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ENERGY & ENVIRONMENT DIVISION

Utility Residential New Construction Programs: Going Beyond the Code

E. Vine

August 1995

ENERGY
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A Report from the
Database on Energy Efficiency Programs (DEEP) Project

Utility Residential New Construction Programs: Going Beyond the Code

Edward Vine

Energy and Environment Division
Lawrence Berkeley National Laboratory
University of California
Berkeley, California 94720

August 1995

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Abstract

Based on an evaluation of 10 residential new construction programs, primarily sponsored by investor-owned utilities in the United States, we find that many of these programs are in dire straits and are in danger of being discontinued because current inclusion of only direct program effects leads to the conclusion that they are not cost-effective. We believe that the cost-effectiveness of residential new construction programs can be improved by: (1) promoting technologies and advanced building design practices that significantly exceed state and federal standards; (2) reducing program marketing costs and developing more effective marketing strategies; (3) recognizing the role of these programs in increasing compliance with existing state building codes; and (4) allowing utilities to obtain an "energy-savings credit" from utility regulators for program spillover (market transformation) impacts. Utilities can also leverage their resources in seizing these opportunities by forming strong and trusting partnerships with the building community and with local and state government.

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Acronyms and Abbreviations

BECO	Boston Edison Company
BPA	Bonneville Power Administration
CMP	Central Maine Power Company
DEEP	Database on Energy Efficiency Programs
DSM	Demand-Side Management
ECH	Energy Crafted Home Program
EEE	Excellence in Energy Efficiency Program
EIA	Energy Information Administration
EPRI	Electric Power Research Institute
HPW	High Performance Window Program
HVAC	Heating, Ventilation, and Air Conditioning
MAP	Manufactured Housing Acquisition Program
NEES	New England Electric System
NYSEG	New York State Electric and Gas
PECO	PECO Energy Company
PG&E	Pacific Gas and Electric Company
SCE	Southern California Edison Company
SGC	Super Good Cents Program

Executive Summary

Based on an evaluation of 10 residential new construction programs, primarily sponsored by investor-owned utilities in the United States, we find that many of these programs are in dire straits and are in danger of being discontinued because current inclusion of only direct program effects leads to the conclusion that they are not cost-effective. We believe that the cost-effectiveness of residential new construction can be improved by taking advantage of key opportunities and by collaborating with the building community and with local and state government.

Background

Residential new construction programs have multiple impacts on energy usage because new homes determine the trends of the future housing stock and the penetration of innovative building technologies into the marketplace, thereby affecting both present and future energy use. The cost-effective savings potential is large in new homes because they can be designed comprehensively and systematically to maximize energy savings.

We present two perspectives in this report: a resource acquisition perspective and a market transformation (program spillover) perspective. The former perspective is the primary goal of most utility energy efficiency programs. We focus on the resource value that residential new construction programs contribute to utilities' DSM portfolios, since from a resource planning perspective, energy efficiency programs are desirable only to the extent that they cost less than the alternatives available for meeting customer energy service needs. However, because these programs may have significant spillover benefits, we also examine residential new construction programs as part of a larger effort to transform markets for energy efficient products and services. Under this concept of market transformation, residential new construction programs influence the attitudes and behavior of key members of the residential construction community (e.g., builders, architects, engineers, retailers, manufacturers, and homebuyers) so that investments in energy efficiency persist even after the program is changed or eliminated. The impact of these programs may not be visible until many years after a program has been implemented. Most current estimates of resource value do not capture spillover benefits and, therefore, understate savings to the program.

Program Selection

Four objectives guided the process of selecting programs to study. First, we focused primarily on utility-sponsored residential new construction programs that promoted the design and construction of energy-efficient buildings, with a particular emphasis on the building shell or envelope. Second, we selected full-scale programs and excluded pilot programs, so that we could examine the implementation and evaluation experiences of "mature" residential new construction programs. Third, and most importantly, in order to estimate the total resource cost of energy efficiency, we considered only those residential new construction programs for which we could obtain information on the total costs and performance of the program. For each program, we needed information on: (1) post-program evaluation of direct annual energy savings, (2) total cost of the program to the utility, (3) total cost of the program to participating customers, and (4) economic lifetimes of measures installed through the program. These requirements proved decisive in choosing the final set of programs analyzed in this paper. And fourth, we selected residential new construction programs that offered rebates to builders, homebuyers, or manufacturers.

Based on a review of the literature, consultations with DSM program experts knowledgeable about residential new construction programs, and a preliminary telephone screening of candidate programs, we were able to complete as fully as possible a standardized data collection form for 10 programs. We established contact with one or more utility staff members familiar with the program and asked them to verify the information we had collected on their programs and to supply missing information.

The Total Resource Cost of Residential New Construction Programs

When weighted by energy savings, we found the average total resource cost of the 10 residential new construction programs in our sample (for the most current year) to be 5.7 ¢/kWh; the median was 20.8 ¢/kWh, and the total resource cost ranged from a low of 3.4 ¢/kWh to a high of 725.1 ¢/kWh (Table EX-1). All costs are expressed in 1994 dollars. Table EX-1 reports the total resource costs for our sample of 10 residential new construction programs as well as the elements used to calculate

them. We also provide the levelized utility resource costs for those interested in a utility perspective (limited to utility costs) rather than a societal perspective (including participant and utility costs).

As shown in Table EX-1, the performance of residential new construction programs is generally poor from a total resource cost perspective. Only two programs were below $0.05/kWh (including one program that focused on manufactured housing and contributed a large percentage of our sample's total energy savings), and 70% of the programs were above $0.15/kWh. Due to the small sample size, we could not conduct a statistical analysis of this sample to determine the key determinants of performance. A larger data set would enable us to learn more about the differences in results.

Based on our interviews with program managers and evaluators and analysis of the data, we concluded that the poor cost-effectiveness of residential new construction programs stem from the following: (1) increased tightening of state building standards and national appliance standards which have improved the baseline; (2) inadequate (incomplete or misdirected) marketing strategies; and (3) savings calculations limited to only those savings achieved by program participants for measures covered under the program, excluding savings by nonparticipants and savings from non-program measures by participants as a result of the program (the "market transformation" perspective).

Improving the Cost-Effectiveness of Residential New Construction Programs

In recent years, some residential new construction programs have been terminated or significantly modified because of economics and/or a general trend on the part of utilities to reduced DSM program budgets to mitigate rate impacts. In response to the problems described in the previous section, four options for improving the cost-effectiveness of these programs are available, some of which have already been undertaken by the utilities in our sample (Table EX-2). These approaches are not mutually exclusive and in some cases may be synergistic: e.g., targeted marketing may lead to reduced program costs. If utilities do not redesign their programs and evaluations to reflect these improvements, then residential new construction DSM programs will be discontinued by investor-owned utilities.

Table EX-1. Cost-Effectiveness of Residential New Construction Programs

Utility (1)	Year	Gross Annual Electricity Savings (MWh)	Economic Lifetime of Measures (Years)	Admin. Costs of Utility ($1,000) (2)	Incentives Paid by Utility ($1,000) (2)	Annual Participant Costs ($1,000) (2)	Levelized Total Resource Costs (¢/kWh) (3)	Levelized Utility Costs (¢/kWh) (3)
BPA - MAP	1994	84,551	45	2,324	45,753	2,434	3.36	3.20
BPA - SGC (4)	1985	208	70	55	83	0	3.42	3.42
BPA - SGC (4)	1986	591	70	339	509	0	7.42	7.42
BPA - SGC (4)	1987	2,452	70	1,926	2,889	0	10.15	10.15
BPA - SGC (4)	1988	3,584	70	2,906	4,358	0	10.48	10.48
BPA - SGC (4)	1989	7,212	70	5,988	8,983	0	10.73	10.73
BPA - SGC (4)	1990	9,065	70	7,047	10,571	0	10.05	10.05
BPA - SGC (4)	1991	10,091	70	5,556	8,333	0	7.12	7.12
BPA - SGC (4)	1992	5,808	70	4,325	6,488	0	9.62	9.62
BPA - SGC (4)	1993	2,348	70	936	1,404	0	5.15	5.15
BECO	1992	8	20	611	73	39	725.12	686.16
CMP (5)	1992	88	20	79	0	193	24.79	7.18
NEES (6)	1992	82	35	496	134	0	46.93	46.93
NEES (6)	1993	123	35	524	164	0	34.14	34.14
NYSEG	1992	230	20	478	180	0	24.77	24.77
O&R	1992	804	30	309	310	0	5.00	5.00
PG&E (5)	1991	3,308	20	1,514	3,221	3,980	26.76	14.54
PG&E (5)	1992	5,425	20	2,885	6,140	8,815	33.40	16.90
PG&E (5)	1993	5,872	20	6,589	9,565	3,395	33.39	27.59
PECO (5)	1992	465	20	324	825	0.54	13.09	13.08
SCE (7)	1991	1,689	20	5,344	1,278	4,333	26.02	15.73
SCE (7)	1992	1,089	20	2,152	1,540	3,932	28.09	13.60
SCE (7)	1993	2,074	20	919	2,282	5,549	16.93	6.19
For Most Recent Programs:								
Weighted Average (8)							5.67	4.78
Average							88.57	81.25
Standard Deviation							223.95	212.83
Median							20.85	10.13

Notes:

(1) See Table 2-1 for identification of utilities and programs.

(2) All costs are indexed to 1994 using a time series of GNP implicit price deflators from the *Consumer Price Index.*

(3) For calculating the levelized total resource cost, we calculate the total resource cost for each program (utility and participant costs) by using the discount rate (5% real) to levelize total costs over the average economic lifetime of installed measures for each program. The levelized costs are then divided by annual energy savings. The levelized utility resource cost was calculated in the same manner, except participant costs were excluded from the calculation.

(4) BPA's figures include BPA and utility costs. Incentive costs were estimated to be approximately 60% of the program costs, based on an outside review of the program (The Results Center 1992).

(5) The new construction programs of these utilities also resulted in gas and/or fuel oil savings that are not reported in the table. Since program costs cover all savings, the levelized total resource cost and utility costs are actually lower than shown. At this time, we are unable to separate out the costs for the non-electricity savings.

(6) NEES data is for Massachusetts Electric Company only.

(7) The energy savings filed with the California Public Utilities Commission were reduced by 50%, based on a measurement and evaluation study.

(8) The weighted average is the average of the programs weighted by energy savings.

Table EX-2. Options for Improving the Cost-Effectiveness of Utility Residential New Construction Programs

1. Promote new technologies and advanced building design practices significantly exceeding state and federal standards
2. Reduce program costs and develop more effective marketing strategies
   a. Reduce, modify, or eliminate financial incentives
   b. Market the advantages of energy-efficient homes to builders
   c. Expand the scope of marketing to include home buyers
   d. Use market segmentation techniques for program targeting to production builders and home buyers
   e. Target specific regions
   f. Expand the scope of marketing to include bankers and realtors
   g. Simplify certification process
   h. Reduce mass-media marketing efforts over time
   i. Collaborate with other utilities
3. Recognize improvement in building code compliance
4. Obtain "energy-savings credit" from utility regulators for program spillover

The Evaluation of Residential New Construction Programs

The goal of new construction program evaluation is to measure how much energy would have been consumed by program participants if the program had not encouraged efficient equipment and building shell to be incorporated into building plans. The key issue in the evaluation of residential new construction programs is the determination of the baseline. Without an appropriate baseline, it is impossible to accurately estimate program savings.

Typically, program designers consider the current state building code as the baseline for participating buildings and as the basis for providing incentives to builders ("program baseline"). For those states without a building code, standard building

practices, usually obtained from builder surveys, were used as the program baseline. The problem with the first baseline (state standards) is that builders both exceed and fall below codes. The problem with the second baseline (builder practices) is that the surveys used to characterize building practices may be inaccurate because they are not conducted on a regular basis and rapidly become outdated.

Because actual builder practices may be different from the program baseline, utilities need to determine an "evaluation baseline" prior to calculating the energy savings from these programs (and, where applicable, for receiving incentive payments). Only one study examined in detail the differences between program and evaluation baselines. PG&E found significant differences in building practices between builders that built developments (production builders) and builders who built a few, custom-built homes (custom builders). For example, PG&E found that: 5% of production builders exceeded state building code (Title-24) shell standards by at least 10% and installed the same HVAC appliances as program participants, in contrast to 25% of custom builders. PG&E also found that its program forced builders to comply with the state building standards when they might not have otherwise done so. PG&E found that, on average, non-participating homes in PG&E's service territory were built that were 5-6% below Title-24 standards across all measures and equipment. These data suggest for this program that in this program year the existing state building code was an inappropriate baseline for residential new construction programs.

Transforming Markets

Residential new construction programs represent the kinds of programs that best fit the following features of market transformation: they introduce measures that are relatively new or that have, for one reason or another, failed to establish themselves in the market due to market barriers. Since one effect of residential new construction programs is a transformation of the construction industry, then the energy savings from this transformation should be included in cost-effectiveness calculations under the resource acquisition perspective.

Estimating the savings from program spillover, however, represents a significant challenge. The benefits of market transformation programs are hard to evaluate

(e.g., through simple, pre-post studies) due to the complex, iterative, and potentially slow moving nature of market transformation. Under the market transformation perspective, evaluators will need to collect data on market changes from a variety of sources and assemble this evidence into a "mosaic" to help policy makers interpret the results of market transformation programs.

A wide range of methodological innovations will be needed to adequately document the effects of program spillover effects. If a primary focus of the evaluation of residential new construction programs as market transformation programs is changes in the market as a whole, rather than analyzing changes undertaken solely by participants, then critical data collection and analytical activities will need to be conducted for evaluating residential new construction programs (Table EX-3).

Table EX-3. A Research Agenda for Evaluating Residential New Construction Programs

Data collection activities

1. Measure the market baseline.
2. Track attitudes and values.
3. Track sales.

Data analysis activities

1. Model market processes.
2. Analyze the relationship between attitudes and behavior.
3. Compare pre-program and post-program market survey and billing data.
4. Perform multivariate regression with control groups from outside the service area.
5. Simulate market transformation.
6. Compare multiple methodologies.

Conclusions

The future of residential new construction programs is in dire straits because many of them are not cost-effective when using traditional evaluation methods. Several utilities in our sample have terminated their programs, significantly modified their programs (e.g., by eliminating incentives and focusing on information and design assistance), or reduced their program budgets. In many cases, these programs were not cost-effective and in need of a design overhaul. However, cost-effective DSM opportunities do remain in the residential new construction sector. Utilities should rethink their program designs and improve their evaluations of residential new construction programs to include energy savings from program spillover in program savings. Utilities can also leverage their resources in seizing these opportunities by forming strong and trusting partnerships with the building community and with local and state government.

Introduction

Residential new construction programs have multiple impacts on energy usage because new homes determine the trends of the future housing stock and the penetration of innovative building technologies into the marketplace, thereby affecting both present and future energy use. Also, the cost-effective savings potential is large in new homes because they can be designed comprehensively and systematically to maximize energy savings. While the actual number of homes built per year is small relative to the housing stock (e.g., homes built in 1988 or later represent only 3 percent of the total 1990 U.S. housing stock (EIA 1992)), residential new construction programs do affect the future housing stock both directly (by what is actually built) and indirectly (by creating a demand for materials that may as a result become available locally to others, and by training builders, contractors, architects, and engineers who will use this knowledge in future construction). If cost-effective energy efficiency opportunities are not fully captured by existing codes and standards, or if codes are not enforced, they will likely become "lost opportunities" for society unless they are included in new construction programs: i.e., retrofitting is not a cost-effective way to install the same level of energy efficiency investments that can be installed at the time of construction - and once a home is built, that particular opportunity is lost forever.

Residential new construction also presents an excellent opportunity for utilities to coordinate their efforts (and, in some cases, develop partnerships) with government agencies for: (1) promoting code levels before they become mandatory, (2) promoting efficient technologies and practices to lay a foundation for code updates, (3) sponsoring training and technical assistance programs for code inspectors and building designers on code requirements and ways to meet and exceed those code requirements, and (4) providing financial assistance to state and local governments for energy code enhancement efforts (Nadel 1992).

This study, the second in a series from the Database on Energy Efficiency Programs (DEEP) project, addresses the key policy issues facing regulatory and utility staff in designing, implementing, and evaluating residential new construction programs.[1] The goal of the DEEP project is to compile and analyze the measured results of

[1] The first DEEP report focused on utility commercial lighting program (Eto et al. 1994).

energy efficiency programs in a consistent and comprehensive fashion (Vine et al. 1993). As the DSM industry has matured, we are now able to report on information previously missing from past analyses of utility DSM programs, such as program savings based on post-program evaluations rather than on unverified program estimates.

We present two perspectives in this report: a resource acquisition perspective and a market transformation (program spillover) perspective. The former perspective is the primary goal of most utility energy efficiency programs. We focus on the resource value that residential new construction programs contribute to utilities' DSM portfolios, since from a resource planning perspective, energy efficiency programs are desirable only to the extent that they cost less than the alternatives available for meeting customer energy service needs. However, because these programs may have significant spillover benefits, we also examine residential new construction programs as part of a larger effort to transform markets for energy efficient products and services. Under this concept of market transformation, residential new construction programs influence the attitudes and behavior of key members of the residential construction community (e.g., builders, architects, engineers, retailers, manufacturers, and homebuyers) so that investments in energy efficiency persist even after the program is changed or eliminated ("lasting changes") (Kitchin 1993; Prahl and Schlegel 1993 and 1994).[1] The impact of these programs may not be visible until many years after a program has been implemented. Most current estimates of resource value do not capture spillover benefits and, therefore, understate savings to the program. If these spillover savings were to be included in the evaluation of DSM programs and were to affect the design and implementation of DSM programs, then the resource allocation perspective would be the only viewpoint of importance. However, since these activities have not occurred, we distinguish the two perspectives.

[1]Market transformation is a complex and diverse phenomenon, affecting a wide range of technologies, economic players, and market structures. No clear and universally accepted definition for market transformation has evolved (e.g., see Weisbrod et al. 1994 and Xenergy 1994). In this paper, we use the definition of market transformation as used by Prahl and Schlegel (1994). Examples of utility and government market transformation programs are described in Goldstein (1994), Nadel and Geller (1994), Nilsson (1992), and Xenergy (1994).

This report is organized as follows. In Chapter 2, we describe the data collection process and summarize key features of the residential new construction programs. In Chapter 3, we report our major findings on the total resource cost and measured performance of the programs. After assessing reasons for the poor cost-effectiveness of these programs, we suggest options for improving the cost-effectiveness of these programs, focusing on program design and marketing. In Chapter 4, we review the evaluation methods used to estimate the energy savings for these programs, paying particular attention to the determination of the baseline used for evaluating programs. We also present some conceptual problems in evaluating program spillover and suggest data collection and analysis activities for evaluating these programs from a market transformation perspective. And in the concluding chapter (Chapter 5), we discuss the future of residential new construction programs with regard to the building community and local and state government.

Residential New Construction Programs

In this chapter, we describe the process of collecting data on the 10 residential new construction programs in our sample, summarize some of the foremost difficulties in collecting data on DSM programs, and review important differences and similarities among the programs. In all cases, published utility evaluations and interviews with utility staff members were used to develop a consistent set of cost and savings data for the programs, so that all of our analyses are based on data verified by utility contacts. Additional program-related information was collected from experts in the field and from state government staff. In several cases, utilities provided more recent data than were available in the published sources of information on a DSM program. Individual descriptions of each program are provided in Appendix A.

We begin by establishing the role of each program in each utility's overall DSM portfolio. We then focus on specific features of the program design and implementation, including program objectives, incentives offered, measures promoted, and the type of quality assurance provided by the program.

