Title

planning for an energy-efficient FUTURE: THE EXPERIENCE WITH IMPLEMENTING ENERGY CONSERVATION PROGRAMS FOR NEW RESIDENTIAL AND COMMERCIAL BUILDINGS, VOLUME S: PROGRAM DESCRIPTIONS

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Lawrence Berkeley Laboratory
UNIVERSITY OF CALIFORNIA

APPLIED SCIENCE DIVISION

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

Volume 2: Program Descriptions

E. Vine and J. Harris

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Prepared for the U.S. Department of Energy under Contract Number DE-AC03-76SF00098.

DISCLAIMER

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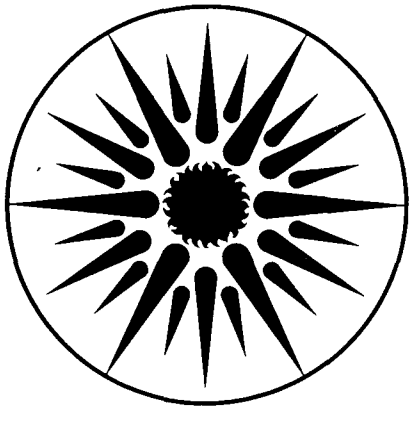

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PLANNING FOR AN ENERGY-EFFICIENT FUTURE: THE EXPERIENCE WITH IMPLEMENTING ENERGY CONSERVATION PROGRAMS FOR NEW RESIDENTIAL AND COMMERCIAL BUILDINGS

VOLUME 2: PROGRAM DESCRIPTIONS

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September 1988

This work was supported by the Assistant Secretary for Conservation and Renewable Energy, Office of Buildings and Community Systems, Building Services Division, U.S. Department of Energy under Contract No. DE-AC03-76SF00098.

PREFACE

This volume contains the descriptions of programs contained in Volume 1 of our main report: *Planning for an Energy-Efficient Future: The Experience With Implementing Energy Conservation Programs For New Residential and Commercial Buildings* (LBL-25525). The programs are listed by program number in Table A-1 and by program category in Table A-2.

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			√							

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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										

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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. Energy conservation programs for new buildings: by program feature.

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

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Table A-2 Continued. Energy conservation programs for new buildings: by program feature.

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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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

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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

NEW RESIDENTIAL PROGRAMS (RES-1)

PROGRAM TITLE: Residential New Construction Program

PROGRAM SPONSOR: Sacramento Municipal Utility District (SMUD)

PROGRAM OBJECTIVES: To encourage the installation of measures and devices that reduce SMUD's summer peak demand in new single-family and multifamily residential construction.

APPROACH: The program provided technical and design assistance and financial incentives to builders to install equipment exceeding Title 24 standards. The measures attempted to reduce summer peak demand and included energy-efficient air-conditioners and heat pumps, shade screens and other shading, and glass orientation. All buildings had to have minimum R-30 ceiling insulation, double-pane glazing for doors and windows, and at least one of the following: shading devices on at least 50% of West glass, or no more than 2% West glass, or a heat pump with an EER of 8.0 or higher. MICROPAS was used in modelling efforts to estimate typical load reduction methods. Emphasis was placed upon high-volume builders. However, mostly smaller builders took advantage of the program because larger builders had their own in-house experts.

TARGET BUILDING TYPES: Single-family and multifamily.

KEY PARTICIPANTS: SMUD and builders

HISTORY:

Date of Implementation: October 1983
Current Status: Discontinued in June 1986 (see below). Planning to be resurrected in 1988 (see below).
General Comments: The Residential New Construction program was formerly called the Building LoaD Reduction program (BLDR). It was also referred to as the SMUD Home Builder Award Program. It started out as a heat pump promotion program. The Home Builder Award Program later included the Passive Solar homes: awards were Silver, Gold, and Passive Solar. The Passive Solar homes (see writeup), in addition to meeting the standards for Silver and Gold awards, met other criteria through a combination of various measures: orientation (house facing north or south), windows (using no more than 4% glass on east and west facing walls, and increasing glass on south walls); thermal mass; and ventilation/cooling (whole house fan, thermal chimney, or adequate windows on north and south sides).

MARKETING/PROMOTION METHODS: Building plan analysis, and free marketing assistance. SMUD included the names of participating builders and their subdivisions in print ads promoting the Home Builder Award program. Silver and Gold Award certificates and Passive Solar Home plaques were displayed prominently.

Financial incentives were provided and were based on a point system that was based on the reduction of peak load, reflected in the type of energy measures installed. In the point system, one point was equal to a peak electrical demand of 10 watts. The minimum award level was 100 points, equivalent to 1.0 kW in peak demand reduction. In the later stages of the program, Silver Awards were given for homes reaching the 100 point level and Gold Awards for 150 points and above. The maximum number of points that could be earned was 300. Multifamily units were given a single award based upon achieving at least 50 points. Builders were paid a straightforward one dollar per

point. Maximum payment limits were $300 per single-family/duplex unit and $150 per multi-family unit. Builders were paid $100 per kW saved, and typical payments were $200 per builder per application. Builders were presented certificates for each qualifying housing unit.

MONITORING/EVALUATION:

Market penetration: During the program (1983-86), 4,165 housing units received awards; 13 builders received awards for 50 or more homes; and 3 of these builders received awards for over 300 housing units each. During the program's lifetime, SMUD added 44,000 residential customers, so that the market penetration rate of the program was about 10%.

Savings:

- Energy: Estimated: 662 kWh per house per year, (or 2,757,680 kWh per year for the whole program, or 82,730,000 kWh over 30 years of the program)
- Peak: 4.2 MW (estimated)
- Dollars:

Costs and cost-effectiveness:

- Program administration:
- Incentives: $510,521
- Private investment:

Discussion:

Only a few tract builders participated in the program, although they accounted for 80% of the awards. Most large builders were reluctant to alter their house designs to comply with the glazing orientation requirements, and some did not want to put shade screens on their homes.

Shade screens and improved air conditioner efficiency, two of the point system measures, were also popular means of compliance with California's energy conservation building standards (Title 24). Accordingly, SMUD realized that the benefits of this program might be illusory since it was essentially giving away money to builders who were already complying with the Title 24 standards.

The financial incentives were not important in influencing builders' decisionmaking - Title 24 was doing this. Consequently, the program was discontinued. A new residential new construction incentive program, planned for 1988, will raise the standards for builders, so that the financial incentives will have more of an impact. The program will likely focus upon peak summer demand-reduction measures.

RELATED PROGRAMS: SMUD's Thermal Storage Program (see writeup). A pilot program was also conducted in 1987 involving the payment of an incentive to builders for allowing the installation of an air conditioner cycling switch prior to occupancy of the home. This approach proved very successful; 211 switches were installed and very few residents requested removal of the switches. This pilot program paid a $100 incentive per installation (based upon an anticipated 1.0 kW load reduction); a $50 incentive is planned for an expanded program in 1988.

REFERENCES: Personal communication from Warren Lindeleaf, Nov. 6, 1987; "SMUD Home Builder Award: Rewarding Energy Efficiency in New Residential Construction," and "SMUD Residential New Construction Award Program," brochures prepared by SMUD.

CONTACTS:

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DATE: Oct. 22, 1987 / June 1, 1988

Name: Warren Lindeleaf
Position/title: Demand-Side Planner
Organization: Sacramento Municipal Utility District
Address: 6201 S Street, P.O. Box 15830, Sacramento, CA 95852-1830
Phone: 916-732-5489

DATE: Oct. 22, 1987

NEW RESIDENTIAL PROGRAMS (RES-2)

PROGRAM TITLE: Passive Solar Home Program

PROGRAM SPONSOR: Sacramento Municipal Utility District (SMUD)

PROGRAM OBJECTIVES: To encourage builders to build passive solar houses that would significantly reduce summer peak demand.

APPROACH: This program was similar in scope to SMUD's Residential New Construction Program (see writeup). The program provided design assistance (architectural review) and marketing assistance for the inclusion of passive solar features, but offered no monetary awards. Computer modelling was used to simulate different building configurations and the orientation of the home. The Passive Solar Home Award was presented for home designs that met specified requirements (in addition to meeting basic standards outlined in the Residential New Construction Program) for glazing (no more than 4% glass on east and west-facing walls, and increasing glass on south walls); orientation (house facing north or south); shading; thermal mass; and ventilation/cooling (whole house fan, thermal chimney, or adequate windows on north and south sides). When residential building standards were revised in 1982, two additional requirements were added: (1) at least 20% reduction in annual heating and cooling energy consumption (kBtu/sq. ft.) below the level required by the state building standards; and (2) maximum peak cooling demand of 2.2 W/sq. ft. of conditioned space. The CALPAS3 computer program was used to determine compliance with these requirements.

TARGET BUILDING TYPES: Single-family

KEY PARTICIPANTS: SMUD and builders

HISTORY:

Date of Implementation: 1981
Current Status: Discontinued in 1985.
General Comments:

MARKETING/PROMOTION METHODS: The program provided Passive Solar Home Award wall plaques for each home constructed, lawn signs, and newspaper ads for volume builders. Although monetary incentives were not offered in this program, Passive Solar homes were eligible for cash payments available through the Residential New Construction Program (to use shade screens and orient their homes correctly).

MONITORING/EVALUATION:

Market penetration:

Year	Number of homes in program	Number of new homes in service territory *
1982	10	3,910
1983	17	6,193
1984	45	7,899
1985	34	12,767
1986	23	13,650
Total	139	45,139

* Includes multifamily units.

Savings:
- Energy:
- Peak:
- Dollars:

Costs and cost-effectiveness:
- Program administration:
- Incentives:
- Private investment:

Discussion:
This program had very little impact, primarily because virtually no large-volume builders participated. Designs were certified for about twice the number of homes actually built, but builders did not follow through with the amount of mass they specified. These builders found the increased mass requirement too expensive and were concerned that homebuyers would not accept heavily-massed houses. Consumers felt that uncarpeted floors are too hard, too cold, and they they tend to bounce too much noise. The builders' concerns appear well-founded: sales of the Passive Solar models of the few large builders who participated were disappointing. Currently, there is very little interest in continuing this type of program.

RELATED PROGRAMS: SMUD's Residential New Construction Program.

REFERENCES: Personal communication from Warren Lindeleaf, Nov. 6, 1987; "SMUD Passive Solar Home Program: Requirements for Certification," notice prepared by SMUD.

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DATE: Oct. 22, 1987 / June 1, 1988

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DATE: Oct. 22, 1987

NEW RESIDENTIAL PROGRAMS (RES-3)

PROGRAM TITLE: Energy Value Home Program

PROGRAM SPONSOR: Northeast Utilities

PROGRAM OBJECTIVES: To promote energy-efficient homes.

APPROACH: This program promotes energy-efficient homes through advertising and rate reductions. Energy Value Homes must meet minimum thermal standards, covering insulation (ceiling, exterior wall, interior wall, floor, and slab), windows, exterior doors, infiltration, and attic ventilation. Passive solar homes incorporate the Energy Value Home standards plus other standards covering solar aperture, exterior walls, and windows. Recommendations are made for heating systems and other appliances. Previously, all single-family homes were eligible; as of Jan. 1, 1988, only all-electric homes are eligible (the company is promoting the judicious use of electricity).

TARGET BUILDING TYPES: Single-family

KEY PARTICIPANTS: Northeast Utilities, homebuyers, realtors, and builders.

HISTORY:

Date of Implementation: 1983
Current Status: On hold, pending further review (see below)
General Comments: Northeast Utilities is the largest utility in New England and through its operating subsidiary, Connecticut Light and Power, it serves 153 communities in Connecticut. The conservation programs of Northeast Utilities are under review, and the program was not included in the latest rate case (Spring 1988). The company is considering a substantial overhaul of the program. On the commercial side, the Energy Value Building program was replaced by the Energy Conscious Construction program in 1986 (see writeup).

MARKETING/PROMOTION METHODS: Cooperative advertising with builders; for all-electric homes meeting standards, the electric rate is reduced $0.01/kWh (the current rate is $0.08/kWh; the reduction is based on total electric usage and lasts for the life of the building). Newspaper, radio, and bill inserts are used. Consumer information kits, certificates for customers, plaques for builders, lawn signs, posters, and open house point-of-purchase materials are also provided.

MONITORING/EVALUATION: None

Market penetration:

Savings:
- Energy:
- Peak:
- Dollars:

Costs (total and annual):
- Program administration:
- Incentives:
- Private investment:

Discussion: Wall thought that the rate reduction was not a major factor, especially for builders.

RELATED PROGRAMS: Northeast Utilities sponsors a similar program for new commercial construction, called the Energy Conscious Construction Program (see writeup).

REFERENCES: Brochures prepared by Northeast Utilities; Wajcs, 1987; Northeast Utilities, *Energy Conscious Construction Program: Implementation Manual,* Energy Management Services, Hartford, Conn., 1986.

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DATE: May 31, 1988

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DATE: Oct. 26, 1987

NEW RESIDENTIAL PROGRAMS (RES-4)

PROGRAM TITLE: Energy Saver Home (ESH) Program

PROGRAM SPONSOR: Tennessee Valley Authority (TVA)

PROGRAM OBJECTIVES: To encourage home builders to incorporate state-of-the-art conservation/solar features into new residential construction.

APPROACH: This program is a cooperative effort among TVA, distributors of TVA power, and home builders to promote and recognize energy-efficient new housing. The program promotes cost-effective, energy-efficient houses and apartments that meet TVA's ESH standards. The standards allow design flexibility and encourage the use of solar energy features (see below). The ESH program offers incentives to power distributors (which may be passed through to builders or consumers) to promote the program. Contractors are provided with proven, cost-effective standards and techniques to use as guidelines for designing and building the energy-efficient homes that prospective buyers are requesting. The energy-saving measures include: extra insulation in the roof or ceiling (R-30), walls (R-15), floors (R-19 in crawl spaces or perimeter insulation of R-5 around slabs); weatherstripping and caulking around doors and windows; double-pane or storm windows; insulated doors; vapor barriers in the walls and floors; adequate ventilation in the crawl space and attic or roof; and efficient heat pumps or air-conditioners. Additional measures that may be included are: high-efficiency air-conditioners or heat pumps; heat pump water heaters; and passive solar windows or sunrooms. Technical and design assistance is available to builders and buyers through the local power distributor. Inspections are conducted during the construction phase. If a home does not meet prescriptive standards, a TVA-designed "tradeoff calculations procedure" permits the home builder as much flexibility as possible in shopping for the various energy-saving components of the home. As the home is built and inspected, it is registered and awarded a special brass plaque.

TARGET BUILDING TYPES: Single-family and multifamily.

KEY PARTICIPANTS: TVA, power distributors, builders, consumers, lenders, appraisers, and home builders' associations.

HISTORY:

Date of Implementation: 1984/85
Current Status: Continuing.
General Comments: The forerunner of this program was the Super Saver Home program that was started in the mid-1970s. In 1980/81, the program was revamped and renamed the Energy Saver Homes Volunteer Program. The basic program as it is currently operated started in 1984/85 when there were signed contracts with power distributors and incentive payments.

MARKETING/PROMOTION METHODS: TVA has used cooperative advertising with power distributors. Most of the marketing has been through traditional marketing vehicles, especially the print medium. This year they will be targeting their marketing to spec builders and potential new homebuyers and builders. The incentives are up to $150 for the construction of a base house that includes basic efficiency features, and additional incentives if the house includes passive solar, efficient heat pumps or air conditioners, etc.:

RES-4

Feature	Single-Family	Multifamily
Passive solar system	$100	$50
High-efficiency heat pump	100	50
High-efficiency air conditioner	50	25
Solar water heater	75	37.50
Heat pump water heater	50	25

Power distributors receive a $200 incentive for the standard heat pump ESH house. For single-family residences, a 20-inch by 24-inch metal sign with stand, indicating the ESH logo, is provided. For an ESH subdivision or apartment complex, larger wooden signs are provided. A brass medallion can also be permanently affixed to the home. An official ESH certificate is awarded to the homeowner. TVA also provides program flyers and brochures, generic program advertising, cooperative advertising, assistance with local "Parade of Homes", open houses, and 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. Home builders' associations in the Memphis, Nashville, and Chattanooga areas and the Tennessee and Alabama state home builders' associations have endorsed the program.

MONITORING/EVALUATION METHODS:

The entire program is currently being reviewed (see below).

Market penetration: As of September 1987, 22,518 new homes had been certified as meeting Energy Saver standards, and 81 (out of 160) local power distributors had contracted to participate in the program. In the areas served by the program's 18 most active power distributors (where 60% of the area's building starts are concentrated), an average of 14% of the housing stock participates in the program.

Savings

- Energy: Predicted: 25% savings for heating (up to 40% savings over typical homes with electric resistance heating; the description of the "average" typical home was based on field surveys conducted in 1987 and on discussions with program field staff). Annual savings of 2,200 kWh per house are expected.
- Peak: Through June 1986, the ESH program had displaced electric capacity at a 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.
- Dollars: Annual savings of $128 per house are expected.

Costs and cost-effectiveness: Predicted: on the average, constructing an ESH adds about 1% to the final cost of the home, or $.40 per sq. ft.

- Program administration:
- Incentives:
- Private investment:

Discussion:

The onsite inspections were very helpful and served several purposes, including: assuring quality installations of heat pumps and insulation, educating builders on

improved construction techniques, and building buyer confidence in the end product by inspecting for features during the construction process.

The current program is not what TVA wants in the future. As it stands now, the Energy Saver Home program has resulted in the construction of high quality, energy saver homes that are leaders in the field. In the future, TVA hopes to have a program that maintains quality with reduced standards so that more homes can qualify. In addition, the future program would be more receptive to consumers (e.g., by increasing the amount of glazing in the house) to increase the marketability of the program. As proposed, the future program would also give increased flexibility to the power distributors in standard qualification procedures and in the type and level of incentives (e.g., for certain technologies and for certain target groups).

RELATED PROGRAMS: TVA has seven regional districts that provide many services, including technical and design assistance and training opportunities in building construction. TVA is also involved in special projects with local and state governments (e.g., energy-efficient housing for low-to-moderate income families in the Chattanooga area; TVA provides plans with energy packages included in them).

REFERENCES: Swisher and Womble, 1985; "Home Builders: Gain a Marketing Advantage...," "Don't Settle for Less than the Best in Your New Home," "Energy Saver Home Incentive Program," "Energy Saver Home Standards," "Solar Homes Design Portfolio," and "Weatherization Materials and Techniques," brochures prepared by TVA; Tennessee Valley Authority, *Conservation Report '86,* Chattanooga, Tenn., 1987.

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DATE: Oct. 27, 1987 / June 22, 1988

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DATE: April 22, 1988

NEW RESIDENTIAL PROGRAMS (RES-5)

PROGRAM TITLE: Super Energy-Efficient Home (R-2000) Program

PROGRAM SPONSOR: Energy, Mines and Resources (EMR) Canada, and the Canadian Home Builders' Association (CHBA)

PROGRAM OBJECTIVES: To save energy for Canada by reducing usage in the housing sector; to improve the ability of Canadian home builders to respond to a changing and competitive housing market; to provide quality housing with superior levels of comfort, lasting value and lower energy costs; to ensure that the construction of super energy-efficient R-2000 housing becomes self-sustaining by 1990; to have the building industry construct 20,000 homes under the program by 1990; to stimulate the housing industry so that R-2000 housing becomes widely demanded and available on a commercially viable basis in the absence of government support; to identify and document barriers to the widespread adoption of energy-efficient housing; to document and monitor the construction techniques, problems, and energy consumption of houses built under the program; and to obtain data on the costs, savings, and performance of R-2000 homes.

APPROACH: The R-2000 Home Program is a cooperative industry/government initiative delivered by the CHBA on behalf of EMR. The program is delivered to builders by their own industry association. Participating builders deal directly with CHBA through the Association's regional offices. The program actively supports the evolution and commercialization of energy-efficient housing through the development of consensus standards for products and equipment; laboratory testing of products and equipment; training and education programs for the building industry; public awareness; the development of inspection procedures for quality assurance; and an extensive field monitoring program involving all R-2000 demonstration homes.

The CHBA provides training and education packages for builders and trades, ensures that builders fulfill the program requirements, and verifies that houses built under the program meet the technical and energy performance criteria established for R-2000 homes. EMR provides overall direction and coordination of the R-2000 Home Program while working closely with CHBA in the training of builders and in the promotion of R-2000 homes. Through its national and regional offices, EMR provides operating funds to CHBA and some financial incentives directly to selected demonstration builders participating in the program. EMR also coordinates advertising and promotional activities in support of the program. While the program does provide contributions for the construction of demonstration homes, the main thrust of the program is technology transfer. From 1988/89 on, the program will focus on the institutionalization of builder training and development activities and research into energy-efficient construction techniques and materials.

This is a voluntary certification program. To qualify for a R-2000 certificate, a home must be built to the energy performance standard for the particular climatic region by a builder registered under the program. Builders are free to design and construct homes of any style or type, as long as the final product meets the R-2000 Home standard of energy efficiency. R-2000 homes have a number of common features: a continuous air-vapor barrier, two to three times the amount of insulation used in conventional construction, a mechanical heat recovery ventilation system that operates continuously, double or triple glazed windows, emphasis on south-facing windows,

and properly sized heating equipment. The R-2000 energy performance target varies according to house size and climate use. Initially, no consideration was given to high-efficiency space and water heating equipment, but changes to the R-2000 energy target are planned. The energy target is determined at the plans examination stage by means of a computer simulation program. This program, known as HOT-2000, is based on the HOTCAN Energy Analysis Program developed by the National Research Council for predicting monthly and annual space heating requirements in residential buildings. An air leakage test by CHBA or an approved agency is conducted prior to the award of the R-2000 certificate. In addition, the builder must certify to the CHBA that the home was built to R-2000 standards.

TARGET BUILDING TYPES: Single-family

KEY PARTICIPANTS: Energy, Mines and Resources, Canada, the Canadian Home Builders' Association, the Canadian Electrical Association, the Canadian Gas Association, builders, and consumers.

HISTORY:

Date of Implementation: 1980/81
Current Status: Continuing (planned to end in FY 1990/91).
General Comments: The R-2000 Home is the result of more than ten years of intensive effort by Canadian researchers to reduce energy consumption in Canadian homes.

MARKETING/PROMOTION METHODS: There are training sessions for participating builders for learning state-of-the-art techniques of housing design and construction. Demonstration homes were built. The first R-2000 home built by a builder (Demonstration Home) is eligible for a $5,500 contribution and the second R-2000 home built by a builder (Skills Enhancement Home) is eligible for a $1,500 contribution. The homebuyer pays the incremental cost associated with the R-2000 option. From 1988/89 on, no contributions will be given to builders. Many benefits of the program are promoted: occupant comfort, indoor environmental control, long-term value, and energy efficiency. A homeowner receives a R-2000 Home Identification Certificate (issued by EMR) and an identification sticker to be attached to the home's electrical panel, identifying the home as an "R-2000 Home," built by a registered R-2000 Home builder. Builders participating in the program learn specialized marketing techniques at workshops. They learn how they can benefit from the national advertising and promotion carried out by EMR and CHBA which tells Canadian homebuyers about the program. The Canadian Electrical Association and the Canadian Gas Association also promote R-2000 homes.

MONITORING/EVALUATION:
Monitoring studies and program evaluation have been conducted. The first 1000 homes had their energy performance measured (space heating, lights, and appliances were measured on a monthly basis); now, one-half of the homes that are built will be monitored; and this percentage will decrease as more homes come on the market. They also monitor indoor air quality and incremental costs (especially those for heat recovery and ventilation equipment). A comprehensive program evaluation was performed in FY 1986-87 and included surveys of homeowners and homebuyers regarding sociodemographics, factors important in the house purchasing decision, willingness-to-pay for R-2000 features, and experiences, attitudes, and general expectations with respect to energy efficiency and housing. R-2000 home builders were surveyed regarding basic residential construction activity, energy-efficiency levels in new house construction, builders' perceptions of the market

for energy-efficient houses, and attitudes towards super energy-efficient houses and related design tools. Structured interviews were carried out with 55 "experts" who were knowledgeable about energy-efficient housing and/or the R-2000 Program. Economic and financial analyses were also conducted, and the development and application of various models of energy use were performed. The evaluation focused on 800 R-200 homes built by March 1986.

Market penetration: 3,500 homes have been built as of Oct. 1987; 1,500 builders have been involved; and 4,500 people (architects and engineers, builders, etc.) have participated in training sessions. The sponsor's goals are to involve 2,500 builders and complete 20,000 homes across Canada by 1991. They expect a market penetration by 1995 for R-2000 housing of approximately 15% of single-family houses, and this would likely be a self-sustaining level. Annual construction, as of early 1987:

Year	Number of certified R-2000 Homes constructed
1982-83	30
1983-84	268
1984-85	91
1985-86	395
1986-87	1006
Total	1790

Savings:

- Energy: 30% lower energy consumption than that of typical Canadian houses built in 1978 and 55% lower than typical houses built in 1975 (actual data).
- Peak:
- Dollars: As of March 1986: energy saving benefits were $11 million and nonenergy benefits were $5 million. If the program achieves its objective of reaching 20,000 homes, an energy savings of approximately $200 million are expected to result.

Costs and cost-effectiveness: The approved funding for the program during the seven-year period ending in FY 1990-91 is approximately $58.6 million. As of March 1986, house construction costs were $6 million and program costs were $22 million. Accordingly, net benefits were -$12 million. The benefit-cost ratio was 0.39 for energy benefits only and 0.57 for all benefits.

- Program administration:
- Incentives:
- Private investment:

Discussion:

The program continues to be updated. Technical criteria will continue to be updated and incorporated in the program (no closure). A point system has been created for home designs so that they can be preapproved. This will eliminate some steps for builders. The final inspection, involving the fan depressurization test, will still be made.

The program evaluation determined that in most regions of Canada's R-2000 housing was economically beneficial to both homebuyers and society. The additional incremental cost for upgrading new homes to meet the R-2000 standards was typically 5% to 10% of the total house construction cost, excluding land. However,

based on existing energy prices, it appears that in many regions the R-2000 target is too energy efficient, especially for fossil fuel heating systems. In light of the uncertainty associated with future energy prices, the fact that the current R-2000 performance standards are not mandated into building codes and, therefore, demand is determined by market forces, along with a desire of the program to maintain consistency, the evaluators recommended that that R-2000 target be maintained, and not become more stringent.

The evaluators noted that a widespread and sustained demand for R-2000 homes has not been developed. While R-2000 homeowners are very aware of the program and of the features which differentiate an R-2000 house from a conventional house, potential homebuyers were not aware of either the program or the unique features of an R-2000 house. However, the evaluators noted that the market was ready to support a 15% penetration rate in single-family houses without contributions or subsidies. They noted that if the market did not develop, it would likely be due to barriers other than those of a financial or economic nature.

There were significant regional variations in the demand for R-2000 housing, particularly the Quebec market, due to the relatively high cost of the R-2000 option, a relatively high energy efficiency of conventional housing which results in low incremental energy savings from the R-2000 option, and a lower willingness-to-pay for nonenergy R-2000 features (such as an indoor environment that is quiet and draft-free yet with excellent ventilation).

Based on the survey of house builders, a higher percentage of R-2000 builders, relative to general builders, claim that they incorporate new energy-efficient materials and techniques into their standard house design. However, in the aggregate, this impact is not significant due to the very small number of conventional houses built by existing R-2000 builders.

Cooperation with national organizations representing the building sector was deemed essential to ensure that the goal to divest the program to the private sector was realized as the program winds down.

The evaluators recommended the following actions: (1) there should be more emphasis on increasing demand for R-2000 housing, particularly through advertising of R-2000 house building capabilities by local builders; (2) there should be increased efforts on the institutionalization of education and training elements, especially in the community college and apprenticeship programs; (3) contributions to builders of R-2000 homes should be eliminated in 1987/88 as planned; (4) the R-2000 standard should be maintained as a voluntary option rather than a mandatory standard; and (5) the current R-2000 energy-efficient target should be maintained but not increased.

RELATED PROGRAMS:

REFERENCES: Canadian Home Builders' Association, "Living in R-2000 Comfort," "Information for Home Builders," *The R-2000 Updater* Vol. 4, No. 1, August/September 1987, brochures and article, Ottawa, Ontario; H. Brian Dickens, *Controlled Ventilation in Housing: A Summary Review*, Report 008-TS, Energy, Mines and Resources Canada, Ottawa, Ontario, 1985; P. Edwards and C.A. McGugan, *Heat Recovery Ventilator Testing, 1983-1984*, Report 009-PE, Energy, Mines and Resources Canada, Ottawa, Ontario, 1986; P. Edwards and D. Giannini, *Induced Draft Water Heater Test*, Report 006-PE, Energy, Mines and Resources Canada, Ottawa, Ontario, 1986; Energy, Mines and Resources Canada,

1987; Energy, Mines and Resources Canada, *Ventilation and Air Quality Monitoring in R-2000 Homes: Measurement and Analysis*, Report No. 002-MR, Energy, Mines and Resources Canada, Ottawa, Ontario, 1986; Energy, Mines and Resources Canada, *Energy Performance of R-2000 Homes: A Comparison of Measured Energy Consumption With the R-2000 Target and Computer Predictions for Homes Built to Current Building Practices*, Report No. 012-MR, Energy, Mines and Resources Canada, Ottawa, Ontario, 1986; Energy, Mines and Resources Canada, "R-2000 Home Identification," "Guide to the R-2000 Home," "R-2000...The Home for Today...And Tomorrow," "R-2000 Factsheets": 'The R-2000 Home Standard,' 'Windows,' 'Wall Construction in R-2000 Homes,' 'Heating Systems,' 'Roofs,' 'Cost and Economics,' 'Basements,' 'Air Quality in R-2000 Homes,' and 'Heat Recovery Ventilator,' brochures and factsheets, Ottawa, Ontario; Ficner, 1984; P. Hendrickson, "The R-2000 Super Energy Efficient Home Program," in Hendrickson, 1986; P. Piersol and K. Matsummura, *Development of a Procedure to Assess Organic Outgassing from Heat Recovery Ventilators*, Report 022-PE, Energy, Mines and Resources Canada, Ottawa, Ontario, 1987; The Bureau of Management Consulting, *Review of Technical Requirements for R-2000 Homes (Interim Report)*, Energy, Mines and Resources Canada, Ottawa, Ontario, 1985.

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NEW RESIDENTIAL PROGRAMS (RES-6)

PROGRAM TITLE: Energy-Efficient Mortgage (EEM) Pilot Program

PROGRAM SPONSOR: Alliance to Save Energy

PROGRAM OBJECTIVES: To promote energy efficiency in existing homes through energy conservation mortgage financing.

APPROACH: A pilot program was conducted in the Hartford, Conn. area with Conn-Save (a statewide utility consortium) to try to get homebuyers to apply for energy-efficient loans. Conn Save had an energy audit program with a rating system built into their audit software. Attempts were made through realtors and lenders to encourage homebuyers to have their homes rated and to obtain loans for energy-efficiency improvements in homes. Since Conn Save's audit program was not aimed at new homes, this effectively excluded new homes from this program.

TARGET BUILDING TYPES: Existing single-family

KEY PARTICIPANTS: Alliance to Save Energy, Conn Save, the Federal National Mortgage Association (Fannie Mae), the Federal Home Loan Mortgage Corporation (Freddie Mac), area realtors and lenders, and consumers.

HISTORY:

Date of Implementation: 1986
Current Status: Stopped in 1987.
General Comments: Fannie Mae and Freddie Mac are secondary mortgage lenders that have two formal underwriting guidelines related to energy efficiency: (1) individuals can qualify for a loan for an energy-efficient home using a 30% loan-to-income ratio (in contrast to a 28% ratio for loans for conventional homes); and (2) buyers can include the cost of certain energy-efficient improvements in their first mortgage by setting money aside in an escrow account to pay a contractor to do the work. The benefits of the 2% "ratio stretch" can be significant. It has been estimated that, in the St. Louis area, the 2% stretch would increase the number of households qualifying for a $50,000 loan from 35,000 to 41,200. Looked at another way, the 2% stretch would allow a given buyer to afford a more expensive home, so that the builder could offer the buyer more amenities than his competitors could on similar houses without the ratio stretch.

The Energy-Efficient Mortgage (EEM) guidelines are on the books and are used with some frequency: the National Association of Home Builders (NAHB) has approved 35 to 40 home energy rating systems for use with their Thermal Performance Guidelines for new homes, which are recognized by Fannie Mae and Freddie Mac. However, banks don't normally send energy-efficient mortgages to Fannie Mae and Freddie Mac because they do not know about the program.

MARKETING/PROMOTION METHODS: Direct talks with realtors and lenders; newspaper articles; and booklets distributed to potential homebuyers.

MONITORING/EVALUATION: An evaluation of the program was completed in 1987 (see below). Active participants in developing the program were interviewed.

Market penetration: No mortgages using the EEM feature were issued during the test period, and relatively few energy audits were requested specifically for the program.

RES-6

Savings:
- Energy:
- Peak:
- Dollars:

Costs and cost-effectiveness:
- Program administration:
- Incentives:
- Private investment:

Discussion:
The pilot program failed due to lack of response. While consumers were receptive to the EEM concept, the following factors led to the program's failure: (1) a very unfavorable real estate market in 1986 (low-interest rates and high sales and refinancing volume) and other factors severely limited interest in any financing innovations that might complicate transactions; (2) low energy prices and rapidly rising housing prices reduced consumer interest in energy efficiency issues; (3) this kind of program needed a more intense, broad based marketing effort with lots of handholding and exposure than was possible with the resources available in the pilot program; (4) the mechanics of the program required realtors and home sellers to initiate the application process, however, the main beneficiaries of the program were homebuyers; and (5) interest in the EEM program from both lenders and realtors was limited (Conn Save did talk with realtors and lenders, but did not provide sufficient money for advertising). The program still has lots of potential and awaits a "full-blown test."

Fannie Mae and Freddie Mac account for only a fraction of the secondary market. The Federal Housing Administration (FHA) and the Veterans Administration (VA) have their own, different energy policies, also little used, which may confuse a buyer further. Accordingly, there is a need to create more consistency and simplicity among the various secondary market energy programs.

RELATED PROGRAMS: The Alliance to Save Energy conducted a national public education campaign in 1984 to inform home buyers and owners about the opportunities to save energy in a home and ways to finance them. A booklet was distributed free to consumers, *Your Home Energy Portfolio*, that explained the benefits of energy-efficiency lending guidelines and encouraged them to seek out lenders that offered these financing options.

REFERENCES: Miller, 1985; Alliance to Save Energy, "Your Home Energy Portfolio," Washington, D.C., 1984; "Energy Conservation Home Financing" brochure prepared by Fannie Mae (Washington, D.C.); Alliance to Save Energy, 1987a and 1987b; Lessner, Slossberg, Gahl and Partners, "Alliance to Save Energy Focus Group of Prospective Home Buyers," Avon, Conn., 1986.

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NEW RESIDENTIAL PROGRAMS (RES-7)

PROGRAM TITLE: Energy Efficient Home Program

PROGRAM SPONSOR: Salt River Project (SRP)

PROGRAM OBJECTIVES: To promote energy conservation, reduce peak load, and increase market penetration of all-electric homes.

APPROACH: The SRP developed this home energy rating and labeling program for all-electric homes. The program involves a package of measures, including the following: energy-efficient heating and cooling systems (e.g., heat pumps with a minimum 8.6 SEER), R-30 ceiling and R-14 wall insulation, weatherstripping around doors, window shading on east/west windows (or double-pane), and the correct orientation of the house.

TARGET BUILDING TYPES: Single-family and multifamily

KEY PARTICIPANTS: Salt River Project, Arizona Public Service, builders and consumers.

HISTORY:

Date of Implementation: 1980
Current Status: Continuing.
General Comments: The SRP covers 480,000 customers. Arizona Public Service, with 600,000 customers statewide, recently adopted the Energy Efficient Home Program.

MARKETING/PROMOTION METHODS: They use individual contacts with builders, media advertising (primarily newspapers), radio, outdoor billboards, and point-of-sale material in subdivisions. A program logo is placed at the subdivision and is required for all advertising. The SRP reviews advertising to make sure the logo is included. The home is marketed as "The Total Electric Energy Efficient Home." The SRP conducts a $500,000 advertising campaign that reaches 92% of the buying audience.

MONITORING/EVALUATION:
None by the SRP; the Arizona Public Service has recently started to monitor energy usage in a few unoccupied test homes (system loads are artificially created).

Market penetration: 9,000 to 10,000 homes were covered by the program this year (47,589 homes since the beginning of the project). There are about 15,000 new all-electric homes (single-family, condos, and townhouses) started each year in this area. Therefore, the program covers 60% to 65% of new home starts each year. About 130 builders are involved.

Savings:
- Energy:
- Peak:
- Dollars:

Costs and cost-effectiveness:
- Program administration:
- Incentives:
- Private investment:

Discussion:

The program has been successful in promoting all-electric homes: 97% of all the new homes that are built are all-electric. People now identify an all-electric home with energy efficiency and vice versa. The program has influenced the market: nonparticipants are buying energy-efficient equipment because no other kind is available in the region.

One obstacle they've encountered is with the cost of shade screens. Custom builders think the screens detract from the aesthetics of the house. They also feel that the additional cost (about $250 to $300 per house) prevents some potential homebuyers from buying a home (but this may just be speculation).

RELATED PROGRAMS: There is a residential retrofit program that offers cash incentives for switching to highly efficient heating and cooling equipment.

REFERENCES: "Energy Efficient Home Builder" brochure prepared by the Salt River Project.

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DATE: Nov. 5, 1987 / May 24, 1988

NEW RESIDENTIAL PROGRAMS (RES-8)

PROGRAM TITLE: Thermal Crafted Home Program

PROGRAM SPONSOR: Owens-Corning Fiberglas Corporation

PROGRAM OBJECTIVES: To promote energy efficiency among builders and consumers.

APPROACH: This program uses the Energy Performance Design System (EPDS) computer program to estimate the energy needed for heating and cooling a house and to estimate the operating costs of the heating and cooling systems (energy used by lights, water heater, and other appliances are not estimated). Energy targets are developed for a certain type of house in a particular climate zone; there are as many targets as there are combinations of house types and climate zones. Comparisons are made between energy used in the target house and energy used in the designed new home. Changes are made to the design of the new home so that the targeted energy use is achieved; and, thus, the home becomes a Thermal Crafted Home (TCH). There are no home inspections: once designated as a THC home, the contractor has a legal requirement to build the home as planned (Builder Agreement) and to use Owens-Corning insulation.

TARGET BUILDING TYPES: Single-family

KEY PARTICIPANTS: Owens-Corning Fiberglas, builders, and homeowners

HISTORY:

Date of Implementation: 1980
Current Status: Continuing
General Comments: The program has evolved technically, but the marketing approach has remained the same. The first version of the EPDS was a manual; the third and last technical version was the incorporation of regression equations into a sophisticated software program (EPDS). Thermal Crafted Homes is not a program that professes to educate or train in the area of quality of construction.

MARKETING/PROMOTION METHODS: This program is marketed through the national Owens-Corning sales force; labels, indicating the house is a Thermal Crafted house, are used. The program also offers participating builders merchandising materials and sales aids. Freddie Mac has recognized the EPDS for rating and labeling homes as part of their mortgage loan program.

MONITORING/EVALUATION:
They monitored 50 homes in the eastern U.S., but this was an internal report and cannot be released to us. They found that measured infiltration rates (air changes per hour) and energy performance were in agreement with predicted values.

Market penetration: One-quarter million homes were built under the TCH program last year in the whole country (there were 1.7 million housing starts in the U.S. last year), reflecting a 15% penetration rate.

Savings:
- Energy:
- Peak:
- Dollars:

Costs and cost-effectiveness:

- Program administration:
- Incentives:
- Private investment:

Discussion:

McBride thought the program was "remarkably successful." Their goal is to upgrade the standards in general. National model energy code standards have recently been revised upwards to the TCH standard (September 25, 1987). Owens-Corning is now in the process of reviewing the TCH standard to see where the program should go. He feels that they are starting to reach some technical barriers with regard to insulation: e.g., there is considerable opposition to the idea of thicker walls (for more insulation).

RELATED PROGRAMS: The EPDS is also used in a program for manufactured housing, called the Energy Qualified (EQ) Program (see writeup).

REFERENCES: Oberg and Jacob, 1984; Owens-Corning Fiberglas Corporation, *Energy Performance Design System (EPDS): The Computer Program Support Manual*, 1983; Owens-Corning Fiberglas Corporation, *Energy Performance Design System: Thermal Crafted Home Plan Analysis Guide*, 1983; Owens-Corning Fiberglas Corporation, *Energy Performance Design System (EPDS): The Reference Manual*, 1983; Owens-Corning Fiberglas Corporation, "Legal Considerations Regarding the Thermal Crafted Homes," brochure, 1983; Design System (EPDS): The Reference Manual, 1983; and Ek, 1983. There are also numerous articles published on the testing of the EPDS.

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DATE: Nov. 11, 1987 / June 29, 1988

NEW RESIDENTIAL PROGRAMS (RES-9)

PROGRAM TITLE: Super Good Cents (SGC) Program

PROGRAM SPONSOR: Bonneville Power Administration (BPA)

PROGRAM OBJECTIVES: To encourage the construction and sale of energy-efficient houses and to assist the region's building industry in making the transition to more efficient construction; to help promote the Model Conservation Standards (MCS) to homebuyers and the shelter industry.

