

ENERGY CONSERVATION IN FEDERAL AND  
FEDERALLY ASSISTED BUILDINGS

GOVERNMENT

Storage

PAPERS

OCT 20 1976

THE  
KANSAS

HEARINGS  
BEFORE THE  
SUBCOMMITTEE ON  
BUILDINGS AND GROUNDS  
OF THE  
COMMITTEE ON PUBLIC WORKS  
UNITED STATES SENATE  
NINETY-FOURTH CONGRESS  
SECOND SESSION  
ON  
**S. 1392**

A BILL TO ESTABLISH A DEMONSTRATION PROGRAM IN ENERGY CONSERVATION, USING PROMISING INNOVATIVE TECHNOLOGY TO THE MAXIMUM EXTENT POSSIBLE THROUGH RETROFITTING EXISTING BUILDINGS WITH ENERGY CONSERVATION EQUIPMENT AND SYSTEMS, AND FOR OTHER PURPOSES

**S. 2045**

A BILL TO INSURE THAT FEDERAL BUILDINGS AND CERTAIN BUILDINGS ASSISTED WITH FEDERAL FUNDS EMPLOY THE BEST PRACTICABLE ENERGY CONSERVATION AND MANAGEMENT PRACTICES, AND FOR OTHER PURPOSES

**S. 2095**

A BILL TO REQUIRE THAT BUILDINGS FINANCED WITH FEDERAL FUNDS UTILIZE THE BEST PRACTICABLE MEASURES FOR THE CONSERVATION OF ENERGY AND THE USE OF SOLAR ENERGY SYSTEMS

---

APRIL 8, 1976

---

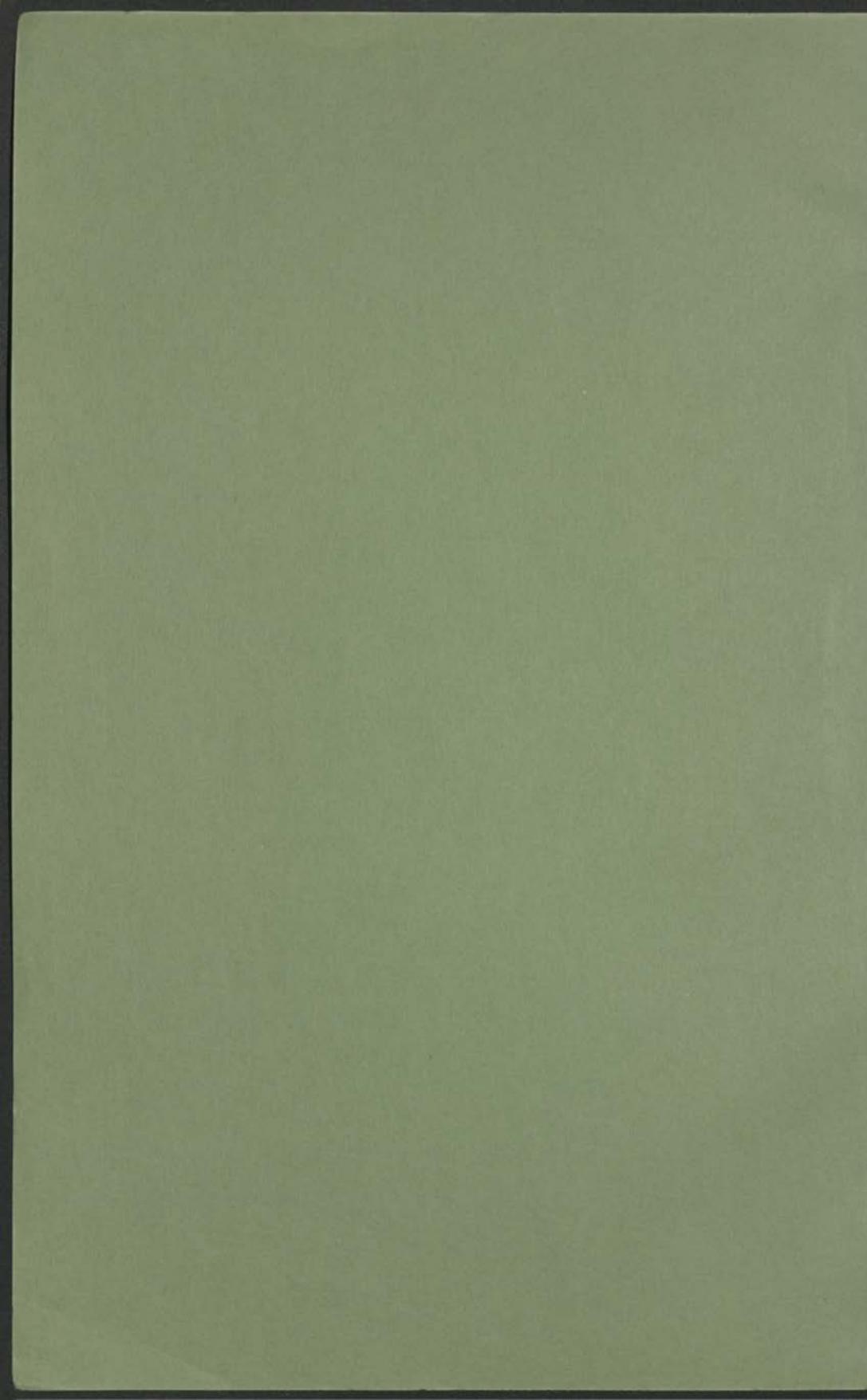
**PART 2**

---

SERIAL NO. 94-H27

---

Printed for the use of the Committee on Public Works



# ENERGY CONSERVATION IN FEDERAL AND FEDERALLY ASSISTED BUILDINGS

---

HEARINGS  
BEFORE THE  
SUBCOMMITTEE ON  
BUILDINGS AND GROUNDS  
OF THE  
COMMITTEE ON PUBLIC WORKS  
UNITED STATES SENATE  
NINETY-FOURTH CONGRESS  
SECOND SESSION  
ON  
**S. 1392**

A BILL TO ESTABLISH A DEMONSTRATION PROGRAM IN ENERGY CONSERVATION, USING PROMISING INNOVATIVE TECHNOLOGY TO THE MAXIMUM EXTENT POSSIBLE THROUGH RETROFITTING EXISTING BUILDINGS WITH ENERGY CONSERVATION EQUIPMENT AND SYSTEMS, AND FOR OTHER PURPOSES

**S. 2045**

A BILL TO INSURE THAT FEDERAL BUILDINGS AND CERTAIN BUILDINGS ASSISTED WITH FEDERAL FUNDS EMPLOY THE BEST PRACTICABLE ENERGY CONSERVATION AND MANAGEMENT PRACTICES, AND FOR OTHER PURPOSES

**S. 2095**

A BILL TO REQUIRE THAT BUILDINGS FINANCED WITH FEDERAL FUNDS UTILIZE THE BEST PRACTICABLE MEASURES FOR THE CONSERVATION OF ENERGY AND THE USE OF SOLAR ENERGY SYSTEMS

---

APRIL 8, 1976

---

**PART 2**

---

SERIAL NO. 94-H27

---

Printed for the use of the Committee on Public Works

U.S. GOVERNMENT PRINTING OFFICE

71-545 O

WASHINGTON : 1976

### COMMITTEE ON PUBLIC WORKS

JENNINGS RANDOLPH, West Virginia, *Chairman*

EDMUND S. MUSKIE, Maine  
JOSEPH M. MONTOYA, New Mexico  
MIKE GRAVEL, Alaska  
LLOYD BENTSEN, Texas  
QUENTIN N. BURDICK, North Dakota  
JOHN C. CULVER, Iowa  
ROBERT MORGAN, North Carolina  
GARY HART, Colorado

HOWARD H. BAKER, Jr., Tennessee  
JAMES L. BUCKLEY, New York  
ROBERT T. STAFFORD, Vermont  
JAMES A. MCCLURE, Idaho  
PETE V. DOMENICI, New Mexico

M. BARRY MEYER, *Chief Counsel and Chief Clerk*

BAILEY GUARD, *Minority Staff Director*

LEON G. BILLINGS and RICHARD D. GRUNDY, *Senior Professional Staff Members*

RICHARD A. HELLMAN, *Minority Counsel*

JOHN W. YAGO, Jr., *Assistant Chief Clerk*; PHILIP T. CUMMINGS, *Assistant Chief Counsel*  
HAROLD H. BRAYMAN, *Senior Professional Staff Member (Minority)*

*Professional and research staff:* KARL R. BRAITHWAITE, JAMES W. CASE (*Assistant Counsel*),  
PAUL CHIMES, TRENTON CROW, KATHERINE Y. CUDLIPP, PAUL F. EBELTOFT, JR., GEORGE F.  
FENTON, JR., RANDOLPH G. FLOOD, KATHALEEN R. E. FORCUM, ANN GARABRANT, RICHARD  
T. GREER, RICHARD M. HARRIS (*Assistant Counsel*), WESLEY F. HAYDEN, RICHARD E.  
HEROD (*Assistant Counsel, Minority*), VERONICA A. HOLLAND, RONALD L. KATZ, JUDY F.  
PARENTE, JOHN B. PURINTON, JR., JAMES D. RANGE, W. LEE RAWLS, CHARLENE A. STUR-  
BITTS, E. STEVENS SWAIN, JR., SALLY W. WALKER, and HAVEN WHITESIDE

---

### SUBCOMMITTEE ON BUILDINGS AND GROUNDS

ROBERT MORGAN, North Carolina, *Chairman*

MIKE GRAVEL, Alaska  
JOHN C. CULVER, Iowa

JAMES L. BUCKLEY, New York  
JAMES A. MCCLURE, Idaho

## CONTENTS

---

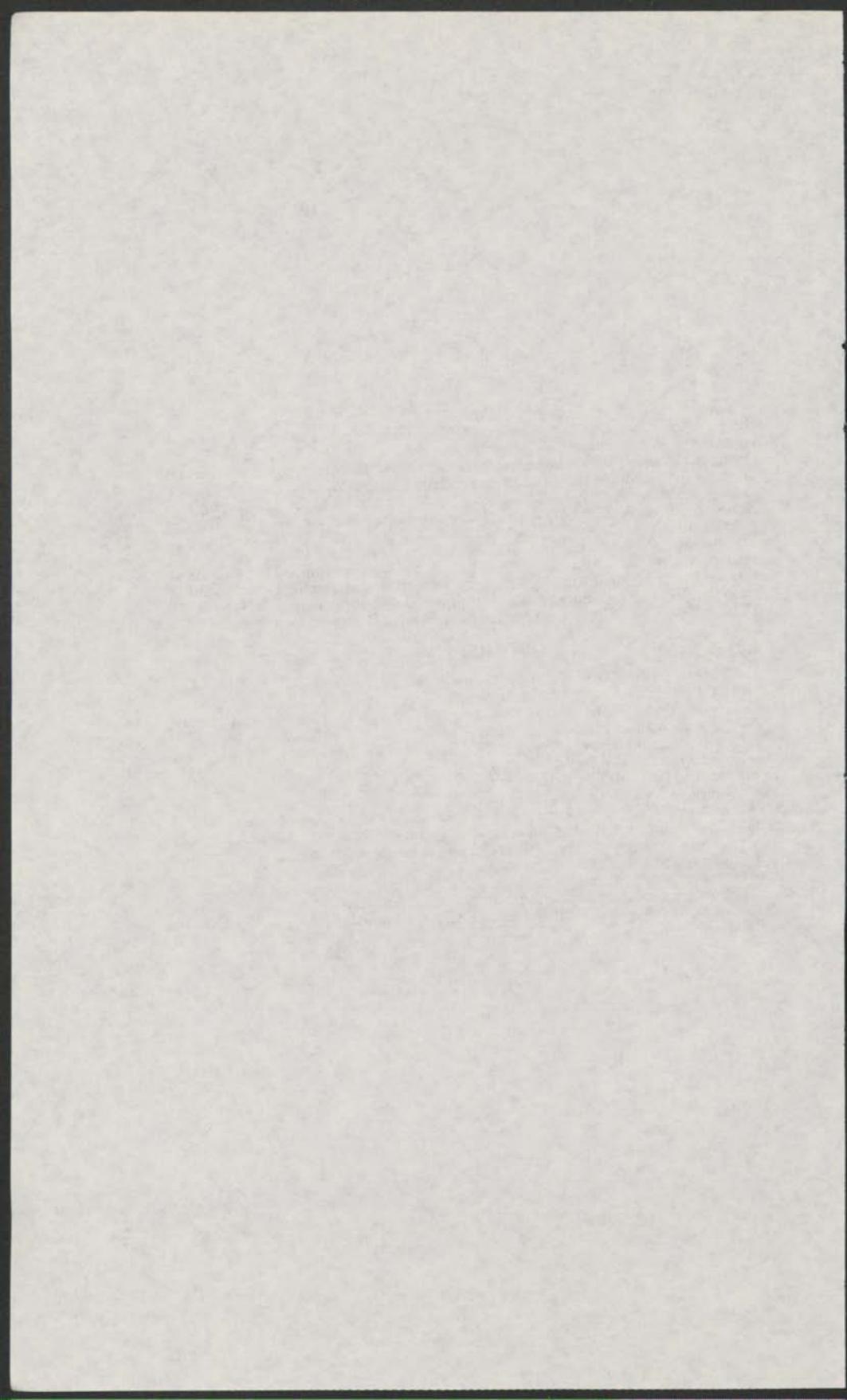
Morgan, Hon. Robert, U.S. Senator from the State of North Carolina, opening statement of .....	1
--	---

### LIST OF WITNESSES

Mannella, Gene G., Deputy Assistant Administrator for Conservation, Energy Research and Development Administration; accompanied by Maxine Savits, Director, Division of Buildings and Industry; and Gerald Leighton, Assistant Director for Buildings and Consumer Products .....	64
Prepared statement.....	67
Panuzio, Nicholas A., Commissioner, Public Buildings Service, General Services Administration.....	21
Prepared statement.....	26
Sant, Roger, Assistant Administrator for Energy Conservation and Environment, Federal Energy Administration; accompanied by Paul G. Brumby, Director, Office of Federal Programs, Energy Conservation and Environment; and Norman W. Lutkefedder, Chief, Solar Energy Division, Energy Resource Development .....	4

### ADDITIONAL MATERIAL

Appendices:	
A. Memorandum from Richard Grundy, Senior Professional Staff Member, Committee on Public Works, to Senator Morgan.....	97
B. Solar Energy Government Buildings Project Draft Guidelines and Draft Implementation Plan .....	123
C. Incentives for Energy Conservation in Multi-Family Dwellings .....	195
D. Selected Articles.....	307
Energy conservation design guidelines for office buildings .....	14
Martinsburg, W. Va., Journal, article from .....	61
Public Law 94-163, Energy Policy and Conservation Act, reprint of title III of .....	80
Senate Resolution 59, Energy Conservation, reprint of .....	40
Ten-year plan for energy conservation in Federal buildings, material relative to .....	9
White, George M., Architect of the Capitol:	
Letter to Senator Randolph .....	45
Report from .....	49
Zarb, Frank G., Administrator, Federal Energy Administration, letter to Senator Randolph .....	59



## ENERGY CONSERVATION IN FEDERAL AND FEDERALLY ASSISTED BUILDINGS

THURSDAY, APRIL 8, 1976

U.S. SENATE,  
COMMITTEE ON PUBLIC WORKS,  
SUBCOMMITTEE ON BUILDINGS AND GROUNDS,  
*Washington, D.C.*

The subcommittee met at 9:10 a.m., pursuant to call, in room 4200, Dirksen Senate Office Building, Hon. Robert Morgan (chairman of the subcommittee) presiding.

Present: Senators Morgan and Randolph (chairman of the full committee).

### OPENING STATEMENT OF HON. ROBERT MORGAN, U.S. SENATOR FROM THE STATE OF NORTH CAROLINA

Senator MORGAN. We will call our meeting to order this morning. I apologize for being late. I couldn't control the traffic, especially if you are a little late getting up in the morning.

I have a short opening statement. We are here today to discuss energy supplies and costs as they affect Federal buildings. Right now energy costs are running neck-and-neck with financing costs—a situation unheard of several years ago. Because of changing cost relationships, we now find that the operating costs of a building can overwhelm the costs of construction.

While I agree that life-cycle costs appear to be a good way to go in the future, I am not convinced that such a systems approach has, or will, produce much innovation. From this perspective, these hearings will address the role that energy management can serve to reduce the life-cycle costs for Federal buildings.

Without the adoption of energy management practices, it will be very difficult to determine the steps needed to conserve energy or to evaluate the success of energy conservation measures. The three bills pending before the subcommittee propose energy management practices to achieve a reduction in energy consumption in government buildings. S. 2045 and S. 2095 would accomplish this through the adoption of improved analysis and design techniques. Both measures would encourage the demonstration of new energy conservation and solar energy systems. In addition, S. 1392 and S. 2095 provide funds for retrofitting existing buildings with energy-saving technologies.

The three bills before us all have as their primary objective the reduction of energy consumption in Federal and federally assisted buildings. They would legislatively mandate such actions, rather than have such practices proceed on a voluntary basis in response to higher

energy costs. My thoughts on voluntary versus mandatory energy conservation are set forth in my opening statement last year on this legislation.

For this reason the witnesses for today have been requested first to review the status of energy conservation, including solar energy, programs by Federal agencies with respect to public buildings, with particular emphasis on Federal buildings; second, to review the statutory basis for such Federal programs; and third, to ascertain the state of the art for the application of energy conservation, including solar energy, methods and technologies to Federal buildings and federally assisted buildings. In addition, the witnesses have been requested to address the technical and economic feasibility for implementing the three bills pending before the committee: S. 2045, the Federal Facilities Energy Conservation and Utilization Act of 1975; S. 1392, the Energy Conservation in Buildings Demonstration Act of 1975; and S. 2095, Conservation and Solar Energy—Federal Buildings Act of 1975.

I look forward to hearing this testimony from today's panel.

Senator Randolph, do you wish to make a statement at this time?

Senator RANDOLPH. Thank you, Mr. Chairman. I do have a short opening statement that should not take too much time from the proceedings.

The energy challenge to America is well known. We must develop our resources so we can supply a greater portion of our needs from domestic resources. Equally important, we must conserve non-renewable resources as well as foster greater utilization of such renewable energy resources as solar energy.

Intelligent energy conservation will not hinder economic growth, increase unemployment, or lower our standard of living. Contrary to this allegation, energy conservation is vital to the sustaining of our standard of living, and rekindling economic growth. Energy conservation is as important in meeting our country's future energy needs as is the development of new energy resource supplies.

Cost-effective energy conservation can reduce consumer costs, while freeing energy supplies for use within other sectors of our economy. In fact, energy conservation measures often are the most cost-effective means to deal with our country's energy problems. In such instances, we should choose energy conservation.

While many energy users are aware of the desirability for conservation, the detailed information necessary to render investment decisions is all too often not available.

Nevertheless, energy conservation is in the economic self-interest of consumers and businessmen, as well as all Americans. Frequently, energy conservation is the most cost-effective means for coping with our country's energy supply problems.

A more concerted national commitment to energy conservation is not only desirable but feasible. The issue is not whether we should conserve energy, rather the issues are how should we conserve energy and how much should we conserve. As a national policy we should encourage the efficient use of energy in the sense that we do not use energy where the value of the product is less than its cost or less than its value in some alternative use.

Energy prices below the true costs of energy are a major disincentive to conservation. One of the reasons why we now inefficiently consume our scarce energy resources is that energy is priced below its replacement cost as well as below its true societal value.

Even where energy conservation measures are cost-effective, many American consumers are finding it difficult, if not impossible, to borrow the necessary capital to finance such improvements as better insulation in their homes or businesses. This is particularly the case for people on low incomes or elderly people on fixed incomes. Yet the costs of energy continue to rise and further bite into their comparatively limited incomes. In such instances, economic incentives may also be necessary, although energy conservation measures are cost-effective in their own right.

We must accept the challenge of energy conservation by consciously designing new buildings and redesigning existing buildings to incorporate cost-effective energy management practices and technologies. The legislation pending before the Public Works Committee is concerned for the energy conscious design of Federal buildings. The issue before the committee is what additional actions the Congress might take to encourage greater energy conservation in buildings owned or leased by the Federal Government.

The Federal Government already has demonstrated energy conservation programs in the facilities it owns. The Federal Facilities Energy Conservation and Utilization Act of 1975, which I introduced last year, directs that all Federal agencies consider energy conservation to the fullest extent practicable consistent with their existing authorities.

Similar legislation was incorporated in the Energy Policy and Conservation Act. That 1975 Act requires the development of a 10-year plan for energy conservation in buildings owned or leased by the Federal Government. This program falls within the jurisdiction of the Committee on Public Works and was discussed in my Senate remarks on this measure. I thus am interested in reviewing the activities of the Federal Energy Administration, in concert with the General Services Administration, to promote greater energy conservation in Federal buildings. Likewise I am interested in the activities of the Energy Research and Development Administration to foster new energy conservation technologies.

Thank you.

Senator MORGAN. We have as our witnesses this morning Mr. John Hill, the Deputy Administrator of the Federal Energy Administration, who has been detained for awhile; and Mr. Roger Sant, the FEA Assistant Administrator for Energy Conservation and Environment; Mr. Nicholas A. Panuzio, the Commissioner of the Public Buildings Service of the GSA; and Dr. Gene G. Mannella, Deputy Assistant Administrator for Conservation of the Energy Research and Development Administration.

STATEMENT OF ROGER SANT, ASSISTANT ADMINISTRATOR FOR ENERGY CONSERVATION AND ENVIRONMENT, FEDERAL ENERGY ADMINISTRATION; ACCCOMPANIED BY PAUL G. BRUMBY, DIRECTOR, OFFICE OF FEDERAL PROGRAMS, ENERGY CONSERVATION AND ENVIRONMENT; AND NORMAN W. LUTKEFEDDER, CHIEF, SOLAR ENERGY DIVISION, ENERGY RESOURCE DEVELOPMENT

Mr. SANT. I am accompanied this morning by Mr. Paul Brumby who is the Director of the Federal Energy Management Program, and Norman Lutkefedder, who is Chief of the Solar Energy Division in the Office of Energy Resource Development.

Senator MORGAN. We are glad to have all of you and we thank you for coming.

Mr. Sant, I believe you are scheduled to go first. I didn't have a chance to see your statement last night, so we will follow you along as you make your presentation. Feel free to summarize it or to present it in any way that you think best.

Mr. SANT. Thank you, Mr. Chairman. It is a short statement, so I think I will take it as written and maybe expand on it as we go through.

I am very pleased to be here today to discuss the Federal Government's activities for conserving energy in its buildings and facilities and to comment on three Senate bills which have been proposed in this area: S. 2095, S. 2045 and S. 1392. I have submitted a statement previously on these three bills, and I think others for the Administration have commented. So I would like to summarize some of that previous testimony and expand upon that briefly in this statement.

I would like first to discuss the framework in which we view energy conservation and solar energy activities in Federal buildings. The Federal Government owns and operates a wide variety of buildings which reflect many of the building types and functions which occur in the private sector. As such, the first major role for energy conservation in Federal buildings is as a demonstration for both new and existing conservation techniques. By providing test sites for these various techniques, the Federal Government can, presumably, speed their adoption into buildings in the private sector by demonstrating their costs and benefits.

The second major role is simply that of conserving public funds. One requirement of fiscal responsibility is that the Federal Government examine its own energy-consuming activities to determine those changes in operation and those investments which will reduce the Federal Government's total expenditures for energy-consuming activities.

The framework in which we view solar energy in Federal buildings has several aspects—two of which I shall discuss at this time.

First, the vast inventory of Federal buildings could provide a substantial market to assist in the early development of the market for economically viable solar equipment. Also, Federal buildings, particularly those which receive wide public exposure, can be valuable to promote public acceptance of solar equipment.

Second, solar heating and hot water systems in buildings should, in the near future, compete effectively with other energy sources—electricity, oil, gas, and so forth—and provide energy which has the added benefits of being clean and renewable.

Our current and planned Federal conservation activities can be seen from this dual perspective. Both the administrative actions undertaken through the Federal Energy Management Program and those actions required by the Energy Policy and Conservation Act are designed to increase the efficiency with which energy is used in Federal facilities, and thus to conserve public moneys.

Federal Management Circular 74-1, issued by the GSA over 2 years ago, directed changes in lighting, heating, and cooling levels to eliminate energy waste. In fiscal year 1974, the Federal Energy Management Program, charting conservation activities of all government people working together, saved the equivalent of 90.5 million barrels of oil annually (247,000 barrels per day) worth \$725 million. Again in fiscal year 1975 the cost avoidance equalled another 97.1 million barrels of oil (266,173 barrels per day) annually worth \$930 million. For the first 2 quarters of fiscal year 1976, this saving is continuing and elevating and energy use has fallen 5½ percent below the actual fiscal year 1975 level.

So currently, Mr. Chairman, we are running almost 30 percent below the levels of energy use in 1973.

Senator MORGAN. Is that really documented? I get the distinct impression that everybody has forgotten about energy conservation.

Mr. SANT. We put out quarterly reports and require extensive reporting from each of the agencies in government, and we believe they are auditable. We audit them annually, and we believe those figures are verifiable by anyone who would like to check them.

I think the figure this year is surprising us all, because we got about a 24 percent reduction, which we held for 2 years, and then suddenly this year we are running 5½ percent below that. So I am fairly pleased with what the Government has done.

Senator MORGAN. I am satisfied your figures are correct; on second thought, we did get a call from one of our contingents complaining that the gentleman had cut off the heat 1 day last week. So somebody must be mindful of it.

Mr. SANT. It is also true that I have personally found some cases where we are breaking the rules. I think that occurs too often, which means we still have a ways to go. But the 30 percent is a fairly attractive number and, if we could emulate it in the private sector, we would be far along.

Senator MORGAN. I really suspect that my instincts or feelings come from the fact that more automobiles are coming from the private sector.

Mr. SANT. Yes, sir.

Tracking energy use and savings is divided between two major categories: land, sea, and air vehicles, and equipment, and buildings and facilities. In fiscal year 1974, the savings in buildings were 113 trillion Btu (13.6 percent reduction) while in fiscal year 1975 they were 136 trillion Btu or 15.2 percent reduction. This equates to 43,043,000 barrels of oil worth about \$412,375,000 for the 2-year period. These savings are about one-third those achieved in operating vehicles and equipment, but still are sizeable.

As part of the legislative requirements contained in EPCA, an Executive Order will be issued specifically directing the development of plans for energy efficiency in the construction and operation of buildings, and in Federal procurement activities. The requirement of section 381(a) (2) of the EPCA is that:

The President shall develop and, to the extent of his authority under other law, implement a 10-year plan for energy conservation with respect to buildings owned or leased by an agency of the United States. Such plan shall include mandatory lighting efficiency standards, mandatory thermal efficiency standards and insulation requirements, restrictions on hours of operation, thermostat controls, and other conditions of operation, and plans for replacing or retrofitting to meet such standards.

In addition to and concurrent with the analysis of conservation measures, an analysis of the potential application of solar energy to both existing and new Federal buildings is being considered. That is, the use of solar energy for heating and hot water will be evaluated and recommended for those locations where it compares favorably on a financial basis with other source possibilities, such as gas, oil or electricity.

I would now like to discuss the proposals which are embodied in S. 2095, S. 2045 and S. 1392. S. 2095 contains comprehensive guidelines for life cycle energy accounting for the analysis of energy use in existing Federal buildings, new Federal buildings and Federal procurement of equipment. The Administrator of the General Services Administration and the Secretary of Defense would be required to develop analytical guidelines for energy conservation in Federal buildings. Each would be required to submit within 1 year an energy use analysis of all existing buildings under his jurisdiction and a plan for incorporating both energy conservation and solar improvements into each such building. The final section of this bill would alter current loan ceilings in Federal mortgage insurance programs to accommodate the increased costs associated with solar equipment.

S. 2045 is similar to S. 2095 but does not include consideration of solar energy. Under this bill, the Administrator of the General Services Administration, in consultation with other agencies, would be required to develop guidelines for the construction and renovation of the Federal buildings. This bill contains an explicit requirement for a survey of existing procurement practices within 1 year and the assurance of a report containing recommendations for the improvement of those practices.

Finally, S. 1392 would establish a demonstration program for Federal, State and local buildings. In this bill, the Federal Energy Administration and the National Bureau of Standards would develop guidelines for identifying candidate buildings for energy conservation refitting. Within 6 months the GSA would select 40 Federal buildings for demonstration and solicit bids for their refitting. The emphasis in these bids would be on innovative techniques. The bill would also establish a 3-to-1 matching grant program between the FEA and State and municipal governments for the refitting of State and local government buildings.

We believe these provisions for Federal, State and local government demonstration projects are unnecessary. Adequate funding authority has been requested by ERDA to demonstrate new solar and energy conservation technologies. Once new technologies are shown to be

technologically and economically useable, they would be able to compete with existing technologies on a financial basis. Though the explicit time requirements contained in the proposed legislation are not now a part of our activities, the guidelines for consideration of energy conservation contained in these bills are similar to those contained in the Executive Order described earlier, and will be taken into account. Accordingly, we feel that S. 2095, S. 2045, are unnecessary, and we would therefore oppose enactment.

The one provision of S. 2095 which is not specifically addressed by our program is that which would raise loan ceilings on Federal mortgage assistance. Our analysis of this alternative has led us to the conclusion that a more important factor inhibiting adoption of solar equipment in residences is the fact that there are no commonly accepted standards for solar equipment to which a banker can turn in deciding whether to give a loan.

Along this line, the Federal Housing Administration of the Department of Housing and Urban Development, in cooperation with the National Bureau of Standards, will soon publish the Intermediate Minimum Property Standards for solar heating and hot water systems. These standards, scheduled to be effective in June 1976, will be used in the mortgage insurance program of the FHA and can be expected to have broad impact on conventional mortgage financing as well.

In summary, then, we are pleased to report on the progress of our activities with regard to energy conservation and to the use of solar energy in Federal facilities. We do not believe that further legislative requirements would be helpful at this time. We will continue to report periodically on these matters and look forward to cooperating with your committee and the Congress toward the achievement of our mutual goals.

Senator MORGAN. Thank you very much.

We are going to alter our procedure a little this morning from that which is usually followed in this committee. I have asked Mr. Richard Grundy of the committee's senior professional staff if he will present any questions to you that he might have with regard to your testimony. As we proceed if there are any questions that I desire to follow up on or have in my mind, I will ask them.

Dick, if you would take over.

Mr. GRUNDY. Mr. Sant, I have several questions with regard to your agency's existing statutory authority. I will leave some of the more general questions until the panel has fully presented their statements.

In particular, under the Energy Policy and Conservation Act, which was passed last year, the President, as you noted in your statement, was given responsibility to develop a 10-year plan for energy conservation in Federal buildings.

As this is evolving, is there a lead agency that has been designated to develop this plan or does this responsibility fall on each individual agency?

Mr. SANT. No. The lead agency role has been assigned, now, to the FEA in continuation of the Federal Energy Management Program. Really, this whole 10-year program was in the mill prior to the passage of the Act, so it is a continuation and expansion of the activities that are already under way.

But the President has assigned the responsibility to the FEA.

Mr. GRUNDY. I was under the impression—and you or Mr. Panuzio may wish to clarify this—that under the earlier plan for Federal buildings, the responsibility for energy conservation, prior to the enactment of the Energy Policy Act, actually fell on GSA.

Mr. SANT. Well, it does, as well as on the Department of Defense. I don't mean to minimize it. But the overall responsibility for the Federal Energy Management Program rests with FEA. We have always worked very closely with GSA as well as the Department of Defense in the running of the building portion and with the GSA on the automobile portion. They really have the line responsibility. We are only the Federal coordinators, if you will.

Mr. GRUNDY. Mr. Panuzio, do you wish to comment further on this point?

Mr. PANUZIO. I think the comments are correct. We have been moving along in the areas that apply to us, which are the Federal buildings. But there are further agencies, such as Defense Agency and HUD, which are responsible with carrying through their areas. FEA, we understand, is coordinating that effort. Responsibility for Federal buildings themselves, as we see it, is the General Services Administration, but certainly we have responsibility to coordinate that effort with others.

Mr. GRUNDY. What do you see as the scheduling for completion of this 10-year plan?

Mr. SANT. Well, the plan has been submitted to the Energy Resources Council, and it is currently being reviewed by the Office of Management and Budget. We suspect we will have resolution of some of those issues within the next 30 days, and hopefully, the Executive Order would be out sometime around then. I would suspect the overall guidelines for building retrofitting would be completed in about 6 months.

I don't know how you feel about that, but I think that is generally the target we are working on.

Mr. PANUZIO. Yes.

[The following is background material relative to the 10-year plan:]

ENERGY POLICY AND CONSERVATION ACT  
(P.L. 94-163, December 22, 1975)

## TITLE III

PART E - OTHER FEDERAL ENERGY CONSERVATION MEASURES  
FEDERAL ENERGY CONSERVATION PROGRAMS

Sec. 381. (a)(1) The President shall, to the extent of his authority under other law, establish or coordinate Federal agency actions to develop mandatory standards with respect to energy conservation and energy efficiency to govern the procurement policies and decisions of the Federal Government and all Federal agencies, and shall take such steps as are necessary to cause such standards to be implemented.

(2) The President shall develop and, to the extent of his authority under other law, implement a 10-year plan for energy conservation with respect to buildings owned or leased by an agency of the United States. Such plan shall include mandatory lighting efficiency standards, mandatory thermal efficiency standards and insulation requirements, restrictions on hours of operation, thermostat controls, and other conditions of operation, and plans for replacing or retrofitting to meet such standards.

(b)(1) The Administrator shall establish and carry out a responsible public education program --

- (A) to encourage energy conservation and energy efficiency; or
- (B) to promote van pooling and carpooling arrangements.

(2) For purposes of this subsection:

- (A) The term "van" means any automobile which the Administrator determines is manufactured primarily for use in the transportation of not less than 8 individuals and not more than 15 individuals.

(B) The term "van pooling arrangement" means an arrangement for the transportation of employees between their residences or other designated locations and their place of employment on a nonprofit basis in which the operating costs of such arrangement are paid for by the employees utilizing such arrangement.

(c) The President shall submit to the Congress an annual report concerning all steps taken under subsections (a) and (b).

EXTRACT FROM  
SENATE REMARKS BY SENATOR JENNINGS RANDOLPH  
CHAIRMAN, COMMITTEE ON PUBLIC WORKS  
ON ENERGY POLICY AND CONSERVATION ACT (OF 1975)  
DECEMBER 15, 1975  
(Congressional Record 121 (186):  )

FEDERAL ENERGY CONSERVATION PROGRAMS

Mr. President, section 381 requires the President to develop and implement a 10-year energy conservation plan for buildings owned or leased by any Federal agency.

The Senate Public Works Committee, Mr. President, has convened hearings on the subject. The Buildings and Grounds Subcommittee, under the able chairmanship of the Senator from North Carolina (Mr. MORGAN), recently initiated an investigation into the activities of the executive agencies in developing energy conservation techniques for application to Federal buildings.

At the forefront of Federal efforts to utilize and develop such techniques is the General Services Administration. As early as fiscal year 1974, the GSA through an aggressive conservation program realized a savings of 20 percent in the consumption of energy in Federal buildings over the previous year. Complete figures are not available for fiscal year 1975, but it is estimated that there was a 30-percent savings.

The General Services Administration, to facilitate further reductions in energy consumption, and in cooperation with

other Government agencies and the private sector, developed two energy conservation guidelines. The first, "Energy Conservation Design Guidelines for New Office Buildings," establishes performance specifications for the construction of new Federal office buildings. The second, "Energy Conservation Guidelines for Existing Office Buildings," sets guidelines for use in retrofitting existing structures.

Later this month, Mr. President, the third conservation document developed by the General Services Administration, "Energy Conservation Guidelines for Building Operations," will be released.

The GSA's program also recognizes the importance of demonstrating new energy-saving techniques in actual building design and construction. The proposed Federal building in Manchester, N.H., was selected as an energy conservation demonstration facility. It is anticipated that a 50- to 70-percent savings in energy consumption will be realized through the use of solar collectors and other advanced building design features. Data compiled at this demonstration facility will be used in future Federal construction.

Mr. President, in light of its leadership in Federal energy conservation efforts, the President on October 18, 1974, asked the GSA to recommend to the Energy Resources Council a multiyear program to increase energy efficiency in all Federal facilities and operations. In response, the Agency has submitted such a plan. The President's selection in 1974 of GSA to formulate an overall Federal energy conservation plan has proven to be a wise one.

As chairman of the Senate Committee on Public Works and personally I encourage the President to again designate the GSA as the lead Agency to coordinate and develop the 10-year energy plan for Federal facilities required by section 381 of this bill.

Mr. GRUNDY. I may be jumping the gun on one of the later statements, but as far as developing the guidelines for building retrofit, is this also viewed as the primary responsibility of FEA, or has this function been delegated to GSA in light of their previous activity?

Mr. SANT. I think it would be primarily in GSA's realm. We will gain assistance from the National Bureau of Standards and HUD and other agencies as we can. And of course, the Defense Department has a number of Federal buildings, and so we are going to have to coordinate that amongst all agencies so that we end up with something that is mutually acceptable.

NBS has done quite a bit of work along these lines, so it is not as if we were starting from scratch.

Mr. GRUNDY. I was thinking of the GSA guidelines that were issued as much as 2 years ago which dealt specifically with this subject.

[A copy of the guidelines referred to follows:]

A SYNOPSIS OF THE  
ENERGY CONSERVATION DESIGN GUIDELINES FOR OFFICE BUILDINGS

The General Services Administration (GSA), which supervises the design, construction, maintenance and operation of most Federal office buildings, recognizes the growing need for guidelines that will make designers, builders, managers, and owners aware of the numerous ways to save energy in building design and operation.

To accomplish this, GSA's Public Buildings Service (PBS) contracted with the energy consulting firms of Dubin-Mindell-Bloome Associates, Heery and Heery, Architects, and the AIA Research Corporation to develop a comprehensive set of energy conservation guidelines.

These guidelines encourage innovations and indicate various methods that can be used to reduce energy consumption in new buildings, while at the same time allowing architects and engineers the greatest latitude in design.

Energy use in buildings is a function of some independent and many inter-related factors. Some of the major factors which influence energy consumption are user needs, climate, sun, wind, site, orientation, building envelope, electrical, illumination, and mechanical systems.

While much of the information contained in these Guidelines was developed from the Energy Conservation Demonstration Building study for Manchester, New Hampshire, the guidelines apply to buildings in all regions of the United States. When the construction of the Manchester Demonstration Project has been completed, the results of the various electrical/mechanical systems will be evaluated. It is anticipated that our findings will necessitate further refinements in the guidelines.

This study contains more than 185 ideas for conserving energy in building design, construction and use. Due to the wide range of these proposals, no single building can be expected to include all of these ideas.

The following is a list of some of the more important points included in the Guidelines:

1. Cover exterior walls and/or roof with earth and planting to reduce heat loss in winter and solar gain in summer.
2. Shade walls and paved areas adjacent to building to reduce temperature.
3. Collect rain water for use in buildings.
4. Select sites with high air quality to enhance natural ventilation.
5. Select sites that have topographical features and adjacent structures that provide wind breaks.
6. Select sites that allow optimum building orientation and configuration to minimize yearly energy consumption.

(2)

7. Select sites that allow occupants to use public transportation systems.
8. Select building configurations that give minimum north wall exposure to reduce heat losses.
9. Construct exterior walls, roof, and floors with high thermal mass, for example, 100 pounds per cubic foot.
10. Consider the length and width aspects for rectangular buildings as well as other geometric shapes in relationship to building height and interior and exterior floor areas to optimize energy conservation. (The minimum exterior building surface area for a given inside area will result in the least heat loss/heat gain through the building shell.)
11. Do not heat parking garages.
12. Consider the amount of energy required for protection of materials and their transport on a life cycle energy basis.
13. In climatic zones where conditions are suitable for natural ventilation for a major part of the year, windows should be installed that open.
14. Use corridors as heat transfer buffers and locate against exterior walls.
15. Landscaped open planning allows excess heat from interior spaces to transfer to perimeter spaces which have a heat loss.
16. Equipment rooms located on the roof reduce unwanted heat gain and heat loss through the surface. They can also allow more direct duct and pipe runs reducing power requirements.
17. Open planning allows more effective use of lighting fixtures. The reduced area of partitioned walls decreases the light absorption.
18. Provide controls to shut down all air systems at night and weekends except when used for economizer cycle cooling.
19. To enhance the possibility of using waste heat from other systems, design air handling systems to circulate sufficient amounts of air for cooling loads to be met by a 60°F air supply temperature and heating loads to be met by a 90°F air temperature.
20. Design HVAC (heating, ventilating and airconditioning) systems so that they do not heat and cool air simultaneously.
21. Adopt as large a temperature differential as possible for chilled water systems and hot water heating systems.
22. Consider the use of thermal storage in combination with unit heat pumps and a hydronic loop so that excess heat during the day can be captured and stored for use at night.

(3)

23. Consider the use of solar energy collectors for heating in winter and absorption cooling in summer.
24. Consider the use of a total energy system integrated with all other systems.
25. Use high efficiency transformers, which are good candidates for life cycle costing.
26. To reduce the quantity of hot and cold water used, consider the use of a single system to meet hand washing needs.
27. Consider the use of solar water heaters using flat plate collectors with heat pump boosters in the winter.
28. Heat building to no more than 68°F in winter when occupied and 60°F when unoccupied.
29. Cool building to no less than 78°F when occupied and no cooling when the building is unoccupied.
30. Light a building when occupied only.
31. In selective lighting, consider only the amount of illumination required for the specific task, taking into consideration the duration and character and user performance required as per design criteria.
32. Turn off lights that are not needed.
33. Schedule cleaning and maintenance for normal working hours or when daylight is available and sufficient for task.
34. Draw drapes over windows or close thermal shutters when daylight is not available and when the building is unoccupied.

Comments on these Design Guidelines are being solicited by the GSA's Public Buildings Service until May 1, 1974.

Mr. PANUZIO. It has been updated, but they serve as the basis for it, some of the directions we are going to use in the guidelines we established for Federal buildings.

