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Planning for an Energy-Efficient Future: The Experience with Implementing Energy Conservation Programs for New Residential and Commercial Buildings

Volume 1

E. Vine and J. Harris

September 1988

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DISCLAIMER

LBL-25525

PLANNING FOR AN ENERGY-EFFICIENT FUTURE: THE EXPERIENCE WITH IMPLEMENTING ENERGY CONSERVATION PROGRAMS FOR NEW RESIDENTIAL AND COMMERCIAL BUILDINGS

VOLUME 1

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EXECUTIVE SUMMARY

This report is one of a series of program experience reports that seek to synthesize current information from both published and unpublished sources to help utilities, state regulatory commissions, and others to identify, design, and manage demand-side programs. This report evaluates the experience with implementing programs promoting energy efficiency in new residential and commercial construction. This investigation was guided by our perspective on how programs address the barriers to widespread adoption of energy-efficient design and better end-use technologies in new buildings. We considered four types of barriers: lack of information, high initial costs, degree of technological development, and perceived risk. We developed a typology that reflects different approaches to overcome these barriers to energy-efficient construction.

We focused our investigation on nonregulatory programs that are designed to complement—or in some cases substitute for—mandatory energy efficiency requirements in local and state building codes. Nonmandatory programs can complement building standards by providing: (1) options for innovative approaches not covered by standards, (2) incentives for early adoption of standards, and (3) training workshops and material for educating the building community and thus enabling and enhancing compliance with standards (e.g., by reducing the cost of compliance to builders and the cost of code enforcement to government).

We evaluated the following types of nonmandatory programs: technology demonstrations and demonstration programs, financial incentive programs (including rebates, conservation rates, hookup fees, reduced rates on loans and loan qualifications, guaranteed savings, and tax credits), consumer information and marketing programs (including energy rating systems and energy awards), technical information programs (including professional guidelines, design tools, design assistance, and standards-related training, compliance, and quality control), and site and community planning. We examined available data on market penetration rates, energy savings, reliability of savings and penetration, program costs, and cost-effectiveness. We compared the relative strengths of the programs and compared programs both within and between different program approaches. Detailed descriptions of these programs are contained in Volume 2.

General program conclusions, applicable to most of the energy conservation programs reviewed in this report, were the following:

- Many different types of nonmandatory programs appeared to be successful in overcoming barriers to promoting energy efficiency in new buildings, and in complementing and facilitating the adoption of future energy conservation building standards and the implementation of and compliance with existing standards; no program strategy was clearly dominant.

- However, few program evaluation studies exist, resulting in a paucity of quantitative data on program effectiveness, especially beyond the pilot or demonstration stages.
- Only a few programs were designed as part of a long-term strategy to promote energy-efficient construction.
- Successful programs were often characterized by intervention early in the design and planning process in order to minimize delays in the project design, approval, financing, and construction process.
- Education, training, and design assistance activities were especially important.
- Most programs focused on the early design stages of a program without addressing issues normally arising later in the program (e.g., detail of construction, quality control, building commissioning, and operations and maintenance).
- Utility rate designs were not typically used as conscious reinforcement for promoting energy-efficient construction.
- Many programs were considered successful for both energy and nonenergy reasons (e.g., improved thermal comfort, creation of new markets, and improved customer relations).
- Nonmandatory programs can reinforce and pave the way for codes.
- Most of these programs can be easily implemented in other areas around the country and in other countries.

In addition to these general conclusions, key findings for specific program categories were the following:

Demonstration programs

- Demonstration programs were often well-funded and helped create the infrastructure and capability to deliver large-scale energy conservation programs. The focus of many demonstration programs was on "innovators" ("market-leaders") and not on high market penetration rates.

Financial incentive programs

- The impact of financial incentives on program participation was greater when offered in conjunction with technical assistance, training, and education.
- The size of an incentive has not been shown to be positively correlated with program participation; the presence of an incentive may have been more important than its magnitude.
- Reduced utility rates were well-received by residential customers and utilities, were easy to implement, and often resulted in peak demand savings.
- Although potentially of great impact, hookup (connect) fees tied to a building's energy efficiency have not been tested in the U.S..
- Few programs have promoted guaranteed savings.
- Reduced mortgage rates and lending policies incorporating energy efficiency guidelines have thus far had limited impact in creating market demand for energy-efficient housing.
- Tax credits were useful for promoting energy efficiency investments, but their future impact is limited since few states still offer tax credits.

Consumer information and marketing programs

- Home energy rating systems (HERS) were more successful, in terms of penetration rates and improved energy efficiency, when they:
  - were actively marketed
  - had a comprehensive appreciation of the market
  - were adaptive to the needs of particular users, and
  - included user participation in the operation and revision of the program.
- Where offered, the average percentage of new residential construction participating in HERS was 40%.
- Measured annual electricity savings of new homes participating in HERS and residential demonstration programs ranged from 30-50%.
- Energy awards were effective in promoting energy-efficient construction when featured as part of comprehensive energy efficiency programs.

Technical information programs

- Design tools were effective in promoting energy-efficient construction when featured as part of comprehensive energy efficiency programs.
- Design guidelines issued by professional organizations were important, over the long term, in establishing new norms of professional practice, new design guidelines, and new local and state building codes; however, more immediate, personal, and interactive design assistance is often needed for promoting energy-efficient construction.
- The focus of many design assistance programs was on "innovators" ("market-leaders") and not on high market penetration rates.
- Design assistance programs demonstrated that the initial reluctance of some designers to have their plans "reviewed" can be overcome when both the design firm and the client are clearly shown the benefits of designing energy-efficient buildings.
- Design assistance programs were most successful when energy efficiency options were introduced as early as possible in the design stage and when they did not add delays to the project design, approval, financing, or construction process.
- Design assistance programs demonstrated that, in many cases, substantial gains can be made in energy efficiency without requiring significant cost increases or significant changes in building practices.
- In some design assistance programs, the added amount of time spent on design and energy modeling in the early stages of a project led not only to energy savings but also reduced initial construction costs for some buildings.
- Technical workshops and seminars were important for encouraging conformance with mandatory standards or voluntary guidelines.
- Quality control inspections were key features of many programs, especially those rating buildings.

Site and community planning

- Solar access protection regulations helped promote energy-efficient construction.
- Increased dwelling density in planned unit developments was a powerful incentive for promoting energy-efficient construction.
- New communities offer the potential for widespread construction of energy-efficient buildings.

For designing and implementing energy conservation programs for new buildings, the evidence suggests that a comprehensive and long-term perspective is needed to design and choose programs. Long-term goals and objectives of programs need to be made explicit for providing program guidance. A well-integrated package of programs should contain the following program strategies: design assistance, financial incentives, quality control, training and education of design professionals and the building community, simple and easy-to-use design tools, rating and labeling of buildings, effective marketing and promotion, energy awards for buildings and for design and building professionals, operations and maintenance activities, building commissioning, process and impact evaluation, monitoring, and feedback activities. This undertaking is as serious as those for past resource decisions and is necessary for the serious promotion of energy-efficient construction in the residential and commercial sectors. If one organization is unable to provide both incentives and support activities, then two or more organizations may be able to coordinate these activities as part of one program (e.g., utilities provide financial incentives and local governments provide support activities).

Most of these programs can be easily implemented in other areas around the country. Geographical and climatic differences were not seen as barriers to the implementation of these programs. However, since program implementation is a political process, different political interest groups may be able to prevent the implementation of a program that was successfully implemented elsewhere. As a word of caution, we do not want to imply that programs can be easily transferred from one region to another. Programs can be used as models, but they must be adapted to fit local circumstances. Program managers need to find out about the details of other programs before adopting them, including any mid-course corrections made during the implementation of the program. Implementation is not an easy task, and there have been lots of failures at various stages in the implementation process. The challenge is to design and implement a program that meets the needs of the target audiences as well as promote energy-efficient construction.

At the end of the report, we examine several critical issues overlooked or not emphasized in the programs reviewed in this study:

- Construction quality, follow-up, and compliance
- Building commissioning and long-term operations and maintenance
- Strategies "outside the building shell"
- Rate incentives and rate design as marketing tools
- Guarantees of savings and of rate stability

These issues are briefly discussed and are introduced in this report because they deserve greater attention in the planning of future programs.

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CHAPTER 1. INTRODUCTION

For over ten years, energy conservation programs for new residential and commercial buildings have been implemented by local, state, and federal government agencies, utility companies, and private organizations in the U.S. and in other countries. Most of these programs have been designed and implemented in isolation from one another and have emphasized different technical and marketing designs. Because of the renewed interest in these programs (in part related to utility demand-side planning efforts[1]), it is important to understand how effective they have been in penetrating the new construction market, in saving energy, and in influencing the design and construction of energy-efficient buildings. In addition, we need to know what kinds of issues remain unresolved and what kinds of programs need to be implemented.

This report is one of a series of program experience reports that seek to synthesize current information from both published and unpublished sources to help utilities, state regulatory commissions, and others to identify, design, and manage demand-side programs.[2] This report evaluates the experience with implementing nonmandatory programs promoting energy efficiency in new buildings. We investigated this topic for several reasons. First, many areas of the country are experiencing increasing demand for electricity, due in large part to all-electric new construction. Constructing energy-efficient buildings (including those with lower demand during utility system peak periods) will reduce the need for, or forestall, new power generating plants. Second, even in areas where there is now a surplus of electric generation capacity, new buildings should be considered a "durable good" that will last for 3 to 5 decades or more; any delay in constructing energy-efficient buildings represents a "lost opportunity" to save energy (Northwest Power Planning Council, 1986). Third, it is often easier and less expensive to construct an energy-efficient building from the beginning than to retrofit an existing building later. Fourth, in those areas where building codes have been in place for a number of years, there is a general reluctance to further tighten the energy-efficiency requirements until other, nonregulatory approaches have been explored. Finally, the implementation of the programs demonstrates that utilities can become active participants in promoting energy-efficient buildings without being linked by their customers with the stigma often connected to mandatory building standards.

The programs examined in this report illustrate the range of approaches taken in promoting energy-efficient buildings. We were interested in both successful and less successful programs, since both can help guide future program design. We feel that our sample of programs represents

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[1] Demand-side planning includes both conservation and load-shifting programs.

[2] A series of end-use energy technology assessment reports is also being prepared by Lawrence Berkeley Laboratory (e.g., Greenberg *et al.*, 1988; Piette *et al.*, 1988).

many of the most important programs encouraging energy-efficient construction in new buildings in the United States and in other countries, and that their collective experience can be helpful as a guide to future program and policy choices. Detailed descriptions of the programs are contained in Volume 2.

The rest of this chapter discusses the methodology used in identifying programs and the conceptual framework used to analyze them. In Chapter 2, we provide an overview of the programs, by category, and indicate some of the most, as well as the least, successful programs or program features. In Chapter 3, we summarize the key findings of the programs reviewed in this report, provide recommendations for program design and implementation, and suggest ideas for new programs for promoting energy efficiency in new buildings that have not yet been fully tested nor implemented on a large scale.

1.1. CONCEPTUAL FRAMEWORK

This investigation was guided by our perspective on how programs address the barriers to widespread adoption of energy-efficient design and better end-use technologies in new buildings. Different frameworks have been used in the investigation of barriers in residential and commercial buildings; our categorization reflects these earlier perspectives (e.g., Blumstein *et al.*, 1980; Nieves and Fang, 1985). We considered four types of barriers: lack of information, high initial costs, degree of technological development, and perceived risk. These barriers are not mutually exclusive and often interact:

Information

Designers, architects and engineers, builders and developers, and the lending community need information on energy-efficient design and product availability, as well as data on their costs and energy performance. In addition, there is a widespread need for better energy design tools and improved methods for evaluating new technologies as they relate to a specific building. The lack of this information and the perception of problems regarding new technologies may prevent even highly motivated individuals from investing in cost-effective, energy-efficient buildings, or inhibit design professionals from recommending such measures.

Initial Costs

Most of the actors involved in the design, construction, and ownership of energy-efficient buildings are sensitive to initial costs and are less concerned with long-term operating costs. Similarly, any time delays in designing and constructing a building represent increased costs that someone must bear. This is of special concern to small developer/builder firms, to owners or developers of "speculative" commercial space, to prospective home buyers with strained budgets, and even to many governmental agencies. Frequently, an increase in initial costs is passed through to the buyer (possibly affecting the buyer's ability to qualify for a loan) and to tenants in apartments and leased commercial buildings. Accordingly, market demand for more efficient buildings may be lessened if the initial costs are perceived as too high, while the corresponding savings in energy operating costs viewed as too small or not reliable.

Technology

The availability of some new energy-efficient technologies may be limited (e.g., electronic ballasts and point-of-use water heaters), especially in those areas where there is no established market. Also, a large number of manufacturers continue to introduce new products into the marketplace at a fast rate. As a result, problems arise related to the quality, performance, and reliability of these products, and possible adverse impacts on occupant health and comfort. The lack of a support infrastructure that is willing and ready to install and/or service new products may compound the problem. Furthermore, new technologies may not be readily accepted without the availability of measured, long-term performance data from a credible source, or some sort of quality assurance from an established institution.

Perceived Risk

For some individuals, the perceived risks associated with constructing (or owning) an energy-efficient building may be considered too high, compared to a more familiar "current practice" building. In the absence of adequate financial incentives, individuals may prefer to wait until new energy-efficiency standards are required, until the advantages of these new technologies have been demonstrated beyond any doubt, or until they are more familiar with the performance of the new designs and products.

Each of these barriers suggests, in turn, possible strategies to overcome barriers to energy-efficient construction in new residential and commercial buildings. In organizing the information on the wide range of programs examined, we developed a typology (Table 1) that reflects different approaches to overcome these barriers to energy-efficient construction. Several of the programs we examined have multiple objectives and may overlap the program categories described in Table 1. Moreover, at different stages in the implementation of a given program, the objectives and emphasis may change, thereby changing the nature of the program. For example, demonstration efforts tend to evolve toward technical information programs. Similarly, financial incentives may be phased out once they achieve a certain amount of visibility and market acceptance, to be replaced by information, marketing, and design assistance activities.

Table 1. Types of nonmandatory programs.

Programs	Barriers Addressed			
	Information	Cost	Technology	Risk
Technology Demonstrations and Demonstration Programs	Yes	[Yes]*	Yes	Yes
Financial Incentives				
Direct Incentives	[Yes]	Yes	No	[Yes]
Reduced Utility Rates and Hookup Fees	[Yes]	Yes	No	[Yes]
Reduced Rates on Loans and Loan Qualifications	[Yes]	Yes	No	[Yes]
Guaranteed Savings	[Yes]	Yes	No	Yes
Tax Credits	[Yes]	Yes	No	[Yes]
Consumer Information and Marketing				
Energy Rating and Labeling	Yes	[Yes]	[Yes]	Yes
Energy Awards	Yes	No	No	[Yes]
Technical Information				
Professional Guidelines	Yes	No	[Yes]	Yes
Design Tools	Yes	No	[Yes]	Yes
Design Assistance	Yes	[Yes]	[Yes]	Yes
Standards-related Training, Compliance, and Quality Control	Yes	[Yes]	[Yes]	Yes
Site and Community Planning	Yes	No	[Yes]	Yes

* A [Yes] response indicates that the barrier addressed is not the primary focus of the program.

We focused our investigation on nonregulatory programs that are designed to complement—or in some cases substitute for—mandatory energy efficiency requirements in local and state building codes. We did not examine implementation issues or impacts of the codes themselves.[3] Building codes and standards, however, do serve an important purpose that is missing in nonmandatory programs. Codes and standards provide a mechanism to establish minimum acceptable efficiency for all new buildings ("sacrificing depth for breadth"). Thus, the role of mandatory regulations is to eliminate (in principle) practices that are the "worst" in terms of energy efficiency. Because such standards are necessarily the products of compromise, they do relatively less to promote development or early acceptance of the best energy-efficient designs,

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[3] For information on current building codes and standards in the United States, see NCSBCS, 1985. Examples of recent studies that have evaluated the implementation of energy-efficient building standards for residential and/or commercial buildings: C-Engineering, 1986; Coates and Sumi, 1987; Horobin, 1986; Huston, 1986; O'Neill and Company, Inc., 1988; Pennington, 1986; Portland Energy Conservation, Inc., 1988; and Wilson, 1985.

products, and materials. In contrast, nonmandatory programs help push efficiency beyond the minimum acceptability for program participants ("sacrificing breadth for depth"): for example, a small number of builders may build superinsulated homes. Nonmandatory programs can complement building standards by providing: (1) options for innovative approaches not covered by standards, (2) incentives for early adoption of standards, and (3) training workshops and material for educating the building community and thus enabling and enhancing compliance with standards (e.g., by reducing the cost of compliance to builders and the cost of code enforcement to government). In sum, these nonmandatory programs may not only provide a receptive environment that eases the process of introducing new standards or upgrading existing ones, but also, in some cases, help promote building practices that exceed state or local standards.

1.2. METHODOLOGY

In selecting programs for new residential and commercial buildings for this review[4], we conducted extensive literature searches and contacted key organizations and knowledgeable individuals in the field.[5] We also sought program descriptions from state energy offices through an announcement in *Conservation Update*, a monthly newsletter published by the U.S. Department of Energy. Our interests included programs that were completed (or otherwise terminated), are presently being conducted, and, in some cases, those about to be initiated. Some of the programs were considered successful by their sponsors, while others were not. The common strand linking these programs was that valuable lessons could be learned from their implementation.

We focused on programs that promote 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).[6] However, we did include programs that address both shell and equipment efficiencies. Similarly, conservation-oriented rate design, such

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[4] These programs included single-family houses, multifamily units, and manufactured houses (mobile homes and modular panelized buildings) for residential uses, and institutional, industrial, and manufactured buildings for nonresidential uses.

[5] Researchers at Lawrence Berkeley Laboratory are conducting a similar overview of experiences with implementing programs to promote energy-efficient construction in both new and existing residential buildings in countries outside the U.S. (personal communication from Andrea Ketoff, Staff Scientist, International Energy Studies, Applied Science Division, Lawrence Berkeley Laboratory, Berkeley, Calif., Jan. 5, 1988).

[6] Information on appliance and equipment efficiency programs has recently been published in a report on utility rebate programs promoting energy-efficient appliances, space conditioning systems, lighting products, and motors (CECARF, 1987).

as time-of-use rates and demand charges, were not included in this report. These rate design strategies are often targeted primarily at existing buildings, although designers of new buildings may take them into account when designing energy-efficient buildings.

Using these criteria, we selected for review a total of 69 programs: 37 programs for new residences, 21 for new commercial buildings, and 11 that apply to both residential and commercial buildings. The programs are listed in Table A-1 at the end of this volume. Detailed descriptions of these programs are contained in Volume 2. Each description is based on a telephone interview with at least one individual knowledgeable about the program (usually a representative of the program sponsor) and on written materials, when available. The interviews lasted from 10 to 30 minutes and were based on a structured questionnaire. The principal topics addressed during the interview were: program objectives, key participants, date(s) of implementation and current status, marketing methods, type of monitoring and evaluation, key results (in terms of market penetration, savings, costs, and cost-effectiveness), the interviewee's overall assessment of the program, and related programs. After the program descriptions were written, they were sent to the interviewees who corrected any inaccuracies in the descriptions, updated the status of the program, and provided new information on specific questions raised during our own review of the program writeups. We found the feedback from this iterative process worthwhile, and we recommend this procedure for future program evaluations.