APPROACH: The SGC Program is a promotion and technical assistance program implemented by participating utilities and supported by an extensive regional advertising/promotional campaign carried out by BPA in conjunction with the utilities. Under this program, the utility reviews builder plans and identifies a cost-effective package of SGC features, inspects homes under construction, certifies completed structures for compliance with SGC standards, awards SGC certificates to builders for their homes that qualify, promotes the sale and occupancy of these homes, publicizes and advances the SGC concept among Northwest builders and other members of the shelter industry, and provides financial incentives to builders or buyers of certified SGC homes. Under this program, BPA supports utility efforts through regional advertising, cooperative local advertising campaigns with utilities, coordination of all advertising and promotional activities, technical and sales/marketing training seminars for utility personnel involved in the program, marketing and promotional materials, and computer software for home energy analyses. BPA also reimburses utilities for their financial incentives. The goal for the SGC program and its companion program (the Code Adoption Assistance Program (see writeup)) is to achieve the cost-effective energy savings from MCS construction. BPA is pursuing this goal.

This program provides construction guidelines and recommended materials that guide builders in building SGC homes. The Super Good Cents construction standard is based on the home's performance rather than on its components: builders can choose from a combination of energy-efficient features to meet specific kWh per sq. ft. performance criteria. A computer software package analyzes the home's design features and computes their performance. The general construction requirements of the program are: insulated doors and windows (triple glazed and double glazed low emissivity glass windows with wood or thermally improved metal frames); wall (R-values of 19, 24, or more), ceiling (R-38), and floor (R-19 or R-30 under floor) insulation above current code levels; methods to control air infiltration and moisture; and equipment to ensure adequate ventilation and air quality; and a high efficiency heating system. There are four designated paths by which residential buildings can be qualified within the SGC Program specifications. The four methods and the multitude of options within each method allow extreme flexibility and a variety of techniques with which to meet the standards: (1) the Thermal Performance Standards require the overall building heat loss to not exceed a specific level depending on climate zone; (2) Energy Budgets require that the long-term average yearly space heating requirements of the dwelling per square foot of conditioned floor area should not exceed certain levels; (3) the Prescriptive Path requires components to meet or exceed the prescribed component standards for framing, ceilings, exterior (above and below) grade walls, floors, basements, doors, windows, solar features, and thermal mass; and (4) the Point System allows modification of base case prescriptive options through the use of alternate component specifications.

A computer software package, Wattsun IV, is available through the utilities for use by consumers and builders to aid in the design and construction of SGC-certified homes. The program provides a recommended package of measures that meet an energy

budget for that home in a specific climate zone, and predicts how efficiently that home will use energy and the length of time required to pay for the additional energy conservation features. This information can be used by a prospective buyer in comparing the energy use of SGC with conventionally-built homes, or comparing the energy efficiency of two SGC-certified homes.

TARGET BUILDING TYPES: Single-family, multifamily, and manufactured homes.

KEY PARTICIPANTS: BPA, participating utilities, builders, and homebuyers.

HISTORY:

Date of Implementation: 1984
Current Status: Continuing
General Comments: Super Good Cents is patterned after a highly successful program (the Good Cents Program) developed by Southern Electric International (SEI), a consortium of southeastern utilities. The word "Super" was added to Good Cents to denote the difference between the MCS standards of this program and the Good Cents programs operated by utilities within the region. Super Good Cents is part of BPA's plan to help carry out mandates in the Northwest Power Act of 1980 by ensuring the efficient use of electricity in new homes. Forerunners of the Super Good Cents homes built under this program were the Thermabilt home in Washington, the Energywise home in Idaho, the model standards home in Montana, and the Oregon Home in Oregon.

MARKETING/PROMOTION METHODS: There are five major elements in promoting the SGC Program. (1) *Advertising.* BPA provides participating utilities with a cooperative advertising allowance of 50 cents per residential customer as well as the support of a regionwide mass media advertising campaign utilizing radio, TV, and newspapers to promote awareness and interest in SGC homes. Television has been primarily used for promoting program awareness (expenditures for television ads through FY 1986 were 60% of the total expenditures for advertising). (2) *Local promotion.* Utilities receive an up-front annual support payment that ranges from $4,000 to $10,000 based on the number of residential customers. In addition, a $100 payment per certified SGC home is given to utilities to support local promotion activities with the shelter industry. (3) *Certification.* All new homes that meet the SGC specifications are certified by the utilities as SGC energy-efficient homes. A certificate accompanies certification, and is given to both the home and the builder. (4) *Shelter industry assistance promotion.* The program provides training, promotional materials, and onsite technical assistance to assist utilities in promoting SGC to their local shelter industry. Promotional materials include construction handbooks, program implementation and advertising guides, a graphics manual, representatives' handbooks, and builders' and homebuyers' guides. Training is provided for both utility personnel and builders. And (5) *Financial incentives.* Financial incentives were added to the program in July 1986. The levels for the incentives for single-family homes were $2,000 in 1986 and $1,500 in 1987; the current level (1988/89) is $1,000 in climate zone 1 (the warmest climate zone), $1,250 in climate zone 2, and $1,500 in climate zone 3 (the coldest climate zone). For multi-family buildings, the incentives were $2,000 for the first unit and $750 for each additional unit in 1986, and $1,500 and $600 in 1987, respectively; the current level (1988/89) is $1,000 and $250, respectively.

The following benefits are stressed: for utilities, reduction of peak electricity demand in winter, enhanced public image, reduced utility rates; for builders, expansion of business by advertising and heightened consumer awareness; and for consumers, reduction

in operating costs, increase in value of home, greater comfort, and easier home resale.

MONITORING/EVALUATION:
A process and impact evaluation study began in August 1985 and will end in April 1989. An interim evaluation report was published in August 1987, covering the period from the start of the program through September 1986. Specific elements of the evaluation include baseline and two follow-up surveys for both consumers and builders, ongoing data collection on the number of new housing starts and SGC home certifications, an incentive analysis, an analysis of the performance of SGC homes, and a utility implementation analysis. There have been seven major surveys (3 consumer surveys, 3 builder surveys, and 1 SGC occupant survey). Three case studies of utilities implementing the SGC program are presented in the interim evaluation report (Aug. 1987), and a second interim report will be forthcoming in July 1988.

Market penetration: As of March 1988, the program had certified over 1,700 single-family homes and over 900 multi-family units. The penetration of the electrically heated new home market in 1988 to date was 18-19%. There was considerable variation among utilities: for example, Ashland, Oregon, obtained penetration levels of 75-80% in 1986 and 1987. As of March 1988, 112 public and private utilities had joined the SGC Program.

More than 3,400 builders have been trained in Super Good Cents construction techniques. There were 27 utility workshops with 644 attendees for 1985 and 1986 combined. There were 91 sessions for builders with 2,430 attendees at introductory sessions and 1,178 at advanced special topic seminars. An additional 22 workshops or seminars were held for other members of the shelter industry.

Savings:
- Energy: Expect 30% to 50% reduction in electricity use, compared to conventionally-designed homes.
- Peak:
- Dollars:

Costs and cost-effectiveness: $1 million in FY 84, and $4.2 million in FY 85.
- Program administration:
- Incentives:
- Private investment:

Discussion:
The findings below are taken from BPA's interim evaluation report (1987).

One of the more significant program achievements has been the public's awareness of the SGC program. The program has met its awareness objectives each year for the first two years of the program--20% in 1985 and 40% in 1986. The 1985 objective was attained (20%) and the 1986 objective was exceeded (48%). (The objective for 1987 is 65%). Thus, it appears that the general awareness and promotion and marketing effort has been successful. In spite of this, there was not an equivalent success in terms of the sale of SGC homes in the market (see above). The first Interim Report (Aug. 1987) recommended a redirection of the media campaign with more emphasis placed on motivating the "aware" consumer to act. It was also recommended that more targeted promotion to a higher income audience and direct mail was warranted, accompanied by less reliance on TV commercials.

RELATED PROGRAMS: Home energy rating systems (see report).

REFERENCES: Pacific Northwest Utilities Conference Committee, 1987; Northwest Power Planning Council, 1987a, 1987b; Columbia Information Systems, 1986 and 1987; Columbia Information Systems, *A Baseline Survey of Consumer Attitudes,* Portland, Oregon, 1986; Mohler and Smith, 1986; "A Builder's Guide to Super Good Cents Construction and Sales (1987)," and "A Home Buyer's Guide to Super Good Cents Comfort and Savings (1986)," "Issue Alert: BPA Launches 'Super Good Cents' (1984)," brochures prepared by BPA; letter from Dick Wanderscheid, Energy Conservation Coordinator, City of Ashland, Oregon, to Donna Geiger, Public Involvement Manager, BPA, Jan. 6, 1988.

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DATE: Nov. 6, 1987 / June 28, 1988

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DATE: June 28, 1988

NEW RESIDENTIAL PROGRAMS (RES-10)

PROGRAM TITLE: Energy Conservation Home (ECH) Program

PROGRAM SPONSOR: Pacific Gas and Electric Company (PG&E)

PROGRAM OBJECTIVES: To encourage the installation of energy-conserving features beyond the state energy code to improve the energy-efficient performance of new residential buildings.

APPROACH: The ECH program was an incentive marketing program to increase building contractors' knowledge of available conservation technologies. To qualify, dwelling units, either single-family or multifamily, were rated according to a system based on installed features. Each point in the rating system represented the potential for saving 3 therms of gas or 30 kWh of electricity per year. A point was also awarded for each 2,000 gallons of water savings per year. After a minimum number of points were accumulated, monetary incentives were awarded on a per point basis. The minimum points to qualify were set at 50. A builder could go beyond the minimum number of points set by PG&E, but points were not permitted for features mandated by state or Federal codes. A builder selected any combination of features which qualified him for the program. The ECH program was the first utility-sponsored conservation program to attempt to quantify passive solar design features for a scoring system.

For single dwellings or projects of three or fewer units, individual verification of all reported ECH connections was made. For larger subdivisions, 10% of all units, randomly selected, including models, were inspected for compliance. If installation problems were noted, the builder was informed and requested to verify installation prior to receiving program incentives. Should a builder fail to comply, no incentives were awarded, ECH promotions were not used in the builder's advertising, and the homes were not reported in the program.

TARGET BUILDING TYPES: Single-family and multifamily

KEY PARTICIPANTS: PG&E and builders.

HISTORY:

Date of Implementation: May 1976
Current Status: Ended in 1981
General Comments: The focus of the program was on the builder rather than on the consumer, primarily due to the well-established communication link already in place between the utility and the builder. There was an 18-month pilot test before a systemwide ECH program was launched in 1976. In 1977, PG&E introduced the Premium Energy Conservation Home (PECH) to determine the feasibility of penetrating the market with a home which would double the energy savings potential of the basic ECH. In the PECH program, single-family homes required 100 points to qualify and then received a $60 cash award for single-family units and $40 for multifamily units. In 1980, the ECH and PECH programs were consolidated and the program was renamed the Energy Conservation Home program with 50 points required to qualify and a $2 incentive awarded for every point accumulated beyond the minimum of 50 with a maximum award limit of $150/unit. On February 1, 1981, the monetary incentives for the revised ECH program were eliminated in anticipation of planned conservation incentives to be awarded builders by the California Public

Utilities Commission. The program ended when higher mandatory state standards for buildings were adopted.

MARKETING/PROMOTION METHODS: A variety of marketing incentives were offered, most of which were directed at informing prospective home buyers of the advantages of buying an ECH: cash awards, promotional literature to be displayed at the time of sale (ECH awards, signs, sales brochures, and individual customer certificates), systemwide advertising (ads, publicity, mass mailings, and public presentations), and personal contacts with builders. The program was promoted by stressing the following points: PG&E was committed to energy conservation because it would reduce the need for costly new power plants, customers were willing to invest in energy-efficient homes because of lower utility bills and higher resale values, and builders received a marketing advantage over less energy efficient homes. Cash incentives of $2 per point were awarded, up to a maximum of $150 per dwelling and $15,000 per subdivision (100 or more units).

MONITORING/EVALUATION:

Energy use of ECH homes was tracked. An evaluation of the program was conducted using econometric analysis, comparing the electric energy consumption behavior of ECH/PECH homes with other homes built during the same period of time, controlling for such factors as: variations in appliance ownership, weather, household income, energy price, the physical size of the dwelling, the number of occupants, recent changes in building codes, and certain aspects of lifestyle and conservation-related attitudes and activities. The total sample size was 180 households.

Market penetration: In 1976, 4,750 homes qualified, representing 8.6% of the new homes connected that year (55,232). In 1977, 19,450 homes qualified, including more than 350 PECHs, representing 20% of the homes constructed that year (97,250). By 1978, ECH market penetration was 37% of new construction. In 1979, 18,000 PECH homes were built.

Savings:

- Energy: For ECH homes, 10% energy savings, and for PECH homes, 20% energy savings were estimated using engineering analysis. Using econometric (conditional demand) analysis, slightly higher savings were calculated (but not significantly different than PG&E's estimates). In 1976, 3,808,000 kWh and 471,000 therms were estimated to be saved (i.e., 802 kWh per house and 99 therms per house).
- Peak:
- Dollars:

Costs and cost-effectiveness:

- Program administration:
- Incentives:
- Private investment:

Discussion:

The program was successful in terms of penetration (see above) and because some progressive builders were installing 150 or more points of conservation features. The growing popularity of the program caused various local public agencies to use ECH program compliance as a requirement for subdivision or planned development approval. Also, product vendors solicited builders to use their devices or systems after receiving point values from PG&E, and a number of builders experimented with new products and installation techniques to obtain higher point totals.

Although an effort was made in 1979 to attract the mobile home industry to participate in the program, little success was achieved. The primary problem was that manufacturers built their product for nationwide distribution, under Federal rather than state regulations.

RELATED PROGRAMS: In 1979, PG&E introduced a more design-intensive passive solar home program, the Suntherm Home Program, that offered a computer analysis of submitted designs, and in some cases, direct design assistance to a builder. Suntherm Homes had to first qualify as ECHs, independent of solar features, and to include solar features supplying a minimum of 50% of the combined energy requirements of space conditioning and water heating. Financial incentives for each qualifying dwelling ranged from $500 to $1,000 for designs supplying between 50% and 75% of the combined water heating and space conditioning requirements. These incentives were limited to five qualifying homes per design and five designs per applicant. A total of 97 single-family and 42 multi-family homes qualified in 1979.

REFERENCES: Hailey, 1980; Parti and Harris, 1982; "Energy Conservation Home Requirements and Agreement," brochure prepared by PG&E, 1980.

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DATE: Oct. 23, 1987 / June 30, 1988

NEW RESIDENTIAL PROGRAMS (RES-11)

PROGRAM TITLE: Conservation Rate Discount

PROGRAM SPONSOR: Carolina Power and Light (CP&L)

PROGRAM OBJECTIVES: Initially, to conserve energy; currently, to conserve energy at peak times.

APPROACH: This program provides a discount of 5% per kWh (total electricity usage) to well-insulated houses (new and existing) with gas heat and to all-electric homes that meet the Common Sense standard; all homes have electric heat pumps). The minimum installed thermal resistance values (insulation) are: R-30 ceilings, R-11 walls, R-19 floors over crawlspaces, double-pane glass (or single-pane glass with storm windows), wood exterior doors with storm doors or insulated metal doors, and adequate natural or mechanical attic ventilation. Substitutions can be made to these insulation values provided the structure's overall heat loss, including duct heat loss, is no greater than 0.1 watts (0.34 Btuh) per square foot of net heated floor area per °F. To sign up, the customer or builder calls the local CP&L office and a marketing representative inspects the residence to confirm its thermal requirements.

TARGET BUILDING TYPES: Single-family, multifamily, and manufactured homes

KEY PARTICIPANTS: Carolina Power and Light, consumers, and builders.

HISTORY:

Date of Implementation: 1980
Current Status: Continuing.
General Comments: The discount was mandated by the Public Utilities Commission to encourage energy conservation; and has been retained as an incentive to build Common Sense homes. Common Sense homes automatically receive a 5% per kWh discount. Winter rates (Nov. - June) are 6.32 cents per kWh, and summer rates (July - Oct.) are 7.32 cents per kWh. The targeted homes are primarily new homes; a few existing homes retrofit to meet the standards for the 5% discount.

MARKETING/PROMOTION METHODS: The program is not marketed or promoted to a great degree; there is some television advertising and bill stuffers. In general, customers and builders have to take the initiative to contact the utility company.

MONITORING/EVALUATION:

Market penetration: At the end of 1987, 13% of the utility's residential customers systemwide (98,000 out of 773,000) were participating in the Common Sense program. Types of homes participating: 55,000 single-family, 30,000 multifamily, and 13,000 manufactured homes. In terms of rate of participation, 74% of new single-family homes built each year participate in the Common Sense program; for multifamily it is 55%, and for manufactured homes it is 24%. The annual average penetration rate for all new house types is 53%. An additional 13,000 customers without heat pumps participate in the 5% discount program, raising the penetration rate from 13% to 14%.

Savings:

- Energy: Estimated: for single-family homes, 4,339 kWh/year/home; for multifamily homes, 1,821 kWh/year/home; for manufactured homes, 6,635 kWh/year/home.

- Peak: Estimated: 0.7 kW for single-family homes, 0.35 kW for multifamily, and 2 kW for manufactured homes.
- Dollars:

Costs and cost-effectiveness:

- Program administration: About $7.00 per customer (averaged over all house types); there are minimal advertising costs.
- Incentives:
- Private investment:

Discussion: The program will continue as part of a residential package. However, the company is currently more interested in peak load reducing and shifting programs. They are not pushing basic energy conservation programs. The current program has its own momentum and sells itself with little promotion by the company.

RELATED PROGRAMS:

REFERENCES:

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DATE: July 7, 1988

Name: Bill Smith
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DATE: Oct. 28, 1987

NEW RESIDENTIAL PROGRAMS (RES-12)

PROGRAM TITLE: Residential Conservation (RC) Rate and Energy Efficient Structure (EES) Program

PROGRAM SPONSOR: Duke Power Company

PROGRAM OBJECTIVES: To reduce peak demand.

APPROACH: This program provides a lower rate (12-14%) for residential customers who meet certain insulation guidelines above the current state standards (e.g., R-30 ceiling/attic insulation vs R-19; and R-19 floor/crawl space insulation vs R-11). These houses also have R-11 wall insulation (which is the same as the state standard), and double glazing of windows and doors (state standards are single glazing, unless more than 20% of the wall is glass). Alternatives to these requirements are acceptable as long as the total heat loss does not exceed 30 Btuh per square foot of net heated area. This rate is available to new and existing residential structures (site built, manufactured, or multifamily).

TARGET BUILDING TYPES: New and existing single-family, multifamily, and manufactured homes.

KEY PARTICIPANTS: Duke Power and consumers.

HISTORY:

Date of Implementation: September 1, 1978
Current Status: Continuing.
General Comments:

MARKETING/PROMOTION METHODS: From 1978 to 1987, the new construction market was contacted using print (e.g., bill inserts), presentations to builders, direct contact with customers, and television advertisements. Since Jan. 1, 1988, media promotion for these programs was terminated because the RC standards appear to have developed their own momentum. In addition, advertising emphasis is now on the Maximum Value Home (MAX) Program (see below). RC construction is still encouraged.

MONITORING/EVALUATION:

Market penetration: 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 RC standards. Many of the ones that aren't meeting the standards are mobile homes; the owners of these homes want low-cost housing and aren't that interested in energy conservation.

Savings:
- Energy:
- Peak: Expect average per customer reductions of 3.7 kW in winter and 0.6 kW in summer.
- Dollars:

Costs and cost-effectiveness:
- Program administration:
- Incentives:
- Private investment:

Discussion:

The program has been very well-received. Consumers across 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 program was considered successful because of the company's efforts to educate consumers about the economic and thermal comfort benefits of additional insulation.

Hendrickson noted that while there has been tremendous success for new construction, the percentage (27%) of the total housing stock meeting the rate qualifications is lower than desired, due to the relatively low level of retrofit activity to date. He also noted that a potential drawback of using the rate structure as an incentive is that results may appear over longer periods of time because the primary focus is on new rather than existing homes. In Duke's case, it took approximately 5 years for substantial results and, therefore, conservation, to occur. The energy savings are mainly due to upgrading new construction which, given market and economic conditions, may require longer periods of time to infiltrate the market. Concentrating efforts on existing house stock through retrofitting may induce the desired behavior throughout the housing market and produce higher levels of results sooner.

RELATED PROGRAMS: On April 17, 1987, Duke Power began to implement the Maximum Value Home (MAX) Program to reduce peak demand and increase energy sales during off-peak periods. Duke Power's RC Conservation Rate plus a 2% discount is offered for meeting insulation levels far beyond state building code levels *and* the installation of a high efficiency heat pump. The heat pump standards are: SEER of 9 or greater, an outside thermostat set at the balance point, and perimeter air distribution. The house must be pre-wired for air-conditioning and water heater load control. The program is targeted to single-family and multifamily homes and is marketed through television advertising, print media, bill inserts, strong builder contacts, and direct contacts by utility representatives. The company expects the same average customer reductions in peak demand as in the EES program. Duke Power is a summer peaking utility, and heat pump sales are needed to improve the balance of summer and winter demand.

REFERENCES: Hendrickson *et al.*, 1985; Davis and Limaye, 1984.

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DATE: June 6, 1988

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DATE: October 30, 1987 / June 6, 1988

NEW RESIDENTIAL PROGRAMS (RES-13)

PROGRAM TITLE: Residential Service Conservation Rate

PROGRAM SPONSOR: South Carolina Electric and Gas Company

PROGRAM OBJECTIVES: To go beyond the state energy code.

APPROACH: A conservation rate was established for residential customers whose homes (new and existing) meet certain insulation standards (for ceilings, walls, floors, water heater, vents, and ducts) that are more stringent than the state code: R-30 ceilings, R-11 walls, R-19 floors, double-pane windows, weatherstripping around doors, insulated ducts, and insulated (R-8 minimum) water heaters. The utility sends inspectors out to make sure the house meets the criteria.

TARGET BUILDING TYPES: New and existing single-family, multifamily, and manufactured homes.

KEY PARTICIPANTS: South Carolina Electric and Gas Company

HISTORY:

Date of Implementation: 1982
Current Status: Continuing.
General Comments: Most builders in South Carolina use the Southern Building Code for new construction.

MARKETING/PROMOTION METHODS: The discounted rate is about 7% for both the summer and winter rates. The program is primarily promoted through utility bill inserts and talks with builders.

MONITORING/EVALUATION:

Market penetration: 3% (10,500 customers out of 365,000 residential customers); each year, 3,500 new homes are added to the new rate.

Savings:
- Energy:
- Peak:
- Dollars:

Costs and cost-effectiveness:
- Program administration:
- Incentives:
- Private investment:

Discussion:
The program is picking up steam. Two years ago, 2,000 customers were on the rate. Promotion of the program has increased, and more customers are getting the rate.

RELATED PROGRAMS:

REFERENCES: "Meter Miser: The Magnificent 7," brochure prepared by SCEG.

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DATE: November 4, 1987

NEW RESIDENTIAL PROGRAMS (RES-14)

PROGRAM TITLE: Super Saver Award Program

PROGRAM SPONSOR: Florida Power Corporation (FPC)

PROGRAM OBJECTIVES: To promote energy-efficient new construction.

APPROACH: An incentive of $350 was given by the utility to the builder or the first owner if the building had met standards 50% better than the state energy code.

TARGET BUILDING TYPES: Single-family

KEY PARTICIPANTS: Florida Power Corporation, builders, and consumers.

HISTORY:

Date of Implementation: 1983
Current Status: Discontinued in Oct. 1986.
General Comments: This program was discontinued because the Florida Energy Code was tightened up, meeting the standards of the utility program. However, there is no inspection to see if builders are complying with the code. The state code does not have funds for training or inspections. There are no penalties for noncompliance. As a result, houses are inspected for health and safety hazards, but not for energy. The Florida PSC has asked all the investor-owned utilities to help promote compliance with the state energy code, and to educate builders and consumers. Consequently, FPC has developed training workshops and is seriously thinking of reviving the energy award program where builders would have to build homes (all-electric and others) 25% better than the state energy code. The company would then inspect the house for compliance and issue certificates to homes that comply. There would be no cash incentives. This program is tentative.

MARKETING/PROMOTION METHODS: Advertising (newspapers), brochures, signs, energy fairs, and the local home builders association's monthly newspaper.

MONITORING/EVALUATION:

Market penetration:

Year	Number of homes	Market penetration*
1983	2,975	37%
1984	3,466	43%
1985	2,975	37%
1986	3,000	38%
Total	12,416	39%

* There are one million residential customers in the service area; approximately 8,000 new single-family homes are built each year.

Savings:
- Energy:
- Peak:
- Dollars:

Costs and cost-effectiveness:

- Program administration:
- Incentives:
- Private investment:

Discussion:

The program was very successful. A lot of builders liked it and want the utility to revive the program.

RELATED PROGRAMS:

REFERENCES:

CONTACTS:

Name: Jack Davis, H2M
Position/title: Program Coordinator
Organization: Florida Power Corporation
Address: P.O. Box 14042, St. Petersburg, Fla. 33733
Phone: 813-866-5592

DATE: Nov. 9, 1987 / July 7, 1988

NEW RESIDENTIAL PROGRAMS (RES-15)

PROGRAM TITLE: Proposed Hookup Charge

PROGRAM SPONSOR: Maine Public Utility Commission (PUC)

PROGRAM OBJECTIVES: To show consumers the operating cost to the utility of electric heat by providing incentives for energy-efficient homes.

APPROACH: This program would have established a sliding scale service connection or hookup charge for new residential customers who install over 100 amps of power or for upgrades of power. 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.

TARGET BUILDING TYPES: Single-family

KEY PARTICIPANTS: Maine PUC, Office of Energy Resources, Public Advocate, builders, and consumers.

HISTORY:

Date of Implementation: Not implemented (see below).
Current Status: Not being considered.
General Comments: There are no hookup charges in Maine.

MARKETING/PROMOTION METHODS: Not implemented.

MONITORING/EVALUATION: N/A

Market penetration:

Savings:
- Energy:
- Peak:
- Dollars:

Costs and cost-effectiveness:
- Program administration:
- Incentives:
- Private investment:

Discussion:

This program was not implemented. There was a stipulated rate design settlement in Oct. 1986 for both Central Maine Power Company (Maine PUC Docket No. 86-2) and Bangor Hydro-Electric Company (Maine PUC Docket No. 86-106) that included this hookup charge and time-of-use rates and reflected a movement towards marginal-cost

pricing. 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. Electricians customarily put in 200 amp service: it is easier for consumers to add electrical appliances after house is built, and builders make more money on installing this increased service. In particular, the electrical contractors were mad at the tariff and lobbied the Legislature.

RELATED PROGRAMS:

REFERENCES: Letters from Central Maine Power (April 18, 1986), Bangor Hydro-Electric Company (March 18, 1986), and Maine Public Service Company (April 18, 1986) to the Public Utilities Commission; Public Utilities Commission, "Order Conditionally Approving Stipulation of the Cost of Service and Rate Design, Oct. 3, 1986," and "Supplemental Stipulation, Oct. 17, 1986," and Maine Revised Statutes Annotated (MRSA) Title 35-A, Sec. 3153-A(2).

CONTACTS:

Name: Richard Parker
Position/title: Senior Utility Planner
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Phone: 207-289-3831

DATE: Oct. 28, 1987 / June 1, 1988

NEW RESIDENTIAL PROGRAMS (RES-16)

PROGRAM TITLE: Energy Efficient Home Program

PROGRAM SPONSOR: New England Electric System (NEES)

PROGRAM OBJECTIVES: To make energy-efficient home designs available to the public.

APPROACH: The NEES sponsored a design competition for architects to develop plans for moderately priced, energy-efficient single-family homes well suited to New England's climate and style. In order to increase energy awareness among their residential customers and encourage energy-efficient home construction, the utilities publicized and distributed construction documents for the top three award-winning designs. Three demonstration homes were constructed, and were made available to the public for viewing (i.e., open houses). The homes have since been sold.

TARGET BUILDING TYPES: Single-family

KEY PARTICIPANTS: Massachusetts Electric Company and the Narragansett Electric Company, subsidiaries of the New England Electric System.

HISTORY:

Date of Implementation: Early 1983
Current Status: The program has ended. They have stopped advertising the program and no longer distribute documents.
General Comments: Plans of 3 passive solar homes were made available to the public in the Fall of 1983. About 35% of the new homes in NEES's service territory are all-electric; therefore, there is a need to steer away from electric heat (e.g., Massachusetts has a new building code, effective July 1, 1988, that will require additional insulation if the house uses electric heat).

MARKETING/PROMOTION METHODS: Project described in *Better Homes and Gardens* and *New Shelter*.

MONITORING/EVALUATION:

Market penetration: 185 home designs were submitted by architects and engineers. Through early 1985, more than 35,000 copies of the design booklet had been mailed; more than 100,000 visitors have toured the houses.

Savings:
- Energy: These homes are expected to use 40%-60% less energy for heating than conventional homes.
- Peak:
- Dollars:

Costs and cost-effectiveness:
- Program administration:
- Incentives:
- Private investment:

Discussion:
The houses were all within the range of the average buyer, and this was a positive

factor in promoting the concept of energy-efficient design. The designs of the houses were flexible (e.g., one could change a bedroom into a den), another positive feature. It was also easy to control air flow, and the passive solar features made a nice contribution. They found passive solar to be very beneficial for electrically heated homes, especially in winter between 5 pm and 8 pm: passive solar moved the demand for heat 2 to 3 hours away from the evening peak.

They did encounter problems with ground-source heat pumps because of technical problems (leaks), unreliability, and delays in repairing the systems (one delay in repair lasted four weeks). Cost-effectiveness of ground-source heat pumps for small well-insulated homes was not good because of the high capital cost. As a result, these heat pumps were taken out of two of the three homes.

The program as a whole was a good educational experience. This program received a National Award for Energy Innovation in 1985.

RELATED PROGRAMS:

REFERENCES:

U.S. Department of Energy, 1985; "Energy Efficient Homes: Presenting the Winners in New England Electric's Energy Efficient Home Design Competition," brochure prepared by New England Electric.

CONTACTS:

Name: Ken Alton
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DATE: Nov. 2, 1987 / June 29, 1988

NEW RESIDENTIAL PROGRAMS (RES-17)

PROGRAM TITLE: Design Assistance Program

PROGRAM SPONSOR: Virginia Division of Energy (VDOE)

PROGRAM OBJECTIVES: To encourage design professionals to develop house plans suitable to Virginia's climate and market.

APPROACH: This program provided architectural assistance to architects, builders, and consumers who sent houseplans or working drawings to Virginia's two solar architects. The architects advised the design community on energy efficiency and passive solar design. This service included one-on-one consultation, literature and plan review, and computer analysis of the efficiency of the projects. Emphasis was placed on soliciting plans that incorporated strategies for natural ventilation and passive cooling.

TARGET BUILDING TYPES: Single-family

KEY PARTICIPANTS: VDOE, architects, builders, consumers, and the Home Builders Association of Virginia.

HISTORY:

Date of Implementation: 1984
Current Status: Terminated in 1987.
General Comments: There was a lot of interest in the program when it first started, but the project was terminated due to lack of interest in energy conservation and passive solar in the mid-1980s. VDOE could not continue to support two solar architects (part-time) due to the lack of demand for their services.

MARKETING/PROMOTION METHODS: Public service announcements, news releases, and posters were sent to homebuilder supply companies.

MONITORING/EVALUATION: None

Market penetration:

Savings:
- Energy:
- Peak:
- Dollars:

Costs and cost-effectiveness:
- Program administration:
- Incentives:
- Private investment:

Discussion:
The program was highly respected and well-received, and the program worked well when interest was high.

RELATED PROGRAMS: The VDOE sponsored the American Institute of Architects' (AIA) short course "Energy in Architecture" from 1984 to 1986. The target audience was architects and designers working in the public and private sectors. Training in energy-efficient design practices and in computer-assisted energy analyses were conducted. The VDOE, along with the AIA and the Virginia Solar Energy Society, sponsored Virginia's first passive residential design competition in 1980, open to all interested individuals, design teams, and builders. The purpose of the design program was to make passive solar heating and cooling systems a conventional practice in the design and construction of single-family and multifamily housing within Virginia. The winning designs were published in a book, *Solar Homes for Virginia.* In 1980-81, VDOE sponsored five different building workshops. Annually, VDOE holds training seminars statewide for building inspectors on the energy provisions of the statewide building code.

REFERENCES: *Solar Homes for Virginia,* Virginia Division of Energy, n.d.

CONTACTS:

Name: Jennifer Snead
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Phone: 804-367-6883

DATE: Oct. 26, 1987 / May 24, 1988

NEW RESIDENTIAL PROGRAMS (RES-18)

PROGRAM TITLE: Energy Efficient Home Award Program

PROGRAM SPONSOR: Nevada Power

PROGRAM OBJECTIVES: Originally, to reduce peak (summer) loads; now, to build off-peak (winter) load.

APPROACH: This program provided awards to builders who built homes that met certain insulation standards and that included a high efficiency heat pump. Initially, all the homes had to be all-electric; now, all homes are targeted for heat pump promotion.

TARGET BUILDING TYPES: Single-family and multifamily.

KEY PARTICIPANTS: Nevada Power and builders.

HISTORY:

Date of Implementation: 1984
Current Status: The program recently changed into a heat pump rebate program for residential and nonresidential buildings.
General Comments: Awards are no longer being given since most builders are already meeting state standards. The primary purpose of the heat pump program is to promote electricity use (in competition with gas companies). There are no rebates for heat pumps in the commercial sector because commercial buildings are primarily electric.

MARKETING/PROMOTION METHODS: Awards and rebates for high efficiency heat pumps. Initially, there was a flat rebate: money was provided if a heat pump was installed. Now, the rebates vary by the size and efficiency of the unit: larger heat pumps receive larger rebates.

MONITORING/EVALUATION:
Heat pump seasonal efficiency rating (SEER) records are continually monitored in order to raise the minimum level of SEER for rebates. Attached are records of rebates for 1984 to the present. In addition, Nevada Power conducts a thorough economic evaluation of its program.

Market penetration:

	Apts.	Condos Townhouses	Custom Houses	Subdivision Houses	Commercial Buildings	Total
1984 *	961	74	0	0	0	1035
1985	2178	332	78	94	32	2714
1986	3357	308	197	246	575	4683
1987 **	1864	265	188	117	303	2737
Total	8360	979	463	457	910	11,169

* For Dec. 1984 only.
** Through Sept. 1987.

Savings:

- Energy:
- Peak: Estimated: 1/2 kW reduction in peak demand for single-family detached houses; 1/4 kW reduction in peak demand for apartments. The peak reductions are due mainly to improvements in the air-conditioning component of the heat pumps.
- Dollars:

Costs and cost-effectiveness: Three benefit/cost ratios were calculated for single-family attached and single-family detached units:

	Attached	Detached
Utility impact	2.55	2.89
Ratepayer impact	0.74	0.76
Participant impact	1.17	NA

- Program administration:
- Incentives:

	Apts.	Condos Townhouses	Custom Houses	Subdivision Houses	Commercial Buildings	Total
1984 *	$240,250	$18,500	$0	$0	$0	$258,750
1985	$283,136	$71,176	$18,718	$26,724	$5,532	$405,286
1986	$352,796	$35,478	$41,317	$54,307	$101,692	$585,590
1987 **	$141,010	$27,124	$40,149	$23,880	$57,897	$290,060
Total	$1,017,192	$152,278	$100,184	$104,911	$165,121	$1,539,686

* For Dec. 1984 only.
** Through Sept. 1987.

- Private investment:

Discussion: About 90% of the inquiries for new service through Nevada Power's Builder Services Department were from residents of multifamily units (most of the multifamily units are all-electric). There was not a large spread in SEERs. In 1987, most of the heat pump and gas/electric package unit SEERS were near 9.0; a few SEERS were between 8.0 and 8.5, and a few between 10 and 11.9. As time goes on, the number of low SEERs is expected to be less and less. This trend is probably more to due with price effects than rebates or standards (there is no minimum SEER in the state code). The average SEER now is 9.0 (in 1985/86, the average SEER was 8.7, and 8.4 in 1984).

RELATED PROGRAMS: They are looking at thermal cool storage and high efficiency motors.

REFERENCES:

CONTACTS:

Name: Ron Zanoni
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Phone: 702-367-5116

DATE: Oct. 30, 1987 / June 23, 1988

NEW RESIDENTIAL PROGRAMS (RES-19)

PROGRAM TITLE: Energy Efficient Building Design Competition

PROGRAM SPONSOR: Energy Efficient Building Association (EEBA)

PROGRAM OBJECTIVES: To recognize and publicize the efforts of builders who have designed and built cost-effective, energy-efficient buildings; to stimulate new, replicate energy conservation technologies; and to give recognition to groups of individuals who have worked on these award-winning projects.

APPROACH: The competition is open to anyone. There are no cash awards; a bronze plaque is attached to the award-winning building. The criteria for entering are: new or retrofit building, must have been occupied for one year, must send in one year's worth of utility bills, must have ventilation measurements, and must have had an energy audit. Accordingly, the performance of the building is a very important aspect of the program. Last year, they received over 40 applications. A jury of 3 people reviews the entries.

The following items are evaluated by the jury: nonrenewable energy required, construction costs, project administration, site environment, building orientation, replication of energy-conserving innovations, integration of interdisciplinary teamwork, exterior aesthetics, thermal envelope design, positioning and area of openings, passive solar heating (if any), ease of maintenance and vulnerability of devices such as skylights and screens, surface area of heated building envelope and volume, gross floor area of conditioned space, use of space, interior environment, indoor environment and use of "indoor air quality systems" in lieu of ventilation and makeup and combustion air, integration of environmental systems, energy budget analysis, air-infiltration test by an independent testing agency, and quality and clarity of documentation.

TARGET BUILDING TYPES: Single-family and multifamily

KEY PARTICIPANTS: EEBA and builders

HISTORY:

Date of Implementation: 1986
Current Status: Continuing
General Comments: EEBA is six years old and is located at the University of Southern Maine's Technology Center (Corham, Maine). The purpose of the EEBA is to foster the development and dissemination of information relating to the design and construction of energy efficient buildings.

MARKETING/PROMOTION METHODS: The program is promoted at conferences, through brochures, and in professional journals. A plaque is affixed to the exterior of the building.

MONITORING/EVALUATION:

Market penetration: 40 applicants in 1986

Savings:
- Energy:
- Peak:
- Dollars:

Costs and cost-effectiveness:
- Program administration:
- Incentives:
- Private investment:

Discussion: George thinks the program is very worthwhile. There were considerably fewer applicants in 1987. EEBA will probably loosen the application process a little to encourage greater participation.

RELATED PROGRAMS:

REFERENCES: "Excellence in Housing '88: Sixth Annual International Energy Efficient Building Conference and Exposition," brochure prepared by EEBA; and "Energy Efficient Building Design Competition Proposal," prepared by EEBA.

CONTACTS:

Name: Doug George (member of EEBA Board of Directors)
Position/title: Owner
Organization: Conserve Associates
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Phone: 603-749-5995

DATE: Dec. 9, 1987 / June 1, 1988

NEW RESIDENTIAL PROGRAMS (RES-20)

PROGRAM TITLE: Cut Home Energy Costs (CHEC) Loan Program

PROGRAM SPONSOR: Manitoba Energy and Mines (MEM)

PROGRAM OBJECTIVES: To promote energy efficiency in existing and new homes.

APPROACH: The CHEC Loan Program is currently being implemented for existing homes; expanding the program for new homes is being planned (see below). Low-interest loans are given to homeowners to improve the home to meet the current standard (R-20 basement (versus R-12 basement), insulated outside sheathing, more insulation in attic (versus R-40 attic), and an air-to-air heat exchanger). The conditions of the CHEC loan are as follows: low-interest rate of 8%; minimum loan of $250 and maximum loan of $2,500; maximum 10-year term; monthly payment of $30.34 or multiples thereof; convenient payments on the homeowner's Hydro bill; a mandatory Home CHEC-UP Energy Analysis; and only the recommendations of the Advisors are eligible.

TARGET BUILDING TYPES: Duplex, triplex, 4-plex, mobile home, and row housing (apartments (which are in the commercial program) and summer homes are not eligible).

KEY PARTICIPANTS: Manitoba Energy and Mines, Manitoba Hydro, Winnipeg Hydro, homeowners, and contractors.

HISTORY:

Date of Implementation: 1977
Current Status: Continuing
General Comments: The program was modified in Oct. of 1986 to increase the loan amount from $1,000 to $2,500, decrease the interest rate from 9.5% to 8%, and reduce the amortization period from 20 years to 10 years. The loan program does not cover equipment. The province of Manitoba is in the process of buying up the gas utility, and the program may be revised to promote efficient gas (heating) appliances. The cost of energy in Manitoba is relatively low: 3.5 to 4 cents/kWh and $4.20 per mcf for natural gas; Manitoba recently experienced a 25% to 30% reduction in the cost of gas.

MARKETING/PROMOTION METHODS: The program is promoted through a variety of activities: direct mail (through Hydro bill stuffers/flyers), counter stands in building supply stores, Home CHEC-UP Advisors, home energy workshops, retailer training workshops, and newspaper advertisements.

MONITORING/EVALUATION: An evaluation of the retrofit CHEC Loan Program was conducted (an in-house study), but it is not available to the public.

Market penetration: For existing homes, about 5,000 homes participate each year, reflecting a 2% annual penetration rate; about 50,000 loans have been processed, so that 19% of the total stock has been penetrated. The stock is 260,000 homes.

Savings:
- Energy:
- Peak:
- Dollars:

Costs and cost-effectiveness:

- Program administration:
- Incentives:
- Private investment:

Discussion:

A program expansion into new homes was also developed but not implemented for the following reasons: (1) the federal R-2000 program (see write up) was in-place (funding for this program will end in 1989); and (2) MEM did not anticipate the expected demand for this program: builders indicated that they will have 100% participation (instead of 30-40%) for the 4,000 new single-family homes built each year (in contrast to an annual average of 2,200 new homes).