Mr. SANT. In addition to that, Mr. Grundy, we are required to develop life-cycle procurement guidelines as well. So it goes beyond even buildings. We are in the process of getting that activity under way. So it would include things other than buildings in the Federal procurement.

Mr. GRUNDY. You mentioned in your statement that this evaluation, although the statute does not require a review of solar energy potentials, is being so broadened by FEA in development of the 10-year plan. Do you anticipate that the plan will include specific recommendations on buildings that should be used for the demonstration of solar energy?

Mr. SANT. Yes, we do.

Mr. PANUZIO. Yes.

Mr. SANT. That was a part of our original idea, and we are continually expanding that so that we insure that we take the best advantage of the opportunities in the solar area.

Mr. GRUNDY. When you have developed this plan, what would you view as the funding mechanism that would be used to implement it? Would you have a single funding request per se or in your judgment, would this responsibility fall on each individual agency?

Mr. SANT. Well, we are currently talking about it with the Office of Management and Budget. Each individual agency would prepare its own request based on the guidelines that we have put out; then those would all be coordinated to see that the criteria being used are common throughout the Federal Government. By the time the funding requests go to the Office of Management and Budget, they will have been totally coordinated and will be viewed as an array of investment opportunities throughout the Federal Government, not just one agency at a time. That way we can reduce the discrepancies, such as one agency being very diligent in preparing all of its requests versus another agency that didn't do much at all.

We hope to coordinate that from a central source to make sure we take advantage of every opportunity.

Senator MORGAN. We are delighted to have our chairman here this morning.

Our chairman is one of the leaders in energy conservation, and I believe he has introduced one of these bills.

Mr. Chairman, we would be glad to hear you at this time.

Senator RANDOLPH. Thank you. You are kind to associate me with concern on this matter. It has been my concern for a long, long time.

This is not the moment for nostalgia, but there were some persons within the Congress a long, long time ago who were working on the problems of energy. And the record bears that out. Now is not the time for the retelling of that.

But I think the energy problem—call it what you may—is more serious today than it was prior to the 1973 oil embargo that hit with all of its power in the shutting off of the petroleum supplies to the United States of America. To me it seems like only yesterday, but to some people it seems a long time ago. But that is another facet of this whole problem.

But the conservation measures that we can make available here at home are those programs that will release us in part from reliance upon energy supplies from abroad.

Insofar as we have a compliance even with the 55-mile-an-hour speed limit, we know that if it is enforced in North Carolina, West Virginia, and throughout our States, that even that measure, which might not seem to be one that has too much impact, can save over 100,000 barrels of fuel every 24 hours. Now, that is a considerable contribution. And that is from only one conservation measure.

I know of one building, a private building in Los Angeles, where there were conservation methods set in motion approximately 2 years ago by that corporation which occupies that building.

Whereas we here today talk about the design of buildings and redesign of buildings from a standpoint of creativity and innovative efforts—all of that is necessary—we are thinking about cost-effective energy conservation.

But to go back to this one building, they had the escalators operating almost around the clock. So the escalators were cut down from a standpoint of that period of time in which they were operating: a lesser number of escalators were operating during the day. But the escalators were moving in the morning and evening when that mobility of people going to and from work was involved.

Also in their cleaning process, the maintenance work of those buildings—where the custodians who were to do that work were doing it at night with all the lights on, they moved that up until late in the afternoon, not waiting for night. As a result they picked up a 2 or 3 hour period where there was not the need for an all-night operation with the associated expenditure of electricity.

And they removed 1,000 light bulbs. This is all a matter of fact from the building itself. These were great energy conservation measures, amounting to some 25 percent saving of the energy within one building.

So as you carry on these hearings on the utilization of our energy resources to the best degree—as we think of Federal buildings, either those owned or leased—we are striking not at just a ripple of this problem; we are really moving into it as it has to be moved into. Because the timid steps which we allowed ourselves to make and then boast about will not suffice.

And I hope that here as we do a thorough job, which you are doing and others are doing, that we will come to grips with the fact that the energy problem is very, very real.

And I am not an alarmist, but I can say to you that the problems now are greater than the problems 3 or 4 years ago. But to have people understand that that is true is very difficult. So sometimes you may have to do what we call the job which no one notices. You don't do it for notice. But you have to do what you are doing here and what others in the government are doing also, as well as in private industry.

I would only ask one question.

What are you able to tell us, we who are on the Hill, not from the standpoint of how we draft legislation, but what can we do on energy consideration as a Congress through your cooperation and through your innovative leadership? What can we do to further imple-

ment the laws which will bring about this energy conservation in the public buildings of the United States?

Mr. SANT. I think in the area of conservation we may be a little more proud than we may be in other areas of energy. That is, with the passage of the Energy Policy and Conservation Act, we now have mandatory automobile fuel economy standards which will double the fuel economy of automobiles.

We have passed mandatory appliance labeling and standards which will probably get a 20 percent improvement in all appliances by 1980.

We have passed a bill that calls for the setting of—they are really voluntary goals for industry—but they are the best that all of us knew how to do at the time.

We have now got the portion of the Act that we have just talked about, the Federal energy management program. In addition to that, we are likely to have mandatory building standards. At least we are hoping that the Congress will see fit to report that out of conference in the next few weeks, and pass it.

We are hoping that we will have weatherization for low income families. We are hoping we will get a tax credit for insulation of existing residences.

If we put all of those together, there are only probably a couple of additional areas that we need to address. One is the possibility of giving further incentive to conserve to commercial and industrial energy users. Mr. Kennedy has introduced a bill that addresses that subject, and we are working closely with him at this time.

The President has introduced a bill called the Energy Independence Authority, which would also address that problem. And when you look at all of those together, Mr. Chairman, I think at the moment we would say that by 1985 we will be using about 7 million barrels a day less than we would have used prior to the embargo.

That is fully 7 million barrels that will not have to be produced or imported by 1985, which is about a 14 percent reduction from the anticipated levels of use that we would expect by that time.

Now, that is not the total potential. I would personally guess that the potential may be twice that at least. And it may be more than that. We are working as much as we can to try and find other avenues. But I think all the ones that have come to our minds have now been passed or are about to be passed. We are going to have to be more creative to identify other measures.

But I share indeed your concern and belief that the potential for conservation is great and that we should be proud of the progress we have made together so far.

Senator RANDOLPH. Thank you very much, Mr. Sant.

Mr. Chairman, I would only suggest that if these savings are in being and a further savings can and will be achieved, then energy conservation will be a very important factor in reducing our reliance upon importation of crude oil products. Somewhere along the line we are failing to tell our story to the American people.

I am not certain just what can be done. But something must be done. Yesterday I talked to a Senator from Minnesota. I hesitate to mention his name because someone might say he is really running for President when he isn't. In just a personal conversation with Senator Humphrey, he said that when he attempts to talk to the people

about the energy crisis—and he feels it is a very, very real crisis—that in a sense many, many people laugh at him. They say, "We can go to the pump today and we are buying in Minnesota a gallon of gasoline at 49 cents," plus whatever you said, 49.8, maybe, "and we get all we want."

We are a nation that acts after the fact rather than before the fact so very, very often. And this catches us with our resources down to meet these problems.

But he says, "Now, what can I do about that? What can I say to these people?" And there he is, a man of many words, isn't he? And yet he is wondering, "How can I impress upon my constituents here the seriousness of this problem?" And he feels it very keenly.

I think that the selling job just has to be done. At the moment the management job we will leave to you and the others who are bringing these programs into reality.

By the way, Mr. Chairman, there was a scheduled airliner moving through a turbulent sky, and the little lady who had never taken a ride before was sitting by a priest. She became so frightened because of the plane rocking back and forth that she looked at him and said, "Father, can't you do something?" And he said, "Madam, I am very sorry. I will be unable to help you. I am in sales, not management."

But what I am trying to say is that we have different facets of this problem. One of the jobs certainly is sales. And, I hope, Mr. Chairman, that you will stand on the Senate floor in the near future and talk about what is being done by the Federal Government to conserve energy. With respect to the programs in the Energy Policy and Conservation Act, we just have to do more than we have been doing.

We have been doing better, and I am weighing my words, and I am not critical. We have been doing better than the press reports seem to indicate. Do you believe that?

Mr. SANT. I believe that, yes.

Senator RANDOLPH. I think that. There is a strength in the provisions of the Energy Policy and Conservation Act that we have been talking about, Mr. Chairman. These strengths are there. I just feel that this kind of a meeting gives us an opportunity to explore once again not just the Federal buildings, owned and leased, but to go a little further beyond that and attempt to have people generally—businesses, organizations of all kinds, our school systems—do a better job than we are doing.

And, as you say, to conserve energy here means a lesser reliance on the energy from overseas.

I thank you.

Mr. SANT. Mr. Chairman, can I just add one thing? It is something I failed to mention. I think the Congress was extremely wise in one other provision of the Energy Policy and Conservation Act. And that is that we provided a role for the States to carry out specific conservation programs of their own, and the Congress authorized \$50 million a year to be provided to the Governors of the States who develop their own conservation programs so we can meet the specific kinds of requirements in a given State.

Some States have differing requirements than other States. And the ability of the Governors to develop a program designed around the specific needs of the State, I think, is one of the other major benefits that came out of the signing of the Energy Policy and Conservation Act. I think that is one of the things that will help get this message out a little bit.

But I certainly agree with you that we have a major problem on our hands of letting everyone become as aware as we may be of the opportunities, as well as of the things we have accomplished so far. I appreciate the chairman's help in the articulation of that.

Senator MORGAN. Mr. Chairman, we thank you for your interest and remarks.

Mr. Sant, are you going to be able to stay with us through the morning?

Mr. SANT. Yes, Mr. Chairman, I will be happy to.

Senator MORGAN. Mr. Panuzio, are you going to be able to stay with us for awhile?

Mr. PANUZIO. Sure.

Senator MORGAN. Dr. Mannella?

Dr. MANNELLA. Yes, sir.

Senator MORGAN. We will proceed as a panel. I asked Mr. Grundy to carry the questioning this morning. He prepared a 25-page memorandum for the committee in which he sums up what has been done and what is before the committee. I will, without objection, include that memorandum in the record of this hearing.

[The memorandum appears at the end of today's proceedings, p.97.]

Senator MORGAN. Mr. Grundy and I talked yesterday afternoon; we know what the points are that we want to develop this morning. Therefore, I am going to turn it back to Mr. Grundy.

Do you want to proceed or do you want to go to Mr. Panuzio?

Mr. GRUNDY. I think it would be better, Senator Morgan, to go to Mr. Panuzio.

Senator MORGAN. Let's shift to Mr. Panuzio and get his statement in the record; maybe we will save time.

We are glad to have you with us. I don't know when you find time to do any work with GSA because we have kept you up here so much.

Senator RANDOLPH. Are you from New England?

Mr. PANUZIO. Yes.

Senator RANDOLPH. And the worst energy situation in this country is going to be in New England when this strikes.

Mr. PANUZIO. No question about it.

Senator RANDOLPH. There is where it is.

#### STATEMENT OF NICHOLAS A. PANUZIO, COMMISSIONER, PUBLIC BUILDINGS SERVICE, GENERAL SERVICES ADMINISTRATION

Mr. PANUZIO. I am Nicholas Panuzio. I am Commissioner of the Public Buildings Service for the General Services Administration. I am here on behalf of Mr. Jack Eckerd, the Administrator.

I have a statement which I would like to submit for the record, and then I would like to briefly run through some of the parts of it.

[The statement appears at p.26.]

Mr. PANUZIO. We have been proceeding very well at GSA with substantial savings in just the operations. Our savings have averaged about 30 percent over the base line figure of 1973, which in real terms is 2,800,000 barrels of oil per year.

For the second quarter of 1976 the energy savings have further improved to 31.7 percent below the same period of 1973.

At GSA our energy conservation program for Federal office buildings has three major areas of concern. First, the design of energy-efficient buildings for our future office needs; second, modification and retrofitting of the existing inventory of buildings; and, third, the institution of building operating standards and practices to reduce energy consumption.

I might comment that one of the hearings in which I testified before Senator Kennedy, I perhaps made a mistake. When a question was asked, what the Congress could do, I pointed out that if GSA was applying our operations standards, we would first of all be turning out every other light on the ceiling. In fact, what I suggested to Senator Kennedy was that we turn them all off, and it got a little dark.

Senator RANDOLPH. We don't need these on. Why don't you ask us to turn them off?

Mr. PANUZIO. I am afraid it might get so dark I can't read.

Senator MORGAN. I thought of it as soon as I saw the chairman come in.

Mr. PANUZIO. I think there is a point which the Congress might look at its own operations as we have done in the operation of our buildings.

Performance requirements are set forth by us in four pamphlets, two of which are concerned with the design of buildings, which we have put out for the general public's use, one of which is concerned with retrofitting existing buildings, and the fourth is how to operate buildings.

Some of the comments made by Senator Randolph are perfectly in place. We have spent about 2 years on the idea of cleaning during the daytime, in turning off every other light within our halls and insuring that our heat is kept at a rate of between 65 and 68 in all Federal buildings, though that sometimes gets some constituents upset.

We have done many of the things that were indicated by the Senator in the building in Los Angeles, including dealing with the escalators, which in most instances could be turned off when the buildings are closed and in many instances are not.

A stringent energy goal for new buildings that we have established is 55,000 Btu's at the building boundary. We believe there are many other things that are important, such as the selection of sites to allow for the optimum building orientation. It is important that we deal with the roofs on many of the buildings by more effective use of insulation and reflective surfaces.

We also must talk about the reduced lighting levels needed and relocation of lighting in certain locations to provide for energy effectiveness and so on.

The fourth area involves the reduction of energy for building heating and cooling systems through use of preconditioned intake air, energy load management systems and thermostat controls.

Unlike the modification of operating standards, the modification for retrofitting of existing facilities to achieve energy conservation will require capital investment.

Now, we have indicated there in the past about a 40 percent possible saving of fuel, 30 percent of which can be done by building operations. But the additional 10 percent or more, in order for it to be achieved, there must be some retrofitting. There is going to be some cost involved.

We recognize the need and strongly support the action by the Congress which will enable the major energy conservation modifications on Federal buildings to take place.

We have made a study of approximately 25 buildings in the country to try to find those that would be best set up for retrofitting, in the hopes it can be built into a program that you may design.

We have begun by building a demonstration building in Manchester, New Hampshire which we consider to be sort of an energy laboratory. There are seven floors. We have left a fact sheet with the report. Each floor is designed to include different features and systems. The operation of the different systems, the placement of the building on the site and many other things will provide us with details that will enable us to know what we have to do in the future.

Senator MORGAN. How far along is that?

Mr. PANUZIO. That building will be completed this summer, and the solar collector will be in place by October. So that by next winter we should be getting some good data because, as I indicated, each floor is different and that is going to help us a great deal.

We are also putting in place a building in Saginaw, Michigan, which is not only tied into the energy concerns but environmentally is being used as demonstration—for instance, using rain water for lawn sprinkler systems and will also be provided with a solar collector. That will be in place at the end of this year. So we will have two buildings ready to go.

We have provided a detailed sheet on the Manchester Building, and we will be glad to on the Saginaw Building.

We are moving ahead with construction in Topeka, Kans. That Federal building will be the first project that is designed by GSA which will deal with holding our level of use at 100,000 Btu—raw source energy—per gross square foot per year, which is the restriction for buildings using electricity as the major energy source. We think the Topeka Building has a lot in it. The exterior walls are designed differently, including a substantial size increase of the walls, both brick and concrete block.

The window areas have been greatly reduced and comprise approximately 17 percent of the outside exterior wall instead of such substantially large windows as we see here. The glass is an inch thick, insulating type windows, have a 5-foot overhang, resulting in no solar gain in the summer while receiving solar gain in the winter. That type of design we have found to be one kind of innovative thing we should be doing in GSA in our designing.

There are four other areas we have dealt with. One is the thermal infrared scanning, which is an effort which we have planned and used involving a fly-over of buildings to see what type of heat is being lost from the buildings and supporting systems.

Second is a computerized energy load management system, which I think has got some real potential. In fact, we have put on computers the use of a building, and the escalators will shut off when the doors are locked, and the heat will be turned down at certain periods, and come up in the morning at certain periods to provide proper heating for the building when needed. And the lights will be down and temperature will be down on week-ends, and motors which aren't needed will be turned off in low periods.

Instead of using energy time that we may be using in peak periods, we may be using energy for computers and other things at lower times when other needs aren't as great.

We also have been getting some evaluations and will have more on both Manchester and Saginaw, which I think will give us some good data.

We have hired an architectural engineering firm in 10 regions to provide us with a survey of selected buildings in all 10 regions to be used in retrofitting. I think we also have to make a strong effort in looking at all the new buildings that we build.

I know Mr. Eckerd is extremely interested in this. He asked me yesterday with regard to the Kennedy Library, to be sure, as that building is being constructed, that we deal with those that are constructing it—because the Government will be maintaining it later on—and insure that a high quality of energy conservation is used in that building.

And I think the Senate, as it is building its addition here, should be looking at whether it is really taking the lead in providing for energy conservation in that building, insuring the height of ceilings and some of the things we have dealt with in the past, that they aren't built in the same way as we have built them in the past.

We have moved along in another area which I think is a very exciting one, and that is megastructure technology. The concept for Federal office buildings will incorporate a triple-layered pneumatic fabric roof, which permits winter sun radiation into the building and reflects summer radiation.

I think many of you have seen the so-called air-supported structures that we have seen in the Pontiac Stadium and many other instances at some of the world fairs. We have a model now which we would like to come up and give you a full demonstration on, which we think is practical. And we think there are two places where it might be used. One is in Phoenix and the other is Denver, where we need Federal buildings.

We use the air-supported roof to control the temperatures for that building, and we keep the temperatures within the area between 40 and 80 degrees. As we construct the building, we think we save substantial dollars in the construction cost because we first put in place these air-supported structures which allows us to continue construction even during the most difficult periods of winter and so on and at a more reasonable level.

Second, we believe that controlling the temperatures between that 40 and 80 degrees enables us to have less of a variance and makes it more energy-conserving.

But we would like to come up and present to you and the committee a whole series on this megastructure. We have received substantially

good reviews from two very notable authors both in the New York Times and the Washington Post. And I think this is a building that is going to be here and has a potential for the future.

Senator MORGAN. We would be glad to see it. I would like to see it.

Mr. PANUZIO. We at GSA are presently reviewing the feasibility of demonstration solar retrofit projects to those existing buildings in our inventory which promise to have the shortest pay-back period for energy consumption reduction and savings in dollars.

We believe these benefits can be increased significantly with retrofit projects that utilize solar technology and conventional energy conservation modifications such as thermoglass, insulation, heat pumps, energy load management systems, and other techniques.

As far as we are concerned from the state-of-the-art technology, additional incentives, demonstration efforts and policy guidance are required to bring them in line.

In effect, we are saying that unless we have more support in doing some demonstration projects, we really aren't going to have a total answer on this.

I don't believe we are ready for a high buy in the solar area yet. However, we are saying that they are expensive because there is not an ongoing process that can produce them and manufacture these at a reasonable cost.

On the other hand, we are not sure we are ready for that so-called big buy until we have some more demonstrations. We only have a feel as to where we are going with it. With specific reference to your request for a review of the statutory basis for our programs, all of the things that we have done already have been done under the authority that has been given to us in the Federal Property and Administrative Services Act of 1949. We think we can continue to maintain that.

These authorities have enabled us to accomplish our energy programs to date which have dealt with solar energy, new building designs and operations controls. So we don't really see a great need for any of the others.

We do see a need for support. I think, as commented by Senator Randolph, the support that we get from the Congress not only shows we are leading the way in our own areas, but also in supporting us in a number of demonstration projects and then taking that information we gather and using it as the basis of policy. I think that would be very helpful.

I have no further comments, Mr. Chairman. I will be glad to answer any questions.

Senator MORGAN. Thank you very much, Mr. Panuzio.

[Mr. Panuzio's prepared statement follows:]

STATEMENT OF NICHOLAS A. PANUZIO  
Commissioner, Public Buildings Service  
Before The  
Subcommittee on Buildings  
and Grounds of the Senate  
Committee on Public Works  
Thursday, April 8, 1976

Mr. Chairman and Members of the Committee.

I am Nicholas A. Panuzio, Commissioner of the Public Buildings Service of the General Services Administration. On behalf of Jack Eckerd, the Administrator of General Services, I very much appreciate this opportunity to discuss the importance of energy conservation in Federal buildings.

We at GSA fully support efforts to improve upon energy efficiency and conservation practices which will contribute to a successful national energy program. We realize, too, that a significant portion of our Nation's energy savings will be achieved through energy conservation in public buildings. In this respect, General Services Administration (GSA) has demonstrated a real savings in reducing building energy consumption.

Our savings have averaged about 30% each year over the baseline of Fiscal Year 1973. In real terms, the reduction is equivalent to approximately 2,800,000 barrels of oil per year.

For the second quarter of Fiscal Year 1976, the energy savings have further improved to 31.7 percent below the same period of Fiscal Year 1973.

Currently, GSA is responsible for 10,000 federally-owned or leased buildings with an inventory of 250 million square feet of space nationwide.

At GSA, our energy conservation program for Federal office buildings has three major areas of concern:

- 1) The design of energy-efficient buildings for our future office needs;
- 2) The modification or retrofitting of our existing inventory of office buildings to make them energy efficient; and
- 3) The institution of building operating standards and practices to reduce energy consumption.

GSA has adopted the performance approach (energy goal) to ensure that all newly constructed existing Federal buildings are highly energy efficient.

The performance requirements are set forth in our Energy Conservation Design Guidelines for New Office Buildings and our Energy Conservation Guidelines for Existing Office Buildings.

The stringent energy goal for new buildings is 55,000 BTU/GSF/YR at the building boundary. The stringent energy goal for modernized existing buildings is 75,000 BTU/GSF/YR at the building boundary.

There are other important energy-saving design techniques. A key feature, often overlooked, is the selection of sites that allow optimum building orientation and configuration to minimize yearly energy consumption.

Another important area is reducing heat transmissions through building roofs by more effective use of insulation and reflective surfaces and through reduced ratios of window-to-wall area.

In the illumination area, we can achieve lower building energy consumption through reduced lighting levels, task-oriented, relocatable lighting, increased switching capability and conversion to higher efficiency sources, such as sodium high-pressure lamps.

A fourth area involves the reduction of energy for building heating and cooling systems through use of preconditioned intake air energy load management systems and thermostat temperature range adjustments by season of the year.

Unlike the modification of operating standards, modification or retrofitting of existing facilities to achieve energy conservation will require, in many cases, significant capital investments. Over the last two years, we have concentrated initially on minor repair and alteration work such as roof repairs, thermo window installation, insulation, etc. But we recognize the need and strongly support action by the Congress which will enable major energy conservation modifications to Federal buildings. Obviously, some existing facilities are less energy efficient than others, and in a formal program we would concentrate on buildings whose energy usage demonstrates the greatest potential for energy savings and on modifications which would yield returns in energy and dollar savings in the shortest "pay-back" period. One example that I mentioned earlier that would accomplish this is an energy control system designed to spread the electrical load in a building. This process reduces the amount of electrical demand at "peak demand periods." By rescheduling the demands of energy-consuming processes in a building, significant reductions in utility billings can be achieved.

We, as others, are aware that the lack of reliable data on comprehensive costs and benefits of alternative energy conservation measures inhibits the widespread adaptation of good, but unproven, new technologies. Recognizing this, we developed, as you are aware, an energy demonstration building in Manchester, New Hampshire, which will exemplify energy con-

servation design through low heat gain and loss through walls and roof, dual glazed windows with overhead protectors, and low-wattage lighting. It will utilize solar collectors to provide an additional source of heating and cooling to the buildings. We also have a solar demonstration project as part of our Saginaw, Michigan, Federal Building.

Mr. Chairman, I am providing you with a more detailed fact sheet on the Manchester building.

Our published energy performance goals are currently being demonstrated in GSA's Topeka Project. This Topeka Federal Building, Courthouse and Parking Facility is the first project designed utilizing GSA's "Energy Conservation Design Guidelines for New Office Buildings." Computer analyses predict an annual energy consumption well under the stringent energy goal of 55,000 BTU/GSA/YR at the building boundary established by these guidelines. Most other existing buildings consume from 100,000 to 250,000 BTU/GSF/YR.

The building envelope was designed to minimize energy usage, without sacrificing aesthetics and function. Exterior walls are constructed of four-inch brick, two-inch polyurethane insulation, and eight-inch concrete block, minimizing heat transmission through the walls by a factor of eight (8) over normal standards. Window area has been greatly

reduced and comprises only 17 percent of the exterior wall area. Glass is one-inch thick insulating type and windows have a five-foot overhang, resulting in no solar gain in the summer while receiving solar gain in the winter. Most of the windows are in the south and west faces of the building and provide an overlook of downtown Topeka. Through the utilization of building mass and insulation, a very energy-conserving building envelope was obtained.

Although the building is only 16 percent complete, we anticipate actual building performance to exceed the design goals. In addition, the Topeka building will yield considerable energy information which can be used in future construction and repair and alteration projects to further improve the energy efficiency of Federal buildings.

There are specific actions which can be taken, with adequate resources, that would increase the energy effectiveness of our Federal buildings. Broadly speaking, these fall into one or more of the three major areas of the GSA energy conservation program previously outlined. Specifically, GSA is currently pursuing several techniques that hold promising expectations for future energy savings. Four of these include:

- 1) The application of Thermal Infrared Scanning to Federal buildings to detect high heat-loss areas;
- 2) Computerized energy load management systems for buildings;

- 3) Energy conservation performance evaluations of installed new technology systems such as that integrated into the Manchester and Saginaw Demonstration buildings; and
- 4) The application of A/E energy usage surveys.

These techniques have demonstrated abilities to decrease energy consumption, either directly as is the case with energy load management systems or through hardware implementations following actions such as the A/E surveys.

In developing new office building concepts, GSA has actively proceeded with a study on megastructure technology. This concept for Federal office buildings would incorporate a triple-layered, thermally-active, pneumatic fabric roof which permits winter sun radiation into the building and reflects summer radiation. We have named this concept "MEG 2" after the consortium of professionals who collectively were able to research and establish the feasibility of key areas of controlled-environment structures for Federal office buildings. (Their group name was Megastructure Environment Group 2.) The building would exhibit several energy conservation features in a totally different building environment which offers many additional benefits.

The MEG 2 Roof Envelope is made up of three layers of fabric whose upper two layers are designed to be half reflective and half translucent.

When the air between the upper two layers is evacuated, the middle layer rises and a reflective surface is formed over the entire roof area. The purpose of this roof mechanism is to admit solar energy into the space when conditions are favorable and to reject it when not needed. The solar radiation entering the space is absorbed by the internal structure and partly stored for later use.

Pneumatic roofs are built and bid competitively today. The MEG 2 pneumatic roof is feasible with technology available today and may be bid competitively after completion of the required adaptive engineering phase.

Mr. Chairman, the MEG 2 facility received very favorable review in Ada Louis Huxtable's recent New York Times article and also in a recent Washington Post article.

We at GSA are presently reviewing the feasibility of demonstration solar retrofit projects to those existing buildings in our inventory, which promise to have the shortest payback period for energy consumption reduction and dollar savings. We believe these benefits can be increased significantly with retrofit projects that utilize solar technology and conventional energy conservation modifications such as thermo-glass, insulation, heat pumps, energy load management systems, and other tech-

niques. It is the general consensus of the building community, and it is our opinion, based on the extensive demonstration and operational experience we have had to date, that large quantities of energy can be saved with current, cost-effective, state-of-the-art energy conservation technologies applied to Federal buildings. For near state-of-the-art energy technologies additional incentives, demonstration efforts, and policy guidance are required to bring them on line.

Mr. Chairman, with specific reference to your request for a review of the statutory basis for our programs, we find this basis in GSA's general authorities to efficiently design, construct, operate and maintain buildings and building systems under our custody and control as set forth in various sections of the Federal Property and Administrative Services Act of 1949, as amended, and the Public Buildings Act of 1959, as amended. These authorities have enabled us to accomplish our energy programs to date.

Mr. Chairman, that concludes my prepared remarks. I would be happy to answer any questions.

FACT SHEET  
General Services Administration  
April 8, 1976

Manchester Federal Building

The Manchester building is being constructed with high density walls, double glazed windows shaded to reduce summer heat and a windowless north wall facing winter blasts.

The building is a laboratory for the installation of recognized and innovative energy systems. For instance, one floor will have uniform lighting similar to that normally provided in most buildings; other floors will have non-uniform, task-oriented, relocatable lighting; another floor will have larger windows designed for maximum use of natural illumination. The building will also include different heating and air conditioning systems on the various floors for comparison purposes.

The building will be fully instrumented to facilitate the collection of data and evaluation of the energy usage of the building as a whole, as well as for the various mechanical, electrical and lighting systems installed on different floors of the building. Detailed plans for the instrumentation and evaluation are being handled by the National Bureau of Standards. Because some of the demonstration features will affect the working environment of the employees, an evaluation will be made of employee reaction to the building and its environmental systems.

The building is currently 80 percent complete and is scheduled for completion in August 1976. It is now estimated that this building will produce a 50 percent energy savings beyond that realized by comparable modern existing buildings.

GSA FACT SHEET  
Commissioner, PBS  
April 8, 1976

COMMENTS ON S.1392, S.2045, AND S.2095

The following comments have been submitted in previous testimony on Senate Bills S.1392, S.2045, and S.2095:

Section 4(a) and (b)(5), Subsection (a) provides for the publication of energy conservation guidelines one year after date of enactment of the measure. To carry out the purposes of this subsection, the bill should provide for publication of these guidelines one year after the date of the appropriation to carry out the purposes of the Act. PBS recommends that the provisions of subsection (b)(5) be deleted entirely. The collection and evaluation of energy use data outside the building envelope is impractical for a satisfactory estimate of the energy expended for a building and therefore not cost effective.

Section 5(d), Subsection (d) requires that the Administrator of General Services as well as other Federal agencies, include estimates of the utilization, including consumption, efficiency, and cost of energy for a building in prospectuses submitted to the Congress and Committees on Public Works of the Senate and House of Representatives. Much of the information this provision would require is not available at the time the prospectus is submitted. While the proposed bill calls for "estimates", the validity of these estimates is questionable. We believe that a commitment to the guidelines in section 4(a) would accomplish the same ultimate objective and inclusion of the requirement of this subsection to be redundant.

PBS defers to the Office of Management and Budget with respect to the provisions of Section 6.

Section 7, Subsection (b) contains a reporting requirement to Congress of one year after date of enactment of the Act. PBS recommends the requirement be changed to "one year after the date of the appropriation..."

Section 8 authorizes the appropriation of \$7.5 million to carry out the purposes of the Act. If it is intended that the authorized funding be allocated among all Federal agencies, we question the adequacy of the amount to implement the provisions of the Act. However, a recommended revised estimate of cost at this time is not readily available.

S.1392, known as the "Energy Conservation in Buildings Act of 1975" proposes the establishment of a demonstration program in energy conservation, using promising, innovative technology through retrofitting existing buildings for energy conservation, and for other purposes.

We support the intention of this bill which would, through Sections 5(a), 5(b), and 5(c) establish authorities for the Administrator of General Services in identifying building candidates for retrofitting, soliciting proposals and awarding contracts in consultation with the Administrator of the Federal Energy Administration and Director of the National Bureau of Standards. Our support for the intent of this legislation is consistent with current efforts of PBS to initially identify twenty (20) Federal buildings for energy conservation retrofitting as part of a longer term effort in this area.

With regard to S.2095, we at PBS are in full accord with the intent and direction of this proposed legislation. However, we are submitting the following comments at this time, concerning the feasibility of certain sections.

S.2095 like S.2045 calls for the development of energy conservation guidelines for use in the design, construction, operation and procurement of Federal facilities; and the development of an energy use analysis of Federal facilities. However, S.2095 goes a step further and encourages the use of solar energy and provides for increased cost limitations to accommodate energy-efficient equipment in federally-assisted buildings.

Section 5(a)(2) calls for an inventory and energy use analysis for all buildings under our control within one year after enactment of this Act. We do not think it is technically nor economically possible to perform these analyses in this short time frame. Rather, it will be of much greater value to perform energy use analyses along with a progressive system of retrofitting the most desirable buildings in terms of payback periods. We would like very much to discuss this approach.

Section 5(b) requires submission of an energy use analysis for all buildings under the jurisdiction and control of the Administrator. To comply with this subsection, the Administrator would have to have had already obtained a building site and developed the design for the proposed prior to the submission of a prospectus. I am sure you are aware that this is contrary to section 7 of the Public Buildings Act of 1959.

Also, Section 5(b) would create additional problems relating to leased facilities. For example, an energy use analysis could not be prepared

at the time a prospectus is submitted because there is no preconceived idea of what building, prior to prospectus approval and required solicitations for space will be ultimately leased. Further, we question the wisdom of making improvements to a leased facility if a lease has a short time to run and there is no plan to extend the lease period. We also question expenditure of funds for developing plans, etc., to remodel a privately owned property under a long-term lease. There may also be instances where the expenditure of funds would exceed amounts allowed by statutory limitations for leased facilities. Therefore, we recommend that leased facilities be exempted from the application of this section.

The provisions of Section 6(a)(1) would increase cost limitations to accommodate energy equipment in Federal buildings where applicable law specifies such a maximum dollar amount or limitation. If the term "maximum" or other cost limitation signifies a limitation established by an appropriation act of a specified amount for construction of a building, this provision would be useless. If an appropriation is inadequate for any reason, as was the case with the Manchester and Saginaw, an additional appropriation must be obtained.

Senator MORGAN. Mr. Chairman, would you have a comment?

Senator RANDOLPH. Thank you, Mr. Commissioner, for your statement, which I will read in full. I wish to mention two communications at this time because you are indicating what you are doing. I shall not be critical when I bring these matters to the attention of your subcommittee, Mr. Chairman.

I wrote a letter on February 18, 1975, to the Architect of the Capitol. At that time I asked that he conduct a survey and take steps for energy savings in our Capitol Buildings. And he replied that he was concerned and wanted to work with us.

We passed Senate Resolution 59 in the Senate on February 5, 1975, which was a sense of the Senate resolution. It was not a joint resolution. We were trying to point out the areas of concern.

It might be helpful, if it would not encumber the record, if we put a copy of the Senate resolution in the record. Because, frankly, it was overlooked. There was practically no notice given to what the Senate had done in this area.

[The resolution follows:]

United States  
of America

# Congressional Record

PROCEEDINGS AND DEBATES OF THE 94<sup>th</sup> CONGRESS, FIRST SESSION

Vol. 121

WASHINGTON, WEDNESDAY, FEBRUARY 5, 1975

No. 15

## Senate

### S. RES. 59—ENERGY CONSERVATION

Mr. RANDOLPH. Mr. President, for myself and 67 other cosponsors, I send to the desk a resolution and ask for its immediate consideration.

The PRESIDING OFFICER. The resolution will be stated by title.

The legislative clerk read as follows:

A resolution (S. Res. 59) to aid in energy conservation.

The PRESIDING OFFICER. Is there objection to the present consideration of the resolution?

There being no objection, the Senate proceeded to consider the resolution.

Mr. RANDOLPH. Mr. President, ordinarily I would not speak in reference to a resolution, but this resolution is one of very real importance, not only to the Members of the Senate, but to the American people as a whole.

I have introduced this Senate resolution, and I am gratified to note that besides this Senator there are 44 Democrats and 23 Republicans who are cosponsors of this resolution, which I call to the attention of the Senate, in support of an Energy Conservation Crusade and Energy Conservation Month.

I feel that it is very important for us to understand, Mr. President, and my colleagues, that American consumers can voluntarily eliminate the wasteful use of energy if we actually embark upon an Energy Conservation Crusade.

The measure would call on the President to declare as Energy Conservation Month the period from February 16 to March 15, 1975.

In less than a decade, Mr. President, the combination influence of increasing energy demands and declining domestic energy reserves has revolutionized this country's energy prospects for the future. Recent events have transformed our Nation's domestic fuel supplies into one large deficit.

Energy conservation affords not only an opportunity but it also presents an obligation to the American people to both reduce present and future deficits as well as foster energy independence.

During the past year our country has become energy conscious. In some instances it is an acute consciousness, in others it is not as apparent.

It is now widely accepted, however, that our practices of energy consumption in the future cannot follow those of the past. All of us will be required to make adjustments in our life styles if a workable energy conservation ethic is to be adopted.

Our citizens know the importance of reducing energy consumption. During last winter's oil embargo, and since, they have demonstrated by the hundreds of thousands an ability to live with less energy. As a result, energy consumption today is below what had been projected even though oil imports are up.

Individual commitment, Mr. President, to conservation can produce even further savings without any real inconvenience or substantial change in the life styles of Americans, that I have mentioned.

Now, there are significant opportunities for energy savings. These exist in the residential-commercial sectors, particularly for space heating and cooling, in transportation, and in industry.

In all, the potential savings were estimated in 1972 as equivalent to some 7-million-plus barrels of oil per day.

Mr. President, it may not seem too important, but I have been carrying this thermometer with me for some 2 or 3 weeks as I go about in my own State of West Virginia and here in Washington, D.C., and in the Capitol buildings.

I attended a luncheon today in room 1202 of the Dirksen Senate Office Building at the Hearst Foundation awards to two outstanding young people from each State, and this thermometer, which was laid on the table, showed a temperature of 83 degrees.

Just last week I attended another luncheon in the same room, with some 200 persons, and the thermometer registered 81 degrees. It is a matter of concern that here on Capitol Hill where we are discussing energy conservation that we also should be candid enough and forthright enough to recognize that the buildings here at the Capitol, the office buildings in both the Senate and the House, are overheated.

I mention this only as an illustration of what is happening these days.

Mr. President, the achievement of even one-half of the potential savings I have mentioned through the voluntary

action of the American consuming public would represent a major move toward energy independence as well as toward which can be achieved by voluntary efforts. Citizen resistance will stiffen to the problems stemming from the importation of petroleum products from abroad.

In addition, we will be buying time to be necessary to develop mandatory controls over energy sources and to promote approaches to our energy supply problems.

What does this resolution which I have represented calling for an Energy Conservation Crusade do? It is a very simple resolution. It calls on Government at all levels, on all segments of business and industry, and on the public, to voluntarily adopt every realistic means, at their disposal in the conservation of energy. With effective national leadership by Federal, State, and local government agencies, by all segments of business and industry, and by consumers, we can, Mr. President, achieve an estimated energy savings equivalent to some 5 million barrels of oil a day.

So we are not dealing in small figures. Through energy conservation we are dealing with a major contribution to the solving of the energy problem that we face.

The importance of promoting more efficient use of our nonrenewable energy resources and the reducing of energy consumption has been cogently demonstrated by the recent OPEC oil embargo. In response to an Energy Conservation Crusade, citizens will voluntarily take the initiative to eliminate the present wasteful uses of energy in our country. This certainly can provide the Congress and the executive branch with time—time to formulate fair and realistic mandatory programs.

A voluntary national energy conservation crusade offers to all the American people an opportunity to reduce energy use without the apparent severe economic impact of higher consumer prices that will result from President Ford's proposed program of mandatory import controls and price tariffs, although this is a matter for differing convictions and viewpoints in the Senate.

Without question increased prices are going to be imposed on the consumer; however, the effect of higher energy costs on the value added to products and sales revenues will be only a few percent. For example, even for energy-intensive industries—such as electrochemical, metallurgical, and stone, clay, and glass—the cost of energy is only about 10 percent of product cost. In a few specialized industries, such as aluminum, it approaches 20 percent.

Anticipated price increases can in large part be absorbed in more efficient use of energy. What is needed is national leadership by the business community, as well as by each of us as consumers.

I wish to note, Mr. President, that there is a limit to the energy savings which can be achieved by voluntary efforts. Citizen resistance will stiffen when hardship—either real or imagined—results from their reduced uses of energy. In the long run, therefore, it will

enable us to develop long-term programs and approaches to our energy supply problems.

The establishment of fair and realistic programs of mandatory controls will require legislative action by the Congress, however. Such programs must be carefully and deliberately developed to assure that they apply equally to all segments of our society. Until this task is accomplished, and afterward, we must rely on the willingness of the American people to institute and maintain voluntary conservation measures.

The achievement of any substantial savings through energy conservation will involve millions of individual decisions, frankly, by the American consumers.

The importance of energy conservation for space heating and cooling is dramatic. Residential uses alone amount to some 12 percent of our nationwide use of energy, or about 60 percent of the energy consumed by households. Perhaps the most significant opportunities for promotion of energy conservation in the residential sector lie in improved insulation, storm window and doors, caulking, and weather stripping of doors and windows.

Mr. President, I call to the attention of my colleagues in the Senate who are interested in this subject that there are some 40 million existing homes in the United States in need of thermal improvements. The costs, which would range from \$450 to \$700 per unit, could be recovered by a homeowner in about 2 years through reduced fuel consumption for space conditioning. What is needed is a national commitment to promote an upgrading of 4 million residences per year over the next 10 years. By the end of the first year the savings could be equivalent to 108 million barrels of oil. Within 3 years, energy consumption could be reduced by almost 1 million barrels of oil per day. At the end of the 10-year period required to retrofit 40 million homes, the 1985 energy savings would be 1,100 million barrels of oil equivalent.

The program would create some 40,000 new jobs in the insulation industry at a time when it is operating at less than 50 percent of capacity. The creation of these jobs and the return to work of those individuals presently laid off would provide a major stimulus to our economy.

In addition, jobs would be created in the manufacturing and installation of storm windows, doors, caulking, and weatherstripping. These positions would be in the sector of greatest unemployment—the unskilled, semiskilled, and minorities.

A major national commitment, Mr. President, will also be required by American business. A four-point energy management program was outlined last year by Secretary of Commerce Dent. He called for a top management commitment to energy conservation. He also called for a thorough audit of all forms of energy use. He believes that it is necessary to set tough, measurable goals for energy conservation. And then he supported a national energy conservation campaign designed to educate and motivate employees, customers, suppliers, and the community at large.

Mr. President, I want to be very careful in my words and I do not want to exaggerate, but the potential savings are staggering. Within the industrial sector energy savings of 15 to 20 percent are realistic over the next few years. Theoretical savings on the order of 30 to 40 percent are possible, but large capital expenditures will be required by industry over several years.