CHAPTER 2. ENERGY CONSERVATION PROGRAMS

In this section, we briefly discuss the different approaches used in promoting new energy-efficient construction in the residential and commercial sectors, and provide a few detailed case studies in each category (highlighted in boxes). We summarize available data on market penetration, energy and cost savings, program costs[7], and cost-effectiveness; other program details are found in Volume 2. We also compare the relative strengths of the programs, both within and among different program categories. Rather than focusing on a particular program within each category, we are interested in general concepts and approaches that can be applied in different situations. The program category findings apply to both residential and commercial construction, unless otherwise noted.

Table 2 lists the 69 programs reviewed in this report: 37 programs for new residences, 21 for new commercial buildings, and 11 that apply to both new residential and commercial construction. The columns in this table are based on the conceptual framework described in the previous chapter. Several programs make use of multiple strategies and could be listed under more than one category. In these cases, we assigned a "primary category" and cross-referenced the program's other features.[8] A similar table (Table A-1), located at the end of this volume, lists the programs in order by program number and by sector.

2.1. TECHNOLOGY DEMONSTRATIONS AND DEMONSTRATION PROGRAMS

The building industry is characterized by a large number of specialized regional or local firms. This is particularly true for home builders and, to some extent, for designers, developers, and builders of small and medium-sized nonresidential buildings (Nieves and Fang, 1985; U.S. Department of Energy, 1987; and Vine and Barnes, 1987). As with other sectors that are highly fragmented, the industry is often slow to adopt new technologies, including energy-efficient design features, equipment, or controls. Demonstration programs often play an important role in field-testing new technologies -- or simply in proving the "buildability", performance, economics and marketability of energy-efficiency features. Sometimes these demonstrations are targeted as much to the staff of the sponsoring agency as to the local building or lending communities, especially when the agency is implementing a conservation program for the first time and wants to become more familiar with new technologies and to know if the program is effective.

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[7] In discussing program costs, we characterize some programs as "costly" relative to other conservation programs; however, the cost of most energy conservation programs are well below the cost of constructing a new power plant.

[8] For each program, the reference number in the last column relates to the identification number for the detailed descriptions in Volume 2.

Table 2. Energy conservation programs for new buildings.

Name of Program	Sponsor	Program Features (√ = Primary Feature)										Program #
		TD	DP	DI	UR	LL	RL	EA	DT	DA	TC	
Technology Demonstrations												
Energy-Efficient Home Proj. of Oregon	BPA	√	•			•	•		•			RES-22
Residential Stds. Demo. Pgm.	BPA	√	•	•						•	•	RES-23
Residential Constr. Demo. Pgm.	BPA	√	•	•						•	•	RES-24
Energy Efficient Housing Demo.	Minn. HFA	√				•			•	•	•	RES-25
Superinsulated Housing Demo.	St. Louis	√	•	•						•		RES-27
Energy Efficient Housing Demo.	Baltimore DHCD	√	•							•	•	RES-28
Resid. Constr. Demo. Manuf. Housing Prj.	BPA	√	•	•			•	•		•	•	RES-32
Class B Passive Solar Perf. Eval. Pgm.	DOE	√	•									RES-36
Solar in Federal Bldgs. Demo.	DOE	√	•									COM-17
Demonstration Programs												
Denver Metro Home Bldrs.' Pgm.	SERI	•	√	•						•	•	RES-26
Affordable Comfort in Manuf. Housing	NCAEC		√	•								RES-30
SolarSave Program	Maine OER		√	•								RES-31
Energy Edge	BPA	•	√	•			•		•	•	•	COM-9
Passive Solar Nonres. Bldgs.	DOE	•	√	•					•	•		COM-16
Passive Solar Manufactured Bldgs.	DOE/SERI	•	√	•						•		RES/COM-3
Code Adoption Demonstration, Early Adopter & Northwest Energy Code Pgms.	BPA	•	√	•							•	RES/COM-8
Tacoma's Early Adopter Pgm.	Tacoma	•	√	•			•			•	•	RES/COM-9
Direct Incentive Programs												
New Construction Rebate Pgm.	PG&E			√					•	•		COM-13
New Construction Incentive	Palo Alto			√								COM-21
Utility Rates and Hookup Fees												
Conservation Rate Discount	Carolina P&L				√						•	RES-11
Residential Conservation Rate	Duke Power				√							RES-12
Residential Service Conserv. Rate	So. Carolina E&G				√						•	RES-13
Proposed Hookup Charge	Maine PUC				√							RES-15

Key to Features:

TD = Technology Demonstration Site(s)
DP = Demonstration Program
DI = Direct Incentives
UR = Utility Rates & Hookup Fees
LL = Low-interest Loans
RL = Rating & Labeling
EA = Energy Awards
DT = Design Tools
DA = Design Assistance
TC = Training, Compliance, & Quality Control

Table 2 Continued. Energy conservation programs for new buildings.

Name of Program	Sponsor	Program Features (√ = Primary Feature)										Program #
		TD	DP	DI	UR	LL	RL	EA	DT	DA	TC	
Reduced Loans and Loan Qualifications												
Energy-Efficient Mortgage Pilot Pgm.	ASE		•			√	•					RES-6
Cut Home Energy Costs Loan Pgm.	Manitoba E&M					√						RES-20
Energy-Efficient Construction	So. Dakota HA	•	•			√				•	•	RES-21
Energy Rating and Labeling												
Energy Value Home	NE Utilities				•		√					RES-3
Energy Saver Home	TVA			•			√			•	•	RES-4
Super Energy-Efficient (R-2000) Home	EM&R (Canada)						√		•	•	•	RES-5
Energy Efficient Home	Salt River Project						√					RES-7
Thermal Crafted Home	Owens-Corning						√		•	•		RES-8
Super Good Cents	BPA			•			√		•	•	•	RES-9
Energy Conservation Home	PG&E			•			√				•	RES-10
Super Saver Award	Florida Power			•	•		√					RES-14
Energy Efficient Home Award	Nevada Power						√					RES-18
Energy Saver Manufactured Home Award	Arkansas P&L			•			√					RES-29
Energy-Qualified (EQ) Home	Owens-Corning			•			√		•			RES-33
Good Cents Commercial	So. Electric						√		•	•	•	COM-7
Good Cents New Commercial	PSC of Oklahoma			•			√		•	•	•	COM-8
Energy Award Programs												
Energy Efficient Bldg. Design Competition	EEBA							√				RES-19
Architect and Engr. Energy Award	Penn. P&L							√				COM-1
Energy Conservation Design Award	Florida Power							√				COM-2
Energy Award	ASHRAE							√				COM-3
Commercial & Industrial Awards	Edison Electric							√				COM-4
Low-Energy Bldg. Design Award	EM&R (Canada)							√				COM-5
Energy Conservation Awards	Owens-Corning							√				RES/COM-7
Professional Guidelines												
Whole Bldg. Performance Stds.	DOE								•			RES/COM-6

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Table 2 Continued. Energy conservation programs for new buildings.

Name of Program	Sponsor	Program Features (√ = Primary Feature)										Program #
		TD	DP	DI	UR	LL	RL	EA	DT	DA	TC	
Design Tool Programs												
Energy Efficient Home	New England Electric	•						•	√	•		RES-16
Whole-Bldg. Energy Design Targets	DOE/PNL								√			COM-18
General Design Criteria	DOE								√			COM-19
Design Assistance Programs												
Resid. New Construction	SMUD			•			•		•	√		RES-1
Passive Solar Home	SMUD						•			√		RES-2
Design Assistance	Va. Dept. Energy			•						√		RES-17
Alaska Craftsman Home	Alaska DCRA									√	•	RES-34
Bldg. Industries Short Course	Arizona Energy Dept.									√		RES-35
New Construction Energy Design Assistance	TVA							•	•	√	•	COM-6
Energy Smart Design Assistance Pgm.	BPA	•	•	•			•	•	•	√	•	COM-10
Design Assistance for New Commercial	Washington State		•	•					•	√	•	COM-11
Technical Assistance	SMUD			•						√		COM-12
Energy Conscious Construction	NE Utilities								•	√		COM-14
Daylighting and Thermal Analysis	SCE			•					•	√		COM-20
Design Assistance for New Bldgs.	San Antonio								•	√		RES/COM-1
Solar Design Strategies	PSIC								•	√		RES/COM-2
Training, Compliance, and Quality Control												
Lighting Code Compliance Training	OSU Extension		•						•	•	√	COM-15
Calif.'s Conservation Stds. (Title 24)	Calif. Energy Comm.								•	•	√	RES/COM-4
Fla. Energy Code and Mktng. Pgm.	Fla. Energy Office						•		•		√	RES/COM-5
Landscaping and Solar Access Protection												
Resid. Solar Access Protection	Nampa (Idaho)			•					•	•	•	RES-37
Community Planning												
Milton Keynes Energy Park Demo.	Milton Keynes (England)	•					•				•	RES/COM-10
Saint Paul Energy Park	Saint Paul											RES/COM-11

Key to Features:

TD = Technology Demonstration Site(s)
DP = Demonstration Program
DI = Direct Incentives
UR = Utility Rates & Hookup Fees
LL = Low-interest Loans
RL = Rating & Labeling
EA = Energy Awards
DT = Design Tools
DA = Design Assistance
TC = Training, Compliance, & Quality Control

Table 2 Continued. Energy conservation programs for new buildings.

Key to Sponsors

ASE	Alliance to Save Energy
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.
BPA	Bonneville Power Administration
DCRA	Department of Community and Regional Affairs
DHCD	Department of Housing and Community Development
DOE	U.S. Department of Energy
E&G	Electric and Gas
E&M	Energy and Mines
EEBA	Energy Efficient Building Association
EM&R	Energy, Mines and Resources
HA	Housing Agency
HFA	Housing Finance Agency
NCAEC	North Carolina Alternative Energy Corporation
OER	Office of Energy Resources
OSU	Oregon State University
PG&E	Pacific Gas and Electric Company
PNL	Pacific Northwest Laboratories
P&L	Power and Light
PSC	Public Service Company
PSIC	Passive Solar Industries Council
PUC	Public Utilities Commission
SCE	Southern California Edison
SERI	Solar Energy Research Institute
SMUD	Sacramento Municipal Utility District
TVA	Tennessee Valley Authority

Demonstration programs often select a small number of sites to test the performance of new technologies in occupied buildings and to prove that the *technology* works.[9] Such technology demonstration sites differ from a second type of demonstration program that is aimed at testing a new *program* approach on a small-scale, pilot basis: if successful, the program is then expanded to a larger scale. Many of the demonstration programs included in this category have incorporated both objectives: to test new technologies and new delivery systems. In Table 2, we distinguish between demonstration programs emphasizing "technology testing" and those focusing on "program testing."

Good examples of technology testing are the Bonneville Power Administration's (BPA) Residential Standards Demonstration Program (RES-23, see Case Study 1) and Residential Construction Demonstration Program (RES-24 and RES-32), and Minnesota's Energy-Efficient Housing Demonstration (RES-25). Good examples of program testing are the Solar Energy Research Institute's (SERI) Denver Metro Home Builders' Program (RES-26, see Case Study 2), BPA's Energy Edge Program (COM-9) and Code Adoption Demonstration, Early Adopter, and Northwest Energy Code Programs (RES/COM-8), the U.S. Department of Energy's (DOE) Passive Solar Nonresidential Buildings Program (COM-16) and Passive Solar Manufactured Buildings Program (RES/COM-3), and Tacoma's Early Adopter Program (RES/COM-9).

A few demonstration programs used at least some level of monitoring to analyze the performance of some buildings and their technologies. Continuous monitoring of energy use and weather was most common. In addition to total household energy use, data for selected end uses (e.g., space heating and water heating) were sometimes collected. We have included one program whose principal focus was on performance monitoring: DOE's Class B Passive Solar Performance Monitoring Program (RES-36), established to evaluate the thermal performance of new passive solar residential buildings throughout the country.

Aside from a few cases (BPA's Residential Standards Demonstration Program (RES-23), DOE's Passive Solar Nonresidential Buildings Program (COM-16) and Passive Solar Manufactured Buildings Program (RES/COM-3), and Tacoma's Early Adopter Program (RES/COM-9)), there have been few evaluations of demonstration programs.[10] As a result, there are few quantitative data on program effectiveness. Although we do have such data for a few programs, it is hard to tell how representative these may be. Thus, the real role of demonstration programs

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[9] It is important to mention that there have been many individual new buildings, designed as "showcase demonstrations" of energy-efficient design, sponsored by major corporations, government agencies, and utilities. Unless these buildings were part of a large-scale program, they are not discussed in this report.

[10] In several programs currently being implemented, a number of buildings have yet to be evaluated: BPA's Residential Construction Demonstration Program (RES-24 and RES-32) and Energy Edge Program (COM-9), and Baltimore's Energy-Efficient Housing Demonstration (RES-28).

may be not only (or mainly) to obtain evaluation data, but also for other reasons, as discussed below.

Case Study 1
Residential Standards Demonstration Program (RES-23)

During the mid-1980s, the Bonneville Power Administration (BPA) conducted a large-scale demonstration program of new, electrically-heated houses built to energy-efficient standards (Model Conservation Standards (MCS)) in the Pacific Northwest. Houses meeting the MCS are expected to use forty percent of the heating energy of an otherwise comparable house built to current standards (the "current practice" house). Started in 1984, the Residential Standards Demonstration Program (RSDP) was designed to demonstrate to the homebuilding industry what MCS were, how to comply with them, and increase the industry's familiarity with them. In addition, the program sought to obtain more accurate estimates of the average energy savings and incremental costs associated with the MCS.

In the RSDP, 423 energy-efficient homes equipped with meters for measuring actual energy use were built across the region's three climate zones. An equivalent number of current practice houses built to the construction practices prevalent in the region between 1979 and 1983, before the program began, were also equipped with meters. In addition, construction cost data and data regarding the characteristics of the homes (e.g., indoor air quality and operation of air-to-air heat exchangers) were also collected.

The average annual space heating use for houses built in the RSDP was measured to be approximately 2.5 kWh per sq. ft. less than for current practice houses. Assuming the average new house built in the region has 1,650 sq. ft. of floor area, this translates into a savings of 4,125 kWh per house. The median incremental construction cost reported by builders was $2.90 per sq. ft. of floor area. Using a 36% markup on direct labor and material costs to account for builders' indirect costs and profit, and adding an administrative cost of 20% to this amount, the final cost to the region was $4.94 per sq. ft. of floor area. Assuming a house that has 1,650 sq. ft. of floor area, the final cost per house is $7,820. However, more recent experience has shown that builders are now meeting MCS requirements for less than $2,000 per house.

Important findings from the RSDP were the following: (1) the thermal performance of the MCS could generally be achieved in a cost-effective manner, (2) houses built to the MCS had a lower present-value cost to the consumer than the comparable current practice houses (including first-cost plus operating costs), (3) special air-infiltration control measures and air-to-air heat exchangers were not economical from the standpoint of saving energy alone, (4) mechanical ventilation systems seemed to be a necessity in all modern houses to help provide adequate indoor air quality, (5) well-insulated houses consumed even less energy for space heating than predicted, (6) conventional houses performed better than expected, (7) the RSDP benefitted BPA's other conservation programs, and (8) the findings from this program have facilitated the acceptance of MCS requirements in several communities in the Pacific Northwest.

Case Study 2
Denver Metro Home Builders Program (RES-26)

From 1980 to 1982, the Solar Energy Research Institute (SERI) constructed twelve new homes using a variety of passive solar and other energy conservation technologies. The Denver Metro Home Builders Program (DEMP) was designed to assist local homebuilders and developers in designing, constructing, marketing, and monitoring energy-efficient passive solar homes that cost no more than $120,000.

There were three stages in the program: design, construction, and marketing assistance. The first phase was a solicitation for builder/passive solar architect team proposals in 1980. SERI selected 12 teams to develop new designs or to revise current home designs using passive solar design concepts. SERI reviewed and critiqued final designs by builders to ensure that the builders had a practical and cost-effective design. The second phase involved construction of the homes. SERI oversaw the installation and operation of monitoring equipment and provided partial reimbursement of builders' expenses for allowing SERI to monitor the houses. In the third phase, SERI, in cooperation with the Denver Metro Home Builders Association, organized the "Passive Solar Home Tour." Approximately 100,000 people visited the 12 new solar homes. The tour helped generate 31 sales contracts (worth $2.5 million) on models, and contributed to a projected 87 additional sales within six months for an additional $6.3 million in business.

Important findings from the DEMP were the following: (1) the home-buying public became acquainted with both builder/architect/energy consultant teams and passive solar concepts, (2) an important linkage was forged between builders and solar designers/architects/energy consultants, (3) while the program failed to maintain large-volume builder's interest and dedication to passive solar housing, it was successful in affecting smaller builders and in establishing an extensive and sophisticated energy-support industry comprised of manufacturers, retailers, and trades people in the Denver area, (4) the program changed many builders' attitudes towards energy-efficient homes and construction practices, so that most home construction in the area by small-volume builders is now energy efficient, (5) some builders who participated in the program later supported a local home energy rating and labeling program, and (6) the project was replicated in several areas of the country, especially in the Pacific Northwest.

Demonstration programs have often targeted designers, architects, engineers, builders, building owners, and developers at the "leading edge" so that others would be encouraged to copy or model these innovators ("market-leaders") (Leonard-Barton, 1981; Riposa, 1983; Shama, 1983). Thus, market penetration was not emphasized in most of these programs, so that the percentage of eligible buildings constructed as a part of these programs was low. The number of eligible buildings constructed in these programs covered a wide range. We grouped the demonstration programs by the number of buildings involved in a particular program. Many of the programs were small (less than 30 buildings): e.g., BPA's Energy-Efficient Home Project (RES-22) and Energy Edge Program (COM-9), SERI's Denver Metro Home Builders Program (RES-26), St. Louis' Superinsulated Housing Demonstration (RES-27), Maine's SolarSave Program (RES-31), and DOE's Passive Solar Nonresidential Buildings Program (COM-16). A few programs were medium-sized (about 150 buildings): e.g., Minnesota's Energy-Efficient Housing Demonstration (RES-25), Baltimore's Energy-Efficient Housing Demonstration (RES-28), and BPA's Residential Construction Demonstration Program (RES-32). And a few programs were large (over 400 buildings): e.g., BPA's Residential Standards Demonstration Program (RES-23) and Code Adoption Demonstration, Early Adopter, and Northwest Energy Code Programs (RES/COM-8), DOE's Solar in Federal Buildings Demonstration Program (COM-17), and Tacoma's Early Adopter Program (RES/COM-9). A few of the programs in the last category were promoting the adoption of energy efficiency standards and trying to maximize penetration: e.g., 937 residential and 84 commercial buildings in BPA's Code Adoption Demonstration, Early Adopter, and Northwest Energy Code Programs (RES/COM-8).