The program for existing residential works well. It could be strengthened with the promotion of efficient heating systems, and program implementation is currently being reviewed.

RELATED PROGRAMS: MEM administers a similar program for existing commercial buildings: the Business and Community CHEC Loan Program. The loans are issued at the Government's borrowing rate which is usually 1% less than the consumer's loan rate. MEM would like to extend the Program to new commercial buildings, but this will not occur for some time.

REFERENCES: "Home Energy Saving Plan," "Home CHEC-UP/CHEC Loan Program," and "How-To Booklets," material prepared by Manitoba Energy and Mines.

CONTACTS:

Name: Tom Akerstream
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Phone: 204-945-2116

DATE: Nov. 12, 1987 / June 10, 1988

NEW RESIDENTIAL PROGRAMS (RES-21)

PROGRAM TITLE: Energy-Efficient Construction Program

PROGRAM SPONSOR: South Dakota Housing Development Authority (SDHDA) and the South Dakota Energy Office

PROGRAM OBJECTIVES: To reduce home fuel consumption and South Dakota's dependence on fuel assistance programs.

APPROACH: South Dakota adopted a voluntary state energy code, and the code was the first one in the country to be used in conjunction with a State Housing Finance Agency. Because it is a voluntary code, a program was established (the Energy-Efficient Construction Program) that allowed home buyers building in compliance with the code and receiving state loan financing to receive an interest rate write-down or buy-down (see below). To ensure building compliance, 62 energy inspectors were trained and certified to inspect homes built under the code guidelines (the inspectors were affiliated with various community action agencies and the South Dakota Energy Office, and included several independent inspectors).

TARGET BUILDING TYPES: Single-family and multifamily.

KEY PARTICIPANTS: South Dakota Energy Office, SDHDA, homebuilders' associations, realtors, subcontractors, and alternate energy user groups.

HISTORY:

Date of Implementation: April 1, 1985
Current Status: Ended May 1, 1986
General Comments: Effective April 1, 1985, 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. The code is unique in that it requires testing for air infiltration using blower-door technology (maximum air leakage of no more than 4 air changes per hour at 50 Pascals). However, an administrative rule adopted in May 1986 gave home buyers the option to waive the energy code requirements for single-family houses. The code is prescriptive for one and two family dwellings. For multifamily housing units, designers may use one of three allowable methods - energy budget, component performance, or prescriptive method. 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).

MARKETING/PROMOTION METHODS: 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. The interest rate buy-down had to conform to federal regulations; accordingly, the incentives were in existence for only the first three years of the mortgage: for the first year, there was 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%).

MONITORING/EVALUATION:

Utility bill data for houses in the program and a comparison group of gas-heated homes were examined. ENVEST and HOTCAN were used for financial analysis of data. A homeowner survey was conducted to measure homeowner satisfaction with the purchased homes and to follow up on any problems which may have arisen during the design and operation of the homes (35 households responded out of 67). An evaluation of 45 homes (out of 72 homes built) with more than 2 months utility data was conducted.

Market penetration: 180 homes (all single-family)

Savings:

- Energy: Achieved 40% to 50% savings; the savings have persisted for 2 years.
- Peak:
- Dollars:

Costs and cost-effectiveness:

- Program administration: $114,535
- Incentives:
- Private investment:
- Additional construction cost: $2,663 for gas-heated homes, and $1,770 for electric-heated homes.
- Payback periods: 8-9 years for gas-heated homes, and less than 2 years for electric-heated homes.

Discussion:

The interest rate buydown did not have much impact on consumers' homebuying decisions (due to the limited nature of the program, see above).

Some parts of the code were too stringent for builders and allowed little flexibility (e.g., allowing substitution of different types and amounts of insulation). The code was developed to be very simplistic and easy to understand; however, the simplicity of the code, as reflected in its prescriptive standard, was too rigid.

Homeowners reported problems with ventilation systems and air-to-air heat exchangers. However, overall homeowner satisfaction with their homes was high. The average gas-heated home had an air change rate of 2.2 air changes per hour (at 50 pascals), and the average electric-heated home had an air change rate of 2.9 air changes per hour.

The training seminars were very helpful and provided one of the few opportunities for builders to learn about new building techniques. However, the people who showed up at the workshops were not really builders but salesmen and service people. The real builders didn't go to the workshops because they needed to make money in the field. Also, a lot of work was contracted out, and the subcontractors did not attend the workshops. Consequently, workshops were held onsite to train the people actually building the houses. Thus, targeting only builders with training was not an effective method: future training and technical assistance efforts must be targeted to hands-on workers and material suppliers.

Air-to-air heat exchangers (AAHX) were too expensive, unreliable, and did not work properly and would not be recommended for future programs. Most of the AAHX were designed and installed to avoid frost buildup, moisture, and condensation problems. However, some cold air did enter, but in very small areas.

The South Dakota Energy Office recommended that the best way to build an energy-efficient house was to tighten the house and provide energy-efficient heating and ventilation equipment. (Note: Wegman felt most heating equipment is overspecified today - 90% efficiency is often recommended; he felt that 80% efficiency is adequate).

There was a lot of learning in the program. Some builders will apply what they learned to their current construction while others might not use what they learn until more time has elapsed and energy prices begin to increase. Overall, the builders were supportive of the program.

Some builders are continuing to use what they learned in the program: in particular, air tightness techniques with mechanical ventilation (they exhaust moisture to the outside). Some builders have returned to their former habits (e.g., using 2x4 insulation, instead of 2x6).

The program did have another positive feature: it united all the builders in the state for the first time. Moreover, the builders are now interested in obtaining contractor's licenses to maintain their competitive edge against unlicensed contractors.

The program was a good real world application because the builders were regular folk with no special expertise in energy-efficient construction. He feels that because of this program, South Dakota is 20 years ahead of most of the other states.

The program received a National Award for Energy Innovation in 1986.

RELATED PROGRAMS: The South Dakota Energy Office is currently working on "Blueprints for the 90s" that will examine what products to use, how one should use them, and when you shouldn't use them.

REFERENCES: Larson *et al.*, 1986; U.S. Department of Energy, 1986a.

CONTACTS:

Name: Steve Wegman
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DATE: Nov. 3, 1987 / June 8, 1988

NEW RESIDENTIAL PROGRAMS (RES-22)

PROGRAM TITLE: The Energy-Efficient Home Project of Oregon (EEHPO)

PROGRAM SPONSOR: Bonneville Power Administration (BPA) (provided administrative costs), Oregon Department of Commerce's Housing Division (ODCHD) (provided $900,000 in low-interest rate mortgage funds), and the Energy-Efficient Housing Group (EEHG) (the consultant that ran the project).

PROGRAM OBJECTIVES: To demonstrate to homebuilders, mortgage lenders, and buyers the market acceptability and specific advantages of solar energy/energy-conserving construction in the entry-level home market.

APPROACH: Public funds were used to: (1) create a favorable atmosphere and an attractive investment vehicle for energy-efficient residential construction; (2) set up a design/build competition aimed at builders; (3) introduce lenders to concepts of qualifying ratio adjustments based on energy savings; and (3) prove in the marketplace the benefits of energy-efficient housing for all participants, from the secondary mortgage market to the homebuyer. Builders were encouraged to adapt a standard starter home model to be more energy-efficient (versus designing from scratch). A design/build competition was held and was viewed as extremely successful: 68 design entries were received from 52 builders. A winning design had to excel in several areas: technically (55% of the possible score), marketability of the design (30%), and the builder's financial qualifications and experience record (15%). A review team (8 members) was assembled, representing the cosponsoring organizations and a cross-section of professional specialties ranging from design, engineering and construction, to lending, appraising, and sales. Sixteen winners and five alternates were chosen; all of the winning designs featured sun-tempering of heating requirements in addition to a tight well-insulated envelope. There were 12 passive solar designs.

Monthly energy savings computations were calculated for each house and provided to the Far West Federal Bank for use in qualifying buyers. The Uniform Rating System (URS), developed by the Western Resources Institute, was used by the bank. The URS rates the energy efficiency of new and existing housing stock and is recognized by secondary mortgage lending institutions, such as Freddie Mac (the Federal Home Loan Mortgage Corporation). The specific savings information for each house was provided to each builder for their use in future sales of their winning model. The primary incentives for participation in the program for builders was advantageous mortgage financing and underwriting and the publicity and marketing of the program (see below).

TARGET BUILDING TYPES: Single-family

KEY PARTICIPANTS: BPA, ODCHD, EEHG, and builders. Cosponsors included: Far West Federal Bank (made the primary mortgage loans), the Oregon State Homebuilders Association (provided publicity and logistic support), and the Oregon Department of Energy (provided technical assistance).

HISTORY:

Date of Implementation: September 1982 to July 1983
Current Status: Terminated
General Comments: The program designers believed that a new technology has not truly become a normal feature of housing stock until it has been proven in the entry-level home market. The ODCHD manages an ongoing program to provide

mortgage financing on affordable homes to below-median-income families in the State of Oregon. The funds are raised through state-backed bond sales, and are typically offered at below-market rates through participating lenders that make the primary mortgage loans. Positive cash flow based on savings can be used in loan underwriting to adjust debt-to-income ratios, thus allowing a lender to qualify more buyers for this type of housing stock. A monthly mortgage payment typically should not exceed 36% to 38% of the applicant's monthly income; for energy-efficient homes, that percentage may be raised as high as 42%, enabling the lender to qualify the buyer for a larger mortgage. In the EEHPO, the use of the URS resulted in the qualification of one buyer who would have otherwise been unable to afford the home.

The program is no longer in effect because of the local gas companies' belief that this program was promoting all-electric homes. About 200 additional homes had been planned, and these homes were to have been all-electric.

MARKETING/PROMOTION METHODS: Promotion and publicity for the design competition was accomplished via press releases (in newspapers and radio), announcements in the newsletter of the Homebuilders Association, and direct mailings to builders. A press conference was called to announce the winners, all of whom were presented an award letter from the Housing Division. Several winners generated their own publicity and/or used the house as a model which resulted in obtaining further sales.

MONITORING/EVALUATION: Metering of homes was conducted. However, there was no evaluation because the project ended earlier than anticipated, and because BPA started their own Residential Standards Demonstration Program (RSDP, see writeup). Meters are still in, but data are not being collected.

Market penetration: 14 homes

Savings:

- Energy: The 14 homes were estimated to save over 2.8 million kWh over the term of the mortgage.
- Peak:
- Dollars:

Costs and cost-effectiveness:

- Program administration:
- Incentives:
- Private investment:

Discussion:

The program was a successful cooperative effort carried out by a coalition of public and private sector participants. Miller noted three points about the program: (1) a mortgage financing/underwriting component will stimulate energy-conserving housing activity, probably at much lower direct governmental cost than isolated awards or training programs; and (2) homebuilders will respond favorably to a performance approach than to a more stringent prescriptive approach. However, Miller believes that people bought the homes because they were nice, well-built homes (builders were supportive of the program, put a lot of effort into building well-built homes, and used the homes as spec houses for advertising their business).

RELATED PROGRAMS: BPA's Code Adoption Demonstration Program, the Early Adopter Program, the Model Conservation Standards Implementation Assistance Program, and

the Residential Standards Demonstration Program (RSDP) (see writeups). None of these programs focused on the financing of homes, the chief focus of this demonstration project.

REFERENCES: Miller *et al.*, 1984.

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DATE: Nov. 9, 1987

NEW RESIDENTIAL PROGRAMS (RES-23)

PROGRAM TITLE: Residential Standards Demonstration Program (RSDP)

PROGRAM SPONSOR: Bonneville Power Administration (BPA)

PROGRAM OBJECTIVES: To demonstrate to the homebuilding industry what the proposed energy-efficient standards (Model Conservation Standards (MCS)) are, how to comply with them, and increase the industry's familiarity with them; and to obtain more accurate estimates of the average energy savings and incremental costs associated with the MCS.

APPROACH: The RSDP is a large-scale demonstration program of new, electrically-heated houses built to the MCS. MCS houses have many of the following characteristics: insulated ceilings (R-30 or R-38) and walls (R-19 to R-31), underfloor insulation (R-19 or R-30), perimeter insulation (R-10 to R-15), double or triple-glazed windows with thermal breaks (insulating material in the window frames to break the thermal path by which heat is lost), insulated entry doors, control of air infiltration through careful caulking, weatherstripping, and vapor barriers, very low infiltration designs incorporating continuous vapor barriers and air-to-air heat exchangers, passive solar designs, and use of heat pumps.

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). 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, solar access, and operation of air-to-air heat exchangers) were also collected. The project was funded by BPA; discretion in designing and implementing the RSDP was left to the states.

TARGET BUILDING TYPES: Single-family and multifamily.

KEY PARTICIPANTS: BPA, the state energy offices of Idaho, Montana, Oregon, and Washington, general contractors, subcontractors, designers, architects, the general public, builders, local code officials, and others familiar with standard residential construction.

HISTORY:

Date of Implementation: 1984
Current Status: Completed
General Comments: The Pacific Northwest Electric Power Planning and Conservation Act of 1980 (P.L. 96-501) established the Northwest Power Planning Council that adopted the MCS for new residential and new commercial buildings in their 1983 Power Plan. BPA has offered major programs designed to meet the Council's goals, including the RSDP.

MARKETING/PROMOTION METHODS: A series of orientation sessions were conducted throughout the four states describing the RSDP to builders, potential homebuyers, and the general public. Each state held between six and seven orientation sessions. Approximately 2,000 persons attended the sessions. The states also held a series

of builder training workshops throughout their respective state; these workshops were particularly targeted to general contractors, subcontractors, designers, architects, local code officials, and others familiar with standard residential construction. Approximately 1,750 builders attended the workshops. BPA also funded a technical assistance hotline. This service, administered by the International Conference of Building Officials (WSEO served as a subcontractor), received over 7,000 calls (from 1984 to 1986) from builders and code officials needing clarification on technical issues.

State energy agencies solicited participation in the RSDP by sending out additional informational brochures to builders that had initially expressed an interest in the program. Each state developed its own method for promoting and marketing the program homes. Most of the states developed a name and logo that identified the energy efficient homes. There was also advertising in local newspapers and open houses.

MONITORING/EVALUATION:

The RSDP included the large-scale monitoring of both construction costs and energy use in approximately 400 energy-efficient houses and an equivalent number of "current practice" houses built recently to conventional standards. As part of the monitoring program, houses were "triple-metered" for electricity consumption by placing separate kilowatt-hour meters on the space heating circuit, the domestic hot water circuit, and the total load. In addition, an integrating temperature recorder that measured both indoor and outdoor temperatures was installed. Cooperating homeowners were paid to record weekly the meter readings and indoor and outdoor temperatures. Occupants of both the MCS and current practice houses were surveyed twice to obtain information on house characteristics, appliances, perceived problems with the indoor environment, energy-related attitudes, and demographic characteristics. Thermal monitoring ended in August 1987; 75% of the original participants volunteered to have their houses monitored for one additional year (1986-87). An infiltration study, comparing tracer gas measurements with blower door results, is continuing.

Market penetration: About 400 energy-efficient homes were built, 2,000 persons attended orientation sessions, and 1,750 builders attended workshops.

Savings:

- Energy: The average annual space heating use for houses built in the RSDP was approximately 2.5 kWh per sq. ft. less than for comparable houses built between 1979 and 1983. 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.
- Peak:
- Dollars:

Costs and cost-effectiveness: The median incremental construction cost reported by builders was $2.90 per sq. ft. of floor area. The Council used a 36% markup on direct labor and material costs to account for builders' indirect costs and profit. This raises the total cost of the conservation measures installed in the houses built in RSDP to $3.95 per sq. ft. of floor area. Adding an administrative cost of 20% to this amount makes the final cost to the region $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.

- Program administration:
- Incentives:

- Private investment:
- Cost effectiveness: There are cost-effective combinations of energy conservation measures for new residential construction that exceed current practice and achieve Council-level performance. The thermal performance of the Council's MCS can generally be achieved in a cost-effective manner. Houses built to BPA's recommended MCS had a lower present-value cost to the consumer than the comparable current practice house (including first-cost plus operating costs).

Discussion:

Parker (1987) described the following lessons learned from the RSDP: (1) well-insulated houses consume even less energy for space heating than predicted, (2) conventional houses perform better than expected, (3) forced-air heating systems in conventionally built houses may perform poorly unless special attention is placed on reducing duct losses, (4) special air-infiltration control measures and air-to-air heat exchangers are not economical from the standpoint of saving energy alone, and (5) mechanical ventilation systems seem to be a necessity in all modern houses to help provide adequate indoor air quality. He concluded by saying that, based on the data from the RSDP, the MCS are particularly good long-term investments: it is cheaper in the Pacific Northwest to conserve electricity with energy-efficient new housing at MCS levels than it is to produce electricity with any new generating source.

The Northwest Power Planning Council (1987) and Vine (1987) noted that there were many reasons why the cost data from this program should be viewed with caution. First, many of the builders who participated in the program had never built to the levels of energy efficiency called for in the MCS. This lack of experience resulted in higher costs. Second, many of the builders who did have some experience building to these higher levels of energy efficiency chose to exceed the minimum program requirements (they installed even more energy-efficient measures than the model standards required). Builders who exceeded the MCS specifications incurred higher costs. Taking these factors into account, the Council's current best estimate of the regional cost of meeting the MCS, including 20% for program administration, is approximately $2.25 per sq. ft. of floor space.

The Council (1987) also noted that some caution must also be applied to the savings data. Again, since many of the builders were building their first highly energy-efficient new home, not all of the construction design goals were met. Taking this factor into account, the Council anticipates that over its life a house meeting the MCS will use approximately 3 kWh per year per sq. ft. of floorspace less for space heating than will an identical house built to current practices. This is equivalent to a 50% reduction in the space heating needs of a typical house. Based on the Council's financial assumptions and projected costs and savings, the regional levelized cost of the MCS is 2.8 cents per kWh.

Selby noted that BPA's other conservation programs have benefitted from the RSDP: the program helped start BPA's Super Good Cents (SGC) program through the development of building specifications and refined the proposed MCS.

RSDP results have already influenced the MCS and the resulting SGC specifications (BPA (RCDP), 1987). The RSDP cost-effectiveness study provided critical information needed by the Council and BPA to make programmatic and policy decisions. This analysis helped identify which measures should be included in the latest version of the MCS and which should not. For instance, air-to-air heat exchangers (AAHX) and air tight construction (advanced drywall approach (ADA, a method that seals together

walls, floors, and ceilings to form a continuous air/vapor barrier) or continuous polyethylene vapor barriers) became optional, rather than a required measure. Also, as a result of RSDP, AAHX specifications were upgraded and now provide useful installation details such as proper sizing of ducting. Also, the ADA was introduced in the RSDP, and due to its success, was offered as an innovation in the first cycle of the Residential Construction Demonstration Program (RCDP) (see writeup), allowing it to gain exposure and mature further. Now, ADA is part of the SGC specifications. Two-by-six exterior walls, which allowed for more insulation, were not commonly used by builders in the region, prior to RSDP. As this technique has gained wider acceptance, 2 X 6 framing material became more readily available and now "advanced framed" walls are standard practice in Oregon and Washington. Advanced framed ceiling trusses, which allow for thicker ceiling insulation, once hard to find, are also now commonly carried by suppliers. "Thermal-break" windows, first required in RSDP, also have become easier to find and are less expensive to purchase.

RELATED PROGRAMS: BPA's Residential Construction Demonstration Program (see writeup).

REFERENCES: Bonneville Power Administration, "The Residential Construction Demonstration Project: Project Brief," brochure, 1987; Bonneville Power Administration, 1986; Crossman, 1986; Drost *et al.*, 1986; Eckman and Watson, 1984; Hart and Selby, 1984; Jackson, 1986; Johnson, 1986; Keating and Bavry, 1986; Keating *et al.*, 1986; Meier *et al.*, 1986; Northwest Power Planning Council, 1987a; Parker, 1986, 1987a, 1987b; P. Reiland, M. McKinstry, and P. Thor, *Preliminary Air-to-Air Heat Exchangers Testing Results for the Residential Standards Demonstration Program*, Bonneville Power Administration, Portland, Oregon, 1985; P. Reiland, M. McKinstry, and P. Thor, *Preliminary Formaldehyde Testing Results for the Residential Standards Demonstration Program*, Bonneville Power Administration, Portland, Oregon, 1985; P. Reiland, M. McKinstry, and P. Thor, *Preliminary Radon Testing Results for the Residential Standards Demonstration Program*, Bonneville Power Administration, Portland, Oregon, 1985; Rowan, 1986; Tangora *et al*, 1986; E. Vine, 1986; E. Vine and B. Barnes, 1986; Watson, *et al.*, 1986.

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DATE: Dec. 10, 1987 / June 23, 1988

NEW RESIDENTIAL PROGRAMS (RES-24)

PROGRAM TITLE: Residential Construction Demonstration Program (RCDP)

PROGRAM SPONSOR: Bonneville Power Administration (BPA)

PROGRAM OBJECTIVES: To examine innovative ways of meeting the requirements of energy-efficient standards (Model Conservation Standards (MCS)); to save electricity by making new homes more energy efficient; to develop and/or refine predetermined conservation techniques and innovations; to examine predetermined conservation techniques and innovations by gathering specific data on reliability, cost-effectiveness, and marketability; to introduce the use of innovations which show potential to be reliable, cost-effective, and marketable; and disseminate information gathered from the project which is useful to the shelter industry or to the policy makers in the region.

APPROACH: The RCDP is designed to develop reliable alternatives for building energy-efficient homes. The RCDP is seen as a testing ground for energy-efficient technologies prior to transferring them to the shelter industry. The project operates on an every other year cycle. The first cycle was conducted in 1986-87. The implementation/construction phase of the second cycle is currently underway (1988) and the third cycle is targeted for 1990.

To participate in Cycle I of the program, contractors had to agree to build their new home to Super Good Cents (SGC) specifications (see writeup), use a MCS-approved air leakage control package, install energy-use monitoring equipment, and incorporate at least one of the following "state-of-the-art," energy-saving innovations: advanced drywall approach (a method that seals together walls, floors, and ceilings to form a continuous air/vapor barrier), high R-value walls, air-to-air heat exchangers with duct heaters, air-to-air heat exchangers with integrated forced-air heating systems, exhaust-air heat pumps, and energy-efficient prepackaged modular homes. During Cycle I, 165 homes were constructed.

For the builder, most of the extra expense in meeting high energy-efficient standards was reimbursed by BPA through the respective state energy offices. Before construction, contractors had to attend a two-day, SGC training session in which standards, technologies, guidelines, and incentives were explained. The program also offered training for subcontractors and crews and technical assistance to both the builder and subtrades. Other builder responsibilities included tracking material and labor costs and filling out detailed check sheets as various components of the homes were installed or completed. Two separate inspections were conducted on finished homes, one for overall SGC compliance and the other for the technical RCDP innovation requirements.

Construction for Cycle II began in September 1987. Applications were sent out to builders for them to choose which innovative programs they wanted to participate in as part of Cycle II of the program. During Cycle II, the following innovations are being tested, demonstrated, and marketed: a "Future House," targeted to be 30% less energy intensive than the current MCS (10 houses); a Super Good Cents (SGC) house with energy-efficient appliances (100 houses); volume builder homes (up to four volume builders will be asked to participate; approximately 20 houses per builder are expected to be built); air leakage control; active ventilation systems (heat pumps; low-cost air-to-air heat exchangers, and non-heat recovery systems) (100 houses); and manufactured (HUD Code) housing (150 houses).

TARGET BUILDING TYPES: Single-family and manufactured homes.

KEY PARTICIPANTS: BPA (sponsor and funder), Washington State Energy Office (WSEO) (administrator), state energy offices of Washington, Oregon, Idaho, and Montana (local project management), builders, and buyers of all-electric new homes.

HISTORY:

Date of Implementation: 1986
Current Status: Continuing
General Comments: The genesis of this program was the Residential Standards Demonstration Program (RSDP, see writeup) in which alternatives to the advanced drywall approach were proposed that were more appealing to the building community and were potentially more cost-effective. Data from Cycle I are presently being entered into BPA's data bases, and preliminary analysis has begun.

MARKETING/PROMOTION METHODS: BPA contracted with the WSEO to coordinate the project. WSEO, in turn, contracted with the state energy offices in Oregon, Idaho, and Montana for local project administration. The state energy offices promoted the program primarily to builders who had constructed a SGC home or had participated in the RSDP. Program mailings were distributed, and the program was described at public meetings and training sessions. Over 2,500 builders in the region have attended RCDP and RSDP training sessions on energy-efficient building techniques and innovation specific requirements. BPA also funded a technical assistance hotline. This service, administered by the the International Conference of Building Officials (ICBO) (WSEO served as a subcontractor to ICBO), received over 7,000 calls, from 1984 to 1986, from builders and code officials needing clarification on technical issues.

Aside from the increase in home value, contractors received cash incentives, ranging from $4,000 to $4,800 depending on the innovation installed, to cover extra cost and any associated risk. Bonuses of $350 to $450 were also paid to homeowners for tasks that related to later monitoring of the home's energy use, such as stringing wire for thermal sensors and installing triple base electric utility meters. On some 35 RCDP homes, contractors received additional $200 bonuses for providing full-scale house doctor treatments (a technique where a home is tested during construction for air leaks using a blower door). The homebuyer, or occupant, was given a cash incentive for either recording data or cooperating in special tests. There was also a bonus for inconveniences, such as requiring homeowners not to use wood stoves or fireplaces during the monitoring period, because this form of heat biases the thermal analysis. The homeowner incentive payment level depended largely upon the number of heating degree days in a year, ranging from $300 in warmer areas to $450 in the higher, colder elevations.

MONITORING/EVALUATION:
For the 165 houses built in Cycle I, the homes will be monitored through April 1988. Measurements from "base-level" monitoring include: triple metering of whole house (measuring space heat, water heat, and total electricity consumption); tightness of home (measured by the blower door test, used to estimate a home's average air change rate over the heating season); perfluorocarbon tracer gas (PFT) (which measures average air change rates over time); house characteristics; indoor and outdoor temperature data; occupant survey; builder exit survey; and cost and appliance data.

A subgroup of 45 RCDP homes is undergoing a special two-week "personal comfort"

ventilation test. The procedure involves one week in which all home ventilation equipment is shut off, and a second week in which it operates normally. A homeowner survey will assess the contrast in liveability between the two weeks. For participating in this test, homeowners received a bonus of $200. In addition, other "innovation specific monitoring" will be conducted on specific types of innovation.

Houses built in Cycle II will be monitored through April 1990 and the following basic monitoring data will be collected: utility energy, space heat energy, water heat energy, blower door, PFT, occupant survey, builder exit survey, and house audit (for house characteristics). The following additional monitoring data will be collected for specific projects: (1) Future House: appliance audit and external loads; (2) energy efficient house: appliance audit and refrigerator use; (3) volume builders: weather data by subdivision; (4) air leakage control: blower door and house doctor; (5) active ventilation: 12 data points; and (6) manufactured housing: case studies of manufacturers' and dealers' experiences, and design data.

For Cycle II houses, the following basic cost data will be collected: ventilation, insulation above Super Good Cents baseline, glazing, builder markup, and sales price. The following additional cost data will be collected for specific projects: (1) Future House: appliance cost; (2) energy efficient house: appliance cost, and thermal insulation cost beyond prescriptive path; (3) air leakage control: blower door and inspection costs; (4) active ventilation: installation, repair, and inspection costs; and (5) manufactured housing: incremental wholesale costs for energy conservation measures.

Market penetration: One year after the solicitation of builders at the start of 1986, a total of 117 RCDP-approved contractors in the four states had built 165 homes that met SGC standards and special RCDP requirements.

Savings:
- Energy:
- Peak:
- Dollars:

Costs and cost-effectiveness:
- Program administration:
- Incentives:
- Private investment:

Discussion: Too early for any definitive conclusions.

RELATED PROGRAMS:

REFERENCES: Crossman, 1986; "Residential Construction Demonstration Project, Fact Sheet - Cycle I, and Fact Sheet - Cycle II," prepared by BPA, 1987; "The Residential Construction Demonstration Project: Project Brief," prepared by BPA, 1987. "Residential Construction Demonstration Project: Manufactured Housing Update," factsheet prepared by BPA, 1988.

RES-24

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DATE: Dec. 10, 1987 / June 23, 1988

NEW RESIDENTIAL PROGRAMS (RES-25)

PROGRAM TITLE: Energy Efficient Housing Demonstration Program (EEHDP)

PROGRAM SPONSOR: Minnesota Housing Finance Agency (MHFA)

PROGRAM OBJECTIVES: To demonstrate to the building community and to the public that energy-efficient housing was within the reach of available technology; to provide for the ongoing education of builders; to create a group of homes that could act as examples of energy efficiency in residential housing; to gather and analyze energy use data; and to obtain the experience needed for developing prescriptive energy standards for future MHFA home mortgage programs.

APPROACH: This demonstration program was an $11 million mortgage loan program that explored new construction techniques and designs to increase the energy efficiency of housing units. Under the program, 144 detached and multifamily housing units distributed throughout Minnesota were constructed by 23 builders. The builders constructed housing developments ranging from 4 to 12 units. These units represented more than 30 different designs and included single-family detached, two-units, quads, and rowhouses (up to 12 units). The designs included passive solar heating, solar water heating, earth berming, double envelope, and superinsulation. The designs for these buildings were selected on the basis of their predicted energy performance, simplicity of operation, integration of solar domestic hot water system, aesthetic qualities, apparent cost-effectiveness, and marketability. More than 7,000 entries were received for the drawings on the 144 housing units. Two to twelve units of each design were constructed and the majority of them were occupied throughout the 1981-82 winter.

TARGET BUILDING TYPES: Single-family, two-units, quads, and rowhouses.

KEY PARTICIPANTS: MHFA, Minnesota Department of Energy, Planning and Development, Northern States Power and Minnesota Gas Company, builders, homeowners, University of Minnesota, U.S. Department of Housing and Urban Development (HUD), private architectural and engineering firms, the building community, and consumers.

HISTORY:

Date of Implementation: 1980
Current Status: Research program ended in 1986
General Comments: This was the first attempt to build a very energy-efficient house for most of the builders. Research findings were intended to be used as a basis for setting future policy in delivering single-family housing through MHFA home mortgage loan programs.

MARKETING/PROMOTION METHODS: A three-day public inspection of selected designs was held prior to construction. Seven percent interest rate financing was provided. An EEHDP Builders' Handbook was prepared. The MHFA assisted builders through a series of educational training sessions and workshops; upon selection of designs, MHFA held additional training sessions for participating builders. Appraisers and inspectors received on-the-job training.

MONITORING/EVALUATION:
An evaluation of the effectiveness of these units began in the fall of 1981, with detailed measurements during 1983-85. Five types of data were collected:

(1) monthly meter readings by the utility companies as well as weekly meter readings by the homeowner for both electricity and gas usage, (2) air-infiltration testing (75 units had blower door tests and 20 of these units had tracer gas tests), (3) two occupant surveys (80% response rate) on appliance use and use of the unit by the occupant, (4) builder-reported data on estimated extra costs, and (5) records on the problems, solutions, and changes in design which occurred during the construction of the units. Domestic supply and hot water temperatures were collected for 47 submetered houses. A detailed investigation of 25 houses was conducted: infrared scanning with fan pressurization, and measurements of furnace efficiencies, wood moisture, and indoor air quality (by passive monitoring techniques). Indoor air quality was investigated in 12 experimental EEHDP houses and in an equal number of control houses: formaldehyde, nitrogen dioxide, and radon were monitored.

Market penetration: 144 houses constructed by 23 builders; 7,000 entries received in design competition.

Savings:
- Energy:
- Peak:
- Dollars:

Costs and cost-effectiveness: The median extra cost of energy efficiency was $7,000.
- Program administration:
- Incentives: $11 million loan program
- Private investment:

Other effects: The average total thermal integrity factor (based on net space heat plus internal gains) for 25 groups of houses was 3.10 Btu per sq. ft. per degree day (below the program goal of 3.0 Btu per sq. ft. per degree day). Average air changes per hour was 5.00. The evaluation report (see references) contains detailed information on the results of the field research.

Discussion:

Hutchinson noted that builders found their greatest problem in attempting to apply construction techniques that would reduce the air change rate was one of training the work crews to properly handle and install air-vapor barriers. The problems that arose during the program were caused by lack of development in building techniques, building material and equipment, and by insufficient knowledge and experience with design and construction of energy-efficient housing.

Hutchinson provides a detailed account of the technical problems encountered by the builders in constructing these units, including the following: concrete slabs with ducts, resulting in large energy losses; insulation on outside of foundation walls protected by stucco, resulting in cracks; large infiltration gaps by plumbing inserts into the building; and lots of moisture problems.

Hutchinson noted that there were three factors responsible for the success of the program: (1) the publication of the Builders' Handbook that included instructions on energy-efficient design principles and calculation procedures, (2) the inclusion of below-market interest rate mortgage financing for all units, and (3) the provision of educational opportunities for architects, designers, engineers, and builders.

Positive spinoffs of the program included the following: (1) the creation of a group

of builders and designers who are interested in building energy-efficient houses (some builders have decided to construct only energy-efficient homes in the future); and (2) all builders have readily accepted the prescriptive energy requirements of the MHFA (see below).

Nelson et al noted that there were few significant correlations between energy performance and design features. They also found no significant differences in air quality between the energy-efficient houses and the conventionally constructed control houses. Radon mitigation using subfloor ventilation was found to be successful in reducing the concentration of radon; attempts to seal out radon in two control houses were not successful. Three general builder guidelines were recommended based on the findings of this research. The guidelines address the application and use of thermal insulation, the reduction of air leakage, and the design and installation of forced-air heat distribution systems. Overall, the houses were found to be very energy efficient, and simple designs appeared to be the most cost-effective.

It is also important to note that the houses investigated in this project were "first generation" energy-efficient houses, and many improvements in energy-efficient design and construction have taken place since these houses were built.

Jeff Christian of Oak Ridge National Laboratory (contract manager) thought the project was beneficial in that it taught people what not to do and, therefore, had a very large impact.

Bruce Nelson of the Minnesota Department of Energy and Economic Development (one of the key investigators in the research project) thought the program had started builders on their way in the energy conservation field, and as a result, some builders have taken over 50% of their market. He also felt that one of the major research findings of this project was that more attention needs to be paid to the details of constructing homes; therefore, less emphasis should be placed on designing energy-efficient homes. Future resources would be better spent on "tightening" up a home, rather than in more design work.

- Based on the results of this program, the MHFA established prescriptive energy requirements for mortgage loan programs (effective Jan. 1, 1982).

RELATED PROGRAMS: Two similar demonstration programs: BPA's Residential Standards Demonstration Program (RSDP) (see writeup) and the Residential Construction Demonstration Program (RCDP) (see writeup).

REFERENCES: Hutchinson *et al.*, 1984; Nelson *et al.*, 1986; Nelson, 1986; Nelson *et al.*, 1986.

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DATE: Not interviewed, but person to contact.

NEW RESIDENTIAL PROGRAMS (RES-26)

PROGRAM TITLE: Denver Metro Home Builders Program (DEMP)

PROGRAM SPONSOR: Solar Energy Research Institute (SERI)

PROGRAM OBJECTIVES: To transfer the results of first-generation passive solar technologies to the Denver homebuilding industry; to influence changes in the use of energy; and to gain important visibility for SERI.

APPROACH: SERI planned and executed a project in the Denver metropolitan area involving the construction of twelve new homes using a variety of passive solar and energy conservation technologies. The program 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 (in fact, the constructed homes ranged in price from $56,000 to $200,000).

SERI organized and implemented the program by: using its own funds to provide energy design consultants to the builders; closely monitoring the program; providing its own expertise in assisting the builders in designing and building the homes; and arranging for media attention.

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 from Sept. 1980 to Jan. 1981, and SERI oversaw the installation and operation of monitoring equipment and provided partial reimbursement of builders' expenses for allowing SERI to monitor the homes (to pay indirectly for the solar consultants' fees). In the third phase, SERI, in cooperation with the Denver Metro Home Builders' Association, organized the "Passive Solar Home Tour."

TARGET BUILDING TYPES: Single-family

KEY PARTICIPANTS: SERI, Denver Metro Home Builders' Association, Colorado Office of Energy Conservation, Western Sun (the regional solar energy center for the western U.S.), the Colorado Chapter of the American Institute of Architects, the Colorado Housing Finance Authority, builders, and architects.

HISTORY:

Date of Implementation: 1980
Current Status: Ended in 1982
General Comments: While the program ended in 1982, monitoring of some homes continued for another year (see below).

MARKETING/PROMOTION METHODS: The houses were displayed in a highly publicized version of the Denver Metro Home Builders' Association's annual "Parade of Homes" from Feb. 21 to March 8, 1981. Approximately 100,000 people visited the 12 new solar homes. The Parade of Homes 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. There were several seminars and workshops, and television, radio, and newspapers were used to promote the program.

MONITORING/EVALUATION:

Thermal monitoring was instituted in Feb. 1981 and continued through 1983. Class B monitoring was used: data were collected on all ambient conditions (outdoor temperature, humidity, solar radiation, etc.), gas and electricity usage, domestic hot water use, and interior temperatures in different zones of the house. The monitoring results were published in Class B monitoring reports published by SERI (see writeup).

Market penetration: 12 houses built and 87 additional homes projected to be built within six months; many new homes have incorporated the energy design ideas developed for the Denver Metro program.

Savings

- Energy:
- Peak:
- Dollars:

Costs and cost-effectiveness: Passive solar homes cost an extra 10 to 15% (about $10,000)

- Program administration: $150,000
- Incentives: unknown, but money was provided for energy design consultants' fees and for marketing assistance
- Private investment: unknown, but builders paid for their land, house, and own marketing.

Discussion:

The home-buying public became acquainted with both builder/architect/energy consultant teams and passive solar concepts and at the same time formulated a positive impression of SERI as the sponsor of such a program. SERI received favorable publicity, and passive solar and its builders and designers gathered interest and broadened their market. Local builders knew how to work specifically with solar and energy conservation consultants, and an important linkage had been forged between builders and solar designers/architects/energy consultants.

None of the top ten Denver area builders, having control over roughly 70% of new construction, currently offers any passive solar options. The large-volume builders were more concerned about affordability and concerned about consumers' willingness to pay the extra costs associated with a solar home. The failure of the Denver Metro program to maintain large-volume builder's interest and dedication to passive solar housing was, therefore, viewed as a major shortcoming to the end results. However, the program was successful in impacting smaller builders and in establishing an extensive and sophisticated energy-support industry in the Denver area. This network includes solar consultants, designers, engineers, architects, insulation contractors, window manufacturers, masonry firms, and several solar heating companies.

One person felt that Denver Metro, in supplying builders with prepaid architects/energy consultants, who frequently worked in isolation of the builders, had failed to truly educate the builders themselves. Therefore, Denver Metro had not stimulated the long-term results it could have. Moreover, this arrangement had resulted in the reliance of builders on architects. Many builders were surprised by designs made by architects, and SERI had to play an extra role in negotiating agreements at the back-end of the design stage. This person felt that the builders were the key users of passive

solar technology. An alternative approach was used in similar programs conducted in the Pacific Northwest (see below).

Holtz thought that the program was successful because it changed some homebuyers' and builders' attitudes towards energy-efficient homes and builders' construction practices. During this program, builders of energy-efficient homes had record sales, and this was a recessionary period. Consequently, other builders took note, and, as a result, most home construction was energy efficient. Also, some builders who participated in the program and were active in the Denver Home Builders' Association (HBA) are supportive of the Energy Savers Home Program that was created last year by the local HBA. This program is an energy rating program, with Bronze, Silver, and Gold awards given for a specified level of energy efficiency.

The impact of the Denver Metro project went beyond the immediate Denver area. Although numerous other local "Denver Metro" programs may have been conducted after its widely publicized success, the most immediate and directly related efforts came in the Pacific Northwest, in Portland, Oregon and Spokane, Washington. In fact, the Portland Solar Homebuilders Program was underway even before the Denver Metro Parade of Homes project was completed. The Northwest programs, funded by the Bonneville Power Administration (BPA) and implemented through Western SUN, were not a complete replication of the Denver Metro program, since they had different contracting arrangements: they required the architect to submit an invoice to the builder who then had to sign, in this way testifying that he had reviewed the plans before the architect was paid. It was hoped that this arrangement would encourage builders to become more closely involved with the solar concepts than the negotiated arrangement in Denver had permitted (see above). In this way, the program intended to force communication between the builders and architects (forcing them to work as a team) in which the builders would not be at a disadvantage through noninvolvement until the later stages of the design process. The idea was to get the builders to oversee the work of the architects.

Aside from the contracting element, arrangements were pretty much the same: the programs took place in three distinct phases of design/construction, monitoring and analysis of the finished homes, and marketing assistance ("home tours") Like SERI, BPA reimbursed homeowners for providing access for monitoring purposes. Western SUN provided each builder with $10,000 toward the costs of hiring the services of the required professional solar design consultants. In the Portland program, ten builder/designer teams began the program, and six homes were built. In the Spokane Solar Homebuilders Program, ten builder/designer teams were selected, and twelve homes were built. The Portland and Spokane Showcases of Homes were run in June and August, 1982, respectively, and with some success. For a variety of reasons, BPA ended its participation in the Home Builders Program in Feb. 1982, after two and a half years and $700,000 worth of work. Western SUN closed its doors to business altogether in May 1982. The effort to replicate Denver Metro in the Northwest was over.

The Portland and Spokane Homebuilders Programs did have their merits. The concept of having a public agency working with homebuilders proved successful. There was a demonstration of reasonably priced homes that looked relatively conventional. Some builders were taught the design of solar housing, and consumers were given an opportunity to consider the option.