2.1 Program Selection

Four objectives guided the process of selecting programs to study. First, we focused primarily on utility-sponsored residential new construction programs that promoted the design and construction of energy-efficient buildings, with a particular emphasis on the building shell or envelope. Although lost opportunities occur if energy-efficient appliances are not installed at the time of construction, programs that simply promote the purchase of energy-efficient appliances, without addressing the building envelope, were not included in this study (e.g., rebates for installing efficient lighting equipment, heat pumps, and other space conditioning equipment). However, we did include programs that addressed both shell and equipment efficiencies.

Second, we selected full-scale programs and excluded pilot programs. The latter were excluded because we were interested in the implementation and evaluation experiences of "mature" residential new construction programs.

Third, and most importantly, in order to estimate the total resource cost of energy efficiency, we considered only those residential new construction programs for which we could obtain information on the total costs and performance of the program. For each program, we needed information on: (1) post-program evaluation of direct annual energy savings, (2) total cost of the program to the utility, (3) total cost of the program to participating customers, and (4) economic lifetimes of measures installed through the program. These requirements proved decisive in choosing the final set of programs analyzed in this report (see below).

And fourth, we selected residential new construction programs that offered rebates to builders, homebuyers, or manufacturers.[1] We did not examine other nonmandatory programs, such as technology demonstrations, consumer information and marketing programs, and technical information programs, because, while important (see Vine and Harris 1990), these programs have seldom been evaluated and pose difficult evaluation problems.

We began the data collection process by reviewing five recent surveys of energy efficiency programs:

1. The Electric Power Research Institute's (EPRI) survey of residential and commercial DSM programs implemented by electric utilities in the U.S. (EPRI 1993).

2. The President's Commission on Environmental Quality's energy efficiency resource directory (PCEQ 1992).

3. The North Carolina Alternative Energy Corporation's survey of residential new construction programs implemented by states, utilities, home builders associations, non-profits, and university extension services (Flur and Markle 1992).

4. The Pacific Northwest Laboratory's survey to identify DSM strategies for new construction that utilities had adopted or developed to promote energy-efficient design and construction (Wise et al. 1994).

[1]Central Maine Power was the only utility in our sample that offered cooperative advertising as the only form of financial incentives (see Section 2.3.2).

5. The Association of Energy Services Professional's (AESP) survey of members' DSM programs that had been evaluated, were in the process of being evaluated, or were planned to be evaluated (AESP 1994).[1]

In addition, we examined the evaluation reports kept in the DEEP library maintained at Lawrence Berkeley National Laboratory and reviewed the following proceedings for selecting residential new construction programs: the American Council for an Energy-Efficient Economy Summer Study, the National New Construction Programs for Demand-Side Management Conference, the National Demand-Side Management Conference, and the National Energy Program Evaluation Conference. After reviewing the initial list of identified programs, we consulted with DSM program experts knowledgeable about residential new construction programs and asked for their suggestions.

In their 1992 survey, EPRI reported that 129 utilities were offering residential new construction programs (EPRI 1993). Upon further review, many of these programs were pilot programs, were just being implemented, were promoting a single appliance, or were part of a larger program (e.g., in Bonneville Power Administration's (BPA) Super Good Cents program, 113 utilities in BPA's service territory participated in this program, and many of these were treated separately in the EPRI survey). In summary, we found very few residential new construction programs that had been evaluated, confirming previous findings (e.g., Flur and Markle 1992; RCG/Hagler, Bailly 1991; Vine and Harris 1990; and Wise et al. 1994).

Since we were primarily interested in programs that had been evaluated, we conducted a preliminary screening of candidate programs through a telephone survey (Appendix B). Based on the findings from this survey, we identified a potential list of 15 residential new construction programs. Using information from all published sources available to us, we were able to complete as fully as possible a standardized DEEP data collection form for 10 programs. We were unable to obtain information on 4 programs because impact evaluation studies had not been completed; and in one case, a utility did not want to participate in our study. The DEEP data collection form is reproduced in Appendix C. We then established contact with one or more utility staff members familiar with the program and asked them

[1]Prior to January 1, 1995, AESP was called the Association of Demand-Side Management Professionals.

to verify the information we had collected on their programs and to supply missing information.

While the number of programs examined in this report is small (10), the delivery mechanisms and technologies offered are quite similar and likely reflect the current activity in residential new construction in many parts of the United States. However, because their focus is mainly on reducing heating energy use, these measures may not be representative of measures in programs offered in the South and Southeast where high summer temperatures and humidity may require different types of measures (e.g., cooling alternatives) than those needed, for example, in the Pacific Northwest or in New England.

2.2 Developing Consistent Program Cost and Energy Savings Information

We frequently found that the information in the evaluation reports did not meet our needs for one of the following reasons:

(1) the costs of the program to the utility, as well as to the program participants, were not reported;

(2) program costs, when reported, were not broken into subcategories other than incentives and administrative costs;

(3) participant costs, when reported, did not clearly indicate whether or not installation costs had been accounted for; and

(4) the number of program participants and the size of the eligible population were not reported.

We were also interested in the type of relationships between utilities and government agencies, an issue that was not discussed in the evaluation reports. Thus, because essential data were lacking in evaluation reports, we sought information from other published material (e.g., utility filings with regulatory commissions) and contacted program managers and evaluators by telephone. In all cases, extensive discussions with utility staff members, over a period of weeks and sometimes months, were required to verify our interpretations of the utility-supplied information.

For the purposes of this report, we have treated our utility contacts as final authorities regarding the accuracy of program data. We acknowledge that the program data that we use in this report may change in response to challenges emerging from a regulatory proceeding or though subsequent examination by the utility or others.

As utility companies reorganize in response to future competition and to cost reductions, staff turnover is increasing (e.g., people moving from DSM to telecommunications, measurement and evaluation groups disbanding, and general staff attrition), resulting in the loss of "program memory" within the company. In most cases, we were able to obtain the needed information.

The process of data collection was similar to our experience in preparing the first DEEP report, as described in Eto et al. (1994). Although utility contacts were generally cooperative in providing information on their DSM activities, our work continues to make it very clear that future data collection and analysis would be facilitated by greater industry standardization of the terms and reporting formats for DSM program information, a recommendation first suggested by Hirst and Sabo (1991), and supported by the work of Berry (1994) and Eto et al. (1994).

2.3 Summary of Residential New Construction Programs

The residential new construction programs in our sample represent a small portion of recent utility experience with DSM (Table 2-1). Residential new construction programs accounted for an average of 4.2% of the utilities' budgets for energy efficiency programs, ranging from 0.6% for Central Maine Power Company's Good Cents Home Program to 10.7% for BPA's Manufactured Housing Acquisition Program. While the resource value of these programs may be minor, there are other reasons why utilities promote these programs, as discussed below.

Table 2-1. Fraction of Utility DSM Budgets Represented by Residential New Construction Programs

Utility (1)	Program Name	Year	Total Utility Expenditures on Electric Conservation Programs ($Million) (2)	Cost of Residential New Construction Program to the Utility ($Million) (2)	Residential New Construction Program Costs as a Percent of Total DSM Expenditures (%)
BPA - MAP	Manufactured Housing Acquisition Program	1993	156.6	16.8	10.7
BPA - SGC	Super Good Cents Program	1993	156.6	2.3	1.4
BECO	Energy Crafted Home Program	1992	57.9	0.8	1.5
CMP	Good Cents Home Program	1992	17.7	0.1	0.6
NEES	Energy Crafted Home Program	1993	56.3	0.6	1.1
NYSEG	NYSE-Star Program	1992	39.4	0.5	1.6
O&R	Good Cents Home Program	1992	11.9	0.3	2.5
PG&E	Comfort Home Program	1992	127.3	9.0	7.1
PECO	Excellence in Energy Efficiency Program	1992	11.0	1.1	10.0
SCE	Welcome Home Program	1992	68.1	3.7	5.4

Notes:

(1) BPA = Bonneville Power Administration (MAP = Manufactured Housing Acquisition Program; SGC = Super Good Cents Program); BECO = Boston Edison Company; CMP = Central Maine Power Company; NEES = New England Electric System; NYSEG = New York State Electric and Gas Company; O&R = Orange and Rockland Company; PG&E = Pacific Gas and Electric Company; PECO = PECO Energy Company; SCE = Southern California Edison Company.

(2) These figures are taken from evaluation reports, annual DSM summaries, and other utility literature; all utility-related literature is cited in Appendix A. In some cases, the figure may include elements of a DSM budget that are not related to energy efficiency - such as load retention. All costs are indexed to 1994 using a time series of GNP implicit price deflators from the *Consumer Price Index.*

2.3.1 Program Objectives

All of the programs in our sample were implemented for increasing the overall level of energy efficiency in residential new construction (Table 2-2). However, the utilities promoted these programs for other reasons as well, such as avoiding lost opportunities and reducing demand coincident with system peak. For example, Pacific Gas and Electric's (PG&E) Comfort Home Program was considered a long-term resource for PG&E, having the complementary goals of energy savings and peak load reduction.

In addition to improving the energy efficiency of participating homes, improving the energy efficiency of the local housing industry (market transformation) was an important goal for three programs. PG&E's Comfort Home Program intended to influence the building practices employed by California builders, for example, by encouraging manufacturers and vendors to develop and more aggressively market energy-efficient equipment, and by increasing the viability and desirability of energy efficiency as an attribute desired by home builders. In addition, PG&E's High Performance Windows (HPW) Program (connected to PG&E's Comfort Home Program) was designed to stimulate market demand and builder acceptance of new high performance windows by offsetting some or all of the higher costs of purchasing these improved windows. The Bonneville Power Administration's (BPA) Manufactured Housing Acquisition Program was aimed at changing the way manufacturers build manufactured homes (i.e., making them more efficient than national codes), while BPA's Super Good Cents Program was implemented for transforming the market to a higher level of efficiency by facilitating the path towards more energy-efficient building codes at the state level.

Improving the comfort level of homeowners was a primary goal of the PECO Energy's (PECO) Excellence in Energy Efficiency (EEE) Program (as well as a secondary goal for many of the other programs). PECO realized that homebuyers and builders were very interested in improving the comfort of their home, and energy-efficient construction was seen as one way of providing this service.

Table 2-2. Overview of Residential New Construction Programs

Utility (1)	Program Lifetime	Program Goals (2)	Average Incentive Levels (3)	Basis for Incentives (4)
BPA - MAP	1992-ongoing	EE, MT	1992-94: $2,500/home 1994-95: $1,500/home	H
BPA - SGC	1984-ongoing	B, EE, LO, MT, PL	$1,000/home, CA	H, CA
BECO	1991-1993	EE, LO	$500 plus $150-$2,800/home	H, P
CMP	1986-ongoing	EE	$500 /1,500 ft^2	CA
NEES	1991-ongoing	EE, LO	$500 plus $150-$2,800/home	H, P
NYSEG (5)	1991-ongoing	EE, PL	$125 plus $2150/home	H, M, P
O&R	1986-1993	EE, LO, PL	SF: $1/$ft^2$ up to 2,000 ft^2 ; MF: $0.50/$ft^2$ up to 2,000 ft^2	E, M
PG&E	1990-ongoing	EE, LO, MT, PL	$500-$1,200/home(6)	E, M
PECO	1985-1994	C, EE	CA: $100/house for first 10 houses and $50/house for additional houses; and $400/house for air-source heat pump	H, M, CA
SCE	1990-1994	EE	$4,000/house (1990); $1,500 (1993); $1,200 (1993); $500 (1994)	H

Notes:

(1) See Table 2-1 for identification of utilities and programs.

(2) Program goals: B = Building code support; C = Comfort; EE = Energy efficiency; LO = Lost opportunities; MT = Market transformation; PL = Peak load reduction.

(3) Average incentive levels (excluding equipment rebates): CA = Cooperative advertising; MF = Multi-family housing; SF = Single-family housing.

(4) Basis for incentives: CA = Cooperative advertising; E = Estimated savings; H = Home built, M = Measure installed, P = Particpating in program.

(5) Since January 1, 1995, incentives have been only offered for ground source heat pumps and water heaters connected to these heat pumps.

(6) If participating in High Performance Window Program: an additional $400-$1,000, depending on which measures were installed.

2.3.2 Incentives Offered

A distinguishing feature of the residential new construction programs in our sample is that all utilities provided explicit incentives for program participation. The incentives distinguish these programs from information-only or design assistance-only programs, although providing information and design assistance were also included as important elements of most programs.

Five types of incentives were offered (Table 2-2):

1. incentives to builders for participating in program (P),
2. incentives for building more than one home (H),
3. incentives for the installation of specific measures (M),
4. incentives for achieving a certain level of energy savings beyond the state building code (E), and
5. cooperative advertising (CA).

As an example of the first incentive mechanism, the Energy Crafted Home (ECH) Program varied participation incentives by type of heating fuel (electric or fossil) and by building type (single-family or multi-family).[1] These incentives were designed to help offset the additional administrative cost for builders to participate in the program. Within a category (e.g., single-family electric heat), the incentive was fixed; a larger home did not receive a larger incentive (as in Orange and Rockland's Good Cents Home Program). The incentives were set to cover the average incremental cost the builder would experience in going from a code-built home to an electrically heated ECH home. Incentives were paid for fossil-fuel homes based on the electrical savings for lighting, hot water heating, and cooling.

As an example of the second incentive mechanism, the New York State Electric and Gas's NYSE-Star Program paid builders $125 to participate in the program and $2,150 per home for each home built in the program.

As an example of the third incentive mechanism, PG&E's Comfot Home Program in 1990-92 offered incentives for high-efficiency cooling equipment, with SEER

[1]In this report, the ECH Program refers to programs promoted both by the Boston Edison Company and the New England Electric System. When appropriate, we distinguish the two programs in the report.

values a minimum of two points above what was used for the state building code (Title 24) compliance: $45 per ton, per SEER point (this incentive was available only to participants using the point or prescriptive method of compliance). In 1993, the incentive was increased to $75 per ton with a minimum SEER value of 1.5 points above what was used for Title-24 compliance. PG&E's HPW Program paid incentives to builders for the installation of windows with characteristics that exceeded minimum Title-24 standards (in order to qualify for the HPW Program, units must first have qualified for the Comfort Home Program using standard windows). In most of the programs in this sample, the measure rebates were designed to cover the incremental measure costs of the higher efficiency measures.[1] PG&E's programs were designed for 75% cost coverage, however, when incentives were actually paid, the incremental measure cost declined to the point that, in some cases, PG&E was paying more than 75%.

As an example of the fourth incentive mechanism, PG&E's Comfort Home Program paid incentives to builders for cooling energy savings, using both envelope and cooling equipment measures: incentives were paid on a sliding scale, based on the number of BTU's of savings over Title-24 compliance minimums, with a minimum base savings of 10%. Incentives for the base savings ranged from $0.03 to $0.15 per thousand BTU annual savings.

Finally, as an example of the fifth incentive mechanism, Central Maine Power would give $500 worth of advertising credits for each 1,500 square feet of housing certified under the Good Cents Home Program, and the builder could use the program's logo and publicity information to help market the builder's homes.

2.3.3 Measures Promoted

All of the programs promoted measures that exceeded state building codes in one or more of the following areas: wall and ceiling insulation, windows, lighting, air infiltration reduction, and ventilation equipment (Table 2-3).[2]

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[1]These are equipment (measure) costs. In most cases, incremental installation costs were assumed to be zero.

[2]The connection between state building codes and utility DSM programs is discussed in more detail in Chapters 3 and 4.

Table 2-3. Residential New Construction Technologies (1)

Utility (2)	Wall Insulation	Ceiling Insulation	Floor Insulation	Space Conditioning Equipment	Windows	Ventilation Equipment
BPA - MAP	R-19 to R-21	R-38 to R-49	R-33	No requirements	Double pane, vinyl frame, low-e glazing, or argon-filled glazing	Controlled mechanical ventilation
BPA - SGC	R-19 to R-26	R-38 to R-49	R-19 to R-30	No requirements	Thermally improved, low-air leakage, double or tiple pane	Air-to-air heat exchangers were required, but are no longer mandatory
BECO (3)	R-20 to R-28	R-30 to R-38	R-30	12.0 SEER for Heat Pump and efficient equipment	Thermally improved, low-e glazing, or argon-filled glazing	Heat recovery ventilators and exhaust-only ventilation
CMP	R-19	R-49	R-19	No requirements	Triple-glazed windows with a thermal break, double-glazed windows with a storm sash or thermal break, or low-e double-pane windows	Exhaust-only ventilation
NEES (3)	R-20 to R-28	R-30 to R-48	R-30	No requirements	Thermally improved, low-e glazing, or argon-filled glazing	Heat recovery ventilators and exhaust-only ventilation
NYSEG (4)	R-24	R-44	R-28	11 SEER for Heat Pump	R-3.12	No requirements
O&R	R-19	R-30 to R-38	R-19	10.6 SEER for Heat Pump in 1986; SEER 12.0 in 1994	Double pane, low-e, wood frame	No requirements

Table 2-3 Continued. Residential New Construction Technologies (1)

Utility	Wall Insulation	Ceiling Insulation	Floor Insulation	Space Conditioning Equipment	Windows	Ventilation Equipment
PG&E (4)	R-21	R-42	Not available	At least 2 SEER points above Title-24 minimums for Central Air Conditioners (e.g., 11.7 SEER for packaged units & 12.0 SEER for split systems)	Low-e coating or suspended films, gap widths of 3/8 of an inch or greater, inert gas fills betwen panes, and with non-metal or thermally-broken aluminum frames	Meet state building code requirements
PECO	R-16	R-30	R-11	Heat Pump	No requirements	No requirements
SCE (5)	R-11 to R-21	R-19 to R-49	Not available	Average: 12.0 SEER for Central Air Conditioner	Many options available	Meet state building code requirements

Notes:

(1) Unless otherwise noted, the measure descriptions are program minimums.

(2) See Table 2-1 for identification of utilities and programs.

(3) The Energy Crafted Home Program is performance-based, giving builders a great deal of flexibility. The features listed for this program are for typical installations under this program.

(4) This is a performance-based program. The features listed are for average installations under this program.

(5) This is a performance-based program. Average installation data not available. Participants must go beyond Title-24 building standards, but ranges are shown on how homes can meet the program requirements.

Similarly, heating and cooling appliances met or exceeded federal appliance energy standards: e.g., the National Appliance Energy Conservation Act (NAECA) required that after January 1992, air-conditioning manufacturers could produce no central cooling systems with a SEER lower than 10.0. In general, the measures in our sample were aimed at reducing space heating energy use, reflecting the geographic bias of this sample of DSM programs (i.e., northern climates).

A few programs encouraged innovative energy efficiency technologies and practices that exceeded state building codes and could form the basis for future residential new construction programs: e.g., improved duct material and installation, down-sizing of Heating, Ventilation, and Air Conditioning (HVAC) equipment, infiltration reduction, efficient lighting, non-mechanical cooling, tree planting, and very efficient windows, as discussed below.

In recent years, improving the efficiency of **ducts** has become an important HVAC measure receiving more attention (Penn 1993a; Stum 1993). From 1993-1995, PG&E's Comfort Home Program provided cash incentives (e.g., $350 per home in 1994) to Comfort Home builders who opted to install ducts according to PG&E standards that specified both improved materials and installation of duct systems. Installation procedures included specifications for ductwork joints and connections, distribution boxes, and plenums. Builders were also provided with basic training free-of-charge and were required to test all of their systems after the HVAC system was installed through use of a duct blaster ("building commissioning"). By participating in this program, the builder's Title-24 cooling budget savings were expected to increase by 10%. The more efficient duct system also led to **down-sizing**: the size of the air conditioner was reduced to below what standard practice system sizing allows; in its 1993 program, a bonus incentive was provided for down-sizing. By reducing the unit's demand, significant on-peak kW savings would be achieved.[1]

Infiltration reduction was an important measure for programs reducing peak cooling and heating demand. For example, PECO's EEE Program provided funds for air infiltration treatment of sample homes in EEE developments in order to educate builders and subcontractors on appropriate air infiltration reduction techniques.