The cost of administering demonstration programs has ranged from $12,500 per home ($150,000 for 12 homes in SERI's Denver Metro Home Builders Program (RES-26)) to $42,500 per commercial building ($30 million for 706 buildings in DOE's Solar in Federal Buildings Demonstration Program (COM-17)). These include costs for planning, administration, monitoring, and evaluation. For example, DOE's Solar in Federal Buildings Demonstration Program (COM-17) cost $30 million to administer (most of this money went into the monitoring of the buildings and for data analysis; an additional $29 million was spent for incentives), and DOE's Passive Solar Nonresidential Buildings Program (RES/COM-3) cost $5.5 million to administer.

Some programs provided information on building energy (kWh) savings, incremental building costs, the level of difficulty in designing and constructing buildings, and technological problems. This information will be useful for helping estimate the future market penetration of energy-efficient buildings. Building-by-building energy savings were *measured* and/or *estimated* in five programs:

Table 3. Energy savings for new buildings.

Name of Program (ID#)	Sponsor	Average Savings (M=Measured; E=Estimated)
Residential Stds. Demo. Pgm. (RES-23)	BPA	40%(E)/45% (M) annual elec. space htng.
Tacoma's Early Adopter Pgm. (RES/COM-9)	Tacoma	42% (M) annual elec. space htng.
Passive Solar Nonres. Bldgs. (COM-16)	DOE	45% (M) annual energy
SolarSave Pgm. (RES-31)	Maine	31% (E) annual energy
Energy Edge (COM-9)	BPA	30% (E) annual elec. use

The incremental cost of building energy-efficient homes was reported in two programs in the Pacific Northwest: BPA's Residential Standards Demonstration Program (RES-23) reported energy-efficient homes typically cost $2.90 per square foot more than conventional homes, and Tacoma's Early Adopter Program (RES/COM-9) reported an incremental cost of $1.50 to $2.00

per square foot. Thus, energy-efficient homes did not have significantly higher first costs than conventional homes. In commercial buildings, the extra design time and energy modeling in the early stages of design can lead to substantial energy savings while reducing initial construction costs (e.g., due to smaller equipment sizes and more efficient lighting and mechanical systems, as reported in DOE's Passive Solar Nonresidential Buildings Program (COM-16)). In fact, the design and construction of energy-efficient buildings often did not require significant changes in building practices: e.g., BPA's Residential Standards Demonstration Program (RES-23), and Energy Edge Program (COM-9), Minnesota's Energy-Efficient Housing Demonstration (RES-25), SERI's Denver Metro Home Builders Program (RES-26), and Tacoma's Early Adopter Program (RES/COM-9). And, in commercial buildings, simple design changes were often found to be the most cost-effective (BPA's Energy Edge Program (COM-9)).

Some problems have been found related to the design, installation, and operation of energy-efficient technologies, but these can often be corrected with proper guidance and training during the implementation of the program (BPA's Residential Standards Demonstration Program (RES-23), Minnesota's Energy-Efficient Housing Demonstration (RES-25), and DOE's Passive Solar Nonresidential Buildings Program (COM-16)). However, there have been instances where costly and inappropriate measures have been installed (e.g., BPA's Residential Standards Demonstration Program (RES-23) and Minnesota's Energy-Efficient Housing Demonstration (RES-25)). Both kinds of problems may lead to a bad image for the sponsors of the program and may reduce program effectiveness for future, widespread, program implementation. Accordingly, there is a need for greater quality control in the design, construction, and operation of energy-efficient technologies (see Section 2.4.4). Also, the training and education of architects and engineers, designers, and builders were found to be effective in obtaining their participation in the program and for improving the quality of building construction: e.g., South Dakota's Energy-Efficient Construction Program (RES-21), and BPA's Residential Standards Demonstration Program (RES-23), Energy Edge Program (COM-9), and Code Adoption Demonstration, Early Adopter, and Northwest Energy Code Programs (RES/COM-8).

In some cases, demonstration programs have helped create the infrastructure and capability to deliver large-scale energy conservation programs for new residential and commercial buildings, although this effect is difficult to quantify. Demonstration programs have helped create new markets (or expand existing markets) for energy-efficient buildings, materials, and equipment. For example, vapor barriers and air-to-air heat exchangers, installed in most houses in BPA's Residential Construction Demonstration Program (RES-23), have become standard construction technologies for new houses in many parts of the Pacific Northwest (despite the decision by the Northwest Power Planning Council to drop air-to-air heat exchangers from the model energy code due to concerns about cost-effectiveness). Some programs have changed builders' attitudes towards energy-efficient homes and builders' construction practices: some builders who participated in demonstration programs continue to build energy-efficient homes and to experiment with innovative building technologies even after these programs were completed (e.g., in Colorado (RES-26), Minnesota (RES-25), South Dakota (RES-21), and the Pacific Northwest (RES-23)). Also, builders in one of these communities later supported a local home energy rating and labeling program (SERI's Denver Metro Home Builders Program (RES-26)). Finally, these programs reportedly have also helped create networks among designers, builders, and utility and government program sponsors, all of whom are more receptive to innovative methods, materials, and technologies than before the programs were implemented: e.g., BPA's Residential Construction Demonstration Program (RES-23) and Energy Edge Program (COM-9), and SERI's Denver Metro Home Builders Program (RES-26).

Buildings and programs have also been showcased as models for other communities: some commercial buildings constructed in BPA's Energy Edge program (COM-9) have become prototypes for other buildings in the region, SERI's Denver Metro Home Builders' Program (RES-26, see Case Study 2) was replicated in the Pacific Northwest, and Washington State's Design Assistance Program for new commercial buildings (COM-11) was the model for BPA's Energy Smart Design Assistance Program (COM-10). In other cases, building and design criteria have formed the basis for: (a) subdivision approval requirements (Nampa's Residential Solar Access Protection Program (RES-37)), (b) prescriptive and performance-based energy regulations and guidelines (Minnesota's Energy-Efficient Housing Demonstration (RES-25)), (c) home energy rating and labeling programs (SERI's Denver Metro Home Builders' Program (RES-26), and (d) grant-funding guidelines (St. Louis' Superinsulated Housing Demonstration (RES-27)).

Finally, demonstration programs have helped program sponsors to become more familiar with new technologies, program areas, program delivery systems, and markets. After dealing with problems in technologies and program implementation at a small scale, sponsors often feel more capable and more willing to expand their program. In sum, achieving notable market penetration rates is often not really a relevant evaluation criterion for demonstration programs; the indirect impact of the demonstration on the target community and its effect on the sponsor and on other programs is often more important.

2.1.1. Summary

The key findings for technology demonstrations and demonstration programs were the following:

- Demonstration programs were often well-funded and helped create the infrastructure and capability to deliver large-scale energy conservation programs.

- Measured building energy savings averaged 45% over current norms for new buildings.
- In many cases, the design and construction of energy-efficient buildings did not require significant construction cost increases or significant changes in building practices.
- The education and training of building professionals and quality control procedures were essential for program success.
- The focus of many demonstration programs was on "innovators" ("market-leaders") and not on high market penetration rates.
- The impacts of some demonstration programs continued after the program ended.

2.2. FINANCIAL INCENTIVE PROGRAMS

Financial incentives play an important role as marketing tools in the implementation of programs and often complement technical assistance, training, and education activities. Financial incentives are used to obtain the target audience's attention and participation, especially by helping overcome actual and perceived costs and risks. In contrast to the use of incentives in existing buildings, we did not find any programs using third-party financing in the promotion of energy-efficient new construction.

Financial incentives have also legitimized and emphasized the public policy pronouncements and goals regarding the need for energy conservation investments. A local government's willingness to contribute a portion of the cost of the investments acts as a "seal of approval" that encourages energy-efficiency investments. On the other hand, the introduction of incentives may lead to greater political risks as controversy develops around the issues concerning incentives, increasing the potential for reduced program support. Because of the importance of financial incentives, we present some questions to consider in designing an incentive program:[11]

1. How should incentives be calculated? Should the incentives be based on consumer economics, reflecting the cost of acquiring a resource, or should they be considered marketing tools, used for obtaining stated penetration goals? Should the incentives be based on the cost of the measures installed or on the measured (or estimated) savings from installing the measure? Should the calculations be fixed and simple (e.g., based on a prescribed list of of measures) or more flexible and advanced (e.g., based on computer modeling)?
2. What is the correct level of incentives needed to affect builder and homeowner decisions? Should they be relatively permanent, or should the level of incentives decline over time, with a set and announced termination date? Can incentives be set at too low a level so that they are no longer effective as a motivating tool?

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[11] These questions are based on our analysis of public comments made on a proposal by the Bonneville Power Administration to provide builder/consumer payments for Model Conservation Standards (MCS) for new energy-efficient construction after 1988. After reviewing these issues, BPA decided to proceed with financial incentives after 1988.

3. Are lump-sum, up-front payments the best option, or are long-term incentives, like rate reductions, more effective?
4. Who benefits and are the benefits distributed to get maximum leverage? Specifically, how are the economic benefits of incentives distributed to manufacturers, wholesalers, retailers, builders, consumers, local government, and utilities?
5. How equitable are the incentives? For instance, should the cost of the incentives for new buildings be shared by all ratepayers, or those in high growth regions?
6. Do incentives artificially inflate true costs and/or slow the tendencies for retail costs of new technology to decline over time? Will builders and suppliers be disinclined to report cost decreases to program sponsors if they know that this will lead to lower incentives?
7. Will some consumers believe that the purchase of energy-efficient buildings do not represent sound investments unless the transaction is accompanied by an incentive?
8. Are the incentives being used to promote one kind of fuel? For example, do incentives for electrically-heated homes have the effect of promoting fuel switching and electric utility load-building?
9. Instead of facilitating the transition towards codes, can incentives sometimes prevent progress towards codes, since builders and buyers expect that once codes are passed, incentives will stop?
10. What happens to a program when the incentives end? Do builders stop building energy-efficient buildings? Is the momentum of other programs slowed or stopped? Do mandatory standards necessarily follow?
11. Will other customer benefits (e.g., increased comfort, lower noise, better indoor air quality, and higher resale value) be lost in the debate over appropriate incentive levels?
12. Are incentives really needed, or are they merely the result of lobbying efforts of constituencies that benefit from incentives?

These questions—most of which do not have simple answers—should be kept in mind when reviewing the following discussion of financial incentives: direct incentives (rebates or in-kind assistance), reduced utility rates and hookup fees, reduced rates on loans and loan qualifications, guaranteed savings, and tax credits.

2.2.1. Direct Incentives

Direct incentives are used to reduce the up-front purchase price, long-run mortgage payments, and risk of energy-efficient technologies to the target audience (e.g., the consumer or builder). Reduction of initial costs is often seen as financially and psychologically more important than an equivalent slight reduction in long-term mortgage payments for building owners. Direct incentives are usually rebates and direct cash payments, often benefitting building owners, and are considered a one-time payment (i.e., they are not recurrent). Sometimes constraints are placed by the program sponsor on how the money is used: in one program, dealers of energy-efficient manufactured homes could only use the money in advertising the program.

As seen in Table 2, few programs offer financial incentives alone. The greatest impact of direct incentive programs on program participation occur when the incentives are offered in conjunction with other programs, such as technical assistance, training, and education. Some examples of direct incentive programs are shown in Table 4, which shows the amount of incentive offered and the number of participants in each program. The incentive programs varied depending on building type (single-family, multifamily, manufactured home, commercial), target audience (builders, homeowners, manufacturers, dealers, designers), and the objective of the program (demonstration or established program). The largest incentives (in total dollars, not dollars per square foot) are usually targeted at builders of commercial buildings participating in demonstration programs. The incentives for builders in residential demonstration programs are typically in the range of $1,000 to $3,000, while the number of participating buildings is limited (usually less than 500). Incentives for builders in home energy rating and labeling programs (see Section 2.3.1) are relatively low (less than $500), while the number of participating buildings is large (over 4,000). In general, the size of an incentive was not positively correlated with program participation; the presence of an incentive may have been more important than its magnitude (Stern *et al.*, 1985).

A number of energy conservation programs offer incentives for installing energy-efficient measures. Qualifying measures are often selected from a prescriptive list of measures prepared by the sponsor (e.g., the daylighting controls offered by Southern California Edison (COM-20)). In contrast, performance-based measures also qualify for incentives: the customer selects measures appropriate to a particular building and which save a specified amount of energy (or energy use). Incentives may be calculated on the basis of dollars per square foot (typically for prescriptive measures) or dollars per kW (or kWh) saved (estimated or measured) (typically for performance-based measures). For example, the City of Palo Alto allows customers to choose performance-based measures to reduce cooling loads: rebates are provided as long as demand is reduced during the City's summer peak demand period (COM-21, see Case Study 3). There are numerous programs that offer rebates for installing thermal energy storage, heat pumps, efficient water heaters, and solar hot water and space heating systems (Piette *et al.*, 1988; CECARF, 1987), but, in general, we did not include in this report technology-specific financial incentives for either new or existing buildings.

Table 4. Programs using direct incentives.

Program #	Name of Program	Sponsor	Amount of Incentive (sf=single-family; mf=multifamily)	Number of incentives	Recipient of Incentives
RES-1	Resid. New Construction	SMUD	$300/sf house or duplex; $150/mf unit; plus bonuses	4,165 houses & units	Builders
RES-4	Energy Saver Home	TVA	$150-$200/house, plus bonuses	22,518 homes	Builders
			$150-$200/house, plus bonuses	22,518 homes	Utilities
RES-5	R-2000 Home	EM&R (Canada)	$5,500 for first home; $1,500 for second home	3,500	Builders
RES-9	Super Good Cents	BPA	$100/home, plus $4,000-$10,000 extra support	25 utilities, 900 homes	Utilities
			$2,000/sf house in 1986; $1,500/sf house in 1987	900 houses (1986-88)	Builders
			$1,000-$1,500/sf house in 1988		Builders
			$2,000/first mf unit, $750/additional unit in 1986	551 units (1986-88)	Builders
			$1,500/first mf unit, $600/additional unit in 1987		Builders
			$1,000/first mf unit, $250/additional unit in 1988		Builders
RES-10	Energy Conservation Home	PG&E	$60/sf house; $40/mf unit; max: $15,000/subdivision	Unknown	Builders
RES-14	Super Saver Award	Florida Power	$350/sf house	12,416 homes	Builders
RES-23	Resid. Stds. Demo. Pgm.	BPA	$2,250/sf house, plus bonuses	423 homes	Builders
RES-24	Resid. Constr. Demo. Pgm.	BPA	$4,000 to $4,800/sf house, plus bonuses	165 homes	Builders
			$300-$450/home	165 homes	Homeowners
RES-29	Energy Saver Manufactured Home Pgm.	Arkansas P&L	$200/home	50 homes	Dealers
RES-30	Manufactured Housing Demo.	NCAEC	$100/home	5 homes	Homeowners
RES-31	SolarSave Program	Maine OER	$2,828/home	4 homes	Homeowners
RES-32	RCDP for Manuf. Homes	BPA	$1,000 to $1,500/home	150 homes	Homeowners
			$2,000 to $3,000/home	150 homes	Manufacturers
			$250 to $500/home	150 homes	Dealers
RES-33	Energy-Qualified (EQ) Home	Owens-Corning	$100/home	Unknown	Homeowners
COM-9	Energy Edge	BPA	$122,049 (avg.)	29 buildings	Builders
COM-11	Design Assistance for New Commercial	Washington State	$7,360 to $7,480	Unknown	Designers
COM-20	Daylighting and Thermal Analysis	SCE	Maximum=$15,000 feasibility study	250 buildings	Designers
COM-21	New Construction Incentive Program	Palo Alto	Maximum=$5,000 feasibility study	Unknown	Designers
RES/COM-3	Passive Solar Manufactured Bldgs.	DOE/SERI	$15,000/manufacturer	8 manufacturers	Manufacturers
RES/COM-8	Northwest Energy Code Programs	BPA	$2,250/sf house, plus bonuses	937 homes	Builders

Case Study 3
New Construction Incentive Program (COM-21)

Since July 1, 1987, the City of Palo Alto has offered a variety of incentives for encouraging energy-efficiency measures in new commercial buildings, so that peak electricity use can be reduced below that required by California's building code standards for new commercial buildings (Title 24). The City offers a $200 per kW rebate for reductions in the envelope cooling load, beyond what would result if the envelope just met the Title 24 standards. The builder can reduce the cooling loads through either a prescriptive or performance approach. The City offers rebates for: electrical lighting demand savings ($175 per kW) due to energy-efficient lighting design, daylighting control, and lumen maintenance control; alternative cooling technologies (thermal energy storage ($350 per kW reduced), gas absorption cooling ($300 per kW reduced), and evaporative cooling ($250 per kW reduced)); load management ($100 per kW for an Energy Management System capable of reducing electrical loads during the City's peak demand period); and other demand-reducing designs and technologies not covered by these standard categories. To qualify for these rebates, all projects must be new, nonresidential construction and must reduce demand compared to a Title-24 conforming system during the peak demand period. The City also cofunds feasibility studies, paying 50% of the cost up to a maximum of $5,000. The study must be a comparative analysis of a conventional Title 24-conforming system with at least two alternative systems, of different technology or design, that reduce summer peak electrical demand.

Some programs offer incentives to designers to reimburse their costs of participating in the program and of redesigning planned buildings to incorporate energy-efficient measures. In Washington State's Design Assistance program (COM-11), for example, incentives to designers ranged from 4.6¢ to 44¢ per square foot.

2.2.2. Reduced Utility Rates and Hookup Fees

Utility companies have used a variety of rate structures designed, in part, to encourage efficient energy use, as well as equitable and reliable cost recovery for the utility: demand charges, time-of-use rates, off-peak rates, seasonal rates, inverted rates, variable levels of service, promotional rates, and conservation rates. These rates, however, are usually not designed specifically to reinforce demand-side management programs. While these rates apply to all customers in a given class, new construction can often take advantage of these rates if they are designed and built correctly.

Two important features differentiate rate reductions from rebates and other direct incentives: their duration and target audience. The percentage reduction in rates typically last for the lifetime of the home (or homeowner) ("continuing incentives"); on the other hand, rebates often occur only once: at the beginning of a program, or after a building has been completed or piece of equipment installed. Reduced rates typically benefit homeowners. Builders indirectly benefit from these rates by the assumed increased demand in energy-efficient housing by consumers favoring lower rates, as experienced in some home energy rating programs (see Section 2.3.1). In contrast, rebates have a mixed target audience (see Table 4) and are often of greatest benefit to the builders. Consumers indirectly benefit from rebates by the increased supply of energy-efficient housing and equipment. Ideally, programs would use both rebates and rate-oriented (continuing) incentives for promoting energy-efficient buildings.

We focused on those programs using conservation rates, the principal type of rate promoting energy-efficient new construction. In these programs, customers meeting the utility's criteria for efficiency are placed in a separate (lower) rate category. Utilities having conservation rates include the following: Duke Power (RES-12, see Case Study 4), Carolina Power and Light (RES-11), South Carolina Electric and Gas (RES-13), Virginia Electric and Power, Arizona Public Service Company, Kansas City Power and Light, Central Maine Power, United Illuminating, Central Power and Light, Gulf States Utilities, and Utah Power and Light (Cogan, 1983, 1987).