RELATED PROGRAMS: A similar program in 1979 at SERI was the Passive Solar Manufactured Buildings Program (see writeup). Several programs in the Pacific Northwest were conducted along similar lines to the Denver program (e.g., the Super Good Cents and RSDP programs (see writeups).

REFERENCES: Lambright and Sipher, 1984; Lambright and Sheehan, 1985; Smith, 1982; and Baccei, 1981.

CONTACTS:

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DATE: Jan. 8, 1988 / May 26, 1988

NEW RESIDENTIAL PROGRAMS (RES-27)

PROGRAM TITLE: Superinsulated Housing Demonstration Program

PROGRAM SPONSOR: City of St. Louis

PROGRAM OBJECTIVES: To explore the use of superinsulation as standard practice in the housing industry, both for new construction and rehabilitation; to facilitate the introduction of radically new, energy-efficient construction principles into residential buildings; and to demonstrate that superinsulation is a highly effective means of residential energy conservation which could be employed in a cost-effective manner in the local climate.

APPROACH: The demonstration program constructed 30 superinsulated housing units of a variety of types (15 apartments and 3 single-family houses rehabilitated, and 12 new townhouses). These units would be test cases to adapt Canadian and European superinsulation standards to a midwestern U.S. climate. The superinsulated units were characterized by maximum wall (R-41) and ceiling (R-63) insulation, multiglazed windows, air-tight construction using a continuous air-vapor barrier, stringent weatherstripping and strategies to tighten windows, and the use of air-to-air heat exchangers for ventilation (0.3 air changes per hour natural ventilation) and heat recovery from exhaust air. The incentive package given to developers consisted of financial (see below), technical, and marketing assistance.

Technical assistance included plan review, computer based calculations, design modifications, training of construction supervisors, and on-site problem solving. After candidate developers were selected, technical assistance was given to upgrade the architectural design of the targeted projects to superinsulation standards. Several new products were introduced into the St. Louis market including a high-density, sprayed-in-place cellulose insulation material, several brands of air-to-air heat exchangers, foam-core stress skin panels, and state-of-the-art HVAC systems.

TARGET BUILDING TYPES: Single-family and multifamily

KEY PARTICIPANTS: City of St. Louis and builders

HISTORY:

Date of Implementation: 1984
Current Status: Continuing
General Comments: The City of St. Louis has been working on demonstration projects with homebuilders and developers since 1983. Prior to this demonstration program, as part of its Rehab 2000 program, a single-family house was rehabilitated with state-of-the-art concepts to demonstrate its feasibility and energy reduction. They estimated a 85% reduction in space heating costs and a 76% reduction in cooling costs. This project also developed software for energy optimization analysis in prospective superinsulation projects.

MARKETING/PROMOTION METHODS: One-half of the incremental cost of the superinsulation improvements was provided by the City of St. Louis. Open houses were held, and brochures and other types of publicity were produced.

MONITORING/EVALUATION: One-year monitoring of utility bills is being conducted.

Market penetration: 30 units constructed; they plan to construct another 100 superinsulated homes this year.

Savings:
- Energy:
- Peak:
- Dollars: Superinsulated housing has the potential to be 50% less expensive on a life-cycle cost basis, with cumulative direct savings to the individual homeowner in the range of $40,000 to $50,000.

Costs and cost-effectiveness:
- Program administration:
- Incentives:
- Private investment:

Other effects: Affordability of homes was increased.

Discussion:

The backing of the developer was critical in successfully modifying a project to the extent undertaken in this project. The analysis and preliminary monitoring have shown that superinsulation is feasible and highly cost-effective in a midwestern climate. The technology was found to be attractive to those in the housing development community. The City has now incorporated language on energy performance in its guidelines for public subsidy funding for housing (see below).

Early in 1986, the City of St. Louis implemented mandatory energy standards for all for-sale and rental properties that utilize seed monies from HUD Community Development Block Grant (CDBG) funds. The standard affects about 1,400 housing units built annually in the City. The development of these standards required the energy savings in the first year to pay the increase in mortgage costs of the energy package. The mandatory energy standards represent a 20-25% reduction in heating and cooling costs over conventional construction practice in St. Louis. An upgraded package, promoted on a voluntary basis by the City, improves chances for project funding with the CDBG funds but is not mandatory. The second stage of measures, approaching superinsulation, targets reductions of 50% over conventional energy costs.

In instituting a superinsulated housing program, the cooperation or active support of a municipality is key to overcoming builder resistance. The strong participation of the public entity can also provide a central coordination to facilitate a dialogue between all members of the building community.

The success of any technology transfer program is tied to long-term results. After the demonstration phase, it is important to have some on-going mechanism to encourage adoption of the new technology. Other approaches may involve loans or grants as an incentive, adoption of energy standards as part of the building code, and the use of marketing incentives such as certified homes to highlight projects utilizing superinsulation.

RELATED PROGRAMS:

REFERENCES: Energy Task Force of the Urban Consortium, 1985; Sackett and Bollinger, 1986.

CONTACTS:

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DATE: June 24, 1988

Name: Jim Sackett
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DATE: Oct. 30, 1987

NEW RESIDENTIAL PROGRAMS (RES-28)

PROGRAM TITLE: Energy Efficient Housing Demonstration Project

PROGRAM SPONSOR: City of Baltimore's Department of Housing and Community Development (DHCD) and the Maryland Department of Housing and Community Development (MD DHCD)

PROGRAM OBJECTIVES: To demonstrate and disseminate information on the benefits of energy-efficient housing in Baltimore; and to demonstrate that energy-efficient homes can be built at lower construction/operation costs than today's conventional housing.

APPROACH: The demonstration program is planning to construct and/or rehabilitate 115 housing units, grouped within the City's 79 square miles. A task force will be set up to develop the energy-efficient standards for development. Construction will start in Fall 1988. The demonstration program will encompass as many building technologies and types as possible, and will include site-built construction as well as factory-built construction. Computer-aided design assistance will also be provided.

TARGET BUILDING TYPES: Single-family and multifamily

KEY PARTICIPANTS: DHCD, MD DHCD, neighborhood organizations, and non-profit housing groups.

HISTORY:

Date of Implementation: 1987
Current Status: Continuing (two year project; ends in Aug. 1989)

General Comments: The DHCD is the project manager. The work plan of this project is being developed.

MARKETING/PROMOTION METHODS: Housing assistance will be provided. There will be conferences, workshops, building seminars, and open houses for inspection by the housing industry, contractors, and the consumer.

MONITORING/EVALUATION:
They are planning to monitor energy usage and indoor air quality for at least two years after construction. Blower door testing and quality control inspections will be conducted.

Market penetration: 115 units expected as part of demonstration program

Savings
- Energy:
- Peak:
- Dollars:

Costs and cost-effectiveness: They received $500,000 from the Maryland Energy Overcharge Restitution Trust Fund to fund the project.
- Project administration:
- Incentives: grant program
- Private investment:

Discussion: The project is just starting.

RELATED PROGRAMS:

REFERENCES: "An Energy Efficient Housing Demonstration Project," grant proposal by DHCD.

CONTACTS:

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DATE: Dec. 16, 1987

Name: Dave Brosch
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DATE: Dec. 17, 1987 / May 26, 1987

NEW RESIDENTIAL PROGRAMS (RES-29)

PROGRAM TITLE: Energy Saver Manufactured Home Award Program

PROGRAM SPONSOR: Arkansas Power and Light (AP&L)

PROGRAM OBJECTIVES: To sell more electricity through the promotion of heat pumps in energy-efficient manufactured housing.

APPROACH: This program was a performance certification program where the manufacturer certified that the home met AP&L's thermal performance standards. These standards were based on a 40% improvement over the minimum thermal performance standards and the installation of a properly-sized, high-efficiency heat pump (minimum SEER of 8.0). The manufacturers were free to meet the energy standards in any least cost manner, but they usually included R-13 wall insulation, R-20 ceiling insulation, R-19 floor insulation, and insulated windows (single storm window placed on inside of window) and doors. Energy Saver agreements were made with manufacturers and dealers.

TARGET BUILDING TYPES: Manufactured homes.

KEY PARTICIPANTS: AP&L, Arkansas Manufactured Housing Association, manufacturers, dealers, and consumers.

HISTORY:

Date of Implementation: 1982
Current Status: Stopped promoting program in 1987.
General Comments: AP&L believes the dealers are the key participant in the consumer decision process. There are other utilities in the area promoting energy-efficient manufactured homes (there are 18 electric cooperatives in Arkansas). About 15% of new homes in area are manufactured homes.

MARKETING/PROMOTION METHODS: A seal was affixed to the electrical panel of the home saying that it was certified. Initially, in addition to advertising the program for manufacturers, co-op advertising was conducted with dealers: a cooperative advertising allowance of $300 was given to any dealer who inventoried at least two Energy Saver homes at the start of the dealer's program participation, and an additional cooperative advertising allowance of $150 was offered to dealers for each Energy Saver home sold and sited in the AP&L service area. The dealer must have had at least one Energy Saver home on the sales lot at the time advertisements were placed. The allowance applied only to radio and print advertisements. These incentives were stopped in 1986 and replaced by another incentive: $200 was given to dealers if they had sold a manufactured home to one of AP&L's customers.

MONITORING/EVALUATION: From 1982 to 1986, three heat pumps were monitored.

Market penetration: At least 50 homes out of about 2,000 homes (2%).

Savings:
- Energy: Heating and cooling energy use was 50% less than a conventionally built home (of comparable size, but without energy-saving features).
- Peak: Peak loads have been shaved: in these homes, 2- to 2.5-ton heat pumps were required, in contrast to 3- to 3.5-ton heat pumps in conventional homes.
- Dollars:

Costs and cost-effectiveness: Approximately $2700 is added to the price of the home (energy package: $1008; heat pump: $1654 (the cost of the heat pump was $500, net of strip heating and air-conditioning)
- Program administration: $95,000
- Incentives: $5,000
- Private investment: None
- Cost-effectiveness: 5 year payback

Discussion:

Hendrickson noted that dealers found the price increase hard to sell, and AP&L encouraged dealers to promote these homes by saying that air-conditioners were not needed, saving the consumer about $1500. Another problem was dealer resistance to inventoring the heat pump equipment, which was time consuming, space consuming, and expensive. AP&L approached this problem by investigating the possibility of allowing the dealer to arrange the heat pump installation at the home site through local vendors. AP&L had some success with an institutional and co-op advertising program, and consumer awareness of the program was high. The problems experienced by the dealers were blamed for the minimal program success to date.

Conn noted that the promotion of the program ended because it was not as cost-effective as promoting heat pumps in conventional housing. In addition, manufacturers were not stocking this type of manufactured home. Also, as noted above, the dealers were resistant to the program because they wanted more incentives to sell the homes. These homes cost more than non-energy-efficient manufactured homes, and the dealers could not justify the extra costs to the low-income consumers who were the principal buyers of these homes. These homebuyers were more interested in the initial cost than the lifecycle cost and could not understand the benefits of a 3 to 5 year payback or of spending an additional upfront cost of $2,000. They had also heard too many negative stories about energy conservation and were, therefore, gun shy. Thus, there is a need to educate the public (especially low-income people with little education) and the dealers. AP&L tried to educate the dealers, but they backed out at the end. Other utilities ran into the same problems.

Conn noted that there have not been any problems with the homes that have been sold. Everyone appears to be satisfied with their comfort and energy savings. He thought the program worked and was an excellent one, but it cost too much to administer it.

RELATED PROGRAMS:

REFERENCES: Hendrickson *et al.*, 1985.

CONTACTS:

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DATE: Jan. 13, 1988 / June 28, 1988

NEW RESIDENTIAL PROGRAMS (RES-30)

PROGRAM TITLE: Affordable Comfort in Manufactured Housing

PROGRAM SPONSOR: North Carolina Alternative Energy Corporation (NCAEC)

PROGRAM OBJECTIVES: To demonstrate that energy efficiency in manufactured homes can be successfully marketed to prospective home buyers.

APPROACH: A marketing demonstration project was conducted to: (1) demonstrate that home buyers want, and will buy, energy-efficient manufactured homes, (2) develop a proven sales kit for retailers of these homes, (3) market the energy efficiency available in these homes, (4) achieve a significant improvement in penetration of an enhanced insulation standard and heat pumps in new manufactured homes, and (5) promote a consensus standard for energy-efficient manufactured homes that is recognized by all utilities in the state. There were three phases to this project. The first phase, gathering information, was carried out through surveys of recent manufactured home buyers in the test market area and the manufactured home retailers who service that area. Fifteen hundred surveys were sent to customers in the EMC service area. Some of the results from the consumer survey were used to develop a subsequent retailer survey. In the second phase, the following marketing tools were designed: consumer and retailer education, advertising, point-of-sale information, and retailer incentives. In the third phase, the demonstration program was implemented. In this program, $100 rebates were offered to customers for purchasing an energy-efficient manufactured home.

TARGET BUILDING TYPES: Manufactured homes

KEY PARTICIPANTS: Alternative Energy Corporation, the state manufactured housing industry trade group, an Electric Membership Cooperative (EMC), consumers, and retailers.

HISTORY:

Date of Implementation: Spring 1987
Current Status: Ended after 6 weeks (marketing & promotion was scheduled for only 6 weeks).
General Comments: In North Carolina, 10% of the population currently lives in manufactured homes. Across the state, manufactured homes have represented 30% of the new single-family homes for the last several years. More than 50% of new utility connects in rural North Carolina are for manufactured homes. The most significant finding of an earlier building simulation project was that either added insulation or heat pumps could save 30% annual energy use in manufactured homes. The state's investor-owned utilities (IOU's) currently promote an enhanced insulation package; however, these homes penetrate only 20% of the new manufactured home market within the IOU's territory. Outside the IOU territory, the penetration is less than 10%. Heat pumps, which are not heavily promoted in manufactured housing (due to their capital cost) by any North Carolina utility, capture only 6% of the market. The project also identified significant barriers preventing energy-efficient options of any kind from entering into the market: retailers and consumers do not believe the benefits of the energy-efficient home, retailers lack sales tools that they will use, no consensus exists among the utilities for an energy-efficient standard, and manufactured housing is an excessively cost-competitive industry.

MARKETING/PROMOTION METHODS: Consumer and retailer education, advertising (television and weekly newspapers), point-of-sale information, direct mail to people who lived in manufactured housing, personal calls to dealers, bill stuffers, brochures,

and $100 rebates to customers purchasing an energy-efficient manufactured home.

MONITORING/EVALUATION:
A marketing consultant is in the process of evaluating the program, and a report is expected to be completed by the end of July 1988.

Market penetration: Only 5 rebates given.

Savings:
- Energy: 30% of annual electricity use, compared to typical home bought
- Peak: Unknown, probably none
- Dollars: $228/year/home

Costs and cost-effectiveness:
- Program administration: $78,900
- Incentives: $500
- Private investment: $20,000

Discussion:
Very low participation levels were obtained. He's not sure why participation was so bad, but believes dealers may not have been 100% behind the program. NCAEC will not continue the program.

RELATED PROGRAMS: Other manufactured housing programs: Bonneville Power Administration (super insulation package), U.S. Department of Energy (slide rules), Florida Solar Energy Agency (infiltration measurements), Tennessee Valley Authority (installation of heat pumps inside mobile homes: makes it more likely that heat pumps will be used, than if the owners had to install heat pumps themselves), and Santee Cooper (an electric cooperative in South Carolina that is attempting to develop a consensus energy-efficient standard for new manufactured housing; all utilities will comply with a thermal standard for the shell; this will make life easier for manufactured home retailers and manufacturers). NCAEC's program is the only program that directly deals with marketing issues.

REFERENCES: Conlin and Paulos, 1986.

CONTACTS:

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DATE: Nov. 16, 1987 / July 7, 1988

NEW RESIDENTIAL PROGRAMS (RES-31)

PROGRAM TITLE: SolarSave Program

PROGRAM SPONSORS: Maine Office of Energy Resources and the Maine State Housing Authority

PROGRAM OBJECTIVES: To reduce energy use and costs in manufactured homes through application of simple passive solar construction and siting practices, relying on the private market and voluntary consumer participation.

APPROACH: In the Fall of 1984, 10 energy-efficient manufactured homes were built by two manufacturers participating in the program. The State of Maine awarded grants of $2,828 to qualified consumers to purchase these homes (as part of a contest). Residents had to have incomes of $28,000 per year or less to compete, and needed to certify their income levels and to obtain financing commitments. The winners were expected to make available one year of energy records and to open their homes to the public during specific periods of the marketing program. The homes had to have 80% of the glazed surface of the home facing south. Only 4 of these homes were sold and correctly sited.

TARGET BUILDING TYPES: Manufactured homes.

KEY PARTICIPANTS: Maine Office of Energy Resources, Maine State Housing Authority, dealers, manufacturers, and consumers.

HISTORY:

Date of Implementation: 1984
Current Status: Ended in 1986
General Comments: The program was formerly called the "Energy-Efficient Manufactured Home Program."

MARKETING/PROMOTION METHODS: An amount of $2,828 was given to owners of the homes; this amount paid for the cost of the energy upgrade of the home. The program was marketed twice: in the Winter and in the Spring.

MONITORING/EVALUATION:

Market penetration: 10 homes were built, and 4 were sold in this demonstration program.

Savings

- Energy: 30% fuel savings estimated
- Peak:
- Dollars:

Costs and cost-effectiveness

- Program administration:
- Incentives: $10,744 (Federal Solar Bank Funds)
- Private investment: unknown, but private financing of solar heating systems were required per federal regulations
- Estimated payback period: varied from 5 to 20 years, depending on assumptions for standard construction and fuel escalation.

Discussion:

Hendrickson noted that the lower than expected sales were due to two reasons: (1) the program was first introduced in December with minimal promotional efforts directed to consumers and after the main selling season; and (2) the lack of training and education among dealers about energy efficiency and energy-saving equipment. In response, educational programs for both dealers and manufacturers were held and were considered one of the program's success.

Hoeh noted several problems with the program. First, the potential homebuyers of these homes were not concerned with energy efficiency, especially passive solar designs. Second, dealers, the important middle persons between the manufacturers and consumers, were usually "mom and pop operations" that didn't market the program or cooperate with the program sponsors. Moreover, they often added markup costs to the homes so that the sponsors could not guarantee what the retail costs of the homes would be nor could they guarantee paybacks. And finally, HUD's regulations for the Solar Bank Program were too complex, detailed, and virtually unworkable. For example, HUD's glazing ratios were inappropriate for northern climates, leading to heating problems in manufactured homes. Also, HUD required these funds to be used to reduce the principal of loans; therefore, those people who wanted to buy a manufactured home without a loan were not eligible for this program.

RELATED PROGRAMS:

REFERENCES: Hendrickson *et al.*, 1985.

CONTACTS:

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DATE: Jan. 27, 1988 / May 26, 1988

NEW RESIDENTIAL PROGRAMS (RES-32)

PROGRAM TITLE: Residential Construction Demonstration Project for Manufactured Homes

PROGRAM SPONSOR: Bonneville Power Administration (BPA)

PROGRAM OBJECTIVES: To determine the cost to upgrade and the energy savings of manufactured homes through the design, construction, and testing of energy-efficient manufactured homes built to a standard equal to that required of site-builders in the region; and to establish a process for qualifying and certifying Super Good Cents (SGC) manufactured homes.

APPROACH: About 150 manufactured homes should be built to the high energy standards already required of site-built homes under the Northwest Power Planning Council's standards. These homes are marketed under the SGC Program (see below). In response to a Request for Proposals (RFP), at least five manufacturers have agreed to participate in the project, to build and deliver a home that meets or exceeds the Model Conservation Standards (MCS). The homes should be placed on their sites by August 1989.

Each state energy office manages and implements the demonstration program in their state. Each office provides a variety of support to manufacturers, dealers, SGC utilities, and homebuyers. The assistance includes: design assistance, technical assistance, an inspection program, dealer training, and SGC utility and homeowner assistance as needed.

TARGET BUILDING TYPES: Manufactured homes.

KEY PARTICIPANTS: BPA, state energy offices, dealers, manufacturers, and homebuyers.

HISTORY:

Date of Implementation: Jan. 1988
Current Status: Continuing
General Comments: The targeted homes are homes constructed under the Federal Manufactured Homes Construction and Safety Standards (FMHCSS). This demonstration program is part of BPA's Residential Construction Demonstration Program (see writeup). BPA also created the Energy-Efficient Manufactured Housing Test and Marketing Program to encourage the design, construction, and purchase of HUD Code homes which are built to the levels of the MCS. The program consists of five parts: performance tests (see below), market analysis, development of a market plan, promotion of the manufacture and sale of energy-efficient manufactured homes under BPA's SGC Program, and public/private involvement. The SGC Program, sponsored by electric utilities and BPA, promotes the construction of energy-efficient new homes in the Pacific Northwest. The Program funds advertising, marketing, and training, plus an incentive payment to the builder or the buyer of each home built and certified as SGC. BPA provides cooperative advertising funds to utilities to conduct their own local campaigns. BPA also conducts a regionwide mass media advertising campaign.

MARKETING/PROMOTION METHODS: From $2,000 (in zone 1, the warmest climate zone) to $3,000 (in zone 3, the coldest climate zone) will be given to the manufacturer; from $1,000 (zone 1) to $1,500 (zone 3) to the homebuyer; and from $2,000 (zone 1) to $3,000 (zone 3) to dealers and homebuyers for the monitoring activities. The homeowner/occupant receive $300 for participating in the monitoring portion of the project.

MONITORING/EVALUATION:
These homes will have their space heating, water heating, and total energy use monitored for one year. Monitoring will begin in the fall of 1988. In addition, case studies of manufacturers' and dealers' experiences, occupant surveys, and radon monitoring (on a voluntary basis) will be conducted. Design and cost data will also be collected.

Market penetration: 150 homes are planned as part of demonstration project (5 homes have already been built). Five of the 17 regional manufacturers are participating in the project.

Savings
- Energy:
- Peak:
- Dollars:

Costs and cost-effectiveness
- Program administration:
- Incentives:
- Private investment:

Discussion: The program is just starting. BPA is getting a high level of interest from regional dealers, especially those that participated in BPA's training sessions.

RELATED PROGRAMS: Previously, in 1985, BPA, under an interagency agreement with the Tulalip Indian Tribes, had 34 manufactured homes built to the MCS standard and sited them in Marysville, Washington, about 50 miles north of Seattle. BPA paid for the upgrade of the homes to meet the MCS standard (Super Good Cents standard) so that BPA could monitor the homes. The homes were built to meet BPA's climate zone 1 energy use criteria. HUD's manufactured homes were exempt from state and local codes. The purpose of the program was to get information on the cost and energy savings of Super Good Cents standards in manufactured homes. The homes are being monitored for space heat, domestic water heat, and total energy use. One year's worth of energy data has been collected and is presently being analyzed. The results will be compared to a subsample of 600 manufactured homes in the Hood River area. The cost paid to upgrade the Tulalip Homes was based on material cost only and ranged from $1.66 per sq. ft. for 4-bedroom homes to $1.95 for 2-bedroom homes; customer costs would have ranged from $3.68 per sq. ft. to $4.32 per sq. ft. (includes markup), respectively, if the same homes had been purchased by the consumer.

BPA also contracted with a manufacturer to construct and deliver five HUD code homes built to the same MCS specifications as required for site-built homes. The manufacturer was instructed to comply with the MCS specifications at the lowest possible cost. Estimated energy savings ranged from 3.55 kWh per sq. ft. in climate zone 1 to 7.15 kWh per sq. ft. in climate zone 3. Customer cost (material cost plus markup) would have ranged from $4.66 per sq. ft. to $6.67 per sq. ft. if they had been purchased through normal channels.

REFERENCES: Pacific Northwest Utilities Conference Committee, 1987; S. Onisko, 1985, 1986; B.L. Mohler and S.A. Smith, 1986; and "Residential Construction Demonstration Project: Manufactured Housing Update," factsheet prepared by BPA, 1988.

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DATE: Jan. 8, 1988 / May 27, 1988

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DATE: Jan. 8, 1988

NEW RESIDENTIAL PROGRAMS (RES-33)

PROGRAM TITLE: Energy-Qualified (EQ) Home Program

PROGRAM SPONSOR: Owens-Corning Fiberglas (OCF) Corporation

PROGRAM OBJECTIVES: To promote energy efficiency in manufactured housing.

APPROACH: This program uses the Energy Performance Design System (EPDS) computer program to estimate the energy needed for heating and cooling a manufactured house and to estimate the operating costs of the heating and cooling systems (energy used by lights, water heater, and other appliances are not estimated). Energy targets are developed for a certain type of manufactured house in a particular climate zone (there are three climate zones, based on HUD's thermal zones); there are as many targets as there are combinations of house types and climate zones. Prototypical homes are examined and a package is put together for each prototype. If a house is designed to meet a certain package, then it's an EQ house. Individual house plans are not reviewed, and there are no inspections: once designated as an EQ house, the contractor has a legal requirement to build to the standards and to use Owen-Corning insulation.

TARGET BUILDING TYPES: Manufactured homes.

KEY PARTICIPANTS: Owens-Corning Fiberglas, dealers, manufacturers, and consumers.

HISTORY:

Date of Implementation: 1980
Current Status: Continuing
General Comments: The program has evolved technically, but the marketing approach has remained the same. The first version of the EPDS was a manual; the third and last technical version was the incorporation of regression equations into a sophisticated software program (EPDS). EQ Homes is not a program that professes to educate or train in the area of quality of construction. Hendrickson noted that this program is probably the single, most widely accepted and utilized energy conservation marketing program in the manufactured home industry today.

MARKETING/PROMOTION METHODS: This program is marketed through the national OCF's sales force, and the primary focus of the program is at the retail level through dealers. The EQ program provides dealers with selling tools and advertising support to aid their sales efforts. The principal promotional and sales incentives include outdoor EQ billboards, banner displays, newspaper advertisement kits, customer literature and literature displays, a flip chart presentation for potential buyers, open house brochures, buttons, T-shirts, pens, hats, etc.. For each EQ home sold, dealers receive 100 to 600 points that can be redeemed for prizes. Participating dealers also receive a commemorative plaque and official EQ certificate, and local media are notified. Member dealers believe that the combination of advertising and cost/savings information is the key to the program's success. Participating manufacturers also receive a commemorative plaque and official EQ certificate, with local media notification. Manufacturers with their own dealer network are used by OCF as an agent through which the EQ program is administered. For consumers, a $100 rebate is available at specially designated times with the purchase of an EQ home. An EQ Home Certificate is given to the consumer at the time of sale.

MONITORING/EVALUATION:

Market penetration:

Savings:
- Energy:
- Peak:
- Dollars:

Costs and cost-effectiveness:
- Program administration:
- Incentives:
- Private investment:

Discussion:
Hendrickson noted that this program has met with acceptance and success. However, he noted that one potential drawback of this kind of program is the consumer's perception of information source credibility. OCF has a vested interest in selling energy efficiency (insulation), and dealers have vested interests in selling upgrade packages (profits). However, dealers claim that the consumer is well educated on the value of energy efficiency and respects the credibility of OCF. Thus, these concerns have not become a hindrance to sales.

RELATED PROGRAMS: The EPDS is also used in OCF's Thermal Crafted Home Program (see writeup) for site built homes.

REFERENCES: Hendrickson *et al.*, 1985; Oberg and Jacob, 1984; Owens-Corning Fiberglas Corporation, *Energy Performance Design System (EPDS): The Computer Program Support Manual*, 1983; Owens-Corning Fiberglas Corporation, *Energy Performance Design System: Thermal Crafted Home Plan Analysis Guide*, 1983; Owens-Corning Fiberglas Corporation, *Energy Performance Design System (EPDS): The Reference Manual*, 1983; Owens-Corning Fiberglas Corporation, "Legal Considerations Regarding the Thermal Crafted Homes," brochure, 1983; Design System (EPDS): The Reference Manual, 1983; and Ek, 1983. There are also numerous articles published on the testing of the EPDS.

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DATE: Nov. 11, 1987 / June 28, 1988

NEW RESIDENTIAL PROGRAMS (RES-34)

PROGRAM TITLE: Alaska Craftsman Home Program (ACHP)

PROGRAM SPONSOR: Alaska Department of Community and Regional Affairs

PROGRAM OBJECTIVES: To encourage builders to go beyond state standards in new houses (i.e., promote energy efficiency) and to build high quality homes; and to create a market for better built and more affordable homes.

APPROACH: The ACHP is an educational/information network designed to keep the building industry in tune with technological advances. The Alaska Office of Energy Programs and the University of Alaska cooperate to educate homebuilders on proven methods of reducing the thermal requirements of a residence. The program sets goals for performance rather than prescribing specific designs or standards. Criteria include: thermal requirements for the building envelope based on local climate and energy costs, blower door tests to ensure minimal air leakage, controlled ventilation systems to ensure adequate air quality, and energy-efficient lighting and appliance requirements.

The program selected 24 builders from around the state to take part as volunteer regional trainers. These individuals came to the program with a vast array of expertise in building homes in Alaska and received an extensive training effort on the latest state-of-the-art superinsulated building technologies. They then returned to their regions to train other builders and serve as resource persons for their regions. ACHP houses are expected to be built during 1988. No funds are provided for actual construction, nor are there any monetary incentives.

TARGET BUILDING TYPES: Single-family.

KEY PARTICIPANTS: Alaska Department of Community and Regional Affairs, the University of Alaska Cooperative Extension Service, the Alaska State Homebuilders Association, and builders.

HISTORY:

Date of Implementation: 1986
Current Status: Continuing.
General Comments: This program is a voluntary program that was set up to go beyond the state energy code. The minimum requirement for this program represents the optimum standard that was examined in the process of developing the state code. New residential standards will go into effect Oct. 1, 1988.

MARKETING/PROMOTION METHODS: Training workshops. Limited marketing, so far: posters, fliers, yard signs, radio spots, and newspaper display ads. A vastly increased marketing effort is expected in FY 1989.

MONITORING/EVALUATION:
In late October 1987, the program was informally reviewed to see what's been learned, what changes were needed, and how to revise the handbook for meeting the Alaska Craftsman Home Standard. An evaluation is planned for FY 1989.

Market penetration:

Savings:

- Energy: Estimate 80% savings compared to conventional (pre-energy standard houses).
- Peak:
- Dollars: Depending upon state region, estimated savings range from $450 to $2800 per house per year for heating savings alone.

Costs and cost-effectiveness:

- Program administration: $228,000 for 1988, $300,000 for 1989.
- Incentives:
- Private investment: Over 10,000 hours of time volunteered by professionals of the building industry so far; there is no direct financial support by the private sector.

Discussion:

Too early to say anything definitive. The program received a National Award for Energy Innovation in 1987.

RELATED PROGRAMS: There is a voluntary home energy rating and labelling program in Alaska, the Energy Rated Home (ERH) Program. The ERH is basically a financial "bridge" to help people go from conventional housing to energy-efficient housing by shifting homeowner costs from energy to the mortgage.

REFERENCES: *Conservation Update*, March 1987; U.S. Department of Energy, *National Awards Program for Energy Innovation: Award Winners 1987*, Washington, D.C., 1987.

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DATE: June 1, 1988

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DATE: Oct. 23, 1987

NEW RESIDENTIAL PROGRAMS (RES-35)

PROGRAM TITLE: Building Industries Short Course

PROGRAM SPONSOR: Arizona Department of Energy

PROGRAM OBJECTIVES: To provide energy conservation information to targeted audiences: real estate people, builders, and apartment managers.

APPROACH: Two to five workshops are held each year; they are one-half day seminars geared for real estate people (topics include home financing, and the Fannie Mae and Freddie Mac programs), builders (topics include information on the latest energy and building technologies, energy-efficient appliances, house orientation, and shading techniques), and apartment managers (topics include the retrofit of existing apartments, and information on how to understand utility bills and demand rates).

TARGET BUILDING TYPES: Single-family and multifamily.

KEY PARTICIPANTS: Arizona Department of Energy, builders, real estate people, apartment managers, and their respective organizations.

HISTORY:

Date of Implementation: 1982
Current Status: Continuing.
General Comments:

MARKETING/PROMOTION METHODS: Mailing lists of targeted groups are used for notification of workshops; news releases.

MONITORING/EVALUATION:

A survey was sent out 18 months ago to workshop participants. A positive response to the program was obtained from the survey returns. The program has been very successful with apartment managers who have told the Energy Office that the workshops have directly impacted their activities. It is much harder to estimate the impact of the program on builders of new homes.

Market penetration: There have been an average of 30-40 participants at the workshops for apartment managers.

Savings:

- Energy:
- Peak:
- Dollars:

Costs and cost-effectiveness:

- Program administration:
- Incentives:
- Private investment:

Discussion:

The program is worthwhile. Because there is no statewide building code in Arizona, the Energy Office has to convince builders to build energy-efficient homes. It is difficult to isolate the energy consumption impacts of this program from other

programs. For example, the Arizona Energy Office has been promoting high efficiency cooling units; at the same time, the two major utilities in the Phoenix area keep increasing the efficiency (SEER) of their cooling equipment and are using incentives to promote their program.

RELATED PROGRAMS:

REFERENCES:

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DATE: Oct. 23, 1987 / June 22, 1988

NEW RESIDENTIAL PROGRAMS (RES-36)

PROGRAM TITLE: Residential Class B Passive Solar Performance Evaluation Program

PROGRAM SPONSOR: U.S. Department of Energy (DOE)

PROGRAM OBJECTIVES: To support passive solar building research by determining consistently the thermal performance of new passive buildings of several different types and in different climates using a low-cost approach.

APPROACH: The Class B monitoring program was a low-cost program that evaluated the thermal performance of a large number of new and existing, passive solar residential buildings throughout the country. Instrumentation was limited to that needed to calculate the monthly building energy balance, separating the heating load into passive, auxiliary, and internal heating requirements. The 1981-82 heating season was the first year of Class B data collection that continued through the winter of 1982-83.

Instrumentation began in 1981, and at that time, the Solar Energy Research Institute (SERI) was to coordinate the national program, and the Regional Solar Energy Centers were to oversee the operation of the monitored sites in their regions. More than 60 buildings were instrumented to some degree. However, the Centers closed at the end of 1981, and SERI then assumed the supervision of as many of the sites as possible. The Class B results represent the world's largest body of consistently collected data on passive solar houses.

TARGET BUILDING TYPES: Single-family

KEY PARTICIPANTS: DOE, SERI, building researchers, design professionals, builders, and heating engineers.

HISTORY:

Date of Implementation: 1978
Current Status: Data loggers were pulled out in 1984/85.
General Comments: DOE's Performance Monitoring and Evaluation Program established three levels of monitoring in the late 1970s: (1) Class A - to examine heat transfer processes, develop and validate algorithms, and analyze new materials and component performance in full-scale facilities; (2) Class B - to determine passive solar contribution to space-conditioning requirements; and (3) Class C - to determine overall building thermal performance and occupant satisfaction. Class A monitoring was performed in 4 unoccupied buildings, Class B involved about 100 occupied homes, and Class C, although intended for 2000 occupied homes, actually included only 421.

SERI is developing a less expensive Class B monitoring system. Short-term tests are being used to obtain key parameters of building efficiency so that long-term performance can be extrapolated from the short-term results.

MARKETING/PROMOTION METHODS: The program was promoted at conventions and conferences. There was a large industry involvement with the National Association of Home Builders and the Passive Solar Industries Council in transferring the results of the program to the builder community.

MONITORING/EVALUATION:

A central feature of Class B monitoring was that it used on-site data processing and displayed performance results using a standardized microprocessor data acquisition system (DAS). Off-site processing of the monitoring results included such elements as regression analysis and comparative analysis of data from different sites. Data were received on up to 22 channels every 15 seconds, and channel averages were stored on cassette tape every hour. These data were later transcribed to a mainframe computer system at SERI. In addition, daily and monthly performance factors were calculated in real time and then printed and stored on a daily basis. Physical and thermal characteristics of the building, such as furnace efficiency and solar aperture area, were measured at the beginning of the monitoring period and stored in the microprocessor software.

Continuous measurements included horizontal and vertical solar radiation, outdoor temperature, indoor temperature in up to five different zones, status of insulating shutters, and all purchased-energy quantities including space heating, hot water, air conditioning, fans, lights, and appliances. Real-time calculations included the major energy flows in the building: heating load, purchased space heating, water heating, internal heating, and solar heating.

Initially, 69 houses were selected to be monitored by SERI out of the 400 houses that were monitored in the Class C monitoring program. Class C monitoring involved noninstrumented energy performance evaluations based on occupant surveys, billing data, and audits. SERI reported on 40 buildings in their first report (see references). For the 1982-83 heating season, 40 buildings were instrumented.

For the 1980/81 heating season, individual summaries for each of 40 homes were presented in a SERI report (see references). Each summary included a description of the building, its thermal characteristics, the measurements taken, and the building's thermal performance. Major findings of this report are described below.

Market penetration: 94 passive solar homes were monitored in this program: the SERI/DOE Class B Program handled 70 and the Bonneville Power Administration Class B program covered 15; utilities, researchers, and designers working without DOE or SERI support accounted for the rest.

Savings

- Energy:
- Peak:
- Dollars:

Costs and cost-effectiveness: The cost of the passive solar homes, excluding land costs, ranged from $30 to $85 per square foot. Conventional homes of identical floor area built in the same locations in the same year were estimated to cost from $40 to $70 per square foot.

- Program administration:
- Incentives:
- Private investment:

Discussion:

Swisher analyzed 12 houses in the Denver metropolitan area and noted the following: (1) those buildings with relatively low heat loss coefficients used less auxiliary heat and made more efficient use of solar gains than those with large glazing areas and high losses; (2) operable solar components, such as thermostatically-controlled fan systems and moveable insulation, were critical to building performance, especially in houses with

large glazing areas; and (3) designers should emphasize simplicity and convenience in manual components and reliability in automatic components.

Swisher and Cowing and Holtz *et al.* observed that (1) these buildings had low auxiliary heating needs, generally 50% to 75% less than conventional homes; (2) the energy saving effects of insulation and weatherization were critical; (3) although the solar performance was quite variable, the passive solar systems contributed an average 37% of the total heating load, or 55% of the net heating load (the total load minus internal gains); and (4) the habits of the building's occupants in operating their building were critical to passive system performance (this was especially true to the use of operable components such as insulation, sunspace doors, and vents). Holtz *et al.* also noted that all three passive systems (direct-gain, sunspace, and thermal storage wall) performed about the same.

According to Holtz *et al.*, the key lessons learned from this program were: (1) build conservation into the design from the start; (2) size the solar aperture for year-round performance (most passive solar designs were overglazed, leading to overheating problems); (3) keep passive designs (architecture and mechanical systems) simple; (4) design the house and its mechanical systems as a whole, not two separate systems; (5) put thermal mass where it will work; (6) interior design should help heat and circulate air; and (7) design movable insulation for fail-safe operation, or choose triple or high-efficiency glazings instead.

Holtz thought that the program was technically very successful in applying a consistent methodology in evaluating the performance of passive solar homes. He also thought the first generation of passive solar homes worked very well. However, he was personally disappointed in that one of the objectives of the program was to track the performance of passive solar homes over time. The homes that were monitored were built in the late 1970s. The Class B methodology could have been used to track the state-of-the-art homes, but this was not done.

RELATED PROGRAMS: The Class C performance monitoring approach attempted to determine as much as possible about the performance of a large number of single-family passive solar homes, both new and existing. Information on overall performance and owner satisfaction was gathered through technical and nontechnical audits administered by trained auditors. Data were collected for 335 homes across the country in 1979-80. The results are summarized in the SERI (1986) report.

REFERENCES: Joel N. Swisher, "Measured Passive Solar Performance from New Residences in Denver, Colorado," in Jeff Harris and Carl Blumstein (eds.), *What Works: Documenting Energy Conservation in Buildings*, pp. 212-224. ACEEE Proceedings, 1984; Swisher and Cowing, 1983; Solar Energy Research Institute, 1986; and Holtz *et al.*, 1985.

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DATE: Jan. 8, 1988 / May 26, 1988

NEW RESIDENTIAL PROGRAMS (RES-37)

PROGRAM TITLE: Residential Solar Access Protection Program

PROGRAM SPONSOR: City of Nampa, Idaho

PROGRAM OBJECTIVES: To preserve the economic value of solar radiation falling on properties; to secure investments in solar equipment; and to assure that the option to use solar energy will be preserved and encouraged.

APPROACH: 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. In 1985, the Idaho Department of Water Resources (IDWR) assisted Nampa in performing a public opinion survey and development of an energy component for their community comprehensive plan. In 1986, Nampa received a Bonneville Power Administration (BPA) grant to study residential solar access protection community energy benefits and develop amendments to its local zoning and subdivision codes. In March of 1987, 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, IDWR assisted Nampa in implementing 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. Workshops were held to assist the private development community and city staff in implementing the new development portion of the ordinance.

The solar access protection ordinance for residences was designed by a Citizens Advisory Committee, which was primarily comprised of representatives from the local development community. The program was designed to meet five design principles: (1) provide effective solar access protection; (2) be administratively simple and efficient; (3) provide equitable treatment to all properties; (4) provide certainty about what levels of sun and shade would be protected in the future; and (5) be flexible in dealing with a variety of development conditions.

The solar access program 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 (PUD) on lots in single-family and low density multi-family zones. The solar access design standard requires that at least 80% of the lots in new subdivisions be oriented so that they have a north-south dimension of at least 100 feet. This will provide solar access to the south walls of houses on lots to the north during the winter heating season. Lots must also be oriented within 30 degrees of south and be located outside the shade of pre-existing vegetation. Optional approaches for meeting the lot design standard are provided for the developer who does not choose to use the basic approach.

In addition, Nampa continues to be involved in peer matching assistance efforts to market the solar access concept to other communities. The city also prepared a solar friendly tree list (solar friendly trees do not create significant shadows during the winter months because of their bare or open branching pattern, foliar period, and other growth characteristics).