[1]Bonus incentives were available for a capacity down-sizing of the AC unit by 1/2 ton ($200 per unit) to 1 ton or more ($400 per unit).

Subcontractors were paid to reduce air infiltration in one demonstration for each home type, with a maximum of two demonstrations for every 30 homes in a subdivision. Blower door test results on the sample were used as the benchmark by which all other homes in the development were measured. Blower door tests on subsequent EEE homes in the same development had to come within 10% of the benchmark sample results.

Except for compact fluorescent lighting, most residential new construction programs did not promote energy-efficient lighting equipment.[1] However, PG&E introduced a **lighting** component in its 1993 Comfort Home program which promoted three categories of fluorescent lighting improvements.[2] The categories were based on the efficiency of the light source substituted for standard incandescent lighting in various fixture types and locations.

Alternatives to compressor cooling was one of the more innovative measures introduced in PG&E's 1993 Comfort Home Program. Compressor cooling has been one of the key driving factors for the addition of new electric generation, transmission, and distribution capacity and has increased the use of chlorofluorocarbons (CFCs) (Feustel et al. 1992.) High-performance fenestration products (featuring low shading coefficient, low-e, high visible light transmittance glazing), ceiling fans, evaporative coolers, and/or whole house fans were encouraged to eliminate the need for compressor-driven cooling by decreasing cooling loads. The reduced loads were expected to save 75% of cooling energy use due to the elimination of a central air conditioner.

Tree planting has been demonstrated to be a very effective measure for reducing cooling loads (Huang et al. 1987; Meier 1990). In PG&E's Comfort Home Program, builders were required to plant a deciduous tree at each home (to be planted within 20 feet to the South or West of each dwelling). They were also provided a coupon for a second tree to be planted to further reduce the cooling load. And in Southern

[1]The ECH Program encouraged hard-wired fluorescent fixtures (for each one installed, the builder received an additional incentive) and required compact fluorescent bulbs to be used in all bare bulb, non-decorative sockets inside an ECH home.

[2]The lighting program was available for less than 6 months and was discontinued in June 1993 due to the lack of fixture availability covered under the program and a program design loophole that allowed an unlimited number of fixtures per application. A new lighting program was introduced in 1994 that was designed to eliminate the problems that were found in the 1993 version.

California Edison's Welcome Home Program, over 2,400 trees were planted in 1993, representing nine percent of the program's estimated savings.[1]

Windows were a significant measure in at least two programs. In PG&E's HPW Program, high performance windows (at a minimum, they must have at least a half-inch of air space) exceeded the state standard. And in BPA's Manufactured Housing Acquisition Program, the baseline window went beyond the state and federal standards for manufactured housing. Due to the program, the new baseline window is now a vinyl-frame, dual-pane window which has become the manufactured housing industry standard in the Pacific Northwest. Incorporating these windows, as well as those with the addition of argon gas and low-emissivity coatings, was a major technological innovation resulting from this program.

2.3.4 Quality Assurance

Quality assurance is a critical and necessary component of residential new construction programs in order to:

1. measure compliance with program specifications,
2. motivate builders to comply with the program,
3. protect the integrity of the program trademark,
4. identify opportunities to expand market penetration, and
5. identify areas where training or technical assistance is needed.

The lack of a good quality assurance program may make energy-efficient homes less efficient and affect a program's energy savings and cost-effectiveness. Quality assurance is often achieved through three mechanisms: measure documentation, site visits, and builder training. All residential new construction home programs have a quality control process for approving an application. The builder is often required to submit certain **documentation** in order to receive a rebate and get his application approved. For example, in PG&E's Comfort Home Program, the builder

[1]The savings from SCE's program have not been measured over time; assuming the shade trees are young (as well as properly located and maintained), then most of the savings will occur only after the trees have reached maturity.

had to submit the following material: e.g., a certificate of insulation (which certifies the level of insulation installed in the home), proof of purchase for qualifying windows, and documentation of the air-conditioner SEER.

All of the utilities in our sample conducted **site visits**, ranging from 1-3 per home, and ranging from a certain percentage of homes to all homes inspected (Table 2-4).[1]

Table 2-4. Quality Assurance Features

Utility (1)	# of Site Visits Per Home	Percent of Homes Inspected (%)	Builder Training Required?
BPA - MAP	2	20	Yes
BPA - SGC	3	3	No
BECO	3	100	Yes
CMP	3	100	No
NEES	3	100	Yes
NYSEG	2	100	Yes
O&R	2-3	100	No
PG&E	1-2	25(2)	Yes
PECO	2	100	No
SCE	1	100	No

Notes:

(1) See Table 2-1 for identification of utilities and programs.

(2) For custom builders: 100% inspection; for production home builders (95% of program participants): 20% inspection.

For example, at least three on-site inspections were conducted in the Energy Crafted Home Program: once, after the insulation was installed (for inspecting insulation, vapor barrier, and ventilation duct work); second, after the drywall was up (for inspecting ventilation system and conducting a blower door test for air leakage); and third, a final walk-through (for verifying and recording model numbers for

[1]For example, of 10,117 single and multi-family units certified in BPA's SGC Program in 1990, 3% were inspected in the monitoring effort. In contrast, all 28 homes built in NEES's ECH Program in 1992 were inspected.

heating/cooling, water heating, and other equipment). Each individual home was certified. The mandatory blower door testing was needed to ensure a maximum air infiltration rate (not to exceed an equivalent leakage area of one square inch per 100 square feet of building shell), since many of the program's savings were expected to come from infiltration reduction.

Builder training is a necessary component of residential new construction programs, and in some regions, like the Pacific Northwest, builder training was the focus of utility and government staff for transforming the market and for facilitating the passage of residential building standards in the states of Washington and Oregon (Table 2-4). In the ECH Program, training for builders and mechanical ventilation installers (there were minimum requirements for continuous mechanical ventilation in the bathrooms and kitchen) was mandatory. However, where training is not mandatory, the results are much different: less than half of the builders who actually built a SGC home attend SGC training, raising the possibility of improper installation and potential failure to meet BPA's program specifications. However, because of BPA's close monitoring of builders and quality control checks throughout the entire building process (e.g., on-site training and blower door testing), BPA felt that the completed homes met program criteria.

2.4 Summary

While the sample of programs examined in this report is small, it is homogeneous (e.g., the delivery mechanisms and technologies offered are quite similar) and likely reflects the current activity in residential new construction in most parts of the United States. However, the program descriptions and results that we provide in the report should be considered "snapshots" in time. Many of these utilities are re-evaluating the role of residential new construction, and program design and performance (and even their survival) may change quite dramatically in the future.

Similar to our experience in preparing the DEEP report on commercial lighting programs, our experience in attempting to develop a consistent data set for this report demonstrated that the absence of standard terms to define DSM activity and the lack of reporting formats are substantial, yet avoidable, liabilities for future DSM programs. Without standardized, consistent information, one cannot accurately

compare DSM program experiences. Our work reduces considerably, but does not eliminate, the uncertainties for the 10 residential new construction programs in our sample. Industry adoption of a standard DSM terminology and a consistent format for reporting the results of DSM programs is important because accurate comparison of program experience is the most reliable basis for improving future programs.

The Cost and Performance of Residential New Construction Programs

This chapter uses the information developed for the 10 residential new construction programs described in Chapter 2 to determine the total resource cost of the energy saved by the programs. Our findings directly address shortcomings that have been identified for previous estimates of total resource costs by (1) relying on post-program evaluations of energy savings rather than unverified pre-program estimates, and (2) accounting for the direct costs borne by both the utility and the participating customer rather than only those costs borne by the utility.

We calculate the total resource costs for the 10 residential new construction programs by levelizing the total cost of the energy savings over lifetime energy savings. After assessing reasons for the poor cost-effectiveness of these programs, we suggest options for improving the cost-effectiveness of these programs, including viewing residential new construction programs as market transformation programs.

3.1 Estimating the Total Resource Cost of Residential New Construction Programs

The total resource cost of energy efficiency acquired through a utility-sponsored residential new construction program is a function of: (1) the annual energy savings of program participants; (2) the total cost of the energy efficiency program, including incentives paid by the utility to participating customers, administrative costs to the utility, and the cost of the program to participating customers; (3) the economic lifetimes of installed measures; and (4) a discount rate that specifies the time value of money. This section describes the development of this information for the 10 utility programs considered in this report.

3.1.1 Annual Energy Savings

The energy saved by a residential new construction program cannot be observed directly because it is the difference between (a) an estimate of the energy use that would have occurred in the absence of participation in the utility's program and (b) the actual energy use as a result of participation. In the absence of program

participation, most programs rely on a "reference point" or "baseline" that most builders would build homes to - either a state building code or a survey of current building practices. The determination of an appropriate baseline is a vexing problem and a challenge to program evaluators; this issue is discussed in more detail in Chapter 4.

All energy-savings estimates presented in this chapter are based on post-program evaluations, either taken from an evaluation report and then verified by the utility or received directly from a utility contact. Relying on post-program evaluation information greatly increases our confidence in several aspects of the energy savings calculation. As discussed in Chapter 4 (see Table 4-1), all of the programs either rely on computer building simulation models that have been calibrated with billing or end-use metered data, or on billing analysis. In this study, we report savings as presented by the utility without passing judgment on the accuracy of the savings estimation.[1] All of the savings reported in this chapter are gross electricity savings.[2] Except for one program (PG&E), all programs assumed zero free ridership, zero free drivership, and zero takeback (as well as no studies on persistence), so that gross energy savings equal net energy savings.[3] Although BPA did not conduct a study of free riders, they did track the construction of homes not participating in their program over time and felt that the likelihood of builders building to Super Good Cents standards was very low.

3.1.2 Costs

The total resource cost of energy efficiency acquired through utility-sponsored residential new construction programs can be split into measure costs and program

[1]We are aware that the savings provided to us by several of the utilities are currently being reviewed in regulatory proceedings.

[2]As noted in Table 3-1, a few programs resulted in both electricity and gas savings. Where possible, we only include program costs that are associated with energy efficiency measures affecting electricity use.

[3]Free riders are customers who participate in a utility's program but who would have installed measures that are the same as, or similar to, those offered by the utility without the program. Free drivers are customers who install energy-saving measures offered by the utility but who do not participate in the utility's program. Unlike free riders, who primarily represent transfers of dollars between ratepayers and participants, free drivers represent net gains to society as a result of a utility's program. We discuss PG&E's measurement of free riders in Chapter 4; the energy savings reported in this report are gross energy savings.

administrative costs.[1] For new home construction programs, measure costs are the costs of acquiring, installing, and operating energy efficiency measures. These are the costs that a builder adopting the measures could expect to bear in the absence of a utility program. In a utility program, the utility may bear some or all of these costs. In most of the programs in our sample, the rebate given by the utility to a builder (or homeowner) was expected to cover the full incremental costs of measure(s) installed in the more efficient home.

Administrative costs are the non-measure costs borne by the utility in implementing programs that lead to installation of efficiency measures. These costs represent the cost to ratepayers and society of utility intervention in demand-side markets. The measure and administrative costs incurred by the utilities were generally well-documented. We did not include information on the cost to the utility of measurement and evaluation (M&E) of program savings, since M&E expenditures in the current year were most likely used to evaluate the savings from previous program years. Furthermore, in order to calculate M&E costs accurately, some portion of the ongoing costs of program tracking and accounting would also need to be included. We chose instead to develop a set of costs that correspond to the energy savings achieved in the current year of program operation.[2]

Customer cost contributions are the critical difference between a utility and total resource cost perspective on the costs of DSM (Krause and Eto 1988). For utility programs that do not pay the full incremental cost of a DSM measure, omission of the customer cost contribution will understate the total resource costs of DSM. Comparisons of DSM programs that rely only on utility costs will be misleading because of differences in program rebate levels. As shown in Table 3-1, for 5 programs, the utility estimated the cost of the program to participating customers in excess of the incentives provided by the utility. For the other 5 programs, there was no incremental cost (including measure and installation costs) to the participant (see Section 3.1.5 for a brief discussion of the uncertainty surrounding this assumption).

[1]In the context of this report, "measure" costs refer to all measures that are promoted in the construction of an energy-efficient home. We do not break out (disaggregate) costs by measure.

[2]In our review of M&E costs incurred in commercial lighting programs, we found that the effect of including M&E costs would increase the utility component of the total resource cost of programs by about 3% (Eto et al 1994).

In some new construction programs, natural gas/fuel oil savings occurred in addition to electricity savings. Because program costs cover all savigns, the levelized total resource cost and utility costs are actually lower than shown. At this time, we are unable to separate out the costs for the non-electricity savings.

Throughout this report, all costs are indexed to 1994 using a time series of GNP implicit price deflators from the *Consumer Price Index* (U.S. Department of Labor 1994).

3.1.3 The Economic Lifetimes of Installed Measures

The economic lifetimes of the measures installed in residential new construction programs are currently the most uncertain inputs to the calculation of the cost-effectiveness of these programs because the expected life of most measures installed in these programs exceeds the time period over which post-program evaluations have been conducted. As a result, we rely on estimated measure lives, ranging from 20 to 70 years (Table 3-1). In general, the longer lifetimes are associated with the life of the structure while the shorter lifetimes are associated with the life of appliances.

3.1.4 The Time Value of Savings

Each utility must specify a discount rate when justifying the value of its programs relative to some other activity the utility might have engaged in. To enhance comparability, we have chosen to use a single real discount rate of 5% for this purpose. This choice is consistent in real terms (i.e., net of inflation) with the range of nominal discount rates encountered in the utility information that we have reviewed.

We calculate the total resource cost for each program by using the discount rate to levelize total costs over the average economic lifetime of installed measures for each program. The levelized costs are then divided by annual energy savings. The total resource cost, also known as the cost of conserved energy (Meier 1982), provides a basis for comparing demand-side energy savings with supply-side resource options.

3.1.5 Measurement Uncertainty

Approximately half of the utilities assumed that the financial incentives provided to builders were adequate for covering their incremental costs in participating in the program. However, only one organization (BPA) actually conducted a study to confirm this assumption. Where builders are known to have exceeded program requirements, their incremental costs (after netting out the rebate) are most likely non-zero. Utilities that currently do not track participant costs will need to conduct studies similar to BPA's study, in order to see if builders' incremental costs are covered by rebates. This will be particularly relevant as utilities reduce or eliminate financial incentives.

3.2 The Total Resource Cost of Residential New Construction Programs

When weighted by energy savings, we find the average total resource cost of the 10 residential new construction programs (for the most current year) to be 5.7 ¢/kWh; the median was 20.8 ¢/kWh, and the total resource cost ranged from a low of 3.4 ¢/kWh to a high of 725.1 ¢/kWh (Table 3-1). All costs are expressed in 1994 dollars. The descriptive statistics are sensitive to two programs in particular: (1) if we exclude BECO's program (which attracted few participants, targeted multi-family units, and achieved few electricity savings), the average total resource cost dropped 80%, from 88.6 ¢/kWh to 17.8 ¢/kWh, and the standard deviation fell 95%, from 224.0 ¢/kWh to 12.1 ¢/kWh -- the weighted average total resource cost (5.6 ¢/kWh) and the median (16.9 ¢/kWh) were not significantly affected; and (2) if we exclude both BECO's program and BPA's Manufactured Housing Acquisition Program (which was the largest program in incentives, total expenditures, and energy savings and was targeted to manufactured homes), the weighted average total resource cost increased to 20.1 ¢/kWh, while the average (20.0 ¢/kWh), standard deviation (11.5 ¢/kWh), and median (20.8 ¢/kWh) were similar to the results in the first case.

Table 3-1 reports the total resource costs for the sample of 10 residential new construction programs as well as the elements used to calculate them. We also provide the levelized utility resource costs for those interested in a utility perspective rather than a societal perspective.

Table 3-1. Cost-Effectiveness of Residential New Construction Programs

Utility (1)	Year	Gross Annual Electricity Savings (MWh)	Economic Lifetime of Measures (Years)	Admin. Costs of Utility ($1,000) (2)	Incentives Paid by Utility ($1,000) (2)	Annual Participant Costs ($1,000) (2)	Levelized Total Resource Costs (¢/kWh) (3)	Levelized Utility Costs (¢/kWh) (3)
BPA - MAP	1994	84,551	45	2,324	45,753	2,434	3.36	3.20
BPA - SGC (4)	1985	208	70	55	83	0	3.42	3.42
BPA - SGC (4)	1986	591	70	339	509	0	7.42	7.42
BPA - SGC (4)	1987	2,452	70	1,926	2,889	0	10.15	10.15
BPA - SGC (4)	1988	3,584	70	2,906	4,358	0	10.48	10.48
BPA - SGC (4)	1989	7,212	70	5,988	8,983	0	10.73	10.73
BPA - SGC (4)	1990	9,065	70	7,047	10,571	0	10.05	10.05
BPA - SGC (4)	1991	10,091	70	5,556	8,333	0	7.12	7.12
BPA - SGC (4)	1992	5,808	70	4,325	6,488	0	9.62	9.62
BPA - SGC (4)	1993	2,348	70	936	1,404	0	5.15	5.15
BECO	1992	8	20	611	73	39	725.12	686.16
CMP (5)	1992	88	20	79	0	193	24.79	7.18
NEES (6)	1992	82	35	496	134	0	46.93	46.93
NEES (6)	1993	123	35	524	164	0	34.14	34.14
NYSEG	1992	230	20	478	180	0	24.77	24.77
O&R	1992	804	30	309	310	0	5.00	5.00
PG&E (5)	1991	3,308	20	1,514	3,221	3,980	26.76	14.54
PG&E (5)	1992	5,425	20	2,885	6,140	8,815	33.40	16.90
PG&E (5)	1993	5,872	20	6,589	9,565	3,395	33.39	27.59
PECO (5)	1992	465	20	324	825	0.54	13.09	13.08
SCE (7)	1991	1,689	20	5,344	1,278	4,333	26.02	15.73
SCE (7)	1992	1,089	20	2,152	1,540	3,932	28.09	13.60
SCE (7)	1993	2,074	20	919	2,282	5,549	16.93	6.19
For Most Recent Programs:								
Weighted Average (8)							5.67	4.78
Average							88.57	81.25
Standard Deviation							223.95	212.83
Median							20.85	10.13

Notes:

(1) See Table 2-1 for identification of utilities and programs.

(2) All costs are indexed to 1994 using a time series of GNP implicit price deflators from the *Consumer Price Index*.

(3) For calculating the levelized total resource cost, we calculate the total resource cost for each program (utility and participant costs) by using the discount rate (5% real) to levelize total costs over the average economic lifetime of installed measures for each program. The levelized costs are then divided by annual energy savings. The levelized utility resource cost was calculated in the same manner, except participant costs were excluded from the calculation.

(4) BPA's figures include BPA and utility costs. Incentive costs were estimated to be approximately 60% of the program costs, based on an outside review of the program (The Results Center 1992).

(5) The new construction programs of these utilities also resulted in gas and/or fuel oil savings that are not reported in the table. Since program costs cover all savings, the levelized total resource cost and utility costs are actually lower than shown. At this time, we are unable to separate out the costs for the non-electricity savings.