Commercial activities account for 14 percent of the total energy budget. Over one-half of the energy consumed in transportation can be attributed to business activities alone.

In summary, Mr. President, potential energy savings throughout the business community, without reducing business activity, are quite large: 15 percent in industrial operations, 25 percent in commercial buildings, and 15 percent in business-controlled transportation.

I know of one commercial building in Los Angeles which houses just one company. In that building many months ago there was a decision by management to have the escalators that were running 10 hours a day operate 2 hours in the morning and 2 hours in the evening. There was a removal of over 11,000 fluorescent light electric bulbs. Still there was security and comfort.

With regard to the cleaning of offices, look in Washington, D.C., in the public buildings, in the private buildings. Look at any city in America at night; at 8, 9, 10, 11, 12, and 1 o'clock in the morning, those buildings are ablaze with the use of electricity.

In the one building I mentioned in Los Angeles, by staggered employment starting early in the evening, there has been a reduction by 3½ to 4 hours in the time utilized for cleaning at night. This one company I mention, since adoption of this three-pronged energy conservation program, has cut its energy usage by 31 percent.

Some say energy conservation is an idle gesture; it is just the opposite. This resolution calls the American people to a crusade; it challenges them to conserve energy. The results would then be reported to the American people by the 31st of March, in the beginning, and monthly thereafter. This is very important.

On the basis of 1973 energy use, we could produce energy savings on the order of 5 million barrels of oil per day.

President Ford has proposed mandatory controls to achieve oil import reductions on the order of one to two million barrels of oil per day.

So I say to Senator HELMS, to Senator FORD, and to the able majority whip, who are in the Chamber, that we in Government can lead the way, in a sense we can serve by example, and call on the private sector to contribute to energy conservation.

Within the vast Federal Establishment there is an enormous potential. The General Services Administration owns or leases 10,000 buildings in all parts of the country. In one 6-month period a year ago, it found that the equivalent of 88,000 barrels of oil were saved simply by removing 1.2 million fluorescent light tubes. Reducing room temperatures to a recommended 68 degrees, instead of generally 76 and 78 and 80 degrees here on Capitol Hill, and with a reduction at night to 55 degrees saved 428,000 barrels of fuel oil.

These and other practices by Federal, State, and local governments would contribute greatly to the reduction of our national energy consumption as well as foster energy self-sufficiency.

Similar savings obviously are available to the American people in their everyday lives, without reducing their standard of living. Conservative use of energy for home heating and lighting, as well as added insulation, can bring about energy savings and counteract rising fuel costs.

One of the most important energy conservation measures we enacted in the 93d Congress was the establishment of a national 55-mile-per-hour speed limit. Transportation accounts for 25 percent of our total energy consumption. Even a small percentage of savings in energy consumption in transportation therefore is significant. Because of the heavy reliance of transportation on liquid fuels, the Federal Energy Administration has calculated that a universal observance of the 55-mile-per-hour speed limit—if it is enforced, Senator HELMS—can save 5 million gallons of gasoline every 24 hours.

One option if it is not enforced is to just withhold the highway funds from the States that do not enforce it. They will take more affirmative action, because they need the construction to go forward.

Carpooling, greater use of public transportation, and consolidation of trips are other easy methods by which the American consumer can save energy.

Other options for conserving energy have been examined by the Senate's National Fuels and Energy Policy Study. Several of these were contained in measures which the Senate approved during the 93d Congress such as the Facilities

Construction Energy Conservation Act of 1973 and the National Fuels and Energy Conservation Act of 1973.

Mr. President, I ask unanimous consent to have printed in the RECORD, at this point in my remarks the names of the Senators who are cosponsors of the resolution I have presented.

The PRESIDING OFFICER (MR. STONE). Without objection, it is so ordered.

Mr. Abourezk, Mr. Allen, Mr. Baker, Mr. Bartlett, Mr. Bellmon, Mr. Bentsen, Mr. Buckley, Mr. Burdick, Mr. Byrd of Virginia, Mr. Byrd of West Virginia.

Mr. Cannon, Mr. Case, Mr. Chiles, Mr. Clark, Mr. Cranston, Mr. Culver, Mr. Curtis, Mr. Dole, Mr. Domenici, Mr. Eagleton.

Mr. Eastland, Mr. Fannin, Mr. Ford, Mr. Gravel, Mr. Hansen, Mr. Hart of Colorado, Mr. Hart of Michigan, Mr. Hertke, Mr. Haskell, Mr. Hatfield.

Mr. Hathaway, Mr. Helms, Mr. Hollings, Mr. Huddleston, Mr. Humphrey, Mr. Inouye, Mr. Jackson, Mr. Javits, Mr. Johnston, Mr. Laxalt.

Mr. Magnuson, Mr. Mathias, Mr. Mansfield, Mr. McClure, Mr. McCovern, Mr. McIntyre, Mr. Mondale, Mr. Montoya, Mr. Morgan, Mr. Moss.

Mr. Muskie, Mr. Nunn, Mr. Pastore, Mr. Pearson, Mr. Percy, Mr. Pell, Mr. Ribicoff, Mr. Schweiker, Mr. Scott of Pennsylvania, Mr. Stennis, Mr. Stevens, Mr. Stone, Mr. Talmadge, Mr. Thurmond, Mr. Tunney, Mr. Williams, and Mr. Young.

Mr. RANDOLPH. Mr. President, seldom have we had this sort of sponsorship. It indicates that there is no partisanship whatever in this approach. We are not pointing the finger at anyone. Frankly, we are pointing our fingers at ourselves.

We all realize that an Energy Conservation Crusade with the Energy Conservation Month I have mentioned, will help us realize that we are challenged in a voluntary way to make this effort. Thus Americans can be made more aware that the problems related to the importation of oil from abroad can in a large measure be solved, by beginning our independence here, with the disciplines that we can build into our daily lives.

I thank the able Majority Leader MIKE MANSFIELD, the Majority Whip ROBERT BYRD, the Minority Leader HUGH SCOTT, and the Minority Whip ROBERT GRIFFIN for this opportunity, at perhaps a late afternoon hour, to consider and to have adopted this resolution, under a unanimous-consent agreement.

The resolution is in no way a gesture. If the President of the United States will proclaim this Energy Conservation Crusade, if he will designate the month indicated as Energy Conservation Month, and will call upon the American people, through his leadership, then we, through our cooperation, can do much in our hour of need.

The PRESIDING OFFICER. The question is on agreeing to the resolution.

The resolution was agreed to, as follows:

S. RES. 60

Resolved, that it is hereby declared to be the sense of the Senate that wasteful energy consumption in the United States must be eliminated at this time when our country is experiencing unprecedented economic and energy problems and is faced with severe shortages of energy, and requests the President to issue a national proclamation calling for a national Energy Conservation Crusade and declaring the period from February 16 to March 15, 1975, as "Energy Conservation Month". In the observation of Energy Conservation Month—

—the President is called on to publicize information for government, industry, and consumer use on appropriate energy conservation measures and to direct the Federal establishment to institute all available actions to reduce energy consumption without reducing the level of essential services being provided to the American people;

—governors, county executives, mayors, and other responsible officials are called on to examine the activities of State and local government and wherever possible institute comparable measures to those of the Federal government to promote energy conservation;

—business and industry are requested to examine their energy consumption practices and institute measures to eliminate unnecessary energy consumption and improve efficiency of use of available energy supplies, to curtail ornamental lighting and nonessential lighting, advertising, to adjust business hours to reduce energy consumption, and to modify building operating and maintenance practices to promote energy conservation; and

—the American people are called on to take the initiative in conserving available energy supplies by observing the 55 mile per hour speed limit on highways, by reducing the use of energy to heat and cool homes, offices, schools, and commercial establishments, by increasing the utilization of mass transportation facilities, carpools, compact cars, and stick-shift motor vehicles, and by installing insulation in their homes.

Sec. 2. The President is requested to report to Congress by March 31, 1975, on the steps taken to promote energy conservation and their results and on any recommendations for legislation he believes necessary to implement a continuing program of energy conservation.

Sec. 3. The President is requested to report monthly to the American people and the Congress on the status of energy conservation initiatives and their effectiveness, domestic energy supplies, domestic energy shortages, energy imports, and the impact of available supplies or shortages on the economy of and employment in the United States.

Mr. ROBERT C. BYRD. Mr. President, I wish to express my appreciation to my senior colleague for the leadership he is giving in this area. I compliment him on the fine statement he has made here today. I appreciate his including my name as a cosponsor.

Mr. RANDOLPH. The Senator from West Virginia has been a part of our consideration and our programming of this resolution, and I am grateful for his assistance.

Mr. ROBERT C. BYRD. I thank the Senator.

Mr. BARTLETT subsequently said: Mr. President, I wish to compliment the distinguished senior Senator from West Virginia for the submission of the conservation resolution. I was privileged to be a cosponsor of this. I am well aware of the senior Senator's interest in matters of energy dating back many years. One year prior to 1971, he submitted a resolution to attempt to bring a solution to the energy crisis. The resolution or bill—I have forgotten, really, which it was—did not pass, but, later, the following year, 1971, he was the cosponsor of Senate Resolution 45, which called for an energy study to be undertaken by the Committee on the Interior, with ad hoc status or associate status given to the Committee on Public Works and to the Committee on Commerce. I am well aware of his interest in finding solutions to the energy problems and I compliment him for his action today.

---

Senator RANDOLPH. The resolution contains a long laundry list of places where energy savings can be made in connection with buildings. In this regard, Mr. Chairman, in response to my inquiry I have a letter from the Architect of the Capitol, George M. White. If you feel that it is advisable, Mr. Chairman, I would ask that it be placed in the record.

Senator MORGAN. We will so order that, Mr. Chairman.

[The letter and attachments follow:]

THE ARCHITECT OF THE CAPITOL,  
Washington, D.C., March 6, 1975.

Hon. JENNINGS RANDOLPH,  
Chairman, Committee on Public Works, U.S. Senate,  
Washington, D.C.

DEAR MR. CHAIRMAN: This will acknowledge your letter of February 18, 1975 asking that a survey be conducted to determine the potential energy savings that can be achieved in the Capitol buildings through a positive energy conservation program.

I am in wholehearted accord with the spirit of Senate Resolution 59 and will continue to seek every possible means of reducing energy consumption in all areas under my jurisdiction, consistent with the requirement to render essential services to the Congress and visitors. As you may know, following the announcement on November 8, 1973 of Federal programs to conserve energy, I developed an energy conservation program for the Capitol Buildings and Grounds which was approved by the Chairman of the Committee on Rules and Administration and the Speaker and which they communicated to all Members by their letters of November 14, 1973. A copy of Senator Cannon's letter and of my own engineering instructions of December 21, 1973 to all Building Superintendents are enclosed herewith. These programs are still in effect, with the exception of the reduced lighting on the Capitol dome which has been restored to approximately 70 percent with approval of the leadership. The results of the program are described in the enclosed statement in the Record of June 21, 1974 by Senator Cannon.

Though, as stated in our instructions, all thermostats in the public spaces should be set no higher than 68 degrees, on unseasonably warm winter days the actual temperature in the Capitol buildings occasionally may be uncomfortably warm, as you have noted, though, of course, no steam is being consumed. Nevertheless, I shall continue to be alert to prevent possible violations of the instructions.

In accordance with your request I have commissioned an in-depth study of possible additional actions which may be recommended in order to further conserve energy, and I shall, of course, promptly report the results of the study to you as soon as it has been completed.

Cordially,

GEORGE M. WHITE, FAIA,  
Architect of the Capitol.

U.S. SENATE,  
COMMITTEE ON RULES AND ADMINISTRATION,  
Washington, D.C., November 14, 1973.

DEAR COLLEAGUE: This letter is to inform you of actions which the Architect of the Capitol has undertaken, with my approval as Chairman of the Committee on Rules and Administration and that of the Speaker of the House, in order that the Congress properly participate in the national effort to conserve energy this winter:

1. Since present heating loads at the Capitol Power Plant can be carried without the use of standby oil fired equipment, all heating loads have been shifted to the existing coal fired boilers.

2. The normal operation of the Capitol Power Plant would call for the seasonal discontinuance of the refrigeration system about November 15th. In accordance with that policy the refrigeration plant has been shut down for the season. Members may feel the effects of this action on unseasonably warm days. However, in order to conserve energy the air conditioning system will not be turned on until spring unless absolutely necessary.

3. Lighting on the Capitol Dome has been reduced by 70 percent and flood lighting of the lower part of the building has been extinguished. The terrace lights have been equipped with globes of  $\frac{1}{2}$  the wattage previously installed.

Minimum lighting on the grounds, adequate for security purposes will be maintained.

4. Operating hours for the escalators, normally from 6:00 a.m. to 8:00 p.m., or until 1 hour after the end of the legislative sessions, will be modified as appropriate.

5. In all spaces, other than in the Members' office suites and the Committee Rooms, thermostats have been set at 68 degrees or less. In addition, the lighting has been reduced in all spaces other than Members' office suites and Committee offices, including tunnels, restaurants, and the garages. The lighting in the Senate Chamber, however, will not be affected during hours when the Senate is in session.

6. The Capitol Police and the Char forces have been instructed to turn off all lights in all unoccupied spaces after working hours and to use lights only in those spaces where they are actually working.

The measures outlined above have reduced our electrical power requirements by about 15 percent and our heating fuel requirements by about 10 percent. In order to further reduce our energy requirements, Members and Committees are requested, to the extent practicable, to set thermostats no higher than 68 degrees in their offices and to reduce lighting to the maximum extent possible without causing eye strain.

I hope all Members and their employees will cooperate to the fullest extent possible in our efforts to conserve energy over the next several months.

Sincerely,

HOWARD W. CANNON, Chairman.

THE ARCHITECT OF THE CAPITOL,  
Washington, D.C., December 21, 1973.

MEMORANDUM

To: All Building Superintendents.  
From: Architect of the Capitol.  
Through: Coordinating Engineer.  
Subject: Energy Conservation.

As you know, although a new importance has now been attached to the subject of Energy Conservation in general, and the reduction of electric lighting and HVAC loads in particular, concern for conservation of energy in buildings within the jurisdiction of the Architect of the Capitol, has been in effect for a number of years.

In the HVAC field, operating schedules have been periodically formulated and distributed for the several seasons of each year, including recommendations to all personnel involved, indicating ways in which to improve operating efficiency and to reduce heating and cooling loads in all buildings. These schedules are designed (1) to improve the operational effectiveness and efficiency of the Capitol Power Plant and (2) to reduce electric power and fuel consumption.

In conformity with the present national energy conservation program the following procedures are established within all buildings under the jurisdiction of the Architect of the Capitol.

1. HVAC Units shall, in general, be started at 6:00 A.M. each morning Monday through Friday and shall be turned off each evening at 10:00 P.M. If the shift engineer is satisfied that the area supplied by any individual system has been vacated prior to the scheduled shut-down time, the unit shall be turned off at the earliest time that its service is not required.

2. HVAC Units that supply air to public areas on Saturday and Sunday shall be started at 8:00 A.M. and shut-down when the building closes.

3. HVAC Units that supply committee rooms only shall be started one hour prior to any scheduled committee meeting and shall be shut-down immediately after adjournment of the meeting.

4. HVAC Units supplying committee rooms that also accommodate staff personnel shall be treated in conformity with procedure No. 1 above or shut-down as soon as the staff personnel have vacated the area.

5. HVAC Units supplying areas manned on a 24 hour basis shall be retained in continuous operation, but at a reduced capacity, whenever circumstances permit.

6. When garages are in general use, operation of all ventilating and exhaust systems shall be restricted to the hours between 7:30 A.M. and 6:30 P.M., or until one hour after the Congress adjourns, whichever is later.

These systems shall not be operated at all when the garages are being minimally used, such as on Sundays and holidays, and at such other times as may appear appropriate.

7. All garage lobby units shall be shut-down until further notice and doors from lobbies to garage areas shall be kept closed.

8. Contact shall be made with key personnel in computer facilities, video tape and recording areas to ascertain minimal requirements for cooling, and based on the information obtained, equipment shall be re-adjusted accordingly.

9. Kitchen exhaust systems shall be turned off one hour after the kitchen operations have been completed.

10. Toilet and general exhaust systems shall be operated in accordance with the schedules outlined under Item 1, 2, 3 or 4, whichever is applicable.

11. The building of fires in fireplaces with flues connected to mechanically induced draft systems is, in general, prohibited; however, if such installations are authorized by the Architect, the shift engineer must verify that the fire is completely out prior to complying with the shut-down time as set forth under Item 1 above.

12. Hot water temperatures for induction units, radiators and boosters shall be reduced by approximately 10 degrees F from normal operating temperatures; surrounding space temperatures shall not, however, be reduced by more than 6 to 8 degrees below normal.

13. All controls on pre-heaters shall be checked and re-calibrated to insure that steam is not used prematurely.

14. All steam traps shall be checked and overhauled if necessary to eliminate any blow through.

15. Units that supply the House and Senate Chambers and Galleries are to be operated only on days that sessions are scheduled.

16. Log sheets shall continue to be sent to the Office of the Coordinating Engineer, and shall now show fan discharge, return air, dew point temperatures and the temperatures of water in and out of the unit when the anti-freeze protection units are in operation. The log shall also indicate the time that units are started and shut-down.

17. An inventory shall be made by each engineer-in-charge as soon as possible and submitted to the Coordinating Engineer, Architect of the Capitol, marked to the attention of the Head Air Conditioning Engineer. The inventory shall list each and every motor associated with heating, ventilating and air conditioning including units that supply video tape, recording and computer facilities. Each motor listing shall indicate the voltage, amperage and horsepower.

In some of the foregoing instances, earlier shut-downs than outlined may be possible, based on the irregularity of activity in certain spaces. The quantity of energy savings resulting from such earlier curtailment could be considerable and it will be incumbent upon Building Superintendents or their designated engineering personnel to explore these possibilities by establishing a system of communication, regarding earlier shutdowns, between the personnel using the space and the building equipment operating staff.

These procedures are not intended to create any undue hardships or discomfort to occupants of the buildings but are intended to be used as guidelines in complying with the expressed desire of the Senate and House of Representatives leadership to participate in a maximum effort in the Conservation of Energy Program.

Because the HVAC systems are major energy users, and affect both electric power and fuel consumption, more emphasis has been placed in these guidelines in that regard; however, special effort is also required to reduce electric energy consumption of all kinds.

Therefore, compliance with the previously announced policy for reduction in lighting loads to the maximum extent possible, in all areas under the jurisdiction of the Architect of the Capitol, will be expected. It is anticipated that a 50 percent reduction in illumination in corridors and public spaces, with an even larger curtailment in garages and certain architectural lighting, can be achieved without detriment to safety and security needs.

GEORGE M. WHITE, FAIA,  
*Architect of the Capitol.*

[From the Congressional Record, June 21, 1974]

CAPITOL HILL ENERGY CONSERVATION EFFORTS—REMARKS BY SENATOR CANNON  
CONSERVATION OF ELECTRICAL ENERGY

Mr. CANNON. Mr. President, I would like to share with my colleagues the commendable results of Capitol Hill energy conservation efforts during the past 6 months.

In separate letters of November 14, 1973, to the Members of the Senate and the House, both the Speaker and I described actions which the Architect of the Capitol was undertaking, with our approval, in order that the Congress might effectively participate in the national effort to conserve energy. These measures include: Earlier than usual discontinuance of air conditioning last fall; reduction of Capitol dome lighting by 70 percent and of other public space lighting by about 50 percent; shorter operating hours for escalators; and 68 degree thermostat settings in spaces other than the Members' office suites and committee rooms. These measures were expected to reduce electrical power consumption by about 15 percent and heating fuel requirements by about 10 percent. In order to further reduce energy requirements, Members and committees were asked to reduce thermostat settings and lighting levels in their offices to the extent practicable.

I am very pleased to report that the results exceeded the aforementioned goals. Our consumption of electrical power has dropped, compared with the same months of the previous year by 14.4 percent in December, 17.8 percent in January, 17 percent in February, and an impressive 23.3 percent in March. At the same time consumption of steam which was produced primarily by coal, also dropped significantly, that is, 14.5 percent in January alone. I wish to commend and congratulate my colleagues in both Houses and all employees of the Congress for this fine effort.

It appears timely now to point out that the forthcoming months of the air cooling season offer the greatest annual opportunity to save significant amounts of electrical energy, primarily because our chilled water compressors are driven electrically. During the unpredictable temperatures of April and May, and later in September and October, attempts to save air cooling energy by higher settings on thermostats can sometimes have the reverse effect on unseasonably cool nights when the switch releases steam into the system. Now that we can expect consistently high summer temperatures, however, the Architect will set thermostats in public spaces at 78 degrees, in accordance with acceptable recommendations. Members and committees and their staffs are requested to do likewise in their offices, to the extent practicable, and to continue their other commendable economies in the use of electrical appliances and lighting.

Senator RANDOLPH. In his closing paragraph Mr. White said:

In accordance with your request I have commissioned an in-depth study of possible additional actions which may be recommended in order to further conserve energy. And I shall, of course, promptly report the results of the study to you as soon as it has been completed.

Now, that letter was written March 6, 1975. I have never received, in over a year, the results of that in-depth study. The report was to be made to the Senate Public Works Committee, and don't misunderstand me but that report, if completed, should be made a part of the record. We are wondering what happened. We do less on Capitol Hill, perhaps, than we do in the other buildings of the Federal Government.

Mr. PANUZIO. Was that letter sent to the Administrator of GSA?

Senator RANDOLPH. No, to the Architect of the Capitol, just on Capitol Buildings. But an in-depth study was to be made. I doubt if it took a year to make it or a year to get the reply back to us.

Mr. Chairman, with your permission I hope that you will give the Architect of the Capitol a nudge, and let's see if we can't have that report for the record.

Senator MORGAN. You can rest assured that we will.

[A report from the Architect of the Capitol follows:]



Washington, D.C. 20515

June 8, 1976

Honorable Jennings Randolph, Chairman  
Committee on Public Works  
United States Senate  
Washington, D.C. 20510

Dear Mr. Chairman:

The following status report regarding energy conservation in the Capitol Building Complex is submitted in pursuance of the request in your letter of May 17, 1976:

As you know, our office has been investigating potential additional energy savings that might be achieved in the buildings on Capitol Hill through augmentation of our energy conservation program. In that regard, I requested an indepth study of possible additional actions which could be taken to conserve energy over and above those actions previously instigated by this office in 1973 and 1974. Mr. Ray Carroll, my Director of Engineering, has been studying this matter and has had discussions with various manufacturers and consultants regarding the possibility of instituting computerized programs to assist in achieving additional energy savings. However, with the rather large and sophisticated computerized systems presently being installed in the Madison Building, and similar installations planned for the Dirksen Extension and for the Capitol Power Plant expansion, it does not appear feasible at this time to make a final decision as to which type of system to pursue for the purpose of energy conservation for all buildings on Capitol Hill.

The fundamental and first action that must be taken prior to the selection of a system, is to complete an energy audit and equipment inventory of all energy consuming devices on Capitol Hill. That inventory is in the process of being completed and

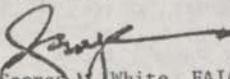
Hon. Jennings Randolph  
June 8, 1976  
Page 2

will give the basic information necessary before effective controls can be achieved. There are, as you may know, an ever increasing number of energy consuming devices being installed on Capitol Hill such as copying machines, increased central computer facilities and terminals (dramatically enlarged in the last two to three years), the addition of new buildings such as the Senate Court Apartments, the Hill Apartments, as well as House Office Building Annex No. 2 (former FBI building), coffee makers and other such devices, and a large number of miscellaneous electrical items that exist in the various offices and committee rooms on Capitol Hill. The inventory is thus somewhat involved.

Please be assured that the study is actively proceeding and that we will keep the Committee apprised of our continued progress. In the meantime, we intend to issue further reminders from time to time to call attention to the continuing need for energy consciousness in order to insure that lights are only used to serve the task required and that ventilation air is reduced to the absolute minimum dictated by the use of a space. Ultimately, of course, we intend to have the capacity to automatically regulate energy consuming equipment as much as possible in order to achieve maximum energy conservation.

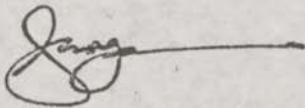
I shall, of course, be pleased to submit any additional information that you may deem advisable.

Cordially,

  
George M. White, FAIA  
Architect of the Capitol

Mr. Chairman:

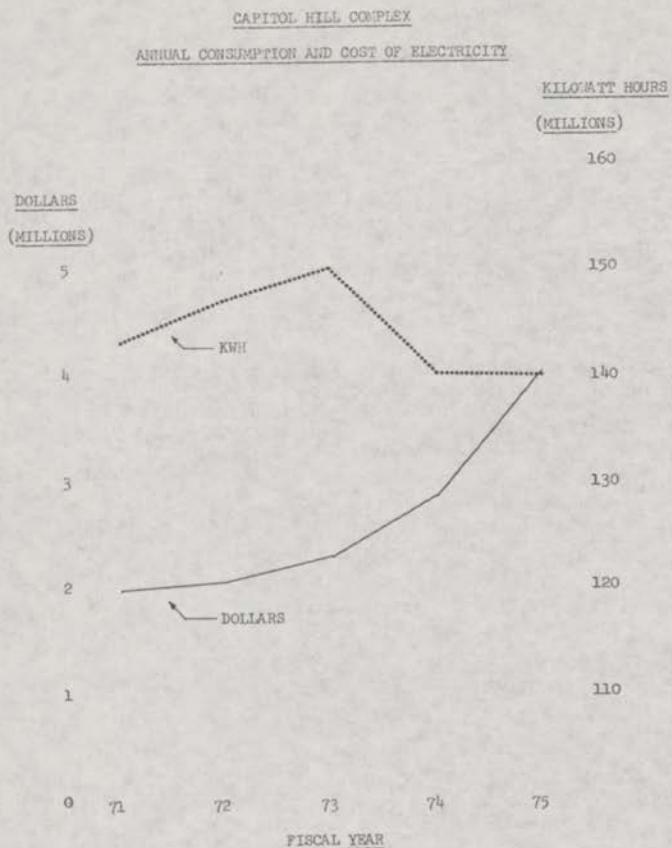
I have attached several charts that illustrate the data being collected and the comparative studies that are being made.

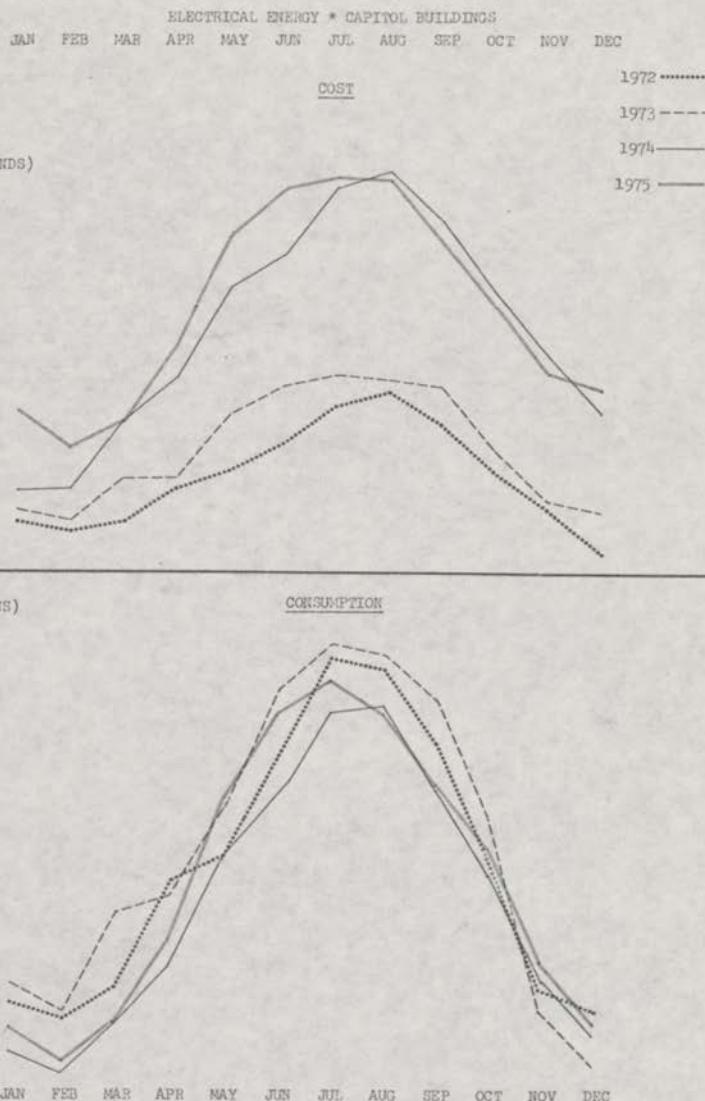


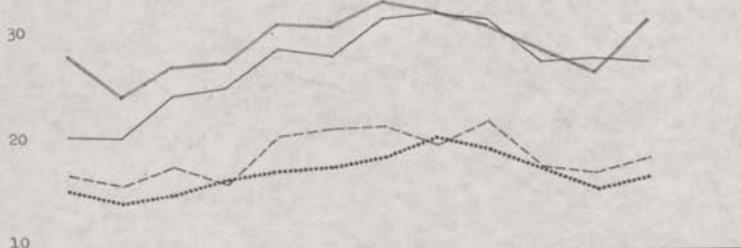
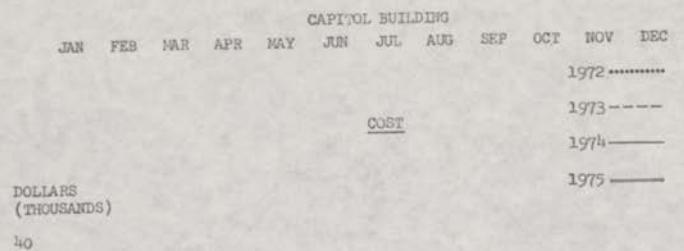
CAPITOL HILL COMPLEX  
ANNUAL ELECTRICAL CONSUMPTION

KWH

BUILDING	FY 1971	FY 1972	FY 1973	FY 1974	FY 1975
CAPITOL	13,453,275	13,589,248	13,688,434	12,129,584	11,769,190
DIRKSEN	11,355,205	11,686,068	11,794,083	11,375,091	10,651,234
RUSSELL	7,231,032	7,278,416	7,342,480	6,914,166	6,869,916
127 "C" STREET	90,270	293,795	308,463	259,462	95,978
LONGWORTH	6,988,558	6,912,668	7,055,555	6,440,251	6,568,086
CANNON	7,287,931	7,136,054	7,217,784	6,354,530	6,268,618
RAYBURN	29,283,912	29,752,734	30,327,857	25,937,127	26,474,584
HOB #1	-	-	1,198,977	1,366,794	1,400,445
HOB #2	-	-	-	-	2,283,208
CAPITOL POWER PLANT	43,382,013	44,317,600	43,558,998	43,854,830	39,918,036
LIBRARY/MAIN	11,110,426	11,953,212	12,201,132	10,847,774	11,403,734
LIBRARY/ANNEX	8,680,467	9,186,954	10,011,955	9,983,960	10,215,470
LEGISLATIVE GARAGE	1,298,748	1,297,399	1,314,198	1,085,177	1,167,569
SUPREME COURT	2,735,408	2,935,988	3,316,545	2,799,655	2,854,490
IMMIGRATION	-	-	-	248,512	1,322,276
PLAZA HOTEL	-	-	-	-	-
CAPITOL HILL HOTEL	-	-	-	-	-
STREET LIGHTING	217,549	233,450	228,150	212,604	222,232
TRAFFIC SIGNALS	73,228	69,975	72,055	70,652	67,768
MISCELLANEOUS	434,244	653,870	848,418	805,198	1,037,860
TOTALS	143,622,266	147,297,431	150,485,064	140,685,367	140,590,694



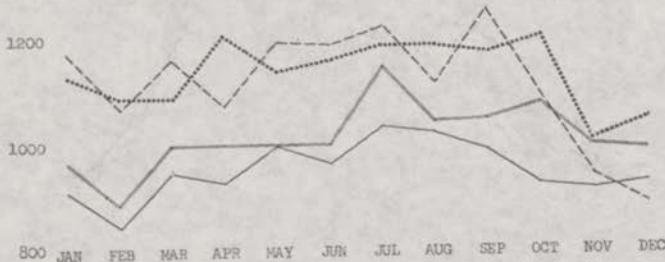




CONSUMPTION

KWH (THOUSANDS)

1400



JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

DIRKSEN SENATE OFFICE BUILDING

1972 .....

1973 - - -

1974 - - -

1975 - - -

COSTDOLLARS  
(THOUSANDS)

30

20

10

0

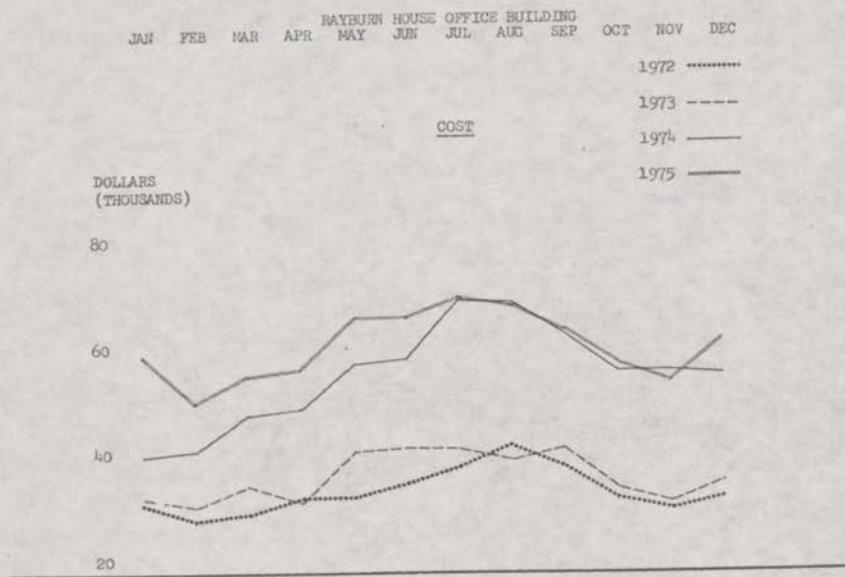
CONSUMPTIONKWH  
(THOUSANDS)

1200

1000

800

600 JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC

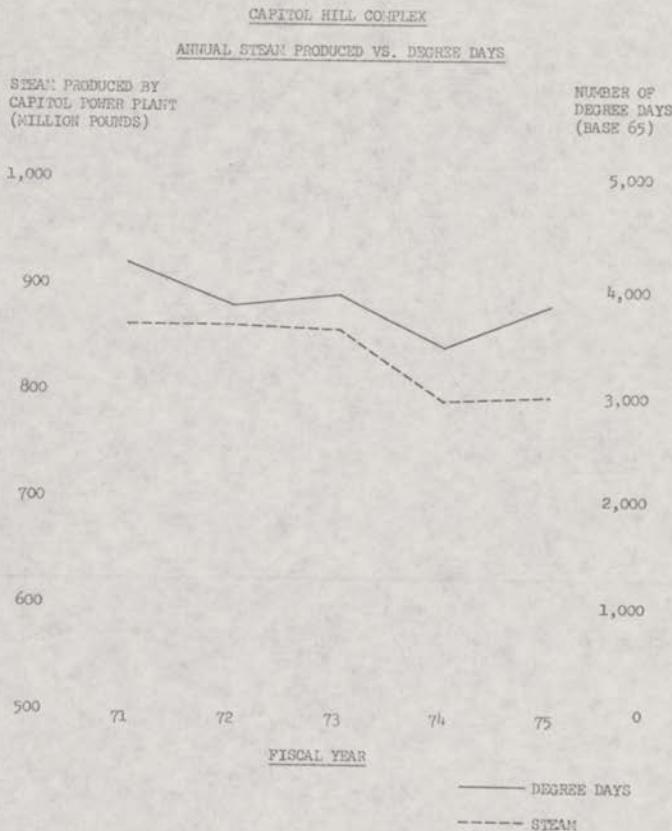
CONSUMPTIONKWH  
(MILLIONS)

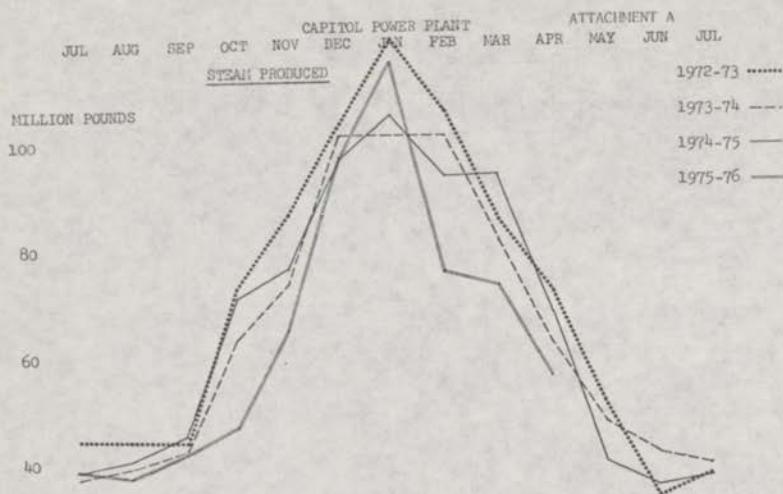
3

2

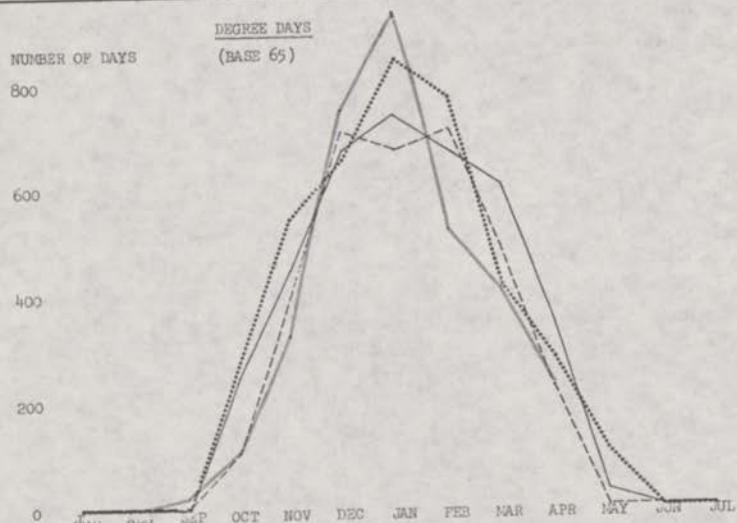
1

0 JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC





20



Senator RANDOLPH. About that same time I also addressed a letter on March 31, 1975, to the Federal Energy Administration and Mr. Zarb replied on June 24, 1975, setting forth certain information. And, again in your judgment, Mr. Chairman, that letter might be placed in the record.

[The letter referred to follows:]

FEDERAL ENERGY ADMINISTRATION,  
Washington, D.C., June 24, 1975.

Hon. JENNINGS RANDOLPH,  
Chairman, Committee on Public Works,  
U.S. Senate, Washington, D.C.

DEAR MR. CHAIRMAN: This is in response to your letter of March 31, 1975, requesting the Federal Energy Administration (FEA) to compile an inventory of residential buildings with regard to their thermal protection characteristics.

We have met with members of your staff and the National Bureau of Standards and the project is underway. We propose the following schedule for completing the inventory of residential housing:

July 11, 1975—Complete evaluation of existing information on single family homes, and determine need for further data collection. This process will include verifying the insulation manufacturer's information and exploring further analysis of the Washington Center for Metropolitan Studies (WCMS) and the National Association of Home Builders (NAHB) data, described below. Contacts with those knowledgeable in this field will be made to solicit advice.

August 1, 1975—Complete survey of existing information on mobile homes and design further data collection.

August 15, 1975—Receive preliminary information from multi-family data research contract. Further data needs will be determined at that time.

January 1976—Compile all existing information on the residential inventory's characteristics in conjunction with 1970 Census of Housing and the 1974 Housing Survey. This information will be analyzed for the conservation potential in residences. We have identified four sources of information which are currently available:

*Washington Center for Metropolitan Studies*

WCMS conducted a survey on Lifestyles and Energy for the Ford Energy Policy Project. Interviews were made with nearly 1,500 households across the country in May 1973. Questions were asked about all aspects of household energy use. Chapter 5 of "A Time to Choose" is based on these survey results.

Several questions were asked relating to energy use for home heating and cooling. Tab A to this letter contains copies of the relevant questions, plus summaries of the data, projected to the national total. As with the Bureau of the Census Survey described elsewhere, the only question asked about insulation was about its presence rather than its quantity. As you can see from the questionnaire, data was collected about the number of storm windows, but to our knowledge this information has not yet been aggregated. A book summarizing the survey information is to be published soon.

FEA has funded a resurvey of the original 1,500 households, plus another 1,500 to be chosen in a similar fashion. This resurvey will reveal trends in energy use patterns since the embargo, and will enable a better analysis of current patterns.

*Bureau of the Census*

Two housing surveys have been taken since the 1970 Census, and another is planned for later this Fall. The first of these (1973) asked no questions related to insulation and storm windows. The second, conducted in the Fall of 1974, asked about the presence of insulation and storm windows, but again, nothing which would enable a quantitative evaluation. This survey information will be available late this year or early in 1976. The 1975 survey will ask similar questions about the presence of insulation. At our request, questions are being added about the level of retrofit activity in the twelve months previous to the survey. This latter information will be useful in determining the response to various incentives for retrofit. The Census Bureau believed that, in the context of their survey, it would not be productive to ask what levels of insulation existed in homes.

Results of the 1975 survey will not be available until late 1976. Copies of the 1974 and 1975 questions are included in Tab B.

#### *Insulation Manufacturer*

The largest manufacturer of insulation is Owens-Corning Fiberglas in Toledo, Ohio. They have spent a substantial amount of money investigating the market for residential insulation, and have released to us parts of that information.

This data appears to be the most detailed currently available. It shows the number of single family homes with accessible attics, broken into categories of insulation levels, by nine regions of the country. Using standard engineering calculations, the company has computed that if the 17,890,000 homes they found to have less than three inches of insulation were to receive another six inches (R-19), the total energy savings would be 682 trillion BTU per year, the equivalent of 320,000 barrels of oil per day.