TARGET BUILDING TYPES: Single-family and multifamily.

RES-37

KEY PARTICIPANTS: Nampa, Idaho Department of Water Resources (IDWR), Bonneville Power Administration (BPA), developers, builders, designers, and homeowners.

HISTORY:

Date of Implementation: June 1, 1987
Current Status: Continuing
General Comments: IDWR's local government's Limited Study Fund (LSF) energy grant program helped fund this project.

MARKETING/PROMOTION METHODS: Training and orientation workshops provided hands-on design instruction and graphic communication of how solar principles apply to residential subdivision design. 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%) and, in the case of multi-family buildings, orients the units properly for solar uses and sites them to minimize internal shading.

MONITORING/EVALUATION:

Market penetration: During the first year, 40 new homes were sited under Nampa's new setback ordinance, and one residential subdivision plat was approved under the new design standards.

Savings:
- Energy: Estimated 20% reduction in heating and cooling levels.
- Peak:
- Dollars: Estimates of annual savings: $348 for a single-story unit, and $515 for a two-story unit; on a 50-year lifecycle basis, these savings are estimated to be between $17,400 and $25,750 for the single and two-story houses. (Passive solar space heat, solar hot water, and photovoltaics are estimated to have the potential of saving an additional $325 and $350 annually for the typical single and two-story houses; on a 50-year lifecycle basis, these savings are estimated to be $16,250 and $17,500, respectively).

Costs and cost-effectiveness:
- Program administration: Minimal to date: 5-10 minutes of local staff time per lot and building siting review.
- Incentives: Density bonus of 10% allowed in those subdivisions that exceed 90% of lots designed for solar access.
- Private investment: A homeowner solar access protection permit costs $100. There is a minimal level of engineering costs in subdivision design and builder/owner compliance for the home siting requirement.

Discussion:
According to sponsors of the workshops, the workshops were very useful for training public and private professionals to implement solar design standards and for facilitating the design process. The participants became familiar with the residential solar design principles that create good solar access, and they also became aware of the potential benefits and marketing potential associated with solar subdivision design. By utilizing existing residential subdivision plats, the participants were trained to identify solar design opportunities and barriers, and were then asked to prepare their own plat re-design. The participants confirmed that requiring solar orientation for 80% of all subdivision lots was a reasonable design standard.

No administrative problems have occurred to date, and developer/builder acceptance has been good.

RES-37

RELATED PROGRAMS: Several local jurisdictions have received small LSF grants since 1983 to address either internal energy management improvements to their public buildings or study and implement residential solar area access or other similar energy-efficient land use development practices. In previous years, funding for the LSF was $30,000 to $40,000. During 1988, IDWR only had $9,000 for this program. These funds are currently assisting the City of Boise, Idaho, which is currently studying modifications to its subdivision and PUD ordinances relating to solar access protection.

Several solar access programs are being implemented in Oregon: Ashland, Redmond and Bend and Deschutes County, Salem, Corvallis, Eugene, Medford, Springfield, and Portland. These communities have created new subdivision plats or infill requirements for solar access. The Washington State Energy Office is also studying solar access for Tacoma. A number of solar access ordinances were adopted in California and the Southwest in the 1970s and early 1980s.

REFERENCES: City of Nampa, "Declaration of Solar Covenants, Conditions, and Restrictions," Nampa, Idaho, n.d.; Conservation Management Services, Inc., 1987; City of Nampa, "Summary of Nampa, Idaho, Solar Access Protection Program," Nampa, Idaho, n.d.

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DATE: Dec. 22, 1987 / June 2, 1988

NEW COMMERCIAL PROGRAMS (COM-1)

PROGRAM TITLE: Architect and Engineer Energy Awards Program

PROGRAM SPONSOR: Pennsylvania Power and Light (PP&L)

PROGRAM OBJECTIVES: To establish good relations with the architectural and engineering community, to increase penetration of electricity in service area, and to recognize energy-efficient design of new commercial and industrial buildings or the energy-efficient retrofit of existing buildings.

APPROACH: This awards program is for new and existing commercial buildings that incorporate energy-efficient design and technologies. The projects must be 100% electric since PP&L is all-electric. Applicants submit a four-page application form, a photograph of the building exterior, and a photocopy of the site plan. This information is used to judge the architectural features of the building from an energy viewpoint and the adaptation of the building to the site environment. Applications are judged by a panel of four judges consisting of one member of PP&L, one architect and one engineer from private practice, and one member from a school of architecture or engineering. The judging is based on (1) the innovative and effective use of electrical energy for building operations, and (2) widespread applicability. The two categories of awards are (1) new energy-efficient industrial and commercial buildings, and (2) energy-efficient retrofit of existing industrial and commercial buildings. Commercial buildings include educational, institutional, and multi-dwelling buildings.

TARGET BUILDING TYPES: New and existing industrial and commercial

KEY PARTICIPANTS: PP&L, and architects and engineers (A&E)

HISTORY:

Date of Implementation: 1983
Current Status: Continuing.
General Comments: The program is held biennially (1983, 1985, 1987). PP&L encourages joint applications from A&E. In 1987, PP&L picked 4 winners - 2 for new buildings and 2 for retrofits.

MARKETING/PROMOTION METHODS: Announcements are mailed to 1,000 A&E at the time of the contest. The winners are announced at a two-day seminar (the Energy Design Forum), at which time the winners are given plaques. The award-winning buildings are written up as case studies and published in trade journals, national publications, and local/regional newspapers. There are no monetary incentives.

MONITORING/EVALUATION: No formal evaluation; however, some of the case studies have actual energy consumption reported in their descriptions.

Market penetration: Disappointing results: only 6-12 applications per contest.

Savings:
- Energy:
- Peak:
- Dollars:

Costs and cost-effectiveness:

- Program administration:
- Incentives:
- Private investment:

Discussion:

The program is very worthwhile for promoting the company, establishing better relationships with A&E, and promoting electricity use (PP&L is in direct competition with gas companies). However, the level of participation is low. There has been a good response to the program from advertising in the local papers, but program advertising in the national journals and magazines has yielded a poor response.

RELATED PROGRAMS: Florida Power has a similar program: the Energy Conservation Design Award Program (see writeup).

REFERENCES: "1987 Energy Awards Program for Architects and Consulting Engineers: Official Entry Form," PP&L, 1987.

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DATE: Oct. 28, 1987 / May 31, 1988

NEW COMMERCIAL PROGRAMS (COM-2)

PROGRAM TITLE: Energy Conservation Design Award Program

PROGRAM SPONSOR: Florida Power Corporation

PROGRAM OBJECTIVES: To encourage the use of energy-saving construction methods and equipment in new commercial, industrial, institutional, and governmental buildings.

APPROACH: The Design Award Program gives recognition to energy-efficient new construction, and the award criteria aids architects and engineers in choosing the best and most cost-effective methods and equipment to reduce energy use. The criteria are tied into the requirements of Florida's State Building Code for Energy Efficiency. Generally, the award program requires that a building's energy consumption be 25% lower than a similar one built to minimum State standards. The Design Award Program has criteria covering the following areas: air infiltration, insulation, glass areas, air conditioning, heating and ventilating systems and equipment (sizing, equipment efficiency, ventilation air, piping and ductwork, and other system considerations), water heating, lighting, and electrical systems. They emphasize good mechanical systems.

TARGET BUILDING TYPES: New commercial, industrial, institutional, and governmental

KEY PARTICIPANTS: Florida Power Corporation, and architects and engineers (A&E)

HISTORY:

Date of Implementation: 1981
Current Status: Continuing
General Comments: Florida's energy code is similar to California's. Florida Power Corporation has been involved in energy conservation since the early 1970s; as a result, they have been very successful in having customers save energy. For example, they have achieved a high saturation of heat pumps without the use of incentives (in contrast to other companies).

MARKETING/PROMOTION METHODS: A Design Award plaque is presented to the building owner or manager and to the A&E to recognize their expertise and achievement in energy conservation. Site signs and display certificates are also available.

MONITORING/EVALUATION:

Market penetration: About 1,000 awards since the beginning of the program, representing 20% of new construction.

Savings:
- Energy:
- Peak:
- Dollars:

Costs and cost-effectiveness
- Program administration:
- Incentives:
- Private investment:

Discussion: Architects like the program, and customers save energy and money. The program was able to achieve a high saturation of heat pumps without incentives because the utility has had sales people out in the field since the early 1970s promoting heat pumps (which have good paybacks, especially in comparison to electric strip heaters); in addition, mechanical industry salesmen have been promoting heat pumps.

RELATED PROGRAMS: They used to have an extensive residential energy conservation program, but it was discontinued last year because the state tightened the residential state energy code. In the old program, a $350 credit was given to homes that exceeded the state code; the credit was applied to a person's utility bill. A new residential program might be started at the end of 1988. Pennsylvania Power and Light also has an awards program for its commercial customers (see writeup).

REFERENCES: "Energy-Saving Building Design Makes Good Business Sense," and "Design Criteria," brochures prepared by the Florida Power Corporation.

CONTACTS:

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DATE: Nov. 4, 1987 / June 28, 1988

NEW COMMERCIAL PROGRAMS (COM-3)

PROGRAM TITLE: Energy Awards Program

PROGRAM SPONSOR: American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE)

PROGRAM OBJECTIVES: 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.

APPROACH: 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 eligible for regional competition. 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).

TARGET BUILDING TYPES: New commercial, institutional, or public assembly buildings.

KEY PARTICIPANTS: ASHRAE (local, regional, and national levels), building owners and managers, building and system designers, and the general public.

HISTORY:

Date of Implementation: 1981
Current Status: Continuing
General Comments:

MARKETING/PROMOTION METHODS: 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 *ASHRAE Journal* and audiovisual presentations and case histories are made. Newspapers, radio and television are also used.

MONITORING/EVALUATION:

Market penetration: About 85-90 awards have been given since the inception of the program.

Savings:
- Energy:
- Peak:
- Dollars:

Costs and cost-effectiveness:

- Program administration:
- Incentives:
- Private investment:

Discussion:

RELATED PROGRAMS:

REFERENCES: "ASHRAE Energy Awards: Award Information and Entry Form," brochure prepared by ASHRAE; personal communication with Gordon Holness, formerly chairman of ASHRAE's Energy Management Committee.

CONTACTS:

Name: N/A
Position/title: N/A
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DATE: No interview.

NEW COMMERCIAL PROGRAMS (COM-4)

PROGRAM TITLE: Commercial and Industrial Awards Program

PROGRAM SPONSOR: Edison Electric Institute (EEI)

PROGRAM OBJECTIVES: To recognize individual utility representatives for successful application of marketing techniques; encourage programs that promote the more efficient use of energy and that benefit both the utility and their customers.

APPROACH: Energy awards are presented for commercial and industrial sectors. The utility representatives send in papers (project descriptions) and a panel of judges evaluate the papers according to a set of criteria. In 1987, the six criteria were: initiative, innovation, success, applicability, interaction, and clarity. Each judge weights the criteria independently from the other judges. Some of the papers tell stories of successful marketing efforts with customers who had already been convinced that gas was the natural choice. Others tell of cases where customers believed they had taken all possible energy conservation steps until the utility representative showed them new, and often innovative, solutions. Awards are also given on the ease with which the projects can be duplicated by other utilities for customers with similar problems, and on the extent to which the author actively participated in the total marketing effort. The program has evolved over the years: in 1987, the four award categories were: Commercial, Industrial, Electrical Service Marketing, and Company Programs. There were 200 entries submitted to the program from 36 EEI member companies.

TARGET BUILDING TYPES: New and existing commercial and industrial

KEY PARTICIPANTS: EEI and utility company representatives.

HISTORY:

Date of Implementation: 1980
Current Status: Continuing
General Comments: EEI is a national association of investor-owned electric utility companies. Most of the awards have been for existing buildings.

MARKETING/PROMOTION METHODS: The winning entries are written up as case studies and distributed to EEI's member companies; journal articles are also written up.

MONITORING/EVALUATION:
None for the program, but some methods are described in the case studies. EEI's Customer Service and Marketing Division is in the process of developing a computer data base with the information contained in the entries submitted to EEI. The data will be used as a marketing resource for EEI member companies and staff. Some results are described in the case studies.

Market penetration:

Savings:
- Energy:
- Peak:
- Dollars:

Costs and cost-effectiveness:

- Program administration:
- Incentives:
- Private investment:

Discussion:

The case studies are seen as proof that the efforts of individual utility representatives can play a major role in furthering the aggressive marketing attitude of the electric utility industry.

RELATED PROGRAMS: In 1973, EEI started publishing a series of case studies of buildings that were built from the start with energy conservation as a major design consideration. The first twenty of these studies were reprinted in a booklet: *Case Studies in Energy Management: How Twenty Companies are Dealing with the Energy Crunch*, 1978. Originally, the case study series were published as paid advertisements in leading architectural, engineering, and builder-owner magazines.

In 1987, EEI inaugurated the "Common Goals Award" for outstanding electric utility consumer programs. There are five different categories: public participation, special needs, energy management, electric safety, and community responsibility.

REFERENCES: Edison Electric Institute, 1984, 1987a, 1987b.

CONTACTS:

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DATE: June 17, 1988

Name: Sally Hooks
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DATE: Nov. 13, 1987

NEW COMMERCIAL PROGRAMS (COM-5)

PROGRAM TITLE: Low Energy Building Design Awards Program

PROGRAM SPONSOR: Public Works Canada and Energy, Mines and Resources Canada

PROGRAM OBJECTIVES: To identify existing energy-efficient buildings, and to select the best proposals for an office building and a hotel-retail-office complex; to recognize and publicize the efforts designers have used to incorporate energy conservation in their buildings; to stimulate new energy conservation ideas and to document the process by which the new design concept might be formed based on proven practices.

APPROACH: The new-designs portion was open to Canadian architect-engineer teams, who were encouraged to take maximum advantage of passive solar heating, and minimize the use of nonrenewable energy sources. There were 80 submissions to the design competition. Six of the winning designs were for existing buildings (designed and completed between 1972 and 1978), and the other 28 winners employed available technology.

TARGET BUILDING TYPES: New and existing commercial buildings.

KEY PARTICIPANTS: Public Works Canada and Energy, Mines and Resources Canada, architects and engineers.

HISTORY:

Date of Implementation: 1979 to 1980
Current Status: Terminated (one-time only competition)
General Comments:

MARKETING/PROMOTION METHODS: Four top awards were each given $10,000; eight runners-up were each given $5,000.

MONITORING/EVALUATION:

Market penetration:

Savings:
- Energy:
- Peak:
- Dollars:

Costs and cost-effectiveness:
- Program administration:
- Incentives:
- Private investment:

Discussion:
A set of recommendations to facilitate energy-conserving design were prepared by the jury. The jury made suggestions in the following areas: curricula, measurement of energy use, energy-accounting procedures, more accurate definition of comfort levels, side effects of energy conservation, appropriate use of computer-aided design, responsibility for energy efficiency, energy system monitoring and retrofitting, fee structures, developers' priorities, and demonstration projects.

RELATED PROGRAMS:

REFERENCES: Public Works Canada and Energy, Mines and Resources Canada, 1980.

CONTACT: No interview.

NEW COMMERCIAL PROGRAMS (COM-6)

PROGRAM TITLE: Commercial and Industrial New Construction Energy Design Assistance Program

PROGRAM SPONSOR: Tennessee Valley Authority (TVA)

PROGRAM OBJECTIVES: To assist architects, engineers, and designers in incorporating efficient electrical applications and other energy strategies in their designs for commercial, industrial, and institutional buildings.

APPROACH: TVA's first efforts in this program were in offering free technical and design assistance to architects, engineers, and designers of new buildings, and this program continues to operate. TVA works with private architects and engineers on specific projects on a one-to-one basis. Assistance includes 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. A written report is provided to the consumer recommending specific strategies to be implemented. This free review service is available for new buildings or major renovations planned for the commercial and industrial market in the TVA power service region. As part of the review, TVA specialists identify the potential for the efficient use of electrical energy through recommendations for: thermal envelope improvements, energy-efficient lighting, daylighting strategies, energy-efficient HVAC systems, load management and thermal storage applications, and solar and renewable applications.

TVA later realized that the one-to-one technical and design assistance program, although beneficial, did not reach a large area of the new construction. They wanted to have more of an impact and wanted not only to tell more people how to make their particular buildings energy efficient, but also to educate them about energy efficiency. In 1981, TVA started producing and distributing feature pages. These feature pages were one- to four-page descriptions highlighting particular energy-efficient buildings. Each page was very graphic, describing the energy-saving features of the building along with estimated savings. Along this same line, TVA also started an Energy Design Guideline Series. These were individual manuals for a particular building type, describing ways to save energy and to utilize energy more efficiently. The topics covered were: identifying design problems/energy use characteristics, selecting and testing energy design strategies, incorporating energy strategies into the design process, and evaluating building performance. Manuals are currently available for schools, offices, hospitals, and hotels/motels. Additional manuals are being developed for retail trade, and restaurants.

In addition to these guidelines, TVA also put together some design tools that could be used on a whole range of building types: ECAP (a multizone PC program), SHADE (selects the best external shading device, based on lifecycle cost and payback), COMPLY (computerized version of ASHRAE 90A-1980 standard), and Energy Nomographs (based on DOE-2 runs). The first three are computer-based tools, and the Nomographs are used by hand. Each of these tools is briefly described below.

ECAP (Energy and Cost Analysis Program) is an energy- and economics-analysis tool intended to help architects, engineers, and designers assess the merits of architectural and system-design alternatives in reducing the life-cycle costs related to energy use in commercial buildings. ECAP is a comprehensive design and analysis tool that deals with all of the energy-related issues of building design

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addressed by TVA's Energy Design Guidelines--namely, the life-cycle energy, demand, and system costs associated with lighting, cooling, heating, and HVAC auxiliaries (and to a lesser extent, in-zone equipment and service hot water). It was designed with the intention that it be easy to use, that it be applicable throughout the architectural design process, and that it be readily understandable and usable by design professionals.

SHADE (Shading Analysis Program) evaluates potential energy and cost savings of various window shading strategies. SHADE allows the user to specify up to five shading devices at any tilt and orientation. The program compares the interior balance-point temperature with the exterior ambient temperature for a given hour. If the exterior temperature is below the balance-point temperature of the space, the space is being heated. Otherwise, it is being cooled. Solar heat gain through the window, both with and without the shading surfaces being tested, is then calculated. The net heat gain is the difference between the two. The conditioning mode (heating or cooling) and the net heat gain are used to determine the effect of the shading strategy on heating and cooling costs. Using this procedure, SHADE computes the annual cost reduction in energy and demand attributable to the test shading strategy.

COMPLY is a computerized analysis tool to determine compliance of new and existing buildings with ASHRAE Standard 90A-1980, *Energy Conservation in New Building Design.* That standard establishes requirements for the design of new buildings regarding the energy efficiency of their exterior envelopes and the selection of efficient equipment and systems for HVAC, service water heating, energy distribution, and illumination. COMPLY determines compliance of a building with the standard by interactively asking the user for all necessary information about the building and its systems. It can be used in identifying energy conservation opportunities and for guiding the architectural design process.

Energy Nomographs is a graphic design tool aimed primarily at architects to help them make wise energy decisions early in the design process.

TVA's most recent efforts have been devoted to starting a new program area that is designed to recognize those professionals whose work demonstrates energy efficiency and the wise use of electricity in commercial and institutional buildings. The Energy Advantage Awards Program, started in Jan. 1988, recognizes three levels of achievement: Merit, Distinction, and Excellence. Members of the project team for qualifying buildings will receive several attractive awards and significant promotional benefits. Free publicity is offered to promote those responsible for the design as well as the building itself. The publicity will include advertisements in professional and trade journals, news releases to mass media, and an annual Energy Advantage publication explaining the features of the designs. Information will also be distributed to members of the architectural and engineering professions, building owners, developers, financiers, real estate professionals, and to businesses and industries. TVA is currently developing the program announcement brochure and submittal package.

The Awards Program and the Energy Design Guidelines and tools have replaced the feature pages.

TARGET BUILDING TYPES: Commercial, industrial, and institutional

KEY PARTICIPANTS: TVA, architects and engineers (A&E), designers, owners and investors, and contractors of commercial and industrial property.

HISTORY:

Date of Implementation: 1979
Current Status: Continuing.
General Comments: A new TVA strategy has been initiated, called "Energy Services." New Construction was changed to the "Energy Advantage Program." Building types receiving assistance to date include schools, day-care centers, retail establishments, housing projects, medical facilities, and town halls.

MARKETING/PROMOTION METHODS: Private designers request assistance, and TVA's A&E will personally visit the project's architect and engineer. Assistance is given at the schematic design level as well as the design development phase. Factsheets on selected completed projects are prepared on an ongoing basis to explain to others energy strategies investigated and the predicted results. Energy Nomographs have been developed to help designers perform energy and cost analysis of commercial buildings, and to examine the energy impact of various design options during the early stages of the design process. These nomographs accompany the Energy Design Guideline series. Energy Design Guidelines offering assistance on a generic building-type basis (e.g., schools, hospitals, offices, hotels/motels, retail trade facilities, and restaurants) are being developed for this program. This is in contrast to the case-by-case approach of the design assistance program. These guidelines will include energy-related design criteria which will be incorporated into the normal design process.

In addition, a manual containing a detailed energy- and cost-based evaluation procedure is being developed to accompany the design guidelines. The manual will provide A&E in the TVA service area with a complete package of evaluation tools and support information. Also, the Energy and Cost Analysis Program (ECAP) and Shade have been developed to accompany the Energy Design Guidelines. The former microcomputer program will provide A&E in the TVA service area with an analytical tool to perform energy and economic analysis on commercial buildings during the entire building design process.

A continuing series of technical seminars and workshops are conducted by TVA for A&E, building owners and managers, developers, appraisers, commercial real estate professionals, and members of financial institutions. TVA also conducts the Biennial Energy-Integrated Approach Conference for designers and commercial sector professionals. TVA uses direct mail to market their program: customers are identified who can use a particular technology and are sent a letter, program literature, and postage-paid return card for requesting additional information. Follow-up telephone calls are also made to determine if there are additional questions or information needs. Advertisements are placed in professional journals.

MONITORING/EVALUATION:

Market penetration: From 1980 to 1986, assistance was provided to A&E on 430 projects (usually, one building per project); as of Sept. 1986, the total number of requests for assistance was 752. During FY 1987, energy design assistance was provided on 95 projects, and construction was completed on 79 projects previously receiving energy design assistance. TVA is currently reaching about 3% of the market though their one-on-one assistance program.

Savings

- Energy: 142,261 kWh of electricity per project (estimated); 90 million kWh of annual energy savings for completed projects (based on followup reports)
- Peak: 50 kW at winter peak (estimated) per project; total savings: 2800 kW for completed projects (based on followup reports)
- Dollars

Costs and cost-effectiveness

- Program administration
- Incentives
- Private investment

Discussion:

Edwards noted that advertisements for the program must be placed in professional journals, such as *Building Design and Construction*, or *Professional Architecture*, rather than *Business Week, Industry Week* or newspapers.

RELATED PROGRAMS: TVA's Energy Design Tools

REFERENCES: Lu, John, and Kajhan Strain, "TVA Commercial and Industrial New Construction Energy Design Assistance Case Studies." *Proceedings of the 11th National Passive Solar Conference.* Vol. 11. American Solar Energy Society, Inc. Boulder, Colorado, June 1986; Billy Edwards, "Tennessee Valley Authority Experiences in Marketing Conservation and Energy Management Programs to the Commercial and Industrial Sector." *PG&E Energy Expo 1986*, pp. 549-557; *Conservation Report '86,* TVA, 1987; "Energy Services for Business and Industry," brochure prepared by TVA, 1987.

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DATE: Dec. 10, 1987 / June 22, 1988

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DATE: Not interviewed.

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DATE: Oct. 26, 1987

NEW COMMERCIAL PROGRAMS (COM-7)

PROGRAM TITLE: Good Cents Commercial Program

PROGRAM SPONSOR: Southern Electric International, Inc. (SEI)

PROGRAM OBJECTIVES: To provide utilities with a technically sound approach to conserving energy in commercial buildings.

APPROACH: The Good Cents concept embodies load retention and increased load factor through the interplay of building envelope measures and efficient equipment sizing and operation. The program addresses three fundamental aspects of a successful marketing program: technical, promotional, and managerial. The case study approach coupled with computer software, tailored to the utility's requirements, is the heart of the technical side of the program. It is capable of providing service area-specific case studies covering a variety of typical commercial installations. These case studies provide the technical and economic foundations, describing the procedure for problem solving and illustrating the implementation process that follows. The case study concept strongly emphasizes the economic aspects of each of the various categories of commercial customers and demonstrates the impact of energy consumption on their cash flow. This information is used by the marketing representative to assist the commercial customer in achieving the appropriate balance and perspective relative to "value of service" and energy conservation/management.

The management of the program is facilitated by a series of reference guides that reach all elements in the process, from program manager to marketing representative. The promotion of the program contains both educational and motivational tools (see below). In sum, the program is a turnkey marketing program that can be customized to the utility's specifications. All training is completed and all products are produced for start-up four to six months after a contract has been signed.

The Good Cents program provides an umbrella of services, including goal setting, data collection and analysis, development of Good Cents construction and system features, preparation of a Standards Handbook, and supporting materials and sales tools.

The Standards Handbook is the technical reference guide of the Good Cents program as it documents the case studies used in the program and the program's technical design process. The handbook documents the Good Cents Commercial Standards and qualification criteria and includes a detailed breakdown and analysis of the buildings used to develop the Standards, a summary of the segmentation analysis of the commercial market, and the results of field surveys. The handbook also provides utilities with design options for achieving energy reductions through improvement of the building envelope and the energy system. The information depicted in the Standards Handbook Case Studies is gathered from visits to actual field construction sites and focus group "interviews" conducted within the client utility's service territory. The buildings represented by the examples in the Standards Handbook are chosen from a "list" as those most likely to impose an influence on the commercial building market (and, therefore, the load shape) of a particular utility's service territory. The detailed characteristics of each building type (thermal envelope, HVAC equipment, and efficiency rating) are then modeled using local weather data at three levels: base case ("spec" building), improved case, and optimized case (Good Cents Commercial "Certified"). This process yields data appropriate to the needs of the marketing representatives in helping commercial customers conserve their electricity use and in assisting the utility to implement a strategic loadshaping program that uses capacity more efficiently.

Other handbooks include: the Commercial Field Handbook, the Manager's Implementation Handbook, and the Building Systems Handbook (see below). Energy simulation software is based on the ASHRAE Simplified Energy Analysis Method (ASEAM) and is designed for predicting building and system energy use, as a comparative tool in making decisions in the design process or to establish compliance with an energy standard.

TARGET BUILDING TYPES: Commercial (less than 60,000 square feet and less than 500 kW demand

KEY PARTICIPANTS: SEI and utilities.

HISTORY:

Date of Implementation: 1986
Current Status: Continuing
General Comments: The following utilities have Good Cents Commercial Programs: Public Service Company of Oklahoma (see writeup), Gulf Power Company, Wisconsin Electric Power Company, and Mississippi Power.

MARKETING/PROMOTION METHODS: Customization of the program is done through audiovisual presentations (for architects and engineers, contractors and developers, general audiences, and trade associations), the Commercial Field Handbook, and a software package. The Commercial Field Handbook provides the field marketing personnel with pertinent information pertaining to situations that they will encounter when implementing and promoting the program. This handbook also explains how the case study approach is used to analyze and target commercial customers. The case studies depict an energy analysis of the commercial building including thermal and equipment features, and an economic analysis of the "business" part of the process tuned to the commercial customer's needs.

The Building Systems Handbook provides the marketing representative the necessary technical background, documentation, and information for effective marketing of the program. It includes technical briefs on building envelope measures and materials that relate to cost-effective, energy-efficient design and construction of commercial buildings. The emphasis is on selling the benefits of electrical energy including economics, convenience, efficiency, and comfort compared to other forms of energy.

The Manager's Implementation Handbook describes a variety of ways to plan marketing strategy, build a well-trained and motivated marketing team, and how to implement and manage the program.

There is also a graphics manual and advertising guide. The program provides training courses on: cooking and water heating, interior/exterior lighting, heat loss/heat gain loan calculations, general HVAC, commercial sales, software, and implementation.

MONITORING/EVALUATION:

Market penetration: 4 utility companies

Savings:
- Energy: Some utilities are reporting building operation savings as high as 40%.
- Peak:
- Dollars:

Costs and cost-effectiveness:

A client utility can acquire the Good Cents Commercial Program products and services designed and developed for their service territory for $70,000 to $95,000, depending on the type of options they desire. An annual license renewal fee is charged on the basis of the number of commercial customers served by the client utility.

- Program administration:
- Incentives:
- Private investment:

Discussion:

The program has just begun. They are optimistic that the program will be used by a number of utility companies, especially those that currently have the residential Good Cents program. The program is currently being modified to provide "umbrella-type" support for other commercial energy applications, such as energy standards for larger commercial buildings, and thermal storage applications.

RELATED PROGRAMS: There is a Good Cents program for the residential sector (see writeup on BPA's Super Good Cents Program).

REFERENCES: "Commercial Good Cents," materials prepared by SEI.

CONTACTS:

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DATE: June 1, 1988

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DATE: Oct. 24, 1987

NEW COMMERCIAL PROGRAMS (COM-8)

PROGRAM TITLE: Good Cents New Commercial Program

PROGRAM SPONSOR: Public Service Company of Oklahoma (PSO)

PROGRAM OBJECTIVES: To provide commercial architects, engineers, contractors, developers, and owners an opportunity for improved energy management, greater comfort levels in their buildings, and lower operating costs.

APPROACH: The Good Cents program is basically a non-prescriptive, performance based program that includes a thorough package of materials consisting of: a technical design study, a marketing strategy and program development study, energy analysis software, audio/visual presentations, program support manuals, and training. The Good Cents program is for new and existing commercial buildings (PSO also has a Good Cents program for new and existing residential buildings). PSO examines blueprints of buildings and conducts heating and cooling load analyses for the basic building and for redesigned buildings that include energy-efficient options. The building must meet minimum appliance efficiencies and insulation criteria for becoming a Good Cents building. They provide a list of 10 weatherization items and the developer must choose 3 of the 10 options. The developer also has the option of using solar transmission and design guidelines to meet the Good Cents standard. The heat gain criteria vary by building size (they use three types of buildings: less than 5,000 square feet, 5,000 to 25,000 square feet, and more than 25,000 square feet). Final inspections are made to ensure the building is a Good Cents building.

TARGET BUILDING TYPES: New and existing commercial

KEY PARTICIPANTS: PSO, architects, engineers, contractors, developers, and owners.

HISTORY:

Date of Implementation: 1986
Current Status: Continuing.
General Comments: This is the first utility in the country to implement a customized Good Cents program for new commercial buildings, and it was developed in cooperation with Southern Electric International, Inc. (see writeup).

MARKETING/PROMOTION METHODS: A Standards Handbook was produced providing marketplace case studies and PSO Good Cents specifics for certification. Manuals were prepared addressing program standards, building systems, and general information. They have a very intensive training schedule for commercial sales representatives and technical services personnel. Incentives are provided to developers only if they install energy-efficient heat pumps in a new or existing commercial building after January 1, 1987 (the Commercial InCENTive). The incentive is a one-time cash payment. The exact amount of this payment is based on the efficiency of the new unit(s) and on the tonnage of the equipment. Heat pump installations in Good Cents-certified structures qualify for a higher payment than do other installations:

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SYSTEM EFFICIENCY		PAYMENT PER TON	
EER Rating	SEER Rating	Good Cents	Other
8.20-8.50	9.00-9.50	$50	$30
8.51-9.00	9.51-10.00	$60	$40
9.01-9.50	10.01-10.50	$70	$50
Above 9.50	Above 10.50	$80	$60

The efficiency ratings must be verified by the Air Conditioning and Refrigeration Institute (ARI) Directory. The marketing program has used mass media (television advertisements that are also tied into PSO's other Good Cents programs, radio), notices in trade publications, and direct mail.

MONITORING/EVALUATION: Buildings are not metered. A program evaluation is conducted each year, and a cost-benefit analysis is performed. However, results on savings and costs are unavailable.

Market penetration: 50-75 buildings in the first 1.5 years of program implementation (the new construction market is currently depressed).

Savings:
- Energy:
- Peak:
- Dollars:

Costs and cost-effectiveness:
- Program administration:
- Incentives:
- Private investment:

Discussion:
The emphasis at PSO has switched to existing commercial buildings because of the depressed market for new commercial buildings. They are very happy with the program, and it is going to continue. Customers also like the program.

RELATED PROGRAMS:

REFERENCES: Termini, 1986; *Good Cents Solutions For Your Commercial Energy Needs,* brochure prepared by Public Service Company of Oklahoma, 1987.

CONTACTS:

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DATE: Oct. 29, 1987 / June 20, 1988

NEW COMMERCIAL PROGRAMS (COM-9)

PROGRAM TITLE: Energy Edge

PROGRAM SPONSOR: Bonneville Power Administration (BPA)

PROGRAM OBJECTIVES: To assist BPA and the Northwest Power Planning Council in assessing the costs (especially, the incremental levelized cost of energy conservation measures) and replicability of conservation savings in the commercial sector; to guide the development of improved standards and building codes; to raise awareness and skills among building designers and developers; to identify design strategies that are successful in meeting the targeted energy budget at a reasonable cost; and to compare predicted versus actual energy use.

APPROACH: The Energy Edge Project was run as a design competition. Applicants were given extensive design assistance and incentives for the design and construction of the buildings. Energy modeling, using hourly simulations, identified optimal combinations of efficiency features. The buildings were selected based on the merits of their design and the costs of their energy conservation measures. Twenty-nine new commercial buildings are planned; 10 buildings have been constructed, 13 are under construction, and 6 have not been started. All the buildings are in the BPA region (Oregon, Washington, Idaho, and western Montana). The buildings are primarily electrically heated and cooled. Buildings were selected in 1986, and construction and energy monitoring will occur over the next three years. These buildings were designed to use 30% less energy than similar buildings conforming to the Model Conservation Standards (MCS) (see below). Extensive technical standards and methods were developed to demonstrate the 30% energy savings. Initially, the buildings were designed to demonstrate state-of-the-art technologies utilized in an innovative fashion without sacrificing construction schedules or tenant comfort. Also, building designs were to be replicable and to demonstrate principles that could be applied to future new commercial buildings. These two criteria -- innovation design and replicable technologies -- were incorporated into sponsors' criteria for selection of participants. However, these two criteria conflicted somewhat, so that final projects often leaned toward relatively conventional but energy-efficient solutions, such as lighting, insulation, ventilation, economizer, and energy management systems.

TARGET BUILDING TYPES: New commercial

KEY PARTICIPANTS: BPA, the four sponsors that administer the program (state energy offices of Oregon and Washington, Pacific Power (a private utility), and Portland Energy Conservation, Inc. (a nonprofit organization)), architects, engineers, developers, contractors, builders, and owners engaged in new commercial building or extensive remodeling.

HISTORY:

Date of Implementation: 1984
Current Status: Continuing
General Comments: The program was conceived in 1984 and agreements with the sponsors that administer the program were signed in 1985. Energy Edge was mandated by the Northwest Power Planning Council in their 1983 regional energy plan. The MCS, also a product of the Council's plan, were recommeded to utilities and local governments in the BPA Region. The MCS for new commercial buildings is a slightly modified version of the ASHRAE 90 - 1980 model energy code (the most significant difference is in the area of lighting: the MCS requires lower lighting

power densities). The Pacific Northwest has 2,000 commercial building starts annually, and many of these are small commercial buildings.

MARKETING/PROMOTION METHODS: Winners in the Energy Edge competition will receive media recognition plus incentive payments to cover all incremental costs required to reach the higher level of energy efficiency. Incentive payments will cover design, construction, and administrative costs (including energy modeling). The program has been promoted to the commercial real estate industry, and a technology transfer program has been developed for disseminating the information learned from this program.

MONITORING/EVALUATION:
Monitoring of actual energy use will be conducted when projects reach 70% occupancy. Four buildings are currently being monitored, and the monitoring for the last building to be constructed will begin in 1989. The monitoring will be conducted for three years for each building; therefore, the end of the monitoring will occur in 1992. Actual performance will be compared to predicted usage based on computer models; the comparisons will be conducted on a per measure, primary end use, and whole building basis. Construction cost information is also being collected to calculate an incremental levelized cost (mills/kWh) for each building and to compare predicted versus actual incremental design and construction costs.

Process evaluation has been conducted and continues, in order to address the following issues: identification of the causes behind the effects of the program, identification of the barriers to effective implementation of the program, interpretation of the program from the perspectives of involved parties, identification of changes in the program market environment, possible modifications to the program, and guidelines for developers, owners, and designers.

Market penetration: 29 buildings

Savings:
- Energy: The estimated average annual electricity savings will be 36% and will likely range from 30-50%.
- Peak:
- Dollars:

Costs and cost-effectiveness:
- Program administration:
- Incentives: Winners of the Energy Edge project competition are reimbursed by BPA for the costs of participating. To date, BPA reimbursements for these costs ranged from $\$0.73/ft^2$ to $\$9.78/ft^2$; the mean was $\$3.90/ft^2$ with a standard deviation of $\$2.46/ft^2$. Total incentive dollars per building have ranged from \$9,939 to \$1,056,330; the mean was \$122,049. Total incentive costs were approximately \$3,417,384.
- Private investment:
- Cost-effectiveness: Based on predicted savings and estimated costs, the average cost per kWh is \$0.023/kWh with a standard deviation of \$0.014/kWh, and the cost per kWh ranges from \$0.005/kWh to \$0.063/kWh.

Discussion:
Perry noted that they were surprised how easy it was in many cases to reach the energy saving goal with one or two very modest measures; this was particularly true for smaller, more envelope-dominated buildings. Perry also noted (1) the difficulties in describing the basecase/MCS building, partly due to the variability of commercial buildings, and (2) the possibility of buildings including less insulation than common

practice, due to adherence to MCS envelope standards.

Miller noted that extra design time and energy modeling can lead to substantial savings while reducing initial construction costs.

Benner *et al.* reported the following preliminary findings based on the process evaluation of Energy Edge (see references): "Additional capability has been developed among sponsors and program participants. New buildings have been designed; a variety of energy conservation measures have been used in contexts where they would not have been used before; and program sponsors and participants have created a more cohesive network of information and technical assistance exchange than had existed in the past. Participants have been exposed to new methods, materials, and technologies and have utilized a number of innovative design features. Participants were also using more energy efficient, highly replicable, off-the-shelf technologies than they were using in the past." One participant noted a positive spin-off: if their Energy Edge building worked, then it would serve as a prototype for future stores as well as the standard for the comprehensive retrofit of 170 existing buildings.

Benner *et al.* also noted that the energy conservation measures (especially lighting and various control measures) were diffusing quite rapidly as participants incorporated them directly into their standard practice. Computer modeling was also seen as extremely valuable for architects, engineers, and owners as a means of "selling" a client on a particular material, system, or building. The sponsors of the program were vital in promoting the program: they were seen by participants as a resource of technical expertise and an important hub in the commercial building network. Participants did use a number of innovative design features, in addition to highly replicable off-the-shelf technologies.

The program did alter the sequence of design activities and, to some extent, the composition of the design team: participating architects and engineers met together much earlier in the design process than is common practice in building design. Also, there was early involvement of contractors and the direct involvement of owners, in contrast to previous practice. The program was educational: the redistribution of professional knowledge enabled the design team to gain insights into the tasks and responsibilities of each other. The program also permitted enough time for participants to examine lots of alternatives; the critical examination of the energy related components of the buildings resulted in a more critical examination of the building generally. A few of the Energy Edge buildings actually cost less to design and build to the program criteria due to lower initial costs for such items as downsized cooling and heating systems. There was a shift in the program from innovation to replication.

BPA noted: (1) building designers were most often the individuals that made fuel choice decisions; (2) most designers and developers placed a high value on design assistance, awards, and recognition for energy-efficient buildings as a motivator to encourage energy-efficient investments; and (3) it was often possible to reduce initial capital costs by reducing the size of heating and cooling equipment and the building's lighting requirements.

RELATED PROGRAMS: BPA's Energy Smart Design Assistance Program and Model Conservation Standards Implementation Assistance Program (see writeups); Washington State Energy Office's Design Assistance Program (see writeup).

COM-9

REFERENCES: Anderson *et al.*, 1988; Benner *et al.*, 1987; Miller, 1986; Perry, 1986; Bonneville Power Administration, "Energy Edge Research and Evaluation Plan (1987)," and "Energy Edge Design Assistance Program Description, Draft (1987)," Portland, Oregon; Alexander J. Willman, "Documenting and Evaluating the Energy Edge Program: Draft Project Management Plan," American Consulting Engineers Research and Management Foundation, Washington, D.C., 1986; American Consulting Engineers Council Research and Management Foundation, "Interim Report #3: Alternative Perceptions of Energy Edge Process and Outcomes," April 8, 1987, and "Interim Report #4: Participant Perceptions of the Energy Edge Program," June 8, 1987, Washington, D.C..

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DATE: Nov. 6, 1987 / June 28, 1988

NEW COMMERCIAL PROGRAMS (COM-10)

PROGRAM TITLE: Energy Smart Design Assistance Program

PROGRAM SPONSOR: Bonneville Power Administration (BPA)

PROGRAM OBJECTIVES: Encourage the construction of energy-efficient new commercial buildings in the Pacific Northwest and the adoption of energy codes for commercial buildings; provide technical support and resources to utilities with the capability and interest in offering building design assistance to their commercial customers; and promote electric load growth in the commercial sector through the use of energy-efficient electric products.