(6) NEES data is for Massachusetts Electric Company only.

(7) The energy savings filed with the California Public Utilities Commission were reduced by 50%, based on a measurement and evaluation study.

(8) The weighted average is the average of the programs weighted by energy savings.

As shown in Table 3-1, the performance of residential new construction programs is generally poor from a total resource cost perspective. Only two programs were below 5 ¢/kWh (one of these focusing on manufactured housing and contributing a large percentage of the sample's total electricity savings), and 70% of the programs were above 15 ¢/kWh. No single feature stood out that differentiated programs with low total resource costs from programs with high total resource costs, such as total administrative costs, total incentive costs, total participant costs, savings per home, or utility costs per home (Tables 3-1 and 3-2). Due to the small sample size, we could not conduct a statistical analysis of this sample to determine the key determinants of performance. A larger data set would enable us to learn more about the differences in results.

3.3 Assessing the Cost-Effectiveness of Residential New Construction Programs

Based on our interviews with program managers and evaluators and analysis of the data, we conclude that the poor cost-effectiveness of residential new construction programs stem from the following: (1) increased tightening of state building standards and national appliance standards which have improved the baseline; (2) inadequate (incomplete or misdirected) marketing strategies; and (3) savings calculations limited to only those savings achieved by program participants for measures covered under the program, excluding savings by nonparticipants and savings from non-program measures by participants as a result of the program (the "market transformation" perspective). Each of these shortcomings is discussed below; the section that follows this discussion presents some recommendations for improving the cost-effectiveness of these programs, some of which have already been undertaken by the utilities covered in this study.

Table 3-2. Participation in Residential New Construction Programs

Utility (1)	Year	Number of homes built	Market Penetration (%)	Savings/ Home (kWh)	Average Square Footage Per Home ($Ft.^2$) (2)	Savings/$Ft.^2$/ Home ($kWh/Ft.^2$)	Utility Costs/ Home ($) (3)	Total Resource Costs/ Home (¢/kWh)
BPA - MAP	1994	18,301	100	4,623	1,454	3.18	$2,627	0.0002
BPA - SGC (4)	1985	44	Don't Know	4,727	2,383	1.98	$3,132	0.120
BPA - SGC (4)	1986	275	7	2,149	2,383	0.90	$3,084	0.042
BPA - SGC (4)	1987	1,607	19	1,526	2,383	0.64	$2,996	0.010
BPA - SGC (4)	1988	2,512	6	1,427	2,383	0.60	$2,892	0.006
BPA - SGC (4)	1989	5,415	21	1,332	2,383	0.56	$2,765	0.003
BPA - SGC (4)	1990	6,736	26	1,346	2,383	0.56	$2,615	0.002
BPA - SGC (4)	1991	7,210	Don't Know	1,400	2,383	0.59	$1,926	0.002
BPA - SGC (4)	1992	4,023	Don't Know	1,444	2,383	0.61	$2,688	0.004
BPA - SGC (4)	1993	2,042	Don't Know	1,150	2,383	0.48	$1,146	0.004
BECO	1992	27 (5)	<1	296	1,800	0.16	$25,337	26.456
CMP	1992	81	Don't Know	1,086	1,972 (7)	0.56	$972	0.306
NEES (6)	1992	20	<1	4,100	2,100	1.95	$31,507	2.347
NEES (6)	1993	63	<1	1,952	2,100	0.93	$10,913	0.542
NYSEG	1992	95	6	2,421	1,512	1.60	$7,473	0.261
O&R	1992	252	21	3,190	2,000	1.60	$2,453	0.020
PG&E	1991	3,611	Don't Know	724	1,857	0.39	$1,311	0.007
PG&E	1992	6,084	31	704	1,857	0.38	$1,483	0.005
PG&E	1993	6,000	Don't Know	783	1,857	0.42	$2,692	0.006
PECO	1992	1,595	21	442	2,500	0.18	$720	0.008
SCE	1991	7,778	27	434	1,800	0.24	$851	0.003
SCE	1992	6,355	22	343	1,800	0.19	$581	0.004
SCE	1993	8,829	30	470	1,800	0.26	$363	0.002

Notes:

(1) See Table 2-1 for identification of utilities and programs.
(2) Because most utilities did not keep track of average building size each year, the same average square footage is used for multiple years, even though the size of participating homes may change from year to year.
(3) All costs are indexed to 1994 using a time series of GNP implicit price deflators from the *Consumer Price Index.*
(4) BPA figurees include BPA and utility data.
(5) Most (24 out of 27) of the participants in this program were from the multi-family sector.
(6) NEES data is for Massachusetts Electric Company only.
(7) Estimated by LBL.

3.3.1 Building and Appliance Standards

All of these programs were initially designed to exceed existing state building standards and federal appliance standards. However, the tightening of state building codes and the increasing efficiency of federal appliance standards in recent years has lowered the "baseline" of energy use, resulting in reduced gross energy savings due to the program. In our sample, the tightening of building standards occurred in the Pacific Northwest, California, Maine, New York, and Pennsylvania. As states review and revise their state building codes in the coming years, these revisions will continue to affect the cost-effectiveness of these programs (Prindle and Slaughter 1993).[1]

3.3.2 Program Marketing

The marketing strategies of some programs were inadequate (incomplete or misdirected) in promoting the program, as shown in the following examples.[2] First, all of the programs used financial incentives for attracting builders, ranging from $2,500/home (BPA's Manufactured Housing Acquisition Program (MAP)) to $500/home for cooperative advertising (Central Maine Power) (Table 2-2). Although we were not able to discern a clear relationship between utility incentive costs and total resource costs, several program managers and evaluators felt that the large amount of money spent on financial incentives (see Table 3-1) contributed to the poor cost-effectiveness of these programs. Second, many of the programs in our sample emphasized financial incentives to builders instead of emphasizing the advantages of living in an energy-efficient home which, according to surveys of

[1]Under the Energy Policy Act of 1992 (Public Law 102-486), all states are required to review their residential building codes to determine whether they should be revised to meet or exceed the Council of American Building Officials' (CABO) Model Energy Code of 1992 (Section 304) (CABO 1992). Each state has the option of revising their code, or maintaining the same code. A recent review of states' building codes found the following: 7 of 50 states had no state codes, 26 state codes unambiguously did not meet or exceed the 1992 Model Energy Code (MEC), 2 state codes marginally did not meet or exceed the 1992 MEC, 17 state codes unambiguously met or exceeded the 1992 MEC, 2 state codes marginally met or exceeded the 1992 MEC, and 1 state code could not be categorized (Klevgard et al. 1994). The total number of states analyzed was 55: five (5) states had separate code requirements for electrically-heated houses and for houses using other heating fuels, and, therefore, these states were considered as having two separate codes.

[2]The following discussion should not be interpreted as a critique of all the marketing strategies used in the programs covered in this report. The marketing strategy problems were encountered in some, but not all, of these programs.

builders in residential new construction programs, are very important selling points for builders. For example, NEES and PECO Energy found builders to be very interested in having their houses marketed for both energy efficiency and comfort.

Third, many of the programs primarily targeted their marketing activities to builders and did not promote the programs to homebuyers (i.e., the program's focus was on creating a supply of energy-efficient housing without creating or stimulating the demand for such housing). For example, participation rates in several of the programs in the Northeast (e.g., BECO, NEES and NYSEG) were below 7% (Table 3-2). Although these programs were promoted at a time of a depressed economy, resulting in very few housing starts, many of the program managers and evaluators felt that increased marketing to homebuyers (particularly, special groups of homebuyers) would have resulted in an increased demand for (and, therefore, construction of) energy-efficient housing.

Finally, several programs targeted custom builders rather than production builders, resulting in fewer homes being built than planned.[1] Historically, custom builders have participated in energy-efficient programs because they are usually willing to experiment with different building practices and home design and can include the incremental cost of energy-efficient measures more easily in the selling price of a home than production builders who are more concerned about the initial cost of a home. However, targeting production builders may be a more effective strategy for utilities to increase market penetration: production builders, by definition, build more homes than custom builders (e.g., in PG&E's Comfort Home Program, for example, custom builders accounted for 509 units, while production builders accounted for 12,274 units, and in BPA's SGC Program, custom builders often built only one SGC home). In addition, on a per unit basis, the amount of time a staff person spends on custom builders is disproportionately larger than the amount of time that is spent on production builders. Production builders, however, were largely absent from the residential new construction programs in our sample.

[1]Production builders are builders who build a large number of homes in a subdivision or planned unit development, and they use a small number of designs compared to custom builders who typically build 1-3 homes a year.

3.3.3 Program Spillover

All of the programs limited their analysis of energy savings to the measures promoted by the program and implemented by program participants. Recent evidence, although mainly anecdotal, indicates that significant changes are occurring in the marketplace due to residential new construction programs. Specifically, builders, contractors, architects and engineers who have been trained in energy-efficient building design and construction transfer their knowledge and skills learned in residential new construction programs to the construction of homes outside of the utility program. In addition, suppliers of home products have increased their stock of energy-efficient technologies, particularly in areas where the utility program has made a significant impact in the area (e.g., high performance windows in California and the Pacific Northwest). Finally, the attitudes and behavior of some home buyers have been affected - program information has educated some of the general public, creating a market demand for energy-efficient housing. Although market transformation activities are difficult to evaluate (see Chapter 4), the energy savings resulting from market transformation may be significant and, in some cases, may be sufficient to make these programs (more) cost-effective.

3.4 Improving the Cost-Effectiveness of Residential New Construction Programs

In recent years, some residential new construction programs have been terminated or significantly modified because of economics and/or a general trend on the part of utilities to reduce DSM program budgets to mitigate rate impacts. For example, in our sample, Boston Edison, Orange and Rockland, and Southern California Edison have stopped their programs; Central Maine Power is contemplating the termination of their program; and Bonneville Power Administration (BPA), Pacific Gas and Electric Company (PG&E), and PECO Energy have significantly revised their programs. In response to the problems described in the previous section, four options for improving the cost-effectiveness of these programs are available (Table 3-3); the first three strategies reflect the resource acquisition perspective, while the last strategy represents the market transformation perspective and is discussed in more detail in Chapter 4.

Table 3-3. Options for Improving the Cost-Effectiveness of Utility Residential New Construction Programs

1. Promote new technologies and advanced building design practices significantly exceeding state and federal standards
2. Reduce program costs and develop more effective marketing strategies
   a. Reduce, modify, or eliminate financial incentives
   b. Market the advantages of energy-efficient homes to builders
   c. Expand the scope of marketing to include home buyers
   d. Use market segmentation techniques for program targeting to production builders and home buyers
   e. Target specific regions
   f. Expand the scope of marketing to include bankers and realtors
   g. Simplify certification process
   h. Reduce mass-media marketing efforts
   i. Collaborate with other utilities
3. Recognize improvement in building code compliance
4. Obtain "energy-savings credit" from utility regulators for program spillover

These approaches are not mutually exclusive and in some cases may be synergistic: e.g., targeted marketing may lead to reduced program costs. Given the general state

of uncertainty regarding the future of the industry in a competitive world, utilities are already beginning to address these concerns by shaping their programs to be more cost-effective. The options described below have been implemented by one or more of the utilities in this study.

3.4.1 Promote New Technologies and Advanced Building Design Practices

Because of the tightening of state building codes and the increasing efficiency of federal appliance standards, residential new construction programs need to promote technologies and advanced building design practices not currently addressed in state building standards, or that significantly exceed state building codes and federal appliance standards (Prindle and Slaughter 1993). As discussed in Chapter 2, a few residential new construction programs in our sample promoted energy-efficient technologies that were either not in existing state and federal standards, or significantly exceeded standards, such as: improved duct design and installation, infiltration reduction, energy-efficient lighting and windows, alternatives to compressor cooling, and tree planting. Additional energy-efficient technologies that might be commercialized in the near future for residential new construction include: combined space conditioning and hot water equipment, ground-source heat pumps, properly sized space-conditioning equipment, high efficiency refrigerator, horizontal axis clothes washer, high spin speed clothes washer, heat pump clothes dryer, low energy/water dishwasher, indirect/evaporative cooling, internal access duct sealants, pilotless instantaneous hot water system, combined refrigerator/water heater, and new lighting measures (Nadel et al. 1993; Nadel and Geller 1994). Some of these measures are already being promoted by the Consortium for Energy Efficiency in the residential sector (see below).

Instead of examining technologies in isolation, utilities need to take advantage of the benefits that occur from interactions when individual components are combined either at the equipment level or through smart building design. Benefits from such systems integration generally include capital cost and energy savings (Koomey et al. 1994). They sometimes also include the added side benefits of improved indoor environment, reduced noise, enhanced labor productivity, and increased comfort. Examples of such interactions include the following: (1) reducing heat losses and gains from the building shell can allow the designer to reduce the size of the furnace or cooling equipment, or eliminate it entirely (Gregerson et al. 1993); and (2) reducing lighting loads by using more efficient equipment, new

glazing technologies, or daylighting may also reduce HVAC energy use (Selkowitz et al. 1992). Finally, comprehensive design of lighting systems that integrate task ambient lighting, energy-efficient lighting technologies, and lighting controls can result in improved lighting quality as well as increased energy savings (Mills and Piette 1993).

3.4.2 Reduce Program Marketing Costs and Develop More Effective Marketing Strategies

Even if residential new construction programs were cost-effective, utilities are facing a highly competitive future that requires them to further reduce program costs. Several approaches are being explored by utilities to reduce program costs:

- **Reduce, modify, or eliminate financial incentives**

  Financial incentives are one of the most visible components of program costs targeted for budget reductions. In addition to the elimination of incentives (being replaced by information-only programs, that is, programs where customers pay the incremental costs of energy efficiency), other options are being explored: (a) reduction (or elimination) of incentives for custom builders (see below); and (b) targeting of incentives only to very high-efficiency appliances, including ones just entering the market, or to production builders (see below).

- **Market the advantages of energy-efficient homes to builders**

  In the evaluation of NEES's ECH Program, custom builders reported that the advantages of an ECH home (e.g., lower operating costs and increased comfort and safety) were more important to builders than financial incentives. The incentive, although necessary to offset the incremental cost to the builder, was not sufficient to convince builders to go through the additional work of designing and building to ECH standards.

- **Expand the scope of marketing to include home buyers, not just builders**

PECO Energy has introduced an "800 number" for homebuyers to use to call their utility to obtain information about the utility's new construction program. And NEES shifted its marketing toward the home buyer. While the builder still remained the center of attention for the program, program marketing was designed to create customer demand for ECH homes which would in turn drive builders' participation. The marketing pieces included newspaper advertising, brochures targeted to home buyers, a video for builders to show prospective clients, an ECH booth staffed by ECH builders at home shows, television "infomercials" and cable advertising, and open houses. In 1993, a public relations/advertising firm developed and implemented a broad marketing strategy to increase program recognition with the home-buying public as well as the lender and realty industry.

- **Use market segmentation techniques to target program to production builders and selected home buyers**

As noted previously, the two types of builders participating in residential new construction programs (custom builders and production builders) incur program costs differentially. While custom builders might be targeted at the beginning of a program (as "innovators"), programs could structure incentives to enlist production builders (as was done by PG&E) to impact more homes (e.g., by requiring a minimum number of energy-efficient homes to be built in order to be eligible for any incentives) (see also Sandahl et al. (1994) for other utility examples).[1] While changes in the production housing industry occur slowly, by encouraging builders (through financial incentives and building design and assistance) to build several homes in a residential new construction program, the money spent on training builders is spread out over a larger number of homes.

[1]In BPA's SGC program, builders often built only one SGC home.

Market segmentation could also be used for targeting specific segments of the home buyer population for new construction. In particular, community leaders and other role models could be targeted to showcase energy-efficient construction to the rest of the community.

- **Target specific regions**

Certain areas within a service territory may be more attractive in getting new participants (e.g., high growth regions), compared to marketing the program across an entire service area. These areas would be ideal candidates for improving the cost-effectiveness of residential new construction programs.

- **Expand the scope of marketing to include bankers and realtors**

Two lending institutions in Pennsylvania link their energy-efficient mortgages with PECO Energy's new construction program. These market players could be very important in the future if energy-efficient mortgages and loans become more popular, as bankers and realtors can play an important role in educating potential home buyers about the advantages of an energy-efficient home. For example, special training courses could be implemented to teach real estate agents how to become more effective in selling energy-efficient homes and improvements to potential home buyers.

- **Simplify certification process by offering only prescriptive compliance path, and eliminate performance compliance path.**

In 1994, PG&E modified its program to be prescriptive rather than performance based, in order to reduce program costs. In a prescriptive program, qualifying measures for incentives are selected from a prescriptive list of measures prepared by the utility. In a performance-based program, customers select (groups of) measures that save a specified amount of energy. PG&E staff felt that the performance approach was too complex and time consuming for builders. PG&E expects to significantly reduce program costs with a more simplified approach, especially for production builders.

The following advantages of the performance-based approach, however, will be lost: (1) the flexibility given to builders for choosing a specific compliance path to achieve required efficiency levels; and (2) potentially larger energy savings, especially from innovative designs. By focusing on prescriptive measures, the benefits of a "smart building design" (where all components are designed to work optimally together) are lost (Koomey et al. 1994; Selkowitz et al. 1993). Thus, in the short-run, program costs may be reduced, but in the long-run, the benefits of this approach may be outweighed by lost opportunity costs and increased dissatisfaction among builders that prefer the flexibility to choose their own measures.[1] Design assistance to builders might ease the above compliance problems.

- **Reduce mass-media marketing efforts over time**

For some programs, a major percentage of the costs of residential new construction programs is administrative, primarily the marketing of the program (Table 3-1). Most of the programs examined in this report relied on mass-media marketing to publicize their program to builders (and in some cases to homebuyers). As these programs develop over time, program advertising will become more targeted and focused, so that the use of mass media will be reduced in effort (e.g., as reflected by Southern California Edison's experience in promoting its Welcome Home Program), while direct contact with builders and homebuyers will increase.

- **Collaborate with other utilities**

One of the principal reasons for having utilities work together in New England Electric System's (NEES) and Boston Edison's Energy Crafted Home (ECH) program and in BPA's MAP was the leveraging of limited funds: by pooling their funds together, utilities could share program development, training, and marketing costs. Other utilities might want to replicate this model; however, in a more competitive environment,

[1]These limitations are less severe in California where builders in PG&E's program retain design flexibility within the Title-24 standards: they still have several performance options for complying with Title 24 even after participating in PG&E's prescriptive program.

the willingness of utilities to work cooperatively is unclear, especially if regulatory incentives for cooperation are absent.

Another model of utility cooperation that will not only reduce program costs but will also help promote new technologies and transform markets are utility consortiums that seek to stimulate the introduction of specific technologies. For example, in the Super-Efficient Refrigerator Program (SERP), a consortium of 24 utilities worked with a number of governmental agencies and private companies to stimulate the introduction of chlorofluorocarbon-free refrigerators that use 25-50% less electricity than currently mandated by the U.S. Department of Energy's efficiency standards (Goldstein 1994; Penn 1993b). Major U.S. appliance manufacturers competed against one another in a $30 million race to manufacture this appliance, and the Whirlpool Corporation won the competition in 1993. The $30 million award was used to cover design, development, and marketing costs as well as more expensive materials and parts. Whirlpool will produce and distribute 250,000 SERP refrigerators during 1994-1997 in order to collect the prize.

Building upon the success of this program, the Consortium for Energy Efficiency (CEE) (a non-profit organization comprised of utilities, environmental and public interest groups, and governmental agencies) is developing a variety of programs to address specific needs of particular market sectors. In 1993, CEE implemented a program for residential clothes washers which set uniform specifications for qualification for different tiers of rebates from the participating utilities (Goldstein 1994).