Case Study 4
Residential Conservation Rate and Energy Efficient Structure Program (RES-12)

Since Sept. 1, 1978, Duke Power Company has provided a lower rate (12-14% reduction) for residential customers meeting certain insulation guidelines above the current state standards. The Residential Conservation (RC) rate is available to new and existing residential structures (site built, manufactured, or multifamily) and is designed to reduce peak demand: an average per customer reduction of 3.7 kW in the winter and 0.6 kW in the summer is expected.

As of Dec. 1987, 242,000 of 1.3 million eligible customers were on this rate. Current estimates are that 73% of all new home construction is built to the RC standard. Since Jan. 1, 1988, media promotion for this program was terminated because the RC standards appear to have developed their own momentum. The program has been well-received. Consumers in North and South Carolina now expect homes that meet these standards, and home builders respond by providing them. The program is popular with consumers because space conditioning costs are reduced, and with the utilities because less energy is used during peak hours. The success of the program was attributed to the company's efforts to educate consumers about the economic and thermal comfort benefits of additional insulation.

Providing conservation rates may be a particularly effective strategy for promoting energy-efficient construction. In Duke Power's program (see Case Study 4), both the utility and the customer liked the reduced rates: they were easy to adopt, reduced peak loads, and provided long-term incentives for expanding the market for energy-efficient buildings.

Another rate-oriented incentive available to utility companies, but not tried for commercial buildings, is the hookup (connect) charge. For example, a utility might promote energy conservation and reduce peak loads by allowing owners of new energy-efficient buildings and equipment to pay reduced connect charges. In many cases, this approach reverses the established system of reduced fees for users with higher connected loads. This approach was attempted in Maine, but failed due to political opposition by the building community (see Case Study 5). A similar incentive—line extension credits for energy-efficient homes—was proposed in 1980 by the California Public Utilities Commission (CPUC) and was supported by builders; however, the policy was seen as redundant with California's new building standards by the CPUC and, ultimately, not implemented.[12] Because this approach has not been implemented anywhere in the U.S., it is unclear how effective the strategy is in promoting energy-efficient construction. A variation of this strategy, the sliding-scale energy/demand-target approach, is discussed in the next chapter.

Case Study 5
Proposed Hookup Charge (RES-15)

The Maine Public Utility Commission (PUC) proposed a hookup charge to show consumers the cost to utilities of producing electricity. The hookup charge would have established a sliding scale service connection for new residential customers who install over 100 amps of power or for service upgrades. There would have been a $600 hookup charge at the time of hookup for new service, or $300 if the house had adequate thermal integrity (based on a criteria of 15 Btu/hr/ft^2 heat loss standard). This standard was tied to Central Maine Power's Good Cents Home standard. There would have been a $300 charge for upgrades of permanent residential service above 100 amps, with no exceptions. Houses without electric heat normally use less than 100 amps. This tariff reflected the long-run cost of providing service to buildings with electric space heat. The charge, while not directly refundable, would have flowed back over time to an appropriate class of high-use residential customers who lived in Good Cents homes.

This program was not implemented. There was a stipulated rate design settlement in Oct. 1986 for both the Central Maine Power Company and the Bangor Hydro-Electric Company that included this hookup charge and time-of-use rates and reflected a movement towards marginal-cost pricing. However, the State Legislature overturned the hookup charge even though the tariff was broadly supported (including support from the major utility companies). The Home Builders Association and the Electrical Contractors Association opposed the PUC's decision and brought sufficient pressure to the Legislature to overturn the tariff.

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[12] Personal communication from William Pennington, former Manager of New Building and Appliance Efficiency Office, California Energy Commission, Sacramento, Calif., Aug. 17, 1988.

2.2.3. Reduced Rates on Loans and Loan Qualifications[13]

The consumer's decision to invest in an energy-efficient building is often based on the following criteria: (1) the expected first-year savings or annual savings accruing as a result of the investment, (2) the cost-effectiveness of the investment (often represented as simple payback—the number of years it takes for the principal to be paid back through nominal dollars saved), (3) the expected capital returns upon resale of the building, and (4) the owner's ability to pay for a particular building. The owner's ability to purchase a home, for example, is often contingent on his or her ability to qualify for a mortgage loan, and that qualification is a function of current income, total debt, and the price of the house. In this section, we examine lending policies that affect the owner's ability to purchase a home.

Lending policies revolve around estimates of a borrower's ability to meet credit obligations. This ability is measured by two ratios: the "debt-to-income ratio" compares total debt to total household income, while the "payment-to-income ratio" compares monthly housing payments to monthly income. For example, the Federal Home Loan Mortgage Corporation (Freddie Mac) has established minimum standards of 36% for the debt-to-income ratio and 28% for the payment-to-income ratio to qualify for a home mortgage. Traditionally, lending institutions have implicitly penalized energy efficiency by not including reduced energy costs in their loan calculations. One reason for this was that the lending industry had no accurate, widely accepted way to ascertain the energy efficiency of a particular structure, and determine the impact of this on the loan qualification ratios.

In the last seven years, there has been a substantial change in this situation. This has been largely due to the development of home energy rating systems (HERS, see Section 2.3.1) which provide the means for ascertaining energy efficiency and energy costs. With a relatively accurate and reliable estimation of energy costs, a lending institution has a basis for altering the expected debt-to-income and payment-to-income ratios. The lower energy expense anticipated from an energy-efficient structure changes the payment ratio, so that a borrower can afford to pay for a larger loan than would otherwise have been the case. Where utility bill savings offset any increases in first-cost on a lifecycle basis, the loan qualifying process is not restrictive, and more marginal buyers may actually qualify for a loan. Thus, households of all income levels, previously considered to be on the borderline of qualification, can qualify more easily (Schuck and Millhone, 1982). In recognition of the economic benefits of energy-efficient construction, the debt-to-income ratios have been changed in many instances by around 2%.

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[13] This section is based on Vine *et al.*, 1987a.

Not all HERS are able to provide the information necessary to allow an estimate of energy expenditure. Moreover, some HERS may be inaccurate or unreliable. Each one has to be considered individually on its own merits. Where a HERS has incorporated calculations that have proven to be effective and acceptable to the secondary mortgage industry in the past, the loan qualifying process is expedited. For example, the National Association of Home Builders' (NAHB) Thermal Performance Guidelines have been readily accepted by lenders, and any HERS based upon these guidelines has a good chance of success with the Federal National Mortgage Association (Fannie Mae) and Freddie Mac, two important secondary lenders which buy mortgages from banks, savings and loans associations, and credit unions (primary lenders). Endorsement by the NAHB's program has been helpful: NAHB has approved 35 to 40 HERS for use with their guidelines.

The number of HERS accepted by Fannie Mae and Freddie Mac is steadily increasing:

Table 5. Lending institutions' acceptance of home energy rating systems.

Sponsor	Fannie Mae/ Freddie Mac Approval	Local Lending Institutions Approval*
Alabama Power	Yes	
Conn Save	Yes	Yes
Denver Energy Resource Center		Yes
Duke Power		Yes
Georgia Power	Yes	
Gulf Power	Yes	Yes
Gulf States Utilities	Yes	
Kansas City Power and Light	Yes	
Public Service Co. of New Mexico		Yes
St. Louis Home Builders Association	Yes	
State of Florida	Yes	Yes
State of Pennsylvania		Yes
Tennessee Valley Authority	Yes	Yes
Texas Utilities Electric Co.	Yes	Yes
Virginia Electric Power Co.	Yes	Yes
Watt Count Engineering	Yes	Yes
Wisconsin Electric Power Co.	Yes	Yes

* By one or more local institutions

Some issues still remain concerning the future impact of these revised lending policies. First, HERS acceptance by the secondary mortgage market was not easy to come by: in some cases, utility contacts spoke of negotiations with institutions in the secondary mortgage market lasting two or more years, reflecting the reluctance of some lenders to accept particular home energy rating programs. Second, Fannie Mae and Freddie Mac account for only a fraction of the secondary market. The Federal Housing Administration and the Veteran Administration have their own, different energy policies which may confuse buyers, lenders, and real estate agents further. Accordingly, there is a need to create more uniform mortgage guidelines that incorporate a building's energy efficiency. A consistent set of guidelines (the Uniform Energy Efficient Mortgage Program) has recently been proposed to simplify the loan qualifying process among the various secondary market energy programs.[14] Third, the number of primary lending institutions that considered energy efficiency and used a HERS rating in their determinations was small. One study cited by Hendrickson (1984) estimated that only 10% of lending institutions considered energy efficiency.

Finally, the simple acceptance of a HERS by Freddie Mac and Fannie Mae does not necessarily mean that local institutions are going to follow suit. We found that about one-third of the states having HERS approved by Fannie Mae/Fannie Mac did not have approval by their local lending institutions (Table 5). In many areas, local banks don't know about these programs. Also, energy remains a minor component in assessing the value of a home, and the number of people (and number of loans) affected by changes in the loan ratio because of energy concerns is small, so that local lending institutions and appraisers often do not want to bother with the extra paperwork. Furthermore, utilities often worked with only one or two local lending institutions who were willing to use home energy ratings. The presence of only one or two participating institutions, however, restricted HERS acceptance, often excluding realtors who either liked to shop around for the lowest interest rate possible from a larger number of local banks, or who developed special relations with particular lending institutions that may not be participating in the home energy rating program.

In conclusion, there is little evidence of the impact of secondary lending institutions on buyers' and builder's willingness to install energy-efficient features. We were unable to find data where the energy efficiency of the home had an impact in the loan approval process. Primary lenders, the local banking and credit union institutions, can potentially have a greater impact since their contacts with consumers are closer. However, relatively few banks actually consider energy efficiency in their lending decisions. Consequently, Freddie Mac and Fannie Mae endorsement has mainly been of greater marketing value to the HERS agencies in dealing with recalcitrant builders, or in arguing the potential of HERS to realtors, than in creating greater demand for energy-efficient housing by the general public. Home builders associations, in particular, have successfully used the marketing argument with their members. Actual research on the number of loans made consequent to the use of energy efficiency information is sorely needed.

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[14] Personal communication from Jim Curtis, Bay Area Energy Consultants, Palo Alto, Calif., Aug. 26, 1988.

In contrast to lowering loan qualifications, reduced rates on mortgage loans (interest rate buy-downs or write-downs) for buildings complying with energy efficiency standards are another strategy attempted in a few demonstration programs: e.g., (The Alliance to Save Energy's Energy-Efficient Mortgage Pilot Program (RES-6), South Dakota's Energy-Efficient Construction Demonstration (RES-21, see Case Study 6), BPA's Energy-Efficient Home Project (RES-22), and Minnesota's Energy-Efficient Housing Demonstration (RES-25). Some of these programs have been successful (see Case Study 6), but most of these programs have not lasted for long periods of time (they were demonstration programs), have encountered resistance among key actors in the financial community (who believed that they would not benefit from the program and also would lose sales due to delays in processing loans), and have had limited impact in creating market demand for energy-efficient housing in their regions (since only a relatively small number of energy-efficient homes were built).

Case Study 6
Energy-Efficient Construction Program (RES-21)

In 1985, the South Dakota Housing Development Authority (SDHDA) and the South Dakota Energy Office allowed homebuyers building in compliance with a voluntary state energy code and receiving state loan financing to receive an interest rate write-down or buy-down. The incentives were in existence for only the first three years of the mortgage: for the first year a 3 percentage-point reduction, for the second year a 2 percentage-point reduction, and for the third year a 1 percentage-point reduction. In the fourth year, the interest rate was the market rate (9 7/8%).

The code required that all newly constructed single-family and multifamily housing units financed by SDHDA meet minimum super-insulation standards by using insulation, airtight construction techniques, and mechanical ventilation. Various workshops and seminars were held on all phases of the energy code. A free plan review service was made available to provide builders with technical assistance during the planning stages and during the construction phase. Site visits were provided as requested. To ensure building compliance, energy inspectors were trained and certified to inspect homes built under the code guidelines. The program lasted only one year because the state legislature passed a rule declaring that the SDHDA could not pass building codes that were more stringent than federal building codes (and the SDHDA code was more stringent than HUD's Minimum Property Standards).

While the interest rate buy-down did not have much impact on consumers' homebuying decisions due to the limited scope of the program, there were several positive results of this program: (1) measured energy savings were high (40% to 50%) and persisted for two years, (2) payback periods were low (less than 2 years) for electric-heated homes, (3) homeowner satisfaction with their homes was high, (4) training seminars were considered by builders to be helpful, (5) builders were supportive of the program, and (6) some builders continued to build energy-efficient homes after the program ended.

2.2.4. Guaranteed Savings

Another financial incentive used by some institutions and builders to promote energy-efficient buildings is "guaranteed savings:" a builder or utility markets the energy-efficient building with a guaranteed maximum utility bill for the first few years of ownership. For example, the homeowner pays no more than $100 on a given bill, and the utility pays the balance. One builder in Butte, Montana, captured 60% of its four-county housing market in three years with a super-insulated home sold with a guaranteed $100 per year maximum electric heating bill (Rocky Mountain Institute, 1987). The builder had to deliver on the guarantee only twice (once paying $3 per year and once $17 per year). At least two home energy rating and labeling programs (HERS, see Section 2.3.1) guarantee the savings of their energy-efficient homes to the home buyer: Virginia Power (see Case Study 7) and Watt Count Engineering, Inc. (Vine *et al.*, 1987b).

Case Study 7
Energy Saver Home

The Virginia Electric Power Company's home energy rating program (see Vine et al., 1987b) guarantees that their rated home will perform to an estimated energy use level (typically 20% to 45% less annual energy use than the state minimum construction standard) for one year from the date of original purchase. No one has ever made a claim on this guarantee since the program's inception in 1982. Furthermore, as a backup to this guarantee, builders sign contracts with Virginia Power for each house that is to be certified. Service representatives from Virginia Power make an average of four inspections of the construction, at different stages of completion, before issuing the final certification.

Approximately 35,000 homes have been rated since 1982, with the bulk of these rated since the beginning of 1985. Prior to 1986, there was a 19% market penetration. In 1986, cooperative advertising for builders and real estate firms began, and the market penetration increased to 25-30%. By the end of 1988, Virginia Power expects to have a 50% market penetration.

These guarantees benefit developers by facilitating the rapid sale of new buildings, ensuring greater profitability and market share. By guaranteeing savings, these incentives have other noneconomic benefits: they increase the trustworthiness of the sponsor providing the incentives and, in the case of HERS, increase the value of the home energy rating system (Vine *et al.*, 1987a). However, while these guarantees entail little risk for the homeowner, they may result in greater risk to the providers: utility companies may have to increase rates, or builders increase selling prices, to recover their costs if savings do not occur, but so far this has not occurred. Accordingly, this approach needs to be tried in other areas to determine the amount of risk that actually occurs with guaranteed savings.

2.2.5. Tax Credits

During the 1970s, federal and state governments (see Case Study 8) adopted conservation tax credits and solar tax credits as incentives to help reduce the first cost of energy efficiency and renewable energy investments. Many of the incentives offset the installation costs of energy equipment (e.g., solar water heaters) rather than the shell of the building. In addition to accelerating the cost-effectiveness of energy-saving measures, the tax credits often had other goals, such as: to develop new jobs and businesses, to achieve environmental benefits, to accelerate technological development, to increase security and reliability of energy supplies, and to counter-balance subsidies to conventional energy sources.

Through 1985, taxpayers were permitted a 15% federal tax credit for the cost of energy conservation measures that did not exceed $2,000 and 40% for solar measures not exceeding $10,000 retrofitted on their residences (U.S. Department of Energy, 1987). With the passage of the Tax Reform Act of 1986, all the federal energy conservation tax credits for residential use were allowed to expire; a few credits for commercial use were extended (Klepper and Christie, 1986/1987). The federal energy tax credit for solar technologies, including photovoltaics, was extended.

Case Study 8
Conservation Tax Credits

California's conservation tax credits (see California Energy Commission, 1983, 1987), were established in 1981 and ended in December 1986. The credits ranged from 10% to 40% of total cost depending on the year of installation, the building type, and the type of measure installed. There was a limit of $1,500 credit for homeowners. For conservation installations costing in excess of $6,000, installed on nonresidential buildings, a credit of 25% was provided without an upper credit limit. Any federal conservation credits were subtracted from the allowable state credit.

Over 900,000 residential customers and about 12,000 commercial customers received conservation tax credits in California. The present value of life-cycle energy savings of conservation measures for which a state tax credit was, or is projected to be claimed, was estimated to be more than $2.4 billion in 1983 dollars. Attic and wall insulation had the greatest present value of life-cycle energy savings over the projected life of the state conservation tax credit: over $1.8 billion and $460 million, respectively.

The incremental effect of the state credit on lifecycle costs and benefits was small: for most measures, the tax credit reduced the payback period one or two years, and in some cases (low-cost measures (weather-stripping, caulking, water heater insulation blankets, low-flow showerheads) and wall insulation), the investments were attractive without the incentives. However, the CEC asserts that the real economic benefit of the credits is in the reduction of the initial cost of the measures (which the credits did reduce) and not in the overall financial measures of payback or net present value.

Some state tax renewable energy tax credits remain: Table 6 shows that 11 states will have state energy tax credits for residential and/or commercial owners after Jan. 1, 1989 (National Appropriate Technology Assistance Service, 1987). However, as recently as mid-1985, residential solar system tax credits were available in 27 states.[15] During this time period, three states rebated a portion of system costs in a manner similar to a tax credit, and one state allowed system costs to be treated as a deduction when calculating income taxes.[16] Also, the value of the equipment was exempt from property taxes statewide in 27 states and a local option in six additional states. State sales taxes were waived or refunded in 10 states. Business tax credits were also provided for commercial installations in 20 states.

In 1985, most states included the same technologies as the federal 40% residential tax credit: active solar, passive solar features, photovoltaic cells, and wind turbines. Among the states with tax credits, the tendency was to allow 15% to 30% of the initial purchase price to be credited against income taxes. Some states linked their credit programs to federal tax credit policy. For example, New York required that any available federal credits be subtracted from the state credit. Most states had a ceiling on the amount that could be claimed: usually, a maximum of $1,000 could be credited for residential installations and carried forward if it exceeded the tax liability in that year. The ceiling varied considerably among states, and the lower amounts (e.g., $300 or less) represented more a state "seal of approval" than a financial stimulant. Renewable energy tax credits for business had higher ceilings in most states (in eight states there was no maximum level).

The solar tax credit studies reviewed by Sawyer and Lancaster (1985) confirmed that a larger tax credit led to greater use of the credit. In contrast, Carpenter and Durham (1985) reported that the level or amount of the tax credit may not be as important as the presence of a tax credit. In a study examining the factors predicting the purchase of solar hot water heaters, the awareness of availability of state tax credits was consistently significant for several models while the variable for the level of the state tax credit was not found to be significant (*ibid*). Thus, Carpenter and Durham suggest that large state credits were higher than necessary and that the same result might have been achieved with a lower credit.

There is also an issue of equity associated with the use of tax credits. Data from the Internal Revenue Service indicate that the residential energy credits (solar and conservation) benefit the most those taxpayers earning higher incomes: e.g., individuals with annual incomes between

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[15] The following discussion on previous renewable energy system tax credits is based on Sawyer and Lancaster (1985).

[16] Credits are more beneficial to the taxpayer than deductions because credits directly reduce the amount of tax to be paid while deductions only reduce the gross income on which the taxes due are calculated.