APPROACH: This 3-year pilot program is designed to be implemented by utilities: BPA's customer utilities will provide technical assistance and information to design professionals. This service includes information about the Commercial Model Conservation Standards (MCS) and appropriate electric technologies and equipment. Utilities will be able to choose a level of participation commensurate with commercial construction activities in their service areas and their desire to participate. Utilities will advertise the availability of services, consult with design professionals, builders, and developers requesting services, provide technical assistance to identify efficiency measures and electric equipment, 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. Utilities may authorize BPA to have Alternative Service Providers offer part of the technical assistance portion of the program in their service territories. 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.

TARGET BUILDING TYPES: New commercial

KEY PARTICIPANTS: BPA, utilities, design professionals, builders, owners & developers.

HISTORY:

Date of Implementation: 1988
Current Status: Continuing (three year pilot program)
General Comments: This activity will be included within BPA's Partnership Program to encourage energy marketing. Participation in the Energy Smart program is an option for utilities to support the adoption of the MCS, thereby avoiding a surcharge should the local jurisdictions within their service territories fail to adopt the MCS.

MARKETING/PROMOTION METHODS: Utilities will promote the program within their service territories and are encouraged to target the program services to building types where there is a high degree of competition between electric and nonelectric fuels. 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.

MONITORING/EVALUATION: BPA plans to perform process and impact evaluations to identify implementation problems, to measure how effectively the program reaches its goals, and to prepare the way for Commercial MCS programs. The process evaluation will examine the reaction of participating utilities, Alternative Service Providers, state energy offices, and developers/builders/architect & engineering firms, and will measure the market penetration of the program. The impact evaluation will examine the efficiency improvements encouraged by the program, initial costs, and potential energy savings.

Market penetration:

Savings:
- Energy: They estimate 10% to 30% energy savings per building.
- Peak: Their goal is to obtain an annual 14-20 MW reduction for 20 to 30 years (assuming a 30% decrease in load)
- Dollars:

Costs and cost-effectiveness:
- Program administration:
- Incentives:
- Private investment:

Discussion:

RELATED PROGRAMS: Washington State Energy Office's Design Assistance Program (see writeup) was a precursor to this regionwide program: the program was part of BPA's Interim Program, but because of problems in getting contracts signed with the utilities, WSEO was the only participant in the Interim Program.

REFERENCES: "Energy Edge Design Assistance Program Description: Final Description," prepared by BPA, 1987.

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DATE: June 21, 1988

Name: Kate Miller
Position/title: (formerly a Public Utilities Specialist at BPA)

DATE: Nov. 9, 1987

NEW COMMERCIAL PROGRAMS (COM-11)

PROGRAM TITLE: Design Assistance Program for New Commercial Buildings

PROGRAM SPONSOR: Washington State Energy Office (WSEO)

PROGRAM OBJECTIVES: To assist the design community in designing new, energy-efficient commercial buildings.

APPROACH: The Design Assistance Program is a free service for designing and building cost-effective, energy-efficient, new commercial buildings. WSEO's energy consultants work with clients to identify practical energy-saving strategies, and computer simulation models are used to test which strategies save energy and provide attractive paybacks. They concentrate on HVAC, lighting, and envelope measures. Some buildings have been constructed. Design assistance has been provided to buildings ranging in size and complexity from a 17,000 square foot savings and loan building to a 160,000 square foot retail store.

TARGET BUILDING TYPES: Commercial buildings

KEY PARTICIPANTS: WSEO, architects, engineers, owners, and designers.

HISTORY:

Date of Implementation: Nov. 1986
Current Status: Continuing, through Dec. 1988.
General Comments: This program is a spinoff of the Bonneville Power Administration's (BPA) Energy Edge program for new commercial buildings. The service was initially developed to meet the need of those people who did not win the Energy Edge design competition. As a result of their participation in the Energy Edge program (WSEO was one of the four sponsors administering the program for BPA), WSEO concluded that computer modeling at the beginning of the design stage was very effective in reducing energy use and costs. BPA is planning to institute a design assistance program for the entire region (called the Energy Smart Design Assistance Program, see writeup); utilities will provide the services throughout the region. However, there will be "alternative service providers" and WSEO may be one of them. Thus, WSEO's program can be seen as a precursor and pilot demonstration of BPA's program.

MARKETING/PROMOTION METHODS: The program has been promoted by two mailings to architects, engineers and developers throughout the state; word-of-mouth; and individual telephone contacts with contractors and developers.

MONITORING/EVALUATION: An evaluation is presently being conducted.

Market penetration: 23 projects completed

Savings:
- Energy:
- Peak:
- Dollars:

Costs and cost-effectiveness:

- Program administration:
- Incentives: The cost of the design assistance has ranged from a low of 4.6 cents per sq. ft. for a 160,000 sq. ft. retail store ($7360) to a high of 44 cents per sq. ft. for a 17,000 sq. ft. savings and loan building ($7480).
- Private investment:

Discussion:

The program is considered to be "extremely successful;" it has been very well received by the design community. Several projects are planning to incorporate energy-conserving design strategies.

RELATED PROGRAMS: BPA's Energy Smart Design Assistance Program.

REFERENCES: "Design Assistance," brochure prepared by WSEO; "Energy Edge Design Assistance Program Description, Draft," prepared by BPA, 1987.

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DATE: June 6, 1988

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DATE: Nov. 6, 1987

NEW COMMERCIAL PROGRAMS (COM-12)

PROGRAM TITLE: Technical Assistance Program

PROGRAM SPONSOR: Sacramento Municipal Utility District (SMUD)

PROGRAM OBJECTIVES: To encourage builders to incorporate the latest energy conservation technologies in new commercial buildings.

APPROACH: This program provided technical assistance to builders on the latest energy conservation technologies in new commercial buildings. A "fact book" was prepared for engineers and architects that included the latest information on energy-efficient motors, lighting, HVAC, etc. Staff contacted the design community to talk about the fact book and latest technologies. Some design review occurred, but only a few plans were submitted for review. Modeling runs were done on DOE-2, Trace, and a daylighting model.

A pilot project was undertaken in 1986 in which four different, existing warehouses and office buildings were retrofitted with daylighting controls. SMUD provided the control equipment, and the four participants paid for the controls. The study provided a good indication of the real-world applicability of control equipment and identified control strategies that optimize load reduction and customer acceptance.

TARGET BUILDING TYPES: Commercial

KEY PARTICIPANTS: SMUD, engineers, and architects.

HISTORY:

Date of Implementation: 1983
Current Status: Discontinued in 1985/86. Some assistance is currently being provided on daylighting. In the next 12 months, a program offering financial incentives for daylighting is planned to be introduced for existing commercial buildings, and findings should be applicable to new commercial buildings. The daylighting program is under the New Construction Program that also includes thermal energy storage and HVAC systems.

General Comments:

MARKETING/PROMOTION METHODS: Technical assistance.

MONITORING/EVALUATION:

Market penetration:

Savings:
- Energy:
- Peak:
- Dollars:

Costs and cost-effectiveness:
- Program administration:
- Incentives:
- Private investment:

Discussion:
The design community participated very little in the design review because they did not want to have their plans reviewed.

RELATED PROGRAMS:

REFERENCES:

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DATE: Oct. 22, 1987 / June 1, 1988

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DATE: Oct. 22, 1987

NEW COMMERCIAL PROGRAMS (COM-13)

PROGRAM TITLE: New Construction Rebate Program

PROGRAM SPONSOR: Pacific Gas and Electric Company (PG&E)

PROGRAM OBJECTIVES: To encourage early compliance with California's new energy conservation standards (Title 24) in new commercial buildings; to promote thermal energy storage (TES) in new commercial buildings; and to promote energy-efficient lighting in non-office buildings.

APPROACH: Program was customized to user needs by offering incentives for early compliance and installation of high efficiency lighting and TES.

TARGET BUILDING TYPES: New commercial; some new industrial.

KEY PARTICIPANTS: PG&E and builders.

HISTORY:

Date of Implementation: June 1985
Current Status: Ended in June 1986 (due to Title 24 standards)
General Comments:

MARKETING/PROMOTION METHODS: Financial assistance was provided for energy-efficient lighting. The rebate was based on square footage of the building: ranged from 50 cents per square foot for buildings meeting the Title 24 standards to 4 cents per square foot for warehouses that meet a threshold of 0.5 watts per square foot (the threshold level varied for building types, from 0.5 to 2.0 watts per square foot). Financial assistance was also provided for TES: $300 per kW. The maximum rebate for a customer was $200,000 ($150,000 for TES and $50,000 for lighting). Technical seminars were held periodically and technical manuals on specific topics (e.g., thermal energy storage for cooling, efficient lighting, and office building energy management) (see below) were distributed to participants.

MONITORING/EVALUATION:

Market penetration:

Savings:
- Energy: For 1987, 30.6 million kWh
- Peak: For 1987, 13.5 MW
- Dollars:

Costs and cost-effectiveness: For 1987, $1.85 million
- Program administration:
- Incentives:
- Private investment:

Discussion:

RELATED PROGRAMS: Since 1982, PG&E has been running the Natural Gas Home Program, offering builders incentives to install energy-efficient natural gas appliances that otherwise would not have been installed in new single-family and multifamily construction.

Also, since 1983, PG&E has been running the Customized Program for Existing Commercial Buildings.

REFERENCES: Charles Eley Associates, *Thermal Energy Storage for Cooling,* Pacific Gas and Electric Company, San Francisco, Calif., 1986; Charles Eley Associates, *Efficient Lighting for Commercial Buildings,* Pacific Gas and Electric Company, San Francisco, Calif., 1985; Charles Eley Associates, *Office Building Energy Management,* Pacific Gas and Electric Company, San Francisco, Calif., 1985.

CONTACTS:

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DATE: June 16, 1988 / June 24, 1988

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DATE: Oct. 23, 1987

NEW COMMERCIAL PROGRAMS (COM-14)

PROGRAM TITLE: Energy Conscious Construction (ECC) Program

PROGRAM SPONSOR: Northeast Utilities

PROGRAM OBJECTIVES: To work actively with the design professional to encourage the implementation of more energy-efficient features in new commercial buildings in order to lower energy demand in their service territory.

APPROACH: For buildings less than 10,000 square feet, a general discussion of the merits of energy efficiency in new buildings is presented to architects and engineers. For buildings greater than 10,000 square feet, energy simulations for the building as proposed and the same building with additional energy-efficient features are presented to the architect or engineer early in the design process. Both energy and cost savings are shown. The architect or engineer then prepares alternative construction estimates and presents them to his clients. The clients choose the configuration that meets their financial criteria.

TARGET BUILDING TYPES: New commercial

KEY PARTICIPANTS: Northeast Utilities, architects and engineers.

HISTORY:

Date of Implementation: July 1986
Current Status: Continuing.
General Comments: The predecessor of this program was the Energy Value Building (EVB) program, started in 1983. The EVB program was an informational program designed to encourage A&E to include energy-efficient features in their buildings. The ECC program includes all the activities of the EVB program plus free, computerized, energy consumption comparisons using the DOE-2 energy analysis program. Northeast Utilities is the largest utility in New England and through its operating subsidiaries, the Connecticut Light and Power Company and the Western Massachusetts Electric Company, it serves 153 communities in Connecticut and 59 in Massachusetts. The fastest growing portion of their load both in number of customers and the demand per facility is the commercial sector. The ECC program is implemented under the "Energy Alliance" (a partnership between Northeast Utilities and their customers).

MARKETING/PROMOTION METHODS: A design manual was prepared, seminars held, and case studies developed and printed as part of the EVB program. Direct mail to A&E community; some newspaper advertising in the beginning, but this has stopped (not effective); and word-of-mouth. A guidebook was prepared containing the results of DOE-2 simulations of a 60,000 square foot office building; both energy and cost savings are presented for different energy designs. The guidebook is targeted at A&E and will serve as an educational tool and a sourcebook for the design professional. Annual seminars are held throughout the service territory for informing A&E about the program. Discussions of daylighting and heat recovery, for example, and a tour of architectural, award-winning, energy-efficient designs form part of the seminars.

MONITORING/EVALUATION: A cost-benefit analysis was conducted. Actual load reduction will be recorded after the measures are installed during construction.

Market penetration: First six months of 1986: 10 participants; 29 participants in 1987, and a goal of 44 participants in 1988. A 10% participation rate is indicated. At least three buildings are being constructed that incorporate energy-efficient lighting and other measures as a result of the simulations.

Savings:

- Energy: 144,000 kWh/year per participant (estimated)
- Peak: 20 kW demand reduction (estimated)
- Dollars:

Costs and cost-effectiveness:

- Program: $108,000 for 1986; $295,248 for 1988 (the program costs include the payroll for administration and implementation, energy simulations, expenses, and advertising and promotion). The cost of the simulations averages about $1,300 per project.
- Cost-effectiveness: Estimated to be less than $0.01 per kWh saved.
- Incentives: (being developed)
- Private investment:

Discussion:

Initially, A&E community was reluctant to get involved with the utility, because they felt their clients were not interested in energy costs. Developers are now indicating more interest in energy conservation and load management because they will increase their profit margin and make their rents more competitive if they can lower operating costs. As a result, the A&E community is now more interested in energy conservation. The company is developing an expansion to the ECC program. The expansion will include incentives for the design and implementation of additional energy-efficient measures.

RELATED PROGRAMS:

REFERENCES: This project received a Connecticut Energy Award and a national award from DOE. U.S. Department of Energy, 1986a; Wajcs, 1987; *Energy Conscious Construction Program: Implementation Manual*, Northeast Utilities, Energy Management Services, 1986.

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DATE: Oct. 26, 1987 / June 10, 1988

NEW COMMERCIAL PROGRAMS (COM-15)

PROGRAM TITLE: Lighting Code Compliance Training Program

PROGRAM SPONSOR: Energy Extension Program of Oregon State University (OSU)

PROGRAM OBJECTIVES: To train building code officials on new lighting requirements for commercial buildings.

APPROACH: This program provides technical reference manuals and accompanying video tapes on various code topics, which could be sent to code officials throughout the state, as an alternative to attending seminars that involve extensive travel time and that may not be timely. OSU Extension Energy Program produced a pilot package consisting of a technical reference manual and an accompanying training video tape on determining compliance with the new lighting codes. The lighting code training package was primarily designed as part of a statewide, continuing, code official, certification program and was intended for distribution to local associations of code officials.

TARGET BUILDING TYPES:

KEY PARTICIPANTS: OSU Extension Energy Program, Oregon Department of Commerce Codes Division (now called the Oregon Codes Agency), Bonneville Power Administration, Oregon Department of Energy, the Oregon Section of the IES, local associations of code officials, and architects and engineers.

HISTORY:

Date of Implementation: Not fully implemented (see below)
Current Status: See below.
General Comments: Oregon adopted on July 1, 1986 a new statewide energy code that includes a section on lighting controls and lighting power budgets. The current code will be revised this year, so education efforts on the current code have ended. The video tape was not distributed, but the technical reference manual that went with it was distributed at workshops on the lighting code.

MARKETING/PROMOTION METHODS: Most of the marketing and promotion has been to code officials. The main method of promotion is the Oregon Building Codes Agency's "CODE SCOOP," a bulletin that is sent out to code officials about nine times a year. The bulletin includes a "training calendar" and course descriptions. Local chapters of code officials organizations have requested lighting code updates at their meetings. IES and the American Institute of Architects have also had meetings devoted to energy/lighting codes.

MONITORING/EVALUATION:

Market penetration: 20-30% of the total number of code officials in Oregon have taken some training in lighting code requirements.

Savings:
- Energy:
- Peak:
- Dollars:

Costs and cost-effectiveness:

- Program administration: $4,000-$8,000 for the OSU effort.
- Incentives: None
- Private investment: None

Discussion:

The videotape was not used to its potential because of three factors: (1) there was a lot of staff turnover in the building code agency responsible for implementing the code, so there was no one person to promote the use of the videotape; (2) there is a revision to the state energy code every three years, and the next revision will be occurring soon, so that no one was willing to promote the videotape knowing that there would be revisions to the code; and (3) the Oregon building code agency installed a hot line to answer questions about the code, thereby removing some training needs. Baker thought the videotape was a good idea, but it was never tested. The manuals have been used a lot.

Baker also noted an apathy in code enforcement. Presently, registered architects and engineers can certify a building has complied with the code through its plan design (although this is rarely done in writing), and, therefore, code officials may overlook the building in their review. Moreover, lighting work is usually enforced by code officials through plan checks only, not by onsite verification (other parts of the energy code, such as insulation, are usually enforced on site). Consequently, a building could pass inspection, but the installed lighting system and loads may not be the same as the ones that the building was designed for. This discrepancy often occurs because lighting is the last item to be installed in a building, and when a building is nearing completion and budgets are tight, lighting systems and technologies are changed to less costly alternatives. A problem resulting from this lack of enforcement is that the developer complying with the code puts in more time and money in meeting the code's standards than people who disregard the code. Consequently, Baker felt there was a need to target not only building code officials but also architects and engineers who are relied on for enforcement but who may not know the code (note: architects and engineers are not required to take training courses on the code, in contrast to building code officials).

Baker also felt that some building code agencies generate general revenue from the fees for code compliance. To increase revenue, fees are increased and staff is decreased, resulting in understaffed code enforcement departments. This in turn results in prioritizing their work: fire, safety, and health take precedence over energy.

RELATED PROGRAMS: California's Title 24 standards are enforced by certification by electrical contractors, after the building has been completed and lighting systems installed. Videotapes have been used extensively in Oregon's Super Good Sense program for new residential construction. Commercial energy code training sessions are offered to small code official groups around the state. There is also a new "Hot Line" and a computer bulletin board for code officials. The Washington State Energy Office has hired a professional engineer to be a "circuit rider" and conduct commercial code training sessions around the state.

REFERENCES: Baker, 1986; "Technical Reference Manual on Section 8310, Artificial Lighting," for the 1986 Oregon Structural Specialty Code.

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DATE: Oct. 29, 1987 / May 27, 1988

NEW COMMERCIAL PROGRAMS (COM-16)

PROGRAM TITLE: Passive Solar Nonresidential Experimental Buildings Program (NEBP)

PROGRAM SPONSOR: U.S. Department of Energy (DOE)

PROGRAM OBJECTIVES: To investigate the potential of passive solar technologies to meet the heating, cooling, and lighting requirements of nonresidential buildings; to build a body of practical information on the design, construction, and performance of nonresidential, energy-efficient buildings; to support the design and implementation of exemplary and prototypical passive solar commercial buildings; and to identify the cost and performance of passive systems in commercial buildings.

APPROACH: At the time, the NEBP was the largest known attempt to guide design and simultaneously evaluate construction and operation costs, actual energy use, occupancy effects, and reactions in climate-responsive, nonresidential buildings. This program provided technical and financial support for a number of innovative nonresidential passive solar buildings around the country. Nineteen buildings were designed, constructed, instrumented, and monitored to determine energy consumption, economic performance, and occupant impact. Over half of the projects focused on daylighting strategies and solar heating.

There were three phases in the NEBP: design, construction, and performance monitoring and evaluation. During the design of these buildings, a team of technical experts helped each project architect maximize energy performance, enhance occupant comfort, and minimize construction cost. Each project team started by establishing a "base-case" building, a nonsolar building that the owner would ordinarily build. Team members calculated heating, cooling, lighting, and other energy requirements, taking into consideration heat generated within the building by lights and people (internal loads), building occupancy, climate, and construction practices. Designers then developed an alternative design, using passive solar approaches to heat, cool, and light the building, and calculated the design's performance using a variety of energy- and cost-prediction tools. These buildings were designed to reflect "state-of-the-art" practices for energy conservation. The tools ranged from complex mainframe, energy-simulation programs like BLAST (Building Loads Analysis and System Thermodynamics) to simpler, hand-calculated procedures. The designs addressed the building's major energy cost requirements (lighting, heating, and cooling), and the designs had to be aesthetically pleasing, integrate mechanical, lighting, and other support systems, and demonstrate "technical validity." The cost of the passive features had to be reasonable as measured by lifecycle cost analysis. A panel of technical experts reviewed the project designs in a series of meetings. The review provided valuable feedback from the earliest stages in design through final preparation of bid documents. Twenty-two building teams completed the design phase.

The resulting array of designs emphasized south-facing roof apertures that provided both heat and light, Trombe walls, and circulation spaces that collected heat for distribution to the rest of the building. Glare and overheating were prevented by diffusing baffles, overhangs, and operable shades. Night flushing of building mass, evaporative sprays, and natural ventilation supplied the bulk of cooling. Both automatic and manual controls were represented.

In Phase II, the construction phase, a portion of the incremental costs associated with the energy systems were reimbursed through DOE cost-sharing funds. However, actual building construction costs were obtained by the organizations and institutions

for whom the buildings were already designed. As a result, 19 buildings were completed. The projects ranged from a 700 sq. ft. classroom module in Alaska to a 66,700 sq. ft. airport in Colorado, and comprised a variety of building types, including schools and libraries, community and health care centers, office buildings, retail outlets, airport terminals, a greenhouse, and an automobile maintenance shop.

After the buildings were constructed under Phase II, they entered the final Phase III: performance evaluation (see below).

TARGET BUILDING TYPES: New commercial

KEY PARTICIPANTS: DOE, SERI, Architectural Energy Corporation (AEC), Burt, Hill, Kosar, and Rittelmann, Lawrence Berkeley Laboratory (LBL), consultants, architects, engineers, and building owners.

HISTORY:

Date of Implementation: 1979
Current Status: Ended in 1986
General Comments: NEBP was funded in the last round of DOE's national demonstration program for solar heating and cooling of buildings under the National Solar Heating and Cooling Act. DOE's Passive and Hybrid Solar Energy Program also conducted the Solar in Federal Buildings Program (SFBP) (see writeup). The buildings in the SFBP focused on passive solar heating solutions. The NEBP complemented the SFBP by highlighting daylighting options with less emphasis on heating. The NEBP was later redirected to emphasize more research and development than commercialization per se.

MARKETING/PROMOTION METHODS: A Request For Proposals resulted in the submission of 400 proposals; DOE contracted with 42, of which 22 completed designs. DOE paid for the incremental costs of passive solar design.

MONITORING/EVALUATION:
Actual construction costs were compared to a range of typical building costs (for similar building types) provided by national construction cost data systems. An occupant evaluation was conducted to determine user satisfaction in those areas affected by the building energy systems. This evaluation used the following sources of information: occupant and builder user questionnaires (weekly and monthly); site visits, observations, and interviews with building managers, owners, and the design team. Each building had a contractual responsibility to provide DOE with energy consumption data for major end uses on a weekly and monthly basis for one year; consequently, hourly data were taken using data acquisition equipment, and the final data archive is at the American Institute of Architects Foundation in Washington, D.C.

Market penetration: Over 400 building owner/designer teams applied to participate in the program, but only the best 42 were selected. Of these, 22 buildings located across the country completed design; 19 completed construction.

Savings:
- Energy: Measured energy use of these buildings was 45% less than for their conventional counterparts (base case), and 60% less than for the average U.S. commercial building. Heating, cooling and lighting energy was reduced by approximately 50%. Daylighting strategies did not lead to increases in cooling or heating energy. Solar heating strategies did not lead to a corresponding increase in

cooling loads. Lighting electricity use was 22% lower in summer months than in non-summer months.

- Peak:
- Dollars: Most passive commercial buildings cost less to operate annually and did not cost any more to build than conventional buildings of the same type. Average operating cost was 51% less than the base case.

Costs and cost-effectiveness: $5.5 million. Phase I involved an average of $27,000 from DOE (about 50% of the cost of designing the passive solar commercial buildings).

- Program administration:
- Incentives:
- Private investment:

Other effects: In many of the demonstration projects, energy use was actually higher than predicted. These increases were caused by changes in occupancy and use patterns, contributing to 20% higher than expected energy use. Actual heating energy use was 31% higher than predicted, and actual cooling energy use was 47% lower than predicted. Buildings owners were satisfied regardless of the difference between actual and estimated energy usage, since the actual energy use was much lower than typical non-solar buildings.

There was a high degree of satisfaction with the buildings and the program. Thermal comfort satisfaction was high; it was highest during the Spring, and most complaints occurred during the morning hours of Winter months. Many of the buildings experienced thermal comfort problems through malfunctioning ventilation systems. Occupant response to daylighting strategies was favorable. Air quality problems occurred when space modifications were made during the construction. In many buildings, infiltration problems occurred right after occupancy. In most cases, these conditions were corrected and the complaints disappeared. Acoustic problems occurred due to the nonabsorptive surfaces of thermal mass and open office plans (designed to enhance convective air movement and light distribution systems). Occupancy problems occurred due to changes made during or after the building was constructed. In almost all of the buildings, actual occupancy patterns differed significantly from those predicted or specified. In particular, timing of occupancy changed: because buildings were popular, people used them many more hours than had been predicted, and additional uses for the buildings emerged. Spaces that were initially designed for one function were modified to accommodate a different function.

As part of the design process, passive solar design guidelines were developed, covering programming and pre-design, schematic design, design development, construction documents, and construction and building acceptance.

Discussion:

Two buildings won architectural design awards from the American Institute of Architecture (AIA). The NEBP itself received the *Progressive Architecture* Research Award for 1988.

The findings of the program have been published in two books (Solar Energy Research Institute, 1985; and Burt Hill Kosar Rittelmann Associates and Min Kantrowitz Associates, 1987), and the following discussion is drawn from these books. The ideas from the first book were incorporated into Appendix A (Principles of Design) of the new ASHRAE Standard 90, published by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (ASHRAE).

This program has provided the largest data base of cost, energy, and occupant

performance of nonresidential buildings to date. Passive, climate-responsive technology generally can provide substantial utility cost and energy savings at little, if any, increased construction cost. Performance parameters contributing to success or failure include occupant behavior, user control, fuel cost, and the skillful handling of design elements such as solar apertures, thermal mass, and daylighting systems and their integration with conventional design issues. Of minor concern are climatic limitations and predominant building load; passive buildings can perform well in a wide variety of climates to reduce lighting, heating, and cooling needs. Climate-responsive design does not place unnecessary constraints on comfort or on building aesthetics and, in fact, can enhance both. The greatest potential in failure lies in poor or complicated controls and designs that do not anticipate changing uses.

Daylighting contributed to significant energy and cost savings as well as environmental comfort for users. Base case lighting energy was reduced by 55% through the use of daylighting and tasklighting. Occupant satisfaction with daylighting strategies was quite high. Manual controls for artificial lighting were easily operated and controlled by occupants and provided the greatest potential for occupant participation in energy savings. In some cases, manual controls were more energy conserving than automated devices.

High thermal mass did not appear to have been a contributing factor in the energy-efficient functioning of these buildings. High mass did not necessarily solve thermal comfort problems and, in some cases, appeared to have contributed to: acoustic problems; difficulty in regulating and timing heat delivery; and difficulty in integrating thermal mass with mechanical systems. Moderate amounts of well-distributed thermal mass appeared sufficient to solve thermal problems. Localized thermal mass (e.g., Trombe walls) can be an efficient strategy to provide delayed heat to specific building locations.

Conflicts between shading devices and apertures impeded ventilation flows. Manually operated ventilation control strategies appeared to work effectively when they were simple, close, and familiar to the users.

Solar buildings succeeded in a wide range of climates, from very cold to hot and humid. Energy performance was not dependent on climatic variables (e.g., heating degree days). The most successful projects were those that integrated the passive heating, cooling, lighting techniques with conventional heating and lighting systems.

Three lessons were learned from the design process: (1) consider energy-conscious design alternatives as early as possible; (2) support all design decisions with thorough analysis that addresses building efficiency in its broadest sense, including economics; and (3) think of passive solar design as an architectural, mechanical, and electrical integration issue, not an "add-on" exercise.

Evaluators uncovered several questions that potentially limit the acceptance of passive, climate-responsive design. One area insufficiently investigated is the design and performance of large nonresidential buildings. Only 3 of the 19 DOE program participants had floor areas over 50,000 sq. ft., but almost 50% of the 1984 nonresidential building floor area exists in buildings in the U.S. larger than this.

Additional research is needed in the development of design tools for accurately

measuring potential energy savings during the design process. Tools that exist today are either cumbersome (i.e., they require extensive computer input, take a long time to return results, and require a more developed or detailed design than is available early in the design process) or are unsophisticated in their approach to integrating the many energy flows in a building. Energy design tools need to be integrated with those in nonenergy areas of architecture, so that the architect can develop building designs on a computer screen and instantaneously see the implications for energy consumption, construction cost, handicapped access, fire protection, and structure.

There is also a need for whole-building analysis to identify the optimum integration of architectural, mechanical space conditioning, and electrical systems with passive solar technologies. More research is also needed in the areas of advanced glazing products, daylighting techniques, and automatic and manual controls that integrate solar and conventional heating, cooling, and lighting systems.

Lambright and Sheehan (1985) noted that the NEBP was a qualified success. It met the original objectives of the program and those defined as it progressed. No other federal building program performed such a detailed, post-occupancy evaluation. The evaluation was thorough, and building users were responsive. Ultimately, the bottom line was proven: passive solar nonresidential buildings use substantially less energy, and they cost no more to build than their nonsolar counterparts. From a technical perspective, they noted the following achievements: energy load studies were successfully conducted and used to influence designers at the front end of the program; a variety of simulation methods and passive solar design components were demonstrated; and some new skills as well as interest in passive solar construction were acquired by designers and builders.

However, Lambright and Sheehan noted, as of 1985, that little technology transfer by DOE, the NEBP participants, or other associations had taken place, in part because the program had been redirected from demonstration to R&D. There had been some dissemination of the project results to AIA and the architects. Also, although a fairly good cross-section of projects had been funded, there were not so many of any ubiquitous structure that quick replications could be expected. Finally, the list of projects did not include large-scale commercial buildings.

RELATED PROGRAMS: DOE's Solar in Federal Buildings Program (SFBP).

REFERENCES: Brandt Andersson, Mari Adegran, Tom Webster, Wayne Place, Ron Kammerud, and Patrick Albrand, "Effects of Daylighting Options on the Energy Performance of Two Existing Passive Commercial Buildings," *Building and Environment* 22(1):3-12 (1987); Brandt Andersson, Min Kantrowitz, Patrick Albrand, Tom Webster, Mari Adegran, and Ron Kammerud, "Effects of Occupant Issues on the Energy Performance of Two Existing Passive Commercial Buildings," *Building and Environment*, 22(1):13-48 (1987); Burt Hill Kosar Rittelmann Associates *et al.*, 1987; Frey *et al.*, 1984; Frey *et al.*, "Monitored Heating Season Performance of the Mount Airy Public Library Building," *Proceedings of the Eighth National Passive Solar Conference*, American Solar Energy Society Inc., Boulder, Colorado, 1983; Frey and Yager, 1984; Gordon *et al.*, 1984; Kantrowitz, 1984a, 1984b, 1984c, 1985; Kroner, 1987; Kurkowski, 1980; Lambright and Sheehan, 1985; Lutha *et al.*, 1983; Solar Energy Research Institute, 1985; Joel N. Swisher and Donald Frey, *Performance Analysis of the Mount Airy Library Building--Final Report.* U.S. Department of Energy, 1984.

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DATE: Jan. 7, 1988 / June 1, 1988

NEW COMMERCIAL PROGRAMS (COM-17)

PROGRAM TITLE: Solar in Federal Buildings Demonstration Program (SFBP)

PROGRAM SPONSOR: U.S. Department of Energy (DOE)

PROGRAM OBJECTIVES: To demonstrate, with known technology, applications of solar heating and cooling in a variety of federal buildings; to transfer solar energy technology from the government to private industry; to provide input for research and design efforts aimed at improving the efficiency and cost-effectiveness of solar installations; to support efforts to shift from nonrenewable to renewable energy sources; and to stimulate interest in solar and to promote the solar industry.

APPROACH: This program supported these objectives by (1) documenting the effectiveness of renewable energy in commercial buildings, (2) creating new procedures to assess building performance, (3) producing a methodology for predicting passive commercial building performance, and (4) producing new design information for large active solar systems. This program was designed in six phases to provide (1) the technical evaluation and selection of a proposal, (2) a site survey, (3) a formal design review, (4) an acceptance test, (5) performance monitoring, and (6) reporting on 706 projects for approximately 16 federal agencies. The projects involve the utilization of solar devices in new or existing federal buildings. The technical evaluation and selection of proposals resulted initially selecting more than 800 projects to be built by 16 federal agencies. The site surveys and design reviews resulted in some projects being rejected for construction. In addition, some agencies voluntarily cancelled construction. These processes reduced to 706 the number of projects actually being constructed. Active and passive solar technologies were included in this program; most projects were domestic hot water systems.

The major portion of the program involved the design, construction, testing, and monitoring of solar systems in 48 states involving 16 federal agencies. These systems included hot water, space heating, cooling, industrial process heat, and combinations of these. DOE provided the funding for these systems and supplied technical assistance to the federal agencies. All of the projects have been constructed, and all but two have had acceptance tests. They are presently evaluating the program. Two major documents on design and on installation, operation and maintenance of large active solar heating systems are being written as part of this program and will be published by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) in the next two years.

Sixteen of the SFBP projects used passive systems and were geographically concentrated in the Middle Atlantic and Mountain States, with a few sites in the Midwest and no passive systems on the West Coast. These projects were generally small to intermediate in size (less than 40,000 sq. ft.), and many of them provided office space as a primary or secondary function. Other functions included providing public space (museum, auditorium, recreation), storage, education, or living space. In every case, the primary passive features were designed to provide space heating and included some form of thermal energy storage. Lesser attention was given to daylighting, and there was essentially no primary attention to passive or hybrid cooling. The passive heating strategies used in the buildings generally represented straightforward applications of traditional systems known to be effective in residential-scale applications. In comparison to most nonresidential buildings, these buildings had relatively small internal loads.

COM-17

TARGET BUILDING TYPES: New and existing federal buildings

KEY PARTICIPANTS: DOE

HISTORY:

Date of Implementation: 1979
Current Status: Continuing (most likely until 1989).
General Comments: From 1979 to 1981, NASA's Marshall Space Flight Center (NASA/MSFC) was the technical project manager. After 1981, the project manager was the Energy Technology Engineering Center (ETEC), a DOE-owned laboratory operated by Rockwell International. DOE's Passive and Hybrid Solar Energy Program conducted the Passive Solar Nonresidential Experimental Buildings Program (NEBP) (see writeup). The buildings in the NEBP highlighted daylighting options with lesser attention to passive heating and cooling. In contrast, the SFBP projects complement these buildings by focusing on heating solutions.

MARKETING/PROMOTION METHODS: Open solicitation (similar to RFP process)

MONITORING/EVALUATION:
The acceptance testing phase of the active sites involved visiting each completed installation and performing a site inspection checkout, an operational mode checkout, and a limited-duration thermal performance test. The performance monitoring phase required that each agency submit monthly performance operation and maintenance reports on a quarterly basis for one year and on a yearly basis for two more years. The performance data included the amount of solar energy collected in storage, the amount of solar energy supplied to the load(s), and the net fuel cost savings. Eight SFBP sites were instrumented with NSDN (National Solar Data Network) type instrumentation to provide real time temperature, flow, insolation, and control status data. Four other SFBP sites were also instrumented with agency-owned data acquisition systems to provide similar data. Ten other SFBP sites, utilizing only Btu meters and auxiliary energy meters, were selected for intensive monitoring and were similar in size, application, and type to the NSDN instrumented sites. The intent of performing a detailed analysis on these ten systems was to demonstrate that the standard SFBP-installed instruments were capable of providing useful, reliable energy and cost savings data.

The performance monitoring task also included measuring of system performance before and after the correction of a problem (five sites) and determining if site visits with portable instrumentation can be useful in predicting long-term performance.

An evaluation is presently being conducted by ETEC.

Market penetration: 706 projects, 16 federal agencies participated in this demonstration project

Savings
- Energy:
- Peak:
- Dollars:

Costs and cost-effectiveness: $59 million ($29 million was for system costs)
- Program administration: $30 million
- Incentives:
- Private investment:

Discussion:

Hassett thought the program made great improvements through the years, and many systems worked well. However, many systems did not work as well as expected, due to avoidable, designer- and installer-related problems. There were no technological surprises. The technologies work if designed and installed correctly. Technologies applied to the wrong applications led to poor system performance. Also, because some agencies lost interest in the program (e.g., there was a change in managers), there was less attention given to the systems which resulted in degradation of performance. He also noted that this program had a significant impact on DOE's solar research program through the identification of problems and issues. For example, research was conducted on design and installation problems and has led to the publication of two manuals on these topics. They also achieved a better understanding of the operations of the solar systems. In summary, very important lessons were learned.

If this program were to be conducted again, he would recommend that more restraints be placed on agencies to force them to follow through on their agreements (perhaps through a cost-sharing agreement or through restrictive contracts). This recommendation is based on his experience with agencies that did not cooperate in the program and that led to poor designs and performance. The agencies made the final decisions on designs, based on recommendations by the contractors.

Hillig thought the program was a good program, but found that a majority of systems need improvement. He also felt that the lack of interest by agencies led to the poor maintenance and operation of systems, leading to poor performance. Some design and installation problems were due to federal agencies that did not listen to the recommendations made during the design process. There is substantial room for improvement. He also noted that only a limited number of systems are cost-effective today due to the low price of oil.

RELATED PROGRAMS: DOE's Passive Solar Commercial Demonstration Program.

REFERENCES: G.J. Billings, 1985; Energy Technology Engineering Center, "SFBP Passive Building Performance Monitoring Plan," Dec. 1983; Energy Technology Engineering Center, 1988.

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DATE: January 12, 1988 / June 8, 1988

NEW COMMERCIAL PROGRAMS (COM-18)

PROGRAM TITLE: Whole-Building Energy Design Targets

PROGRAM SPONSOR: U.S. Department of Energy (DOE) and Pacific Northwest Laboratory (PNL)

PROGRAM OBJECTIVES: To encourage the design and construction of energy-efficient buildings by informing designers and owners about cost-effective goals for energy use in new commercial buildings.

APPROACH: This research program is divided into two phases: planning and development. In the first phase, a methodology for setting targets for energy performance in new commercial buildings was proposed. The targets would be used as voluntary guidelines for the buildings industry and act as indices or yardsticks to measure the annual performance of building designs. The targets do not specify performance criteria for building components, or methods, materials, or processes that must be used. The intent is to provide flexibility for innovative responses in designing energy-efficient and cost-effective new commercial designs. Accordingly, the primary focus of this program is to develop a flexible methodology for setting target guidelines, rather than to determine numerical target values. The target-setting methodology is called the Targets Model.

The proposed plan is to develop a Targets Model which would use computer analysis tools to determine building targets. The Targets Model itself would be based on a concept of space functions, that is, a building is a collection of spaces that can be categorized by function. Categories of space functions include lobbies, private offices, and kitchens, all of which can occur in a number of building types. The building target would then be the floor-area-weighted average of targets for the space functions it contains. A key advantage of this approach when used with computer analysis tools is that the model can produce both example targets for various building types and custom targets for a specific building. Included in the proposed model are a cost model containing situation-specific costs for energy and construction and the concept of three target levels--typical, good, and the technical/cost-effective limit.

In general, the proposed Targets Model would use design requirements for building functions as input. Examples of requirements are a building's relationship to its surroundings, occupancy levels, desired thermal comfort, and illumination needs. Based on the requirements, space-function characteristics would be determined. Example characteristics include the envelope design, the scheduled use and loads, the temperature and humidity, and the lighting system. The appropriate characteristics would be fed into the space-function energy model to determine the energy impacts of the characteristics. These results would be input into to an energy-cost and building-cost model to calculate the energy-related costs. The results from the energy-cost and building-cost model would be fed through the characteristic selection procedure to select the options that are reasonably balanced between energy use and cost-effectiveness, setting the target for that space function. The final step would be to sum the targets for each function on the basis of the area for that function to obtain a target for the building.

They have just begun the second phase: the development of the methodology. A final Targets Model will be created and validated through detailed testing. In addition, demonstration target values will be produced that show energy-efficient solutions for typical economic perspectives. A workshop was conducted, and two project

review panels will be established: a Buildings Industry Review Panel, consisting primarily of building owners, developers, contractors, and occupant representatives, and a Technical Review Panel, consisting of representatives from the design community.

TARGET BUILDING TYPES: New commercial

KEY PARTICIPANTS: DOE, PNL, and the design community.

HISTORY:

Date of Implementation: 1987
Current Status: Continuing (for next 3 years)
General Comments: These research activities support DOE's Commercial Building Systems Integration Research Program. The goal of the program is to develop the scientific and technical basis for improving integrated decision making during design and construction. DOE might use the results of this program as input to its development of whole-building design standards for federal nonresidential buildings (see writeup).

MARKETING/PROMOTION METHODS: N/A

MONITORING/EVALUATION:

Market penetration:

Savings:
- Energy:
- Peak:
- Dollars:

Costs and cost-effectiveness:
- Program administration:
- Incentives:
- Private investment:

Discussion:

RELATED PROGRAMS: DOE's revision of General Design Criteria Manual for DOE buildings (see writeup).

REFERENCES: Crawley *et al.*, 1987.

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DATE: Dec. 4, 1987

NEW COMMERCIAL PROGRAMS (COM-19)

PROGRAM TITLE: General Design Criteria (GDC)

PROGRAM SPONSOR: U.S. Department of Energy (DOE)

PROGRAM OBJECTIVES: To provide general design criteria (covering architectural and engineering disciplines) for use in the acquisition of the DOE's facilities (DOE-owned, -leased, or -controlled sites); and to establish responsibilities and authorities for the development and maintenance of these criteria.

