process can be summarized as follows:

Table 2. Measure Costs (program stages)

	Planning	Pilot Contracting	Field Implementation	
	1987-88 (est.)	1990 (actual)	1991 (actual)	1992 (est.)
1. Air Sealing	$500-$750	$400	$170	$200
2. Attic Insulation	$500-$750	$500	$750	$800
3. Hatch Insulation	$25	$10	$18	0
4. Hatch/Stair Covers	n/a	n/a	$100	$105
5. Basement Insulation	$500	$650	$200	$200
6. Window Measures				
Storms/Replace	$1,200	$800	$156	$200
7. Thermostats	$100	$110	$110	$110
8. Lighting				
Bulbs/Hsld.	$30	$52	$80	$85
Fixtures/Hsld.	$80	$90	$71	$75
9. Water Measures	$20	$45	$57	$57
10. Duct Measures				
Sealing Leaks	n/a	n/a	n/a	$300
11. Attic Fan Covers	n/a	n/a	$45	$45

- Early assumptions about program impact and cost effectiveness should not be used to rigidly eliminate a program design if the range of potential outcomes presents a possibility of success.

- The implementation of a program must allow for significant short term feedback with a rapid response capability, which will facilitate the transition from stage to stage.

- Utility program managers and planners must be flexible in allowing for the ongoing modification (in some cases significant modifications) of program designs as the program gains field delivery experience and new technologies or techniques become available.

- If the program allows flexibility, it will be able to incorporate the rapidly growing body of energy efficiency products, installation techniques and building science knowledge if the program allows this flexibility.

Energy Fitness: Door-to-Door Electric Savings

Energy Fitness was an adaption of the Santa Monica RCS audit program to a DSM lighting strategy to serve urban neighborhoods. The original plan evolved from the collaborative negotiations in 1988 and was implemented first in Worcester, Massachusetts by Massachusetts Electric Co. It has been replicated by New England Electric System in 6 communities and by both Boston Edison and Western Massachusetts Electric Company throughout their service territories.

Although the Energy Fitness Program is a simple program compared to the space heat program from a technical perspective and involves only a single visit of less than one hour, the program experienced the same transition stages as the Space Heat Program. The transition from planning to mature implementation resulted in dramatically different program from the initial stages to the final stage in field implementation.

The transition stages required approximately two and one half to three years to complete. Due to space limitations, the description of the stages and the level of detail presented is less than that for the Space Heat Program. The goal is to illustrate the level of difference between each program stage even though it was for a very different program.

Planning Stage Assumptions

In 1988 the assumption were as follows:

- The product list would include 7, 8, 9, 13 and 15 watt compact fluorescent bulbs, A/C filter replacement, refrigerator coil and gasket cleaning and hot water measures where there was electric water heating.
- There would be an average of between 3 and 4 bulbs installed in fixtures which were on (called "burn time") for more than two hours.
- The costs per household to deliver the system would be approximately $75 per household for labor and administrative costs and approximately $80 for installed measures. Savings were projected at between 400-450 kwh per year for all measures. A seven year measure life was used for the bulbs.

Initial Implementation Stage

In 1988-1989 the initial field implementation indicated that there were several flaws with the initial assumptions. These were identified and features changed in subsequent programs designs. The changes included the following:

- The initial assumption of two people crews was quickly replaced with individual installers, thus reducing costs considerably.
- The measures installed were discovered to be inadequate in terms of light output and the level of training required to identify locations was more than expected.
- Lower wattage bulbs (7 and 9 watt) were eliminated and the 22 watt and 28 watt bulb were incorporated.
- Costs were reduced to under $65 per household for labor and administration, but materials costs were increased for the higher wattage bulbs (9w bulbs cost under $10 while 22w bulbs cost over $17).
- Follow up phone surveys, four to six months after installation, indicated that 25%-40% of the bulbs were removed from the initial installations due to low light output and other customer objections.
- Bulb retention rate was a major factor in concluding that the program may not be cost effective. The initial savings projections were reduced to 200 kwh for each home as a result of removed products and lower installation rates.

Program Redesign Stage

The initial field experience led to some additional modifications to improve cost effectiveness and customer satisfaction. These included the following:

- The expansion of bulb options to include electronic ballasts and higher wattage of products such as 18, 20 and 27 watt bulbs.
- The streamlining of data collection and administrative processing by the utility and contractors. This reduced labor and administrative costs from $65 to under $50 per household.
- Increased training, feedback, and retraining of staff to improve the quality of design analysis were carried out and programs were switched from short term blitz of six months to programs of longer duration. This allowed staff to benefit from field experience.
- As a result of these changes, the number of bulbs increased to approximately 6 per household with a retention rate to over 90%. The savings projections increased to the 350-400 kwh per year range.

Mature Program Operation Stage

The ability to improve on the basic design through increased productivity and quality was identified in follow-up surveys. This resulted in several additional changes:

- The addition of quality and productivity incentives and goals increased production and measure installation rates.

- Improved training resulted in increasing retention rates to 95%-98%.

- Projected savings increased again to over 450 kwh per year and cost decreased further to under $45 per household. The program became fully cost effective compared to the initial field implementation results.

Program Innovation Stage

The ability to refine and improve a mature program is clearly an objective of any program operator and utility. The Energy Fitness program represents an example of this. One program in Connecticut was able to combine the services of the electric program with both the gas utility and the water authority to achieve an expanded program. The result was even lower costs per measure for each utility/agency and increased savings for the household. The total program cost effectiveness was enhanced as a result.

Summary

The example of these two programs, as well as experience with several other programs, indicates that DSM programs undergo similar transitions during the implementation and operation stage. The stages often have dramatic differences with respect to costs, savings and design. The implication for DSM programs is to incorporate this concept of evaluation of program stages into the design of evaluation processes, goals, objectives, and expectations.

DSM programs are much more quickly implemented in the field than supply side options. They are not, however, instant on and off resources. Each program, regardless of its complexity undergoes these transactions which should be expected and planned. The implications include the timing of evaluations, checkpoints for program feedback and adjustment, flexible guidelines which allow for rapid response to field conditions, and multi-year implementation time frames.

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