Table 6. State renewable energy system tax credits effective after Jan. 1, 1989:

State	Eligible Technologies	Credit (res=residential; com=commercial)	Maximum Credit	Expires
Delaware	Solar hot water systems	$200	$200/residential	None
Hawaii	Active/passive solar, PV, wind, heat pump water heaters	15% res; 15% com	No limit	12/31/92
Idaho	Active/passive solar, renewable energy systems	100% deduction (res only)	$5,000 per tax yr (res only)	None
New Mexico	Solar and wind	25% equipment	$1,500 in 1988; $0 in 1989	12/31/89
North Carolina	Solar	25% res/com	$1,000	None
	Wind	10% res/com	$1,000	None
	Hydro	10% res/com	$5,000	None
	Methane gas	10% res/com	$2,500	None
	Ethanol gas	20% res/com	No limit	None
	Wood-burning conversion	15% res/com	No limit	None
	Cogeneration	10% res/com	No limit	None
North Dakota	Active/passive solar, wind, geothermal	15% res/com (5% per yr for 3 yrs)	No limit	None
Oklahoma	Active/passive solar, wind, PV	45% res in 1988 40% res in 1989 35% res in 1990	$10,000/res	12/31/90
		30% com	No limit/com	
Oregon	Active/passive solar, wind,	25% first $1,000 in 1988 & 1989,	$1,000/res	12/31/89
	geothermal, hydro	35% com over 5 yrs.	$3.5 million/com	12/31/90
	Alternative energy devices	1st yr. energy savings in kW hrs. multiplied by $0.60	$1,500/res	
Rhode Island	Active/passive solar, wind	10% res/com	$1,000/res, $1,500/com	6/30/90
	Hydro	10% res/com	$50,000/res/com	
South Carolina	Solar, wind, hydro, wood,	25% res/com	$1,000 res/com	None
Utah	Solar, hydro, PV, wind, biomass biomass, other qualified renewables	25% res; 10% com	$1,500/res; $25,000/com	12/31/90

$25,000 and $100,000 represent about 65% of the credits taken. Tax credits are rarely used by low-income households (less than 1% of the credits), many of whom cannot benefit because they do not pay income taxes. Other studies confirm the regressive nature of the tax credits at the state level and conclude that the tax credits appear to redistribute wealth toward high-income groups (Carpenter and Chester, 1984; Petersen, 1985).

In conclusion, the presence of a tax credit has been found to be useful for promoting energy efficiency investments. While many low-cost energy efficiency measures were installed by consumers, some investments with high initial costs were made as a result of the tax credit. However, several issues remain that may limit the future impact of tax credits. First, the tax credit has primarily benefitted high-income homeowners who have the resources to make energy efficiency investments and who normally file tax returns. Second, anecdotal evidence indicates that, in some cases, tax credits caused the cost of certain measures to increase arbitrarily, resulting in windfall profits for the distributor. Accordingly, tax credits (as well as other financial incentives) need to be tied to some performance control to guarantee useful energy commensurate with the cost of the measure. Third, the widespread use of tax credits in the future appears to be limited as federal and state governments attempt to reduce budget deficits. Finally, the issuance of income tax credits is limited to state and federal government; utilities, regional power distributors, and local government cannot use this kind of tax credit as a program strategy.

2.2.6. Summary

The key findings for financial incentive programs were the following:

- Financial incentives varied by target sector (e.g., builder versus homeowner), duration of impact (occurring at one point in time versus over lifetime of building), breadth of impact (e.g., all homeowners versus high-income homeowners), program sponsor (e.g., state government versus utility), amount of controversy, and equitability.
- The impact of direct incentives on program participation is greater when offered in conjunction with technical assistance, training, and education.
- The largest direct incentives were targeted at developers participating in commercial building demonstration programs.
- The size of an incentive has not been shown to be positively correlated with program participation; the presence of an incentive may have been more important than its magnitude.
- Reduced utility rates were well-received by residential customers and utilities, were easy to implement, and often resulted in peak demand savings.
- Although potentially of great impact, hookup (connect) fees tied to a building's energy efficiency have not been tested in the U.S..
- Few programs had promoted guaranteed savings.
- Reduced mortgage rates and lending policies incorporating energy efficiency guidelines have thus far had limited impact in creating market demand for energy-efficient housing.
- Tax credits were useful for promoting energy efficiency investments, but the credits typically benefitted high-income households, and their future impact will be limited since few states still offer tax credits.

2.3. CONSUMER INFORMATION AND MARKETING

Information/marketing programs can be used to publicize energy conservation programs ("program marketing") as well as to help expand and intensify the market for energy-efficient products ("market enhancement"). Many programs include both objectives by increasing the target audience's (e.g., consumers, builders, and developers) awareness, acceptance, and support of particular energy conservation programs. Several types of marketing methods are used, often in combination with one another: *education* through bill inserts, brochures, information packets, displays, and direct mailings; *direct contact* through face-to-face communication in workshops and seminars; *trade ally cooperation* through cooperative advertising and marketing and certification; and *advertising and promotion* through mass media (radio, television, and newspaper) and point-of-purchase advertising. General information programs (e.g., speaker bureaus, education programs, and displays) that increase consumer awareness of energy conservation programs were not emphasized in this report because their objectives are so general that it is difficult to classify them as "new construction" programs.

Two types of consumer information and marketing programs are considered in the following discussion: home energy rating systems (HERS) and energy awards. The former is an excellent example of how different marketing strategies can be used in an integrated fashion to successfully promote conservation programs to several target audiences. In contrast, the latter is directed mainly to designer/builder professionals, and, by itself, has a more limited impact. However, when combined with other features, such as building energy ratings, the impact of energy awards becomes more significant.

2.3.1. Energy Rating and Labeling

The energy rating and labeling of new buildings has been an important activity for a number of years, and marketing appears to be one of the most important determinants of program success in this field (Vine *et al.*, 1987a). An evaluation of 34 home energy rating and labeling programs (HERS) being conducted around the country found that HERS were more successful, in terms of penetration rates and in improving the energy efficiency of the building sector, when they were actively marketed, had a comprehensive appreciation of the market, were adaptive to the needs of particular users, and included user participation in the operation and revision of the program (*ibid*). Exemplary programs include the Tennessee Valley Authority's Energy Saver Home Program (RES-4, see Case Study 9), Canada's R-2000 Home Program (RES-5), the Salt River Project's Energy Efficient Home Program (RES-7), BPA's Super Good Cents Program (RES-9), and Southern Electric's Good Cents Commercial Program (COM-7). In contrast, programs with poor track records were those that had a restrained approach to the implementation of HERS—by insisting on treating implementation problems as basically technical, engineering problems (e.g., focusing on the accuracy of the tool), or by taking a laissez-faire approach to marketing (e.g., simply meeting a demand for energy efficiency, rather than helping to create more demand)—or were those that had adopted an active approach but were not responsive to the needs of their target groups.

Home energy rating systems have been effective in the new housing market, especially when two market criteria were met: (1) the HERS was introduced in a recessionary period, when builders are most receptive to novel ways of promoting their buildings, in ways that involve actual savings to future homeowners; and (2) the HERS is actively promoted by the HERS agency, with widespread media campaigns and extensive support of builders, including cooperative advertising, and marketing materials and assistance.

Case Study 9: Energy Saver Home Program (RES-4)

The Energy Saver Home (ESH) Program is a cooperative effort among the Tennessee Valley Authority (TVA), utilities, and home builders to promote and recognize energy-efficient new housing. Since 1984, the program has promoted cost-effective, energy-efficient houses and apartments that meet TVA's ESH standards. The ESH program offers incentives to utilities which may be passed on to builders or consumers. Technical and design assistance is available to builders and buyers through the local utility. Inspections are conducted during the construction phase.

As the home is built and inspected, it is registered and awarded a special brass plaque. An official ESH certificate is awarded to the homeowner. TVA also provides program flyers and brochures, generic program advertising, cooperative advertising, assistance with local tours of homes, open houses, home shows, and a portfolio featuring 27 designs of passive solar homes. TVA publishes quarterly issues of the ESH Update newsletter. Workshops for builders, real estate professionals, and appraisers are conducted to provide up-to-date information about energy efficiency. The Federal Home Loan Mortgage Corporation and the Federal National Mortgage Association recognize TVA's ESH program, and, in underwriting homes, are willing to extend extra loan qualification considerations to the buyers of ESH homes. State and local home builders associations have endorsed the program.

During its first three years, about 14% (22,518) of the new home market has been certified as meeting Energy Saver standards, and over 50% (81) of the power distributors have contracted to participate in the program. The ESH program estimates 25% heating savings (up to 40% savings over typical homes with electric resistance heating); an annual savings of 2,200 kWh ($128) per house are expected. Through June 1986, the ESH program had displaced electric capacity at an estimated cost of $460 per kW (far below the $1,000 to $3,000 per kW cost for a new coal or nuclear plant). Each home is expected to reduce TVA's winter peak load by 0.8 kW. The ESH program also estimates that, on the average, constructing an ESH adds about 1% to the final cost of the home, or $0.40 per square foot.

Three additional features were especially important to the success of home energy rating systems: (1) the credibility and trustworthiness of the HERS sponsor (e.g., some consumers were suspicious about the potentially contradictory objectives of utility companies sponsoring HERS: promoting energy efficiency versus making money by selling energy); (2) cooperation with local, state, and national builders associations (some of these organizations actively researched the market, promoted the success of building innovators, and helped develop local and regional HERS); and (3) cooperative advertising between sponsors and the building and financing communities (e.g., a HERS sponsor would pay 50% of a builder's advertising expenses, if the HERS name (logo) and energy efficiency were prominently displayed in the advertisement).

Home energy rating programs directly impact the behavior of participants in these programs and also indirectly influence the behavior of the general housing market by generally raising expectations with regard to energy efficiency. Consequently, these complexities make it difficult to evaluate the net impact of HERS and, therefore, to measure program success. To date, there has been no attempt to measure the complete impact of HERS. Nevertheless, we present some data from an earlier report (Vine *et al.*, 1988) on HERS market penetration and energy savings that present a partial picture of the success of HERS. Although HERS often target both new and existing construction, we limit our remarks to the former.

Table 7 shows market penetration data for home energy rating systems, expressed in relative terms (the annual percentage of the new housing stock participating in the rating program) and in absolute terms (the total number of rated homes since the program's inception). The range in market penetration rates was large: from 2% for Arkansas Power and Light's Energy Saver Manufactured Home Award Program (RES-29) to 100% where all new homes are constructed to the HERS standard (see below). The programs obtaining a high annual market penetration rate were Alabama Power (78% for multifamily units), Public Service of New Mexico (about 100%), Kansas City Power and Light (100%), the Salt River Project (60%) (RES-7), Duke Power (90-95%), and the Texas Utilities Electric Company (60%). The average market penetration rate was around 40% for new construction. However, the high percentages are somewhat deceptive because the size of the new housing market is often small; exceptions to this fact are those utilities that have rated more than 10,000 homes, including Alabama Power, the Salt River Project (RES-7), Virginia Electric Power, Florida Power (RES-14), Mississippi Power and Light, and the Tennessee Valley Authority (RES-4).

The HERS market penetration data presented in Table 7 are poor indicators of the actual influence of home energy rating programs. First, many of the programs surveyed were relatively new, and some had undergone recent upgrades leading to penetrations lower than those before changes in the rating system had been introduced. Second, the market penetrations in the table describe current HERS and do not reflect the success of past programs, mainly because such information was not readily available to us.

Table 7. Energy savings and market penetration for new buildings in home energy rating programs.

HERS Sponsor (ID#)	Savings	# of Metered Homes	Comparison Home[α]	Annual Market Penetration[†, ‡]	Bldg. Type[‡]	Program Lifetime
Measured savings						
Alabama Power	50% annual electric savings (heating & cooling)	30	Avg. construction	35% (12,400 SF) 78% (16,483 MF)	SF,MF	1978-
Arkansas Power & Light (RES-29)	50% annual electric savings (heating & cooling)	3	Avg. construction	2% (50)	MH	1982-87
Energy, Mines, and Resources (Canada) (RES-5)	30% energy savings	800	Avg. construction	(3,500)	SF	1980-
Mississippi Valley Gas	30-33% energy savings	4	Avg. construction	10% (60)	SF	1982-
Public Service Company of New Mexico	50% energy savings	200	Prev. certif. homes	Approx. 100%	SF	1976-
Estimated savings						
Bonneville Power Administration (RES-9)	30-50% annual electric savings		Avg. construction	19% (1,700 SF, 900 MF)	SF,MF	1984-
Kansas City Power & Light (Missouri)	over 50% energy savings		State standards	100%*	SF	1983-
Salt River Project (Arizona) (RES-7)	15% annual electric savings		Avg. construction	60% (47,500)	SF,MF	1980-
Oklahoma Natural Gas	15% energy savings		Avg. construction	15%	SF	1979-
Virginia Electric Power	20-45% energy savings		State standards	25-30% (35,000)	SF	1985-
Programs with no savings data						
City of Austin				25-30% (1,000)	SF	1985-
Delmarva Power & Light (Del., Md., & Va.)				18% (85)	SF	1982-
Duke Power (RES-12)				90-95%	SF	1958-
Florida Power (RES-14)				39% (12,416)	SF	1983-86
Georgia Power				50%	SF	1978-
Mississippi Power & Light				10% (41,000)	SF	1976-
Nevada Power (RES-18)				(7,900)	SF	1983-
Owens-Corning (RES-8)				15%	SF	1980-
Tennessee Valley Authority (RES-4)				14% (22,518)	SF,MF	1984-
Texas Utilities Electric Company				60%	SF	1986-
Watt Count Engineering				(8,000)	SF	1972-
Wisconsin Electric Power				8% (580)	SF	1985-

[α] Homes used for energy use comparisons are average construction (current building practice), previous certified homes, or homes built to state standards.

[†] Penetration is measured as the annual percentage of the new housing stock participating in the program. Numbers in parentheses indicate the total number of rated homes since the program's inception.

[‡] SF=Single-family; MF=Multifamily; MH=Manufactured House

[*] Virtually all new homes are constructed to HERS standards, but not all are certified.

Third, there is often a tradeoff between high market penetration rates and the stringency of the building criteria: in some cases, the energy efficiency standards may have been established close to existing standards so that high market penetration rates were achieved (conversely, tougher standards may lead to lower penetration rates). And fourth, the influence of home energy rating systems is broad and affects nonparticipants as well as HERS participants. As home energy rating systems alter the housing market so that energy efficiency becomes entrenched as a marketable feature of a house, some builders will build to the standards of a particular HERS program and advertise their homes as meeting the standards without obtaining an actual certification. In sum, the entire housing industry may have upgraded the energy efficiency of its product without participating in a HERS. Or builders may not have improved the energy efficiency of their houses. As a result, the data on net energy savings from HERS are neither sufficient nor adequate.

Typically, the reported success of a home energy rating system was inferred from rough estimates of energy savings made under certification programs. HERS authorities often had some notion of the average saving per certified structure, and they also had some concrete data on the number of residences actually certified. Simple arithmetic produced a value used to index the success of the program. Some home energy rating systems qualified their estimates by noting that many programs had an impact beyond that represented in the number of actual ratings as building practices and standards changed throughout the industry.

The estimates of the savings attributed to construction to a certain HERS standard were based on either computer simulation studies or on some, usually limited, field tests. Major exceptions to this were large utility companies and companies that metered the heating and cooling consumption of homes (Table 7). Savings were estimated in dollars or in energy consumption units (kWh, therms, Btus) and were often made in relative terms with a shifting reference base. The reference base could be a fixed minimum standard (e.g., a state minimum standard of a prior year), or an estimate based on typical "current building practice" ("average construction").

Only two rating programs used state standards for their comparisons: Kansas City Power and Light estimated over 50% energy savings and Virginia Electric Power estimated 20% to 45% energy savings (Table 7). For the programs using average construction for their comparisons, estimated energy savings ranged from 15% to 50% and measured energy savings ranged from 30% to 50% (Table 7). While the ranges of energy savings are similar for the different methodologies, one should be aware of the limitations of these methodologies. Estimates based on a past regulatory standard are deceptive because the standard might be a poor indication of what builders are currently building in the marketplace. In this situation, a HERS might exaggerate the energy savings attributed to the policy because it did not control for the upgrading expected through normal market forces and the diffusion of innovations and higher standards adopted without the presence of a HERS. In contrast, estimates based on current typical building practices are most likely to be "guesstimates," since current building practice is poorly defined, not practiced by everyone (i.e., not all buildings comply with building codes), has uncertain energy use implications, is usually estimated rather than measured, and does not take into account the influence of HERS on nonparticipants. Because of these limitations, those utilities predicting savings estimates based on current standards were the most wary. They were concerned about their liability and did not want to deceive consumers with uncertain promises. Hence, their saving estimates were conservative, underestimating actual savings.

We have updated this work by interviewing again some of the same organizations described in the previous report, contacting new organizations implementing home energy rating systems, and referring to others described in the literature. Using this information, the most current listing of HERS is presented in Table A-2 at the end of this volume.

Recently, energy rating programs have started to be used in the commercial sector. One of the most ambitious programs is the Good Cents Commercial Program by Southern Electric International (SEI) (COM-7). SEI's program addresses the technical, promotional, and managerial aspects of rating programs, and each program is customized to a utility's specifications. Currently, four utilities are participating in this program: Public Service Company of Oklahoma (COM-8), Gulf Power Company, Wisconsin Electric Power Company, and Mississippi Power. In addition, although not principal program features, BPA is labeling new commercial buildings in two programs: Energy Edge (COM-9) and the Energy Smart Design Assistance Program (COM-10).

2.3.2. Energy Awards

Energy awards are sometimes presented in recognition of those design professionals whose work demonstrates energy efficiency in new construction (i.e., "the best" energy-efficient buildings). The primary objective of design competitions and awards is to generate interest in energy-efficient buildings within the design community. However, the programs have limited impact by themselves and often no technical assistance is provided to the competitors on how to design these buildings; that is, there is no interaction between designers and sponsors of the program. In other cases, the design competition may be part of a demonstration program, and the winning designs may become the prototypes of buildings built in the program (e.g., New England Electric's Energy Efficient Home Program (RES-16)). Energy awards were most effective in promoting energy efficiency in new construction when they were featured as part of comprehensive energy efficiency programs: an energy award was an effective marketing device in attracting program participants and in publicizing the advantages of energy-efficient construction.

The principal sponsors of energy award programs are utilities (Pennsylvania Power and Light (COM-1), Florida Power (COM-2)), professional organizations (the Energy Efficient Building Association (RES-19), the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (COM-3, see Case Study 10)), government (Canada (COM-5)), and trade organizations (the Edison Electric Institute (COM-4) and the Owens-Corning Fiberglas Corporation (RES/COM-7)).