APPROACH: This program is revising the GDC so that it is up-to-date and easy to follow. The GDC is reformatted to the Construction Specifications Institute's (CSI) construction specification format, so that architects and engineers will be more easily able to use the criteria. Six major portions of the work were conducted: structural, site/civil, mechanical, electrical, architectural, and specialized non-reactor nuclear facilities. Two drafts of the report have been published, and over 9,000 comments have been received. A General Design Criteria Planning Board has helped oversee the review process. Only the DOE facilities are affected by the GDC. After the DOE promulgates their whole building energy performance standards (see writeup), the energy conservation section of the GDC will be revised to include any necessary changes.

For new construction, the DOE facilities must be designed to comply with the more stringent requirements of the "Interim Energy Conservation Standards for New Commercial Buildings," when promulgated, or ASHRAE Standard 90. Analysis of the building to determine energy conservation features and energy source alternatives are accomplished in the preliminary design (Title I) phase. The conceptual design phase cost estimates must include adequate funding to cover energy conservation alternatives. Determination must be made before the completion of the preliminary design phase as to which energy conservation alternatives shall be incorporated into the building design based on LCC.

As part of the GDC, energy conservation reports (summary evaluation) must be developed for each new building and building addition where total energy consumption is expected to exceed 500 million BTU per year or the building is larger than 10,000 gross square feet. The report is included as part of the preliminary design, where final selections of energy conservation features or renewable energy sources are made. The report contains the results of the annual energy consumption calculations for the "base-case" building and the results of the energy analysis and life-cycle cost analysis used to consider alternative building systems and the use of renewable energy sources.

TARGET BUILDING TYPES: New and existing DOE facilities

KEY PARTICIPANTS: DOE, architects, engineers, and designers.

HISTORY:

Date of Implementation: 1984
Current Status: Continuing
General Comments: Several years ago, the DOE decided to revise DOE Order 6430 that resulted in the General Design Criteria that was published in 1983 and was already dated (having been in coordination for six years). For architects and engineers, the GDC was hard to follow and was not observed in practice. The DOE instituted a program in 1984 to

keep its GDC updated and to streamline the coordination process. The DOE is also responsible for collecting data on new building designs and has created a building design data base.

MARKETING/PROMOTION METHODS: Distributed to all DOE offices.

MONITORING/EVALUATION: The Energy Conservation Reports, which are required for the majority of new building construction within the DOE, are reviewed by the energy coordinators at the DOE operations offices and submitted to the In-house Energy Management Program for final review. These reviews are to ensure that the most life-cycle cost-effective approaches are used in these buildings.

Market penetration: The GDC are required to be used by all DOE offices as well as all contractors involved in the design and construction of DOE buildings. Since the DOE employs many architectural and engineering firms in the design process, the GDC significantly penetrate the private sector. Since FY 1980, the DOE has designed over 200 new buildings on its sites. These buildings represent approximately 5 million gross square feet and a combined total projected average energy use of 2 million Btus per year.

Savings:
- Energy: 46% reduction in average building energy use (when compared to the DOE's average building energy use in FY 1987 on a square foot basis)
- Peak:
- Dollars: Annual savings of approximately $5.8 million.

Costs and cost-effectiveness: All of DOE's new buildings are designed to be life-cycle cost-effective.
- Program administration:
- Incentives:
- Private investment:
- Additional cost: Less than 5% of total construction costs.

Discussion:

RELATED PROGRAMS: DOE's Whole Building Energy Performance Standards (see writeup).

REFERENCES: U. S. Department of Energy, 1987b.

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DATE: Dec. 9, 1987 / June 17, 1988

NEW COMMERCIAL PROGRAMS (COM-20)

PROGRAM TITLE: Daylighting and Thermal Analysis Program

PROGRAM SPONSOR: Southern California Edison Company (SCE)

PROGRAM OBJECTIVES: To encourage energy efficiency in new commercial buildings in order to manage the growth of the peak load during the months of June through September.

APPROACH: The program offers technical assistance and financial incentives to encourage daylighting controls and, more recently, efficient space conditioning. SCE hopes to influence the design community, so that they can promote energy conservation in their discussions with builders. Daylighting is seen as a dynamic lighting technology that involves consideration of heat gain, glare, penetration into the building, and light variability. SCE's daylighting strategy pays careful attention to building design and orientation and takes into consideration toplighting, sidelighting, shading devices, and lighting controls for calculating kWh savings and peak load reductions. Computer programs, such as DOE-2.1, Quicklite.Plus, Skylite, Microlight, or Daylite, are typically used in assisting architects, engineers, and building owners. The space-conditioning program promotes the design and installation of high-efficiency space-conditioning equipment. Designers and builders of new commercial buildings are encouraged, through financial incentives, to choose space-conditioning equipment that exceeds California's Title 24 building standards and/or the state appliance standards. In addition, heating, ventilation, and air-conditioning distributors are offered incentives to encourage customers to purchase more efficient space-conditioning equipment.

TARGET BUILDING TYPES: New commercial

KEY PARTICIPANTS: SCE, builders, design professionals, and local American Institute of Architects' (AIA) chapters.

HISTORY:

Date of Implementation: 1983
Current Status: Continuing.
General Comments: This program started out as a daylighting program; space-conditioning incentives were added in 1986. SCE hopes to expand the program to include thermal analysis and selection of glass (awaiting approval from the California Public Utilities Commission). SCE is a summer peaking utility.

MARKETING/PROMOTION METHODS: The principal promotional effort has been to contact building design practitioners and interest them in daylighting technology. Financial assistance is provided (up to a maximum of $50,000 per account): $50/kW and 4 cents/kWh saved for daylighting controls; $75/kW for toplights (e.g., skylights); and $50-100/ton of energy-efficient space conditioning in order to meet certain thresholds above California standards. SCE also pays half the cost of a feasibility study, up to $15,000, and rebates part of the cost of the hardware investment. SCE conducted 5 to 8 seminars with local AIA chapters on daylighting design, and all of them were well attended.

MONITORING/EVALUATION:
An evaluation is currently underway by an outside contractor, and a report is expected

to be released in late 1988. Several case studies are presented in Ferguson (1986).

Market penetration: For daylighting controls: SCE has signed agreements with 327 participants; of these, 190 projects have been completed to date. For space conditioning: 627 customers are presently participating; of these, 343 have completed the requisite installation requirements.

Savings:

- Energy: From daylighting applications: projected program savings of 26 million annualized kWh; from space conditioning applications: projected savings of 15.6 million annualized kWh.
- Peak: Estimated 12 MW from daylighting and 16 MW from space conditioning.
- Dollars:

Costs and cost-effectiveness: $3.5 million for space conditioning program

- Program administration:
- Incentives: $1.2 million for daylighting applications
- Private investment:

Discussion:

Ferguson is very enthusiastic about the program: the daylighting controls work! There are not many other similar programs around. Although the number of completed projects is small, the impact is large: these buildings would not have included daylighting without SCE's assistance. One daylighting project received a National Award for Energy Innovation in 1985, and a State Award for Energy Innovation from the California Energy Commission in the same year. A second daylighting project received a National Award for Energy Innovation in 1987.

RELATED PROGRAMS: SCE's Energy Management Hardware Rebate Program has invested approximately $10 million in rebate incentives for air-conditioning improvements, lighting changes, and other equipment that would help them improve control of their energy costs; approximately $4.7 million was committed to new commercial construction projects. These incentives have stimulated more than $130 million in customer energy-saving investments. SCE is planning a Southern California Daylighting Resource Center. The Center will be jointly designed with a local university and will include a sky simulator and photometric laboratory.

REFERENCES: Ferguson, 1986; U.S. Department of Energy, 1985, 1987a; Ander and Hassan, 1986; Southern California Edison, *1987 Energy Management Plan*, Rosemead, Calif., 1986.

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NEW COMMERCIAL PROGRAMS (COM-21)

PROGRAM TITLE: New Construction Incentive Program

PROGRAM SPONSOR: City of Palo Alto

PROGRAM OBJECTIVES: To reduce peak electricity use below California's building code standards for new commercial buildings (Title 24).

APPROACH: This program offers a variety of incentives for encouraging energy-efficient measures in new commercial buildings. The City offers a $200 per kW rebate for reductions in the envelope cooling load, beyond what would result if the envelope just met Title 24 package A requirements. The builder can reduce the cooling loads through either a prescriptive approach or a performance approach. The City offers a $175 per kW rebate for electrical lighting demand savings due to energy-efficient lighting design, daylighting control, and lumen maintenance control. The City offers rebates for alternative cooling technologies: thermal energy storage ($350 per kW reduced), gas absorption cooling ($300 per kW reduced), and evaporative cooling ($250 per kW reduced). The City offers a load management incentive: $100 per kW reduced rebate for an Energy Management System (EMS) capable of reducing electrical loads during the City's peak demand period. The City also offers financial incentives for demand-reducing designs and technologies not covered by these standard categories. The rebate for these projects is based on the following equation:

$$\$ \text{ per kW rebate} = 350 - 0.07\,([\text{kWh saved/year by project}]/[\text{peak kW saved by project}])$$

This equation relates the value to the utility of peak kW reduction (when compared to marginal supply cost) less the lost energy revenue associated with the project. To qualify for these rebates, all projects must be new, nonresidential construction and must reduce demand 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 systems, of different technology or design, that reduce summer peak electrical demand. The study must be based on standard engineering principles and be signed by a professional engineer.

TARGET BUILDING TYPES: New commercial

KEY PARTICIPANTS: Palo Alto, architects, engineers, and building owners.

HISTORY:

Date of Implementation: July 1, 1987
Current Status: Continuing
General Comments:

MARKETING/PROMOTION METHODS: Newspapers and workshops.

MONITORING/EVALUATION:

Market penetration: Unknown, but there is very little new construction in Palo Alto.

Savings:
- Energy:
- Peak:
- Dollars:

Costs and cost-effectiveness:
- Program administration:
- Incentives:
- Private investment:

Discussion: Too early to say; the program just started.

RELATED PROGRAMS:

REFERENCES: "New Construction Incentives Program Application Form," "Feasibility Study Requirements and Application," "Custom Incentive Requirements," "Load Management Incentive Requirements," "Alternative Cooling Technology Requirements," "Lighting Requirements," "Building Envelope Requirements: Performance Approach," and "Building Envelope Requirements: Prescriptive Approach," information fliers prepared by the City of Palo Alto, 1987.

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DATE: Oct. 30, 1987 / June 1, 1988

NEW RESIDENTIAL/COMMERCIAL PROGRAMS (RES/COM-1)

PROGRAM TITLE: Design Assistance for New Buildings

PROGRAM SPONSOR: City of San Antonio

PROGRAM OBJECTIVES: To assess predesign energy conservation strategies for new buildings, and to provide direction for the community's overall economic development.

APPROACH: Three computer-aided programs are used to evaluate quickly and cost-effectively the energy efficiency of new buildings. The City uses the Predesign Energy Program (PREP) to analyze efficiency in new individual buildings during the conceptual stage of design. PREP calculates annual heating, cooling, lighting, appliance usage, and estimates annual kWh usage and peak kW load (demand). The second program, the Central Energy Systems Analysis Program (CESAP), analyzes energy efficiency for a group of buildings and determines if a new district heating and cooling system would be a cost-effective application to serve the development project's energy requirements. CESAP has the capability of combining individual building heating and cooling loads to determine the costs associated with a central district heating and cooling system versus conventional building energy plants. The third program, the Energy Economics of Design Options (EEDO), is used to determine energy conservation opportunities in residential buildings in different neighborhoods. Using the results from PREP and EEDO analyses for four to six houses in a particular neighborhood, the City prepares "home energy guidelines" for similar houses in that neighborhood. The guidelines present the best energy conservation measures for residents to implement.

TARGET BUILDING TYPES: New residential (single-family only) and commercial

KEY PARTICIPANTS: City of San Antonio, builders, owners, and architects.

HISTORY:

Date of Implementation: 1985
Current Status: On hold.
General Comments:

MARKETING/PROMOTION METHODS: The City has been marketing its demand-side management programs in neighborhoods, by way of presentations to neighborhood groups. The City has produced "home energy guidelines" for neighborhoods, has made public service announcements on energy on television, and produced 15-20 minute cable programs on energy.

MONITORING/EVALUATION:

Market penetration: 10 developers; no new buildings have been built under the program; home energy guidelines have been prepared for 7 neighborhoods located throughout the city.

Savings:
- Energy:
- Peak:
- Dollars:

Costs and cost-effectiveness:

- Program administration:
- Incentives:
- Private investment:

Discussion:

The software has lots of potential. The City is in the process of convincing the municipal utility to take on these programs as part of their demand-side planning efforts. The City wants to reduce 400 to 700 MW by the year 2000. Recently, the City and the utility created a Demand-Side Management Committee to evaluate demand-side management programs and to make recommendations to the utility for implementing these programs.

RELATED PROGRAMS: The City offers rebates for high efficiency air-conditioners and heaters and is considering a high efficiency lighting program.

REFERENCES: Myers and Diserens, 1985.

CONTACTS:

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DATE: June 22, 1988

Name: Mike Myers
Position/title: (formerly an energy specialist with the City of San Antonio)

DATE: Oct. 30, 1987 / June 29, 1988

NEW RESIDENTIAL PROGRAMS (RES/COM-2)

PROGRAM TITLE: Solar Design Strategies

PROGRAM SPONSOR: Passive Solar Industries Council (PSIC)

PROGRAM OBJECTIVES: To deliver state-of-the-art design information in a simple, practical format--targeted to one specific local area, and adaptable to a builder's own designs, markets, and requirements.

APPROACH: The PSIC prepared a set of building design tools (Solar Design Strategies) offering specific passive solar design information for homes in each of six local climates in North Carolina and in Minnesota. The guides were introduced at two pilot workshops for builders in Raleigh, N.C. and Minneapolis, Minnesota. Each package included a 20-page guidelines booklet presenting detailed information about a range of options for achieving various levels of energy performance; a four-page worksheet to help the builder or designer pre-evaluate the effects of different strategies; and an example booklet, complete with instructions, an example house, and filled-out worksheet. The guidelines are not considered a primer on energy conservation or passive solar design, although they do show what is important in the design of passive solar homes. The guides are intended for either residential or commercial buildings with modest internal gains (generally less than 5,000 sq. ft.).

TARGET BUILDING TYPES: New residential and new commercial.

KEY PARTICIPANTS: PSIC, U.S. Department of Energy, Solar Energy Research Institute, Los Alamos National Laboratory, Florida Solar Energy Center, the National Association of Home Builders, builders, and designers.

HISTORY:

Date of Implementation: 1984
Current Status: Continuing
General Comments: The guides were developed over a three year period. Eventually, the guidelines will be available for more than 2,400 locations across the U.S.

The genesis of this work was the research carried out by Doug Balcomb at Los Alamos National Laboratory (LANL) on passive solar design tools (Volumes 1, 2, 3, and 4 of the Passive Solar Design Handbook). Volume 1 (1980) was a qualitative introductory review of passive solar design and how it worked. Volume 2 (1980) was a very quantitative calculation manual and included standards for passive solar performance and ways in which such standards might be obtained. Volume 2 contained complete performance calculations and design details for six different passive systems and was the first of its kind as a design handbook. Volume 3 (1982) was a refinement of Volume 2 and covered 94 different passive design systems at 219 different locations across the U.S. and Canada. Volume 4 (1984) (*Passive Solar Heating Analysis: A Design Manual*) was the product of a joint effort between LANL and the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) and was a much simplified rewrite of Volumes 2 and 3 and included new R&D results. At least five software companies have converted the handbook techniques to microcomputer programs, making the process easy and understandable.

The utility of these tools was demonstrated through the New Mexico Showcase of Solar Homes, a passive solar residential construction project. Guidelines and

standards for solar performance, based on the Design Handbook, were used in the Showcase of Solar Homes. In this program, builders accepted the guidelines for constructing homes, and 20 model solar homes were built in 1983. All homes made use of such primary passive solar techniques as south-facing indirect gain sunspaces and Trombe walls or direct gain windows and clerestories for both heating and daylighting. In addition, they all incorporated many standard conservation and solar measures, such as insulated double-glazed windows, thick wall and ceiling insulation, tile floors, and adobe walls for thermal mass.

The replication of the New Mexico program was attempted in Wichita, Kansas, where homes were built in a housing development incorporating Balcomb's design tool. Six builders were involved in the program, and by 1985, ten of the thirteen homes built at the site were sold. Larger builders were not attracted to the program. The Wichita replication was considered to be only a moderate success.

The Passive Solar Design Handbook Volume 3 and the passive solar design and standards previously developed for the New Mexico Showcase of Solar Homes have also been used as part of the regular instruction given by the Public Service Company of New Mexico to the drafting department of the Luna Vocational Technical Institute (Las Vegas, New Mexico). Three houses designed by students were built in Las Vegas, and an open house was held after the passive solar all-electric houses were built. This Passive Solar Homes Program received a National Award for Energy Innovation in 1987.

MARKETING/PROMOTION METHODS: "Multiplier workshops" will be held: workshops with utility technical service people or with executive directors of local home builder associations, so that they can conduct their own workshops on the guidelines.

MONITORING/EVALUATION:

Market penetration:

Savings:
- Energy:
- Peak:
- Dollars:

Costs and cost-effectiveness:
- Program administration:
- Incentives:
- Private investment:

Discussion: Too early to say; program just started.

RELATED PROGRAMS:

REFERENCES: *Energy and Housing Report* Nov. 1987, p.4; Lambright and Sheehan, 1985; U.S. Department of Energy, 1987a; and Passive Solar Industries Council, 1987.

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DATE: Dec. 8, 1987 / June 6, 1988

NEW RESIDENTIAL PROGRAMS (RES/COM-3)

PROGRAM TITLE: Passive Solar Manufactured Buildings Program (MBP)

PROGRAM SPONSOR: U.S. Department of Energy's (DOE) Passive Solar Buildings Program

PROGRAM OBJECTIVES: To stimulate the reduction in the consumption of nonrenewable energy resources in manufactured buildings through the use of energy conservation and passive solar design technologies; to support the design and implementation of exemplary passive solar manufactured buildings; to identify the cost and performance of passive systems in manufactured buildings; to facilitate public and designer education and provide information about the benefits of passive solar design; to demonstrate the practical and architecturally pleasing opportunities of passive solar use in manufactured buildings; and to identify low-cost passive heating systems appropriate for integration into manufactured buildings and to integrate them into the design of the buildings.

APPROACH: The overriding goal of this program was to commercialize new passive designs in manufactured buildings. There were three phases in the program: design, prototype construction, and monitoring and marketing. These three phases were conducted separately, with funding for each successive phase contingent on DOE approval of its forerunner. Federal money started Phase I, with cost-sharing coming in Phases II and III. Twenty-six manufacturers began the program in 1979, but because of money problems (cutbacks at DOE), only eight firms moved into Phase II and survived to have their buildings monitored in Phase III. However, the Solar Energy Research Institute (SERI) suffered budget restrictions and was unable to complete all of the monitoring.

TARGET BUILDING TYPES: New residential and commercial manufactured buildings

KEY PARTICIPANTS: DOE, SERI, builders, and manufacturers.

HISTORY:

Date of Implementation: 1979
Current Status: Ended in 1984
General Comments: The MBP was a demonstration program under the Solar Heating and Cooling Act, implemented by DOE and the U.S Department of Housing and Urban Development (HUD). Approximately 30% of annual single-family housing starts are factory built.

MARKETING/PROMOTION METHODS: A Request for Proposals was sent out, followed by direct personal communication with the largest builders. Each manufacturer participating in Phase II received $15,000 from DOE.

MONITORING/EVALUATION:
Monitoring was restricted due to budgetary problems. Monitoring of the thermal performance of passive systems in five residential and three nonresidential manufactured buildings was conducted with Class B monitoring equipment by SERI. In addition, building cost and cost savings were determined. Results were reported for individual buildings (see SERI report), but not for the entire program.

Market penetration: Acorn Structures, Inc., of Concord, Mass., which manufactures and sells manufactured houses nationwide, added several passive designs

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to their product line and sold at least 20 homes as a direct result of the program. Usury, Inc., of Richmond, Va., added a direct gain design and a solarium design to their product line. Several of the other manufacturers incorporated passive and energy conservation features into their basic product line, although no detailed survey has been made to determine actual sales.

Savings:
- Energy:
- Peak:
- Dollars:

Costs and cost-effectiveness:
- Program administration:
- Incentives:
- Private investment:

Discussion:

New product lines were considered, interest in passive solar construction was sparked, and various building manufacturers developed new competence in the passive solar field. Energy conservation is now routinely considered within the industry, as well as passive solar on a limited scale. The industry recognizes solar principles and has made changes to their designs, but they have not executed passive solar design to the full extent.

There were problems for the manufacturing industry associated with working with the government: delay of payment, excessive and redundant paperwork, and difficulty in dealing with changing requirements relating to control procedures.

The MBP ended due to budget reductions and market uncertainties.

Lutha and Sargent felt that the buildings that were built in the program were successful: technically, passive solar designs worked. However, because there was a depressed housing market at the time, people were more concerned with initial costs, rather than with lifecycle or operating costs. The passive solar designs, therefore, did not catch on in the marketplace. Consequently, Lutha felt that a certain amount of marketing is needed, perhaps aimed at the upper-income groups who were the most likely potential homebuyers. The MBP had not targeted this group; the MBP had tried to keep the costs low so that the homes would be attainable by a broad segment of the population. This strategy might have been wrong.

RELATED PROGRAMS:

REFERENCES: Solar Energy Research Institute, 1986; Lambright and Sheehan, 1985.

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DATE: Jan. 7, 1988 / July 14, 1988

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DATE: Jan. 7, 1988 / June 24, 1988

NEW RESIDENTIAL PROGRAMS (RES/COM-4)

PROGRAM TITLE: California's Conservation Standards for New Buildings (Title 24)

PROGRAM SPONSOR: California Energy Commission (CEC)

PROGRAM OBJECTIVES: To promote energy-efficient construction in new residential and new commercial buildings through building regulations, training workshops, and design tools.

APPROACH: Mandatory state conservation standards required by the State Legislature for new residential buildings were adopted in 1975, became effective in 1978, and were revised in 1982, 1983, and 1987. Similarly, nonresidential building standards became effective in 1978, and at the request of the building industry, were revised in 1983 and 1985 in a joint cooperative effort. These standards were innovative, since they were the first such standards adopted anywhere in the United States.

California's new **residential** building standards (1982) include mandatory measures and infiltration control that all new residential buildings must have, and are based on efficiency measures, such as substantially increased wall and ceiling insulation, special thermostat controls, double-paned windows, window shading, limited glazing area, and efficient equipment. They also allow the use of solar water heating, and any appliance installed by a builder in a new residential building must comply with minimum appliance efficiency standards.

Energy budgets were established for each of 3 building types in 16 different climate zones in the state. The three building types are single-family detached, single-family attached, and multifamily. Once all of the mandatory measures have been included in the building design, there are two options for demonstrating compliance with the energy budget: the prescriptive approach and the performance approach.

The prescriptive approach is the most straightforward approach to compliance. Builders and design professionals following the prescriptive path select from five lists of conservation measures, called alternative component packages, which meet the standards. All the measures from the selected list must be incorporated in the building design. The components in each list were chosen so the package was equivalent with annual energy budgets. The major difference between the packages is which measure is emphasized for achieving the energy savings. The choice of which package to use is left up to the designer and each is sufficient for code compliance.

The performance approach requires more effort in demonstrating compliance but allows a wider variety of design measures and thus provides greater flexibility than the prescriptive approach. In the performance approach, the code specifies an annual custom energy budget for the building based on size, location, and other characteristics. The energy budget is determined by the designer by modeling the building design with the measures required in an alternative component package. The designer must demonstrate that the building will use no more energy than is specified by the custom energy budget. The performance approach permits the designer to trade off different aspects of the building design, one against the other, as long as the final design does not exceed the established energy budget. The two basic calculation methods available for demonstrating compliance with the

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performance approach are a point system and a computer program. The point system assigns positive or negative points to every common design option based upon its impact on energy consumption. By incorporating options that achieve the correct point total, the designer can determine if a particular building meets the energy budget. Private vendors must certify to the CEC that their computer programs meet the requirements for determining compliance with the building efficiency standards. There are currently three private vendor computer programs which may be used to determine compliance.

The new **nonresidential** standards (1983) are very similar to the current residential standards in that: (1) the state has been divided into 16 climate zones, (2) there are mandatory features which must be met, and (3) there are two compliance approaches (prescriptive packages and performance approaches). The mandatory measures include the following: pipe insulation, appliance and equipment efficiencies, controls for lighting and space conditioning systems, ventilation system design, control of air leakage through windows and doors, and service water heating system design. For each climate zone, the CEC established prescriptive packages which automatically meet the new standards. These packages prescribe insulation levels, glazing percentages and shading coefficients, lighting levels, and space conditioning systems. For prescriptive methods, compliance with the energy budget may be achieved by installing one of these alternative component packages (no computer calculations are required to demonstrate compliance if one of these packages is used). The required components in each alternative component package vary according to building occupancy type and climate zone. In more energy intensive occupancies, more energy conservation efforts are cost-effective. The prescriptive approach is appropriate for building designs that are relatively simple and can be designed satisfactorily with the components specified in the alternative component packages.

The performance approach provides the greatest flexibility of building design and lighting and mechanical systems. In the performance approach, a design is modelled with an approved computer simulation program. If the design meets a specified building energy budget, it complies with the standards. The CEC has established building energy budgets for low-rise (1-3 stories) and high-rise (4+ stories) offices and for retail and wholesale stores in each climate zone. Two public domain computer programs are available for determining compliance using the performance approach. DOE-2.1C is used for larger, more complex buildings. SCM is used for smaller, simpler buildings.

The new nonresidential standards differ from the previous standards in the following ways: they reduce lighting and related space conditioning through improved lighting design, more efficient equipment, and daylighting; they increase the use of passive solar techniques (thermal mass and shading); they provide a more efficient building envelope (more efficient window systems); they provide for ventilation, emphasizing indoor air quality by referencing ASHRAE Standard 62-1981; and they improve space conditioning system efficiency through more efficient equipment and effective use of economizers.

The new nonresidential standards will eventually cover the range of commercial and industrial building types, as well as high-rise residential buildings. The new standards first addressed the buildings most often being constructed, emphasizing the major energy-using buildings. These included office buildings and retail and wholesale stores. Future standards for grocery stores, schools, restaurants, hospitals, nursing homes, hotels, motels, high-rise residential buildings, auditoriums, gymnasiums, warehouses, and miscellaneous buildings will be developed.

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The revised nonresidential standards for **office buildings**, adopted in 1984, were voluntary (optional) until January 1, 1987, when they became mandatory. They were optional for two years to allow time for builders and designers to better understand and prepare for the changes. The new energy standards require few, if any, design changes to the envelope of most new office buildings. The most significant changes fall into three categories: lighting, space conditioning systems, and building department compliance documentation. The most significant changes will be in the lighting system with an emphasis on the use of lower levels of overall lighting and greater use of daylighting and tasklighting. With the lower lighting levels, construction cost may decrease since the subsequent lower cooling loads will allow the installation of smaller air-conditioning systems. And the smaller systems and loads will reduce operating costs. Even though some of these changes are significant, they are not expected to be difficult to meet. The new standards are also expected to help designers better understand the efficiency of their designs.

The CEC adopted revised energy standards for **retail and wholesale stores** in 1985 and new lighting standards for all occupancies, except schools, in 1987, which became mandatory on July 1, 1988. These regulations were incorporated into the regulations already adopted for office buildings, and include both performance and prescriptive requirements. The performance requirement for retail stores differs from offices in lighting power density; the prescriptive retail standard requirements relate to lighting and ventilation.

The nonresidential standards development process used a different approach than the process used for developing the residential standards. The Nonresidential Building Standards Development Program was conducted as a joint industry and government effort. The revision period for offices started in August 1981 and lasted two and one-half years. From the beginning, CEC sought the participation of building industry professionals, representing about 50 industry organizations, in drafting the standards. Throughout the process, the CEC consulted with both a Technical Review Committee (TRC), made up of specialists in six areas of building design and construction, and a Professional Advisory Group (PAG) that included architects, engineers, builders, building officials, and building investors and operators. The intent of the CEC in establishing the PAG was to provide a vehicle for industry input into the standards development process, to ensure that the standards ultimately developed would be workable in the mainstream of the industry. The cooperative work of the CEC and these industry members was presented to interested parties and the general public in over 31 hearings and meetings. Individual specialists in the advisory groups also provided direct assistance to various aspects of the staff work throughout the process, including the development of engineering and economic assumptions used in the analysis.

The three-year transition period for offices was designed to allow for gradual industry assimilation, feedback, and refinement of the standards and of the tools to implement them. Development of the standards was guided by the CEC using the criteria that they (1) should not require undue deviations from current design and construction practice; (2) should not reduce the environmental quality and marketability of buildings; (3) should provide simple methods of compliance; and (4) should be based on conservation measures which have been shown to be practical, reliable, available, and cost-effective. The standards met these goals.

The CEC is working with builders, building officials, and consumer groups to ensure consistent and effective implementation of its present standards. The residential

and nonresidential building standards are enforced by city and county building departments, which are to issue building permits only after reviewing plans for compliance.

TARGET SECTORS: New residential and new commercial

KEY PARTICIPANTS: CEC, builders, and the design community

HISTORY:

Date of Implementation: 1982
Current Status: Continuing
General Comments: There are more than 500 building departments in California. They range in size from 2 to 4 person departments with a $100,000 budget to 400 persons with an $80 million budget.

MARKETING/PROMOTION METHODS: Training classes (seminars/workshops) are offered through professional organizations, by architects, building designers, building officials, and other industry representatives. Over 10,000 professionals have been trained. The CEC 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 the performance standards: public domain computer programs were developed along with a method for verifying and approving private vendor computer programs. A design compliance manual was written from a building designer's point of view, to be 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. To date, such tools have not been provided to building designers by the private sector. These tools were completed simultaneously with the development of standards.

With the assistance of the CALBO Advisory Committee (five building officials) and the Residential Advisory Group, the CEC has produced additional materials to assist in the implementation of the efficiency standards. Compliance forms were provided to local building departments to simplify the plan review process. Educational materials were also developed to simplify compliance by the building industry. A monthly newsletter was prepared that contained articles about the standards, staff interpretations of the standards, and answers to questions about the standards. A toll-free telephone line (hotline) was established to provide immediate answers to questions about the standards.

MONITORING/EVALUATION:

Market penetration:

Savings:

- Energy: For new low-rise office buildings, energy use is estimated to be reduced by 40% to 50% compared to current (1978) Title 24 standards; a savings of 85,000 Btus/sq. ft./yr. is expected for a typical 10,000 sq. ft. office in Fresno. Energy savings from retail building standards are estimated to be 7 billion kWh statewide for the years 1985-2004. For residential buildings, savings of 80% to

90% for heating and cooling and 50% to 70% for hot water are estimated (a total energy use reduction of 50% is expected, compared to pre-1975 homes). Compared to pre-1975 homes, homes built to the new standards will save an estimated 280 billion kWh of electricity and 25 billion therms of natural gas statewide by the year 2000.

The California Energy Commission has estimated the annual energy savings of their conservation programs on electricity use and natural gas use for each of four specific years:

	Electricity Savings (Gwh)			
	1983	1990	1997	2005
1975 Residential Building Standards	850	1798	2601	3337
1978 Residential Building Standards	51	179	291	393
1983 Residential Building Standards	45	764	1467	1989
1978 Commercial Building Standards	778	2091	3123	4102
1984 Commercial Building Standards	0	857	1783	2426
1984-86 Commercial Building Standards	0	420	867	1275

	Natural Gas Savings (MMth)			
	1983	1990	1997	2005
1975 Residential Building Standards	290	637	913	1,160
1978 Residential Building Standards	14	55	88	120
1983 Residential Building Standards	0	72	133	184
1978 Commercial Building Standards	20	28	49	72
1984 Commercial Building Standards	0	-9	-16	-21
1984-86 Commercial Building Standards	0	0	0	-1

- Peak: For residential buildings, a savings of about 2,000 MW is estimated for the year 2000. The California Energy Commission has estimated the impacts of their conservation programs on peak load for each of four specific years:

	Peak Demand Savings (MW)			
	1983	1990	1997	2005
1975 Residential Building Standards	496	1082	1583	1956
1978 Residential Building Standards	16	45	70	93
1983 Residential Building Standards	0	250	488	562
1978 Commercial Building Standards	289	789	1207	1611
1984 Commercial Building Standards	0	344	719	978
1984-86 Commercial Building Standards	0	116	265	407

- Dollars: Initial construction cost savings of $11,200 for the same typical low-rise office in Fresno, with energy-related operational costs reduced by $325,000 over the building's lifecycle. For residential buildings, a cumulative cost savings to consumers of about $30 billion is estimated by the year 2000.

Costs and cost-effectiveness: The standards would cause an initial increase in the cost of the pre-1975 house of between $5,000 and $8,000.

- Program administration:
- Incentives:
- Private investment:

Discussion:

Major advantages of the revised standards are improvements in design flexibility, simplified procedures for compliance, and, in many cases for nonresidential buildings, reduction in construction costs due to smaller equipment sizes and more efficient lighting and mechanical systems.

One of the significant factors preventing more energy-efficient designs has been the lack of simple, low-cost, and readily available analysis tools that provide reliable, useful information on the energy performance of design measures. The new standards are accompanied by a range of methods, each suited to application for particular buildings and situations. Designers should find these tools useful not only for demonstrating compliance with the performance approach, but also as a source of valuable information during design development.

Constructing some nonresidential buildings to comply with "second generation" standards (those adopted in 1984 for offices) while constructing others under "first generation" standards (those adopted in 1978 for all other buildings) complicates compliance for the building industry. The same problem existed for residential buildings in the early 1980s.

The residential building standards implemented by the CEC in 1983 provided numerous performance-oriented options for compliance, to provide more flexibility to the industry, however, these options made compliance with the standards more complex. Additional options provided through legislation (AB 163) further increased the flexibility and complexity of the standards. A recent monitoring study of the program (plan checking and field monitoring of 113 residential and 40 nonresidential buildings) indicated that the more complex the methods of compliance become, the more chances for error and less compliance.

Given this complexity, implementing the standards has required major ongoing educational efforts for building industry professionals and the staffs of local building departments. There is a clear need for the CEC to establish more understandable procedures and to expand and improve its technical assistance programs. Accordingly, the CEC has worked with the California Building Codes Institute to establish regional training and plan check centers for building officials, is developing a computer information network for the building industry and building departments, has developed a concise custom budget procedure, has developed a new, more accurate and simple point system, and in cooperation with representatives of the building community has sponsored numerous training sessions. In addition, the CEC has worked with vendors to develop simplified computer programs to show compliance with the performance standards, and continues to provide a hotline for builders.

Most building departments have limited staff to enforce health and safety standards

and the energy conservation standards. Under these conditions, health and safety standards receive a higher priority than the energy standards.

RELATED PROGRAMS: California's energy conservation standards for residential and nonresidential buildings have been used as the basis of energy conservation standards by the Northwest Power Planning Council, South Dakota, Alaska, and the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE's (Standard 90).

REFERENCES: Doug Beaman, "Non-Residential Energy Standards: Offices," *Northern California Sun*, Northern California Solar Energy Association, 3(4):9-10 (1986); C-Engineering, 1986; C-Engineering, *Annual Report: 1985-86*, Prepared for the California Energy Commission, Contract Number 400-85-013, Sacramento, Calif., 1986; California Energy Commission, *Building Energy Efficiency Standards: 1988 Edition*, Report P400-88-001, Sacramento, Calif., 1988; California Energy Commission, *Energy Conservation Manual for New Residential Buildings*, Report P400-88-002, Sacramento, Calif., 1988; California Energy Commission, *Alternative Calculation Methods Approval Manual for the Low-Rise Residential Building Energy Efficiency Standards, Sacramento, Calif., 1988; California Energy Commission, 1987 Biennial Report: California's Energy Outlook*, Report P106-87-002, Sacramento, Calif., 1987; California Energy Commission, *Energy Efficiency Manual - Second Generation Nonresidential Standards*, Report P400-86-010, Sacramento, Calif., 1986; California Energy Commission, *Conservation Report*, Report P400-86-020, Sacramento, Calif., 1986; California Energy Commission, *1985 Energy Efficiency Standards: Training Guide for Office Building Compliance*, Report P400-86-002, Sacramento, Calif., 1986; California Energy Commission, *Preliminary Conservation Report*, Report P400-85-010, Sacramento, Calif., 1985; California Energy Commission, *Initial Study/Negative Declaration: Retail Building Standards for Nonresidential Building Standards Program*, Report P700-85-001, Sacramento, Calif., 1985; California Energy Commission, "New Energy Efficiency Standards for Nonresidential Buildings: A Comprehensive Summary of the Streamlined Standards for Office Buildings." Sacramento, Calif., 1984; California Energy Commission, *Notice to Local Building Officials: New Point Tables and Point Scores for Compliance with AB 163*, Report P400-84-005, Sacramento, Calif., 1985; California Energy Commission, *California Energy Commission Blueprint*, No. 1, Summer 1984; California Energy Commission, *1983 Biennial Report: Securing California's Energy Future*, Sacramento, Calif., 1983; California Energy Commission, *Staff Proposal for Nonresidential Building Standards*, Report P400-83-019, Sacramento, Calif., 1983; California Energy Commission, 1983a; California Energy Commission, "Nonresidential Building Standards Development Program Update," Sacramento, Calif., 1983; California Energy Commission, *Staff Proposed Methodology for Setting Energy Efficiency Standards for Nonresidential Buildings*, Report P400-82-020, Sacramento, Calif., 1982; California Energy Commission, *Professional Advisory Group (PAG) to the California Energy Commission on the Energy Conservation Standards for New Nonresidential Buildings*, Report P400-82-050, Sacramento, Calif., 1982; California Energy Commission, *Energy Conservation Standards for New Nonresidential Buildings*, Report P400-82-054, Sacramento, Calif., 1982; California Energy Commission, *Energy Efficiency in the Commercial, Industrial, and Agricultural Sectors: Progress and Prospects*, Report P103-82-001, Sacramento, Calif., 1981; California Energy Commission, *Building Regulations Applicable to Residential Buildings*, Report P400-81-005, Sacramento, Calif., 1981; California Energy Commission, *Proposed Residential Building Standards: Draft Environmental Impact Report*, Report P700-80-013, Sacramento, Calif., 1981; California Energy Commission, *Regulations Establishing Energy Conservation Standards for New Nonresidential Buildings*, Report P400-80-002, Sacramento, Calif., 1980; California Energy Commission,*Regulations*

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Establishing Energy Conservation Standards for New Residential Buildings, Report P400-80-003, Sacramento, Calif., 1980; California Energy Commission, *Overview of the Proposed 1980 Residential Building Standards*, Report P400-80-038, Sacramento, Calif., 1980; California Energy Commission, *Proposed 1980 Residential Building Standards*, Report P400-80-037, Sacramento, Calif., 1980; California Energy Commission, 1980; California Energy Commission, *Regulations Establishing Energy Conservation Standards for New Residential and New Nonresidential Buildings*, Sacramento, Calif., 1978; Feinbaum, 1983; Horobin, 1986; Huston, 1986; Pennington, 1986; Wilms, 1982; and Wilson, 1985.

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DATE: July 22, 1988

NEW RESIDENTIAL/COMMERCIAL PROGRAMS (RES/COM-5)

PROGRAM TITLE: Florida Energy Code and Marketing Program

PROGRAM SPONSOR: State of Florida

PROGRAM OBJECTIVES: To promote energy-efficient buildings.

APPROACH: The Florida Energy Efficiency Code for Building Construction sets minimum energy-efficiency requirements for new construction, additions to existing buildings, and substantially renovated buildings. New buildings, both residential and nonresidential, must be designed to comply with the code. The code provides a uniform standard for thermal efficiency by regulating the design of the building's exterior envelope and the selection of energy-consuming heating, air-conditioning, and water heating systems for the building. The code is a performance-based code, although some residential buildings can comply with a prescriptive method. Major revisions have been made to the residential portion of the code; they are planning revisions for the commercial portion (based on new ASHRAE 90).

There is no regulatory authority over the building departments: all enforcement authority is given by State law to the local enforcement agencies, usually the local building department. The State, therefore, relies heavily on the proper training of building code personnel to enforce the code. Owners of buildings must certify compliance with this code to the local building department prior to receiving a permit for construction or renovation. The local building department inspects the buildings for compliance with the standards before construction or renovation. The local building official also issues an energy performance index display card that is placed on the building permit at the time of final inspection by the building department.

TARGET SECTORS: New and existing residential and commercial

KEY PARTICIPANTS: Florida Department of Community Affairs (DCA), Florida Home Builders Association, Governor's Energy Office, University of Florida's Solar Energy and Energy Conversion Laboratory, Building Officials' Association of Florida, builders, developers, and homebuyers.

HISTORY:

Date of Implementation: Oct. 1, 1980 (state code became effective)
Current Status: Continuing
General Comments:

MARKETING/PROMOTION METHODS: The DCA conducts 30-40 training seminars per year, and they are in the process of preparing energy code training materials. They do not use private contractors for the training programs. They have received good support from the municipal and investor-owned utilities, Florida Home Builders Association, and the Building Officials' Association of Florida, which have provided organizational support for putting on the seminars.

The code has a Residential Points System Method, called an Energy Performance Index (EPI): builders who meet the standards get 100 EPI points; if they include additional energy-efficient technologies, their points are reduced. The Method can be used both as a design and

sales tool. The local home builders associations (HBA) have helped in promoting compliance with the state standards; in addition, solar energy entrepreneurs and other experts have formed organizing committees within the local HBA to push for educating builders about the state standard. One local HBA has developed a home rating program (4 or 5 stars), using the EPI as the basis of their program. The Florida HBA designed a reference manual to assist home builders and buyers. The manual contains current energy-saving building design concepts and products applicable to Florida's climate, as well as a detailed explanation of the state code. The Florida HBA also prepared a videotape, brochure, and educational seminars.