There is some question of the accuracy of these estimates of the level of insulation in homes. Owens-Corning has been reluctant to release details of this and other surveys, presumably because of the amount of money they have invested in them.

We view Owens-Corning's estimate of the conservation potential as a minimum figure. It includes only ceiling insulation in those homes with accessible attics. There are numerous other effective conservation measures whose combined potential is at least as great as 682 trillion BTU per year. The NAHB-Research Foundation recently estimated the national potential at between 650,000 and 1,000,000 barrels of oil per year for just half of the existing single family housing stock.

#### *NAHB-Research Foundation*

As part of a contract for the FEA, the NAHB-Research Foundation surveyed existing data describing housing construction practices since 1940. Copies of the sheets relating to insulation and storm windows are included in Tab D. As with other information, these figures show only the existence of insulation, not its level.

The above information relates almost exclusively to single family units, both attached and detached. You inquired about two other categories of housing as well: multi-family buildings and mobile homes. We are about to award a contract to investigate the conservation possibilities in the multi-family sector. This contract will last three months and will yield data and policy and program recommendations. Consumption in such buildings has been estimated to be less than 10 percent of the entire residential sector. Conservation activities are complicated by the number of different factors involved, including owners, tenants, builders, and managers, each of whom has different financial interests in the use of energy. A separate study, to be completed within the next month, has investigated the extent of the practice of master metering of apartment buildings and its impact on energy use. Preliminary results show that tenants who do not see a separate energy bill consume 35 percent more energy for non-heating purposes than do tenants who must pay for their individual consumption.

We have also begun to investigate conservation in mobile homes. Little is known about the use or conservation of energy in mobile homes. In fiscal year 1975 we funded basic research about energy use in mobile homes to determine the conservation potential in both new and existing mobile home energy use patterns by region and economic groups, and are investigating the technical problems of upgrading homes already in place.

We have been active in developing programs and policies to promote conservation in the private housing sector. You are familiar with our efforts for tax credits, building standards, and low-income winterization assistance. In addition, we are involved in three major program efforts in this field: Project Conserve, Homeowner's Manual and Business Guide. A brief description of these programs is included in Tab E.

Our development of conservation programs will be continuing as we analyze the residential inventory. If there is further information on data or programs which would be helpful to you or your staff, please contact us. We are looking forward to working closely with you in this area.

Sincerely,

FRANK G. ZARB,  
*Administrator.*

Senator RANDOLPH. We suggested that there be a national inventory of residential buildings as to their thermal protection characteristics,

just to see what the picture was. The National Bureau of Standards also was to work on this survey.

The FEA gave us a schedule for the completing of the inventory of this residential housing problem.

With your permission, Mr. Chairman, I would ask Mr. Grundy to tell us where we are and what report has come after over a year since the request was made.

Mr. GRUNDY. Under the original schedule, Mr. Chairman, the compilation of the information upon which to make an evaluation of the potential for energy conservation in residential buildings was to be completed in January of 1976, this year. But that would just be the compilation of the data itself. The report to the Committee would be forthcoming at some time thereafter. Now, we have not had any recent discussions with the FEA on this matter. This is why the letter was called to your attention, so it could be raised in these hearings.

Mr. Sant may wish to reply for the record on the basis of the earlier correspondence.

Mr. SANT. I am not up to date with that issue, Mr. Chairman, and I would be happy to provide you immediately with—I know that we have been running information on residential areas for tax credit purposes and other purposes. I think we have a fairly good idea of what is needed. But I don't remember the detail in which the chairman had asked for that survey to be made. But we will be happy to respond to you immediately.

[Subsequent to this hearing, the FEA transmitted to Senator Randolph an update to the letter of June 24, 1975. That letter and accompanying report may be found in Appendix C, p. 195.]

Senator RANDOLPH. Thank you, Mr. Chairman. I have a clipping from the Martinsburg Journal of April 5, 1976, about a school in eastern West Virginia which has just been dedicated. That school is solar heated. I believe it is the first in the United States of America. I want to be very careful as to the documentation. With your permission, Mr. Chairman, I will ask that this news account of the recent dedication of The Page Jackson Elementary School be placed in the record, because of the solar heating process which is being employed there.

Senator MORGAN. We would welcome it, Senator.

[The news item follows:]

*[From the Martinsburg, W. Va., Journal, April 5, 1976]*

#### BYRD CALLS JEFFERSON SOLAR SCHOOL "UNIQUE"

Charles Town, April 5—Calling the new Page Jackson Elementary School "a unique project," Senator Robert C. Byrd took part in the groundbreaking ceremonies this morning for the school to be completely heated and cooled by solar energy.

Senator Byrd, who was instrumental in obtaining a federal grant of \$599,000 from the Energy Research and Development Administration for the solar roof, congratulated all "who had a part in this unique project."

The senator declared, "We dedicate in our spirits this pioneer effort." He said the Page Jackson School will be one more step forward, a clean, energy-saving structure, "a far cry from the two-room school I attended."

Pointing out the value this project has for Jefferson County and West Virginia, Senator Byrd said that with the state a leader in coal, gas and oil, the new solar school will be now placing West Virginia "in the vanguard in developing solar energy."

Dr. John Douglas McChesney, assistant state superintendent of schools, spoke briefly, saying the project is something new and unique, and the school will be "a pacesetter."

School Superintendent Harold Pickens was master of ceremonies and introduced members of the Jefferson Board of Education and special guests.

The new elementary school, aside from the solar roof, will cost \$1.2 million and will house students in the Charles Town area grades kindergarten through third.

Construction will begin immediately on the gently rolling hillside about one mile west of Charles Town along Route 340.

Senator MORGAN. I have been hoping that we could get a solar demonstration project at a school in North Carolina. We would be interested in that. I would be interested in talking to some of the others here about my school.

Senator RANDOLPH. Mr. Chairman, it is a short drive up to where this school is; I think you and Mr. Grundy might drive up. We would make you welcome there. You could look at it and see what has been done. It would be about an hour and 20 minute drive at the 55-mile-an-hour speed limit.

Senator MORGAN. We will do that.

Mr. Panuzio, let me thank you for your presentation and comment on the fact that I don't understand how you have been able to grasp all of the very details of your new position so quickly.

One day he is talking with us about appraisals of government buildings and the next day he is talking with us about energy, apparently without a good deal of assistance while testifying.

Mr. PANUZIO. I have enjoyed it.

Senator MORGAN. I will again turn the questioning over to Mr. Grundy.

Senator RANDOLPH. [Off the record.]

[Discussion off the record.]

Mr. GRUNDY. I would like to ask several questions specific to the GSA activities, with reference to subcommittee activities. You have mentioned in your statement, as well as other people have mentioned, that energy conservation in the retrofit of existing buildings involves significant capital investments. What do you see as the necessary pay-back period on these investments before they can be considered cost-effective?

Mr. PANUZIO. Solar energy is just not going to be cost-effective. The way we are putting solar components on, for instance—let's just talk about the Manchester Building. In the Manchester Building the solar unit alone is going to be costing over \$400,000. It is going to be a long time before that becomes cost-effective, if really ever. I think we have got to look at whether or not there is any commitment on the use of fuel or cutting down on that and getting ourselves into kind of a way in which we are self-sufficient as a nation in energy.

I think on some of the buildings the costs are going to be very difficult to justify. But if we are going to make that kind of commitment to get ourselves into the kind of structure where we are self-sufficient, then we are going to have to make those.

And as to the amount, some of it depends on the buildings. One of the reasons we are going to the 10 regions and trying to do a couple in each region is because each region is different. Solar energy, as we understand it, doesn't fit just into the place which has the most time of warmth like some of the southwest or southeast or similar areas. It also may be the nature of the components which the light and sun rays consist of. That is why we placed the demonstration projects in Manchester and in Saginaw.

Each one is going to be different. Until we have an evaluation by the architects, I don't think we will know what each one will cost and which ones can be cost-effective and which ones will not be.

Mr. GRUNDY. As far as solar is concerned, I think Dr. Mannella will get into this further, because it is a new and evolving technology. I therefore will defer a couple of questions to him on its potential costs.

I am thinking principally of energy conservation. It has been noted that there are not only energy savings but cost savings that can result from these activities which were the basis of the 10-year plan when enacted by the Congress.

Do you at GSA envision that you would have to recover such a capital investment over a period of 10 years in order to justify these investments? Or is there a certain minimum pay-back period that you envision?

Mr. PANUZIO. We believe that the fact of saving energy is somewhat a good reason for the investment. I can't really guarantee you we are going to pay them off in a 10-year period, but I would think there would be substantial savings.

I will point out to you on the 30 percent savings we have seen on operations alone has enabled us to keep our level of budgeting right now as to cost for energy in our annual budget somewhat the same just because we have been able to save at the same time the costs have been going up.

So I think it is just a very hard thing to determine. I would hope there would be cost savings, but I wouldn't be able to say on the basis we know now.

Senator RANDOLPH. Mr. Chairman, I interrupt again because of this solar school. If this article could be placed where we were talking with the commissioner on the subject—

Senator MORGAN. Mr. Chairman, what I want to know is where you got your money for it.

Senator RANDOLPH. We have been working with ERDA. This is a historic groundwork team. My colleague, Senator Byrd, was there as the speaker for the event. It is a unique project, and it is the only completed completely solar energy heated and cooled school, as I understand it.

This school is the Jackson School, in Jefferson County, at Charles Town, W. Va. It is a clean, energy-conserving structure. This school, being unique with respect to solar heating and cooling, is in the vanguard of solar energy development.

Dr. John Douglas McChesney, who is the Assistant State Superintendent of Schools, indicated that it was new and that it was a pacesetter in what was being done. It is an elementary school with a solar roof. For the reason that I gave earlier it is a breakthrough with an actual school with heating and cooling by solar energy.

I also am reminded that we are working at the present time on a solar heating and cooling project for our West Virginia University Agricultural Laboratory at Morgantown and also a building in Parkersburg, W. Va., which is the county seat of Harrison County.

Senator MORGAN. What does this do when the State produces so much coal oil?

Senator RANDOLPH. This is just a recognition that we are not provincial. That is at Charleston, the State Capital city. So we are attempting to do what we must do. We must utilize the forms of energy and develop them as quickly as possible. Of course, coal is king, and I am not talking about that.

Senator MORGAN. Thank you, Mr. Chairman.

Dr. Mannella?

**STATEMENT OF GENE G. MANNELLA, DEPUTY ASSISTANT ADMINISTRATOR FOR CONSERVATION, ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION; ACCOMPANIED BY MAXINE SAVITS, DIRECTOR, DIVISION OF BUILDINGS AND INDUSTRY; AND GERALD LEIGHTON, ASSISTANT DIRECTOR FOR BUILDINGS AND CONSUMER PRODUCTS**

Dr. MANNELLA. Thank you. With your permission, I would like to have the statement inserted in the record in its entirety and I will summarize and highlight several points.

Senator MORGAN. We will insert the entire statement. And, frankly, we prefer it that way.

[The statement appears at p. 67.]

Dr. MANNELLA. I would like to introduce two of my colleagues who are accompanying me. They are Dr. Maxine Savits, Director of the Division of Buildings and Industry, and to her left is Mr. Gerald Leighton.

Mr. Chairman, ERDA shares the interest of the subcommittee in energy conservation in general and in the building sector in particular. Thirty-two percent of all energy consumed in the United States is consumed in the building sector—approximately half in the residential area and half in the commercial and Federal sector.

In response to this challenge ERDA has a program of research development and demonstration addressing these problems, which we think is an aggressive program. The program derived from an authority that was given to us in several pieces of legislation—basically the Federal Nonnuclear Energy Research and Development Act of 1974.

Our interpretation of that directive is that we are charged with developing the technology to make energy conservation in the form of increased utilization efficiency rather than restrictive usage.

In other words, our goal is to use the energy available in the most efficient way and with a minimal efforts impact on the life style of the people.

We recognize that there are some special considerations that relate to energy conservation with regard to the building industry, and these are: the diffuse nature of the building industry, zoning restrictions, and some financial considerations that are perhaps somewhat unique.

We have essentially two thrusts in our program that I would like to touch upon today. One, we have a general, what we might call supporting technology activity that is oriented towards energy-efficient materials, methods and for retrofitting of existing buildings, as well as new construction, as well as a number of demonstration projects that we hope will be the main means of getting the information out into the marketplace.

I would like to mention a few of these demonstration projects. We have a contract with a consortium in New York City to select

typical office buildings in that city that have the highest potential for energy conservation retrofit. They are canvassing about 900 buildings, trying to identify those that will be typical of the situation in other cities so that whatever we find out through this particular demonstration can be easily translated.

We also have an effort with the West Coast restaurant chain of Sambo's to include the latest state-of-the-art energy conservation techniques in a new restaurant they are putting up in Albany, New York. This is an effort to try to establish what can be done in the fast food business, which has some special types of energy considerations. They are cooperating with us in the building of this new restaurant to see if it is possible to capture waste heat and other losses peculiar to that operation.

We have a demonstration project in Jersey City, which is being undertaken for us by Aerospace Corp., to retrofit and evaluate the results of retrofitting a number of municipal buildings utilizing hardware. This is particularly attractive, Mr. Chairman, because Jersey City is one of the cities that has a technology agent resident program there that is part of the National Science Foundation RANN program (Research Applied to National Needs).

We feel there is a possibility for immediate dissemination of anything that we learn in this particular demonstration to the other cities and localities that have this technology agent as part of the NSF program.

We have through our Oak Ridge National Laboratory a contract with the University of Tennessee, to initiate construction of a residence that would utilize a technology that we call the Annual Cycle Energy System or ACES. It is a house which is designed in such a way that you essentially store heat in the summer to help cool the house and release it in the winter to help heat the house.

This technology can in certain climates reduce the energy requirements for space conditioning in this building by a factor of two. And the unit that is being built on the campus of the University of Tennessee is the proof-of-concept installation which we will be operating and getting data on.

The Veterans Administration has completed a feasibility analysis for incorporation of the same kind of technology into a nursing home in Delaware. They intend to install this technology and evaluate its performance.

Finally, ERDA itself is one of the largest Federal operators of all types of buildings. We operate about 80 million square feet of laboratory space. We have been examining our own inventory of buildings to determine targets of opportunity to put this new technology into place.

Our first undertaking is with the Argonne National Laboratory right outside of Chicago, where they will be demonstrating certain energy techniques in existing buildings with the idea that we could translate these results into the general area as quickly as possible.

One other point I would like to make, Mr. Chairman, is that there are 14 departments and agencies engaged in activities related to energy conservation research and development for buildings. ERDA has taken the lead and chairs an Interagency Task Force on Buildings Conservation Research and Development which meets monthly.

The basic idea here is relatively straightforward. It is to achieve good communication to avoid overlap and duplication and to make sure we are combining our efforts and talents on all of the projects under way.

My colleagues here at the table represent two of the agencies which are very active in that monthly meeting.

Then, finally, with regard to the existing legislation and references to some of the items I made earlier, it is our feeling that sufficient legislative authority does exist for the various agencies of the Executive Branch to carry out the intent of the subcommittee in this regard.

Senator MORGAN. Thank you, Dr. Mannella. We appreciate the presentation.

[Dr. Mannella's prepared statement follows:]

STATEMENT OF

GENE G. MANNELLA  
DEPUTY ASSISTANT ADMINISTRATOR  
FOR CONSERVATION  
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

BEFORE THE  
SUBCOMMITTEE ON BUILDINGS AND GROUNDS  
OF THE  
COMMITTEE ON PUBLIC WORKS  
UNITED STATES SENATE

APRIL 8, 1976

STATEMENT BEFORE  
SENATE COMMITTEE ON PUBLIC WORKS  
SUBCOMMITTEE ON BUILDINGS AND GROUNDS

APRIL 8, 1976

Chairman Morgan, Committee members and guests

I am Gene Mannella, Deputy Assistant Administrator for Conservation in the Energy Research and Development Administration. I am accompanied today by Dr. Maxine Savitz, Director of the Division of Buildings and Industry, and Mr. Gerald Leighton, Assistant Director for Buildings and Consumer Products.

In your invitation to appear before this committee, you stated that the purpose of these current hearings were to examine the status of ERDA's conservation effort applicable to public buildings, in particular Federal buildings; to review the statutory basis for the programs; and finally to develop a consensus on the state of the art for the application of energy conservation measures and technology to Federally owned and assisted buildings.

I will try to address those points in my prepared remarks and of course will answer all questions the Committee may have at the conclusion of my prepared remarks.

Thirty-two (32) percent of all energy consumed in the United States is consumed by the buildings sector. A vigorous program of research, development, and demonstration has been initiated by ERDA to retard the projected growth in energy consumption in buildings which would occur without improvements in utilization efficiency.

I would first like to discuss the legislative mandate for ERDA's involvement in Buildings Conservation.

Public Law 93-577, the "Federal Nonnuclear Energy Research and Development Act of 1974" charges the Agency to develop a foundation to support a broad range of, and I quote:

"Energy policy options through conservation . . . by socially and environmentally acceptable means."

The quote is from Section 3(a). The purpose of the Act is stated in Section 3b(1) to be, and again I quote:

". . . conduct a comprehensive national program of basic and applied research and development . . . and utilization technologies, within the Energy Research and Development Administration."

Quoting further from (b)(3) and (b)(3)(A)(iv):

". . . these program elements and activities shall include but not be limited to, research, development, and demonstrations . . ."

". . . advanced urban architectural design to promote efficient energy use on the residential and commercial sectors improvements in home design and insulation technologies, small thermal storage units and increased efficiency in electrical appliances and lighting fixtures; . . ."

The program initiated in FY 1976 is designed to carry out those legislative mandates.

The goal of the buildings program is to significantly reduce projected consumption without affecting the standard of living, that is to say, the ERDA program is directed at increased efficiency of energy utilization in the built environment. The program goal is to promote and cause through the necessary research, development and demonstrations, the accelerated use of new and existing technologies to improve the utilization efficiency of energy in the . . .

built environment, consistent with the need to repair and protect the environment and to conserve limited resources. All this must be accomplished within an economically viable framework.

Special considerations that affect progress toward energy conservation goals in buildings include:

1. diffuse nature of the building industry
2. financial constraints that presently inhibit decisions for energy saving technology that is cost-effective in the life cycle sense but higher in first cost
3. the diffuse nature of the regulatory apparatus including code officials, zoning jurisdictions, taxing authorities, etc.
4. lack of industry commitment to R&D for more efficient consumption and cost implications of alternative choices.

Commercialization of R&D products and implementation of energy consumption standards for buildings, is facilitated by involvement with the principal implementing industries from the outset of most projects in the program. Simultaneous consideration of institutional and financial barriers that inhibit the acceptance of energy conserving technology and operating practice is undertaken so that information will be available to allow governments at all levels to address and remove them as needed.

Incentives and disincentives that will lead to adoption of energy saving technology and practice are being identified, with full analysis of impacts due to implementation. The diversity of factors

that bear on energy consumption in buildings require that a very broad range of incentive/disincentive devices be considered. The range of decision making ranges from the individual consumer who selects an appliance, to a large industry that selects a major new product design requiring retooling and major capital investment. Devices to be considered are energy consumption standards at the national level for application to buildings and appliances tax credits and incentives for investment in energy saving technology, innovative financing techniques that more perfectly reflect life cycle cost and energy consumption consequences, and many others.

The program which has been undertaken is an integrated program aimed at overcoming the various technical and institutional factors, which inhibit the implementation of new technologies and practices which significantly increase energy utilization efficiency in this sector.

The activities initiated in FY 1976 include those directed at developing energy efficient materials, methods and processes for retrofitting of buildings, as well as use in new construction. These efforts involve private industry and other government agencies in order to obtain the maximum leverage to introduce into the marketplace economically viable retrofit. Data on energy use in existing buildings and in the building process are being accumulated and analyzed to assist in defining the future RD&D program. Some of the specific activities initiated in FY 1976 of direct interest to the proposed legislation include:

.. A contract with a consortium of the Tishman Research Corp. and Syska and Hennesey, both of New York City, to survey existing office buildings in New York City to identify those with the highest potential for energy conservation retrofit. The office buildings which will be completely analyzed for possible retrofit, after a statistical selection from 900 office buildings in New York City will be typical of similar type office buildings throughout the United States. The well known mechanical/electrical engineering consultants, Syska and Hennesey, are developing operating and retrofitting procedures designed to be of maximum energy savings potential, be cost effective and the results can be rapidly disseminated to the marketplace.

.. A contract has been negotiated with Sambo's Restaurant Corp. of Santa Barbara, California, for inclusion of the latest state-of-the-art energy conservation techniques in their next fast food restaurant being built in Albany, New York. The research aspects of the program are to investigate means of capturing waste heat and other energy losses which are peculiar to such a restaurant application. Extensive monitoring and analysis of energy consumed as compared to standard Sambo's restaurant construction will be used as case histories for rapid dissemination to other restaurants in the U.S. The State University of New York is responsible for data collection and evaluation.

.. A demonstration project in Jersey City is being undertaken for ERDA by the Aerospace Corp. of Los Angeles to retrofit (and evaluate the results of retrofitting) a variety of municipal buildings utilizing commercially available hardware. Aerospace Corp. is a key participant in the NSF/RANN funded technology agent program and can thus assist

in transfer of results directly to the 26 other local governments involved in the program and through Public Technology, Inc. to many cities and full service counties.

.. The Oak Ridge ERDA Laboratory and its subcontractor, the University of Tennessee, have been authorized and are constructing a demonstration residence utilizing the research findings of FY 1975 for the Annual Cycle Energy System (ACES). The ACES technology can, in median climates, reduce the energy requirements for space conditioning by a factor of two. The proof-of-concept installation will provide a reliable case history for dissemination of the ACES technology to the marketplace. Preliminary discussions have been held with local governments to examine the feasibility of undertaking a demonstration of ACES for a large commercial building this year. The Veterans Administration has completed the feasibility analysis for incorporation of ACES in a nursing home in Delaware and intends to install and evaluate its performance. In addition to pursuing a vigorous RD&D program, we are concerned with our own internal operations. ERDA is one of the large Federal operators of all types of buildings -- we currently operate 80,000,000 square feet of commercial, laboratory and industrial space.

.. A program has been defined and a contractor selected to undertake an evaluation of energy saving techniques for existing buildings within ERDA's Argonne National Laboratory (ANL). ANL is located near the urban center of Chicago and various programs will be undertaken to transfer the results from the laboratory buildings to the private sector in addition to transfer to other ERDA laboratories.

.. The GSA is constructing new office space in Manchester, New Hampshire. That building is to serve as a demonstration of multiple technologies for minimizing requirements for nonrenewable resources in office buildings. ERDA is funding the NBS to undertake the long-term evaluation of this building and systems therein.

In the technology area we are pursuing with industry advanced thermally activated heat pumps; development of high efficiency lighting systems; new materials for insulating existing and new buildings; etc. Our community systems activities include such diverse activities as gathering information about and developing an understanding of the energy parameters of community development; evaluating the feasibility - energy, environmental and economic - of the wide-scale utilization of total energy systems, integrated with major utility systems or as isolated plants, etc.

A major research activity has been initiated to develop the foundation which will be required to develop and promulgate energy efficiency standards for new construction as proposed in the pending legislation which has passed each House of the Congress. This research activity is also directed at assisting all units of State and local governments in developing and adopting standards for new and retrofit construction with or without a Federal mandate. Specifically, the research activities underway are directed at assisting State governments in meeting the requirements of Title V, Part C, of Public Law 94-163, the "Energy Policy and Conservation Act." Furthermore, the research

activities are providing the basis of scientific knowledge upon which the Secretary of HUD can develop and promulgate Federal energy efficiency standards when the proposed bill is enacted into law.

There are fourteen Federal Departments and Agencies engaged in activities related to energy conservation R&D for buildings. ERDA has established and chairs an Interagency Task Force on Buildings Conservation Research and Development which meets monthly. This activity is intended to first minimize unwarranted duplication of research activities; provide a smooth and continuing medium for the exchange of information between Agencies and provide the bridge between the developer of technology, ERDA and the users of technology such as the General Services Administration, HEW, Department of Defense, HUD, VA.

This relationship has established a two-way flow. First, we are able to provide the technology base for users, such as in the Standards area. In addition, and just as important, the Federal buildings inventory can provide a first market for technologies which are emerging and which are not yet ready to be marketed in a true commercial sense, e.g., with warranties and performance bonds.

These activities would, in fact, be beneficial in carrying out the objectives of the three bills under consideration. However, in light of the requirements of Part E of Public Law 94-163, the three bills under consideration may be redundant.

However, there is adequate ERDA authority to perform research, development, and demonstration activities to lead to more efficient commercial buildings both in the public and private sector. Further, the bills under consideration may be redundant in light of the requirements of Title II, Part E, of the Energy Policy and Conservation Act, Public Law 94-163, and it is our judgment that no further legislation is required. ERDA will defer to FEA for specific comments on EPCA.

Senator MORGAN. Let me get one thing straight. Is there coordination between FEA and ERDA? How does that coordination work? Are we duplicating efforts in any—

Dr. MANNELLA. I would like to answer just briefly and then turn it over to Mr. Sant. I have been with ERDA a relatively short period of time, but I have observed that there is substantial coordination between the two agencies. In our particular area it takes place primarily in the meeting of individuals, the face-to-face kind of exchanges of information and concepts.

There is a memorandum of understanding being developed between the two agencies which will formalize this and suggest certain approaches and periodic meetings, which is not quite finished yet but ought to be ready for execution very shortly.

Would you care to add to that, Mr. Sant?

Mr. SANT. Furthermore, Mr. Chairman, as a matter of course we review each contract proposal that is coming out from either agency to make sure there is no duplication. The principals of each of the various offices as well as the Assistant Administrator, Austin Heller, and I meet about every 30 days to review that list.

We have made every effort to get the House oversight committees on the same wavelength as we are and have testified jointly on several occasions as to what our mutual responsibilities are. We are doing everything we can to minimize duplication. But there will be some overlap and should be, because ERDA's responsibility is principally in bringing on things that are not yet commercially available. And our job is principally to try and make the things that are commercially available of greater use within society.

So I think within those broad definitions we have a fairly good understanding. Any time there is a question that we can't resolve, the Energy Resources Council has the responsibility to resolve that issue.

Senator MORGAN. Dr. Mannella, you said you had how much space?

Dr. MANNELLA. ERDA operates through the national laboratories and the research centers some 80 million square feet. I am looking for the number of buildings in my fact book; I believe it is something like 6,000 buildings.

Senator MORGAN. Now, are you overlapping with Mr. Panuzio and GSA? Or what is happening there?

Mr. PANUZIO. It is different buildings. ERDA operates their own series of laboratories and energy centers and so on. We operate about 230 million square feet of space, which is primarily devoted to office space and other uses of the government. It is two different operations.

Senator MORGAN. Is your 80 million square feet just laboratory space?

Dr. MANNELLA. The bulk of it is laboratory space, but there is substantial office space involved in that.

Mr. SANT. Could I point out that there are about 2.8 billion square feet under government direction, so GSA is running roughly 10 percent of that amount. And then the rest of the agencies make up the balance.

Mr. PANUZIO. The Defense Department has—

Mr. SANT. Has the bulk of that.

Senator MORGAN. Let me ask one final question before we go on to Dick. I assume that all of you feel that government has a role in innovations with regard to energy conservation and development. Do you feel that the government has that role to play, rather than waiting for private industry, to adopt their techniques?

That is really a question that was discussed the other morning with the State architects. I expressed the opinion then, much as you have, that we must look to government to develop new ideas and new techniques in this field.

Dr. MANNELLA. Clearly, Mr. Chairman, in the case of my agency, ERDA, we perceive that as our fundamental role, to develop new technology in the area of energy conservation.

Senator MORGAN. I can see that surely there.

But, Mr. Panuzio, your Manchester project and one in—

Mr. PANUZIO. We believe that unless the Federal Government does a number of demonstration projects to find the best road for the private sector to pick up on, we won't get it going. We believe our mission is some of these things we have talked about.

Senator MORGAN. Mr. Grundy has a very good line of questions that he wants to develop.

Dick, I will turn it over to you. I won't utilize all the time.

Mr. GRUNDY. Thank you. I feel like I am pre-empting you, however.

Senator MORGAN. In court the judge doesn't serve as both prosecutor and defense. He just sort of listens. And that is what I prefer to do.

Mr. GRUNDY. I would like to go back to the 10-year plan that is being developed for Federal buildings before I get to the research and development questions.

First, with regard to ERDA and its 80 million square feet, does that include the space that is under contract to the National Laboratories?

Dr. MANNELLA. Yes. I would imagine that is the bulk of it.

Mr. GRUNDY. Then, in developing the plan, is it envisioned that the National Labs will be included even though they are a contract operation, not federally owned operations?

Dr. MANNELLA. I understand the buildings are federally owned buildings, but are operated under contract.

Mr. GRUNDY. So we are really talking about Federal buildings, rather than federally leased buildings, in most instances.

Dr. MANNELLA. That is right.

Mr. GRUNDY. But those buildings are not under GSA's supervision at all at the present time?

Dr. MANNELLA. That is right.

Mr. GRUNDY. In developing the 10-year plan for the government as a whole, is this restricted to federally owned buildings, or does it go beyond that to include federally leased buildings?

Mr. SANT. Well, the intent of Congress and the Energy Policy and Conservation Act was to include both. I don't think we have much choice but to have our plan encompass both sets of buildings.

Mr. GRUNDY. How would you propose that the funding be accomplished to institute energy conservation measures in buildings that are leased by the Federal Government?

Mr. SANT. That may be difficult, but we could certainly impose mandatory lighting standards and then State standards in the lease procedures. And then perhaps, in the retrofit area we can also negotiate that as part of the lease. That is what we are exploring at the present time.

Mr. GRUNDY. The Federal Energy Administration also has a responsibility to provide technical assistance to the States to develop State energy conservation plans.

[Title III of Public Law 94-163—State Energy Conservation Plans follows:]

ENERGY POLICY AND CONSERVATION ACT  
(P.L. 94-163, December 22, 1975)

## TITLE III

## PART C - STATE ENERGY CONSERVATION PLANS

## FINDINGS AND PURPOSE

Sec. 361. (a) The Congress finds that --

(1) the development and implementation by States of laws, policies, programs, and procedures to conserve and to improve efficiency in the use of energy will have an immediate and substantial effect in reducing the rate of growth of energy demand and in minimizing the adverse social, economic, political and environmental impacts of increasing energy consumption;

(2) the development and implementation of energy conservation programs by States will most efficiently and effectively minimize any adverse economic or employment impacts of changing patterns of energy use and meet local economic, climatic, geographic, and other unique conditions and requirements of each State; and

(3) the Federal government has a responsibility to foster and promote comprehensive energy conservation programs and practices by establishing guidelines for such programs and providing overall coordination, technical assistance, and financial support for specific State initiatives in energy conservation.

(b) It is the purpose of this part to promote the conservation of energy and reduce the rate of growth of energy demand by authorizing the Administrator to establish procedures and guidelines for the development and implementation of specific State energy conservation programs and to provide Federal financial and technical assistance to States in support of such programs.

## STATE ENERGY CONSERVATION PLANS

Sec. 362. (a) The Administrator shall, by rule, within 60 days after the date of enactment of this Act, prescribe guidelines for the preparation of a State energy conservation feasibility report. The Administrator shall invite the Governor of each State to submit, within 3 months after the effective date of such guidelines, such a report. Such report shall include --

- (1) an assessment of the feasibility of establishing a State energy conservation goal, which goal shall consist of a reduction, as a result of the implementation the State energy conservation plan described in this section, of 5 percent or more in the total amount of energy consumed in such State in the year 1980 from the projected energy consumption for such State in the year 1980, and
- (2) a proposal by such State for the development of a State energy conservation plan to achieve such goal.

(b) The Administrator shall, by rule, within 6 months after the date of enactment of this Act, prescribe guidelines with respect to measures required to be included in, and guidelines for the development, modification, and funding of, State energy conservation plans. The Administrator shall invite the Governor of each State to submit, within 5 months after the effective date of such guidelines, a report. Such report shall include --

- (1) a proposed State energy conservation plan designed to result in scheduled progress toward, and achievement of, the State energy conservation goal of such State; and
- (2) a detailed description of the requirements, including the estimated cost of implementation and the estimated energy savings, associated with each functional category of energy conservation included in the State energy conservation plan.

(c) Each proposed State energy conservation plan to be eligible for Federal assistance under this part shall include --

- (1) mandatory lighting efficiency standards for public buildings (except public buildings owned or leased by the United States);
- (2) programs to promote the availability and use of carpools, vanpools, and public transportation (except that no Federal funds provided under this part shall be used for subsidizing fares for public transportation);
- (3) mandatory standards and policies relating to energy efficiency to govern the procurement practices of such State and its political subdivisions;
- (4) mandatory thermal efficiency standards and insulation requirements for new and renovated buildings (except buildings owned or leased by the United States); and
- (5) a traffic law or regulation which, to the maximum extent practicable consistent with safety, permits the operator of a motor vehicle to turn such vehicle right at a red stop light after stopping.

(d) Each proposed State energy conservation plan may include --

- (1) restrictions governing the hours and conditions of operation of public buildings (except buildings owned or leased by the United States);
- (2) restrictions on the use of decorative or non-essential lighting;
- (3) transportation controls;
- (4) programs of public education to promote energy conservation; and
- (5) any other appropriate method or programs to conserve and to improve efficiency in the use of energy.

(e) The Governor of any State may submit to the Administrator a State energy conservation plan which is a standby energy conservation plan to significantly reduce energy demand by regulating the public and private consumption of energy during a severe energy supply interruption, which plan may be separately eligible for Federal assistance under this part without regard to subsections (c) and (d) of this section.

#### FEDERAL ASSISTANCE TO STATES

Sec. 363. (a) Upon request of the Governor of any State, the Administrator shall provide, subject to the availability of personnel and funds, information and technical assistance, including model State laws and proposed regulations relating to energy conservation, and other assistance in --

(1) the preparation of the reports described in section 362, and

(2) the development, implementation, or modification of an energy conservation plan of such State submitted under section 362 (b) or (e).

(b)(1) The Administrator may grant Federal financial assistance pursuant to this section for the purpose of assisting such State in the development of any such energy conservation plan or in the implementation or modification of a State energy conservation plan or part thereof which has been submitted to and approved by the Administrator pursuant to this part.

(2) In determining whether to approve a State energy conservation plan submitted under section 362 (b) or (e), the Administrator --

(A) shall take into account the impact of local economic, climatic, geographic, and other unique conditions and requirements of such State on the opportunity to conserve and to improve efficiency in the use of energy in such State; and

(B) may extend the period of time during which a

State energy conservation feasibility report or State energy conservation plan may be submitted if the Administrator determines that participation by the State submitting such report or plan is likely to result in significant progress toward achieving the purposes of this Act.

(3) In determining the amount of Federal financial assistance to be provided to any State under this subsection, the Administrator shall consider --

- (A) the contribution to energy conservation which can reasonably be expected,
- (B) the number of people affected by such plan, and
- (C) the consistency of such plan with the purposes of this Act, and such other factors as the Administrator deems appropriate.

(c) Each recipient of Federal financial assistance under subsection (b) shall keep such records as the Administrator shall require, including records which fully disclose the amount and disposition by each recipient of the proceeds of such assistance, the total cost of the project or program for which such assistance was given or used, the source and amount of funds for such projects or programs not supplied by the Administrator, and such other records as the Administrator determines necessary to facilitate an effective audit and performance evaluation. The Administrator and Comptroller General of the United States, or any of their duly authorized representatives, shall have access for the purposes of audit and examination of any pertinent books, documents, papers, and records of any recipient of Federal assistance under this part.

#### ENERGY CONSERVATION GOALS

Sec. 364. Upon the basis of the reports submitted pursuant to this part and such other information as is available, the Administrator shall, at the earliest practicable date, set an energy conservation goal for each State for 1980 and may set interim goals. Such goal or goals shall

consist of the maximum reduction in the consumption of energy during any year as a result of the implementation of the State energy conservation plan described in section 362(b) which is consistent with technological feasibility, financial resources, and economic objectives, by comparison with the projected energy consumption for such State in such year. The Administrator shall specify the assumptions used in the determination of the projected energy consumption in each state, taking into account population trends, economic growth, and the effects of national energy conservation programs.

#### GENERAL PROVISIONS

Sec. 365. (a) The Administrator may prescribe such rules as may be necessary or appropriate to carry out his authority under this part.

(b) In carrying out the provisions of sections 362 and 364 and subsection (a) of section 363, the Administrator shall consult with appropriate departments and Federal agencies.

(c) The Administrator shall report annually to the President and the Congress, and shall furnish copies of such report to the Governor of each State, on the operation of the program under this part. Such report shall include an estimate of the energy conservation achieved, the degree of State participation and achievement, a description of innovative conservation programs undertaken by individual States, and the recommendations of the Administrator, if any, for additional legislation.

(d) There are authorized to be appropriated for carrying out the provisions of this part \$50,000,000 for fiscal year 1976, \$50,000,000 for fiscal year 1977, and \$50,000,000 for fiscal year 1978.

#### DEFINITIONS

Sec. 366. As used in this part --

(1) The term "public building" means any building which is open to the public during normal business hours.

(2) The term "transportation controls" means any plan, procedure, method, or arrangement, or any system of incentives, disincentives, restrictions, and requirements, which is designed to reduce the amount of energy consumed in transportation, except that the term does not include rationing of gasoline or diesel fuel.

Mr. GRUNDY. In developing those plans, the States are prohibited from including federally owned buildings and federally leased buildings. My question deals with the buildings that are leased. The State is not allowed to deal with such buildings even though they are not Federal buildings. The Federal Government, however, in its plan does cover federally leased buildings. What happens when the Federal Government ceases to lease that building and it reverts? Where does the coverage now fall? Is it covered by the Federal or State plan? And how do you propose that this be dealt with?

Mr. SANT. Well, I don't know. I suspect that the only thing that would cover that is a proposal for mandatory building standards throughout the United States, not just Federal or State or public. The total residential and commercial structures would be covered within State building codes or local jurisdiction codes. And, clearly, any building that is built after those standards become effective will have to meet those standards no matter who the owner is. That is our ultimate plan.

But as far as retrofitting, I don't believe they would be covered under any program. The State, under the grant program that we have, is required to have a mandatory lighting standard as well as mandatory building standards in effect. So the State would have some jurisdiction there, perhaps, under that program.

Mr. GRUNDY. Is there the possibility that the building might be built to be leased to the Federal Government and subject to the Federal requirements, and then the Federal Government terminates the lease and the building is not consistent with the State requirements: Which requirements would you envision would preempt? Federal or State?

Mr. SANT. The Federal requirement, if there was a mandatory building standard, would certainly preempt anything in the State. It would require that the State at least meet that minimum standard. If there is no minimum Federal requirement, then the State standard would be the only standard in effect. And I would think then the State standard would take effect if the Federal Government gave up on its lease.

Mr. GRUNDY. But not until such time as it did?

Mr. SANT. Of course, prior to that time it is covered under the federally owned and leased buildings provision that we are required to carry out.

Mr. GRUNDY. Even though those requirements may not be as stringent as the State requirement?

Mr. SANT. That is correct. But I doubt seriously that that is going to occur, Dick.

Senator MORGAN. Let me interject a question in here. Is there any real reason why the Federal Government should be exempt from meeting the State standards? It has always been a source of irritation to me and to the average citizen to find in many areas that we are required to do certain things, whereas the Federal Government is exempt from doing those things.

Mr. SANT. Well, I really don't remember the history of the legislative drafting that well. I think that was considered at the time in the conference committee, and it was decided that the State should not preempt the Federal standards, that the Federal standards should be

set by a common Federal authority to make sure that it would be stringent enough to satisfy the Congress when it was done. Now, I presume that was the reasoning of the conferees at the time of the drafting.

Mr. PANUZIO. I think, Senator, there is no question about it. The most irritating thing to the local government is to find the Federal Government is exempt. I think wherever standards have been set by a State government, certainly the Federal Government should adhere, at least make the commitment to adhere to those standards.

Mr. SANT. If they are more stringent than the Federal standards.

Senator MORGAN. It seems to me, especially with regard to the situation that Mr. Grundy was pointing out—where you are leasing a building that may very well revert back to private ownership or use within the State—certainly those buildings ought to be required to meet the State standards.

Mr. SANT. It only becomes a factor, I guess, if the State standard is more stringent than the Federal standard. At the present time it is not the case, and we don't expect it to be the case. But hypothetically, if that became so, what you are urging is that the Federal standards be changed to at least meet what the local standard is. I see no problem with that.

Mr. GRUNDY. With regards to the Federal plan again. You said that the Federal Government has 2.8 billion square feet under its control, and you are developing an applicable plan for energy conservation. I have two questions. First, how will you determine what methods are going to be viewed as cost-effective for incorporation in that plan? Obviously, the more you include in that plan, the more the capital requirements are going to be.

Mr. SANT. We have not completed that. We are still in discussion with OMB. The Federal Government typically uses a 10 percent rate of return, and it is sort of a bench mark. So far discussions have included cash flow analysis using 10 percent as the discount rate as the way of determining the cost-effectiveness on a life-cycle costing basis.

I don't know whether 10 percent will be the final number that we agree to, but that is probably close. And it is a figure that the Office of Management and Budget has used fairly traditionally.

Mr. GRUNDY. Would you have envisioned that cost-effectiveness would be judged over the lifetime of the building or over some shorter period of time?

Mr. SANT. Over the lifetime of the building so that we look at the total life of the building as it is best estimated.

Mr. GRUNDY. Do you envision that when the plan is developed that there will be an accompanying budget estimate of what it would cost to implement that plan?

Mr. SANT. I suspect so. The number is rather large. We have made a couple of stabs at that number, and it shocks a few people. It just gives an idea of what we have come up with in looking at total square footage of the Federal Government. We get about \$2.5 billion as the amount that might be cost-effective.

Now, that is not an exhaustive survey, and one we would like to say is the final number. But it is a large number and we shouldn't overlook that fact.

Mr. GRUNDY. In that regard would you envision that that fund for implementing that program would be requested from the Congress en bloc or would they be requested by each individual agency?