Case Study 10:
Energy Awards Program (COM-3)

Since 1981, the American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE) has conducted their Energy Awards Program to recognize successful energy management techniques, to make ASHRAE members aware of the energy situation, and to share information on energy technologies among ASHRAE members. Energy awards are presented in five categories, one of which is new commercial, institutional, or public assembly buildings. All entrants must be members of ASHRAE with a significant role in the design or development of the energy-conserving aspects of the project. Projects must be in one of the five categories and must have been in successful operation for at least one year. Actual energy consumption data for 12 months must be available and submitted for evaluation. Seven judges are selected based on their experience in the field of energy use and building design. The following point systems is used for analyzing the entries: energy efficiency (30 points), innovation (15), breadth of application (15), cost-effectiveness (20), quality of presentation (10), and a miscellaneous category (10). Three awards are given per category, for a maximum of 15 awards per year. There are 150 chapters in ASHRAE, and each chapter has its own awards. Chapter award winners are nominated for regional awards. There are 12 regions in ASHRAE, and each region is allowed one award winner per category to be nominated for the national awards (maximum of 60 awards at regional level and 15 at national level). Winners of chapter and regional competitions are the focus of publicity generated at the local level and receive awards at chapter, regional, and national meetings. Selected projects are featured in the ASHRAE Journal, and audiovisual presentations and case histories are made. Newspapers, radio and television are also used to promote the program.

2.3.3. Summary

The key findings for consumer information and marketing programs were the following:

- Home energy rating systems (HERS) were more successful, in terms of penetration rates and improved energy efficiency, when they:
    - were actively marketed,
    - had a comprehensive appreciation of the market,
    - were adaptive to the needs of particular users, and
    - included user participation in the operation and revision of the program.
- Where offered, the percentage of new residential construction participating in HERS ranged from 2-100%; the average market penetration rate was 40%.

- Measured annual electricity savings of new homes participating in HERS ranged from 30-50%.
- Other features important to the success of HERS were: the credibility/trustworthiness of the HERS sponsor; cooperation with building associations; and cooperative advertising between sponsors and the building and financing communities.
- Low-income homebuyers rarely participated in HERS; this was particularly true in manufactured housing.
- Until recently, the commercial sector has not been the focus of energy rating programs.
- Energy awards were effective in promoting energy-efficiency construction when they were featured as part of comprehensive energy efficiency programs.

2.4. TECHNICAL INFORMATION

2.4.1. Professional Guidelines

The provision of technical information for design practitioners and building professionals is often considered one of the first resources to be developed in the promotion of energy-efficient construction. One source of technical information is guidelines on designing and constructing energy-efficient buildings issued by professional organizations, often in conjunction with a code adoption process. While guidelines are also offered in many programs, as part of the interactive discussions between program sponsors and target groups, the guidelines considered in this section are those that are generic to all building types, without reference to specific building sites or geographic locations.

The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) is a technical society that develops voluntary consensus standards and guidelines to assist industry and the public. ASHRAE standards are documents that define properties, processes, dimensions, materials, relationships, concepts, test methods, and recommended design and practice. ASHRAE standards are often approved or modified, then adopted, by code-setting organizations at the local, state, national, and international levels. Over 60 ASHRAE standards are currently available. One of them, Standard 90, "Energy Conservation in New Building Design," has served as the basis for building code provisions in all 50 states (Standard 90.2 is for low-rise residential and Standard 90.1 is for all other buildings) and is undergoing a process of refinement. The length of time for the development of each standard varies depending on the complexity of the standard, the number of public reviews, and the number of comments received. At least two years has been required for the development of most ASHRAE standards.

ASHRAE guidelines are documents used in the design, testing, application, or evaluation of a specific product, concept, or practice. Guidelines are not definitive but encompass areas where there may be varieties of approaches, none of which is required to be precisely correct. Guidelines often take less time to develop than standards since comments resulting from public review are considered but not necessarily resolved, as required for standards. Within five years after publication, each standard and guideline is reviewed at which time action is taken to reaffirm, withdraw, or revise.

Another source of professional guidance comes from the federal government, the U.S. Department of Energy (DOE) (RES/COM-6, see Case Study 11). The standards established by DOE and ASHRAE have been important in establishing new norms of professional practice, new design guidelines, and new local and state building codes. These norms have provided the technical and institutional underpinnings for much of the changes in design and construction practices. However, state and local design professionals may need more individual design assistance on a project-specific basis than a set of written guidelines or standards. In addition, the relatively lengthy amount of time it takes for innovative building designs, materials, and techniques to be recognized by professional organizations and federal agencies acts as an incentive for innovative design professionals to look elsewhere for more immediate, personal, and interactive assistance, as discussed below.

Case Study 11
Whole Building Performance Standards (RES/COM-6)

The U.S. Department of Energy (DOE) is developing whole building performance standards for both new residential and commercial buildings. The proposed interim mandatory energy conservation standards for new Federal 2residential buildings require Federal agencies to design energy-efficient buildings that use energy that meets or is lower than the energy consumption goal established for the design. For non-Federal residential buildings, the performance standards are voluntary and serve as guidelines for providing technical assistance for the design and construction of energy-efficient buildings. DOE's interim energy conservation voluntary performance standards for new commercial and multifamily high-rise residential buildings require Federal agencies to design their buildings to satisfy the energy efficiency requirements of these proposed standards. These standards would also act as guidelines to the design professions for the design of energy-conserving buildings. The format is similar but not identical to ASHRAE Standard 90A-1980 recommended for the design of new commercial buildings

DOE's whole building performance standards specify maximum levels of total building energy consumption ($BTU/ft^2/yr.$) *to which new buildings would be designed. The most significant aspect of these standards is the use of computer simulations to demonstrate that the designed energy consumption of a new building does not exceed the energy level specified for the building type in its applicable climate area. In contrast, ASHRAE-based state standards are often component prescriptive or performance standards that identify minimum performance criteria for the major components of a building. DOE's whole building performance standards, therefore, represent a progressive departure from the standard practices of the building community in that it requires a "whole building" approach rather than a building component-by-component compliance process. The ASHRAE Standards also contain a whole building performance design approach, but it is less frequently used than the prescriptive approach.*

2.4.2. Design Tools

As part of most design assistance programs (see next section) and as part of information transfer activities of other programs, special design tools for evaluating energy-efficiency features have been developed and made available to the design community. The available design tools are varied, including workbooks, guidebooks, energy nomographs, calculator programs, daylighting models, and microcomputer or mainframe computer software. In some cases, the same tools have been used for both complying with local or state energy codes and for improved design that goes beyond the standards (e.g., the design manuals for complying with California's building standards (RES/COM-4).

We encountered three programs primarily directed to the production of design tools. New England Electric's Energy Efficient Home Program (RES-16) produced plans for three passive solar homes and distributed 35,000 copies of the plans. DOE is currently revising their General Design Criteria (COM-19) and developing Whole Building Energy Design Targets (COM-18) for new commercial buildings. Design tools that were simple, low-cost and readily available and that provided reliable, useful information on the energy performance of proposed design measures were the goal of many conservation programs, and were developed in several programs: BPA's Super Good Cents Program (RES-9), Canada's R-2000 Program (RES-5), Owen-Corning Fiberglas' Thermal Crafted Home Program (RES-8), TVA's New Construction Energy Design Assistance Program (COM-6, see Case Study 12), the Passive Solar Industries Council's Solar Design Strategies (RES/COM-2), and California's Conservation Standards Implementation Program (RES/COM-4).

Design tools were also particularly important in the following programs: BPA's Energy Edge Program (COM-9), DOE's Passive Solar Nonresidential Experimental Buildings Program (COM-16), Southern Electric International's Good Cents Commercial Program (COM-7, COM-8), Washington State's Design Assistance for New Commercial Buildings Program (COM-11), Northeast Utilities' Energy Conscious Construction Program (COM-20), San Antonio's Design Assistance for New Buildings Program (RES/COM-1), Oregon State University's Lighting Code Compliance Training Program (COM-15), and Nampa's Residential Solar Access Protection Program (RES-37).

As in the case with energy awards, design tools themselves have a limited impact in promoting energy-efficient construction. When the design tools are featured as part of a comprehensive energy efficiency program, such as a design assistance program, the tools become an important resource to use in educating, training, and convincing design professionals of the value of energy-efficient design.

Case Study 12
New Construction Energy Design Assistance Program (COM-6)

In this program, the Tennessee Valley Authority (TVA) has prepared an Energy Design Guideline Series containing individual manuals, one for each building type, that describe ways to utilize energy more efficiently. The topics include: identifying design problems and baseline energy use characteristics, selecting and testing energy design strategies, incorporating energy strategies into the design process, and evaluating building performance. TVA's manuals are currently available for schools, offices, hospitals, and hotels/motels. Additional manuals are being developed for retail trade and restaurants. The energy-related design criteria in the guidelines are intended to be incorporated into the normal design process. In addition, TVA is currently developing a manual containing a detailed energy and cost-based evaluation procedure to accompany the design guidelines. This manual will provide architects and engineers in the region with a complete package of evaluation tools and support information.

2.4.3. Design Assistance

In contrast to the broad and generic approach characteristic of professional guidelines and most design tools, design assistance programs are typically identified with a customized approach that is building specific. Moreover, aside from programs providing direct rebates for appliances and equipment, the provision of technical assistance in designing energy-efficient buildings is one of the most common types of energy-efficiency programs offered by utilities and governmental agencies to new residential and commercial customers. As part of the design process, these design assistance programs often include consulting services and site-specific design review between energy experts and the architect and engineering team and their client. These programs tend to be most successful when they introduce energy efficiency options as early as possible in the design stage, where key actors are often most open to new ideas and suggestions. Other key actors (such as lenders and real estate agents) may be included in these early discussions in order to educate them about the potential energy and financial savings resulting from energy-efficient improvements.

Because money and time are at a premium at the design stage, both the design team and the client (and lender) must be convinced that the benefits of the increased design effort and expense are worthwhile, in terms of energy efficiency and marketability of the property. To stimulate greater participation in the early stages, design assistance is frequently combined with marketing and financial assistance. For example, in BPA's Energy Edge Program (COM-9), designers were reimbursed for their costs of participating in the program and were paid the cost of redesigning their buildings for incorporating energy-efficient measures.

In addition to review of architectural and engineering drawings, assistance with computer modeling is often provided to simulate the effect on energy performance and cost-effectiveness of different building configurations, orientations, design features, and energy technologies. Computer programs are most often used to estimate the energy needed for heating and cooling a building and the operating costs for heating and cooling. Sometimes, energy used for lights, water heating, and other appliances is also estimated, as well as peak electricity demand or energy usage by time-of-use (as defined in the rate design). Both peak demand and energy by time-of-use are of increasing concern as factors affecting energy operating costs.

Examples of design assistance programs in the residential sector are the Alaska Craftsman Home Program (RES-34) and Arizona's Building Industries Short Course Program (RES-35); in the commercial sector, examples include TVA's New Construction Energy Design Assistance Program (COM-6), BPA's Energy Smart Design Assistance Program (COM-10, see Case Study 13), Washington State's Design Assistance for New Commercial Buildings Program (COM-11), Sacramento's Technical Assistance Program (COM-12), and Northeast Utilities' Energy Conscious Construction Program (COM-20).

Design assistance can be provided by professionals either in-house or outside the sponsoring agency. For example, TVA (COM-6) uses its own architects and engineers to work with private architects and engineers on specific projects on a one-to-one basis. If in-house expertise is not available, architectural and engineering firms might be able to provide the necessary resources for providing design assistance. For instance, Washington State (COM-11) used a competitive selection process for selecting four firms to work with developers and builders in their Design Assistance program. Washington State chose this approach because they didn't have design engineers in their office, there were experienced consulting firms in the state, and the agency hoped to create a larger market for energy design firms in the state. A third option—allowing utilities to choose their own experts (in-house or outside the utility)—is planned for BPA's Energy Smart Design Assistance Program (COM-10, see Case Study 13).

Case Study 13
Energy Smart Design Assistance Program (COM-10)

The Bonneville Power Administration (BPA) has recently designed this program to encourage the construction of energy-efficient new commercial buildings in the Pacific Northwest and the local adoption of energy codes for commercial buildings, and to provide technical support and resources to utilities with the capability and interest in offering building design assistance to their commercial customers. In this three-year pilot program, BPA's customer utilities will provide technical assistance and information about the Northwest Power Planning Council's Commercial Model Conservation Standards (MCS) and appropriate electric technologies and equipment to design professionals. Utilities will also dispense BPA funds to reimburse design professionals for their costs of participating in the process, and provide formal recognition to building owners and designers if certain conditions are met. There are no incentives to help pay for the measures that are installed. BPA will provide information, training, and marketing materials and will establish a clearinghouse of information on the state-of-the-art design practices, and electric technologies and equipment.

Assistance will be given at the schematic design level as well as during design development. Assistance will include identifying energy saving options most appropriate for the specific project, providing energy and cost analyses, and making recommendations on the basis of cost-effectiveness and energy performance of each option in relation to the whole building. Two levels of awards will be presented: "Energy Smart Awards" for those who have constructed buildings at levels at least 10% more energy efficient than if constructed to the MCS; and "Energy Edge Awards" for those who have constructed buildings at levels at least 30% more energy efficient than if constructed to the MCS. For Energy Smart buildings, certificates will be provided to building designers and owners. Award benefits for Energy Edge buildings will include site signs, publicity (directed to prospective tenants, builders, developers, and designers), building plaques and certificates for the building designers, and formal recognition at appropriate regional and national conferences.

Market penetration of design assistance programs has been quite low: most programs have targeted professionals at the "leading edge" so that others would be encouraged to copy these innovators. In addition, lengthy, personal discussions between the design professional and the sponsoring organization have limited the number of program participants. For example, TVA has only reached directly about 3% of the design community in their region (from 1980 to 1986, TVA provided design assistance to architects and engineers on 430 projects (usually, one building per project)).

The more recent design assistance programs have shown that the initial reluctance of some designers to have their plans "reviewed" can be overcome when both the design firm and the client are clearly shown the benefits of designing energy-efficient buildings: long-term energy cost savings, the potential for first-cost savings in some cases, improved professional reputation and status, and an increased competitive edge. The implementation of these programs has shown that, in many cases, substantial gains could be made in energy efficiency without any significant cost increases or significant changes in building practices. Design assistance programs were most successful when energy efficiency options were introduced as early as possible in the design stage, so that delays in project design, approval, financing, or construction would be minimized. In some programs, the added amount of time spent in design and energy modeling in the early stages of a project led not only to energy savings but also reduced initial construction costs, generally as a result of down-sizing HVAC equipment to meet reduced loads, or by installing fewer but more efficient lighting fixtures (BPA's Energy Edge Program (COM-9)).

These programs have also had important indirect effects, by helping to create a network among designers, builders, and utility and government program sponsors, all of whom are more receptive to innovative methods, materials, and technologies. For example, one developer participating in a design assistance program in the Pacific Northwest has decided to use his prototype for future buildings in the region (BPA's Energy Edge Program (COM-9)). Furthermore, a new private service industry has emerged to assist the residential and commercial design and construction community in complying with new standards. Consequently, an opportunity exists for targeting programs to this industry in demonstrating to them new technologies and new designs that go beyond present standards.

2.4.4. Standards-related Training, Compliance, and Quality Control

Technical workshops and seminars are sometimes conducted, as part of energy conservation programs, to provide technical information and training to architects, engineers, building owners and managers, builders, developers, building code officials, appraisers, commercial real estate professionals, and staff of financial institutions. These training activities are especially important to encourage conformance with mandatory standards or voluntary guidelines. For example, one of the most important findings in the evaluation of Washington State's commercial energy code was that most officials responsible for the commercial energy code did not feel adequately trained or educated to enforce it (O'Neill, 1988). As a result, mechanical and lighting code requirements, in particular, were largely being ignored by the building officials in most jurisdictions.

In response to and in anticipation of these kinds of problems, the California Energy Commission (CEC) has conducted numerous training workshops around the state for promoting compliance with its new mandatory energy conservation requirements for new commercial buildings (RES/COM-4, see Case Study 14). In addition, several design manuals have been prepared for the CEC by California architectural firms. BPA's residential demonstration programs (the Residential Standards Demonstration Program (RES-23), the Residential Construction Demonstration Program (RES-24), and Super Good Cents (RES-9)) have also included extensive training seminars for the building community to meet the proposed energy efficiency standards (the Model

Conservation Standards) in the Pacific Northwest. Similarly, energy rating and labeling programs for homes (e.g., Canada's R-2000 Program (RES-5)) and commercial buildings (Southern Electric International's Good Cents Commercial program (COM-7)) have emphasized the training of design and building practitioners for meeting the voluntary standards in their programs.

Case Study 14
Energy Conservation Building Standards (RES/COM-4)

Major ongoing educational efforts for building industry professionals and the staffs of local building departments have been required to promote compliance with California's conservation standards for new residential and nonresidential buildings. Training classes (seminars/workshops) are offered through professional organizations, architects, building designers, building officials, and other industry representatives. Over 10,000 professionals have been trained. The California Energy Commission also developed methods for lenders and appraisers to give appropriate consideration to a new home's energy-conserving features.

Design tools were made available as direct outputs of the standards development process to assist in building design, as well as enabling builders to demonstrate compliance with performance standards. For example, a design compliance manual, written from a building designer's point of view, is used as a guide at each step of the design process to ensure that the ultimate design will meet or exceed the standards. These tools provide specific information concerning energy savings of alternative measures, and the energy effects of other building variations.

Compliance forms are provided to local building departments to simplify the plan review process. Educational materials help simplify compliance by the building industry. A monthly newsletter contains articles about the standards, staff interpretations of the standards, and answers to questions about the standards. A toll-free telephone line (hotline) provides immediate answers to questions about the standards.

An innovative training program is taking place in Alaska that encourages builders to go beyond state standards in constructing high quality new homes. The Alaska Craftsman Home Program (RES-34) has selected 24 builders from around the state to take part as volunteer regional trainers. These individuals, already possessing expertise in building homes in Alaska, receive extensive training in the latest state-of-the-art superinsulated building technologies. They then return to their regions to train other builders and serve as resource persons for their area.

In addition to ongoing education and training activities, quality control inspections are sometimes made during the construction process and/or after the building has been completed to ensure that the building has been constructed properly and the equipment are working as designed. Quality control inspections are important for all programs, especially those that rate buildings. The Public Service Company of Oklahoma's Good Cents New Commercial Program (COM-8) includes final inspections to make sure the constructed building is a Good Cents building, and TVA's Energy Saver Home Program (RES-4) and BPA's Super Good Cents Program (RES-9) conduct inspections during the construction phase prior to certification. Finally, Canada's R-2000 Program (RES-5) requires an air leakage test prior to awarding the house a R-2000 certificate.

2.4.5. Summary

The key findings for technical information programs were the following:

- Design guidelines issued by professional organizations were important, over the long term, in establishing new norms of professional practice, new design guidelines, and new local and state building codes; however, more immediate, personal, and interactive design assistance was often needed for promoting energy-efficient construction.
- Design tools were effective in promoting energy-efficient construction when they were featured as part of comprehensive energy efficiency programs.
- Simple, low-cost and readily available analysis tools that provide reliable, useful information on energy performance of proposed design measures were considered important for the success of design assistance programs.
- Design assistance programs demonstrated that the initial reluctance of some designers to have their plans "reviewed" can be overcome when both the design firm and the client were clearly shown the benefits of designing energy-efficient buildings.
- Design assistance programs were most successful when energy efficiency options were introduced as early as possible in the design stage, and when they did not add delays to the project design, approval, financing, or construction process.
- Design assistance programs demonstrated that, in many cases, substantial gains could be made in energy efficiency without requiring significant cost increases or significant changes in building practices.
- In some design assistance programs, the added amount of time spent on design and energy modeling in the early stages of a project led not only to energy savings but also reduced initial construction costs.
- The focus of design assistance programs was on "innovators" (market-leaders") and not on high market penetration rates.
- Significant indirect effects of design assistance programs were: a more receptive environment to innovative methods, materials, and technologies; a new private service industry in designing and constructing energy-efficient buildings; and the development of prototypes for future buildings.
- Technical workshops and seminars were important for encouraging conformance with mandatory standards or voluntary guidelines.
- Quality control inspections were key features of many programs, especially those rating buildings.