In 1995, CEE implemented two programs affecting the residential sector. In the Residential and Small Commercial Lighting Initiative, CEE is promoting the purchase of screw-in compact fluorescent lighting (CFL) products in the residential and small commercial sectors (California Compact 1994). Program incentives go directly to manufacturers of CFL products, but sales occur through the normal retail distribution chain. Any utility can participate in this program if they offer incentives to manufacturers of screw-based energy-efficient

lighting products and use the initiative's technical specifications and scoring system to evaluate manufacturer proposals. The benefits of utility participation include the following: (1) very low program administrative costs, (2) quickly develops the retail sales chain, and (3) acquires supporting materials and tools (e.g., data base program tracking software, a product performance testing program, and assistance with product tracking for program evaluation purposes). Fifteen utilities are currently sponsoring this initiative.

CEE's High Efficiency Residential Air Conditioning Initiative was launched in 1995 to encourage manufacturers to produce higher-efficiency products (Krepchin 1995). The initiative includes both efficiency and installation components, and the efficiency criteria are divided into five tiers of increasing efficiency. It is up to the utility to decide whether or not the incentives apply to air conditioners, heat pumps, or both. To convince manufacturers that it is worthwhile to emphasize higher efficiency levels in their manufacturing operations, utilities are encouraged to commit to offering incentive through the end of 1998 for higher tiers.

Finally, the U. S. Environmental Protection Agency is working with home builders and vendors to develop new homes that use 30% less energy than homes built to the standards in the 1992 Model Energy Code. The goal of the Energy Star Homes Program is to achieve 10% market share by the year 2000 and 100% market share by 2010. Through this program, builders have access to financing options and marketing and advertising support. Thus far, EPA has marketed its program to builders and vendors; however, utilities are becoming more interested in adopting and participating in EPA's program in order to promote a national brand name that increases customer awareness, influence secondary lenders to provide innovative financing, and facilitate builder participation by eliminating confusion with multiple utility program specifications and requirements.

3.4.3 Improve Building Code Compliance

A few studies have shown that compliance with state building codes is higher for participants in utility residential new construction programs than for non-participants. PG&E found that, on average, non-participating homes in PG&E's service territory were being built that were 5.8% below (i.e., did not meet) Title 24 standards across all measures and equipment. PG&E's Comfort Home Program forced builders through the program's "Plan Check" process to comply with the standards when they might not have otherwise done so. Accordingly, PG&E claimed additional energy savings from its Comfort Home Program through its role in enforcing compliance with the Title-24 standards. The 5.8% enhanced enforcement savings for homes built under the 1992 Title-24 standards was filed in PG&E's March 1994 Advice Filing with the California Public Utilities Commission (CPUC). The CPUC approved PG&E's request, and the savings will be incorporated in PG&E's 1994 earnings claim.

A similar result was found in the analysis of compliance with Oregon's building code: all of the buildings reviewed and that participated in utility programs complied with the energy code and, on average, these homes' performance was 6% better than anticipated by the code (Frankel and Baylon 1994). Thus, the evidence suggests that residential utility programs have a very positive impact on compliance and result in noticeable improvements in energy performance. Other utilities might want to pursue this approach, particularly in areas where noncompliance is an issue (see Chapter 4).

3.5 Summary

The total resource cost for each of the 10 residential new construction programs is presented in Table 3-1. In this report, we considered the total resource cost of a program to be the total cost of the efficiency measures delivered through the program, using a 5% real discount rate. Our findings directly address shortcomings that have been identified for previous estimates of total resource costs by (1) relying on post-program evaluations of energy savings rather than unverified pre-program estimates, and (2) accounting for the direct costs borne by both the utility and the participating customer, rather than only those costs borne by the utility.

When weighted by energy savings, we find the average total resource cost of the 10 residential new construction programs in our sample is 5.7 ¢/kWh (in 1994 dollars); the total resource cost ranged from a low of 3.4 ¢/kWh to a high of 725.1 ¢/kWh. The reasons for the poor cost-effectiveness of residential new construction programs are diverse, but, based on our analysis, the following appear to be significant: (1) increased tightening of state building standards and national appliance standards has improved the baseline; (2) inadequate (incomplete or misdirected) marketing strategies; and (3) savings calculations limited to only those savings achieved by program participants for measures covered under the program, excluding savings by nonparticipants and savings from non-program measures by participants as a result of the program (market transformation impacts). We believe that the cost-effectiveness of residential new construction programs can be improved by: (1) promoting technologies and advanced building design practices that significantly exceed state and federal standards; (2) reducing program marketing costs and developing more effective marketing strategies; and (3) recognizing the role of these programs in increasing compliance with existing state building codes. If the cost-effectiveness of these programs is not sufficiently improved by taking advantage of these opportunities, then we suggest that residential new construction programs should be evaluated, recognized, and credited for energy savings obtained from program spillover (market transformation) impacts, as discussed in the next chapter.

The Evaluation of Residential New Construction Programs

In this chapter, we present a brief overview of the methods used in evaluating residential new construction programs. The determination of the proper baseline is a critical issue in the evaluation of residential new construction programs, and in this chapter we examine how utilities construct a baseline, how non-participants compare to existing codes, how participants compare to non-participants, and how participants comply with existing code requirements. Because we believe that residential new construction programs will need to capture program spillover effects for making their programs more cost effective, we discuss the evaluation issues involved in examining these programs from a market transformation perspective and then propose a set of research projects involving data collection and data analysis activities.

4.1 Evaluation Methods

The goal of new construction program impact evaluation is to measure how much energy would have been consumed by program participants if the program had not encouraged efficient equipment and building shell to be incorporated into building plans. New construction programs present a unique challenge to evaluators due to the lack of pre-program billing history. Therefore, most new construction program evaluations rely on engineering models for estimating energy savings. However, impact evaluations that estimate DSM program savings from measured data have shown that pre-program engineering estimates are often inaccurate in predicting the level of savings a DSM program will eventually realize (Nadel and Keating 1991).

Problems with engineering estimates of DSM program savings may result from inadequate and uncalibrated building prototypes and incorrect assumptions about technology performance and occupant behavior. One explanation for these problems is that the simulation models were designed specifically as code compliance tools and, as such, have built-in assumptions that enhance code compliance and enforcement, but do not necessarily enhance accurate savings estimates. Engineering methods can produce good results when the analyst pays careful attention to the limitations inherent in a particular engineering method and input assumptions regarding building description, technology performance, and

occupant behavior. Accordingly, most evaluations of residential new construction programs use billing (or end-use metered) data and onsite data to calibrate the engineering models. Furthermore, engineering methods are generally used to estimate gross program impacts, which consider impacts at the customer meter, while impact evaluations generally estimate net program impacts, which consider issues such as free-riders, takeback, and persistence. As noted below, most program evaluations assume zero free ridership, and none studied takeback nor persistence.

The evaluations of residential new construction programs varied in breadth and scope. Most evaluations of these programs used building energy computer simulation models for estimating the change in energy consumption and demand for specific energy conservation actions (Table 4-1).[1] Typically, a base building computer model is developed, and the unit demand and energy savings are calculated by comparing the simulation results for the building with energy-efficient technologies to the base building performance. Simulation methods can capture interaction effects between measures and end-uses. In the impact evaluation methods used in the residential new construction programs, engineering methods are often used in conjunction with data from onsite data, end-use metering, short-term measurements, or utility billing data. For one utility, their analysis of billing data found measured energy consumption to be not significantly different from the usage predicted by their computer simulation model (NEES).

In addition to calibrating engineering models, a few utilities used post-program billing data for comparing energy use between participants and non-participants. In order to distinguish program effects from weather, price, and other exogenous factors, three utilities conducted multiple regression analysis in their comparison of participants and non-participants (Table 4-1).

[1]A multitude of building energy simulation computer programs are available and used in DSM programs (see Roberts et al. 1994).

Table 4-1. Evaluation Data and Methods

	Evaluation Data				Evaluation Analysis				
Utility (1)	Engineering Data	On-Site Data	Billing Data	End-Use Metered Data	Engineering Analysis	Computer Building Simulation	Billing Calibration	Billing Analysis	End-Use Metering Analysis
BPA - MAP	✔		✔					✔ Bill Comparison & Regression Analysis	
BPA - SGC	✔	✔	✔	✔	✔	✔	✔	✔ Bill Comparison & Regression Analysis	✔
BECO	✔	✔	✔ (2)		✔	✔		✔(2)	
CMP		✔	✔	✔ (3)				✔ Bill Comparison & Regression Analysis	✔(3)
NEES	✔		✔		✔	✔	✔	✔	
NYSEG	✔	✔	✔		✔	✔	✔		
O&R	✔	✔			✔	✔			
PG&E	✔	✔	✔	✔	✔	✔	✔	✔ Regression Analysis	✔
PECO	✔		✔		✔	✔	✔	✔	
SCE	✔		✔					✔ Regression Analysis	

Notes:

(1) See Table 2-1 for identification of utilities and programs.

(2) For a few multi-family units; not for single-family.

(3) For space heating energy use.

The most comprehensive impact evaluation of a residential new construction program was conducted by PG&E. Using data from participating and nonparticipating builders, billing records, on-site field audits, customer surveys, and whole-premise and end-use metering of occupied participant and nonparticipant units, the evaluation of the Comfort Home Program was based on an integrated analysis using engineering, statistical, and load data analysis. A baseline for the participant population was first developed (see below). The participant model was then created by modifying the baseline model to incorporate the energy efficiency measures (e.g., air-conditioner SEER and insulation R-values). Because of the impracticality of simulating energy use for each participant, customer-level engineering adjustment factors were estimated through simulations of prototype homes that varied key model inputs. These adjustment factors were used to calculate energy use for each home in the analysis.

Adjustments to the gross engineering energy-usage estimates were performed by using Statistically Adjusted Engineering (SAE) models to estimate cooling and heating usage "realization rates" of expected cooling and heating usage.[1] Participant and nonparticipant SAE realization rates were calculated separately in order to explain systematic differences in participant and nonparticipant energy attributable to rebound effects and baseline equipment performance.

The load data made it possible to (1) calibrate the engineering-based model to better simulate actual usage patterns; (2) estimate operating factors to produce peak demand impacts; and (3) conduct preliminary load profile comparisons to examine different energy-usage patterns between program participants and nonparticipants. While differences in participants and nonparticipant demand were evident via the load profiles (e.g., 1.24 kW difference at time of system peak on the week day), they were not program impacts since the baseline for the program was the energy use (kWh) built to Title-24 standards, not nonparticipant building practices (see below).

[1]In SAE models, typically building data are merged with occupant survey, weather, and engineering data sets to produce the final SAE analysis data set (Violette et al. 1991).

4.2 Baseline

The key issue in the evaluation of residential new construction programs is the determination of the baseline. Without an appropriate baseline, it is impossible to accurately estimate program savings. Typically, program designers consider the current state building code as the baseline for participating buildings and as the basis for providing incentives to builders ("program baseline"). For those states without a building code, standard building practices, usually obtained from builder surveys, were used as the baseline. The problem with the first baseline (state standards) is that builders both exceed and fall below codes. The problem with the second baseline (builder practices) is that the surveys used to characterize building practices may be inaccurate because they are not done on a regular basis and rapidly become outdated.

This section focuses on how utilities construct a baseline, how non-participants compare to existing codes, how participants compare to non-participants, and how participants comply with existing code requirements.

4.2.1 Baseline Determination

Because actual builder practices may be different from the program baseline, utilities need to determine an "evaluation baseline" prior to calculating the energy savings from these programs (and, where applicable, for receiving incentive payments), as shown in Table 4-2. For example, in PG&E's Comfort Home Program, the existing state building code (Title 24) was used as the program baseline. Builders applying for participation in the program submitted two energy-efficiency plans: one "baseline" plan that met the Title-24 standards, and one "enhanced" plan that met the program standards (e.g., 10% more efficient than Title 24).[1] However, in the evaluation of the program, the evaluation baseline was determined by examining the nonparticipant population through on-site surveys and end use metering. A computer model was used to created a nonparticipant model based on the characteristics of the metered sample of buildings, along with the actual weather for a particular climate zone. The nonparticipant model was calibrated using load data collected for that climate zone. This model was then adapted to create the participant baseline, by adjusting the non-programmatic building characteristics (e.g., square feet and number of stories).

[1]PG&E's baseline plan was more stringent than the Title-24 requirements: e.g., PG&E required all measures to be permanently installed, which eliminated consideration of measures such as temporary window shading that is allowed in the code.

Table 4-2. Program and Evaluation Baselines in Residential New Construction Programs

Utility (1)	Program Baseline	Program Requirements	Evaluation Baseline Data (2)
BPA - MAP	Federal building code	Exceed Federal regulations	B
BPA - SGC	Current practice	Exceed current practice by 30-50% space heating energy use	BP, E, IB, IBI, IT, OS
BECO	State building code	Exceed state code	Not measured
CMP	Current practice	Exceed current practice by 40% space heating energy use	OS
NEES	State building code	Exceed state code	Not measured (3)
NYSEG	State building code	Exceed state code by 25%	B, OS
O&R	State building code	Exceed state code	BP, IB, IBI, IT
PG&E	State building code	Exceed state code by 10% cooling energy use	BP, OS, E
PECO	State building code	Exceed state code	B, IB, OS
SCE	State building code	Exceed state code by 10% cooling energy use	B

Notes:

(1) See Table 2-1 for identification of utilities and programs.

(2) Evaluation baseline data: B = Billing data of nonparticipants; BP = Building permits; E = End-use metering; IB = Interviews with builders; IBI = Interviews with building inspectors; IT = Interviews with trade allies; OS = Onsite surveys of nonparticipants

(3) Baseline study underway - report is expected to be completed by Summer 1995

In Orange and Rockland's (O&R) Good Cents Program, multiple methods were used to establish the proper baseline. In addition to reviewing the New York State energy code, the utility conducted the following activities:

1. reviewed blueprints submitted for building permits for a sample of nonparticipating homes and surveyed a small sample of buildings to

confirm that measures listed on the blueprints were actually installed,

2. interviewed builders and vendors about baseline construction practices, and

3. contacted distributors and contractors to confirm measure installation.

Central Maine Power (CMP) audited recently constructed non-Good Cents homes in their service territory to determine a baseline thermal performance. The audit analysis compared key building thermal characteristics of audited non-Good Cents homes with the Good Cents standards and compared the design heat loss estimates for both types of homes. And New York State Electric and Gas (NYSEG) conducted on-site audits of a sample of homes and used billing data to benchmark the building simulation model for estimating energy use for non-NYSE-Star homes.

4.2.2 Program Baseline Versus Evaluation Baseline

Only one study examined in detail the differences between program and evaluation baselines. Based on self-reports from a telehphone survey conducted in 1991, PG&E found significant differences in building practices between production builders and custom builders. For production builders, PG&E found that: (1) 83% of non-participating builders did not historically exceed Title-24 shell standards by 10% or more; (2) 12% exceeded Title-24 shell standards by 10% historically but selected HVAC appliances to meet minimum Title-24 standards; and (3) 5% exceeded shell standards by at least 10% and installed the same HVAC appliances as program participants. For custom builders, PG&E found that: (1) 51% of them did not historically exceed Title-24 shell standards by 10% or more; (2) 24% exceeded Title-24 shell standards by 10% historically but selected HVAC appliances to meet minimum Title-24 standards; and (3) 25% exceeded shell standards by at least 10% and installed the same HVAC appliances as program participants. These data suggest that the existing state building code is an inappropriate baseline for residential new construction programs, although the validity of the self-reported data needs to be confirmed (see below where enforcement of state codes is discussed).

4.2.3 Participants Versus Non-Participants

Based on the auditing of participants and non-participants, New York State Electric and Gas found NYSE-Star homes to be significantly different than nonparticipants in terms of natural air infiltration (0.22 ACH versus 0.44 ACH), wall insulation (R-24 versus R-19), floor insulation (R-28 versus R-14), attic insulation (R-44 versus R-38), and windows (R-3.12 versus R-2.76).

In contrast, Orange and Rockland found that baseline construction practices in the single-family home market were very close to Good Cents building energy efficiency practices. This was especially true for air infiltration rates (similar air-infiltration barriers) and windows (similar high performance windows). Thus, both the baseline and Good Cents homes had design heat loss characteristics well below state code, so that the nets savings for participants were lower than expected.

4.2.4 Compliance with State Codes

One cannot automatically assume that all builders will comply with building codes. One would expect variation in code compliance as a result of many factors, such as the amount of resources available for code inspections, the expertise of building code officials, the type of training and educational efforts available for informing builders and the building code community about energy code requirements, and the scope of the quality control process offered in residential new construction programs (see Chapter 2).[1]

In general, the utilities in our sample have been reluctant to get involved in the building code inspection process. Only two utilities compared building code compliance for program participants and non-participants. In one case, PECO Energy found 72% of its EEE homes complied with the state standard for attic insulation (R-30), while 65% of non-EEE homes complied with this standard. Since this study, the utility revised its EEE home program (new called the Smart Choice Program), so that all homes in its program exceed the state standard for wall insulation by 25% and attic insulation by 20% (all homes are inspected prior to being certified). In another study, PG&E found its Comfort Home Program not only caused homes to be built

[1]Compliance can be measured by a prescriptive basis (e.g., identifying whether specific prescriptive components of the code were installed or built) or by a performance basis (e.g., comparing the energy use of an "as-built" home with the energy budget required in the building code).

that exceeded state energy efficiency standards but also forced builders through the program's "Plan Check" process to comply with the standards when they might not have otherwise done so. Thus, PG&E found that, on average, non-participating homes in PG&E's service territory were built that were 5-6% below Title-24 standards across all measures and equipment.

Compliance with state building codes varies from state to state, often reflecting the institutional environment for both code adoption and compliance established prior to code adoption. We are aware of statewide analyses of code compliance in three states (California, Oregon, and Washington) that indicate the amount of noncompliance with state building codes (Frankel and Baylon 1994; Valley Energy Consultants 1994; Warwick et al. 1993). The Washington and Oregon analysis also included an estimate of the energy savings impacts from noncompliance which provides needed information for assessing the value of noncompliance. While there was some noncompliance (3%) with the Washington code, the impact on thermal performance of typical homes was estimated to be minor (Warwick et al. 1993).

The Oregon analysis found many problems with compliance from a whole house perspective: while the level of compliance on individual components was high (80%, or 98% if the heat loss rate is allowed to vary within 5% of the code target to comply), only 55% of the houses met all of the specific prescriptive requirements (prescriptive compliance is the basis of the Oregon Energy Code) (Frankel and Baylon 1994). However, the principal difficulties associated with prescriptive compliance generally had a very small impact on the total heat loss rate: these deficiencies were largely balanced by a combination of improved efficiency in other building components and improved efficiency in mechanical equipment (*ibid*).

Four studies have been conducted in California to examine the compliance of builders with state energy conservation building standards: two have been statewide studies (Berkeley Solar Group 1995; Valley Energy Consultants 1994) and two have been limited to a utility service area (Eley Associates 1994; Quantum Consulting Inc. and RCG/Hagler, Bailly, Inc. 1993). Each of these studies had methodological limitations (e.g., the statewide studies depended on the cooperation of building departments that voluntarily agreed to participate in a study; similarly, the utility studies depended on the cooperation of developers). In general, the California analyses showed that a large number of buildings met the intent of the building

standards and, on average, the houses complied with the standards. However, in both the statewide and utility studies, a high number of violations (in plans, in the field, and in energy impacts) were found, especially for builders not participating in utility new construction programs.