Mr. SANT. I think they would be requested by each individual agency under a common set of criteria so that it is clear that when the OMB accepts a budget proposal, that it is accepted in the context of all the agency proposals at the same time. So GSA and the Department of Defense and ERDA and the respective agencies would each submit their own proposal to the Appropriations Committee, but they would be all under the same set of criteria.

Mr. GRUNDY. Let's move on to solar energy. The plan that you are developing and the discussion that we have just had on energy conservation was for cost-effective technologies. On the basis of your statements today, if I am correct, you have all stated that solar energy techniques presently are not cost-effective.

Mr. SANT. In my testimony I wasn't quite that explicit. I believe we have found a number of occasions where solar technology is competitive with electric resistance heating. And we have a number of buildings that are heated with electric resistance heating. Where the cost of electricity is at a level of 4 cents a kilowatt hour, we think there is a chance to be cost-competitive right now.

Mr. GRUNDY. But you are making a distinction between solar heating compared with resistance heating and cooling.

Mr. SANT. That is true. Although most cooling is done by electricity as well, solar cooling is still being developed and is not yet cost-justified. However, solar water heating is cost-justified in many regions today, while solar space heating is generally only cost-effective in comparison to electric resistance heating and then only in areas where the cost of electricity is above 4 cents a kilowatt hour.

I don't know whether that is your experience or not.

Mr. PANUZIO. I was trying to comment before, as I understood your question, on whether or not retrofitting of the buildings, whether or not we found the solar energy to be cost-effective and whether we could pay it off in a 10-year period. I said we might in a 10-year period, but I really wasn't ready to make that statement now.

I have a different point of view on new buildings and new construction than I do on retrofitting. I think retrofitting is costly, and I don't know whether or not it would be cost-effective. But I think on new buildings if you include escalation in money, fuels and so forth it could be in the course of a 10 to 20 year period under certain conditions and in certain locations.

Mr. GRUNDY. Maybe Dr. Mannella should answer this question. At this stage in the development of solar technologies what is your judgment on the advisability of proceeding principally through the demonstration grant program method, where solar energy is viewed as a research and development project as opposed to going through the typical traditional appropriation funding mechanism where solar energy installations are handled as part of your normal government budget process?

Dr. MANNELLA. I am not sure the point is very clear. I think that we agree with statements that you have heard here that retrofitting in existing buildings with solar technology alone is going to be very difficult to justify on a cost-effective basis.

If it is possible to retrofit those buildings with certain conversion technology which cuts down the load on the solar system, then you might have possibilities. And in a new building, if you would observe good building practices with energy-conserving techniques, then you might be able to get the load for the heating and cooling down to the point where the solar would perhaps be able to compete.

What is necessary to make this thing really work, of course, is the availability of reliable and relatively low cost components in the marketplace. And this is only going to come through significant production that is generated by demand. ERDA's program in the solar technology is oriented toward developing these kinds of components and these storage techniques that go along with making an energy source.

So I guess I am saying that the important thing is to generate the demand out in the marketplace so the industry will be stimulated to produce the components at a competitive price.

Senator MORGAN. Dr. Mannella, that very point is what I understand to be one of the real problems. The demand is not there sufficiently for manufacturers to devote their resources to the manufacture and the marketing of the solar units and so forth. What are we doing in government, what are you doing, or what do you know that we are doing, to generate the demand? Are there any programs whereby we are—I don't like to use the word "subsidize"—maybe pick up part of the cost for home builders who will use these technologies and monitor them in order to create the demand and also to accumulate data on which to base our research?

Dr. MANNELLA. Exactly, Mr. Chairman. We feel if we get the basic information out there regarding the economic facts of this kind of system plus the decreased dependence on oil as a fuel, that this will go a long way toward creating this demand. We have, for example, a project right here in Prince Georges County of a solar home, which is highly instrumented, which we are doing on a combined basis with the Potomac Electric Power Co. The house will be heavily instrumented, and we will, over several heating and cooling seasons, get data on the actual operation of that system.

Senator MORGAN. But I take it that system is a custom manufactured system. You say you have a product here. That really doesn't create enough demand for a manufacturer to produce these products at a low enough cost so that they can be purchased by the man who really wants to buy one and install it in his house. What are we doing in that area?

Mr. SANT. Let me add to that. In fact, I would like to submit for the record the Draft Guidelines and Draft Implementation Plan for the Solar Energy Government Buildings Project which address this in detail. It is just an outline draft, but I think the committee could benefit by at least our first attempt at drafting those guidelines. (See Appendix B, p. 123.)

We find that the government with its very large inventory of buildings could provide an aggregated market for solar heating and hot water applications where we get fairly fast paybacks. For example, solar water heaters in the barracks of the Department of Defense could get around a 6- to 7-year payback. That is kind of the first level of priority.

The next level of priority would be solar heating retrofit beyond the demonstration level where we can create a commercial market for things that are now commercially viable. What ERDA would continue to do would be demonstrate in areas where that commercially available product is not quite there yet or where it is not going to meet those cost-effectiveness criteria.

So I think viewing these things together you may see that we are trying to significantly expand the market that is available for these projects.

Senator MORGAN. Are there commercially available solar heating and cooling units on the market now for an individual homeowner who wants to move forward in this area?

Mr. SANT. There are not anywhere near the number of solar systems as gas heaters, or other current commercial systems. Solar heating systems are available not by the major manufacturers but generally by small manufacturers. The same thing holds true with solar water heaters.

Senator MORGAN. I don't know whether this is original with me. But one of the things I have heard is that because there is so little demand for solar energy, that there really aren't enough systems available to really get a feeling of how they will work. Perhaps if the Federal Government could provide "X" dollars—we'll say \$5 million—that would be very little—to subsidize homeowners who wanted to install solar heat. This would pay the difference between conventional—I think one of you mentioned it this morning—to pay the difference between conventional systems and what would be the cost for solar systems on the condition that they would install it and keep data.

Would this create enough demand for these systems so that some of the manufacturers would go into this field?

Mr. SANT. That is possible.

Mr. PANUZIO. Unless you have a big buy, you are not going to have the manufacturers going into the design of this. One of the problems I see with the big buy is that unless we have enough demonstrations to really get people involved and to understand it and to accept it, then the big buy isn't going to work.

In other words, if there is a general feeling on the part of the guy in the street that he is really not sure about this whole game and he doesn't have enough information about it and isn't convinced yet, he is not going to do it.

I think this is a two-step process. I think the government is going to have to make the big buy so the manufacturers are willing to build up and make these at a reasonable price. Before that there is going to have to be some substantial belief on the part of the people that are going to buy them that it works.

I think that is where some of these demonstration projects, if they can be accelerated and more can be done, can be helpful.

Mr. SANT. There is also a tax credit that has been pending for some time. It has passed the House and has been in the Senate for some time. It would provide a tax credit for people wishing to install solar devices. That is one other way of approaching the problem.

Senator MORGAN. Did I not hear one of you say this morning that there is a provision where you can assist in the purchase of—

Dr. MANNELLA. You may have been referring to the provision in the Solar Heating and Cooling Act which provides for demonstration of solar heating and cooling units. And I believe that 144 units are planned in that demonstration. The total that will be demonstrated is several thousand. The 144 is the first installation. And the dollar figures provided for that are in the neighborhood of \$60 million.

Senator MORGAN. Dick tells me that is in part a HUD program. I get two reactions.

Dr. MANNELLA. HUD is implementing the residential part of that, but it is an ERDA program.

Senator MORGAN. You said this morning that you have a demonstration project in Prince Georges County. There is one out at the Air Force Academy that I looked at when I was there. But it seems that there are so few in response to the urgency of the situation. I just wonder if there is some means you can come up with whereby we could promote enough uses of solar energy so that some commercial manufacturers could get in there.

We will say that I am going to buy a new house, but I am not really willing to take the full risk myself; however, I would be willing to share the risk. If I could get some assistance, and if you had enough others across the country, then you might get some of your major manufacturers to commit more resources.

Dr. MANNELLA. Some of the items that I mentioned—for example, the house in Prince Georges County is perhaps not really justified to call it a demonstration. It is an experiment. We are going to get technical data out of that that is going to guide the future of our program.

I think the sort of thing that you are talking about that would in the aggregate contain enough units to get enough data on a large geographic area and create a small demand for the units are the several thousand units that are called for in this solar heating plan.

Mr. SANT. A heat pump should be considered a solar device. A heat pump is now commercially available by the major manufacturers. It really uses the solar principle, and it is very cost-effective in many cases now. And we have been pushing very hard on that end. I don't think we ought to overlook this in this total package. It really could be classified—and should be—as a solar device.

Mr. PANUZIO. If the Federal Government wanted to provide mortgage rates at somewhat less than commercial rates to those who would be willing to build homes, install an energy-saving device such as a solar system and could get their system at a reduced price which they would pay off over the terms of their mortgage, it might generate a little interest.

Senator MORGAN. There are a lot of possibilities. I won't take the rest of the morning to explore them, so that Dick can continue the line of questioning that we want to develop. I will talk about them later.

Mr. GRUNDY. Thank you, Mr. Chairman.

Obviously, the issue here ultimately is not only getting the technology to the marketplace but getting the information on the technology transferred to the people who are making decisions. Someone is going to have to make a decision of not going the traditional way in favor of such as solar energy.

Dr. Mannella, in your statement you mentioned that part of your research activity is directed at assisting State governments in formulating State energy conservation plans. In this regard how do we get your agency's results transferred into the market? Is there a formal procedure that is evolving here as a preferential way that the Administration sees for getting information on new technologies to the decision makers? Or are you planning to rely on the development of the FEA guidelines associated with State energy conservation plans as a principal vehicle of transferring this information?

I know that it has not been the subject of this hearing, but the concept of an energy conservation extension service has been discussed. What is the thinking of the Administration on this point?

Dr. MANNELLA. As far as ERDA is concerned, I think we have not really completely finalized our thinking on this for several reasons. When we look at the total amount of information that we want to disseminate, we find it consists of many different categories and is going to go to different groups of people.

We are working with industries and we are working with the building sector. We are working with other Federal agencies. I don't think there is going to be one single final mechanism that we use. And we are really in the process of examining the possibilities right now.

Mr. SANT. We have testified that at the present time we would not favor the enactment of the energy extension service only because we have these other mechanisms that the Congress has put in place, particularly the State program, with the thought that the States could implement that through the University Extension Services or any other procedures they would like to institute. And we would like to give that a try before we duplicate that activity or in any way overlap it.

That is our current program, to try to make that as effective as we can and see where the gaps are that we can fill through some other mechanism.

Mr. GRUNDY. As far as this transfer of information on the various projects which are under way by ERDA under the Solar Heating and Cooling Demonstration Act you make reference to State and local government buildings and private buildings. There is very little in the testimony today, at least, of an equivalent activity on Federal buildings. Am I reading the testimony right? If so, what is the reason for this?

Mr. SANT. I think the Solar Heating and Cooling Demonstration Act was designed for the private sector and not for public buildings. All of ERDA's demonstrations are certainly directed at the private sector. It is our intention in submitting these draft guidelines to expand in the government use as well. The amount of dollars has not been determined as yet because we really have not done a complete inventory. But that is the process that we are in right now.

Mr. PANUZIO. We have some demonstration programs, as I commented, Saginaw and Manchester, both of which have been supported for approximately \$900,000—\$430,000 on Manchester and \$350,000 on Saginaw—in addition to which we have got the study going in the 10 regions for the 20 buildings to be retrofitted from existing inventory and the use of the Topeka Building with regard to some energy-saving devices—not use of solar energy, but use of energy-

saving devices. But Saginaw and Manchester are solar collectors themselves and, I think, are supported by ERDA.

Dr. MANNELLA. There are half a dozen projects of that sort that are either under the purview of GSA or other government agencies, including ERDA.

Mr. GRUNDY. I realize the numbers are not the same, but one of the bills before the committee refers to the selection of 40 federally owned buildings to be used for demonstrations. Do you have any feeling, at this point in time, on how this number relates to the programs evolving on solar energy and heating?

Dr. MANNELLA. Well, I think that the six or so projects that I just mentioned are the current evolution of that demonstration program.

Mr. GRUNDY. But the program of ERDA as it relates to demonstration per se is much broader than that in terms of total number of buildings. The obvious question is, if the government is encouraging the private sector to demonstrate new energy technology, why are they not taking an equivalent stand with respect to their own facilities?

Mr. PANUZIO. We are dealing with 20 potential retrofits for the Federal Government plus the two we have talked about. And where the Act calls for 40, I am sure that that is a goal that could be reached. So I think we are talking along the lines of doing something in the Federal Government so as to affect the private sector. I don't think we are asking the private sector to do any more than we are doing with our Federal buildings.

In other words, we are talking 20 and I am sure there are others in the other sectors.

Mr. SANT. The Department of Defense is planning 55 solar buildings. I don't know what is happening in other agencies, but we are approaching 100 then.

Mr. GRUNDY. As far as this program is concerned, I think we are speaking of solar heating and cooling.

Mr. SANT. Solar heating and water. The cooling is a little tougher than that.

Mr. GRUNDY. Are you saying that the funds for this activity are being appropriated to ERDA and then handled on a transfer-of-funds basis?

Mr. SANT. Yes, that is the way the demonstration projects are handled. However, for the Solar Energy Government Buildings Project, the funding would not be channeled through ERDA or FEA but would go directly to the construction agencies.

Mr. PANUZIO. I would assume if they went beyond the demonstration projects at the point where we are saying each individual agency would come in with their own plan, I think the demonstrations are going to be supported by—

Mr. SANT. The noncost-effective things are going to have to be funded with demonstration moneys where the cost-effective things can be done under the normal process.

Mr. GRUNDY. In terms of appropriations process, moneys would be handled through ERDA?

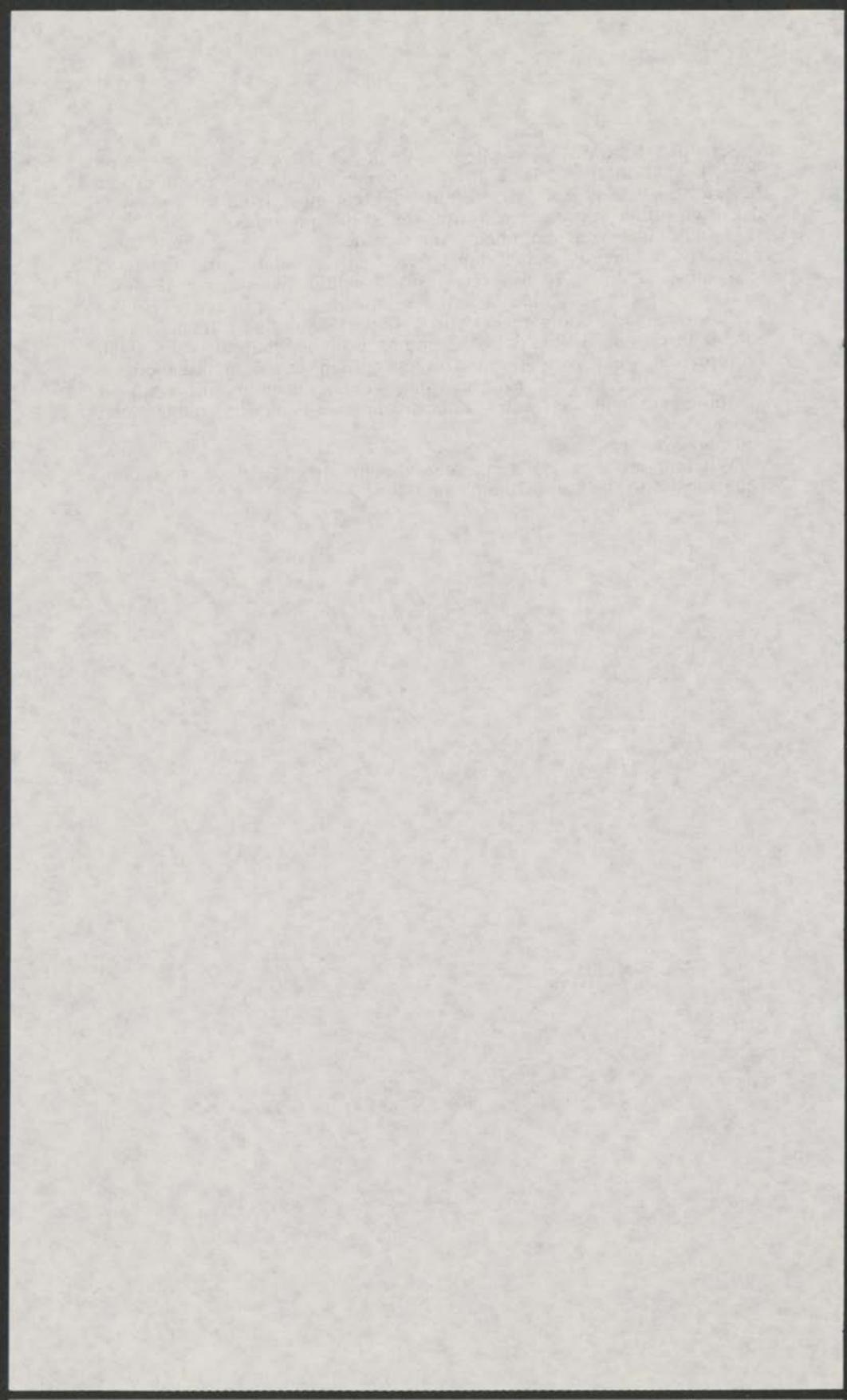
Mr. SANT. Yes, for the demonstration projects, but the process for the proposed Solar Energy Government Buildings Project is still to be determined.

Senator MORGAN. Gentlemen, I think we have covered it pretty well. I want to thank Dick for developing the line of questions. As he said, this is a new approach, but I can get more from the testimony if I listen rather than have to formulate all the questions.

I would like your comments on whether or not you think these projects are already being done. Mr. Sant, I believe you indicated that most of them really were. But I would like to pin it down so I can say, "Yes, here are the demonstration projects; FEA or ERDA is already doing them," or "They are not doing them." Also, for all three bills I would like a comparison of what these bills will require and what you are now doing. When the committee comes to analyze the record, to see what we should come up with, if anything, we will be better able to talk in specifics rather than generalities.

Thank you very much.

[Whereupon, at 11:35 a.m., the subcommittee recessed, to reconvene subject to the call of the Chair.]



---

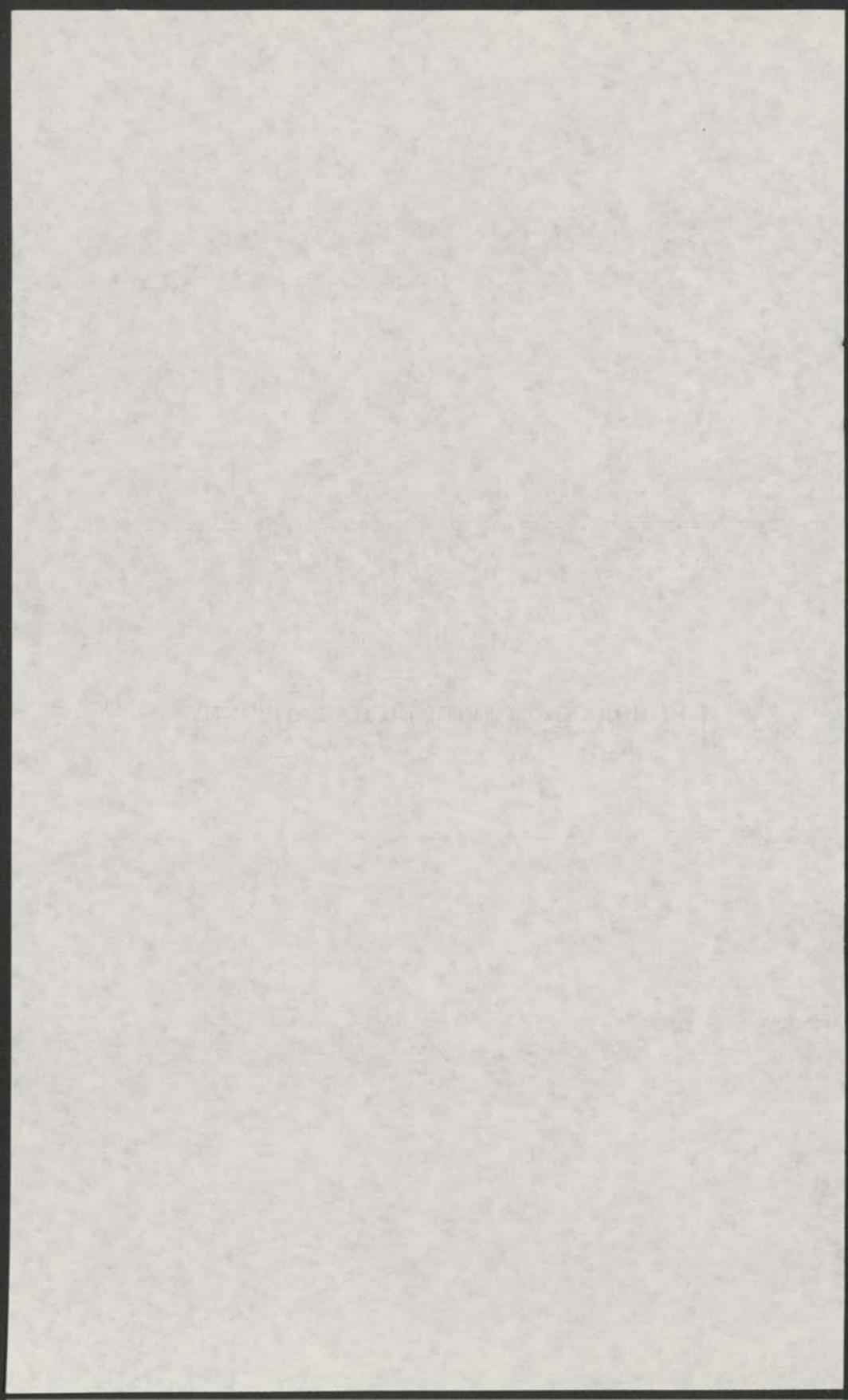
---

APPENDIX A

---

MEMORANDUM FROM RICHARD GRUNDY

---



JENNINGS RANDOLPH, W. VA., CHAIRMAN  
 EDMUND S. MUSKIE, MAINE  
 JOSEPH M. MONToya, N. MEX.  
 JAMES R. MCGEE, ALA.  
 LLOYD KENTON, TEX.  
 QUENTIN N. BURGICK, N. DAK.  
 JOHN C. CULVER, IOWA  
 ROBERT MORGAN, N.C.  
 GARY HART, COLOR.  
 M. BARRY MEYER, CHIEF COUNSEL AND CHIEF CLERK  
 BAILEY GUARD, MINORITY CLERK

United States Senate

COMMITTEE ON PUBLIC WORKS  
 WASHINGTON, D.C. 20510

April 5, 1976

MEMORANDUM

TO: Senator Robert Morgan, Chairman  
 Subcommittee On Buildings and Grounds

FROM: Richard D. Grundy  
 Senior Professional Staff

RE: Energy Conservation and Solar Energy Programs  
 for Federal Buildings

As you are aware, on Thursday, April 8, 1976, legislative hearings, begun last year, will be reconvened at 9:30 a.m. in Room 4200 to further examine energy conservation and solar energy programs affecting Federal buildings and federally-assisted buildings. The announced purposes of this hearing are --

--first, to examine the status of energy conservation, including solar energy, programs by Federal agencies with respect to public buildings, with particular emphasis on Federal buildings;

--second, to review the statutory basis for such Federal programs; and

--third, to ascertain the state-of-the-art for the application of energy conservation, including solar energy, methods and technologies to Federal buildings and federally-assisted buildings.

In addition, the witnesses have been requested to address the technical and economic feasibility for

implementing the three bills pending before the Committee: S. 2045, the Federal Facilities Energy Conservation and Utilization Act of 1975; S. 1392, the Energy Conservation in Buildings Demonstration Act of 1975; and S. 2095, Conservation and Solar Energy--Federal Buildings Act of 1975.

The invited witnesses were --

The Honorable Jack M. Eckerd  
Administrator  
General Services Administration

The Honorable Robert C. Seamans  
Administrator  
Energy Research and Development Administration

The Honorable Frank G. Zarb  
Administrator  
Federal Energy Administration

The actual witnesses will be confirmed on Tuesday, April 6, 1976 (see Attachment A).

The premise behind these hearings and the proposed legislation is that there is no reason for treating Federal buildings differently than similar buildings in the public and private sector; energy conservation, including solar energy, practices, where practicable, should be employed for all buildings. Moreover, the Federal government has an opportunity to display leadership in implementing sound energy conservation and solar energy practices in new Federal buildings and in developing sound technical approaches for retrofitting existing Federal buildings.

Since last November's hearings by the Subcommittee, the Energy Policy and Conservation Act (P.L. 94-163) has been enacted providing for development of a 10-year plan for energy conservation in Federal buildings and for establishment of Federal procurement policies which reflect energy conservation. On March 26, 1976, FEA Administrator Frank G. Zarb spoke before the Phoenix Chamber of Commerce of "the Federal program to identify a number of Federal buildings throughout the country which could be retrofitted to use solar energy for heating and hot water. Providing a market for first-generation solar technology in existing government buildings would help in developing the economic infrastructure necessary to support a viable solar energy industry." Details of this program were not discussed; however, the principal statutory authorities for this program most likely stem from the Energy Policy and Conservation Act (P.L. 94-163) and the Solar Heating and Cooling Demonstration Act of 1974 (P.L. 93-473).

This memorandum reviews (a) the potential energy conservation savings in Federal buildings, (b) legislation enacted to date, and (c) pending measures before the Committee on Public Works, as well as other related bills before the Congress.

## BACKGROUND

Almost equal with transportation as a major consumer of energy is the heating and cooling of buildings. About 9 percent of the total energy consumed in the United States is for space conditioning (or heating and cooling) of commercial buildings, while 12 percent is used for similar residential purposes. When industrial buildings also are included, more than 25 percent of the United States' total consumption (or demand) for energy is for the space conditioning of buildings where people live and work.

The November 1974 Project Independence Blueprint estimated that by 1985 the equivalent of almost 500 million barrels of oil per year can be saved through an accelerated energy conservation program in residential and commercial buildings.

As the "landlord" for the Federal government, the General Services Administration (GSA) controls more than 224 million square feet of space in nearly 10,000 buildings. This amounts to almost 10 percent of the 2.5 billion square feet of such space in the United States. A significant fraction of all the buildings in use today will remain so past the year 2000. The energy conservation practices employed for this space thus are very important.

During Fiscal Year 1975, the Federal government was charged by the President to reduce energy consumption by 15 percent below that for Fiscal Year 1973. The result of the program, however, was a reduction of 21 percent for the first quarter of 1975 over Fiscal Year 1973. The savings were estimated at 19.7 million barrels of oil and \$181 million in energy costs for the quarter.

Presently there are numerous opportunities to conserve energy in new and existing buildings by employing known methods and technologies by--

--modifying building orientation and configuration on the site, to take advantage of natural light and ventilation;

--improving the building envelope, such as thermally improved walls, roofs and windows, to utilize sun energy when needed and block it out when not desired, as well as the use of vegetation to shield against excessive sun and wind;

--lowering energy use for building illumination by the adoption of such techniques as task oriented lighting, the use of natural lighting on the building perimeter, and the utilization of waste heat from lights;

--reducing energy for building heating and cooling systems by such methods as (a) replacement of constant-volume air circulation systems (which vary temperature, to provide constant comfort level) with variable volume systems (which hold air temperature constant, and vary volume to maintain comfort levels), and (b) installation of heat pumps to perform both the heating and cooling functions at a considerable savings of electricity.

--reducing energy consumption for vertical transportation systems; and

--reducing energy use for domestic hot water systems.

The GSA's "Energy Conservation Design Guidelines for Office Buildings," which has subsequently been revised, set forth 185 ideas for conserving energy in the design, construction, and operation of office buildings. The companion document, "Energy Conservation Guidelines for Existing Office Buildings" sets forth more than 300 recommendations. (A synopsis of these guidelines is set forth in Attachment B) Application of these guidelines could save between 20 and 30 percent of the energy consumed in the operation of existing office buildings. This would amount to a maximum savings of 1.0 to 1.5 million barrels of oil per day (or \$13 to \$20 million per day at current OPEC oil prices).

This energy conservation program in Federal buildings has been administered by the GSA under its general statutory authority, without the mandates proposed in S. 2045, as well as S. 1392 and S. 2095.

The financial implications of energy conservation also deserve mention, since additional capital costs frequently amount to 10 to 20 percent above usual construction costs. During the era of seemingly inexhaustible energy, our society evolved attitudes, policies, tax laws, and institutional practices which engendered a powerful demand for buildings of low first cost.

In marked contrast, the energy efficient building requires high "front end" costs. In this regard, it is especially significant that the payback period for such capital expenditures is from 10 to 15 years. This is about half the usual time required to recoup investments in traditional large-scale utility systems.

New buildings and major improvements to existing buildings, including energy efficient measures, are financed to a large extent on borrowed funds. The traditional approach to reduce the risk associated with this type of debt has been to minimize initial construction costs as much as possible. This aspect, together with certain tax considerations for commercial buildings which favor the economics of higher operating expenses over higher capital expenditures, make the "first cost" problem a formidable barrier to the construction of energy efficient buildings.

It may therefore be necessary to provide certain incentives to overcome economic and other barriers and to galvanize action for implementation. Incentives can be offered in a variety of forms, such as tax credits, guaranteed loans, subsidized interest rates, rapid depreciation allowances, subsidies, or technical assistance. And the sources of such incentives can range from local communities to the Federal government. Addressed at these concerns the Energy Conservation Act of 1976 (S. 2932), discussed herein, provides Federal loan guarantees for

energy conservation and the House passed H.R. 6860, the Energy Conservation and Conversion Act of 1975, provides investment tax credits and other financial incentives.

#### SUMMARY OF EXISTING STATUTORY AUTHORITIES

The 93rd and 94th Congresses have witnessed enactment of the initial elements of a National Energy Policy, as well as a national energy research, development, and demonstration policy. The resultant statutes as well as pending legislation can be categorized in the following general functional areas:

First, measures to protect against interruptions in energy supplies, such as the Energy Policy and Conservation Act (P.L. 94-163) which authorizes creation of a national system of strategic reserves and provides general standby energy emergency authorities; formulation of gasoline rationing contingency plans; allocation of petroleum and petroleum products; and programs to meet commitments under the International Energy Agreement.

Second, measures to reshape and restrain energy demand such as programs to conserve energy through the formulation of State energy conservation programs, modification of buildings (e.g. Federal buildings), improved automobile fuel efficiency, and encouragement of mass transportation facilities.

Third, measures to increase energy supplies.

Fourth, measures designed to reduce dependence on foreign oil, such as coal conversion.

Of particular concern for the Subcommittee on Buildings and Grounds are two provisions of the Energy Policy and Conservation Act (P.L. 94-163) which affect

energy conservation in buildings. These sections require Federal Energy Conservation Programs (Title III, Part E, Subsection 381 (b); Federal procurement (Subsection 381 (a)), the formulation of State energy Conservation Programs (Title III, Part C, Sections 361 to 366).

Federal Energy Conservation Programs

Under Federal Energy Conservation Programs (see attachment C), the Energy Conservation and Policy Act (P.L. 94-163) requires the development of a 10-year plan for energy conservation in buildings owned or leased by an agency of the United States. This plan is to include --

- mandatory lighting efficiency standards;
- mandatory thermal efficiency and insulation requirements;
- restrictions on hours of operation;
- thermostat controls; and
- other conditions of operation.

In addition the Federal plan is to include plans for retrofitting or replacing Federal buildings to meet established Federal energy conservation standards. Implementation of a 10-year Federal energy conservation plan is conditioned on the use of authority under other Federal law.

This program is clearly within the jurisdiction of the Committee on Public Works, as discussed in Senator

Randolph's remarks during the Senate consideration of the conference report on this measure (see Attachment D). Moreover, as pointed out by Senator Randolph, it would be appropriate that the President designate the General Services Administration as the lead Federal agency to coordinate, develop, and implement this 10-year plan for Federal facilities. (At this time this authority is being administered by the Federal Energy Administration.)

Moreover, the formulation and implementation of this 10-year plan will involve major Federal expenditures. At the present time there is no assurance that this will be undertaken consistent with the GSA's Guidelines for New or Existing Buildings (or equivalent guidelines). In addition, the Federal funds required for implementation are unlikely to be submitted to the Subcommittee on Buildings and Grounds for authorization; rather the monies will be buried throughout the Federal budget, for individual agencies.

#### Federal Procurement

The Energy Policy and Conservation Act also contains energy conservation requirements affecting Federal procurement. The President is required to develop mandatory standards to govern Federal procurement policies and to assure their implementation (Attachment C, Subsection 381(a)).

Similar authority is proposed in S. 2045.

State Energy Conservation Plans

In order to encourage the States to establish energy conservation programs and formulate energy conservation plans, the 1975 Energy Policy and Conservation Act (P.L. 94-163) authorizes \$150 million in grants-in-aid to assist States in this regard. In summary, in order to be eligible for such Federal assistance proposed State Energy conservation programs (and plans) must include among their provisions:

--mandatory thermal efficiency standards and insulation requirements for new and renovated buildings (except buildings owned or leased by the United States);

--mandatory lighting efficiency standards for public buildings (except public buildings owned or leased by the United States); and

--mandatory standards and policies relating to energy efficiency to govern the procurement practices of such State and its political subdivisions;

as well as programs to promote the availability and use of carpools, vanpools, and public transportation (except that no Federal funds provided under this part shall be used for subsidizing fares for public transportation); and a traffic law or regulation which, to the maximum extent practicable consistent with safety, permits the operator of a motor vehicle to turn such vehicle right at a red stop light after stopping. In addition, the

the State energy conservation plan may include --

--restrictions governing the hours and conditions of operation of public buildings (except buildings owned or leased by the United States); and

--restrictions on the use of decorative and non-essential lighting,

as well as transportation controls. Upon the basis of the State energy conservation plans the FEA Administrator must establish energy conservation goals for 1980 for each State consistent with technological feasibility, financial resources, and economic objectives, taking into account population trends, economic growth, and the effects of national energy conservation programs.

For these purposes the FEA Administrator is to formulate Federal guidelines. However, from the standpoint of the Subcommittee on Public Buildings and Grounds there are two policy issues of concern: first, buildings owned or leased by the Federal government are specifically exempted from the State energy conservation programs (and plans). Since such programs are a requirement of Federal programs, it seems only reasonable that the Federal government should adopt a leadership posture regarding buildings owned or leased by the Federal government.

Second, there is no statutory requirement that the FEA Administrator consult with the GSA when formulating Federal guidelines for new and renovated buildings, despite the GSA's leadership and generally recognized expertise. There thus is a considerable potential for an overlap and duplication of effort.

RESEARCH, DEVELOPMENT AND DEMONSTRATION

The Federal research and development program on energy conservation and on solar heating and cooling is set forth in the following four statutes enacted in 1974 by the 93rd Congress --

--The Energy Reorganization Act of 1974 (P.L. 93-438) vested in ERDA the overall responsibility for Federal energy research, development and demonstration.

--The Federal Nonnuclear Energy Research and Development Act of 1975 (P.L. 93-577) provided specific Federal goals for ERDA's programs.

--The Solar Energy Research, Development and Demonstration Act of 1974 (P.L. 93-473) established a national solar energy program and provided for the transfer of this program to ERDA. This Act also required ERDA to establish and operate a Solar Energy Data Bank.

--The Solar Heating and Cooling Demonstration Act of 1974 (P.L. 93-409) provides the basic framework for the Federal solar energy demonstration program. The Act initially directed NASA to develop solar energy systems and demonstrate these systems in commercial applications and directed HUD to demonstrate these systems in residential applications. The Act also directs HUD to establish and operate a Solar Heating and Cooling Information Data Bank, and to develop performance criteria and test procedures for solar heating and cooling systems. However, the solar energy functions of NASA and NSF were transferred to ERDA on its creation.

In the context of these hearings the Solar Heating and Cooling Demonstration Act of 1974 is of particular concern.

Solar Heating and Cooling Demonstration Act of 1974

The Solar Heating and Cooling Demonstration Act of 1974 (P.L. 93-409) calls for HUD to develop interim and definitive performance criteria and to establish procedures

-14-

for product certification. To date, interim performance criteria for solar heating and cooling systems have been developed for HUD by the National Bureau of Standards.

In their first round of proposals, HUD awarded 143 solar heating units to dwelling units in 27 states and Puerto Rico: 44 of these grants were offered to builders, developers and similar private organizations; 8 were made to local governments, housing authorities and similar public bodies; two were to Indian tribes; and 3 went to universities.

Out of the 143 dwelling units involved, 102 were single family dwellings, and the balance were in multi-family units. In turn, 34 of these involve only domestic water heating; 98 units involve heating systems (all but 2 of these also include domestic hot water); and 11 units will combine heating, cooling and hot water systems. Among these 33 units involve retrofit of hot water or heating and hot water installations; while the rest are in new construction.

Under the Solar Heating and Cooling Demonstration Act of 1974, several Federal agencies also are undertaking related programs. For example, the DOD is installing 50 solar heating units in family homes at 11 Army, Navy, and Air Force installations. In addition, the DOD has identified a 6-year \$1.35 billion Energy Conservation Investment Program to retrofit existing buildings.

Similar programs by other Federal agencies can be assumed, at considerable expense to the Federal government. However, as for the Federal energy conservation program, the solar heating and cooling demonstration program for buildings owned and leased by the Federal government is not subject to Congressional review. In addition, the expenditures are disbursed throughout the Federal budget, with the actual total expenditures unknown.

#### PENDING LEGISLATION

Several measures concerning energy conservation, including solar energy, are currently pending before the Committee on Public Works. The principal measures are --

--S. 2045, the Federal Facilities Energy Conservation and Utilization Act of 1975, introduced by Senator Randolph on June 27, 1975, and passed by the Senate during the 93rd Congress as section 6 of S. 2176, the National Fuels and Energy Conservation Act of 1973 (See Senate S. Rept. 93-526), and as H.R. 11565 (S. Rept. 93-654) which died without a House-Senate conference;

--S. 1392, the Energy Conservation in Buildings Demonstration Act of 1975, introduced by Senator John Tunney on April 9, 1975; and

--S. 2095, the Conservation and Solar Energy--Federal Buildings Act of 1975, introduced on July 10, 1975 by Senator Gary W. Hart and cosponsored by Senators Philip Hart, Hathaway, Humphrey, Javits, McIntyre, Nelson, Pell, Randolph, and Sparkman.

In addition there are several bills directly or indirectly affecting energy conservation before other Senate Committees such as S. 2932, the Energy Conservation Act of 1976; the House passed H.R. 6860, the Energy Conservation and Conversion Act of 1975; and the House and Senate passed H.R. 8650, the Energy Conservation Buildings Act of 1976, which are discussed herein.

S. 1392, the Energy Conservation in Buildings Demonstration Act of 1975

The Energy Conservation in Buildings Demonstration Act of 1975 (S. 1392) establishes an energy conservation demonstration program for retrofitting selected existing Federal, State and municipal buildings. The measure requires the FEA Administrator, in consultation with the Director of the National Bureau of Standards and appropriate architectural and engineering societies, to establish procedures for identifying buildings as candidates for retrofitting. Provision is made for the selection of at least 40 Federally owned buildings to be retrofitted. The GSA Administrator is empowered to solicit proposals and award contracts for the design and installation of energy conservation equipment. Federal matching grants are authorized on a three-to-one basis for retrofitting State and municipal buildings.

In addition, S. 1392 requires Federal agencies to prepare an energy utilization analysis and energy-economic analysis for each building to be constructed, repaired, or maintained under their supervision. The measure also directs that energy utilization and cost data be indicated in prospectuses submitted for approval.

The measure requires the GSA, in consultation with FEA and the Office of Federal Procurement Policy, to survey all Federal procurement in excess of \$10,000 from the viewpoint of energy conservation, and report to the President and the Congress, recommending improvements.

The measure also directs GSA to submit an annual report to Congress of their activities under this Act, and directs each Federal agency to examine their buildings and report to the Congress on improvements that could be made to conserve energy.

The measure authorizes \$300 million to carry out the purposes of this Act.

S. 2045, the Federal Facilities Energy Conservation and Utilization Act of 1975

The Federal Facilities Energy Conservation and Utilization Act of 1975 (S. 2045) directs the GSA Administrator, after consultation with other agencies, to publish energy conservation and management guidelines and provides that the guidelines shall include information on all variable factors that may affect energy

conservation and utilization, such as architectural features, site orientation, building composition, energy consumption practices, new techniques, and energy expended in manufacturing and handling the basic materials used in construction, repair, or maintenance of such buildings. (These guidelines are modeled after the guidelines already issued by the GSA.)

The measure also requires Federal agencies to prepare an energy utilization analysis and an energy-economic analysis for each building to be constructed, repaired, or maintained under their supervision. The bill also directs that energy utilization and cost data be indicated in prospectuses submitted for approval.

The measure also directs GSA, in consultation with FEA and the Office of Federal Procurement Policy, to survey all Federal procurement in excess of \$10,000 from the viewpoint of energy conservation, and report to the President and the Congress, recommending improvements.

In addition, the bill directs GSA to submit an annual report to Congress of their activities under this Act, and also that each agency examine their buildings and report to the Congress on improvements that could be made.

S. 2045 authorizes \$7,500,000 to carry out the purposes of the Act.

S. 2095, the Conservation and Solar Energy--Federal Buildings Act of 1975

The Conservation and Solar Energy--Federal Buildings Act of 1975 (S. 2095) directs the GSA Administrator and the Secretary of Defense (DOD), in consultation with each other, to develop and publish consistent guidelines assuring that the most effective and efficient energy conservation measures are incorporated into the design, construction, renovation, and operation of Federal and Federally-assisted buildings. In addition, the measure directs that these guidelines shall be developed in accordance with the energy related studies and findings of the Energy Research and Development Administration (ERDA) and the Federal Energy Administration (FEA). These guidelines also are to incorporate the use of solar energy systems into the design, construction, and renovation of such buildings.