2.5. SITE AND COMMUNITY PLANNING

Site planning refers to those measures taken outside of the building that influence the amount of energy used inside the building. The most common methods revolve around protecting solar access, while more extensive means relate to community planning and development. There are few examples of site planning *and* building-level strategies, nor of linking utilities with community planning. Moreover, many utilities are presently participating in economic development projects without offering energy efficiency design assistance. The potential impact of site and community planning activities is significant and are in need of further demonstration.

2.5.1. Landscaping and Solar Access Protection

During the late 1970s and early 1980s, a number of local and state governments passed legislation encouraging the use of solar energy through solar tax credits (see Section 2.2.5) and through the protection of solar access for both new and existing buildings (Carino and Wong, 1987; S. Johnson, 1979). The control of vegetation to protect solar access was enforced through zoning provisions, subdivision amendments, and requirements that the development process include consideration of the issue. The City of Davis, California, was one of the first cities in the state to use several of these provisions in their development process (see next chapter). Also, in California, the Solar Rights Act amended the state Subdivision Map Act to require that local governments consider solar access. Many of these ordinances continue to be enforced, and new ordinances have been adopted to protect solar access. We do not know how many of these ordinance provisions have been applied to actual development proposals. We do know, however, that community solar access plans are being used as models for other communities (e.g., Nampa's Residential Solar Access Protection Program (RES-37, see Case Study 15)).

Case Study 15
Residential Solar Access Protection Program (RES-37)

The City of Nampa has been the most successful jurisdiction to date in Idaho in amending and implementing local residential land development codes for community energy conservation. As part of the city's Residential Solar Access Protection Program, Nampa adopted local ordinance amendments that provided solar access rights to new residential units and established a local permitting program to assist individual homeowners in protecting solar access to their homes. Following ordinance adoption (June 1987), the city implemented portions of its recently adopted solar access subdivision design standards through a series of training workshops, development of a "solar friendly" tree list, development of a model subdivision covenant for solar access protection, and helping other jurisdictions address residential solar access protection.

The solar access protection ordinance for residences contains three primary components: (1) a new development solar access design standard; (2) a solar setback standard for siting residential buildings on vacant lots in existing platted subdivisions; and (3) a solar access guarantee, which primarily affects future trees in existing neighborhoods. The new development design standard applies to subdivision and Planned Unit Developments on lots in single-family and low density multifamily zones. A 10% density bonus is granted by the city if the developer meets the design standard with at least 90% of the lots (instead of 80%).

The key provisions of these regulations (S. Johnson, 1979; Miller, 1979a, 1979b; Warren, 1979) maximize solar access through:

- Site selection: the highest densities of housing units are placed on south-facing slopes and lower densities on north-facing slopes
- Street layout: streets are oriented on an east-west axis to the greatest extent possible
- Lot layout: lots are oriented with their greatest dimensions north and south
- Building siting: the long axis of the building envelope is oriented east and west to the greatest extent possible, buildings are sited as close as possible to the north lot line to increase yard space to the south for better control of shading, and tall buildings are sited to the north of shorter ones
- Building form: buildings are designed to maximize solar utilization (this may include height restrictions)
- Landscaping: trees are located near buildings to provide wind barriers or shade, but not so as to block solar collectors

In some ordinances, only fully weatherized homes can qualify for solar access protection, as in Woodburn, Oregon (Wilcox, 1981). Moreover, the adoption of these codes has led to an increased awareness of solar access issues among builders and developers, and an increased awareness of the potential for solar design in home plans. For example, since the Ashland, Oregon solar access ordinance went into effect, approximately 20% of all the dwelling units constructed in Ashland have had some solar application (either solar hot water, solar greenhouses, or passive solar design) (Fregonese, 1981). While solar access protection is currently not a high priority item for most local and state governments, the groundwork for these kind of programs has been completed, so that future programs can be more easily implemented.

2.5.2. Community Planning and Development

In most states, state legislation permits localities to amend most planning and zoning guidelines to consider and encourage energy conservation, renewable resource use, and energy-efficient patterns of development. Integrating energy efficiency with community planning and development has been tried in existing communities as well as in new towns and economic development areas. In existing communities, zoning incentives, in the form of increased dwelling unit density ("density bonus"), have been used to promote compliance with energy efficiency standards. In 1979, the City of Lincoln, Nebraska, authorized a 20% increase in dwelling unit density to developers of community unit plans who complied with a set of energy conservation standards adopted by the city council (J. Johnson, 1979 and 1980). As opposed to a more usual subdivision, a community unit plan is generally characterized by smaller lots, clustered housing, and more open green space commonly shared by all homeowners. Approximately 80% of Lincoln's new developments proceed through the community unit plan process rather than the subdivision process. Developers were advised to take several factors into consideration in drafting their community unit plans, including site selection, street layout, lot layout, building siting, building form, and landscaping.

In Ashland, Oregon, developers who employed passive solar energy designs and other energy-saving features, including superinsulation and heat pumps, may be eligible for up to a 40% increase in dwelling unit density if the designs of the housing units exceeded minimum requirements established by the city (Wilcox, 1981; Fregonese, 1981). The energy-efficient density bonus was based on the expected thermal performance of the structure (Btu/degree day/sq. ft.). Most developers using simple passive solar designs have received density bonuses of 2% to 25%. The density bonus is considered by the city to be a powerful incentive for promoting energy-efficient construction.

Energy-efficient buildings can also be promoted as part of a larger program in which an entire community or economic development area is built using the latest energy efficiency technologies. This kind of undertaking requires a large amount of resources that public agencies do not normally have or are willing to commit. Consequently, the private sector, with some public assistance, has been the principal planner and developer of new communities. The best examples of integrating energy-efficient construction in a new community are St. Paul's Energy Park in Minnesota (RES/COM-11) and Milton Keynes' Energy Park Demonstration in England (RES/COM-10, see Case Study 16).

2.5.3. Summary

The key findings for site and community planning programs were the following:

- Solar access protection regulations help promoted energy-efficient construction.
- Increased dwelling density in planned unit developments was a powerful incentive for promoting energy-efficient construction.
- New communities offer the potential for widespread construction of energy-efficient buildings.

Case Study 16
Milton Keynes Energy Park Demonstration (RES/COM-10)

The Milton Keynes Energy Park Demonstration is part of a new city (Milton Keynes), centrally located between London and Birmingham. A variety of housing is planned (1,000 housing units) for the Energy Park, and all the houses will have to achieve a standard of at least 30% better than current building regulations demand. The Energy Park emphasizes a reduction in demand for energy by: (1) energy-efficient local planning (making maximum use of solar energy and using the landscape to improve the local microclimate, (2) specifying energy performance standards (improved insulation and energy-efficient design), (3) encouraging the use of efficient heating systems, controls, plant, and appliances, and (4) specifying the most efficient equipment for industrial process.

There are three phases in the residential development program. In Phase I, 600 houses have been completed, designed to meet the energy performance standards and intended to demonstrate the practical application of proven technology. In Phase II, different housing schemes are planned and are aimed at attracting a higher proportion of state-of-the-art and prototype energy-conscious designs. Phase III is currently being planned to include a mixed commercial and residential development. A range of commercial and community facilities is planned: shops, a public house, a restaurant, schools, and meeting halls. The commercial development will cover one million square feet in an 80-acre employment area in the Park, and all commercial development will have to meet energy-efficiency standards.

About 600 houses and two commercial buildings are now completed in the Energy Park. The energy performance standard for houses has been extended to cover all new houses in Milton Keynes (approximately 2,500 houses per year). The introduction of an energy performance standard for houses is currently being considered by a number of towns and planned new settlements in the United Kingdom, based on the Energy Park demonstration. At least 30% energy savings are expected in the houses, and in many cases up to 50% energy savings will be achieved. For commercial buildings, the savings in energy costs are expected to be between 40% and 50%.

CHAPTER 3. SUMMARY AND DISCUSSION

3.1. SUMMARY OF KEY FINDINGS

This report evaluates the experience with implementing programs promoting energy efficiency in new residential and commercial construction. We focused on nonmandatory programs, such as: technology demonstrations and demonstration programs, financial incentive programs (including rebates, conservation rates, hookup fees, reduced rates on loans and loan qualifications, guaranteed savings, and tax credits), consumer information and marketing programs (including energy rating systems and energy awards), technical information programs (including professional guidelines, design tools, design assistance, and standards-related training, compliance, and quality control), and site and community planning. We examined available data on market penetration rates, energy savings, reliability of savings and penetration, program costs, cost-effectiveness, and replicability. We compared the relative strengths of the programs and compared programs both within and between different program approaches.

General program conclusions, applicable to most of the energy conservation programs reviewed in this report, were the following:

- Many different types of nonmandatory programs appeared to be successful[17] in overcoming barriers to promoting energy efficiency in new buildings, and in complementing and facilitating the adoption of future energy conservation building standards and the implementation of and compliance with existing standards; no program strategy was clearly dominant.
- However, few program evaluation studies exist, resulting in a paucity of quantitative data on program effectiveness, especially beyond the pilot or demonstration stages.
- Only a few programs were designed as part of a long-term strategy to promote energy-efficient construction.
- Successful programs were often characterized by intervention early in the design and planning process in order to minimize delays in the project design, approval, financing, and construction process.
- Education, training, and design assistance activities were especially important.
- Most programs focused on the early design stages of a program without addressing issues normally arising later in the program (e.g., detail of construction, quality control, building commissioning, and operations and maintenance).
- Utility rate designs were not typically used as conscious reinforcement for promoting energy-efficient construction.
- Many programs were considered successful for both energy and nonenergy reasons (e.g., improved thermal comfort, creation of new markets, and improved customer relations).

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[17] A successful program is one in which, at a minimum, energy conservation features have been incorporated into the design of buildings and, at a maximum, energy savings (especially, electricity savings, the most costly form of energy) have been significant and cost-effective, and/or market penetration has been extensive. Other indicators (e.g., occupant satisfaction and indoor air quality) are also sometimes included in defining a successful program.

- Nonmandatory programs can reinforce and pave the way for codes.
- Most of these programs can be easily implemented in other areas around the country and in other countries.

In addition to these general conclusions, key findings for specific program categories were the following:

Demonstration programs

- Demonstration programs were often well-funded and helped create the infrastructure and capability to deliver large-scale energy conservation programs. The focus of many demonstration programs was on "innovators" ("market-leaders") and not on high market penetration rates.

Financial incentive programs

- The impact of financial incentives on program participation was greater when offered in conjunction with technical assistance, training, and education.
- The size of an incentive has not been shown to be positively correlated with program participation; the presence of an incentive may have been more important than its magnitude.
- Reduced utility rates were well-received by residential customers and utilities, were easy to implement, and often resulted in peak demand savings.
- Although potentially of great impact, hookup (connect) fees tied to a building's energy efficiency have not been tested in the U.S..
- Few programs have promoted guaranteed savings.
- Reduced mortgage rates and lending policies incorporating energy efficiency guidelines have thus far had limited impact in creating market demand for energy-efficient housing.
- Tax credits were useful for promoting energy efficiency investments, but their future impact is limited since few states still offer tax credits.

Consumer information and marketing programs

- Home energy rating systems (HERS) were more successful, in terms of penetration rates and improved energy efficiency, when they:
  - were actively marketed
  - had a comprehensive appreciation of the market
  - were adaptive to the needs of particular users, and
  - included user participation in the operation and revision of the program.
- Where offered, the average percentage of new residential construction participating in HERS was 40%.
- Measured annual electricity savings of new homes participating in HERS and residential demonstration programs ranged from 30-50%.
- Energy awards were effective in promoting energy-efficient construction when featured as part of comprehensive energy efficiency programs.

Technical information programs

- Design tools were effective in promoting energy-efficient construction when featured as part of comprehensive energy efficiency programs.
- Design guidelines issued by professional organizations were important, over the long term, in establishing new norms of professional practice, new design guidelines, and new

local and state building codes; however, more immediate, personal, and interactive design assistance is often needed for promoting energy-efficient construction.

- The focus of many design assistance programs was on "innovators" ("market-leaders") and not on high market penetration rates.
- Design assistance programs demonstrated that the initial reluctance of some designers to have their plans "reviewed" can be overcome when both the design firm and the client are clearly shown the benefits of designing energy-efficient buildings.
- Design assistance programs were most successful when energy efficiency options were introduced as early as possible in the design stage and when they did not add delays to the project design, approval, financing, or construction process.
- Design assistance programs demonstrated that, in many cases, substantial gains can be made in energy efficiency without requiring significant cost increases or significant changes in building practices.
- In some design assistance programs, the added amount of time spent on design and energy modeling in the early stages of a project led not only to energy savings but also reduced initial construction costs for some buildings.
- Technical workshops and seminars were important for encouraging conformance with mandatory standards or voluntary guidelines.
- Quality control inspections were key features of many programs, especially those rating buildings.

Site and community planning

- Solar access protection regulations helped promote energy-efficient construction.
- Increased dwelling density in planned unit developments was a powerful incentive for promoting energy-efficient construction.
- New communities offer the potential for widespread construction of energy-efficient buildings.

3.2. PROGRAM RECOMMENDATIONS AND STRATEGIC INTERVENTION

3.2.1. Strategic Intervention

Most programs do not have a long-term, explicit strategy for promoting energy-efficient construction. Many programs have not set long-term goals or targets, nor do they know how close they are to achieving the goals. Because programs are typically designed in response to goals and objectives, the lack of a long-term strategy may result in vague and unworkable program design and program implementation. As a result, programs may be terminated before they reach full maturity.

Accordingly, programs should be strategically introduced at certain stages to accomplish long-term goals. For example, in areas where there is already a minimum energy conservation building standard that would not be tightened until nonmandatory approaches are considered, demonstrations are often the first type of program introduced by an organization to promote energy-efficient construction. These programs typically emphasize "technology testing" and "program testing" and are targeted at a narrow audience. Once the program has proven that the technology and program "work," the organization considers other strategies for obtaining broader participation: dissemination of the demonstration results, technical and financial assistance programs for the design and construction community (e.g., rebates, training seminars, and workshops), and educational and financial programs for consumers (e.g., reduced utility rates for homeowners). Energy rating systems may be effective at this stage. After the program has been implemented for some time, the program targets hard-to-reach groups: for example, developers of multifamily units, low-income households, speculative builders, and landlords with short-term leases. After these programs have been in effect for a number of years, more stringent building codes and standards may be introduced to make sure that nonparticipants are constructing more energy-efficient housing. At this stage, standards-related training, compliance, and quality control programs are important.

An exemplary set of programs that demonstrate the exception to this trend and demonstrate "strategic intervention" are the programs currently being conducted by the Bonneville Power Administration (BPA). BPA is committed to promoting the voluntary adoption of energy-efficient building codes in the Pacific Northwest, pursuant to the 1986 Power Plan of the Northwest Power Planning Council. This commitment is demonstrated through market-based incentives and nonmandatory programs with prescribed goals and target dates. Moreover, many different types of organizations are cooperating in this effort: for example, utility companies and state and local governments. Recently, state utility commissions have been requiring utilities in other states to develop long-term programs for promoting energy-efficient construction as part of "least-cost utility plans." We believe the programs in the Pacific Northwest are one model for utilities in other regions to consider in their development of demand-side utility plans and programs for new construction.

3.2.2. Program Design and Implementation Recommendations

For designing and implementing energy conservation programs for new buildings, the evidence suggests that a comprehensive and long-term perspective is needed to design and choose programs. Long-term goals and objectives of programs need to be made explicit for providing program guidance. A well-integrated package of programs should contain the following program strategies: design assistance, financial incentives, quality control, training and education of design professionals and the building community, simple and easy-to-use design tools, rating and labeling of buildings, effective marketing and promotion, energy awards for buildings and for design and building professionals, operations and maintenance activities, building commissioning (see Section 3.3.2), process and impact evaluation, monitoring, and feedback activities. This undertaking is as serious as those for past resource decisions and is necessary for the serious promotion of energy-efficient construction in the residential and commercial sectors. If one organization is unable to provide both incentives and support activities, then two or more organizations may be able to coordinate these activities as part of one program (e.g., utilities provide financial incentives and local governments provide support activities).

Most of these programs can be easily implemented in other areas around the country. Geographical and climatic differences were not seen as barriers to the implementation of these programs. However, since program implementation is a political process, different political interest groups may be able to prevent the implementation of a program that was successfully implemented elsewhere. As a word of caution, we do not want to imply that programs can be easily transferred from one region to another. Programs can be used as models, but they must be adapted to fit local circumstances. Program managers need to find out about the details of other programs before adopting them, including any mid-course corrections made during the implementation of the program. Implementation is not an easy task, and there have been lots of failures at various stages in the implementation process. The challenge is to design and implement a program that meets the needs of the target audiences as well as promote energy-efficient construction.

3.3. CRITICAL ISSUES

Several critical issues were overlooked or not emphasized in the programs reviewed in this study:

- Construction quality, follow-up, and compliance
- Building commissioning and long-term operations and maintenance
- Strategies "outside the building shell"
- Rate incentives and rate design as marketing tools
- Guarantees of savings and of rate stability

These issues are briefly discussed in this section and are introduced in this report because they deserve greater attention in the planning of future programs.

3.3.1. Construction Quality, Follow-up, and Compliance

Most of the programs examined in this report concentrated on building design with little attention paid to the actual quality of construction and equipment installation, which in some cases (e.g., shell insulation, air-tightness of building shells and ducts, and placement and calibration of heating, ventilation, and air-conditioning (HVAC) systems and lighting controls) can profoundly affect the energy performance of the building and equipment. In other cases, change-orders during construction, after the approval of design plans for compliance with energy codes, can affect the performance, especially where a change in one feature affects other equipment or systems. These issues apply to incentive and labeling programs, as well as building codes. Program sponsors should make sure that inspections of equipment and construction are conducted periodically through the construction process to ensure compliance with the program requirements and the original intent of design engineers and architects.

3.3.2. Building Commissioning and Long-term Operation and Maintenance

Expanding on the previous issue, what happens to a building after construction (during commissioning and occupancy) may be as important as how it was designed and constructed. Problems with the building's performance (including the comfort of the occupants and indoor air quality, as well as energy) may lead to alterations in equipment and/or operations that can reduce energy efficiency. Some of these problems may be avoided by implementing a long-term operation and maintenance (O&M) program that includes effective feedback to the facilities manager, regular preventive maintenance, and other steps to ensure that the building systems are functioning properly. Ideally, potential problems with the long-term performance of building systems and the requirements of a long-term O&M plan should be addressed at the pre-design, design, and construction stages. Because of the number of actors involved (building owners, designers, contractors, manufacturers, and tenants), the institutional arrangements for resolving these problems may be complicated. Possibilities include: (1) incorporating commissioning, operator training, or even O&M for the first three years as an integral part of a design/build (or construction only) bid specification; (2) separately contracting with a "third party" that specializes in building commissioning and/or O&M; or (3) encourage each of the participants to share the responsibility by participating in a quality assurance or building commissioning team. Government agencies or utilities could provide examples of each of these through demonstration projects (with careful monitoring) in their own facilities.