Because of the amount of resources, training, and education devoted to code adoption in these states, states with less experience and resources targeted to code enforcement are expected to have higher rates of noncompliance with state building codes. Furthermore, knowing how well builders comply with (or exceed) the building code is critical for completing a sound evaluation and, perhaps, getting recognition and credit for additional energy savings as a result of the program.

4.3 Free Riders

All but one of the utilities in our sample assumed that the builders participating in their program would *not* have built energy-efficient homes that met program standards if there had not been a program (i.e., zero free ridership). For example, the Philadelphia Electric Company assumed zero free ridership, because, according to contractors specializing in the installation of air infiltration reduction measures, air infiltration measures were performed exclusively on EEE homes. Similarly, PG&E assumed no free riders in the Enhanced Duct component of their Comfort Home Program, because they assumed contractors would not improve upon standard practices without program training.

Only one utility recognized the fact that some builders (particularly, innovative custom builders) build to (or exceed) program standards and, therefore, have conducted studies of free ridership. PG&E assumed a free ridership rate of 5% (based on their analysis of nonparticipating production builders) for their entire Comfort Home Program, because they assumed that 5% of builders would have increased the efficiency of the central air conditioner unit that they used to comply with Title 24. But PG&E believed their estimate to be conservative because they felt it unlikely for builders to install a significantly greater SEER unit than they used for Title 24 compliance.

It is important to note that the measurement of free riders in new construction programs is difficult, particularly since the survey methods used to estimate free

ridership are very sensitive to the design and wording of the questionnaire (Vine 1992). If new construction programs promote very innovative and advanced energy efficiency measures and building design practices, then free ridership should remain low. However, if the codes do not significantly exceed current state code, then free ridership will be a problem.

4.4 Market Transformation

Residential new construction programs are one of many specific policy and program approaches than can contribute to market transformation.[1] Market transformation has not yet reached the stage of being an explicit policy objective for states or utilities and, currently, there is no utility that is eligible for financial incentives in exchange for causing basic changes in market processes.

Resource acquisition programs appear to have worked best with relatively mature technologies where the market infrastructure exists and is adequate and predictable (e.g., efficient commercial and industrial lighting) (Prahl and Schlegel 1994). In contrast, residential new construction programs represent the kinds of programs that best fit the model of market transformation: they introduce measures that are relatively new or that have, for one reason or another, failed to establish themselves in the market due to market barriers (see Vine and Harris 1990). One can also view market transformation as setting the stage for resource acquisition (or vice versa). Under this approach, the primary role of market transformation programs would be to accelerate the diffusion of immature technologies to the point where resource acquisition becomes a viable strategy. Some examples below illustrate the market transformation perspective.

Since 1983, when the Model Conservation Standards (MCS) for residential new construction were adopted by the Northwest Power Planning Council, several programs were implemented to bring about market transformation. These included testing and demonstration programs, incentive programs offered by utilities (BPA's Super Good Cents (SGC) Program), combined with incentive programs to encourage

[1]These different approaches work in different ways, and many of these approaches can complement each other to form a complete market transformation strategy, such as (Nadel and Geller 1994): research and development, demonstrations and field tests, commercialization incentives, marketing and consumer education, financial incentives, voluntary commitments, bulk purchases, building codes, and equipment efficiency standards.

local governments to adopt the MCS as local codes and technical and financial assistance (Brown 1993). These activities set the stage for market transformation, which culminated in codes equivalent to MCS adopted in Washington in 1990 and in Oregon in 1991. Along the way, building codes were adopted in 1986 in Washington and Oregon that achieved approximately half of the MCS savings without direct utility financial support. A number of factors point to spillover effects occurring in the market. As a result of the SGC Program and related programs, the market for windows changed dramatically: in 1983, aluminum windows made up roughly 80% of the market, but by 1993, vinyl windows had captured 77% of the market.

BPA's Manufactured Housing Acquisition Program reflected a joint effort among utilities, government, and manufacturers to develop an acquisition program in which energy-efficient manufactured homes were acquired directly from the 18 manufacturers in the Pacific Northwest to meet a common specification that included a package of all regionally cost-effective energy efficiency measures. The program was intended to reduce space heating energy consumption by more than 50% compared to pre-existing practice. Due to the program, the new baseline window is now a vinyl-frame, dual-pane window which has become the manufactured housing industry standard in the Pacific Northwest. Incorporating these windows, as well as those with the addition of argon gas and low-emissivity coatings, was a major technological innovation resulting from this program.

PG&E's Comfort Home Program intended to influence the building practices employed by California builders, by encouraging manufacturers and vendors to develop and more aggressively market energy-efficient equipment, and by increasing the viability and desirability of energy efficiency as an attribute desired by home builders. The High Performance Windows component of the Comfort Home Program was designed to stimulate market demand and builder acceptance of new high performance windows by offsetting some or all of the higher costs of purchasing these improved windows. Some market transformation occurred: in PG&E's 1992 program, the penetration of high performance windows increased in the residential market due to the program: in a sample of program participants, approximately 46% of the Comfort Home sample was constructed with some variety of high-performance windows, while none of the members of a non-participant sample were found to have high-performance windows.

Finally, in its program evaluation, Central Maine Power found that its Good Cents Home Program may have had an impact on the energy use of non-Good Cents homes by increasing the awareness of efficient construction techniques among non-participating builders and non-participating home buyers.

4.4.1 The Evaluation of Residential New Construction Programs as Market Transformation Programs

Since one effect of residential new construction programs is the transformation of the construction industry, then the energy savings from this transformation should be included in cost-effectiveness calculations under the resource acquisition perspective. However, estimating the savings from program spillover represents a significant challenge, both conceptually and pragmatically. While proponents assert that market transformation programs have the potential to generate greater savings, more cost-effectively, than traditional resource acquisition programs, such benefits are harder to evaluate (e.g., through simple, pre-post studies) due to the complex, iterative, and potentially slow moving nature of market transformation. Under the market transformation perspective, evaluators will need to collect data on market changes from a variety of sources and assemble this evidence into a "mosaic" to help policy makers interpret the results of market transformation programs and their impact on energy use (Prahl and Schlegel 1994).

With market transformation as the goal of a program, a new issue arises related to the life cycle of a program and the relative roles of free riders and free drivers. In the early stages of market transformation, free riders may be unavoidable to achieve economies of scale to dramatically reduce costs or change standard practice. However, when calculating net savings, a program is penalized for having a large percentage of free riders. Similarly, if nonparticipants achieve energy savings because of the program, they should be added to program savings rather than subtracted from the savings of participants - otherwise, there would be a systematic bias - underestimation of program savings (Goldstein 1994; Kitchin 1993; Prahl and Schlegel 1993). In the later stages of a program, the utility may be achieving savings from free drivers, but savings from free drivers are not normally accounted for in the calculation of net savings.[1] Unless utilities are explicitly credited for such results

[1]For example, an evaluation of B.C. Hydro's Power Smart High-Efficiency Motors Program estimated a 23% free drivership rate (Nelson and Ternes 1992). Because the free driver estimate was based on

in the calculation of their incentive payments (decreasing the emphasis on net savings and increasing the emphasis on gross savings), these actions will tend to reduce the apparent net impacts of their program.[1]

The evaluation of market transformation by residential new construction programs is also challenging because some of the techniques used in the evaluation of DSM programs may not be appropriate for the evaluation of program spillover (Kitchin 1993; Prahl and Schlegel 1994). New techniques will need to be designed for addressing three key market transformation issues:

1. **Market changes.** Although many techniques test and control for differences between participants and nonparticipants, they do not test or control for differences in markets resulting from the program. And these market changes (e.g., differences in prices of electricity and substitute fuels, costs, and availability of efficient equipment or other efficiency measures) that result from the program have an impact on the behavior and choices of participants and nonparticipants and, therefore, program savings.

2. **Long-term changes.** Changes in the attitudes, motivations, knowledge, and incentive structure of market actors may occur imperceptibly over a matter of years, so that long-term tracking studies are needed.

3. **Comparison group.** Finding a comparison group will become increasingly difficult as more utilities implement DSM programs - especially, if a program is designed to achieve market transformation.

only one survey, the evaluation team adopted a conservative estimate of 11.5% for the impact evaluation. The evaluation showed an adjusted savings that was 75% of the initial savings estimate (incorporating the 11.5% free driver estimate). If a 23% rate had been used, the evaluated savings would have been as high as 85% of the initial savings estimate, and if the free driver estimate had been reduced to 0%, then the evaluated savings would equal 66% of the initial savings estimate.

[1]Of course, there will still be a need to minimize the degree of ratepayer risk associated with the possibility of paying for market changes that were not actually caused by the utility (Prahl and Schlegel 1994).

4.4.2 A Research Agenda for Improving the Evaluation of Residential New Construction Programs

A wide range of methodological innovations will be needed to adequately document the effects of market transformation programs, especially involving market research (e.g., market targeting, test marketing, and identification of customer needs) (Oswald et al. 1994). If a primary focus of the evaluation of residential new construction programs is the focus of changes in the market as a whole, rather than analyzing changes undertaken solely by participants, then the following data collection and analytical activities need to be conducted for evaluating residential new construction programs.

- **Data collection activities.**

  1. **Measure the market baseline.** A prerequisite of any attempt to understand the long-term effects of a DSM program on a market system is to understand the initial characteristics of such a system. Compared to previous efforts, these activities need to be expanded and systematized, conducted periodically over time, and cover a wide range of indicators, such as: sales data, stocking practices, and distribution of appliances. Market surveys should target market actors for which change is expected to be the most important.

  2. **Track attitudes and values.** It is important to systematically document the effect of DSM marketing efforts on the attitudes and values of a utility's customers - both participants and nonparticipants. Due to the gradual, incremental nature of market transformation, it is necessary to conduct longitudinal panel studies, or at least regular surveys of participants and nonparticipants, in order to track attitudinal change. These studies will also be needed for evaluating the persistence ("lasting changes") of attitudes and behaviors and their impact on energy use.

  3. **Track sales.** Sales of efficient equipment and services, including insulation, windows, and ducts (from dealers to customers, from

manufacturers to distributors, and from distributors to trade allies) need to be tracked through regular tracking studies over time.

- **Data analysis activities.**

  1. **Model market processes.** To see how changes in market components affect the diffusion curves of specific technologies, models of market transformation which integrate and synthesize disparate types of data need to be developed.

  2. **Analyze the relationship between attitudes and behavior.** Research is needed to better document the long-term relationship between attitudes and behaviors considered conducive to energy efficiency, so that, for example, the impacts of information strategies can be measured.

  3. **Compare pre-program and post-program market survey and billing data.** The pre-program implementation conditions serve as the baseline for comparing energy savings.

  4. **Perform multivariate regression analysis with control groups from outside the service area.** This approach takes into account differences in the market between the service areas of the program and the service area of the control group. In the recent past, with the spread of DSM programs to many utility service areas, it is becoming more difficult to find control groups in an area where DSM programs are not being implemented. However, if residential new construction programs are being eliminated, this problem may disappear.

  5. **Simulate market transformation.** Engineering-econometric forecasting models can be used to simulate how energy use would have changed in the absence of a DSM program. By combining engineering information with data on DSM measures, equipment stock, building characteristics, fuel choices, and energy use, net savings can be estimated as the difference between post-program use and the simulation of what energy use would have been according to the model. The use of these models is very speculative (e.g.,

forecasting technology change in the absence of a program), and has no standard methodological approach (Kitchin 1993).

6. **Compare multiple methodologies.** Multiple analytical methodologies need to be used to obtain a more accurate estimate of savings and changes from these programs. Differences in estimates of market transformation savings need to be investigated and explained in terms of data accuracy, analytic bias, and methodological limitations.

4.5 Summary

The determination of the proper baseline is one of the critical issues in the evaluation of residential new construction programs, and the way utilities construct a baseline (e.g., using existing codes, results from surveys of current building practices, or findings from onsite audits) will affect the gross energy savings from residential new construction programs. However, if utilities wish to capture program spillover effects, then the evaluation of these programs will present a major challenge to the evaluation community. Evaluators will need to develop innovative evaluation designs and techniques for analyzing market changes, long-term changes, comparison groups, and attitudes and behavior. At a minimum, the following data collection activities will need to be undertaken: measurement of the market baseline, tracking of attitudes and values, and tracking of sales. Similarly, the following data analysis studies will need to be conducted: modeling of market processes, analyzing the relationshiop between attitudes and behavior, comparison of pre-program and post-program market survey and billing data, statistical analysis with control groups outside the service area, the simulation of market transformation, and the comparison of multiple methodologies used in evaluating market transformation in one residential new construction program.

The Future of Residential New Construction Programs

The future of residential new construction programs is in dire straits, because many of them are not cost-effective (Chapter 3). Several utilities in our sample have terminated their programs, significantly modified their programs (e.g., by eliminating incentives and focusing on information and design assistance), or reduced their program budgets. In many cases, these programs were not cost-effective and in need of a design overhaul. However, cost-effective DSM opportunities do remain in the residential new construction sector. Utilities should rethink their program designs (Chapter 3) and improve their evaluations of residential new construction programs to include energy savings from program spillover in program savings (Chapter 4). Utilities can also leverage their resources in seizing these opportunities by forming strong and trusting partnerships with the building community and with local and state government.

5.1 Partnerships With the Building Community

Most of the programs in our sample developed close working relations with the design and building communities (see Sandahl et al. (1994) for other utility examples). Program evaluations of residential new construction programs have shown that builders are very receptive to utility residential new construction programs, for the following reasons:

1. **Rebates.** The rebates provided to builders are used to reduce their incremental costs in complying with the program, or the rebates are passed on to the homeowner;

2. **Computer modeling.** The modeling for program qualification is very effective for showing builders how to build energy-efficient homes cost-effectively;

3. **Site inspections.** The inspections are useful for improving the quality of construction, thereby helping ensure the persistence of energy

savings and reducing the level of dissatisfaction of homeowners after the home is built; and

4. **Marketing advantages.** Lower operating costs and increased comfort and safety associated with new construction were considered by some builders to be more important than financial incentives for attracting additional sales.

In addition, a few program evaluations found that most builders' opinion of the utility company had generally improved as a result of the residential new construction program, primarily as a result of training and technical assistance.

5.2 Partnerships With Government

As mentioned at the beginning of this report, residential new construction presents an excellent opportunity for utilities to develop partnerships with government agencies for: (1) promoting code levels before they become mandatory, (2) promoting efficient technologies and practices to lay a foundation for code updates, (3) sponsoring training and technical assistance programs for code inspectors and building designers on code requirements and ways to meet and exceed those code requirements, and (4) providing financial assistance to state and local governments for energy code enhancement efforts (Nadel 1992; Sandahl et al. 1994). The most exemplary examples of this kind of partnership are BPA's Super Good Cents Program and their Manufactured Housing Acquisition Program (for points 1 to 4). For example, the Super Good Cents Program was very instrumental in making the new Washington and Oregon state building codes more energy efficient and making double-pane vinyl windows the standard in the Pacific Northwest. Other good models of partnerships with government are NEES's Energy Crafted Home Program (with the New Hampshire Governor's Office of Energy and Community Services) and NYSEG's NYSE-Star Program (with the New York State Energy Office).

In this project we investigated the level of code coordination between utilities and government to see if utilities were actively taking advantage of the opportunities discussed above.[1] Based on our sample, aside from builder training, the level of

[1]Other examples of joint projects between government and utilities include (1) matching funds for conservation and energy assistance, (2) joint delivery of services (e.g., program management, technical support, or program implementation, and (3) joint funding of third parties (e.g., universities or nonprofit agencies) to conduct broad-based efficiency research (Brown 1990). Accordingly, programs

coordination and activity is presently quite low.[1] This reluctance is probably due to a number of reasons, but a major reason is the tightening of state building standards, resulting in less opportunities (potential) for making significant changes in the codes and, therefore, less interest in investing time and resources in working with government. Since all states will be required to review their residential codes to see if they meet or exceed the Council of American Building Officials' Model Energy Code (see Chapter 3), this reluctance is expected to continue (e.g., see Prindle and Slaughter (1993) for an analysis of the implications of this requirement on Georgia Power Company's Good Cents Program).[2] On the other hand, some utilities may be willing to work with government on improving codes, since it is more cost-effective for them to do this than to provide incentives. Finally, even in areas of high code compliance, there is still a need to simplify compliance and to synchronize changes in the codes with the revision cycles of national building codes.

If utilities decide to work with government (e.g., in jointly sponsoring training programs and workshops), the former could work on pilot testing potential code revisions with the expectation that after these have been market proven, they would be added to the mandatory building code - either as mandatory provisions, or optional provisions in which builders could receive incentives or other types of positive feedback - e.g., moving up the queue in getting a permit, reduction in hookup fees (see Vine and Harris 1990).

5.3 Summary

Utilities will need to form partnerships with the building community and with local and state government if the utilities continue with residential new

such as home energy rating systems and low-cost financing programs are not discussed in this report, but are discussed in Vine and Harris (1990).

[1]In general, training and education activities have included providing education, training and information about new residential construction practices to builders, designers, code officials, lending institutions, and realtors. All of the programs in our study conducted training sessions. In some cases, (e.g., NYSEG), participating builders must attend a NYSE-Star training workshop to become a NYSE-Star builder. The primary reason for offering these seminars is to explain the standards of the program, construction methods, and energy-efficient equipment options. In BPA's Super Good Cents Program, most of the training in the Pacific Northwest was provided by state energy offices or extension services.

[2]This is a procedural requirement that may not result in substantive changes to state codes. States are only required to consider the MEC, compare MEC to their own code, and then submit their findings and decision to DOE.

construction programs. If incentives are reduced or eliminated, information-type programs will still be valuable in educating the building community on the merits and financial rewards of energy-efficient construction. Similarly, as state building codes are revised and strengthened, utilities will need to coordinate their program efforts and may even be asked to take a more active role in supporting energy-efficient construction and building code enforcement. In response, government might simplify code requirements so that they are easier to enforce and provide strong optional energy-saving steps into the code, so that utilities can take advantage of these options in their programs. Past programs have shown that the building community and local and state government can work together with utilities to promote energy-efficient construction. If utilities remain committed to improving the energy efficiency of residential new construction, then these partnerships will continue to be developed and strengthened in the near future.

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Appendix A

Residential New Construction Program Summaries and References

Bonneville Power Administration (BPA)

BPA's **Manufactured Housing Acquisition Program (MAP)** was an outcome of a group of key actors interested in energy-efficient manufactured housing: manufacturers, utilities, the Northwest Power Planning Council, trade associations, regulatory agencies, and state energy offices. A large-scale demonstration was initiated in 1987 as part of Bonneville Power Administration's Residential Construction Demonstration Project (RCDP): regional HUD-code manufactured home producers built 150 energy-efficient homes to meet the MCS. The demonstration showed that the industry could produce homes with significantly increased insulation levels and energy-efficient windows, making them far more energy efficient (over 50% space heating savings) than typical manufactured homes. The knowledge gained from the RCDP was used to establish the technical, information, and funding requirements for including manufactured homes in BPA;s Super Good Cents (SGC) marketing and incentives program which had already been established for site-built homes (see elsewhere).

On July 1, 1989, the SGC program for manufactured housing officially started. In this program, SGC informed and attracted potential buyers to SGC homes through advertising and labeling. Buyers would order an SGC home from the dealer, and the utility paid an incentive to the buyer. The utility inspected the home for compliance with SGC requirements. The utility incentives to the homebuilder or the dealer (up to April 1992) ranged from $2,000 to $3,000, depending on climate zone. Nearly 500 program homes were built in the first year, representing 5% of new manufactured homes built in the area. All manufacturers eventually joined the program, and penetration reached over 57% (for new manufactured homes built in the region). Because of SGC's initially low penetration rate and the desire to aggressively acquire cost-effective conservation as an energy resource, the Power Council, BPA, manufacturers and utilities decided to implement the MAP program.