S. 2095 directs that the guidelines shall apply with respect to all new and existing buildings, and related procurement activities. Moreover, each agency shall, to the maximum extent feasible, follow such guidelines in all of its other activities, including those involving leased space. In this regard, each Federal agency proposing to construct, acquire, or lease a building is required to submit a detailed "life cycle energy cost analysis" to GSA or DOD. In

addition, no Federal agency may purchase any item or equipment, having as its purpose the generation, utilization, or conservation of energy, unless a detailed life cycle energy cost analysis of such item is submitted by the seller.

In addition, the measure directs the Administrator (GSA) and Secretary (DOD) to submit to Congress, as part of every prospectus, an "energy use analysis" with respect to the construction, acquisition, or leasing of any new building to which the proposed guidelines are applicable, and incorporate the findings into plans and specifications for the building.

The bill also directs that an inventory and energy use analysis be made of all existing buildings under GSA and DOD jurisdiction, indicating improvements that should be made to utilize the best energy conservation measures, and also the use of solar energy systems.

S. 2095 provides that, where a construction or rehabilitation cost limitation may be, or has been, established by law or otherwise, this maximum may be increased if installation of solar energy or other special energy equipment is proposed. In addition, the measure provides that any excess cost permitted, due to installation of solar or special energy devices, are to be taken into account in determining the value of the building with respect to all future transactions.

Moreover, the GSA and DOD are directed to jointly prescribe regulations, specifying types of energy equipment that will qualify a building for these benefits, and procedures for computing the extra dollar value.

The provisions of S. 2095 also apply to Federally assisted buildings, including those involving mortgage guarantees, and also Postal Service buildings or leased space.

The measure authorizes such funds as necessary to carry out various provisions of the act but omits specific dollar amounts.

#### OTHER MEASURES

##### S. 2932, the Energy Conservation Act of 1976

Another bill, the Energy Conservation Act of 1976 (S. 2932), was introduced on February 5, 1976, by Senators Kennedy, Hollings, Jackson, Magnuson, and Pearson, and jointly referred to the Committees on Banking, Housing and Urban Affairs, on Commerce, and on Interior and Insular Affairs. The principal features of the measure are --

--Federal loan guarantees (not to exceed \$10 billion at any one time) for financing energy conservation improvements, with priority for homes and small business, including farms. Industrial energy users not able to obtain financing from commercial sources could also qualify for guaranteed loans. Interest rates subsidies for residential consumers and small

businesses are provided to reduce the lending rate to 5 percent with not more than 20 percent of the loans to be subsidized at a rate of 2 percent.

--Use of State governments as agents of the Federal government in preparing and carrying out State energy conservation implementation programs to provide consumer information, energy audits, loan procedures, and installation of energy conserving materials; and

--A Federal grant-in-aid program of \$50 million annually for 4 years to assist States in designing and carrying out their State conservation implementation programs.

These loan guarantees would be made solely for the purpose of reducing the amount of energy used in residential, commercial, and public buildings and in manufacturing plants and small businesses. Only permanent improvements, such as insulation, storm windows, solar energy equipment, revamping of ventilation systems, heat pumps, and heat exchangers, can qualify for Federally guaranteed loans. Also, loans would have to be repaid with the projected savings that are realized over the life-cycle of the energy conserving facilities.

H.R. 6860, the Energy Conservation and Conversion Act of 1975

Among its provisions the Energy Conservation and Conversion Act of 1975 (H.R. 6860) contains the following authorities:

Five-Year Amortization--Five-year amortization (rather than regular depreciation) would be provided for certain equipment that would conserve oil and gas, including equipment that would use

waste as fuel, solid waste recycling equipment, solar energy equipment where the investment credit is not claimed, shale oil conversion equipment, coal processing equipment, coal slurry pipelines, and deep mining coal equipment. In general, the 5-year amortization provisions would apply after March 17, 1975, and before January 1, 1981.

Investment Credit Modifications -- The investment credit of present law would be extended to insulation installed after March 17, 1975, and before January 1, 1978, in a structure which was in existence on March 17, 1975, and which was used on that date in a trade or business. The investment credit would also be extended to solar energy equipment installed after March 17, 1975, and before January 1, 1981.

The investment credit would no longer be available in the case of an air-conditioning or heating unit which is placed in service after the date of enactment of the act. In addition, the investment credit would not be available in the case of any electrical generating property fueled by petroleum or petroleum products, including natural gas, which is placed in service after April 17, 1975. This latter provision would not apply in the case of certain binding contracts in effect on April 17, 1975, and in the case of certain lease-back transactions.

Insulation of Principal residence -- An income tax credit would be provided to an individual for expenses incurred with respect to the insulation of that person's principal residence (if the residence was in existence on March 17, 1975). The term "principal residence" would include a rented dwelling unit. The credit would equal 30 percent of the first \$500 of insulation expenditures (a maximum credit of \$150). The credit would be available with respect to insulation expenditures made after March 17, 1975, and before January 1, 1978. Qualified insulation would include regular insulation, storm (or thermal) windows and doors, or similar items (such as weatherstripping and caulking) designed specifically and primarily to reduce heat loss or gain of a building, if such items have a useful life of at least 3 years and meet performance standards prescribed

by Treasury Department regulations (in consultation with the Federal Energy Administration and the Department of Housing and Urban Development).

Residential Solar Energy Equipment -- An income tax credit would be provided to an individual for expenses incurred with respect to the installation of solar energy equipment in, on, or connected to that person's principal residence. The credit would be available in the case of an existing or newly constructed principal residence. In order to qualify, the original use of the equipment must commence with the taxpayer, and the equipment must use solar energy to heat or cool the building or to provide hot water for use within the residence. The equipment would be required to meet interim or definitive performance criteria prescribed by the Secretary of Housing and Urban Development.

The credit would equal 25 percent of the first \$8,000 of expenditures, for a maximum credit of \$2,000. The credit would be available with respect to expenditures made after March 17, 1975, and before January 1, 1981.

H.R. 8650, The Energy Conservation Buildings Act of 1976

The Energy Conservation in Buildings Act (H.R. 8650) passed by the House of Representatives on September 8, 1975 (H.Rept. 94-377), and the Senate on March 9, 1976 (S. Rept. 94-623), requires the Secretary of Housing and Urban Development to formulate energy efficiency standards for new commercial and residential structures throughout the United States. Guidelines for commercial buildings are required within 18 months of enactment and for residential structures within three years.

---

---

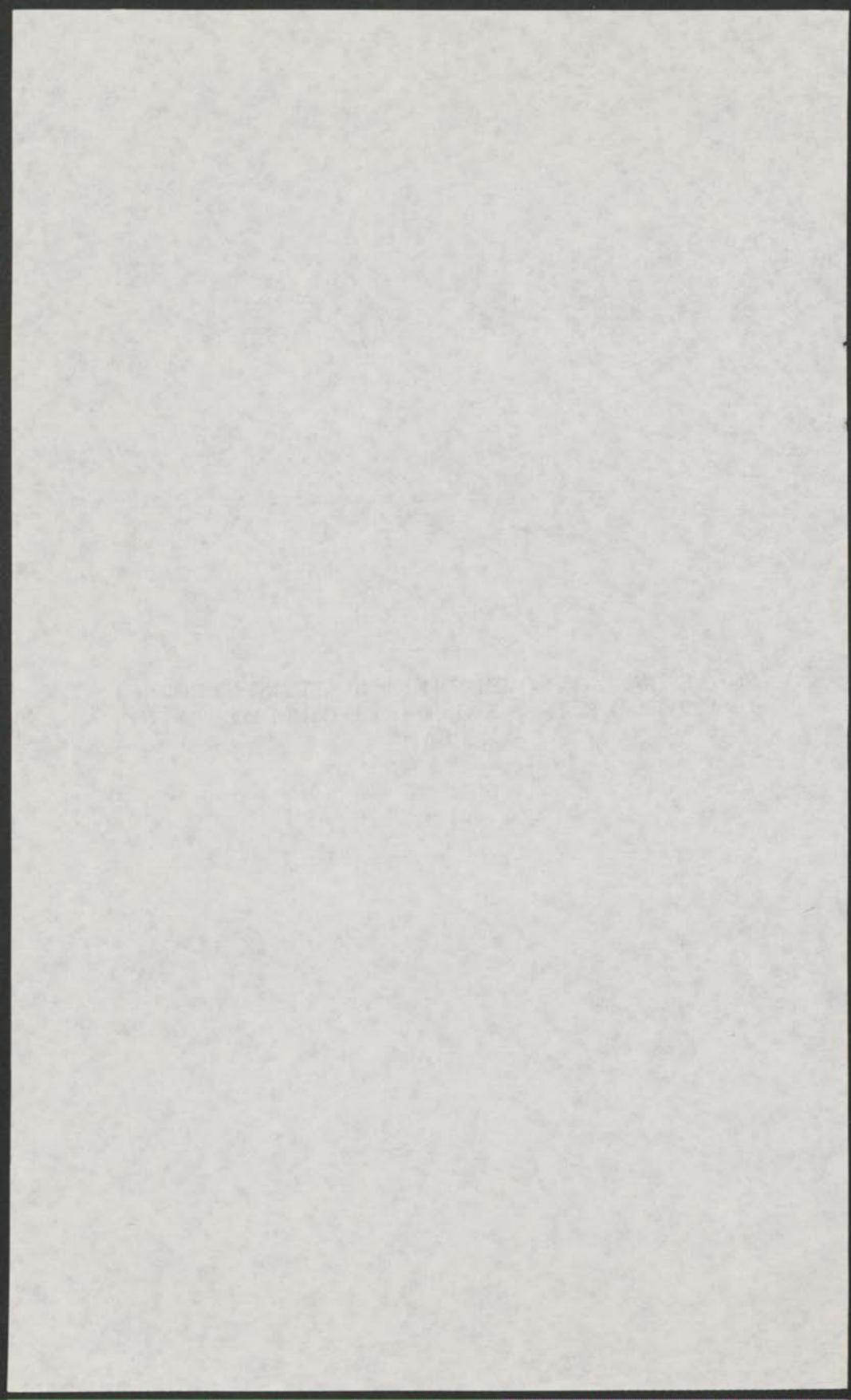
## APPENDIX B

---

### SOLAR ENERGY GOVERNMENT BUILDINGS PROJECT DRAFT GUIDELINES AND DRAFT IMPLEMENTATION PLAN

---

---



SOLAR ENERGY GOVERNMENT BUILDINGS PROJECT  
DRAFT GUIDELINES AND DRAFT IMPLEMENTATION PLAN

PREPARED FOR THE FEDERAL ENERGY ADMINISTRATION  
OFFICE OF SYNFUELS, SOLAR AND GEOTHERMAL ENERGY

The MITRE Corporation  
McLean, Virginia

*March 26, 1976*

The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies of the U. S. Government.

(125)

## TABLE OF CONTENTS

	<u>Page</u>
LIST OF ILLUSTRATIONS	v
1.0 PROGRAM OBJECTIVE	1
2.0 APPROACH TO THE OBJECTIVE	1
2.1 Spectrum of Impacts	2
3.0 PROGRAM STRUCTURE	3
3.1 Project Description	3
3.2 Project Phases	3
4.0 DEVELOPMENT OF IMPLEMENTATION PLAN	5
4.1 Contract Support	5
4.1.1 Preliminary Development Support	5
4.1.2 Policy Section and Support	5
4.1.3 Implementation Section and Final Report	7
4.1.4 Analysis of Impacts	7
4.1.5 Industry-Market Infrastructure Analysis	7
4.1.6 Procurement Arrangements	7
4.2 Agency Support	8
4.2.1 Agencies That Own and Manage Buildings	8
4.2.2 RD&D Support Agencies	11
4.2.2.1 National Aeronautics and Space Administration	11
4.2.2.2 Energy Research and Development Administration	11
4.2.2.3 National Science Foundation	12
4.2.2.4 National Bureau of Standards	12
4.2.3 Policy Support Agencies	13
4.2.3.1 Small Business Administration	13
4.2.3.2 Experimental Technologies Incentives Program (NBS)	13
5.0 CRITICAL ISSUES	15
5.1 Funding	15
5.2 Incentives	15
5.3 Phasing in to Normal Operations	15
5.4 Small-Business Aspects	15
5.5 Statutory Authority and Limitations	16
5.6 Building Assessments	16
5.7 Life-Cycle Costing	16
5.8 Procurement	16
5.9 Project Management	17
5.10 Educational Activities	17
5.11 Need for Stimulating Innovation	17

## TABLE OF CONTENTS (Concluded)

	<u>Page</u>
GLOSSARY	18
ATTACHMENT - DRAFT IMPLEMENTATION PLAN SOLAR ENERGY GOVERNMENT BUILDINGS PROJECT	
DISTRIBUTION LIST	43

## LIST OF ILLUSTRATIONS

<u>Figure Number</u>		<u>Page</u>
1	Schedule for Implementation Plan, Government Buildings Project	6
2	Agency Support for SEGBP Implementation Plan	9

SOLAR ENERGY GOVERNMENT BUILDINGS PROJECT (SEGBP)\*  
IMPLEMENTATION PLAN DEVELOPMENT

1.0 PROGRAM OBJECTIVE

The Federal Energy Administration proposes a five-year program to assist in accelerating the establishment of a commercial solar heating and cooling industry in the United States. This program has been designated the Solar Energy Government Buildings Project (SEGBP) and is the subject of this document.

2.0 APPROACH TO THE OBJECTIVE

The heating and cooling of buildings and the provision of domestic hot water consume at least one quarter of all the energy used in the United States. It is generally agreed that a substantial portion of this energy could be economically furnished by the sun if a vigorous, efficient solar heating and cooling industry existed, in place of the present small and struggling industry. In order to encourage the development of such an industry, the National Program for Solar Heating and Cooling has been developed. This program includes research and development activities designed to improve the technology of solar heating and cooling and to develop better understanding of the constraints and barriers to its widespread use, a demonstration program to develop realistic cost and performance data for solar heating and cooling systems and to demonstrate their viability to the building industry and the public, appropriate programs of education and information dissemination, and a commercialization program.

Even if efficient, reliable solar heating and cooling systems were available, if public understanding and acceptance of the concept were high, and if governmental and institutional barriers to their employment were removed, an economic barrier would remain. Such systems, manufactured in small numbers by essentially handicraft methods, would be too expensive to generate a mass market. On the other hand, a mass market is required to justify the adoption of mass-production and cost-cutting techniques and to build up the network of materials suppliers, fabricators, installers, servicers, and financiers which will constitute a viable industry.

The Federal Government owns or leases approximately 450,000 buildings containing 2.8 billion square feet of floor space. The SEGBP will use this vast Federal building inventory to provide a significant early market for solar hot water and space heating equipment (space cooling and dehumidification will be considered for subsequent efforts.)

\*A glossary of acronyms and technical terms is included, starting on p. 18.

A number of Federal agencies have already started, or are planning, solar application programs. What the SEGBP proposes is to organize and augment these efforts to optimize their effectiveness in encouraging the development of an industry infrastructure. It is important that the scale and timing of the total effort gradually build a market which will provide a smoothly growing demand and reasonable assurance of multiyear purchases to justify industry investments.

Many technical problems, including life-cycle costing (LCC) methodology, procurement methods, funding alternatives, performance standards, and building survey techniques will have to be developed. It is more efficient to resolve as many as possible of these questions at one time, by joint effort, than for each agency to seek its own solutions.

### 2.1 Spectrum of Impacts

Those who have proposed the SEGBP are moderately optimistic about its chances for success. It should be emphasized, however, that confidence in those chances can be improved only by conducting the studies and surveys proposed for the Project. When these careful quantitative assessments have been made, judgments will be possible as to the continuation and scale of Project implementation.

The ideal outcome of SEGBP would be the installation of sufficient solar equipment on government buildings to stimulate development of a vigorous, independent solar industry capable of competing successfully in the market place for government and private purchases; all this within normal cost/benefit practices and only moderate Federal subsidy. Short of this, other more limited but desirable outcomes are possible. For example, a substantial number of the most favorable Federal installations could be made, resulting in a worthwhile saving in fuel and Federal expenditures. The impetus of SEGBP, while conceivably insufficient by itself to kick off a viable industry, could accelerate the process.

A justification for the early survey and assessment activities of SEGBP is that the knowledge and insight gained will permit better-informed administrative and legislative decisions on incentives to be made, and will reduce the time required to respond to such decisions if they are positive and thus require response.

## 3.0 PROGRAM STRUCTURE

3.1 Project Description

As currently envisioned, the Project includes the following key points:

- All planning and designs for new Federal buildings or major renovations will include an assessment of the feasibility of using solar water heating and space heating. Similar consideration will be given to replacing conventional water heaters with solar in existing buildings by retrofit.
- Solar systems will be purchased and installed on Government buildings whenever they are competitive with conventional systems on a life-cycle cost basis (i.e., total costs of purchase and operation over the period of useful life) unless precluded by mission constraints. In addition to the purchase of immediately competitive systems, a certain quantity of systems that would be competitive if manufactured in volume (i.e., competitive on a "should-cost basis"), though not now competitive on a hand-crafted basis, may be purchased.
- The quantity of solar hot water and heating systems purchased by the Federal Government should be substantial enough to initiate the use of automated production techniques and thus contribute to development of a solar industrial capability.
- Solar-equipped buildings will be operated through normal facility management techniques (i.e., no special instrumentation or reporting requirements that would increase operating costs).

3.2 Project Phases

The key points described above can also be presented in the following two phases:

Phase I - Project Planning

- Develop Project Implementation Plan.
- Project approval by Office of Management and Budget and Energy Resources Council.

Phase II - Project Implementation

- Assess Government buildings inventory and planned construction for possible solar applications, using LCC on an individual building basis.

- Purchase solar systems for Government buildings whenever they are competitive with conventional systems on a life-cycle basis, including the "should-cost" feature when appropriate. Such procurements should be made in a manner to maximize their favorable impact on the development of an industry and should be substantial enough to initiate use of automated production techniques.
- Install the solar systems on Government buildings.
- Operate the solar equipped buildings through normal facility management techniques (i.e., no special instrumentation or reporting requirements which would increase operating cost).

The steps listed under Phase II, above, are sequential in nature for each category of buildings and solar applications, but will not be carried out simultaneously for all categories. The assessment will identify building-region-application combinations with varying levels of economic viability (or with varying levels of subsidy required). These will be rank-ordered from those categories that are immediately cost/beneficial without subsidy (e.g., perhaps water heating in Arizona barracks, competitive with electric resistance heating) to those requiring increasing levels of subsidy. Policy decisions will be required to determine which categories will be implemented at any given time.

#### 4.0 DEVELOPMENT OF IMPLEMENTATION PLAN

The SEGBP has been under consideration for the past year, with substantial interagency coordination and FEA/ERDA contract support (see Section 4.1 below).

FEA, in conjunction with the appropriate agencies, is developing a detailed Implementation Plan. Work is proceeding toward completion of a draft Implementation Plan, detailed guidelines regarding the Project's objectives and goals, and, with special emphasis, analysis of the costs and benefits of the Project. The detailed Implementation Plan should be completed by August 31, 1976. Figure 1 presents the schedule for developing the Implementation Plan. The Plan (Phase I) will provide the direction to implement immediately the first operational steps of the Project (widespread assessments and decisions to use solar technology where cost-competitive and not precluded by mission constraints). Also, the Plan will detail the costs and benefits of conducting the life-cycle cost analyses on a "should-cost" basis (i.e., costs anticipated when the system under consideration is produced in volume quantities substantial enough to initiate use of automated production techniques) and prepare recommendations for the appropriate level of Federal support.

##### 4.1 Contract Support

The following contracts and interagency agreements will provide support to FEA in developing the final Implementation Plan.

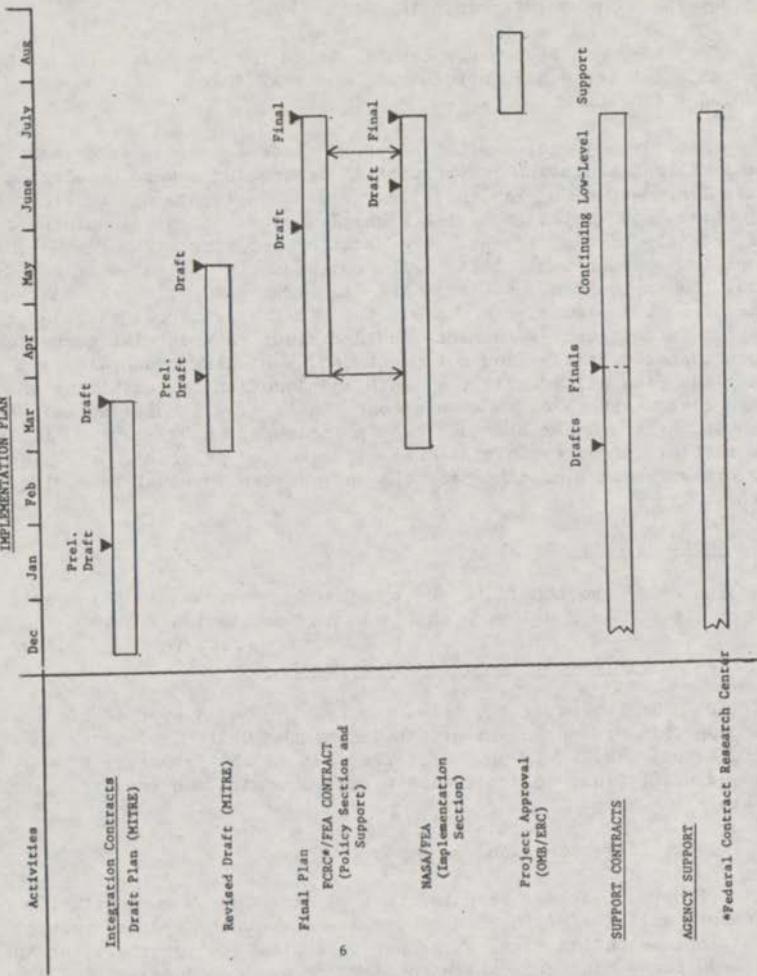
###### 4.1.1 Preliminary Development Support

The MITRE Corporation, McLean, Virginia, has supported FEA in developing this present document, including the Draft Implementation Plan (Attachment). MITRE is now supporting FEA in the preparation of a revised Draft Plan, incorporating agency comments and support contractor inputs.

###### 4.1.2 Policy Section and Support

A Federal Contract Research Center, selected by competitive procurement, will assist the FEA to prepare the policy chapters of the final Implementation Plan, by preparing drafts and incorporating appropriate support contractor and agency inputs and comments; and will collaborate closely with the NASA effort (Section 4.1.3, below), by supplying policy materials for implementation chapters and reviewing NASA drafts, to ensure internal consistency in treatment of policy.

FIGURE 1  
SCHEDULE FOR IMPLEMENTATION PLAN, GOVERNMENT BUILDINGS PROJECT  
IMPLEMENTATION PLAN



#### 4.1.3 Implementation Section and Final Report

The National Aeronautics and Space Administration, through inter-agency agreement with FEA, will draft the implementation chapters of the Plan, incorporating appropriate support contractor and agency inputs, and will produce a draft Plan incorporating those chapters and the policy chapters (Section 4.1.2, above) and will produce a final version of the Plan responsive to agency comments.

#### 4.1.4 Analysis of Impacts

Arthur D. Little, Inc., Cambridge, Massachusetts, will provide inputs for the Implementation Plan, including (1) impacts of SEGBP commercialization strategy, relationship to other commercialization strategies, and solar heating and cooling energy and economic projections, and (2) life-cycle cost analyses, and industry-market infrastructure analysis.

#### 4.1.5 Industry-Market Infrastructure Analysis

InterTechnology Corporation, Warrenton, Virginia, will provide inputs for the Implementation Plan, including (1) identify and descriptions of each segment of the solar heating and cooling industry infrastructure, requirements and opportunities of each segment (financial opportunities and costs of using automated production techniques, etc.), cost breaks within each segment; requirements of overall infrastructure; and interrelationship between various segments; (2) "should-cost" analysis; draft procedures for using "should costs" in life cycle cost analysis; and (3) review of life-cycle cost analyses supplied by the Government Technical Representative.

#### 4.1.6 Procurement Arrangements

Don Sowle Associates, Arlington, Virginia, will provide inputs to the Implementation Plan, including (1) development and analysis of innovative procurement strategies to stimulate development of industry infrastructure and address various small-business-related problems; (2) discussion of certain problems and opportunities associated with actual implementation of the Project with each construction agency including (a) logistics of multiyear, aggregated collector procurement, etc., (b) analysis of various funding authorization frameworks such as fenced funds, etc., and (c) analysis of current practices regarding procurement decisions--particularly assessment methods such as life-cycle cost assessments, etc.; and (4) analysis of existing statutory and regulatory requirements for actual implementation of the Project.

#### 4.2 Agency Support

The vigorous cooperation of all the Federal agencies involved in building management, or in the development of energy technology or policy, is essential if the SEGBP is to fulfill its goals. This requires that the Plan realistically reflect the needs and operating conditions of the agencies, and thus requires that the agencies participate fully in the development of the Plan. Each agency is expected to:

- (a) Carefully review the present document and make suggestions for changes that will make the Plan more responsive to agency needs and more compatible with agency operating conditions.
- (b) Raise policy problems insufficiently covered, and implementation procedures not included in the drafts of the Plan.
- (c) Contribute descriptions of agency activities or plans relevant to the SEGBP.
- (d) Review subsequent draft Plans and suggest further revisions as appropriate.

Specific support sought from agencies that have building construction responsibilities, agencies involved in RD&D relevant to solar heating and cooling, and agencies having related policy responsibilities is presented in Figure 2, and discussed below. It is particularly important that the agencies cited analyze those requirements carefully, and participate fully in developing them in final form.

##### 4.2.1 Agencies That Own and Manage Buildings

Agencies such as DOD, GSA, USPS, VA, etc., that own and manage buildings should develop estimates of the number and classification of buildings under their control that could represent potential markets for solar heating and hot water systems. During Phase I, Implementation Plan Development, this information should be supplied by the managing agencies from data that exist within the agency at the present time. It is intended that substantial work to develop new data is to be avoided and certainly detailed buildings surveys or assessments are not required. The objective of Phase I data collection is to provide a reasonable estimate of market size for overall planning purposes.

The essential data required during Phase I should include:

- (1) Hot water requirements in gallons per year, by state
  - (a) For planned future construction
  - (b) For existing buildings

AGENCY SUPPORT FOR SECBBP IMPLEMENTATION PLAN			
DOB	DSA	USPS	VA
HRD	HEA	NPS	NSA
HUD	HEA	ERDA	NASA
NSF	NSA	ERDA	Other Construction Agencies
NBS	NSF	ERDA	NSF (NBS)
SBA			PEA
NEP			
Identify Retrofit Potential in Agency			
Identify New Building Potential in Agency			
Identify Hot Water Application Potential in Agency			
Discussion of Agency Perception of Problems Facing Implementation			
Discussion of Agency Perceptions for Implementation under various scenarios			
Report Economic Analyses which have been performed			
Report Existing Projects			
Discussion of Procurement Related Issues			
Survey of State-of-the-Art			
Description of R&D Activities			
Description of Commercialization Activities			
Description of Information Dissemination Activities			
Description of Performance Standards			
Discussion of determining heating and cooling loads			
Discussion of industry stratification			
Discussion of producer incentives			
Discussion of LCC			
Discussion of promoting agency participation			
Discussion of regulatory issues			
Discussion of Technology Transfer			
Discussion of Total National Value			
Overall Integration			

FIGURE 2  
AGENCY SUPPORT FOR SEGBP IMPLEMENTATION PLAN

(2) Floor space of buildings to be heated, in square feet, by state

- (a) For planned future construction
- (b) For existing buildings

The above data should not be derived from buildings having a projected life of less than 10 years.

Agencies having more data available should provide additional information from their existing data base:

- Numbers of buildings, by building type and state
- Heating or water heating method used at present and fuel source (natural gas, oil, etc.)
- Breakdowns by relative suitability for solar application
- Breakdown by relative present heating efficiency

Building types include residential (single- and multifamily), office buildings, warehouses, hospitals, barracks, etc. Relative suitability for solar application should be based upon such existing information as geometric siting, shading, installation space for collectors, insulation characteristics, planned life span of building, and amenability of building to solar retrofit.

Agencies having completed surveys for potential solar applications should provide the survey results, project recommendations, and survey methodology descriptions in lieu of the data requested above.

FEA will use suitable planning factors for heating loads per square foot for planned and existing buildings, and for the relationship between heating requirements and solar equipment requirements, to arrive at potential solar equipment market size. The factors to be used will include quantity of thermal energy required per square foot of floor space per year and quantity of thermal energy collectible per square foot of collector per year, both as functions of region.

Each building user agency should also assemble and submit the following information:

- Description, extent, and schedule of present agency plans for utilization of solar energy.
- Discussion of problems and opportunities (technical, economic, institutional) perceived by the agency in accelerating SHACOB (solar heating and cooling of buildings).

- Based on the above discussion, and other information, any agency assessment of SEGBP with respect to specific strategies to be included or avoided in Phase II.
- Any analysis performed by the agency to investigate SHACOB potential.

#### 4.2.2 RD&D Support Agencies

Agencies engaged in research, development, and demonstration in areas important to SEGBP should develop and submit the information indicated below:

##### 4.2.2.1 National Aeronautics and Space Administration

(A) Survey of state of the art

(1) Collectors

- (a) Air
- (b) Liquid

(2) Conversion systems

- (a) Heat exchangers

(3) Storage systems

(4) System integration

(5) Controls

##### 4.2.2.2 Energy Research and Development Administration

(A) Survey of state of the art

(B) Description of RD&D activities

(1) Technology areas being considered under R&D

(2) Objectives of Demonstration Program

(3) Commercialization schedule for solar components and systems

(4) Residential demonstration schedule

(5) Commercial demonstration schedule

(C) ERDA's role in commercialization

(1) RFI, RFP, PON mechanisms

## (D) Information dissemination activities

- (1) Procedures to assure the latest advances from RD&D (industry and Federal) are incorporated, on at least an annual basis, into the SEGBP procurement arrangements.

- (E) Discussion of performance standards
- (F) Discussion of industry stratification
- (G) Discussion of producer incentives
- (H) Discussion of LCC procedures

4.2.2.3 National Science Foundation

## (A) Discussion of technology transfer

- (1) Possible approaches to make SEGBP industry participants responsive to technological innovations

- (B) Discussion of producer incentives
- (C) Discussion of Total National Value

- (1) Identify national impacts of SEGBP implementation (qualitatively)
- (2) Recommend procedures for quantifying SEGBP impacts
- (3) Recommend procedures for internalizing impacts in "should-cost" of solar systems for use in Government buildings

## (D) Discussion of information dissemination.

4.2.2.4 National Bureau of Standards

- (A) Discussion of information dissemination
- (B) Description of intermediate minimum property standards
  - (1) Materials
  - (2) Construction
  - (3) Testing and Evaluation
    - (a) Recommended testing procedures
    - (b) Testing procedures that may be incorporated to expedite assessments
- (C) Efforts toward consensus standards
- (D) Methods for determining building heating and cooling loads
  - (1) Description of National Bureau of Standards Load Determinations (NBSLD)
    - (a) Applicability
    - (b) Cost of implementing

(2) Discussion of other possible load models

- (a) U.S. Postal Service (USPS)
- (b) American Gas Association (AGA)
- (c) Others

(3) Possible expeditious methods for assessing building loads

(D) Discussion of LCC procedures

#### 4.2.3 Policy Support Agencies

Agencies engaged in the development of policy relevant to SEGBP should develop and submit the following information:

##### 4.2.3.1 Small Business Administration

- (A) Optimum stratification of industry
- (B) Possible incentives to promote small business participation
  - (1) Establishing distribution networks
  - (2) Centralized capital-intensive facilities
  - (3) Small business set-asides
  - (4) Producer loans and/or tax credits or deductions
  - (5) Capital formation problems of small business
  - (6) Reduction of "red tape"
  - (7) Federal support in qualification testing

##### 4.2.3.2 Experimental Technologies Incentives Program (NBS)

- (A) Outline present results of policy experiments related to LCC
- (B) Description of strategies to encourage agency participation
- (C) Description of following procurement-related issues
  - (1) Performance Specifications
  - (2) LCC
  - (3) Value incentives clauses
  - (4) System purchasing
  - (5) Initiative purchasing
- (D) Discussion of standards, certification, economic, and enveloping regulations consideration in terms of:
  - (1) Strategy
    - (a) Legislative changes
    - (b) Agency-initiated changes

(2) Goals

- (a) Standards development
- (b) Codification
- (c) Rates and rate structures (reflective of needs for technical change)
- (d) Definition of "envelope" boundaries

## 5.0 CRITICAL ISSUES

Certain issues, discussed below, must be resolved if the SEGBP is to be successful, or even possible at all. In most cases, those issues are beyond the capacity of any one agency to solve and they will require considerable analysis, interagency agreement, and conceivably changes in legislation. It may prove desirable to establish interagency task groups of specialists to deal with some of these issues.

### 5.1 Funding

With a generally austere budget picture for some time to come, and with each agency operating under severe budgetary restraints, the questions of how much money can be devoted to SEGBP implementation, what sources can be used, and how the implementation funds should be handled are important and difficult.

### 5.2 Incentives

Some discussion has been presented of the possibility of using "should-costs" for solar equipment, i.e., using in cost/benefit calculations the costs solar equipment could be expected to reach if the vigorous industry is developed that is the goal of the commercialization program. Some consideration should also be given to the impact and appropriateness of additional incentives, and to the proper levels of incentive.

### 5.3 Phasing in to Normal Operations

SEGBP is a one-time project. Its intent is to give industry an initial pulse to help break the cycle in which small markets and therefore small production rates produce high costs, and high costs produce small markets. As soon as feasible, solar heating and cooling should become a normal, competitive option for all government buildings, and for all private buildings as well. The management and phasing of SEGBP should be designed to maximize its leverage in developing a normal private industry and market.

### 5.4 Small-Business Aspects

Definitions of optimal protection for small businesses, and appropriate procedures for achieving that protection must be developed. This poses some difficulties because of the probable necessity, in some cases, of aggregating purchases to some minimum size that will justify cost-cutting production techniques.

### 5.5 Statutory Authority and Limitations

Each agency involved in implementation of SEGBP operates under a different set of statutory authorities and constraints. These will have to be resolved in each case to determine the extent to which, and the procedures under which, each agency can participate in SEGBP. Statutory changes may be required in some cases.

### 5.6 Building Assessments

The conduct of assessments of agency building inventories and construction plans is the first step in implementing SEGBP, and will quickly determine the probability of success or failure of SEGBP in meeting its goals. It is therefore essential that these assessments be promptly begun and properly executed. At the same time, such assessments could represent a substantial expenditure of agency attention, time, and money. These considerations dictate that careful common-sense guidelines for the conduct of the necessary assessments be developed at an early point. A first draft of guidelines for the information to be submitted for Phase I is included in Section 4.2.1. Guidelines for the more detailed information to be collected in Phase II will be developed with agency participation during the completion of this Plan.

### 5.7 Life-Cycle Costing

The concept of life-cycle costing is essential to the evaluation of solar technology, which is characterized by higher first costs than conventional equipment, offset by zero fuel costs. At least eight different approaches to life-cycle costing have been proposed for consideration for SEGBP. It will be necessary to analyze these approaches carefully, and to adopt the best for Project use (see Section 5.3.1 of Attachment).

Uniform guidelines will have to be developed for LCC computational methodology as well as for competitive fuel costs as a function of time, discount rates or other cost-of-money parameters, life expectancy of solar equipment, cost of solar equipment (including consideration of "should-costs"), operating and maintenance costs, and other factors entering the LCC computations.

### 5.8 Procurement

Procurement methods vary from agency to agency, by statute and by established practice. The Experimental Technologies Incentives Program administered by NBS has demonstrated that the Federal procurement process, even under existing statutes, can be a powerful tool for the introduction of desirable technological innovation into industry. SEGBP will have to explore these possibilities with great care.

5.9 Project Management

FEA has undertaken to get Phase I of SEGBP, the preparation of an Implementation Plan, started, and to take the lead through this Phase. During Phase I the appropriate management mechanisms for Phase II will have to be developed. It is likely that some mixture of decentralized and centralized responsibility will be chosen, with agencies undertaking some activities for themselves and lead agencies established for other activities.

5.10 Educational Activities

During Phase II the implementation of SEGBP will pass into the hands of procurement personnel and facility administrators in many government departments and all parts of the country. If the Project is to succeed, these people must understand and accept it, and must make substantial changes in their present methods of operation. These widespread changes will be difficult, even impossible, without an organized effort to educate them about the need for change, the benefits that change will bring them, and the operational details of SEGBP as it affects them.

5.11 Need for Stimulating Innovation

A real danger exists that SEGBP might stimulate the growth of industry in directions that would lock it in to less-than-optimum solar methods and equipment. Considerable attention must be devoted to preserving industry flexibility and stimulating innovation so that improvements can readily be made as time goes on, and as such improvements are indicated by experience, change of circumstance, and the results of research.

## GLOSSARY

AGA	American Gas Association
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
ASTM	American Society for Testing and Materials
COP	Coefficient of performance
Discount Rate	A rate applied to estimate the present value of future costs or savings
DOD	Department of Defense
ERC	Energy Resources Council
ERDA	Energy Research and Development Administration
ETIP	Experimental Technologies Incentives Program. A program administered by the National Bureau of Standards, designed to develop means to use the leverage of Federal procurement to encourage the adoption by industry to beneficial innovations.
FEA	Federal Energy Administration
FEMP	Federal Energy Management Program
GSA	General Services Administration
HEW	Department of Health, Education, and Welfare
HUD	Department of Housing and Urban Development
LCC	Life-cycle costing. A method of calculating the cost of equipment by aggregating first costs with operating, maintenance and indirect costs over the projected life of the equipment
NASA	National Aeronautics and Space Administration
NBS	National Bureau of Standards
NBSLD	NBS Load Determination

## GLOSSARY (Concluded)

NPS	National Science Foundation
OMB	Office of Management and Budget
RD&D	Research, Development and Demonstration
Retrofit	To install solar equipment on an already existing building; usually replacing or supplementing conventional heating equipment
SBA	Small Business Administration
SEGBP	Solar Energy Government Buildings Project
SEIA	Solar Energy Industry Association
"Should-Cost" Basis	A costing system under which the first costs for equipment, which are used in LCC computations, are the costs for equipment estimated to be achievable through mass production, rather than the present cost of largely tailor-made systems.
Total National Value	The total value to society of a course of action, including not only direct economic benefits but such benefits as natural security, improved balance of payments and protection of the environment, which are difficult to quantify.

DRAFT IMPLEMENTATION PLAN  
SOLAR ENERGY GOVERNMENT BUILDINGS PROJECT

## TABLE OF CONTENTS

	<u>Page</u>
LIST OF ILLUSTRATIONS	v
LIST OF TABLES	v
1.0 EXECUTIVE SUMMARY	1
2.0 GOAL OF THE SOLAR ENERGY GOVERNMENT BUILDINGS PROJECT	3
3.0 IMPACTS OF SEGBP	4
3.1 Impacts on Government Buildings	4
3.2 Primary Energy Impacts	8
3.3 Other Impacts	8
4.0 RELATIONSHIPS TO OTHER EFFORTS	10
4.1 The Federal Energy Management Program (FEMP)	10
4.2 National Solar Heating and Cooling RD&D Program	11
4.2.1    Structure	11
4.2.2    RD&D and Commercialization	12
4.3 Industrial Efforts	13
4.3.1    Standards: Two-Phase Approach	13
4.4 Interfaces	14
5.0 TECHNOLOGY AND ECONOMICS	15
5.1 State of the Art in Technology	15
5.1.1    Collector Technology	15
5.1.2    Advances in Flat-Plate Technology	16
5.1.3    Other Collection Systems	16
5.1.4    Heating and Cooling Technology	17
5.1.5    Present Size of the Industry	18
5.2 Projected Economics	18
5.2.1    General	18
5.2.2    MITRE Study Ground Rules and Data	19
5.2.3    MITRE Study Results	22
5.3 Government Procurement Methods	24
5.3.1    Lowest Purchase Price vs. Lowest Life-Cycle Costs	24

## TABLE OF CONTENTS (Concluded)

	<u>Page</u>
5.3.2      Experimental Technology Incentives Program (ETIP)	25
6.0      IMPLEMENTATION PLAN	27
6.1      Strategy	27
6.2      Implementation Tasks	28
6.2.1      Quantitative Goal Development	29
6.2.2      Assessment Procedure Development	29
6.2.3      Management and Funding Definition	31
6.2.4      Information Dissemination	33
6.2.5      Assessments	34
6.2.6      Minimum SEGBP Purchase Generation Scheme	34
6.2.7      Procurement Strategies	35
APPENDIX A - ACTIVITIES IN THE AGENCIES/DEPARTMENTS	36
APPENDIX B - AGENCY COMMENTS ON JANUARY 22 DRAFT	38
REFERENCES	41

## LIST OF ILLUSTRATIONS

	<u>Page</u>
5-1 REGIONS AND REPRESENTATIVE CITIES	20
6-1 SEGBP IMPLEMENTATION	30

## LIST OF TABLES

	<u>Page</u>
3-1 Energy Used in Heating and Cooling Residential and Commercial Buildings	5
3-2 Potential Energy Savings DOD and USPS Applications	7
5-1 Annualized Cost Comparisons of Solar vs. Electric Heating and Cooling Systems for Single Family Dwellings	23

DRAFT IMPLEMENTATION PLAN  
SOLAR ENERGY GOVERNMENT BUILDINGS PROJECT

1.0 EXECUTIVE SUMMARY

Solar heating and cooling of buildings (SHACOB) has the potential to effect a large saving in the Nation's oil consumption. If this goal is to be achieved, aggressive strategies must be implemented to overcome the technical, economic, and institutional barriers that block commercialization.

One such barrier to commercialization is the lack of adequate scale and infrastructure in the solar heating and cooling industry. The Solar Energy Government Buildings Project (SEGBP) has been proposed to help resolve this problem. SEGBP will be an active procurement effort, designed to create an interim market through the purchase of solar systems for use on government buildings, thus offering the industry an opportunity to capitalize the costs of developing production and distribution capabilities. At the same time, relationships will be developed between the manufacturers, suppliers of raw materials, and distributors, possibly to the extent of developing production linkages. Development of relationships with the construction and the heating, ventilation, and air conditioning (HVAC) industries as well as labor unions will also be encouraged.