MONITORING/EVALUATION:
The State does not know how well the building departments are enforcing the code. The DCA receives quarterly reports from the building departments which consist of energy component summary sheets submitted by the builders with their application for a permit. The DCA is currently developing a residential data bank from these reports and plan to provide this information to building departments and to any other interested parties. The information should be available in the Fall of 1988. There is no on-site monitoring.

Market penetration:

Savings:
- Energy: From 1980-83: 35 x 10^{12} Btu (estimated)
- Peak: Not addressed by the code.
- Dollars:

Costs and cost-effectiveness:
- Program administration:
- Incentives: None.
- Private investment:

Discussion:
The Florida Energy Code won an Energy Innovation Award from the U.S. Department of Energy in 1984. The Florida Improved Home Energy Code and Marketing Program won a similar award in 1986.

Private contractors are not used for holding training programs because: (1) the DCA has found that in the past that it is difficult for a contractor to provide the consistent and in-depth training that they would like (especially, in regard to interpretations, intent, and product installation); (2) it is very important that the State present as unpartial a representation of materials and products as possible; (3) using their own staff helps them develop good relations with the enforcing agencies, so that they contact the DCA when they need interpretations or clarifications; and (4) by running training programs, the DCA staff understand the problems the enforcement agencies may be having, areas in the code that may need clarifying or updating, and new products and materials that are currently available.

RELATED PROGRAMS: California's Title-24 code and program (see writeup).

REFERENCES: U.S. Department of Energy, 1984, 1986a; "Florida Energy Efficiency Code for Building Construction," brochure prepared by the Florida Department of Community Affairs, Tallahassee, Fla.

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NEW RESIDENTIAL PROGRAMS (RES/COM-6)

PROGRAM TITLE: Whole Building Performance Standards

PROGRAM SPONSOR: U.S. Department of Energy (DOE)

PROGRAM OBJECTIVES: To develop performance standards to achieve the maximum practicable improvements in energy efficiency and use of non-depletable resources for all new buildings.

APPROACH: The proposed interim mandatory energy conservation standards for new Federal **residential** buildings require a Federal agency to establish an energy conservation goal for the design of a new Federal residential building using COSTSAFR (Conservation Optimization Standard for Savings in Federal Residences), a designated Federal microcomputer program. The agency must then adopt such procedures as may be necessary to assure that the design of such a building is not less energy conserving than the energy consumption goal established for the design.

COSTSAFR determines the most effective set of energy conservation measures that will produce the optimum life cycle cost for a specific type of residential building in the geographic location where it will be constructed. This most effective set of measures is expressed as a total point score which, in turn, serves as the energy consumption goal for the design of a Federal residential building. COSTSAFR produces a compliance point system that is intended to be used by Federal officials in the very beginning of the procurement process enabling Federal officials to develop housing Requests for Proposals (RFPs) for their construction projects. This will give bidders the ultimate amount of design flexibility while assuring that energy conservation objectives will not be compromised. The point system is to be used by proposers to demonstrate that their specific designs comply with the energy consumption goal. The point system also provides a standard method for each proposer to estimate the energy cost over the life of the building in discounted dollars. This estimate can then be used by evaluators to estimate the total energy performance of each proposal.

For Federal residential buildings, the performance standards are mandatory design requirements; 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.

The interim energy conservation voluntary performance standards for new **commercial and multi-family high rise residential** buildings require Federal agencies to design their buildings to satisfy the energy efficiency requirements of these proposed standards. These standards would 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 by the American Society of Heating Refrigerating and Air-Conditioning Engineers, Inc.

The proposed standards contain Principles of Effective Energy Conserving Building Design that provide designers with ways to produce good building energy designs. The principles encouraging good design practice are:

- minimize the impact on functional requirements
- reduce loads
- reclaim waste energy where possible
- use renewable energy where possible
- improve energy using system efficiency

- improve transport system efficiency
- control operation and scheduling of systems
- optimize the interaction of the above

The design procedures and specific strategies that would be used to accomplish the conservation objectives that underlie the above principles are presented sequentially from building loads, through systems, to energy management control systems and building operation and documentation so as to parallel the building design process.

There are three methods of compliance with the standards: prescriptive, system performance, and energy budget. The prescriptive alternative specifies particular building elements, such as the attributes of the building envelope, efficiency of lamps and ballasts, or the coefficient of performance (COP) of air conditioners. The prescriptive alternative affords simplicity of calculations at the expense of design flexibility. The prescriptive criteria method requires the minimum amount of calculation and effort to achieve compliance, but permits only a few tradeoffs or optimization procedures. The systems performance alternative specifies criteria for the design of the energy-using and transfer systems of buildings. The systems performance criteria can be the method of choice when a more innovative design is required, although it requires some increased calculation compared with the prescriptive method. The energy budget approach allows compliance with even the most innovative design concepts to meet the proposed interim standards, but will require the use of a computer program to model building energy use in accordance with building loads and the proposed schedules of operation.

TARGET BUILDING TYPES: Residential (single-family and multifamily buildings less than 4 stories high), and commercial (including multifamily highrises that are 4 stories or more)

KEY PARTICIPANTS: DOE

HISTORY:

Date of Implementation: Research began in 1976
Current Status: See below.
General Comments: In 1976, Congress passed legislation (the Energy Conservation and Production Act) requiring the promulgation of energy conservation standards for buildings. In 1979, DOE issued a Notice of Proposed Rulemaking (NOPR) for building energy performance standards (BEPS). BEPS specified maximum levels of total building energy consumption (BTU/ft^2/yr.) to which new buildings would be designed. The most significant aspect of the BEPS was that it was a whole building performance standard that required computer simulations to demonstrate that the designed energy consumption of a new building did not exceed the energy level specified for the building type in its applicable climate area. In contrast to BEPS, ASHRAE-based state standards are component performance standards that identify minimum performance criteria for the major components of a building (i.e., envelope, heating, ventilation, air-conditioning, and lighting systems). The BEPS, therefore, represented a radical departure from the standard practices of the building community in that it required a "whole building" approach rather than a building component by component compliance process. Additionally, it required a computer simulation analysis in place of hand written compliance procedures. The ASHRAE Standards also contain a whole building performance design approach but it is less frequently used.

The NOPR was controversial and generated over 1800 comments, totaling

40,000 pages. The comments included technical and other substantive criticisms of the performance standards, and, accordingly, DOE decided to reevaluate their position. Since the publication of the proposed standards, the Act was amended twice, resulting in two approaches: mandatory design requirements for Federal residential buildings, and voluntary performance standards for non-Federal residential buildings. In August 1986, DOE issued a NOPR for Federal residential buildings (the Department of Defense constructs many residential buildings). In May 1987, DOE issued a NOPR for commercial buildings. DOE is planning to issue interim rules for commercial buildings and Federal residential buildings in FY 1988. DOE is developing standards for all other residential buildings, and a NOPR is expected to be issued this FY 1988.

After the interim rules are issued, there is required a demonstration period of one year, followed by a report to Congress six months after the publication of the demonstration report. DOE has decided that the interim rules for commercial buildings will be mandatory for all Federal agencies.

MARKETING/PROMOTION METHODS:

MONITORING/EVALUATION:

Market penetration:

Savings:

- Energy: Compliance with the provisions of the interim standards will provide a range of 15% to 30% in annual energy savings to Federal agencies constructing office buildings.
- Peak:
- Dollars:

Costs and cost-effectiveness:

- Program administration:
- Incentives:
- Private investment:

Discussion:

RELATED PROGRAMS: DOE and the Pacific Northwest Laboratory are developing "whole-building energy design targets" for commercial buildings (see writeup). DOE is also developing general design criteria for buildings that incorporate new design standards and are very generalized (see writeup). The three methods of compliance are very similar to those used in California's new commercial building standards (see writeup).

REFERENCES: U.S. Department of Energy, 1986c, 1986d, 1986e, 1987c; U.S. Department of Energy, *COSTSAFR -- User's Manual, in Support of Proposed Interim Energy Conservation Standards for New Federal Residential Buildings,* Washington, D.C., 1986; U.S. Department of Energy, *Environmental Assessment in Support of Proposed Interim Energy Conservation Standards for New Federal Residential Buildings,* Washington, D.C., 1986; U.S. Department of Energy, *Lighting Prescriptive and System Performance Compliance Calculation Program Documentation - Version 1.0, in Support of Proposed Interim Energy Conservation Standards for New Commercial and Multifamily Highrise Residential Buildings,* Washington, D.C., 1986; U.S. Department of Energy, *Envelope System Performance Compliance Calculation Program Documentation - Version 1.0, in Support of Proposed Interim*

Energy Conservation Standards for New Commercial and Multifamly Highrise Residential Buildings, Washington, D.C., 1986; U.S. Department of Energy, *Economic Analysis, in Support of Proposed Interim Energy Conservation Standards for New Commercial and Multifamly Highrise Residential Buildings*, Washington, D.C., 1986; and U.S. Department of Energy, *Environmental Assessment, in Support of Proposed Interim Energy Conservation Standards for New Commercial and Multifamly Highrise Residential Buildings*, Washington, D.C., 1986.

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DATE: Dec. 4, 1987

NEW COMMERCIAL PROGRAMS (RES/COM-7)

PROGRAM TITLE: Energy Conservation Awards

PROGRAM SPONSOR: Owens-Corning Fiberglas Corporation

PROGRAM OBJECTIVES: To recognize architects and engineers (A&E) and building owners who had made significant contributions to energy conservation through creative design techniques.

APPROACH: A competition for A&E that recognizes outstanding energy-conserving designs of commercial and industrial buildings. All registered A&E practicing in the U.S. were eligible for the competition. A building was eligible if it was completed, under construction, or commissioned and designed on the date of the entry. Entries were judged in six categories: commercial (office buildings, shopping centers, retail stores, and hotels), governmental (post offices, military facilities, and government offices), industrial (manufacturing plants and power processing structures), institutional (schools and hospitals), residential (multifamily housing covering single or multiple buildings of 50 or more living units and single-family detached units), and nonresidential retrofit (any existing nonresidential building that has been rehabilitated substantially, renovated, or reused). Each category was separated into two divisions, one for completed buildings and another for those in the design or construction stage. The awards jury was composed of professionals representing private practice, research, education, and government. There was no consistent set of criteria for choosing winners, and the jury selecting the winners changed each year. All data were self-reported: the entry form asks only general questions, leaving the choice of details up to the entrant.

TARGET BUILDING TYPES: New commercial, governmental, industrial, institutional, and residential; and existing nonresidential.

KEY PARTICIPANTS: Owens-Corning Fiberglas Corporation and the design community.

HISTORY:

Date of Implementation: 1972
Current Status: Ended in 1984
General Comments: The program was endorsed by the U.S. Department of Energy and a variety of professional organizations, including the American Institute of Architects (AIA) and the American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE). The program evolved from "energy flag wavers" (whose innovative designs were expressions of experimental research in the built form) to winners that demonstrated "state-of-the-art energy excellence, the integration of mechanical and architectural design, and a harmonious balance between the building and its surroundings." The program was dropped because of lack of interest in the program (number of entries dropped) and because the program achieved its initial objectives (to encourage energy conservation in commercial buildings). Lalendorf also thought that since energy conservation is now an important design factor in many major commercial buildings, the program has succeeded in meeting its principal goal. The buildings that received an energy design award during the first ten years of the program were used in the Booz-Allen and Hamilton study as a data base from which to identify design and performance trends. The Booz-Allen and Hamilton report (referenced below) lists each of the projects along with the location, type of building, design team, and other pertinent demographics.

MARKETING/PROMOTION METHODS: Winners received sculptures and/or certificates of achievement, and they also received advertising and publicity support at both the local and national levels.

MONITORING/EVALUATION: An evaluation of the program was conducted for DOE (see below).

Market penetration:

Savings:
- Energy: Average energy use for the award winners was 50% to 60% below new conventional buildings.
- Peak:
- Dollars:

Costs and cost-effectiveness: Many of the award winners were built for no extra cost.
- Program administration:
- Incentives:
- Private investment:

Discussion:
An analysis of the buildings receiving awards was conducted by Booz-Allen and Hamilton for the U.S. Department of Energy (see below). They found the following trends in their sample:
- the most commonly used energy strategies involved modifying the building envelope and improving the HVAC system;
- active solar was commonly used in this sample but showed a relative decline in the program's later years;
- passive solar, particularly the use of daylighting, increased in popularity;
- overall, there was some shift from a mechanical system emphasis to more integrated, architectural solutions;
- average energy use for the award winners was 50 to 60% below new conventional buildings;
- energy performance levels for new buildings markedly improved over the past 10 years;
- most winning buildings were designed to minimize site energy use (energy consumed at the building boundary) rather than source energy use (amount of energy consumed by a power plant to generate electricity); this finding implies:
  - a trend toward all-electric commercial buildings,
  - emphasis on the reduction of heating loads and the use of fossil fuels in improvements in energy design, and
  - shifting of commercial building electric demand profiles, from summer to winter peaking, due to wider use of electric heat pump systems for space heating
- although energy-efficient buildings currently tend to have an initial cost premium, a number of award winners were built for no extra cost (normally, the incremental cost can be under 10%).

RELATED PROGRAMS: ASHRAE's Energy Awards Program (see writeup).

REFERENCES: "Owens-Corning Fiberglas Energy Conservation Awards," *Lighting Design and Application* March 1984:16-25; "12th Annual Owens-Corning Fiberglas Energy Conservation Awards Program (1983)," and "9th Annual Owens-Corning Fiberglas Energy Conservation Awards: Award Winners (1980)," brochures prepared by Owens-Corning Fiberglas; U.S. Department of Energy, 1982.

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NEW RESIDENTIAL PROGRAMS (RES/COM-8)

PROGRAM TITLES: Code Adoption Demonstration Program (CADP), the Early Adopter Program, and the Northwest Energy Code Program (NWECP)

PROGRAM SPONSOR: Bonneville Power Administration (BPA)

PROGRAM OBJECTIVES: For CADP, to stimulate voluntary adoption of energy-efficient building codes (the Model Conservation Standards (MCS)) before January 1986; for NWECP, to provide longer-term funding support for enforcement of the MCS after January 1, 1986.

APPROACH: BPA's Code Adoption Demonstration Program and Early Adopter Program support voluntary action to adopt and implement energy-efficient residential and commercial building codes that meet or exceed the MCS. Pilot programs, aimed at developing the skills and knowledge needed to effectively implement and enforce the MCS, are continuing through December 1988. Under these programs, BPA provides reimbursement to jurisdictions that adopt the MCS before January 1, 1989, for the additional or incremental costs of enforcing these standards. In addition, financial incentives are provided through December 1988 to builders within "early adopting" jurisdictions to offset additional construction costs associated with meeting MCS requirements. Reimbursement under the demonstration program and the method of MCS enforcement to be carried out at the local level were left, for the most part, to the discretion of individual program participants. The Early Adopter Program has replaced the CADP.

Beginning January 1, 1989, and for a transitional period of 4 to 6 years, the NWECP will provide funding to encourage the adoption and implementation of energy-efficient building codes or mandatory utility-service requirements for new residential and commercial buildings. During this transitional period, BPA will reimburse participating jurisdictions and utilities for the incremental costs of enforcing building codes or legally enforceable standards for new construction that meet the energy-efficiency specifications established by the Northwest Power Planning Council. The NWECP was developed concurrently with the implementation of the CADP.

TARGET BUILDING TYPES: New residential and new commercial

KEY PARTICIPANTS: BPA; for the CADP: builders; for the NWECP: local jurisdictions

HISTORY:

Date of Implementation: 1984
Current Status: Continuing
General Comments: The Pacific Northwest Electric Power Planning and Conservation Act of 1980 (P.L. 96-501) established the Northwest Power Planning Council that adopted the MCS for new residential and new commercial buildings in their 1983 Power Plan. The Plan prescribed a January 1, 1986 deadline for adoption and implementation of the MCS, either as traditional building codes or legally enforceable utility service standards. Jurisdictions that failed to adopt and implement the MCS before January 1, 1986 were potentially subject to a surcharge on wholesale power purchases from BPA. In December 1985, the 1983 Power Plan was amended to extend the deadline for mandatory adoption of the MCS as a regional building code. As part of this extension, the Council recommended that BPA continue to provide financial support for enforcement and builder incentives for an additional three years (through December 1, 1988) to jurisdictions that adopted the MCS.

MARKETING/PROMOTION METHODS: In the CADP, the level of BPA funding for builder incentive payments was negotiated on a case-by-case basis, and varied from jurisdiction to jurisdiction. In jurisdictions that distributed incentives on a square foot basis, payments for new single-family buildings ranged from a high of $2 per square foot plus an $800 air-to-air heat exchanger (AAHX) allowance for each unit installed, to $1.50 per square foot plus $800 AAHX allowance. Other jurisdictions provided flat-rate incentives of $2,250 per single-family building, regardless of size. In all cases, builder incentive payments declined over time. Under NWECP, MCS builder and consumer payments will continue until 1991, decreasing as penetration increases. In June 1984, 2,600 copies of the CADP Solicitation were distributed over the four state area (Idaho, Montana, Oregon, and Washington), announcing the program and inviting local jurisdictions to apply.

MONITORING/EVALUATION:
An evaluation of the City of Tacoma's early adopter program has been conducted (see writeup).

Market penetration: Thirty-one cities and counties in the Pacific Northwest have adopted codes that meet the Council's standards. Construction has been completed on the following housing types: 595 single-family units, 178 single-family remodels/additions, 164 multifamily buildings (1298 units), and 84 commercial buildings.

Major statewide building code upgrades have occurred in Washington and Oregon. Washington's new code provides 59% of the model standards level savings in the Zone 1 climate in western Washington and 50% in Zone 2 in eastern Washington. Oregon's new code currently provides 32% of the savings, increasing to 58% in 1989.

Savings:
- Energy:
- Peak:
- Dollars:

Costs and cost-effectiveness:
- Program administration:
- Incentives:
- Private investment:

Discussion:
Crossman identified five major lessons learned from the experience of implementing the MCS: (1) flexibility in program design is both desirable and necessary, but must be balanced against administrative simplicity; (2) when it comes to building codes or mandatory utility service requirements, money alone is not the answer; (3) institutional resistance to change is strong and takes many forms - it should be expected; (4) code change is a complex and evolutionary process that requires many years; and (5) MCS-level codes and energy-efficiency requirements can be adopted and successfully enforced on a project-specific basis within relatively short timeframes, if careful attention is paid to program detail and process issues. Widespread, regional integration of mandatory standards will require a longer transition period.

Crossman also noted that poor timing, perceptual and institutional barriers, accompanied by a general dislike of mandatory standards and Federal requirements, led to the reluctance of builders and communities in adopting the MCS. Local economic circumstances, shelter industry reaction within the community, and ongoing controversy regarding technical aspects of the MCS, all contributed to inaction and

lack of progress toward regional adoption. In the absence of strong and stable construction industry support and direction, many jurisdictions simply took a 'wait and see' attitude.

Crossman identified the following common characteristics shared by current CADP program participants: (1) prior experience in implementing conservation programs/activities, (2) a belief that homes built to MCS requirements are better constructed than less energy-efficient homes, and (3) geographic proximity to another early adopting jurisdiction. Real world experience and the opportunity to observe other code officials effectively conducting energy-related plan reviews and inspections is critical, and no less important than conducting builder demonstration programs.

Crossman concludes, based on BPA's experience so far, that as much as five to eight years may be required to achieve full regional integration of MCS technologies into established construction practice.

RELATED PROGRAMS: Energy efficiency in new homes is being marketed and promoted under the Super Good Cents Program (see writeup). A widespread builder demonstration program (the Residential Standards Demonstration Program (RSDP), see writeup) was conducted by state energy offices and BPA in 1984 and 1985. A new research and demonstration project (the Residential Construction Demonstration Project (RCDP), see writeup) is underway and focuses on innovative ways of meeting MCS requirements.

REFERENCES: Pacific Northwest Utilities Conference Committee, 1987; Northwest Power Planning Council, 1987a and 1987b; Crossman, 1986; Eckman and Watson, 1984; Cruz, Calif., 1984; Hammarlund, 1986; "Model Conservation Standards Adopted by Spokane (Wash.) County Officials," *Energy and Housing Report,* Nov. 1987, p. 8; McCutcheon *et al.*, 1985; Washington State Energy Office, *Model Conservation Standards Bibliography.* Report No. WAEONG 86-15, Olympia, Wash., 1986; BPA, "Early Adopter Status Report, Nov. 1987," Portland, Oregon, 1987.

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NEW RESIDENTIAL PROGRAMS (RES/COM-9)

PROGRAM TITLE: Tacoma's Early Adopter Program

PROGRAM SPONSOR: Tacoma Energy Office and Bonneville Power Administration (BPA)

PROGRAM OBJECTIVES: To demonstrate to the homebuilding industry in Tacoma what the proposed energy-efficient standards (Model Conservation Standards (MCS)) are, how to comply with them, and increase the industry's familiarity with them; and to obtain more accurate estimates of the average energy savings and incremental costs associated with the MCS.

APPROACH: In November 1983, the Tacoma City Council voted to become the first political jurisdiction in the Pacific Northwest to adopt the Northwest Power Planning Council's MCS standards, which took effect in Tacoma on June 1, 1984. MCS compliance was to be required as a condition for electric space-conditioning service. Through changes in the City building code and in the plan review and inspection process, only those plans meeting the MCS for insulation, infiltration, glazing, and in the case of commercial buildings, lighting and HVAC, would be approved. An augmented inspection process would ensure compliance with the MCS. In May 1984, just prior to the start of MCS enforcement within the city, the City Council directed its municipal electric utility (Tacoma City Light) to enforce the MCS in those portions of its service area outside the Tacoma city limits in Pierce County. Enforcement there would be secured by requiring MCS compliance before electric service hookup. Thus, Tacoma's energy code program is a dual component project, which includes an energy code plus a service standard.

To offset the costs associated with the early adoption of the MCS, Tacoma obtained a series of grants from BPA to cover: Tacoma's incremental costs in changing its building permit and inspection processes to conform to the MCS; payment of incentives to local building contractors to offset some of their costs associated with learning new procedures and techniques and constructing more energy-efficient buildings; builder training; and new home marketing assistance. The city was also reimbursed for providing information and technical assistance to other jurisdictions considering early adoption of the MCS and for documenting its MCS experience. In addition, Tacoma was to be reimbursed for providing data intended for assessment of the cost of administering the program, constructing buildings to the new standard, and comparing energy use to non-MCS buildings. BPA intended the grants to cover essentially all of Tacoma's incremental costs as an early adopter of the MCS and to help builders defray at least some of the costs associated with planning and building to the new standards.

Builders were able to satisfy the MCS requirements through one of three different approaches: the component approach (each individual component of the building is specified, but tradeoffs between individual envelope components are permitted), the prescriptive approach (where specific insulation levels are specified, and where there are requirements for mechanical equipment efficiency, pipe and duct insulation, water heating, lighting, and glazing), and the energy budget approach (where builders are permitted to combine individual building components as long as the total calculated energy consumption does not exceed the MCS prescribed maximum).

Having chosen a compliance path and satisfied the plan reviewers in the Tacoma Energy Office that the proposed building meets the new standards, the builder receives a building permit. The permit holder signs a plan correction form, agreeing

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to meet the MCS specifications, and can then begin construction of the structure. When the builder notifies the Buildings Division that the building is ready for the conventional inspections (i.e., foundation, frame, and final inspections, each composed of a series of subinspections), inspectors from the office perform onsite inspections of work in progress. The Energy Office also performs an energy inspection appropriate to the stage of building completion.

After the final series of inspections has been successfully completed, a Certificate of Completion is issued, indicating that the building is ready for occupancy. Upon issuance of the Certificate of Completion, the Energy Office calculates the incentive to be paid to the builder for participating in the MCS program; the incentive is reduced each year. The incentive is paid on the basis of heated square footage (up to a maximum of 2,000 square feet), plus an additional $800 to offset the cost of an air-to-air heat exchanger.

TARGET BUILDING TYPES: New residential, new commercial, and major renovations and conversions to electric space heat

KEY PARTICIPANTS: BPA, the City of Tacoma, building contractors, subcontractors, and the general public.

HISTORY:

Date of Implementation: June 1, 1984
Current Status: Continuing
General Comments: The Pacific Northwest Electric Power Planning and Conservation Act of 1980 (P.L. 96-501) established the Northwest Power Planning Council that adopted the MCS for new residential and new commercial buildings in their 1983 Power Plan. The MCS were designed to reduce electricity consumption in residential and commercial new construction and remodeled structures and were initially scheduled to be implemented on a regionwide level on January 1, 1986.

BPA's Code Adoption Demonstration Program (now called the Early Adopter Program, see writeup) supports adoption and implementation of energy-efficient residential and commercial building codes that meet or exceed the MCS. Pilot programs, aimed at developing the skills and knowledge needed to effectively implement and enforce the MCS, are continuing through December 1988. Under these programs, BPA provides reimbursement to jurisdictions that adopt the MCS before January 1, 1989, for the additional or incremental costs of enforcing these standards. In addition, financial incentives are provided through December 1988 to consumers and/or builders within "early adopting" jurisdictions. These timelines are being extended until Jan. 1, 1992.

Tacoma is the fourth largest city in the Pacific Northwest with a population of approximately 160,000.

MARKETING/PROMOTION METHODS: Unique to Tacoma's program is an emphasis on builder assistance through training and education programs, home marketing programs, and financial assistance programs. The City has conducted training seminars on energy-efficient construction techniques for the building industry. The City has also implemented a marketing program to promote energy-efficient "Super Good Cents" homes to make home buyers aware of the benefits of this kind of home. Finally, Tacoma has implemented a Financial Assistance Program that provides a cash payment to help builders defray the cost of meeting the

stringent MCS standards. The financial assistance component of the program will be phased out as builders become more efficient at meeting the MCS requirements.

MONITORING/EVALUATION:

Two process evaluations and one impact evaluation of the program were conducted between 1984 and 1986. The purpose of the second process evaluation was to see how much had changed since the early stages of the program and to see which trends identified in the first evaluation persisted into the third year of the MCS. The impact evaluation estimated the normalized annual consumption of MCS and "Current Practice" homes and estimated the heating energy use for both groups of homes. MCS homes that were built and occupied prior to June 1985 constituted the initial experimental group of 127 homes. The control group consisted of 480 electrically heated residences built in the Tacoma City Light service area prior to June 1984.(when the MCS standards were adopted by Tacoma), but not before January 1983. Electricity records were gathered for both groups for the period from January 1985 to June 1986. A household mail survey on energy use behavior, attitudes and demographic characteristics of MCS and Current Practice households was conducted (response rate of 75%). The final analysis data set consisted of 62 MCS and 312 Current Practice households. Further analyses of later single and multi-family homes will be completed by Aug. 1988.

Market penetration: Between June 1, 1984 and March 31, 1985 Tacoma issued a total of 315 MCS building permits, including 107 commercial and 208 residential permits. During the period October 1, 1984 through March 31, 1985, Pierce County issued 134 permits for structures covered by the MCS. Through June 30, 1986, Tacoma issued permits for 1,331 new residential and commercial structures in the city and county, including more than 3,200 multi-family dwelling units. Although 375 of an estimated 500 residential builders in Tacoma and Pierce County have now participated in the Early Adopter Program, three-quarters of these had only built one MCS home. The hoped-for impact of builder learning on incremental costs may, therefore, take longer to achieve than earlier anticipated.

Savings:

- Energy: 5,000 kWh savings per year (18,400 kWh/year for MCS homes versus 23,500 kWh/year for current practice homes); 42% heating savings (3.3 kWh/sq. ft./year for MCS versus 5.7 kWh/sq. ft./year for current practice)
- Peak: 1 MW of space heating savings in new construction per year (estimated)
- Dollars:

Costs and cost-effectiveness: Because of an increase in the average number of inspections per house, the incremental cost of MCS enforcement for new, single-family residences was estimated to increase from $134 to $192 between early 1985 and mid-1986. In spite of the increased inspection time, the Energy Office enforcement budget changed very little, implying that inspectors and plan reviewers increased their productivity. Builders reported that the additional cost of constructing to the MCS was in the $3,000 to $4,000 per house range, or $1.50 to $2.00 per square foot.

- Program administration: Approximately $6.2 million was provided by BPA. The total MCS budget in Tacoma for calendar 1984 was $373,687, of which approximately one-half went to program development costs (e.g., program start-up, staffing, establishment of record-keeping routines, and equipment acquisition). The other half of the budget was devoted to actual implementation and operation of the MCS in Tacoma. The Tacoma budget also covered the cost of the Energy Office operation at the Pierce County Buildings Division.

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- Incentives:
- Private investment:

Discussion:

Bronfman et al (1987) found that the City of Tacoma was able to integrate the MCS into its building permit and inspection processes by establishing a separate office for MCS information, builder consultation, energy plan reviews, and inspections. Building permit applicants were routed to the Energy Office, while the Energy Office MCS inspections were incorporated into the routine for approving construction projects. MCS builders contacted in the process evaluation reported no major problems meeting the new standards. By contrast, the MCS procedures at Pierce County were wholly external to the permit and inspection processes. Compliance with the MCS at the county level was the responsibility of the City Energy Office, county routines being unaffected by the city-adopted MCS.

Initially, the most formidable barriers to implementing the MCS in Tacoma were related to the lack of certain specified materials (windows and water heaters) and to difficulties in understanding the specifications for air-to-air heat exchangers. However, these early problems have been largely solved. For example, difficulties in obtaining MCS glazing were alleviated by working with local manufacturers and dealers to explain the requirements and identify qualifying windows.

Initially, delays in MCS marketing homes limited awareness and demand among both the homebuying and building communities. However, Tacoma's participation in BPA's Super Good Cents program appears to be providing the marketing element which was missing from the early stages of the MCS. The Energy Office staff reports that both the city and the builders are satisfied with Super Good Cents.

A serious barrier to implementing the MCS in Pierce County was the lack of integration of the MCS plan review and inspection processes into the County Buildings Division routines, and this problem persists.

Tacoma received a national energy innovation award in 1986 from the U.S. Department of Energy.

RELATED PROGRAMS: BPA's Super Good Cents, Early Adopters, Residential Standards Demonstration Program, Residential Construction Demonstration Program (see writeups), and BPA's Code Enforcement Hotline.

REFERENCES: Pacific Northwest Utilities Conference Committee, 1987; Northwest Power Planning Council, 1987; Lerman and Bronfman, 1985, 1986; Bronfman *et al.*, 1987a, 1987c; City of Tacoma, 1986; U.S. Department of Energy, 1986a.

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NEW RESIDENTIAL/COMMERCIAL PROGRAMS (RES/COM-10)

PROGRAM TITLE: Milton Keynes Energy Park Demonstration

PROGRAM SPONSOR: Milton Keynes Development Corporation

PROGRAM OBJECTIVES: To enable residents and business to benefit from reduced costs; provide residents and business with a range of modern information services; provide a high quality environment; create unique investment opportunities, increase energy awareness; and promote energy efficiency.

APPROACH: The Energy Park (300 acres) is part of a new city (Milton Keynes), centrally located between London and Birmingham. The town's population is about 138,000 and will increase to more than 200,000 people by the end of the century. The Park will contain employment areas, housing, parkland, and a range of community facilities. It will eventually house 3,100 people with employment for about 2,000. A variety of housing is planned (1,000 housing units) for the Energy Park: housing for sale, plots for self-build, and housing in which tenants buy a "share" of their house. All the houses will meet a predetermined energy performance standard, assessed at the design stage, using a microcomputer-based program, the specially developed Milton Keynes Energy Cost Index (MKECI). To be accepted for the Energy Park, a house 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 rather than to pioneer new forms of energy supply, and to maintain energy efficiency by providing energy management services and by ensuring that people have access to information and advice. The demand for energy in the Energy Park will be reduced by: (1) energy-efficient local planning (making maximum use of solar energy and using the landscape to improve the local microclimate (e.g., by using "shelter belts" to reduce wind speeds and the consequent heat loss from buildings)), (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. The designs of the buildings have been left to the developers, as long as they meet the energy standards. About 50 energy-efficient homes, built by 32 private developers, were displayed at an exhibition show village (Energy World) in 1986, and all have been sold and occupied. Housing developments in Phase I were intended to demonstrate the practical application of proven technology.

In Phase II (starting 1987/88), over 20 different housing schemes are planned and are aimed at attracting a higher proportion of state-of-the-art and prototype energy-conscious designs. Thus, the Development Corporation will be taking a more active role in determining the design of low-energy homes, rather than relying on developers' designs. All housing developments in Phase II will be subject to the following additional energy policies: (1) the overall required standard of energy efficiency will be increased by improving the MKECI standard; (2) each house scheme will be required to make a specific contribution to the development of energy-efficient housing (this could either be a technology, such as a covered street scheme, or an overall approach, such as an innovative low-cost housing scheme); and (3) increased international participation will be sought from EEC and OECD countries.

Phase III is currently being planned to include a mixed commercial and residential development adjacent to the lakeshore of Furzton Lake. Consultants are studying the possibility of harnessing the ambient heat of the water for transfer into the environmental systems water in the buildings using heat pump technology.

The energy performance standard has now been applied to the entire city of Milton Keynes, not just the Energy Park. The Development Corporation is now involved in developing supporting a national energy labeling system.

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. The first two commercial buildings are nearing completion and will achieve savings in energy costs of at least 40%.

TARGET SECTORS: Developers, architects, other building professions, businessmen, consumers, homeowners, and educational groups (including school children).

KEY PARTICIPANTS: Milton Keynes Development Corporation, private companies, UK government departments, local authorities, the energy utilities, the telecommunications authorities, architects, developers, manufacturers, and consumers.

HISTORY:

Date of Implementation: 1984
Current Status: Continuing (part of a seven year program)
General Comments: The Energy Park is promoted by Milton Keynes Development Corporation which, together with other public authorities, accounts for 20% of the total investment in land, buildings, and infrastructure. The remainder (in excess of $240 million) is made up of private investment.

MARKETING/PROMOTION METHODS: The Energy Park has been publicized at national conferences, through press conferences, and through a regular newsletter. There are regular UK ministerial visits and increasing numbers of international visitors.

The Energy Park was launched in 1986 by the Prime Minister at the special "Energy World" exhibition. A showcase of 50 low-energy houses, the exhibition was attended by more than 70,000 people. Varying in size, price range and extent of innovation, the houses demonstrated different approaches to energy-conscious design. The show village enabled the energy utilities to demonstrate the most up-to-date applications of their fuels in houses; architects and developers to show people low-energy houses developed for Energy Park and elsewhere; and manufacturers to demonstrate products and appliances.

The key project in the Energy Park will be the Energy Center which will be promoted as an international information, education, and recreation center. The Center will act as a focus for all activities in the Energy Park, providing management and business services and an administration base for companies based there. It will also promote understanding of all aspects of energy and its efficient use. The Center will comprise a visitors and interpretation center, an exhibition area, a technical information center, and an education center. Practical demonstration, with "hands-on" exhibits for visitor participation, will be emphasized.

A new independent organization, the National Energy Foundation, will be involved in the management of the Center. The Foundation has been established as a charitable trust to promote energy awareness in the United Kingdom and carry out programs such as national energy labeling and energy education.

MONITORING/EVALUATION:

A Monitoring Service has been established in the Energy Park. This service will provide information for government agencies concerned with promoting energy efficiency in buildings, assist the utilities in assessing the energy requirements of low-energy buildings, and provide a test bed for all interested parties to assess the performance and marketability of innovative products and services.

Currently, information is being obtained from 200 houses; more houses will be monitored in Phase II. Fuel and building performance data (internal temperatures and humidity) are collected using a specially designed Building Interface Unit located in each house. Every 24 hours these data are transferred to a Central Monitoring Office on the instruction of its computers. The data are transmitted along a dedicated cable network incorporated within the conventional telephone network. This information is supported by meteorological data from a site-based fully automated weather station.

The Monitoring Service is being used to provide data for a number of purposes for different clients including the government and utilities. The data will be used, for example, to validate the Milton Keynes Energy Cost Index, to assess fuel demand, and to examine the performance of electrically heated houses.

Market penetration: 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.

Savings:

- Energy: 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%.
- Peak:
- Dollars:

Costs and cost-effectiveness:

- Program administration:
- Incentives: None.
- Private investment: More than $240 million.

Discussion:

The Energy Park is seen as the focal point of energy efficiency activity in the United Kingdom. Fuller is pleased with the progress of the Energy Park so far. He believes that to be successful, one must be single-minded and work with all interested groups (the public, developers, architects, etc.), and one cannot depend on the help of government. By far, the largest impact of the program has been its scale. He knows of similar, smaller initiatives in other countries, but does not know of any program on the scale of the Energy Park. Another important feature of the Energy Park is that it is tangible to developers: they can see the homes and discover that they were built without any real incremental costs and without the use of exotic technologies.

Housing developments in Phase I were intended to demonstrate the practical application of proven technology, and this aim has been achieved. These conventional houses have clearly demonstrated that low-energy houses can be developed on a commercial basis, that residents like them, and that developers can market them successfully.

RELATED PROGRAMS: Milton Keynes has conducted a number of smaller energy conservation demonstration programs.

REFERENCES: *Milton Keynes Energy Park: Setting New Standards in Energy Efficiency,* and *Milton Keynes Energy World: An International Exhibition of 50 Energy-Efficient Houses, Official Guide,* brochures prepared by Milton Keynes Development Corporation; "International centre of energy efficiency planned," *Energy Management,* Oct. 1986, monthly newsletter by the Department of Energy, England; Milton Keynes, *Energy Park News,* No. 1 (Nov. 1985), No. 3 (March 1987), and No. 4 (Dec. 1987); Milton Keynes, "Housing in the Energy Park: Proposals for Phase II," n.d..

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DATE: Jan. 7, 1988 / June 8, 1988

NEW COMMERCIAL PROGRAMS (RES/COM-11)

PROGRAM TITLE: Saint Paul Energy Park

PROGRAM SPONSOR: City of St. Paul and Port Authority of the City of St. Paul

PROGRAM OBJECTIVES: To be a model of an energy-efficient urban environment; to demonstrate the most innovative techniques and technologies of energy conservation in the design and operation of residential, commercial, institutional, and industrial facilities and to apply them to contemporary urban activities; to provide a unique and attractive setting for both the development of new businesses and the expansion of existing businesses, especially those dealing with energy issues; to create jobs through comprehensive programs of education, training, and employee support services; to provide a variety of affordable, energy-efficient housing options; to create a model urban development, integrated with existing environments, where people can live in close proximity to their work and can minimize their dependence on automotive transportation; and to encourage innovation, creativity, and excellence in design in response to energy issues and contemporary urban social problems.

APPROACH: The Saint Paul Energy Park is a 218-acre light industrial park, midway between downtown St. Paul and downtown Minneapolis. The Park contains a central heating and cooling system, a total working/living environment that includes 771 rental and for sale housing units, a commercial complex with more than 50 shops and boutiques and four major restaurants, a hotel, a medical clinic, multi-tenant office and light industrial buildings with space for sale or lease, and several light industrial plants. The buildings are designed with the latest in energy-saving devices and materials. The energy system supplies hot or chilled water produced by heat pumps from a central plant to all buildings in the Energy Park. Under the Master Plan, 28% of the Park's acreage will be devoted to housing (771 units), 38% to light industrial, and 20% to commercial buildings.

The dominating element of the Energy Park is the Centrum, the most visible portion of the Park and containing the most diverse mix of uses. The Centrum comprises the Energy Technology Center (ETC) that provides rental space plus shared support facilities for embryonic energy-related companies. The objective of the ETC is to provide a supportive environment to serve as an incubator for the growth of new energy-related businesses and foster the development of innovation in energy conservation, production, and management. The ETC will include a greenhouse, model shops, library, conference rooms, and technical laboratories available for common use. In addition to providing educational and management tools for small businesses, the ETC will house job training facilities to aid the process of moving people into the jobs created in Energy Park. The Centrum will also contain a hotel and conference center, retail space, housing, the central energy production system, an energy interpretive center, and transit.

As of January 1, 1988, more than $250 million has been invested in the Energy Park, exclusive of infrastructure. When all of the facilities now authorized or under construction are completed, Energy Park will employ 4,745 people. The Park is 95% completed.

TARGET BUILDING TYPES: New residential, commercial, and industrial

KEY PARTICIPANTS: City of St. Paul, Port Authority of St. Paul, and businesses.

HISTORY:

Date of Implementation: 1980
Current Status: Continuing
General Comments: The Port Authority has the authority to acquire and develop land for industrial purposes and can develop anywhere within the City; it is the implementor of the Park. The implementation of Energy Park began with the Negotiated Investment Strategy (NIS), an effort at a new and creative urban policy initiated by the Carter Administration in the early 1980s. The NIS was to be a means of securing local, state, federal, and private investment in urban areas through a negotiation process. Three cities were chosen for the NIS experiment: St. Paul, Columbus (Ohio), and Gary (Indiana). St. Paul worked out agreements on three major investment areas, one of which was the Energy Park.

MARKETING/PROMOTION METHODS: Promotional literature.

MONITORING/EVALUATION: Energy use of Energy Park users will be monitored. Monthly bills are available.

Market penetration:

Savings:
- Energy:
- Peak:
- Dollars:

Costs and cost-effectiveness:
- Program administration:
- Incentives:
- Private investment:

Discussion: The Energy Park is viewed as a success by its sponsors.

RELATED PROGRAMS: The Milton Keynes Energy Park (see writeup).

REFERENCES: Port Authority of the City of St. Paul, *Annual Report 1986,,* St. Paul, Minn.; "Saint Paul Energy Park," brochure prepared by the Port Authority of the City of St. Paul; City of St. Paul and Port Authority of the City of St. Paul, *The Energy Park Master Plan: Policies,,* St. Paul, Minn., 1981.

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