From April 1992 to Oct. 1994, BPA revised its incentive system: BPA paid manufacturers $2,500 (reflecting the price paid to avoid the need for a new electric power source) for any manufactured home sited in an area served by a publicly owned utility. Typically, the manufacturer passed the utility payment along to buyers as a rebate on the incremental wholesale cost. The utility was also given $100 to compensate for the extra administrative duties that it performed. If the

manufactured home was sited in an area served by an investor-owned utility (IOU), the IOU reimbursed BPA for the $2,500 payment. Guidelines were given to the manufacturers to ensure that all of the electrically-heated manufactured homes met MAP specifications. Trained quality control inspectors verified the homes as they were built at the manufacturing plant. The utility companies then inspected the home again after it was set up at the site. The MAP homes were given the SGC label by the manufacturers.

Since the MAP program went into effect, virtually every new electrically heated manufactured home sited in the Pacific Northwest has been built to high energy efficiency levels. As of February 1995, over 46,000 homes had been built under the program. In October 1994, an upgraded national code (influenced by the MAP program) went into place, and the payment to manufacturers declined to $1,500 to reflect the higher baseline efficiency level. Partially due to the program's success and to the higher production rates than anticipated, several utilities elected to withdraw from the program about one year earlier than planned. Due to budget pressures on BPA and some of the utilities, termination of MAP was announced in January 1995, to be effective July 26, 1995. Other program options are being investigated. However, BPA is still promoting the SGC standards for manufactured homes.

BPA's effort to upgrade the efficiency of new manufactured homes is a success story. Utilities, manufactured home producers, and homebuyers all won, with a complete penetration of the electrically heated manufactured home market. The reason for the success is that the MAP program benefited from over five years of experience. As noted by Lee et al (1994): (1) **Knowledge of the industry.** The series of projects conducted with the industry built the bridges and understanding necessary to convince all parties to participate in the MAP program. Over time, considerable trust was established among the parties. (2) **Technical Feasibility.** Small and large-scale demonstration projects showed that it was possible to construct homes to meet the efficiency requirements established by the Power Council and BPA. (3) **Demonstrated Energy Savings.** The extensive computer analysis and the data from the demonstration projects showed that the expected energy savings were real. Measured energy savings became the basis for cost-effectiveness analyses that convinced BPA and the utilities of the benefits of the MAP program. (4) **Costs and Economics.** The partnership with the manufactured housing industry allowed BPA to acquire reliable cost data. The early projects showed the industry how much the

cost of their homes would increase and demonstrated the response of consumers to higher first costs, reduced utility bills, and rebates. (5) **Delivery Mechanism.** BPA, utilities, and manufacturers developed a proposal to implement a conservation acquisition and market transformation strategy that was the cornerstone of the MAP program.

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Bonneville Power Administration (BPA)

BPA's **Super Good Cents (SGC) Program** focuses on increasing the efficiency of new, electrically-heated residential construction by offering incentives for efficiency that meet the Northwest Power Planning Council's Model Conservation Standards (MCS).[1] The program has four goals: (1) increase consumer awareness, acceptance and demand for new homes built to the MCS levels; (2) increase builder understanding and acceptance of the MCS; (3) move building practices closer to the MCS; and (4) develop support for the implementation of the MCS in local and state building codes.

The SCG program, which began in 1984, was part of a two-pronged implementation effort. The SGC program was a marketing and education program promoting energy-efficient building practices. In addition, it was a building code adoption program (called the Early Adopter Program). The main objective of the program was to reduce the amount of electricity necessary to provide space heating, water heating, and cooling in newly constructed, electrically-heated homes. The program initially targeted site-built, electrically-heated, single-family and multi-family homes, but in 1988 factory-built manufactured homes were added.

The program has evolved over the years. In the first two years of the program (1985 and 1986), the program spread information about the program (primarily through television, radio, newspaper, magazine, and billboard advertising), provided training to utility personnel to help them operate the program, and educated builders about the details of SGC construction. Financial assistance was also provided in the form of administrative and advertising support for utilities and incentives (starting in 1986) for owners or builders of SGC homes. The incentive was a $2,000 payment per home, regardless of climate zone.

In 1987-88, changes were made in the program specification and incentives. The major specification changes were the elimination of the requirement for heat-recovery ventilators and continuous air-vapor barriers (they were found not to be cost-effective). Also, the incentives became variable by climate zone instead of being

[1] In Sept. 1984, BPA signed a contract with Southern Electric International for the generic Good Cents program design, trademark rights to the name and logo, and some preliminary marketing assistance.

based upon a regionally fixed number (the area served by BPA is divided into three climate zones based on the number of heating degree days). The incentives were reduced from a flat $2,000 to $1,000 in Zone 1 (the mildest region), $1,250 in Zone 2, and $1,500 in Zone 3 (the coldest region). In 1987, BPA implemented its Surcharge Policy that required all utilities to submit a residential MCS plan by the end of the year. As a result, many of the remaining eligible utilities were brought into the SGC program. Also, BPA focused more on local implementation and support than regional effort (a "decentralization policy"): e.g., BPA provided on-site technical assistance for the utilities to implement the program and increased expenditures for utility advertising.

In 1989, BPA continued the program as a voluntary marketing and promotion effort and maintained the incentives. Manufactured housing was added to the SGC program in the fall of 1989 and to the regional SGC advertising campaign in the spring of 1990. Through 1991, BPA provided additional incentives for SGC compliance of $1,000 for new site-built homes and $2,000 for new manufactured housing. BPA also provided training programs to utility company personnel who were administering the SGC programs. All of the SGC services were provided at no charge to the customer.

In 1992, BPA was forced to change its program as the states of Washington and Oregon adopted the MCS as standard building code (see below). BPA raised the standards to a level 30% above the original SGC standards, and the program was expanded to include the promotion of energy-efficient electric end-use devices in the home. They did so because they saw the program as a means of expanding the concept of energy efficiency and as laying the groundwork for building codes exceeding current MCS levels when the next opportunity for code revision arrives. Incentives were provided for increased ceiling, wall, floor, and slab perimeter insulation; double or triple pane windows; and thermally approved doors. There were also provisions for the use of passive solar design features to meet the new SGC standards.

Utility participation in the SGC program increased each year from 1984 (22 utilities) to 1988 (113 utilities). The 1988 participation rate of 88% included nearly all the utilities that could be reasonably expected to join. Most of the utilities not participating were either running acceptable alternative programs to the SGC or were covered by the Early Adopter or Northwest Energy Code (NWEC, a code-

language version of the MCS) jurisdictions. Prior to the adoption of new statewide codes, at least 90 jurisdictions in Oregon and Washington adopted the NWEC - as a result, the SGC program was scaled back or, in some cases, the utility no longer operated the SGC program after code adoption. The annual participation rate for certified SGC homes built within the BPA service territory was 26% in 1990 and a cumulative program penetration of 20% (Jennings and Block 1991).

In 1991, the states of Washington (effective July 1, 1991) and Oregon (effective Jan. 1, 1992), representing 90% of the new home starts within the BPA service territory, adopted building codes whose specifications met the SGC standards. No statewide code exists in Montana, and the Idaho code is below MCS levels. As a result, BPA set higher building standards and appliance efficiency standards for the 1992 SGC program.

The program's overall success was due in part to the SGC's marketing emphasis and the Early Adopter's code adoption emphasis. By running these two programs concurrently, the level of awareness of the importance of energy-efficient homes was raised, examples of such homes were built proving viability of the standards, and pressure was put on local governments to adopt the SGC building standards into the local building codes. The effect of successfully changing building codes is greater and more cost-effective than a program limited to marketing and incentives.

The SGC name and logo have an established reputation of quality following six years of program operation and advertising. SGC is now synonymous with high quality and a high level of energy efficiency. Overall program penetration has remained significantly below projected program targets (26% in 1990 versus a 60% target). Penetration rates are still low in the service areas of several large utilities that are now in their second or third year of program operation, while a few have achieved greater than 50% penetration.

Measures of success of SGC program:

(1) increased regional capability to provide energy-efficient new construction,

(2) raised regionwide awareness of both energy efficiency and SGC homes,

(3) achieved a high level of participation among utilities,

(4) created SGC housing units and saved the energy that would have been lost had these been built to current practice,

(5) trained builders and utilities all over the region,

(6) familiarized builders and utilities within the MCS, and

(7) developed support for setting residential building codes at the MCS level (contributed to code improvements to near-MCS recommended levels in Oregon and Washington).

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Boston Edison Company (BECO)

The **Energy Crafted Home (ECH) Program** was developed to promote energy efficiency in residential new construction through a combination of marketing to builders and home buyers, training and technical assistance for builders, quality assurance inspections, and financial incentives. The ECH Program was sponsored by major electric utilities in Massachusetts, Rhode Island, and New Hampshire: Massachusetts Electric and its affiliates (Narragansett Electric and Granite State Electric), Western Massachusetts Electric, Blackstone Valley Electric, Eastern Edison, and Boston Edison. The utilities shared in the program development, training, and marketing costs. A single program was thought to present fewer barriers for builders, who frequently build in more than one service territory and do not want to learn multiple sets of guidelines for utility conservation programs.

The ECH program began full implementation in Jan. 1991. Over 600 builders were trained through the ECH Program. Specific end-use technologies targeted were heating, cooling, and lighting. The 1992 program was performance-based. In June 1993, the program ended because of poor cost-effectiveness. A new prescriptive program serving this market was started, offering rebates for upgrading windows and insulation and installing hard-wired CFL fixtures. These prescriptive measures were intended to achieve savings by upgrading individual components, not as an alternate means of achieving ECH compliance.

The ECH Program was designed to operate with a builder-utility collaboration approach. Coordination of this multi-utility program was done by a third party. The utilities worked closely with other involved trades and were able to pool resources and retain the services of regional builders, architects, and engineers to lend their expertise to the design of the program. Over a dozen task teams were assembled to work on specific issues such as building shell, cooling, lighting, appliance, construction details, ventilation, etc. Each team was responsible for providing input on program specifications for that area. Builders were able to tell the utilities when standards were impractical or to suggest specific energy-efficient techniques that have worked for them. Moreover, these local professionals all felt some ownership in the ECH program and, therefore, were likely to build ECH homes themselves and to encourage their colleagues to do likewise.

A Builders' Advisory Board was established to provide a forum for communication between the sponsors and the builders. The builders were kept appraised of program status and reviewed program documents. The building community was very supportive of this program: e.g., the Massachusetts Association of Home Builders endorsed the program.

For builders, one of the first steps in the process of participating in the program was attending a mandatory training workshop. After the workshop, a builder submitted plans to the utility company for approval. A plan evaluator inspected the plans to make sure that they met the performance-based standards (a computer simulation program was used to determine whether a building was in compliance); if not, the builder and plans evaluator examined other options. An ECH home was certified if it met the following guidelines: (1) a mandatory equivalent leakage area (ELA) of one square inch per 100 square feet of building shell (verified through a blower door test); (2) mandatory capability of continuous mechanical ventilation from the bathrooms and kitchen; and (3) mandatory residential energy simulation modeling utilizing a particular software.

After plans were approved, construction could begin. After successful completion of the final inspection (the final inspection was the third inspection in the program), an incentive check was sent to the builders: incentives varied by house type and fuel type: e.g., $150 for single-family with fossil fuels, $1,650 for single-family with electric-heat, $75 for multi-family with fossil fuels, and $900 for multi-family with electric heat. The builder was then registered as an ECH builder after building an ECH house.

References:

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Central Maine Power (CMP)

Central Maine Power's **Good Cents Home Program** started in 1986 for single-family and multi-family construction. Through June 1991, a Good Cents Home must have met the following thermal performance standards:

Homes less than or equal to 1,250 sq. ft.: 16.5 BTUH/ sq. ft.

Homes more than 1,250 sq. ft.: 15.0 BTUH/ sq. ft.

These standards were based on a 29.9 Btuh/sq. ft. baseline estimated by a 1985 field survey of typical residential new construction practiced. In 1991, engineering audits revealed that the appropriate new baseline design heat loss for non-Good Cents homes was 19.9 BTUH per square foot (one-third less than the previous baseline).

The program provides home owners and home builders with computer-generated analyses that identify the thermal performance standards of the home (BTU/sq. ft. of heat loss) and estimate fuel consumption. The program recommends a certain package of energy-saving measures that can be installed; however, the only requirement for Good Cents certification is that the home meet the overall thermal performance standard for heat loss. The implementation of the program has focused predominately on the building community, with CMP customer service advisors devoting most of their time to contacting builders and promoting Good Cents to them. Home buyers were targeted primarily through television and newspaper advertising.

CMP Good Cents Advisors offer assistance to builders in determining energy costs and savings, payback data on Good Cents features, payback of construction options, and operating costs for heating equipment. In addition, CMP sponsors builder seminars on construction techniques and energy-efficient equipment options, and publishes a quarterly Good Cents newsletter that is distributed to all participating Good Cents builders and homeowners and to non-participating builders.

To certify that builders are building in compliance with Good Cents standards as well as to assist them with problem solving, CMP Advisors perform three inspections on proposed Good Cents Homes at various stages in the construction

process. When a CMP Advisor certifies a home as meeting minimum Good Cents standards, a Certificate of Award is presented to the owner of the Good Cents Home.

Because of concerns about cost-effectiveness, the Good Cents program was revised in 1991, and included the following revisions:

(1) The air exchange rate was reduced from 0.5 ACH to 0.3 ACH.

(2) Non-electrically heated customers were charged for Good Cents certification and inspection.

(3) The installation of water-saving appliances and devices, energy-efficient lighting and appliances was encouraged.

Because CMP has been losing electric heating customers at a rate of 26% annually since 1991 and because of low avoided costs, the Company is no longer promoting this program and may terminate the program in 1995.

References:

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New England Electric Service (NEES)

The **Energy Crafted Home (ECH) Program** was developed to promote energy efficiency in residential new construction through a combination of marketing to builders and home buyers, training and technical assistance for builders, quality assurance inspections, and financial incentives. The ECH Program is sponsored by major electric utilities in Connecticut, Massachusetts, Rhode Island, and New Hampshire: Massachusetts Electric and its affiliates (Narragansett Electric and Granite State Electric), Western Massachusetts Electric, Connecticut Light and Power, Newport Electric, and Eastern Utility Associates (Blackstone Valley Electric, and Eastern Edison). The New Hampshire Governor's Office of Energy and Community Services also helps implement the program in New Hampshire. The utilities and government share in the program development, training, and marketing costs. A single program is thought to present fewer barriers for builders, who frequently build in more than one service territory and do not want to learn multiple sets of guidelines for utility conservation programs.

The ECH program began full implementation in Jan. 1991. Over 600 builders have been trained through the ECH Program. Specific end-use technologies targeted were heating, cooling, and lighting. The 1992 program was performance-based. In early 1993, another program was started that focused on prescriptive measures (rebates were offered for upgrading windows and insulation and installing hard-wired CFL fixtures). These prescriptive measures were intended to achieve savings by upgrading individual components, not as an alternate means of achieving ECH compliance. These rebates were instituted to catch some of the lost opportunity savings which were being missed when builders of houses with electric heat chose not to participate in the ECH program.

The ECH Program was designed to operate with a builder-utility collaboration approach. Coordination of this multi-utility program was done by a third party. The utilities worked closely with other involved trades and were able to pool resources and retain the services of regional builders, architects, and engineers to lend their expertise to the design of the program. Over a dozen task teams were assembled to work on specific issues such as building shell, cooling, lighting, appliance, construction details, ventilation, etc. Each team was responsible for providing input on program specifications for that area. Builders were able to tell the utilities when

standards were impractical or to suggest specific energy-efficient techniques that have worked for them. Moreover, these local professionals all felt some ownership in the ECH program and therefore were likely to build ECH homes themselves and to encourage their colleagues to do likewise.

A Builders' Advisory Board was established to provide a forum for communication between the sponsors and the builders. The builders were kept appraised of program status and reviewed program documents. The building community was very supportive of this program: e.g., the Massachusetts Association of Home Builders endorsed the program.

For builders, one of the first steps in the process of participating in the program is attending a mandatory training workshop. After the workshop, a builder submits plans to the utility company for approval. A plan evaluator inspects the plans to make sure that they meet the performance-based standards (a computer simulation program is used to determine whether a building is in compliance); if not, the builder and plans evaluator examine other options. After plans are approved, construction can begin. After successful completion of the final inspection, an incentive check is sent to the builders. Initially, there was a $150 incentive plus the utility covered certification fees for fossil fuel-heated homes; but in January 1994, incentives for fossil fuel-heated homes were eliminated. And for builders of electric-heated homes, they were initially given $2,500 per home, but as of Jan. 1994, builders were given $2800 plus $500 for the first ECH home built. Also, builders were given $25/CFL that was hardwired. The builder is then registered as an ECH builder after building an ECH house.

References:

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New York State Electric and Gas (NYSEG)

NYSEG's Residential New Construction Program is part of the **NYSE-Star Program.** This program is designed to reduce electric consumption and demand in new residential buildings (single-family and multi-family) by encouraging new energy-efficient construction. In 1991, this program was piloted in two cities in New York. This program provides technical assistance, training, financial assistance, and marketing assistance to builders constructing new residential dwellings. Homes meeting program standards are certified as "NYSE-Star" homes. NYSE-Star is a non-profit organization formed to certify homes built to levels 25% above the existing New York State Construction Code. Participating members of NYSE-Star include the New York State Builders Association, the New York State Energy Office, the New York State Energy Research Development Association, and the major investor-owned utilities in New York (NYSEG, Niagara Mohawk, Rochester Gas and Electric, Long Island Lighting Company, ConEd, Orange and Rockland, and Central Hudson).

For all new construction, this program uses building efficiency performance standards that allow flexibility in selecting energy-efficient building shell measure packages that meet NYSE-Star standards. These include blower door-assisted air sealing, improved windows, and higher levels of insulation. Other measures include lighting, space conditioning, electric water heating, and appliances.

Incentives are provided to offset the incremental costs of installing the measures and administrative costs for the builder to participate in the program in 1993. This program also contains builder certification, builder education, on-site quality assurance procedures, and marketing assistance to promote consumer demand for energy-efficient housing. Since 1993, NYSEG's NYSE-Star program has targeted both single-family and multi-family homes. Non-electric homes are not supported by NYSEG's program.

As of January 1, 1995, the program changed significantly: the program emphasized information, ended cooperative advertising, and limited rebates to ground-source heat pumps and water heaters connected to these heat pumps.

References:

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Orange and Rockland (O&R)

The first **Good Cents Program** started in 1977 and was designed to encourage the construction of more energy efficient homes. O&R implemented the program in 1986 while qualifying their first home in 1987. The program was initially promoted in New York and New Jersey, but the program in New York ended in September 1993, and the New Jersey program continues but without rebates. Most of the homes participating in this program are multifamily homes: in 1992, 132 multifamily versus 120 single family. The current criteria for qualifying as a Good Cents homes is 14 Btuh/ft-squared. O&R targeted space heating and air-conditioning measures via high efficiency heat pumps and building envelope measures. Rebates were provided for energy-efficient heat pumps, and the builder received another incentive of $1/square foot up to 2,000 square feet for single-family homes, or $0.50/square foot up to 2,000 square feet for multifamily homes.

The New York program was targeted primarily to builders, especially speculation builders. Training is not required, but he NYSE-Star program offers a training course for builders.