In addition to providing this interim market for solar devices, SEGBP will directly decrease the amount of conventional energy consumed by the Government for heating and cooling of buildings. This will be done by encouraging or requiring that life-cycle cost (LCC) analysis procedures are used in making HVAC procurement decisions in both new and retrofit situations, and that solar equipment be installed when appropriate.

In carrying out this strategy, SEGBP will include a number of tasks including:

- Quantify production and cost goals for adequately stimulating industrial development
- Develop standard LCC and building performance assessment procedures
- Define management and funding options
- Disseminate information concerning assessment procedures and solar equipment performance
- Carry out assessments

- Define a procurement schedule
- Develop procurement strategies.

Implementation of SEGBP will require the cooperation of many Government agencies. Applications will be made on installations managed by such agencies as DOD, GSA, HEW, VA, NPS, and USPS. Policy analysis assessing the effectiveness of project strategies in achieving the commercialization goals will be carried out by FEA, ERDA, NSF, and ETIP. ERDA and NASA will provide technical support in system design and evaluation. Overall coordination of Phase I of the Project, the development of an Implementation Plan and its submission for approval by OMB and ERC, will be the responsibility of FEA.

Responsibility will be assigned later for execution of Phase II of the Project:

Phase II

- Assess Government buildings inventory and planned construction for possible solar applications, using LCC on an individual building basis.
- Purchase solar systems for Government buildings whenever they are competitive with conventional systems on a life-cycle cost basis including the "should-cost" feature when appropriate. Such procurements should be made in a manner to maximize their favorable impact on the industry and should be substantial enough to initiate use of automated production techniques.
- Install the solar systems on Government buildings.
- Operate the solar-equipped buildings through normal facility management techniques (i.e., no special instrumentation or reporting requirements that would increase operating costs).

## 2.0 GOAL OF THE SOLAR ENERGY GOVERNMENT BUILDINGS PROJECT

The Solar Energy Government Buildings Project focuses on one primary goal: to help stimulate industry development and the formation of an industry infrastructure. In pursuing this goal, SEGBP will attempt to create a significant interim market for solar systems by encouraging their use in Government buildings, thus giving the new solar heating and cooling industry an opportunity to capitalize automated production facilities. In order to do this, SEGBP must include the following:

- Encourage the use of life-cycle costing (LCC) methods for the design of new Government buildings or extensive Government renovations, and the subsequent use of solar systems when cost-effective.
- Encourage LCC methods in reviewing present Government heating, cooling, and hot water plants and their subsequent retrofitting with solar systems when cost-effective.
- Develop Government procurement procedures that will effectively lead agencies to utilize solar heating, cooling, and hot water systems, and industry to develop its capacity to supply such systems.

With the realization of this goal and these objectives, an industry will be formed, producing at a level of production high enough to permit the costs of solar heating systems to be reduced to approximately 50 percent of present systems costs. Exact cost reduction goals will be determined as one task of the Project. Product reliability and the experience of installation and service personnel should be increased to a level sufficient to promote customer confidence.

The Energy Policy and Conservation Act (P.L. 94-163), in Title III, Part E, Section 381, will affect solar heating and cooling. This Section mandates the development and implementation of standards for energy conservation and efficiency to govern all procurement policies of the Federal Government, and development and implementation of a ten-year plan for energy conservation with respect to operation of buildings owned or leased by the Government. Solar heating and cooling may be viewed as one of a number of energy conservation measures that may be applied to Federal buildings.

## 3.0 IMPACTS OF SEGBP

The SEGBP has the potential for substantial impact on the national energy situation by leading the way to a significant reduction in the amount of energy consumed in heating and cooling of buildings, which currently accounts for at least 25 percent of all the energy consumed in the United States. According to a 1972 analysis,<sup>(1)</sup> the energy consumption patterns outlined in Table 3-1 are projected, barring any effects of any energy conservation or demand reduction measures that may be taken. Energy conservation can in fact play a large part in reducing this demand. The Federal Energy Management Program has reduced energy use by 25 percent in existing buildings, with further reduction possible. New buildings will be constructed that are twice as energy-efficient as existing buildings.

This section discusses, essentially, two levels of impact that may result from the SEGBP: reduction of Government use of energy for heating buildings and providing hot water, and reduction of total U.S. residential and commercial energy consumption for space and water heating. After FY 1979, solar cooling will be included, as proven equipment for this purpose becomes available.

3.1 Impacts on Government Buildings

The Federal Government now owns or leases approximately 486,000 buildings or approximately 2.7 billion square feet. The Department of Defense owns approximately 81 percent of Federally owned floor space (not including space owned by the U.S. Postal Service). The General Services Administration and the Veterans Administration control the major part of the remaining floor space. Federally supported institutional buildings are not included in these figures.

A preliminary analysis<sup>(2)</sup> by DOD has determined that, of the 2.1 billion square feet owned by DOD, approximately 30 percent has the potential for retrofit with solar equipment (~630 million square feet). Assuming that 0.2 to 0.5 square foot of collector is required for each square foot of floor space, the retrofit potential for DOD is 126 to 315 million square feet. Assuming a collector produces 160,000 to 240,000 Btu per square foot per year, a potential sensible heat production of  $20.2 \times 10^{12}$  Btu to  $75.6 \times 10^{12}$  Btu may be realized. Assuming an alternative fuel conversion to heat efficiency of 50 percent, an energy saving of  $40.4 \times 10^{12}$  to  $151.2 \times 10^{12}$  may be achieved.

The USPS owns or operates approximately 75 million square feet of floor space in 36,000 buildings. Of this floor space, approximately 80 percent is concentrated in 750 buildings. It is also noted that approximately 80 percent of the space conditioning energy used by USPS is used in 750 buildings. Because USPS jointly controls or leases the

TABLE III-1  
ENERGY USED IN HEATING AND COOLING  
RESIDENTIAL AND COMMERCIAL BUILDINGS<sup>(1)\*</sup>

		(10 <sup>15</sup> Btu/Yr)		
		1977	1985	2000
Space Heating	Gas	4.74	4.69	5.14
	Oil	5.72	5.89	6.75
	Electricity	0.97	1.77	2.89
	TOTAL	11.43	12.35	14.78
		=====	=====	=====
	Gas	0.15	0.20	0.19
	Electricity	0.72	1.06	1.72
	TOTAL	0.87	1.26	1.91
		=====	=====	=====
Total, Heating and Air Conditioning		12.30	13.61	16.69

\*Superscript numbers in parentheses refer to list of references on page 41.

remaining 20 percent of floor space, a floor space of 60 million square feet will be assumed. If, as in the case of DOD, only 30 percent of the floor space is available for retrofit, the potential solar collector procurement will be 3.6 to 9 million square feet of collector. Using the same assumptions as used for DOD, a sensible heat production of  $0.6 \times 10^{12}$  Btu to  $2.2 \times 10^{12}$  Btu may be realized, amounting to energy savings of  $1.2 \times 10^{12}$  to  $4.4 \times 10^{12}$  Btu per year. So the potential impact for space conditioning in DOD and the USPS buildings alone would be in the range of 42 to  $155 \times 10^{12}$  Btu per year or 19,300 to 72,400 barrels of oil per day in energy savings.

In addition to the potential energy savings from space conditioning, DOD has determined(3) that the potential also exists for installing over 5 million square feet of solar collectors for producing service hot water. This would constitute an additional energy production of  $1.2 \times 10^{12}$  Btu of sensible heat or an energy saving of  $2.4 \times 10^{12}$  Btu per year, or 1,116 barrels of oil per day.

To summarize the impact of the SEGBP on DOD and USPS applications, there is a potential for saving some 20,500 to 73,500 barrels of oil per day (see Table 3-2). This does not take into account the significant saving that may accrue from installations operated by other agencies, in particular GSA, VA, and HEW. The VA and HEW potentials are of considerable importance because of the immediate opportunity for installing water heaters at their hospital facilities.

TABLE III-2  
POTENTIAL ENERGY SAVINGS:  
DOD AND USPS APPLICATIONS

	Sensible Heat ( $10^{12}$ Btu)	Energy Savings (bbls/day)
DOD		
Heating & Cooling	20.2 to 75.6	18,790 to 70,325
Hot Water	1.2	1116
USPS	0.6 to 2.2	558 to 2047
TOTAL	22 to 79	20,464 to 73,488

This very large potential amounts to some 135 million square feet of solar collector. It can be assumed that 20 percent, or 27 million square feet of this can be installed during the five-year SEGBP. At present, total solar system costs vary from \$14 to \$20 per square foot, so that the total cost for this installation would be from \$378 million to \$450 million. Annual fuel savings (assuming \$11/bbl for crude oil) would amount to \$16 million to \$58 million per year. The solar systems would thus pay for themselves in about 23 years. Decreasing component costs resulting from SEGBP and other activities, and increasing fuel costs, would cut this payback period substantially. Further, if other benefits resulting from the use of solar energy were figured into the cost analysis, the payback period would be reduced even further. Some of these other benefits are discussed in Section 3.3.

### 3.2 Primary Energy Impacts

Although the potential energy savings in government buildings are not insignificant, they are secondary to the potential of the program to reduce overall consumption of conventional energy. The major goal of SEGBP is to stimulate the development of a solar industry by providing an interim market for solar components. As noted above, the potential demand for DOD and USPS is in the range of 135 to 330 million square feet of collector. This is approximately a 270- to 660-fold increase over the size of the present industry.

Assuming that SEGBP would have the effect of adequately stimulating industry, and that other Federal efforts in developing market demand are successful, the energy saving would be considerable. An accelerated commercialization program may possibly achieve energy savings equivalent to 233,000 barrels of oil per day by the year 1985. (4)

### 3.3 Other Impacts

Successful implementation of the SEGBP and other programs aimed at promoting the commercialization of solar heating, cooling, and hot water systems will result in several hard-to-quantify impacts, sometimes aggregated into the concept of "Total National Value."

Decreasing our nation's dependence on foreign fossil fuel supplies through the use of solar energy will enhance our balance of trade position. Further, development of a substantial commercial capability in this area will also present opportunities for exporting both technology and hardware, thus further supporting our international economic position. Success in this program may support, as well as be supported by, progress in the Experimental Technology Incentives Program (ETIP) being directed by NBS. Shared experiences may uncover innovations that can be applied to life-cycle costing procedures in the procurement of other products consumed in the government sector.

Solar heating and cooling clearly offers a popular approach to helping to meet our nation's energy needs. Although other measures such as conservation and increased nuclear and coal utilization will be required, an early and forceful thrust in solar energy will demonstrate a balanced Federal program and an emphasis upon developing clean, inexhaustible energy sources.

## 4.0 RELATIONSHIPS TO OTHER EFFORTS

SEGBP is, essentially, a procurement-oriented project. It is not the purpose of this project to develop or demonstrate solar heating and cooling technology; rather, it will create a vehicle by which developed and proven solar technology commercialization may be accelerated.

SEGBP will be the focal point for ongoing solar heating, cooling, and water heating procurement projects within a number of Federal agencies. ERDA and NASA, through their efforts within the National Plan for Solar Heating and Cooling RD&D, will offer technical support to the participating agencies. SEGBP will also support the goals of the Federal Energy Management Program (FEMP). These two parallel efforts are discussed below. The project will also be closely coordinated with existing industry groups such as the Solar Energy Industry Association (SEIA) to assure the program is responsive to industry needs. Existing solar energy applications programs in other agencies are listed in Appendix A.

4.1 The Federal Energy Management Program (FEMP)

The President has tasked FEA and GSA to develop a program with the goal of increasing the efficiency of Federal facilities and operations. With the cooperation of 22 major departments and agencies, an implementation plan has been developed around the following "action plan":

- "Zero Energy Growth" as a long-term goal;
- Seven major initiatives:
  - I. Optimal use of simulators and other techniques to minimize ship and aircraft fuel consumption.
  - II. Make new buildings twice as efficient as comparable recent construction.
  - III. Retrofit existing buildings to cut energy use 25 percent.
  - IV. Install load management systems in appropriate buildings.
  - V. Set minimum fuel economy targets for both sedans and trucks to increase fleet efficiency by 50 percent by 1985.
  - VI. Implement driver education and motivation program for employees.
  - VII. Apply life-cycle costing techniques to major purchases such as appliances.

- Other initiatives and studies;
- Continuation and strengthening of current energy conservation activities;
- Institutional framework for program implementation.

Energy management within the Federal government has shown relative success over the past two years; energy savings<sup>(5)</sup> of about 24 percent or 250,000 barrels of oil equivalent per day have been achieved. Through the implementation of the above initiatives now in the proposal stage, it is hoped that additional energy savings of at least 150,000 barrels of oil equivalent per day can be achieved, thus offsetting the projected demand growth for energy in the Federal sector.

#### 4.2 National Solar Heating and Cooling RD&D Program

The overall goal of the National Program for Solar Heating and Cooling (as stated in ERDA-23A,<sup>(6)</sup> p.3) is to "stimulate the advancement of an industrial, commercial and professional capability for producing and distributing solar hot water heating and space heating and cooling systems, thus reducing the demand on present fossil fuel supplies through widespread use in heating and cooling of residential buildings."

##### 4.2.1 Structure

The RD&D Program will function as a vehicle of solar heating and cooling information exchange and development between the Government and the private sector. The Program will thus serve as a primary mechanism of industrial, economic, and institutional input into Federal energy plans so that areas in greatest need of RD&D may be established.

The RD&D will advance on three fronts: residential demonstrations, commercial demonstrations, and R&D on basic and advanced concepts in support of the demonstrations.

Several cycles of residential and commercial demonstration will be conducted by the end of FY 1977 in the case of solar heating and by the end of FY 1979 for combined solar heating and cooling systems. The processes of designing, integrating, financing, obtaining permits, building, and marketing the systems will be analyzed in terms of a wide range of site-specific variables, such as climatic conditions, types of housing units, financial institutions, building practices, architectural preferences, local building codes and zoning regulations, housing markets and housing demands, type of community, and fuel costs. The analyses will be fully documented in order to identify the actual problems encountered in bringing solar heating and cooling of buildings into the marketplace. The results obtained from these demonstration projects

will be used to formulate a series of recommendations on changes that are needed in existing procedures and legislation.

Development effort will support the conversion of available technology into systems and subsystems for use either in later cycles of the demonstration programs, or in the private sector of the U.S. economy, following the conclusion of the Federally sponsored demonstrations.

Also, a research and development effort will support innovative and advanced investigations of solar heating and cooling that are essential to accelerated progress in other subprogram elements and the rapid commercialization of the technology. In addition to technical studies, legal, institutional, environmental, and economic incentive questions affecting the utilization of solar heating and cooling will also be addressed.

The overall management and coordination of the National Solar Energy RD&D Program is the responsibility of ERDA. Responsibility for the Demonstration Program, however, is being shared by ERDA with HUD and NASA as outlined in P.L. 93-409 (the Solar Heating and Cooling Demonstration Act of 1974) and P.L. 93-438. Whereas ERDA's RD&D is focused primarily on hardware development, the National Aeronautics and Space Administration (NASA) is providing research, development, laboratory testing, evaluation, and systems-subsystems integration. Commercialization issues are being investigated jointly by ERDA; NASA, HUD, NSF, and FEA.

#### 4.2.2 RD&D and Commercialization

Although the National Plan for Solar Heating and Cooling is an integrated effort, encompassing both RD&D and commercialization, it is important to note the distinction between these two areas of endeavor.

RD&D, which is the primary charge of the National Solar Heating RD&D program under ERDA, focuses on the development of viable solar technologies and the demonstration of solar applications in such a way as to prove their feasibility and to maximize their exposure to the public eye. Economic, legal, and institutional barriers that may block commercialization of solar heating and cooling are being investigated jointly by ERDA, NASA, FEA, NSF, HUD, and other agencies. Accelerated commercialization, the primary focus of FEA's interest, is concerned with the implementation of measures to alleviate the effects of commercialization barriers including those identified in the RD&D program. SEGBP will address one of these barriers, i.e., the lack of a sufficient industry size and infrastructure to permit low-cost production, installation, and reliability of solar heating and cooling systems.

#### 4.3 Industrial Efforts

The success of the National Solar Energy Program depends not only on conducting successful research, development, and demonstration projects but also on the widespread and continuing integration of solar technology into the national economy. This requires the intimate involvement of small as well as large business entities in the execution of the program.

Every Federal effort must be designed in good part to facilitate and encourage private-sector participation. Unnecessary barriers to such participation must be removed. The implementation of the SEGBP will be carried out in consultation with industry as appropriate, and the voluntary performance of industry will be monitored to determine the extent to which it is contributing to the national goals and to identify constraints that can be removed by Federal action.

##### 4.3.1 Standards: Two-Phase Approach

Commercial application of solar heating and cooling, by small or large companies, requires accelerated preparation of performance criteria. Private homes are now being constructed, and others are on the drawing boards, with solar systems. Standards are urgently needed to protect the consumer, including Federal construction agencies, to satisfy mortgage lenders and FHA mortgage insurance requirements, and to satisfy procurement officers.

On April 28, 1975, FEA met with representatives of the American National Standards Institute (ANSI) and the American Society for Testing and Materials (ASTM), among other organizations. The need was addressed to get industry involved in the area of developing standards for solar equipment. A subsequent meeting at FEA on June 16, 1975, with NBS, HUD, ERDA, ANSI, ASTM, ASHRAE, and other Government and non-Government organizations, resulted in a two-phased approach on such standards--"Intermediate Minimum Property Standards" and long-range "consensus" standards.

NBS and HUD have begun to prepare Intermediate Minimum Property Standards for solar hot water and space heating systems. When effective (planned for July 1976), they can be applied to individual system installations so that solar-equipped residences may be covered by FHA mortgage insurance. These standards will be prepared by the Government primarily to meet the needs of Federal programs. The various standards groups will form a close working relationship during this effort so that they can stay informed, offer advice, and integrate the Federal effort into the private sector's longer-range planning.

The Federal effort is no substitute for the "consensus" standards that will be broadly accepted and will require time for negotiations and concurrence among the many sectors involved.

At some point in the standard-setting process, hard decisions will be made that temporarily jell standards, with the knowledge that subsequent improvements may not be immediately recognized and sanctioned. This must not, however, discourage significant innovation, and there is a recognized need for institutionalized quick-response procedures that will serve to update our standards and criteria.

#### 4.4 Interfaces

As stated earlier, SEGBP is a procurement-oriented project. It will be conducted as part of the National Plan for Solar Heating and Cooling, in parallel with the other components of that Plan.

The implementation of Phase II of this Project will be administered, more than likely, by an agency or group of agencies not yet chosen. FEA will focus on overall policy issues relating to commercialization. NSF will work with FEA in analyzing the effectiveness of the program in meeting the commercialization goals as well as assessing the impacts of the program in terms of "Total National Value." ETIP will supply guidance to the agencies involved in the area of "policy experiments" that address the initiation of procurement procedures that are consistent with the goals of the Project.

## 5.0 TECHNOLOGY AND ECONOMICS

The technology for SHACOB (solar heating and cooling of buildings) and solar water heating is relatively well-advanced in the United States. However, it is accepted that the utilization of this technology was not economically competitive with other energy technologies before the advent of the "energy crisis." The situation has changed, with oil and gas shortages, escalating costs of producing electricity, and materials shortages producing cost-push inflation. Since solar energy is diffuse in nature, its availability is periodic and its intensity is basically regional, its usefulness as an energy source is also regionally economical.

5.1 State of the Art in Technology

Over 100 buildings in the United States incorporate solar heating and/or cooling. Over 60,000 residences in the southern regions of the country are or were at one time provided with solar-heated hot water. The availability of inexpensive natural gas and cheap electricity has forced the conversion of many of these hot water systems, built in the 1930s and 1940s. The basis of these early systems was the "Florida collector," a copper sheet welded to serpentine-patterned copper tubes. This absorber was blackened, insulated on the back, and covered with a single glazing of tempered glass. These heaters were usually of the thermal-syphon type, with the water tank (usually made of galvanized iron) placed on the roof above the collector. The copper-iron interface was a source of galvanic corrosion, which placed iron oxides in the water. An "ion brake," or an insulating connector, could have avoided this corrosion if it had been used. However, many of these systems have been in operation nearly 40 years without replacement.<sup>(7)</sup> Research over the intervening decades has brought improvements to flat plate collectors.

5.1.1 Collector Technology

The most common type of absorber of incident solar radiation is the flat-plate collector. It usually contains a metal absorber sheet which has been treated or blackened to maximize absorption. A selective surface may be applied to the absorber which acts like an energy diode; i.e., it maximizes absorption of energy in the visible light spectrum (0.3 to 2.0  $\mu\text{m}$ ) and minimizes re-radiation (emission) in the infrared spectrum ( $>2.0 \mu\text{m}$ ). The collected heat is then transported from the absorber plate by convection, by blowing air under the sheet, circulating water by pumping or thermal syphoning through tubes bonded, welded or integral with the sheet, or by trickling water down the front surface of the sheet. The back of the collector is generally insulated to reduce losses of heat to the surroundings. The front of the sheet is usually "glazed," or covered with glass or plastic in one, two, or three layers. The glazing passes the sunlight through to the absorber, and

acts as a re-radiation, conduction, and convection shield to trap the collected energy within. The collector is usually tilted at an angle which maximizes incident solar radiation. For heating in winter, this angle (with respect to horizontal) is usually about the latitudinal angle plus 10° to 15°; in summer, minus 10° to 15°; for year-round systems, the latitude angle is near optimum. It is usually placed to face due south in the northern hemisphere. Depending on a variety of conditions, modern flat plate collectors have daily average efficiencies of collection of 20 to 40 percent of the incident solar radiation.

#### 5.1.2 Advances in Flat-Plate Technology

Some of the most recent advances in the state of the art have raised collector efficiencies. These include: integral tube-and-sheet design (the roll-bond technique); antireflective glass coatings to dramatically increase the transmissivity of glass; selective surfaces with absorptivity comparable with flat black (i.e. 0.9-0.95) but with emissivities less than 0.2, including black nickel, black chrome, and copper oxide; hermetical sealing compounds (of the silicone type) which enable long life under adverse weather conditions, temperature extremes, and solar ultraviolet radiation; the formulation of various plastic glazings with improved thermal and transmission properties; and the development of anticorrosion inhibitors for use with aluminum absorbers.

Advances have also been made in the areas of convection suppression. Honeycombs and partial vacuums have considerably reduced the amount of upward heat loss caused by convection in the space between the absorber plate and the glazing.

#### 5.1.3 Other Collection Systems

While the technology of flat plate collectors is relatively advanced, the costs of such collectors are high and the efficiencies are still somewhat lower than what may be possible. Also, some uncertainties exist as to the expected lives of collectors. The 20 years or more which seem necessary for reasonable economic viability are believed to be achievable, but this belief must be verified for each type of collector by vigorous testing.

One of the most promising types of alternative collector designs is the glass tubular, evacuated collector. Its efficiency, averaged over the day, approaches 50 percent. It is made entirely of glass; and thus, may be manufactured more cheaply than metal collectors. Since the glass has a low iron content, its transmission properties are excellent. The evacuated space between the absorber tube and outer tube eliminates convection losses and provides long life to the selective surface on the absorber. Its design is modular, easy to install, and easily maintained. It can be designed to accommodate air or water as a heat transfer fluid.

Its losses are so low that operation with air could produce 40 percent average daily efficiencies with a constant outlet temperature in excess of 200°F, compatible with absorption air conditioning systems.

Another alternative is the focusing collector. These are of three basic types, parabolic trough, parabolic dish, and hemispherical dish. These must track the sun through the sky, and thus require tracking systems and sometimes servomechanisms. They generally provide higher temperatures of collection than flat plate collectors, but with comparable efficiencies of collection. The parabolic trough and dish types generally require a tracking absorber, but in some commercial designs, a tracking target is used. The hemispherical dish type often has a tracking target and a fixed absorber. Temperatures of collection can reach more than 1000°F in a "solar furnace," but commercial building HVAC system designs would generally operate with input temperatures below 250°F. The collection temperature depends primarily on the concentration ratio, the relative area of the absorber to the target. Because HVAC systems require relatively low operating temperatures, either a flat plate, tubular, or parabolic trough collector with a small concentration ratio might be appropriate.

#### 5.1.4 Heating and Cooling Technology

Solar heating and cooling system technology involves the use of a collector, a circulating loop, a storage system, a refrigerating unit, and one or more heat exchangers to reject heat and/or transfer it to the conditioned air space or hot water system. Heat exchangers include furnace forced-air heating coils or A-frames, heating coils for hot water tanks, and cooling tower coils for air-conditioner systems. These heat exchangers are generally off-the-shelf designs which are available throughout the HVAC industry. Storage systems include hot water storage in insulated metal, fiberglass, or plastic tanks; rock bed storage; or storage within the latent heat of fusion in eutectic salts. There are problems with each storage technique--weight, volume, cost, corrosion, expansion, and decomposition are some of these problems.

Air conditioning systems, at present, represent perhaps the least advanced of all SHACOB technologies. The main candidates for use in buildings are the absorption air conditioner (developed for use with natural gas); the Rankine cycle/Stirling cycle mechanical systems; and the adsorption-type air conditioning systems. Absorption systems, such as LiBr-H<sub>2</sub>O and H<sub>2</sub>O-NH<sub>3</sub> systems, have few moving parts but generally have problems with non-condensable gas buildup, high inlet temperature requirements, low COP (coefficient of performance) and high initial costs. The Rankine cycle engine (driving a heat pump) has the advantage of high COP (relative to electrical demand) and low inlet temperature requirements, but is generally, at present, unreliable, short-lived, and costly to operate and maintain. Stirling cycle engines have not been

commercialized, but may show promise. Adsorption cooling systems have not as yet been commercialized, but have been laboratory tested by the gas industry. They also require high inlet temperatures and may require replacement of the adsorber medium at regular intervals. The number of adsorption-desorption cycles is limited by temperature cycling, decomposition, and fouling by particulates in the circulated air. Thus, the ultimate answers are not clear, but the opportunities for technical breakthroughs to lower costs, increased reliability and maintainability, and improved performance are evidently within our technological grasp.

#### 5.1.5 Present Size of the Industry

In a recent survey conducted by the FEA Office of Data, it was determined that the number of firms presently producing and selling medium temperature solar collectors (160°F to 210°F) numbered 69. The quantity of collectors manufactured and sold increased from 136,000 sq. ft. in 1974 to 276,000 sq. ft. for the first six months of 1975. The number of manufacturers which produced and sold over 10,000 sq. ft. increased from one in 1974 to 15 during the first half of 1975.

ERDA has published a catalog which presents the responses received to a Request for Information issued in June 1975. This catalog lists 28 manufacturers of solar collectors with air as a heat transfer fluid and 91 manufacturers of solar collectors with liquid as a heat transfer fluid. In total, 444 solar related products including collectors, heat exchangers, cooling units, controls, collector components, and complete systems are listed.

### 5.2 Projected Economics

#### 5.2.1 General

A number of studies have been performed to support estimates of the economic viability and potential market penetration of SHACOB systems. Several of these studies are being analyzed to determine their usefulness in guiding SEGBP. One such study, cited here in illustration, is a parametric study of the cost-effectiveness of the installation of SHACOB systems recently performed at The MITRE Corporation.<sup>(8)</sup> Specific analysis was conducted for each of ten cities representing the various climatic regions of the conterminous United States. Residential and commercial buildings, which together consume about 90 percent of all energy utilized for space heating, water heating and space cooling, were analyzed<sup>(9)</sup>. One of the major goals of the Solar Energy Government Buildings Project is to diminish economic barriers to the widespread utilization of solar energy for heating and cooling. Therefore this study, having been conducted in the framework of projected reduced collector costs, is of interest.

Although the study takes into account a very large number of considerations and variables, further refinements of or changes to the model structure, or use of different values for certain parameters could conceivably lead to different conclusions. Therefore, the conclusions presented here should be interpreted within the framework of the ground rules, data and assumption employed.

#### 5.2.2 MITRE Study Ground Rules and Data

The following are the basic ground rules and input data utilized for the MITRE study:

(1) The conterminous United States is divided into eight climatic regions as shown in Figure 5-1, and analysis is conducted for the following ten cities:

No.	City	Climatic Region
1	Boston, Mass.	Northeast
2	Washington, D.C.	Southeast
3	Charleston, S.C.	Southeast
4	Miami, Florida	South Florida
5	Bismarck, N.D.	North Central
6	Madison, Wisconsin	North Central
7	Fort Worth, Texas	South Central
8	Grand Junction, Colo.	Mountain
9	Seattle, Washington	Pacific Northwest
10	Los Angeles, Calif.	Pacific Southwest

(2) For each of the ten cities, the following four types of buildings are considered:

Single family dwelling  
 Multi-family low rise apartment building  
 Low rise office building  
 Retail store

(3) The major heating and cooling systems analyzed for each building type in each city are:

(a) Solar Heating and Cooling (SH&C) - defined as consisting of a solar collector unit for heating a water storage system and utilizing heat exchangers for water heating and space heating and hot water for the absorption cooling system. Electric resistance heating is assumed as the backup energy source for all three applications. This system offers solar water and space heating and space cooling.



FIGURE 5-1  
REGIONS AND REPRESENTATIVE CITIES

(b) Solar with Heat Pump (SH&HPC) - consisting of a solar collector and heat exchanger system for space and water heating and a heat pump for space cooling and auxiliary heating. Additional heating, if required, is provided by an electric furnace. This system offers solar water and space heating.

(c) Solar Heat with Vapor Compression Cooling (SH&VCC) - consisting of a solar water and space heating system as in (b) and an electric vapor compression cooling system.

(d) Conventional Electric (EH&C) - assumed to consist of an electric hot water heater, an electric furnace for space heating, and an electric vapor compression air conditioner.

(e) Heat Pump (HPH&C) - Assumed consisting of an electric vapor compression heat pump for space heating and cooling and an electric hot water heater. Auxiliary heating is assumed to be provided by an electric furnace.

If system (a) is found cost-effective, it is concluded that solar heating and cooling is cost-effective, while if system (b) or (c) is found economic then it may be stated that only solar heating is cost-effective.

(4) For the solar system options, tubular glass solar collectors, with an output efficiency of 0.45 and installed with a tilt at the angle of latitude are assumed. The optimum size of the collector within the constraints of the roof area is computed for each case.

(5) In all cases, an equipment life cycle of 20 years is assumed.

(6) A projected solar collector cost in 1990 of \$4.50 (installed, 1975 dollars) is used throughout the analysis.

The additional cost of the storage, controls, and other auxiliaries for the solar system are taken from a Stanford Research Institute study<sup>(9)</sup> while the differential costs of the heat pump and absorption air conditioner are taken from a General Electric study.<sup>(10)</sup>

(7) Of the four types of buildings, single family dwellings are assumed to be owned by the occupant while the other three are assumed to be operated commercially. Thus, for the single family dwellings, capital expenditure incurred for installing the heating and cooling system is considered part of the mortgage and a tax deduction at a tax rate of 25 percent is computed.

For the other three building types, the capital costs of the heating and cooling systems are depreciated on a straight line basis, savings

in energy costs are adjusted downward by 50 percent to reflect the corporation tax rate, and a return on investment criteria is used for determining cost-effectiveness.

(8) The costs of electricity used for computation of savings is the marginal rate at which the savings are expected to accrue rather than the base rate for the initial consumption levels. These marginal rates are shown in Table 5-1 along with the results.

(9) An annual inflation rate of 3-1/2 percent for increase in price of electricity is assumed.

(10) A home mortgage interest rate of 8-1/4 percent for purchase of solar equipment is assumed.

#### 5.2.3 MITRE Study Results

Selected results to highlight the major conclusions are presented below.

Table 5-1 gives the results for a single family dwelling for two separate sets of economic comparisons:

- (1) Solar heating and solar absorption cooling (SH&C) vs. conventional total electric heating and cooling (EH&C),
- (2) Solar heating with electric vapor compression cooling (SH&VCC) vs. conventional electric heating and cooling (EH&C).

The table projects substantial annualized cost savings for a solar heating and cooling system over conventional total electric systems for seven out of the ten cities. In Fort Worth, Texas, and Seattle, Washington, the two systems are projected to be competitive while a conventional total electric system is more economical in Miami, Florida.

Substantial annualized savings are also projected for a solar heating and electric vapor compression cooling system over a conventional electric heating and cooling system in eight cities, while in two cities the savings are minimal.

Similar analysis conducted for the other three types of buildings (not presented here in detail) showed a substantial cost advantage (though not as great as for single family dwellings) of solar heating systems over conventional total electric systems.

A separate analysis (not detailed here) comparing a solar heating system with a heat pump cooling system with a total electric heat pump system indicated that the solar system was more economic for single and

TABLE V-1  
ANNUALIZED COST COMPARISONS OF SOLAR VS. ELECTRIC  
HEATING AND COOLING SYSTEMS FOR SINGLE FAMILY DWELLINGS

NO.	CITY	APPROPRIATE ELECTRICITY	ANNUALIZED SAVINGS OVER TOTAL ELECTRIC HEATING AND COOLING SYSTEMS (EH&C)		SOLAR HEATING AND VAPOR COMPRESSION COOLING
			RATE ¢/kWh	SOLAR HEATING AND COOLING	
1	Boston Mass.		3.05	\$581	\$545
2	Washington, D.C.		2.83	545	415
3	Madison, Wis.		2.10	378	385
4	Bismarck, N.D.		1.76	357	369
5	Charleston, S.C.		2.74	217	201
6	Miami, Fla.		3.23	- 268	69
7	Ft. Worth, Texas		1.44	- 14	29
8	Los Angeles, Calif.		2.43	193	147
9	Seattle, Wash.		0.92	0	30
10	Grand Junction, Colo.		2.10	423	403

multi-family dwellings while the heat pump was cost-effective for low rise commercial buildings and retail malls.

MITRE estimates based on data in the General Electric study (10) show that residential buildings account for about 56 percent of the total volume of all residential and commercial buildings. Moreover, not all commercial buildings are heated or cooled for the entire 24-hour duration every day.

Thus, it may be concluded that with a projected solar collector cost of \$4.50 per square foot, solar heating will be substantially more cost-effective than conventional electric or heat pump heating systems in nearly all the ten cities analyzed. Further analysis is needed to relate these locations to the entire country to arrive at valid national projections.

### 5.3 Government Procurement Methods

In this section the traditional procurement methods used in the government are compared with more appropriate ones for use in SEGBP. The section also describes the Experimental Technology Improvement Program (ETIP) briefly because it is somewhat relevant to the procurement of solar systems for SEGBP.

#### 5.3.1 Lowest Purchase Price vs. Lowest Life-Cycle Costs

The Federal government traditionally procures products for its use on a lowest purchase price basis. While such a method of procurement provides an incentive for achieving lower production costs, it has other drawbacks. It does not adequately focus industry's attention on operations and maintenance aspects of a product nor does it expressly reward any innovative efforts directed towards longer, more efficient, and reliable performance of a product.

An alternative cost criterion for procurement of a product is life cycle costing (LCC). The concept of life-cycle costing is essential to the evaluation of solar technology, which is characterized by higher first costs than conventional equipment but higher costs which may be offset by zero fuel costs.

A sophisticated life-cycle cost analysis would have to take a large number of factors into consideration (e.g., discount rate, general rate of inflation, specific rate of cost increases for alternative fuels, tax considerations where applicable etc.) Each of these factors, in turn, leave various components. A factor such as discount rate may be assumed (i.e., OMB's assumed discount rate of 10 percent) or may be derived from other factors in a given case and used as a criteria for evaluation.

With a methodology for conducting LCC defined, a need will still exist for specifying values that may be assumed in all analyses. These guidelines will have to include, at the least projected competitive fuel costs, life expectancy of equipment capital and maintenance costs, discount rates, inflation rates, and tax rates. Depending on the methodology chosen, this list may grow significantly larger. Further, annual updates of these guidelines would probably be required.

Although the LCC method utilizes projections and estimates that are not firm figures in an accounting sense, it is still a more appropriate method and encourages improvements in a product as well as its production methods and is thus preferable.

A number of benefits accrue to the nation by substituting solar energy for other energy sources. It is a domestic source of energy and contributes to the balance of trade surplus. In its utilization, there are no direct pollutant emissions. (This is not true in a total energy sense since energy and power from polluting sources may be required in the manufacture of solar systems.) There is also the potential of exporting solar systems if an efficient industry for manufacture of solar systems is developed in the United States.

These hard-to-quantify and somewhat indirect, but very important, benefits are sometimes aggregated into the concept of "Total National Value." In the final version of this Plan, a careful definition of this concept will be presented.

It is not possible to account for these national level considerations in a LCC analysis conducted on a building-by-building basis. It does, however, appear important to take the first steps toward eventual widespread use of solar heating and cooling (and reduced oil imports) even if the economics do not overwhelmingly dictate their use. Perhaps an overall value-based adjustment should be used in deciding whether or not a slightly uneconomic solar system should be installed.

#### 5.3.2 Experimental Technology Incentives Program (ETIP)

The objective of this program is to find ways to stimulate civilian R&D and the application of R&D results so as to improve productivity in government and industry.

The program strategy is to design and conduct policy experiments in close cooperation with the relevant agencies. The main areas of activity of ETIP are in governmental procurement, governmental regulation, civilian R&D, small business problems and Federal financial assistance programs.

Most of the above areas relate to one or more facets of the overall task of substantive solar energy utilization in the United States. Of

immediate interest to the SEGBP is the ETIP involvement in policy experiments relating to the procurement of Federal buildings and finished goods for all levels of governments. ETIP is presently working with GSA in the design and conduct of experimental procurements of air conditioners and hot water heaters, among other products. Each experiment lasts three years so as to give suppliers sufficient lead times to plan significant innovations. ETIP and GSA are using life-cycle costing and value incentive clauses in the above procurements.

FEA is cooperating with ETIP in its development of procurement arrangements for solar energy equipment.

## 6.0 IMPLEMENTATION PLAN

In order to achieve the goals stated above, an aggressive Project must be initiated which will take into account the requirements of legislation (including some pending legislation if adopted), the potential size of the government buildings market (new and retrofit), procedures for performing life-cycle cost analyses, innovative methods of procurement to promote the utilization of new technologies, and the size and structure requirements for the solar industry in order to meet cost and reliability objectives.

This section discusses a proposed methodology for treating these issues and subsequently achieving the goal of sufficiently stimulating the development of a solar energy industry such that the total consumption of energy for residential and commercial space conditioning will be significantly reduced.

6.1 Strategy

The strategy of the SEGBP is to provide an interim market for solar energy devices through the use of government buildings applications. The formation of this interim market should be appropriately time phased in order to:

- Allow for the parallel development of manufacturing capability, distribution networks, installation expertise, integration with the existing HVAC and construction industries, and experience in servicing;
- Encourage an evenly graduated increase in market demand, suitably distributed over the various regions of the country.

The early tasks of the project will focus on the development of quantitative goals in terms of market size/production capability and the resultant system costs. At the same time, LCC procedures and available solar systems having been disseminated to the participating agencies, LCC analyses will begin. Integrating the preliminary results of the LCC analyses and production capability goals, a procurement schedule will be formulated. Large-scale time-phased procurement commitments will be made as early as possible, thus allowing the industrial segment to schedule the development of its production capability. At this point, procurement strategies which will promote maximum agency participation within the government and industrial initiative in terms of seeking out non-government markets will be finalized.

In terms of emphasis placed on specific solar applications, the immediate focus (1977-78) will be on solar hot water heaters. This is advantageous because (1) the technology is ready for commercialization

now, and (2) application will entail a large number of installations rather than a large volume of collectors. This situation will give the project an initial thrust into an area where success is relatively certain. Emphasis on number of installations over volume of collectors will help create the required distribution networks and installation and service expertise that will be needed to handle the greater volume of collectors in the later phases of the project.

As solar heating technology becomes more reliable, heating applications will begin (1978-79). At first, it is expected that solar heating components will be applied to DOD installations or other applications where operations can be closely controlled and monitored until their viability is certain. At this juncture, applications will be sought which will maximize public exposure; i.e., post offices, National Park Service buildings, etc. Applications such as these, again, will not at the beginning require great volumes of collectors but, rather, will afford the opportunity for a large number of installations. Toward the end of this period, larger volume applications, particularly within DOD, will be sought.

Solar cooling and dehumidification are the least advanced of the solar space conditioning technologies, thus, results of RD&D efforts will be critical in determining the direction of this phase of the project. Because of this, major emphasis will not begin in these areas until the 1979-81 time period. Initial applications will be sought in controlled situations. Because these technologies require, in general, larger installations, this phasing is compatible with the general scheme of promoting larger volumes of collector procurement in the later phases of the project.

#### 6.2 Implementation Tasks

In order to carry out the strategy discussed above, a number of tasks are proposed, including:

- (1) Quantitative Goal Development
- (2) Assessment Procedure Development
- (3) Management and Funding Definition
- (4) Information Dissemination
- (5) Execution of Assessments
- (6) Definition of Minimum SEGBP Purchase Generation Requirements
- (7) Development of Procurement Strategies.

These tasks, their functional relationships, their subtasks (in ovals) and their results (in diamonds) are depicted in Figure 6-1.

#### 6.2.1 Quantitative Goal Development

The Quantitative Goal Development task will essentially focus on defining the required size and makeup of the solar industry given certain collector cost goals.

Various recent studies have generated data which could be synthesized to develop "break-even" costs for collectors in various regions of the country. An analysis of cost decreases brought on by increases of production will identify the cumulative production capability of industry required to achieve these "break-even" costs. The regional applicability of solar systems as outlined in these studies may also be used to define the regional emphasis of this project.

The size stratification of the industry should also be analyzed in this task. On the one hand, specific manufacturers should be of adequate size to realize the benefits of volume production. On the other hand, Federal support should be equitably distributed between large and small businesses. Smaller regional markets may warrant smaller regional production capabilities. In these cases, the higher production costs resulting from lower economies of scale may be offset by lower distribution costs. In either case, antitrust considerations should be analyzed.