3.3.3. Strategies Outside the Building Shell

Very little attention has been paid to energy-saving opportunities "outside the building shell" which may have a significant impact on the amount of energy used inside the building: e.g., site planning, landscaping, and community design and infrastructure (streets, sewers, water, and power distribution). In fact, as these activities receive more attention, there may be possibilities for developers to negotiate tradeoffs between further improvements to the building shell and more cost-effective site improvements in the environment immediately surrounding the building (e.g., planting trees in parking lots versus installing more insulation in walls).

Moving from the immediate building site to the community or urban scale, we expect these activities to be more broadly implemented as more attention is paid to mitigating the effects of urban "heat islands." Urban climatologists and energy researchers have demonstrated that developed urban areas create summer "heat islands," with a typical daily average increase in ambient temperatures of 3 to 5 °C (Akbari *et al.*, 1987; Huang *et al.*, 1987). In mid- and low-latitude cities, the heat island effect contributes to the discomfort of urban dwellers in the summer, as well as significantly increasing air conditioning loads. The urban heat island results from the interaction of many factors, such as heat release from buildings and vehicles and increases in surface areas of buildings and streets, coupled with decreases in the urban albedo (the relative amount of radiation reflected to the sky) and in the evaporation rate due to trees and vegetation being replaced by pavement and structures (*ibid*). Residential and small commercial buildings in urban areas are particularly sensitive to the heat island effect since their cooling loads are envelope-dominated.

While some planners have regarded urban heat islands as inevitable products of urbanization, others have speculated that they could be alleviated through the following techniques: adding vegetative cover (which also provide wind-shielding, shading, and lowered dry-bulb temperatures), increasing the number of fountains and pools, choosing light colors for building exteriors, avoiding the use of dark-colored streets, and altering the physical layout of cities. Computer simulations indicate that these strategies can significantly reduce summer cooling loads, resulting in peak power savings on the order of 18% to 30% (Huang *et al.*, 1987).

The City of Davis, California has implemented programs promoting both energy-efficient construction and community planning to help reduce the heat island effect (Vine, 1981). In 1975, Davis became one of the first communities in the country to adopt an energy conservation building ordinance. The code emphasizes increased insulation, natural ventilation, and the following passive solar design features: proper building orientation, control of the amount and orientation of glazing, shading, thermal mass, and light colors on exterior surfaces. The community planning policies adopted in Davis include: proper lot orientation, narrower streets, landscaping of commercial areas, shading of paved parking lots, and use of alternative parking lot materials. The City's energy conservation planning policies were considered by municipal staff and officials to be important in facilitating the implementation of the new building code and in encouraging the use of energy-conserving features in both the residential and nonresidential sectors. In the future, other communities may adopt policies and enact legislation that reduce the heat island effect as its significance becomes more widely understood.

3.3.4. Rate Incentives and Rate Design as Marketing Tools

More attention needs to be paid to the use of rate incentives and rate design as marketing tools to attract the attention and participation of target groups. As one utility planner stated: "The tools in the [rate design] kit are powerful but awkward. Their use involves impacts on other objectives, which ... can work at cross-purposes" (Mather, 1987). The requirements for revenue recovery, equity, and simplicity in rate design (often competing among themselves) have traditionally left little room for new objectives, such as deliberately promoting customers' or builders' decisions to invest in energy-saving features. The traditional view of rate economists is that cost-based pricing, which gives the "proper" market signals, is as far as rate-design should go to encourage efficient energy use. This view takes little account of the numerous market imperfections described earlier in this report. A notable exception to this traditional view of rate-making is the use of residential rate discount for efficient new homes (see Section 2.2.2). A second example is the effort by a few utilities to design special time-of-use rates to promote thermal storage.

However, there are a number of other possible rate-design innovations that could be effective in promoting energy efficiency in new construction - and potentially more cost-effective than traditional utility rebates. Consider three examples of rate-design strategies that seem to merit more serious testing through pilot programs. First, any new entrant to the electric grid might be required to pay a one-time, non-refundable "capital recovery fee" to account for the full marginal capital costs associated with the increased load of a new building (Rocky Mountain Institute, 1987). Second, utility hookup fees could be based on a sliding scale: energy-efficient buildings would be charged less compared to inefficient buildings. In many cases, conventional hookup fees actually reward higher loads: a builder gets "free footage" allowances for installing more energy-intensive equipment, such as electric resistance heating or gas fireplace accessories. Buildings with large peak loads, such as a conventional all-electric home, would pay a hookup fee large enough to cover (up-front) all or most of the capital costs which the house imposes on the system (Rocky Mountain Institute, 1987). The proceeds of these fees would go into a balancing account, from which the utility would then pay rebates to those who choose to build homes that are above average in efficiency. By adjusting the fee and rebate levels, the fee income could be made to balance the rebate expenditures. The fee would also be adjustable: as technologies change, the indices used in calculating the fee structure would change. A third option is for new buildings using more (or less) than an established energy and peak demand target of a building energy rating program to pay a sliding-scale fee (or rebate), similar in design to the previous approach (Koomey and Rosenfeld, 1988).

3.3.5. Guarantees of Savings and of Rate Stability

As noted in Section 2.2.4, guaranteed savings is an approach that looks promising but has not been extensively tried. The uncertainty of actually achieving predicted savings and payback times may be at least as much of a constraint on conservation investments as the initial cost itself. Thus, it is possible that better leverage of existing funds will occur by guaranteeing savings than by actually paying an incentive to each participant. Moreover, the existence of a guarantee may have a more important impact on program participants than the amount of money offered to them. The idea that an efficient building would qualify for a special utility rate, with "guaranteed rate stability" for, as an example, five years, may be particularly appealing to many customers (and, hence, to developers).

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Table A-1. Energy conservation programs for new buildings: by program number.

Program #	Name of Program	Sponsor	Program Features (√ = Primary Feature)									
			TD	DP	DI	UR	LL	RL	EA	DT	DA	TC
Residential Programs												
RES-1	Resid. New Construction	SMUD			•			•		•	√	
RES-2	Passive Solar Home	SMUD						•			√	
RES-3	Energy Value Home	NE Utilities				•		√				
RES-4	Energy Saver Home	TVA			•			√			•	•
RES-5	Super Energy-Efficient (R-2000) Home	EM&R (Canada)						√		•	•	•
RES-6	Energy-Efficient Mortgage Pilot Pgm.	ASE		•			√	•				
RES-7	Energy Efficient Home	Salt River Project						√				
RES-8	Thermal Crafted Home	Owens-Corning						√		•	•	
RES-9	Super Good Cents	BPA			•			√		•	•	•
RES-10	Energy Conservation Home	PG&E			•			√				•
RES-11	Conservation Rate Discount	Carolina P&L				√						•
RES-12	Residential Conservation Rate	Duke Power				√						
RES-13	Residential Service Conserv. Rate	So. Carolina E&G				√						•
RES-14	Super Saver Award	Florida Power			•	•		√				
RES-15	Proposed Hookup Charge	Maine PUC				√						
RES-16	Energy Efficient Home	New England Electric	•						•	√	•	
RES-17	Design Assistance	Va. Dept. Energy			•						√	
RES-18	Energy Efficient Home Award	Nevada Power						√				
RES-19	Energy Efficient Bldg. Design Competition	EEBA							√			
RES-20	Cut Home Energy Costs Loan Pgm.	Manitoba E&M					√					
RES-21	Energy-Efficient Construction	So. Dakota HA	•	•			√				•	•
RES-22	Energy-Efficient Home Proj. of Oregon	BPA	√	•			•	•		•		
RES-23	Residential Stds. Demo. Pgm.	BPA	√	•	•						•	•
RES-24	Residential Constr. Demo. Pgm.	BPA	√	•	•						•	•
RES-25	Energy Efficient Housing Demo.	Minn. HFA	√				•			•	•	•
RES-26	Denver Metro Home Bldrs.' Pgm.	SERI	•	√	•						•	•
RES-27	Superinsulated Housing Demo.	St. Louis	√	•	•						•	
RES-28	Energy Efficient Housing Demo.	Baltimore DHCD	√	•							•	•
RES-29	Energy Saver Manufactured Home Award	Arkansas P&L			•			√				
RES-30	Affordable Comfort in Manuf. Housing	NCAEC		√	•							

Key to Features:

TD = Technology Demonstration Site(s)
DP = Demonstration Program
DI = Direct Incentives
UR = Utility Rates & Hookup Fees
LL = Low-interest Loans
RL = Rating & Labeling
EA = Energy Awards
DT = Design Tools
DA = Design Assistance
TC = Training, Compliance, & Quality Control

Table A-1 Continued. Energy conservation programs for new buildings: by program number.

Program #	Name of Program	Sponsor	Program Features (√ = Primary Feature)									
			TD	DP	DI	UR	LL	RL	EA	DT	DA	TC
Residential Programs												
RES-31	SolarSave Program	Maine OER		√	•							
RES-32	Resid. Constr. Demo. Manuf. Housing Prj.	BPA	√	•	•			•	•		•	•
RES-33	Energy-Qualified (EQ) Home	Owens-Corning			•			√		•		
RES-34	Alaska Craftsman Home	Alaska DCRA									√	•
RES-35	Bldg. Industries Short Course	Arizona Energy Dept.									√	
RES-36	Class B Passive Solar Perf. Eval. Pgm.	DOE	√	•								
RES-37	Resid. Solar Access Protection	Nampa (Idaho)			•					•	•	•
Commercial Programs												
COM-1	Architect and Engr. Energy Award	Penn. P&L							√			
COM-2	Energy Conservation Design Award	Florida Power							√			
COM-3	Energy Award	ASHRAE							√			
COM-4	Commercial & Industrial Awards	Edison Electric							√			
COM-5	Low-Energy Bldg. Design Award	EM&R (Canada)							√			
COM-6	New Construction Energy Design Assistance	TVA							•	•	√	•
COM-7	Good Cents Commercial	So. Electric						√		•	•	•
COM-8	Good Cents New Commercial	PSC of Oklahoma			•			√		•	•	•
COM-9	Energy Edge	BPA	•	√	•			•		•	•	•
COM-10	Energy Smart Design Assistance Pgm.	BPA	•	•	•			•	•	•	√	•
COM-11	Design Assistance for New Commercial	Washington State		•	•					•	√	•
COM-12	Technical Assistance	SMUD			•						√	
COM-13	New Construction Rebate Pgm.	PG&E			√					•	•	
COM-14	Energy Conscious Construction	NE Utilities								•	√	
COM-15	Lighting Code Compliance Training	OSU Extension		•						•	•	√
COM-16	Passive Solar Nonres. Bldgs.	DOE	•	√	•					•	•	
COM-17	Solar in Federal Bldgs. Demo.	DOE	√	•								
COM-18	Whole-Bldg. Energy Design Targets	DOE/PNL								√		
COM-19	General Design Criteria	DOE								√		
COM-20	Daylighting and Thermal Analysis	SCE			•					•	√	
COM-21	New Construction Incentive	Palo Alto			√							

Key to Features:

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Table A-1 Continued. Energy conservation programs for new buildings: by program number.

Program #	Name of Program	Sponsor	Program Features (√ = Primary Feature)									
			TD	DP	DI	UR	LL	RL	EA	DT	DA	TC
Resid./Comm. Programs												
RES/COM-1	Design Assistance for New Bldgs.	San Antonio								•	√	
RES/COM-2	Solar Design Strategies	PSIC								•	√	
RES/COM-3	Passive Solar Manufactured Bldgs.	DOE/SERI	•	√	•						•	
RES/COM-4	Calif.'s Conservation Stds. (Title 24)	Calif. Energy Comm.								•	•	√
RES/COM-5	Fla. Energy Code and Mktng. Pgm.	Fla. Energy Office						•		•		√
RES/COM-6	Whole Bldg. Performance Stds.	DOE								•		
RES/COM-7	Energy Conservation Awards	Owens-Corning							√			
RES/COM-8	Code Adoption Demo., Early Adopter & Northwest Energy Code Pgms.	BPA	•	√	•							•
RES/COM-9	Tacoma's Early Adopter Pgm.	Tacoma	•	√	•			•			•	•
RES/COM-10	Milton Keynes Energy Park Demo.	Milton Keynes (England)	•					•				•
RES/COM-11	Saint Paul Energy Park	Saint Paul										

Key to Features:

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DP = Demonstration Program
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DT = Design Tools
DA = Design Assistance
TC = Training, Compliance, & Quality Control

Table A-1 Continued. Energy conservation programs for new buildings: by program number.

Key to Sponsors	
ASE	Alliance to Save Energy
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc.
BPA	Bonneville Power Administration
DCRA	Department of Community and Regional Affairs
DHCD	Department of Housing and Community Development
DOE	U.S. Department of Energy
E&G	Electric and Gas
E&M	Energy and Mines
EEBA	Energy Efficient Building Association
EM&R	Energy, Mines and Resources
HA	Housing Agency
HFA	Housing Finance Agency
NCAEC	North Carolina Alternative Energy Corporation
OER	Office of Energy Resources
OSU	Oregon State University
PG&E	Pacific Gas and Electric Company
PNL	Pacific Northwest Laboratories
P&L	Power and Light
PSC	Public Service Company
PSIC	Passive Solar Industries Council
PUC	Public Utilities Commission
SCE	Southern California Edison
SERI	Solar Energy Research Institute
SMUD	Sacramento Municipal Utility District
TVA	Tennessee Valley Authority

Table A-2. Home energy rating programs for new construction.

Sponsor	Name of Program (ID#)	Program Lifetime	Reference[†]
Alaska, State of	Energy Rated Homes	1987-	1,2
Ann Arbor (Michigan)	Voluntary Improvement Program	Not known	3
Arizona Public Service	Energy Efficient House	Not known	4
Arkansas Power and Light	Energy Saver Award Program (RES-29)	1982-87	5
Austin (Texas), City of	Energy Star	1985-	1,3
Cedar Falls Utilities (Iowa)	Energy Efficient Home	1978-	3
Cobb Electric Membership Corporation (Georgia)	Energy Management Construction	Not known	3
College Station Municipal Utility (Texas)	Not known	1987	6
Colorado, State of	Energy Saver Homes	1986-	7
Connecticut Light and Power Company	100 Plus	1982-	3
CONN SAVE	Home Energy Rating	1984-	1,3
Delmarva Power and Light (Del., Md., Va.)	Super E Home	1982-	1
Denver Energy Resource Center	Home Energy Rating Program	1986-	1,3
Detroit Edison	Energy Efficiency Excellence Award	Not known	3
Duke Power Company	Energy Efficient Structure Program (RES-12)	1958-	1,3
Energy Institute (Colorado)	Home Energy Loan Program	1984-	8
Florida, State of	Florida Energy Efficiency Code	1978-	1,3
Florida Power Corporation	Energy Saver Award (RES-14)	1983-86	3
Greenville Utilities Commission (N.C.)	E-300 Structure	Not known	3
Illinois Power	National Energy Watch (NEW)	1977-85	1
Iowa Power and Light	Payback Plus Home	Not known	3
Kansas City Power and Light	SAVE	1983-	1,3,4
Lakeland Electric and Water (Florida)	Manufacture Home Energy Value Award	Not known	3
Massachusetts, State of	Mass Save	1982-	1
Mississippi Valley Gas	Gas Mark	1982-	1
Mississippi Power and Light	Energy Saving Home & E3 Home	1976-	1
Missouri Power	Conservation Program	1976-	4
Modesto Irrigation District (Calif.)	Power Saver Home	1985-	3,4
Nevada Power	Energy Efficient Home Award (RES-18)	1984-	1,3
Northeast Utilities (Conn.)	Energy Value Home (RES-3)	1983-	4
Oklahoma Natural Gas	Conservator Home Award	1979-	1
Old Dominion Power (Kentucky)	Wise Choice House	1985-	4
Pennsylvania, State of	Home Energy Cost Estimator	1984-	1
Philadelphia Electric	Excellence in Energy Efficiency	Not known	3

[†] 1 = Vine *et al.*, 1987b; 2 = *Conservation Update* Dec. 1986, p.2; 3 = Hendrickson, 1986; 4 = Callaway *et al.*, 1986; 5 = Hendrickson *et al.*, 1985; 6 = *Energy and Housing Report* 7(8):7 (1987); 7 = Baccei, 1986; 8 = U.S. Department of Energy, 1987a.

Table A-2 Continued. Home energy rating programs for new construction.

Sponsor	Name of Program (ID#)	Program Lifetime	Reference†
Public Service Company of New Mexico	SMART Program	1976-	1
Sacramento Municipal Utility District	Residential New Construction Pgm. (RES-1)	1983-86	4
St. Louis Homebuilders Association	Energy Mark	1980-	1
Salt River Project	Energy Efficient Homes (RES-7)	1980-	1
Santee Cooper (South Carolina)	Energy Efficient Home Award	Not known	3
South Carolina Electric and Gas	Residential Energy Conservation Rate	1973-	4
Southwest Gas	Flame of Excellence	1984-	1
Southwestern Electric Power Company	Energy Efficient Home	1976-	3
Southwestern Public Service (Texas)	Energy Efficient House	1969-	3,4
Suburban Maryland Building Industry Association	E-7 Energy Conservation Award	Not known	3
Texas-New Mexico Power Company	Energy Checked Efficiency Home	1975-	3
Texas Utilities Electric Company	Energy Action Home	1986-	1,3
Union Electric (Mo.)	National Energy Watch (NEW) Program	1974-75	1
United Illuminating (Conn.)	Hug 'N Snug Energy Saver Home Program	1985-	3
Virginia Electric Power	Energy Saver Home	1985-	1,3
Washington, State of	Energy Rates Houses of America	1981-	1
West Texas Utilities	Energy Saving Plan Award	1983-	3
Wisconsin, State of	Not known	1987-	9
Regional/National			
Bonneville Power Administration	Super Good Cents (RES-9)	1984-	3,6
Edison Electric Institute	National Energy Watch	1977-86	1
Manville Corporation	Energy Conquest Home	Not known	3
Owens-Corning Fiberglas Corporation	Thermal Crafted Home (RES-8)	1980-	3
	and Energy Qualified Home (RES-33)	1980-	3
Southern Electric International	Good Cents	1976-	3
Tennessee Valley Authority	Energy Saver Home (RES-4)	1984-	1,3
Watt Count Engineering	Watt Count Energy Saving System	1972-	1
Western Resources Institute	Energy Rated Homes	1981-	3
International			
British Columbia Hydro	Double E and Super EE Home Programa	Not known	3
Canada: Energy, Mines and Resources	R-2000 (RES-5)	1980-	3
France	High Energy Performance Label	1984-	3

† 1 = Vine *et al.*, 1987b; 3 = Hendrickson, 1986; 4 = Callaway *et al.*, 1986; 5 = Hendrickson *et al.*, 1985; 9 = *Conservation Update* Oct. 1986, p.8;

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