References:

Synergic Resources Corporation. 1993. "Comprehensive Evaluation of Orange and Rockland Utilities' Good Cents Home Construction Program." Bala Cynwyd, PA: Synergic Resources Corporation.

Pacific Gas and Electric (PG&E)

PG&E's **California Comfort Home Program** was part of their RNC program and encouraged builders to exceed Title-24 cooling efficiency standards by at least 10% by installing measures such as high-efficiency air conditions and increased insulation. After qualifying for the CCH program, participants could apply for the High Performance Window (HPW) part of the RNC program. The HPW program is a prescriptive approach that offered builders incentives for installing windows that exceeded Title-24 standards.

PG&E first introduced the California Comfort Home (CCH) program to home builders in 1990. The program was initially designed to encourage builders to exceed Title-24 Residential Energy Standards for cooling by 10% or greater. Builders focused on several areas of improvement including high-SEER air conditioners, increased ceiling and wall insulation, and increased duct insulation. Cash incentives were based on total cooling budget improvements. In 1990, 1991, and 1992, bonus cash incentives were also available for the installation of high performance windows.

In 1993, the program was updated to provide incentives for a variety of energy efficient components including air conditioning, improved duct installation, lighting, and natural gas space and water heating and appliances. Special bonus programs were also made available to encourage down-sizing of the air conditioning unit and the use of non-traditional cooling methods in place of refrigerant-based air conditioning.

In 1994, the program underwent a comprehensive program redesign in an effort to: (1) increase program cost-effectiveness by consolidating a prescriptive program around critical measures with the greatest potential for efficiency improvement, and (2) provide a more accessible program to California builders by reducing the processing requirements and expanding the program offerings to include pass-along home buyer rebates.

Most contracts for the 1991 and 1992 CCH programs expired as of Feb.. 28, 1994.

Since Dec. 31, 1992, the minimum Title-24 allowable air conditioner SEER is now 9.7 for packaged systems and 10.0 for split systems. The CCH program in 1993 reflected this change and required an increase over this new minimum by 2 SEER points. In

addition, Title 24 no longer allows the use of default window U-values, so the impact of high performance windows will now be felt in terms of Title-24 compliance.

New California Residential Building Standards resulted in modifications to the RNC Program, effective Jan. 1, 1993, resulting in the original program coming to an end. Units will continue to be completed during 1993 and the first half of 1994. Under standard permitting procedures, builders are allowed 12-18 months to complete construction.

References:

Caulfield, T. and A. G. Lee. 1994. "PG&E Residential New Construction Program Impact Evaluation," *Proceedings from the 1994 ACEEE Summer Study* Vol. 8, pp. 29-35.

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PECO Energy Company (PECO)

PECO Energy's **Excellence in Energy Efficiency (EEE) Program** started in 1985 to improve the operating experience of residential customers with heat pumps. Implicit in the design of the program was the building of load to enhance utility profitability. The program was also designed to improve customer satisfaction by lowering energy bills and increasing comfort. Over the years, the goals of the EEE program have expanded. No longer is EEE a heat pump program per se. The program strives to improve energy efficiency for both electric and gas customers.

The EEE Program requires participating builders to meet energy efficiency standards above and beyond Pennsylvania's Act 222, the Building Energy Conservation Act. Builders must certify compliance with standards for: infilration control, properly designed ductwork and pipes, high-efficiency heating and cooling equipment, domestic water heating efficiency measures, building envelope treatments, and controlled venting for fireplaces and gas-fired cooking equipment.

The EEE Program focuses on proper installation of required measures, changes in construction practices, and performance-based testing (e.g., blower door testing for measuring air infiltration). PECO also provides participating EEE builders with a cooperative advertising budget, technical support for promotions, and staff support for open houses. In addition to promoting the program to builders, PECO Energy markets the program directly to homebuyers through print, radio, and transit advertising.

More than 18,000 EEE homes have been built, over 200 home builders have participated in the program, and nearly 25% of all new homes in the service territory have been constructed to EEE standards.

In July 1994, PECO Energy introduced a new program (Smart Choice Home) that goes beyond the EEE Program by including duct leakage testing and increased levels of insulation that significantly exceed state requirements and EEE standards.

References:

Xenergy, Inc. 1992. "Evaluation of Philadelphia Electric Company's Excellence in Energy Efficiency Program." Xenergy, Quakertown, PA. 1992.

Southern California Edison (SCE)

From April 1990 to April 1994, SCE's **Welcome Home Program** provided incentive payments to builders to construct dwellings that were more efficient than would be required by the Title-24 building standards. These incentives were applied to air-conditioner/heat-pump efficiency and to building envelope measures such as glazing and insulation. The program rewarded builders for 10%, 20%, and 30% savings in excess of Title-24 requirements and encouraged a greater degree of compliance with the Title-24 building construction standards. As of February 1992, over 10,000 homes participated in the program, of which about 6,000 were sold and occupied.

The program primarily targeted builders, and the utility promoted the following program benefits to them: (1) provides a competitive edge by offering added value to discriminating buyers; (2) pays builders financial incentives that help offset the cost of energy-efficient upgrades; (3) imparts an enhanced image of product; and (4) provides a full array of on-site promotional materials and sales agent training.

In 1990, builders received incentives of $4,000 per house. In 1992, the incentive was $1,500, and in 1993, the incentive was $1,200. In 1994, the utility worked with air conditioning distributors to reduce the rebate in half: the utility would pay an incentive of $550 and the distributors would reduce their costs by the same amount, so that the incremental cost to the builder was zero. The air conditioning distributors were also responsible for marketing the program (i.e., SCE did not market the program in 1994).

References:

Southern California Edison. 1993. "1991 Welcome Home Program - Appliance Kilowatt Hour Usage and Savings by Time of Use for Southern California Edison" (Nov. 24, 1993), Rosemead, CA: Southern California Edison Company.

Southern California Edison. 1993. "Southern California Edison 1990-1991 Welcome Home Program Impact Analysis" (Sept. 1993), Rosemead, CA: Southern California Edison Company.

Appendix B

Telephone Screening Survey Form

RESIDENTIAL NEW CONSTRUCTION PRELIMINARY SURVEY

Utility Name:

Program Name:

Person Interviewed:

Date of Interview:

PHONE NOTES:

1. Does this program go beyond existing state (or local) codes? If so, how much (a specific percentage)?

2. Has this program ever been evaluated to see how well it is (was) doing?

3. Are any formal process or impact evaluations available?

4. Do you have any information on how cost-effective the program has been? Do your cost-effectiveness calculations include participant costs?

5. Have you done any research to determine the baseline energy-use in existing construction?

6. Do you have any information on the level of non-compliance with existing codes?

7. Has any research been done on how non-participating builders have been affected by the program?

8. Other comments:

Appendix C

DEEP Data Collection Instrument*

* The version of the Data Collection Instrument (DCI) that is reproduced in this Appendix is the most recent version used in our residential new construction research efforts. It should be noted that the development of the DCI is an ongoing process, and that the DCI has evolved over the course of our research. We will continue to revise and improve the DCI as we analyze DSM programs in the future.

DEEP DATA COLLECTION INSTRUMENT

Refer to the instructions for a description of terms

DEEP Staff Member: Ed Vine **Phone:** (510) 486-6047

Date Submitted: _____

Utility Name: _____

Program Name: _____

Program Start Date: _____ ✔ **Ongoing**

❒ **Terminated - Program End Date:** _____

Data Period

DEEP data covers program activities from: _____ to: _____

Measure installations occurred from: _____ to: _____

I. General Program Overview

Program Status:

- ❒ Pilot
- ❒ Transition
- ❒ Full Scale
- ❒ Phase Out

Program Objectives:

- ❒ Energy Efficiency
- ❒ Load Shifting
- ❒ Valley Filling
- ❒ Peak Clipping
- ❒ Load Building

Implementing Agent:

- ❒ Utility
- ❒ Energy Service Company
- ❒ Government Agency
- ❒ Contractor
- ❒ Other (specify: _____)

Eligible Market:

- ✔ New Construction

Program Type:

✔ Installation of Conservation Measures

Eligible Customers:

✔ Residential

Marketing Objectives

What were the utility's primary marketing objectives for this program?

_____

_____

Werethere concerns about load building?

_____

_____

Marketing Strategy

What was the basic marketing strategy for this program?

_____

_____

Marketing Methods

- ☐ Direct Mail
- ☐ Newspaper Ads
- ☐ Radio/TV Ads
- ☐ Telemarketing
- ☐ Bill Inserts
- ☐ Brochures
- ☐ Newsletters
- ☐ General Advertising
- ☐ Seminars/Workshops
- ☐ Shows & Exhibits
- ☐ Tests/Demonstrations
- ☐ Other (specify: ____)

Direct Contact By:

- ☐ Utility
- ☐ Trade Ally
- ☐ ESCO

Marketing Incentives

How much were the incentives and who received them?

_____

_____

Marketing Incentives (√ if used)

	Recipients of Incentives			
Incentive Type	**Customers**	**Trade Allies**	**Manufacturers**	**Government**
Rebates				
Direct Installation*		–	–	
Subsidized Financing/Loans		–	–	
Bill Credits				
Services				
Leasing		–	–	
Rate Discounts		–	–	
Cooperative Advertising	–			–
Bulk Power Purchasing			–	
Gifts			–	–
Tax Incentives		–	–	
Other (specify: _____)				

* No out-of-pocket cost to program participants

Targeted Market Group

- ❒ Homeowners
- ❒ Non-Res. Building Owners
- ❒ Renters
- ❒ Non-Res. Leasors/Renters
- ❒ Building Operators/Managers
- ❒ Other (specify: _____)
- ❒ A/E Firms
- ❒ Realtors
- ❒ Developers
- ❒ Builders
- ❒ Contractors
- ❒ Trade Associations
- ❒ Manufacturers
- ❒ Wholesalers
- ❒ Retailers
- ❒ Energy Service Companies
- ❒ Non-Profit/Not-for-Profit Groups
- ❒ Government

Changes in Program Description from Previous Years

_____

_____

_____

_____

Technologies Offered by Program

Using the checklist on this page, please indicate the types of technologies that can be installed through your program.

❒ **All Measures**

❒ **HVAC**
- ❒ High Efficiency
- ❒ Heat Pump
- ❒ Duct Sealing and Balancing
- ❒ Operations and Maintenance
- ❒ Other (specify: _____)
- ❒

❒ **Water Heating**
- ❒ High Efficiency
- ❒ Heat Pump
- ❒ Piping Insulation
- ❒ Insulation Blankets
- ❒ Low-Flow Showerheads
- ❒ Low-Flow Aerators
- ❒ Operations and Maintenance
- ❒ Other (specify: _____)

❒ **Other**
- ❒ _____
- ❒ _____
- ❒ _____

❒ **Lighting**
- ❒ Compact Fluorescents
- ❒ Electronic Ballasts
- ❒ High Efficiency Magnetic Ballasts
- ❒ Reflector Systems
- ❒ Efficient Fluorescent Lamps (T-8 etc.)
- ❒ Lighting Controls
- ❒ Occupancy Sensors
- ❒ Operations and Maintenance
- ❒ Other (specify: _____)

❒ **Building Envelope**
- ❒ Insulation
- ❒ Infiltration Control
- ❒ Glazing and Glazing Control
- ❒ Operations and Maintenance
- ❒ Other (specify: _____)

Program Uniqueness

On-Site Inspections

How many homes are inspected?

_____

_____

How many on-site inspections are done per site?

_____

_____

When are the on-site inspections done?

_____

_____

Existing Codes and Standards

How does this program compare to state (or federal) building codes?

_____

_____

How does this program compare to federal (or state) appliance standards?

_____

_____

Are there plans to incorporate the program's technologies into national or state standards, and if not, why not?

_____

_____

Utility and government interaction

What is the level of code coordination between utilities and government?

_____

How active is your utility in:

(1) analyzing prospective code changes?

_____

_____

(2) advocating code changes that are cost effective?

_____

_____

(3) using its program to lay the foundation for future code changes?

_____

_____

(4) working with government on training and technical assistance efforts?

_____

_____

(5) who is being trained (builders, architects and engineers, subcontractors, building code officials)?

_____

_____

How active is state government in:

(1) simplifying code requirements so that they are easier to enforce and more readily adaptable to your program?

_____

_____

(2) updating its code on a regular basis to keep up with, or even ahead of, prevailing construction practices?

_____

_____

(3) providing strong optional energy-saving steps into codes, steps that your utility can use as the basis for a voluntary incentive program?

_____

_____

(4) improving the enforcement of existing codes?

_____

II. Program Participation

	Annual (indicate year)	Cumulative (from ____ to ____)
Number of homes built under this program		
Number of new homes built in service area		
Percent of new construction built under this program	%	%
Number of builders participating in this program		
Number of builders in service area		
Percent of builders in service area participating in program	%	%

Do you have many repeat participants? If so, how do you track their participation with regard to a cumulative participation rate?

_____

Demographics of Participants

Building Type	Number of Buildings	Builder Type	Number of Builders
Single Family		Custom	
Multi-Family		Production	
Manufacture d Housing			
Fuel Type	**Number of Buildings**		
Electric only			
Gas only			
Electric & Gas			

III. Program Costs

In this section, we are interested in obtaining the most detailed breakdown of program costs that you can provide us. Please indicate below the cost categories that your utility uses and program expenditures for the time period indicated. Common subcategories are:

Incentive Costs: Audits, Equipment, Installation
Non-Incentive Costs: Program Design, Marketing, Administration, Overhead, Tracking, Data Processing, Labor, Shareholder Incentives
Measurement and Evaluation Costs: Impact, Process, End-Use Metering, Overhead, Tracking
Participant Costs: Equipment, Installation, Maintenance

Note: If available, please report cost information in nominal dollars.

Specify Dollar Year(s) Used: _____

Cost Information for Time Period: _____ **to :** _____

Utility Costs	Expenditures (in $1,000s)
Incentive Costs:	
Non-Incentive Costs:	
Total Utility Costs (excluding M&E)	

Measurement and Evaluation Costs:	Expenditures (in $1,000s)	Already Spent (use √)	Projected Cost (use √)	Program Year(s) Evaluated	Year(s) Evaluation Costs Incurred
Total M&E Costs:					

Are Tracking Database costs included in Measurement and Evaluation Costs? Yes ❒ No ❒

Participant Costs	Expenditures (in $1,000s)
Total Participant Costs	

Is the cost of equipment installation included in the *incentive* costs above? ❒ Yes ❒ No

Is the cost of equipment installation included in the *participant* costs above? ❒ Yes ❒ No

What is the overall design of the rebate level offered by the utility (e.g., percent of incremental costs or percent of total costs)? Does this include installation costs?

_____

_____

_____

If they are not indicated in one of the tables above, what is your estimate of total installation costs (not including the cost of measures themselves)?

_____

_____

What is the source of your estimate of installation costs?

_____

_____

_____

IV. Evaluation Methods and Results

In this section of the survey, we are asking for detailed information on the evaluation methods used by your utility, and the results of those methods. We begin with questions about the utility tracking database, then proceed with questions about evaluation methods which analyze energy consumption, such as billing analyses and end-use metering. After asking for information about persistence, free rider, and free driver methodologies, we provide space for the savings estimates themselves.

For many utility programs, different methods are used to evaluate the savings for different measures. In the following table, use ✔s to summarize the evaluation methods used. Then proceed to answer the more detailed questions about the evaluation methods used.

Measure/ or Group of Measures/ or Program	Tracking Database Estimate/ Engineering Algorithms	Computer Building Simulation (e.g., DOE-2)	Comparison of Customer Billing Data	Regression of Customer Billing Data	Regression with Conditional Demand Analysis	Regression with SAE Estimate	End-Use Metering

Please describe the methodology used to evaluate program savings. Where appropriate, how were results from different methods combined to yield final savings estimates?

_____

_____

_____

_____

_____

Baseline Information

Please complete the following questions on your baseline for new construction.We are interested in the sources and estimates used in creating your baseline.

How do you determine the efficiency of new construction?

❑ Market surveys ❑ Site surveys ❑ Expert judgment ❑ Federal laws ❑ State laws ❑ Other

Do you have a state/regional building code?

❑ Yes ❑ No

What is the level of compliance with the state/regional building code, and has it been measured?

_____

_____

Do typical building practices exceed existing codes and standards, and have they been measured?

_____

_____

Can energy savings from code compliance be added to the energy savings for buildings that go beyond the code?

_____

_____

Free Riders and Free Drivers

Free Rider Estimates

Were free riders estimated and, if so, how were they measured?

❑ Yes
- ❑ Survey
- ❑ Discrete choice model
- ❑ Other (please specify:)

❑ No

What question(s) were asked, and what response to each question indicates a free rider?

_____

_____

What was your estimate of free ridership? _____

Free Driver Estimates

Were free riders estimated and, if so, how were they measured?

❑ Yes
- ❑ Survey of participating builders
- ❑ Survey of nonparticipating builders
- ❑ Survey of trade allies
- ❑ Focus group

❑ No

What question(s) were asked, and what response to each question indicates a free driver?

_____

_____

What was your estimate of free drivership? _____

Persistence and Takeback

Any studies done on persistence and takeback in new constrcution?

_____

_____

Total Energy Savings

In the following table, please provide the post-program annual savings estimates (*without* including adjustments for free riders or free drivers, when possible) along with the standard error or standard deviation of the result, when available.

Annual Measured Savings	Std. Dev.	Method(s) used to Estimate Savings	Time Period of Savings

Avoided Costs and Utility Cost-Benefit Analyses

The avoided cost of electricity provides a benchmark for program performance that is specific to each utilities' circumstances. We solicit the information in this section so that we can compute the levelized avoided cost of the program as estimated by program planners at your utility. We will use this information to determine the cost-effectiveness of the program.

(☐ Check here if the TRC and levelized cost figures used below are post-program, rather than pre-program, estimates.)

Have Utility Cost Test (UCT) and/or Total Resource Cost Test (TRC) ratios been estimated for this program?
p Yes p No

What are the UCT and TRC ratios?

_____

_____

_____

What environmental adders/adjustments were included in the TRC?

_____

_____

What is the utility's estimate of levelized program cost?

_____

What are the discount rate and number of years over which program costs are levelized and program savings are assumed?

_____

_____

How satisfied have homeowners and builders been?

Does your utility receive financial incentives for implementing this program?

V. Additional Program Information

Lessons Learned

(Include difficulties encountered in program implementation, evaluation, and end use technologies; significant program changes due to evaluation; recommendations for program improvement (including greater cost-effectiveness and minimizing utility costs); and key elements for program success)

Related Programs

_____

_____

_____

DOCUMENTATION

Process and Impact Evaluation (✔ if available)

- ❒ Process evaluation data are available for this program
- ❒ Process evaluation reports are available for this program

- ❒ Impact evaluation data are available for this program
- ❒ Impact evaluation reports are available for this program

Additional evaluations planned or ongoing:

_____

_____

Publications:
(include title, author, date published, DEEP library number, report availability, summary, and comments)

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Primary DEEP Contact:

Name _____ Title _____

Address _____

_____

City _____ State ____ Zip

Phone # _____ Fax # _____

Program Manager

Name _____ Title _____

Address _____

_____

City _____ State ____ Zip _____

Phone # _____ Fax # _____

Program Evaluator

Name _____ Title _____

Address _____

_____

City _____ State ____ Zip _____

Phone # _____ Fax # _____

Appendix A

Summary Program Description

(Include type of program, eligible customers, end uses promoted, implementing agents, program year(s), program cost, rebate level, energy and capacity savings (specify net or gross), basis of energy savings estimate, number of participants, participation rate if available, and any unique program features)