The results of this subtask will be a definition of the size and structure requirements for the solar energy industry. Minimum production size requirements will also need to be determined in order to identify the extent of government commitments required to support each individual producer. Given the degree to which a particular producer is automated, a level of production depending on economic optimization and physical limitations (in terms of primary materials flow, machinery, labor, etc.) will need to be identified. Various levels of automation should result in a step function relating production costs to production capacity. These step functions should also take into consideration various levels of vertical (primary, secondary, and finished product flow) integration and horizontal (distribution, installation, and service) integration. Cumulative production capability milestones should also be specified along with their resultant systems costs. The latter output will be of use in justifying the use of projected component costs ("should costs") rather than current actual component costs in the LCC analyses.

#### 6.2.2 Assessment Procedure Development

There are four subtasks involved in developing the assessment procedure:

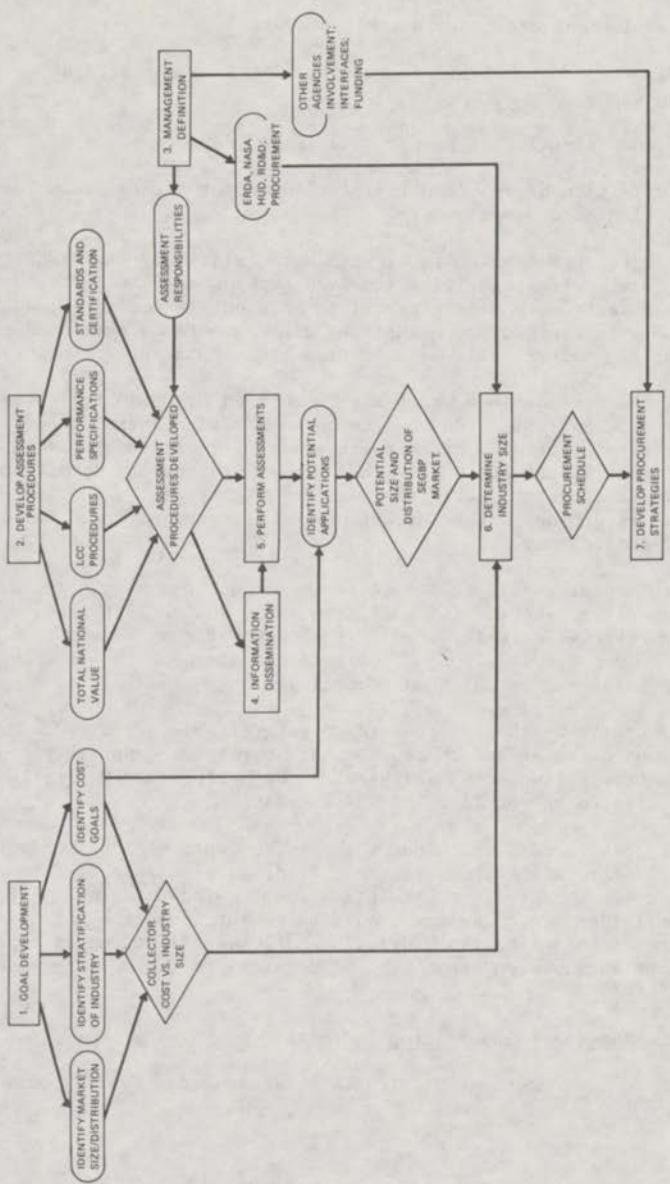


FIGURE 6-1  
SEGBP IMPLEMENTATION

- (1) Development of standard LCC procedures
- (2) Development and justification of "Total National Value" concepts
- (3) Standardization of performance specifications
- (4) Definition of required legislation and/or agency executive action to do assessments.

Although LCC procedures are, in general, relatively straightforward, there are several specifics involved here which complicate the situation. Because some diversity exists between agencies in accounting and cost analysis procedures, guidelines will have to be developed to assure that the analyses will be performed by a standard methodology.

Beyond the cost savings which may be accrued by basing procurement decisions on LCC analyses, the government should also extend its evaluation to the total costs and benefits that may be realized by the Nation. In light of this "Total National Value," solar heating and cooling may be perceived as a system providing a variety of material needs in terms of pollution reduction, export market potential, and increased national energy self-sufficiency.

A macroeconomic analysis should be conducted to evaluate and quantify the impact of establishing a solar heating and cooling industry with regard to these material needs. The macro-effects should then be normalized to a per square foot of collector basis, and the life-cycle cost of the solar system adjusted accordingly.

It is imperative that a standard set of reliable performance specifications of solar components be made available to participating agencies so that reliable LCC analyses may be performed. Manufacturers' claims may have to be verified by ERDA and NASA.

Finally, the conditions under which assessments must be conducted should be clearly defined. Current proposed legislation should be responsive to the physical constraints of performing assessments of existing buildings. A consensus should be sought among the participating agencies to define those existing buildings (in terms of size and/or energy consumption) that will be required to undergo the assessment.

#### 6.2.3 Management and Funding Definition

There are four subtasks within the Management and Funding Definition task:

- (1) Define the responsibilities of participating agencies
- (2) Define strategies that will encourage agency participation
- (3) Define funding authorization framework
- (4) Define project management arrangements.

It is necessary to delineate the specific roles and responsibilities of the various agencies involved in this program to facilitate its effective and efficient management.

The primary concern of FEA is that SEGBP be directed toward the overall goal of the rapid commercialization of solar equipment. This is ensured by large purchases of solar equipment and installation of such equipment; the former encourages uses of large volume production techniques while the latter helps establish an infrastructure of installation and servicing industries capability. FEA, therefore, will only monitor the Project from an overall policy and goals standpoint.

The primary responsibility for the operational aspects of the Project will be assigned to appropriate agencies, perhaps to the Department of Defense and the General Services Administration. Since these agencies own a large fraction of the buildings under consideration, they could be responsible for the on going day-to-day management of the project. USPS and VA could have responsibility procuring and installing solar equipment for their own buildings.

ERDA will be the main agency providing technical support to the Project. Such support will cover all phases of the Project, ranging from preparation of functional specifications of the equipment to be procured to the continuing and final evaluation of the program. NASA and NBS will provide technical assistance to ERDA on an as-needed basis in ensuring the technical integrity of the program.

At present, ETIP has been conducting policy experiments in order to find ways to stimulate desirable technological change so as to improve productivity in government and industry. ETIP, in close cooperation with the participating agencies, helps design policy experiments, and, when appropriate, it provides funds to cover the extraordinary costs associated with conducting the experiments. In return, ETIP requests its agency partners to make a serious high-level commitment to the conduct of the experiments, and contribute their own resources and staff. In this manner, actual experience with policy change is obtained, which is intrinsically better than speculation about hypothetical change; those who would implement subsequent formal policy change are gaining firsthand knowledge of the change, which should expedite the

transition; given the proposed change is worthwhile, those people occupying decision points are well informed as to the efficacy of this proposition. SEGBP, with ETIP, should work towards developing such a strategy to be applied in expediting the transition to solar heating and cooling in government buildings.

A funding authorization framework will have to be developed which will allow for the guarantee of a substantial market but still offers effective management control.

The task force developing FEMP considered two alternative funding methods, (1) "fenced" funding analogous to that used in EPA pollution abatement and (2) single agency funding. The "fenced" funding concept provides reasonably effective management control and a high level of agency accountability, and there is a precedent for such an approach. Preliminary discussions indicate that DOD would prefer to operate in this manner. However, in the case of FEMP, it was concluded that it would be difficult to define exactly what should or should not be included. This situation also exists, to some extent, with solar applications. It was felt by the task force that agency inputs are likely to be affected by a perception that funds used for energy conservation are obtained at the expense of mission funds and that the multiplicity of administrative and Congressional reviewers would result in very uneven treatment. For these reasons, single agency funding was recommended for FEMP.

One alternative would be to fund the participating agency:

- (1) For the conduct of the assessment (up to 0.1 percent of the total project cost);
- (2) Where the solar alternative is the most cost effective on a LCC basis, fund the agency at a level which would cover the incremental cost of the solar system on an initial cost basis.

This second part of the proposition could have numerous alternatives. The LCC analyses could be performed with current collector capital costs. If the analysis shows that the system is not cost-effective using current collector costs, "should costs" might be used. In this manner, funding can be obligated for future years on the basis of expected costs. Similar adjustments may be performed with regard to projected alternative fuel costs. Thus, different levels of feasibility would be identified on a temporal basis and funding could be phased accordingly.

#### 6.2.4 Information Dissemination

Information concerning available solar systems, systems performance, and LCC and building performance assessment procedures will have to be

made available to key persons in participating agencies. The present series of Federal Workshops on Building Science and Technology being conducting by the NBS Center for Building Technology, Institute for Applied Technology has offered an excellent forum for representatives of government agencies to discuss a broad range of topic related to building design and construction. One of these workshops highlighted Solar Heating and Cooling Demonstrations within the government. Such efforts should be expanded for SEGBP.

In addition to the workshops, a procedural manual and catalog of performance specifications should be developed and updated regularly. GSA has published three handbooks concerning the design of energy conservation features within Federal buildings. Over 5,000 copies of the first handbook, "Energy Conservation Design Guidelines for Federal Office Buildings" (March 1974) have been distributed to members of the construction industry. The second handbook, "Energy Conservation Guidelines for Existing Office Buildings" (June 1975), addressed the issue of renovating existing buildings for energy conservation purposes. The third handbook (December 1975) discusses conservation guidelines in building operations. Handbooks similar to these, emphasizing LCC procedures, should be developed for SEGBP, as well as FEMP.

#### 6.2.5 Assessments

Assessments will have to be carried out on a case-by-case basis. Because of the potential cost in time and manpower involved in assessing the Government's  $2.7 \times 10^9$  square feet of building space, it would be desirable to develop a quick and inexpensive method of doing the assessments both in the case of retrofit and new construction.

Three categories of buildings should be considered for assessment: existing, planned, and proposed. It is hoped that the current managers of existing buildings will carry out the assessments of these structures. Planned buildings, those for which detailed plans have already been drawn, similarly should be assessed by their prospective managers. Projected buildings, those for which a projected need exists and are in the conceptual design stage but have not, as yet, reached the detailed design stage, may require a specialized contractor (under contract to FEA or the prospective manager) to execute the assessment.

#### 6.2.6 Minimum SEGBP Purchase Generation Scheme

This task should, essentially, synthesize the results of all the previous tasks. It should result in a procurement schedule which represents an evenly graduated increase in market demand, suitably distributed over the various regions of the country.

#### 6.2.7 Procurement Strategies

The procurement strategies should be designed with two objectives in mind:

- (1) Simplicity: Potential solar energy component manufacturers and vendors should not be subjected to excessive "red tape."
- (2) Agency and Industrial Initiative: Participating industries should be encouraged to commit as much of their own resources as possible; industries should be encouraged to seek out non-government markets.

In order to achieve the first objective, potential vendors should only have to deal with a single agency in each given application.

The second objective in terms of the government agencies, may be approached by evaluating agencies' proposals on the basis of the amount of cost-sharing they are willing to undertake with SEGBP in each particular application. Industrial initiative may be promoted by requiring manufacturers to seek commercial outlets for their components (e.g., for every three square feet of collector sold to the government, the manufacturer must sell one square foot to the public sector).

The question of large vs. small manufacturers must also be addressed here. It has been found that the minimum size for an automated flat-plate collector production line is one million square feet per year (two 8-hour shifts at 500,000 square feet per shift). Procurement, especially from new manufacturers, should be sensitive to this limitation.

APPENDIX A

ACTIVITIES IN THE AGENCIES/DEPARTMENTS

## APPENDIX A

ACTIVITIES IN THE AGENCIES/DEPARTMENTS

Department of Defense has over 400,000 buildings including 2.1 billion square feet. Some of DoD solar energy and conservation related activities are:

(1) Energy Conservation Investment Program - designed to make existing buildings less energy intensive through a proposed \$1.35 billion six-year retrofit program. Of this, \$138 million is represented for FY 1976. Average amortization of these FY 1976 projects is about four years.

(2) DOD is installing 50 solar heating units in DOD residences at some 11 Army, Navy, and Air Force installations and also is installing a solar heating and cooling system on a new administration and classroom building in Fort Hood, Texas.

(3) DOD is investigating the possibility of heating domestic hot water for two dispensaries and nine BOQ/BEQs.

United States Postal Service has 33,000 facilities aggregating over 185 million square feet.

USPS has two solar utilization projects:

(1) U.S. Post Office in Ridley Park, Pa., of about 6500 square feet. The solar system will assist a conventional boiler and air conditioning system. This experiment will explore economic and practical aspects the solar system and the operations and maintenance costs will be measured for two years.

(2) The Main Post Office in Boulder, Colorado, will be retrofitted with a supplemental solar system for heating and cooling. This is a joint ERDA-USPS project.

General Services Administration is responsible for 10,000 federally owned or leased buildings with 250 million square feet of space. Since 85 percent of these buildings will still be in operation in 2000 AD, retrofit or modification to conserve energy is most desirable.

(1) GSA published a series of three handbooks dealing with energy conservation in existing and new office buildings.

(2) GSA reduced energy consumption by approximately 30 percent over two years. There is a potential for a further 10 percent reduction by making prudent investments.

(3) In two demonstration projects in Manchester, N.H. and Saginaw, Mich., 8000 and 4600 square feet collectors will be used.

National Park Service. The Visitor Center, Bighorn Canyon National Recreational Area near Lovell, Wyo., will have a 2500 square feet of glass-covered solar panels. There will be a rock heat storage system in the building for heating and cooling.

APPENDIX B

AGENCY COMMENTS ON

JANUARY 22 DRAFT

APPENDIX B  
AGENCY COMMENTS

A draft of this document, dated January 22, 1976, was extensively circulated for review among a number of Federal agencies. Many of the comments and suggestions received as a result of this review have been incorporated in the present draft. Other comments are listed below, to be considered for incorporation in subsequent drafts.

Timeliness of SEGBP

The question was forcibly raised as to whether SHACOB (with the exception of hot-water supply) is ready to be introduced into the normal operation of Federal building activities without the close supervision and tentative approach implied in an RD&D program. If the answer to this question is negative, it would be more appropriate to consider the activities covered in this Plan as extensions of the ERDA RD&D program than as a somewhat separate SEGBP.

Emphasis on Industry

Since the primary purpose of SEGBP is to stimulate the development of a solar industry rather than to save conventional energy consumption in Federal buildings, it was suggested that this emphasis be made more clear through the organization and content of the Plan.

Coordination with Other Programs

Several comments emphasized the necessity of close coordination with other Federal programs, such as the ERDA Solar Energy RD&D program and the Federal Energy Management Program (FEMP), expressing a judgment that the first draft did not adequately stress this requirement. In particular, it was pointed out that a substantial network of assessment and reporting, required for FEMP should be used for SEGBP. On the other hand, some reviewers suggested the inclusion of such activities as instrumentation and data collection in SEGBP which are extensively included in the RD&D program and whose inclusion here might be considered redundant. Both types of comment emphasize the need for coordination between programs and for overall system optimization.

Funding

Many comments emphasized the need for additional funding to any agency which is given substantial additional responsibility under SEGBP. This is recognized as a critical policy question facing project implementation.

Regionalization

Comments stated that SHACOB is site-specific in its technical effectiveness and economic viability. This makes regional considerations important, and recommends the inclusion of FEA Regional Offices as important participants in SEGBP.

Economic Viability of SHACOB

Several reviewers raised the question as to whether SHACOB would ever be economically viable at a sufficient level to support an industry, and consequently whether SEGBP is justified. Some thought the presentation suffered from over-optimism. Even if SHACOB is likely to become economically viable, the Plan should not overestimate SEGBP's effectiveness in reducing costs. In addition, several questioned the specific estimates of cost reductions, payback periods and their impacts on marketability. It was pointed out that cost reductions might be expected in solar collectors, but not in the components of solar systems which are essentially conventional.

Life-Cycle Costing (LCC)

A number of specific criticisms and caveats were expressed with regard to the adoption of LCC. It was recommended that LCC parameter values be determined by Phase II surveys, not during Phase I (Plan Development). The uncertainties of such parameter values as lifetimes for essentially untried systems were remarked on. The need for explicit "cookbook" guidelines for LCC analysis was stated. The building-by-building nature of LCC was noted, as was the requirement for LCC to cover the combination of solar and conventional systems used in each case. It was pointed out that the draft's discussion of LCC assumed that system reliability could be predicted confidently at the time of analysis.

Two Levels of Life-Cycle Costing

Life-cycle costing methodology will be used in two ways in SEGBP. It will guide the assessment of SEGBP impacts at the regional and national levels, being applied to aggregated categories of buildings. It will also be applied on a building-by-building basis with full consideration of the specific detailed characteristics of each building, location and operating agency, in order to determine for which buildings solar equipment is in fact cost beneficial on an LCC basis.

"Should Costs"

The use of "should costs" in LCC computations introduces the possibility of subsidizing systems which may never be economic. If "should costs" are to be used, great care must be taken to avoid this effect.

Certification and Testing

Reviewers stated the need for certification and testing by approved private-sector facilities, and recommended that such certification be made a requirement for system procurement under SEGBP.

Inclusion of Other Buildings

It was recommended that consideration be given to including such Federally-assisted buildings as schools, colleges, hospitals, and HUD-supported low and moderate income housing; also that the project be designed and implemented in such a way as to encourage emulation by state, city and county governments. It was pointed out that the FEA regional offices could participate in this last activity.

Utility Interface Problems

It was pointed out that reducing the total load on public utilities by such programs as FEMP and SEGBP, while counting on the utilities for back-up energy poses serious problems for the utilities.

Stimulating Innovation

Although this was mentioned in the draft as a possible problem some felt that its importance was understated. Acceptance by the Federal Government could imply approval of inadequate designs, result in publicizing poor performance and consequently damage public acceptance, and stultify R&D to improve systems. SEGBP should encourage continued innovation and improvement of systems.

Conservation and SHACOB

It was stated that energy conservation must be implemented before or in conjunction with SHACOB. Solar systems should not be installed on buildings which are not energy efficient. The design of a solar system and the assessment of its costs and benefits depend essentially on the basic energy efficiency of the building.

Federal vs. Public Markets

The distinction between the direct impact of the Federal buildings included in SEGBP on the solar industry and the much greater impact of the general public use of solar energy which could be facilitated by the initial market stimulation of SEGBP should be made clearer in the Plan.

A number of detailed suggestions for improving the text were submitted, many of which can easily be incorporated in subsequent drafts. Specific technical scientific and engineering problems were raised, which will be considered in the appropriate context.

## REFERENCES

1. Associated Universities, Inc., Energy Systems and Resource Data for Use in the Assessment of Energy Technologies, Upton, New York, April 1972.
2. Office of Assistant Secretary of Defense for Installations and Logistics, statement before U.S. House of Representatives Committee on Public Works and Transportation, October 29, 1975.
3. U.S. Army Corps of Engineers Research Laboratory, Preliminary Estimates, Champlain, Illinois.
4. Arthur D. Little, Inc., "Project Independence Evaluation System Update, Preliminary Findings."
5. Federal Energy Administration, Federal Energy Management Program, Multi-Year Action Plan, September 1975.
6. Energy Research and Development Administration, ERDA-23A.
7. National Science Foundation, "Demand Analysis Solar Heating and Cooling of Buildings, Phase I Report, Solar Water Heating in South Florida: 1923-1975," NSG-RA-N-74-190.
8. The MITRE Corporation, "Cost-Effectiveness of Solar Heating and Cooling of Buildings," Arnold Cohen, MTR-7048, October 1975.
9. Stanford Research Institute, "Patterns of Energy Consumption in the United States," January 1972.
10. General Electric, "Solar Heating and Cooling of Buildings - Phase 0, Feasibility and Planning Study," NSF-RA-N-74-021.

---

---

---

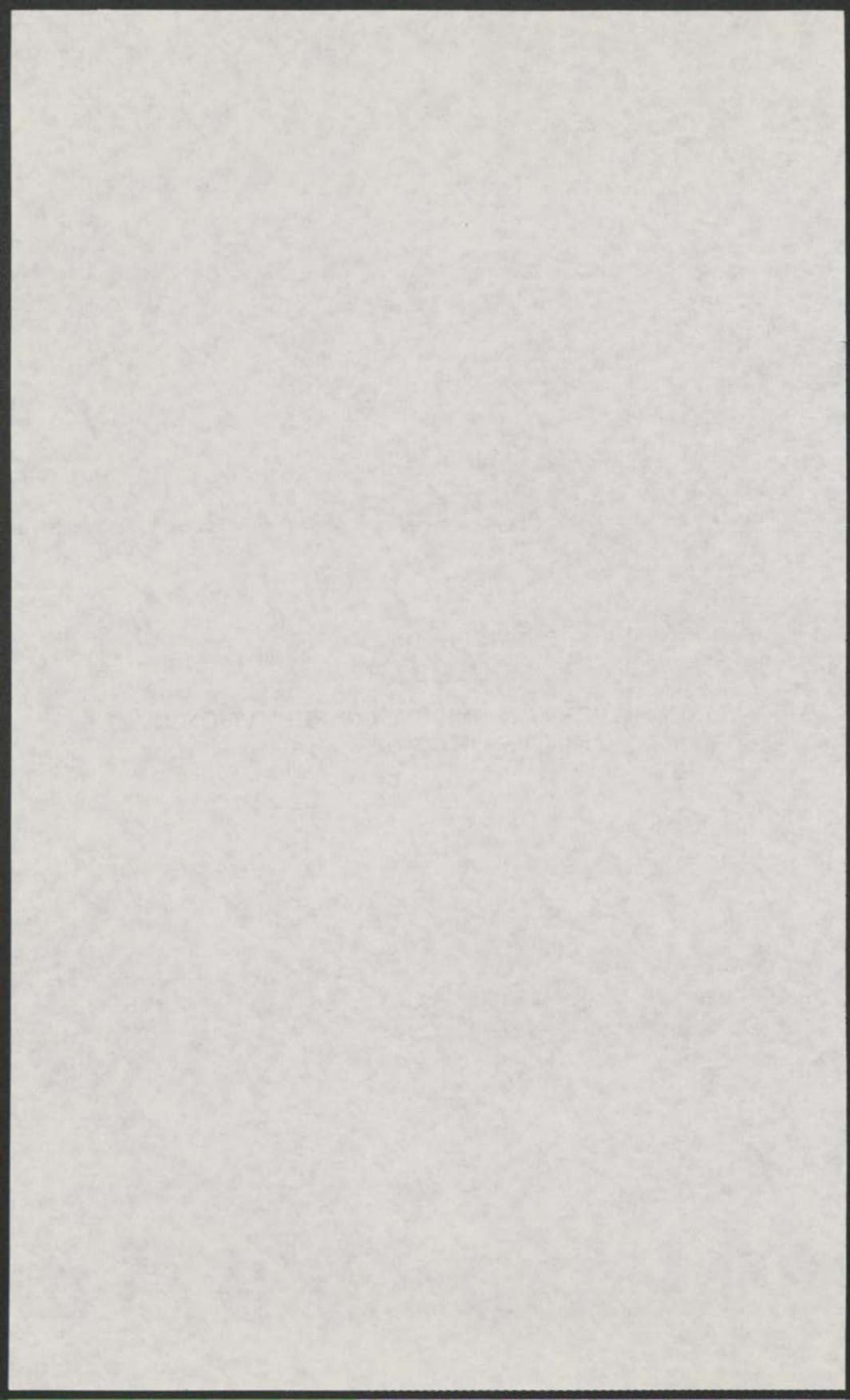
## APPENDIX C

---

### INCENTIVES FOR ENERGY CONSERVATION IN MULTI-FAMILY DWELLINGS

---

---



FEDERAL ENERGY ADMINISTRATION

WASHINGTON, D.C. 20461

JUN 9 1976

Honorable Jennings Randolph  
Chairman, Committee on Public Works  
United States Senate  
Washington, DC 20510

Dear Mr. Chairman:

Thank you for your letter of May 17, 1976, requesting an update of my letter to you of June 24, 1975, which concerned data on energy consumption in residences. That letter summarized our knowledge on this subject as of last June and laid out a schedule for the collection and analysis of further information. Two of the surveys which we anticipated receiving early in 1976 have not yet been completed, and we have therefore not been able to meet the schedule described in June.

Under a contract to the Federal Energy Administration (FEA), the Washington Center for Metropolitan Studies conducted a resurvey in May 1975 of the households which they originally contacted in May 1973. This study will show how consumer spending and habits have changed for a wide variety of energy-related activities since the embargo of 1973-74. Due to delays in collecting and collating this information, our Office of Economic Impacts does not expect this information to be ready for analysis until September 1976. We will share this analysis with you as soon as it is completed.

The other survey which will supply useful information is the Census of Housing conducted in the fall of 1974. This survey included questions about the general insulation characteristics of housing. The published summaries of this data which we had anticipated in early 1976 have not yet been completed. This information will also be supplied to you as soon as possible.

(197)

Our study of multi-family housing was completed on schedule last September. One principal conclusion was that the multi-family housing market is so fragmented as to make a major program in this area unwarranted at this time. I am supplying a copy of this study under separate cover.

Finally, we are discussing with the National Association of Home Builders Research Foundation a potentially inexpensive method of surveying existing single family housing for its insulation characteristics. We expect to reach a decision on funding this project within the next month.

Though no effort has yet been completed to draw these studies together, I have asked our Office of Buildings Programs to report to you a summary of our knowledge on the energy-related characteristics of housing. They will submit this summary to you before July 9.

I regret that we have not informed you earlier of the delays we have encountered. However, we will provide all information mentioned above as it is received.

Sincerely,

Frank G. Zarb  
Frank G. Zarb  
Administrator

Enclosures

DRAFT REPORT

Incentives for Energy Conservation in Multifamily Dwellings

Prepared for: Federal Energy Administration  
Under Contract No. CO-04-50226-00

19 September, 1975

Real Estate Research Corporation  
420 Lexington Avenue  
New York, N. Y. 10017

## TABLE OF CONTENTS

I. Executive Summary	1
II. General Approach	5
III. Multifamily Housing Inventory	9
A. Total Inventory	9
B. Structural Characteristics	15
C. Occupancy Characteristics	19
D. Energy Usage	26
IV. Patterns of Multifamily Energy Consumption	33
A. Introduction	33
B. Total Multifamily Energy Consumption	33
C. Per Dwelling Unit Consumption	35
V. Current Context of Energy Conservation	44
A. Introduction	44
B. Factors Relating to Energy Conservation	45
C. Factors Relating to Specific Sectors	58
VI. Incentives for Energy Conservation	66
A. Introduction	66
B. Incentive Formulation	66
VII. Strategy Formulation and Evaluation	71
A. Introduction	71
B. Action-Actor Groups	71
C. Strategy Formulation	72
D. Strategy Evaluation	75
1. Qualitative Assessment	75
2. Quantitative Assessment	84
3. Economic Impact	88
4. Priority Savings Areas	90
Appendix	1970 Public Use Sample - Computer Printout (Not included with all copies)
Appendix	Bibliography

EXECUTIVE SUMMARY

Relatively little is known about the characteristics of the multifamily housing market, particularly as they relate to energy consumption. In this study, significant structural characteristics of the multifamily inventory are examined, consumption patterns determined, present incentives and disincentives to energy conservation identified, and alternative incentives and conservation strategies developed.

In 1970 there were 9.8 million multifamily dwelling units in the United States (in buildings with five or more apartments), approximately 15% of the total housing inventory. Between 1971 and 1974 an estimated 2.3 million units were added, increasing the share of total inventory to about 17%. The largest increases in recent years have occurred in the southern states; the largest number of apartments are in the Northeast. Ninety per cent of all apartments are located in metropolitan areas. Approximately half of the multifamily inventory in 1970 was constructed before 1950, a proportion now closer to 40%. Public housing units are slightly less than 10% of the total multifamily.

Ninety-five per cent of all apartments are rental units; 87% have 2 - 5 rooms in the unit. The percentage of owner occupied apartments (largely, but not entirely, condominiums and cooperatives) is highest in the South Atlantic and Mountain states, reflecting the recreation market in those areas.

Multifamily dwellings are occupied by 19 million persons - approximately 2.1 per unit - constituting about nine per cent of the total population. Multifamily residents tend to have lower incomes than the rest of the population; 70% had incomes of less than \$10,000 in 1970 compared with 50% of the total population.

Natural gas is the major heating fuel used in multifamily buildings; it is used by half of all units. In the Northeast, fuel oil is the principal heating fuel, accounting for 62% of the total. In all other regions natural gas is predominant; electric heat is most prevalent in the South where it accounts for almost one-third of the units heating source. Most multifamily tenants pay directly for at least a part of their energy; two thirds pay directly for electricity, and one-half for natural gas. The proportion is significantly lower in the west south central states.

Multifamily units are relatively efficient and account for a small proportion of the total; they represented about 15% of all dwelling units in 1970, but they accounted for only 8.5% of residential energy consumption. On a per dwelling unit basis, the greatest consumption was found in the northeastern states, pre-1950 buildings, small buildings, large apartments, low rise buildings, high income households, and public ownership buildings. The smallest range of consumption variation was found in age of structure and in household income. Within the individual apartment, over two-thirds of the energy consumed is for space heating and cooling, with domestic hot water another 20%.

Present patterns of consumption, developed during a long period of low cost energy, have resulted in many obstacles to effective conservation practices. Most

conservation disincentives are related to the low cost of energy in a given situation, the apparent inability to obtain significant savings, the cost of taking many conservation actions, the complexity of the energy using systems themselves, and an absence of cooperation between tenants and owners. Nearly all owners have taken some initial first-stage steps to conserve energy as costs have risen rapidly during the past two years - reduction in heating, cooling, and lighting levels and more diligent maintenance practices. Tenants have tended to cooperate in conservation when asked, but have a strong likelihood of resuming established consumption practices within a short time. Tenants often lack basic information to use energy efficiently or to motivate them to do so.

The cost of energy, when it is high or increasing, is the greatest incentive to energy conservation - perhaps the only significant one. Conservation actions are taken largely by the party on whom the burden of cost falls. The strongest and most imaginative current conservation programs are those undertaken by some utilities; owner-management groups have acted less frequently.

Incentives for conservation are classified in five categories ranging from the mandatory to those which are completely voluntary. Regulatory, fiscal, economic or financial, informational, and educational are the incentive types used as a framework for analysis. Incentives, in turn, are related to types of conserving actions and actor groups capable of taking the requisite actions. For purposes of this analysis, owners, managers, and tenants are considered the actor groups, capable of taking actions relating to building or equipment retrofit, building or equipment operation, or dwelling unit operation.

The analysis identifies strategies or combinations of incentives judged most likely to stimulate given conservation activities and provides a mechanism for determining the effectiveness of those activities. Three market segments are identified as having high potential for energy savings - the northeastern region generally, master metered buildings as a group, and public housing. Incentive strategies for each are recommended and a methodology established for developing and evaluating strategies for other market segments. The wide variation in (or absence of) cost estimates for conserving actions limits current ability to refine estimates of cost savings and economic impacts in specific situations. The analysis does, however, permit adequate identification of priority conservation programs.

II. GENERAL APPROACH

Energy conservation potential in multifamily housing units is an area which has not been explored in detail in the past. Although many persons have identified the need for greater attention to this energy consumption sector, relatively little attention has been directed specifically at the consumption patterns of different types of apartment units. In fact, concern with residential energy consumption has generally been confined to single-family dwelling units or to the residential sector as a whole.

The overall purpose of this research effort, therefore, was to provide a framework for the Federal Energy Administration to use in developing marketing programs directed at the multifamily component of the United States housing inventory. Specifically, the study elements were designed to identify the following:

1. Market characteristics of the multifamily housing inventory in the United States.
2. The generic types of actions which can be undertaken to improve energy conservation in multifamily units.
3. The specific types of incentives and disincentives which can operate to influence conservation actions.
4. The probable impact of such incentives and disincentives on energy consumption levels.
5. Alternative strategies which can be employed through the introduction of incentives to encourage energy conservation in multifamily housing units.

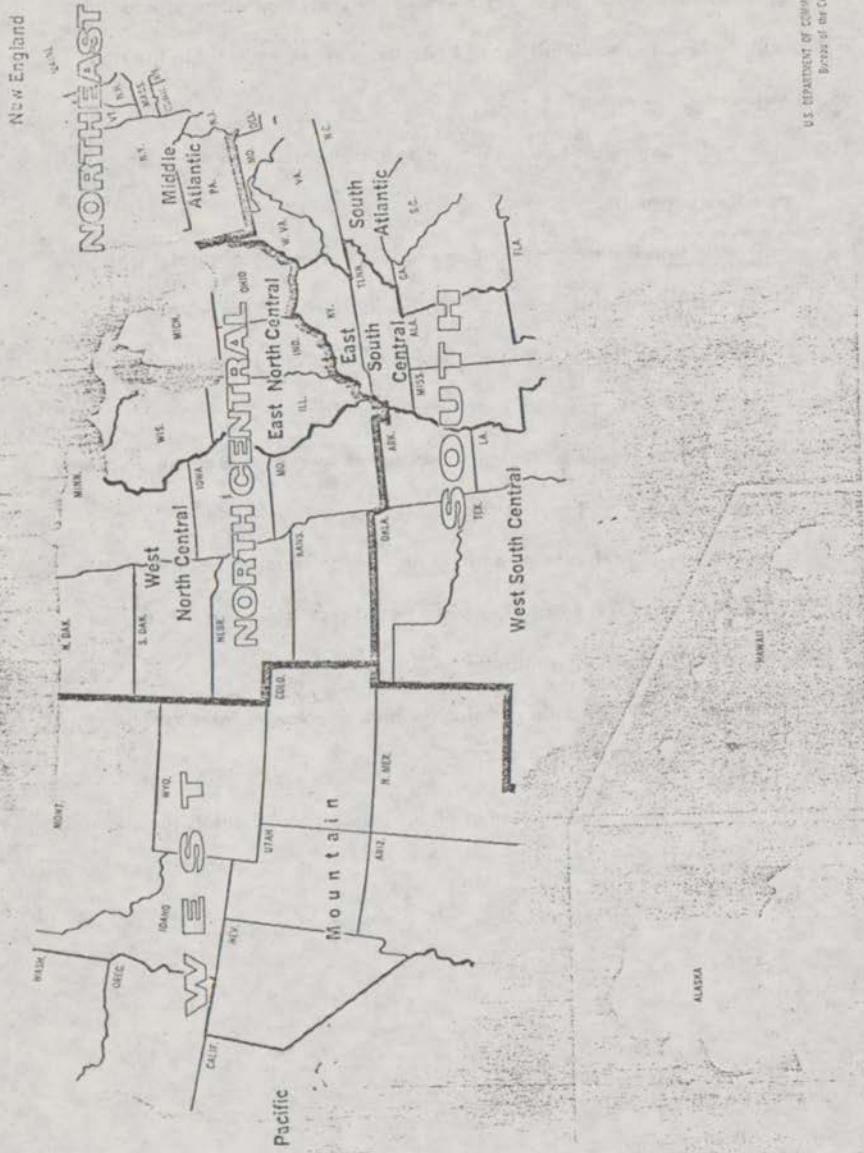
The study was divided into four main parts. The first phase was a literature and source review which included a series of interviews with organizations and individuals actively involved or knowledgeable about energy consumption in multifamily housing. This phase also involved the compilation of statistical data describing the multifamily housing inventory in the United States. Upon completion of the data collection phase, key actors, market factors, conservation actions, and incentives and disincentives were identified. The second phase then involved the development of hypotheses regarding the interrelationships between significant elements of the multifamily housing sector and energy consumption. These hypotheses were then tested by further interviewing and verification in the literature. The third phase of the study included the formulation of alternative strategies for encouraging energy conservation, creation of evaluation criteria, and actual strategy evaluation. The final component of the study was the identification of critical areas for conservation action and the preparation of specific recommendations.

The complex interrelationships between key variables necessitated an iterative process of hypothesis formulation and testing. Verification of assumptions and hypotheses was accomplished by the use of published technical documents, census reports, unpublished census data, and interviews with the following types of actors:

1. Apartment owners and managers
2. Tenant and consumer groups
3. Officials of public housing authorities
4. Representatives of utility companies
5. Representatives of professional and trade organizations
6. Field representatives of the Federal Energy Administration

Although detailed explanations of key elements are presented where appropriate throughout the report, the definitions of basic terms used frequently in the study are as follows:

1. Multifamily unit refers to a housing unit in a structure with five or more dwelling units.
2. Census division is a geographic area composed of contiguous states with Alaska and Hawaii included in one of the divisions. There are nine divisions used by the United States Bureau of the Census for presentation of census statistics, as shown on the accompanying map.
3. Census region is a geographic unit composed of two or more census divisions, as shown on the accompanying map.
4. Conserving action refers to an action, such as the installation of insulation or the lowering of a thermostat, which has a direct impact on the level of energy consumption in a dwelling unit.
5. Incentive refers to any action or circumstance which stimulates the undertaking of a conserving action.
6. Disincentive refers to any action or circumstance which inhibits the undertaking of a conserving action.



### III. MULTIFAMILY HOUSING INVENTORY

The purpose of this chapter is to present a general statistical description of those characteristics of the multifamily housing inventory in the United States which have been hypothesized to have a significant impact on energy consumption levels. Although multifamily housing has been a significant component of the housing markets of many metropolitan areas, relatively little analysis has been undertaken of the existing apartment inventory in the country as a whole. Indeed, much more consideration has historically been given to the tenure characteristics of the nation's housing stock than to its structural components.

The major source of information used in developing a profile of the multifamily housing inventory has been the United States Bureau of the Census. While there is limited published information available about the nation's multifamily stock, unpublished data compiled as part of the Census Bureau's 1970 Public Use Sample provide more detailed descriptions of multifamily housing characteristics. The base data are summarized in this chapter, and a copy of the computer printout from which the summary tabulations were prepared is presented in the appendix to this report.

#### A. Total Inventory

According to the 1970 U.S. Census of Housing, there were 9.8 million multifamily units in the United States in 1970. These units comprised slightly less than 15 percent of the country's total housing inventory, as shown on Tables 1 and 2. Multifamily units accounted for the highest percentage of all year-round units in the Middle Atlantic and Pacific states; they represented the lowest percentage of all year-round units in the East South Central and West South Central states.

UNITED STATES GEOLOGICAL SURVEY

Total		All Year Round Units		Multifamily Units						Multifamily Units as a Percent of Total All Year Round Units			
				Total Occupied Units	Owner Occupied Units	Total Occupied Family Units	Owner Occupied Family Units	Renters Occupied Units	Owner Occupied Vacant	Total Units	Occupied Units	Owner Occupied	
North Central													
New England	3,553.2	3,645.7	2,272.3	1,421.4	207.5	555.5	500.0	78.1	491.9	65.5	14,096	0.8%	
Maine Attende	13,344.2	11,875.4	6,607.2	5,145.2	205.4	3,024.0	2,017.2	166.2	2,771.0	316.8	24,586	53.1%	
Total	16,197.9	15,483.1	6,917.0	6,560.6	714.8	3,627.5	3,447.2	184.3	3,262.9	105.3	22,346	22.3%	
North Central													
East North Central	13,114.1	12,281.6	6,351.0	4,028.6	722.5	-	1,629.4	1,466.1	66.6	1,401.3	165.3	12,349	11.8%
West North Central	5,261.3	5,153.2	3,260.3	1,554.2	407.3	2,113.2	2,018.8	10.4	470.7	63.4	9,285	9.7%	
Total	18,672.3	17,515.5	11,922.1	6,613.4	1,139.8	2,742.6	2,412.6	83.7	1,832.2	226.7	21,634	10.9%	
South													
South Atlantic	10,147.8	9,495.9	5,072.3	3,445.7	709.9	1,239.9	1,102.1	79.3	1,022.6	117.4	12,226	11.7%	
East South Central	4,169.6	3,897.5	2,575.5	1,260.0	302.3	212.5	211.7	6.2	205.5	30.8	5,188	5.5%	
West South Central	5,566.0	5,351.0	3,555.3	2,066.0	414.1	551.0	532.7	11.6	444.1	25.3	8,356	7.7%	
Total	20,663.4	19,256.4	12,156.1	6,501.3	1,636.3	2,070.4	1,771.5	99.1	1,672.4	267.9	20,188	10.5%	
West													
Mountain	2,771.2	2,518.3	1,648.6	807.7	202.9	-	296.4	261.8	18.2	281.6	34.6	10,476	1.1%
Pacific	9,221.2	8,631.0	5,518.0	3,700.3	370.3	-	1,721.5	1,522.4	25.4	1,425.0	166.1	18,776	15.0%
Total	11,942.4	11,160.3	6,360.4	4,575.9	771.1	-	2,019.0	1,819.2	96.6	1,722.6	200.7	16,996	11.5%
Total United States	67,609.4	65,445.1	39,885.5	21,599.6	4,254.0	9,820.4	9,523.6	461.7	8,490.1	975.6	14,254	14.1%	

Note: Detail may not add to total due to rounding.

Source: 1970 U.S. Census of Housing, Real Estate Research Corporation.

Table Q

## 1970 REGIONAL HOUSING INVENTORY AS A PERCENT OF TOTAL UNITED STATES UNITS

All Year Round Units				Multifamily Units			
Total Units	Total Occupied Units	Owner-Occupied	Renter-Occupied	Total Multifamily Units	Total Occupied Units	Owner-Occupied	Renter-Occupied
<u>Northeast</u>							
New England	5.7%	5.7%	5.6%	4.9%	5.7%	3.9%	5.8%
Middle Atlantic	18.7	16.8	21.8	11.9	31.3	32.8	32.6
Total	23.9%	24.4%	22.4%	16.8%	36.9%	38.5%	33.4%
<u>North Central</u>							
East North Central	19.4%	19.5%	20.9%	17.1%	17.2%	16.6%	13.9%
West North Central	8.2	8.1	6.9	6.7	9.6	5.2	4.1
Total	27.6%	27.6%	29.9%	23.8%	26.8%	21.8%	18.1%
<u>South</u>							
South Atlantic	15.0%	14.9%	15.0%	14.6%	16.7%	12.6%	17.1%
East South Central	6.2	6.1	6.5	5.5	7.1	2.5	1.3
West South Central	9.7	9.4	9.7	8.8	14.4	5.7	5.1
Total	30.9%	30.4%	31.2%	28.9%	35.2%	20.7%	19.8%
<u>West</u>							
Mountain	4.0%	4.0%	4.1%	3.7%	4.8%	3.0%	2.9%
Pacific	13.6	13.6	12.4	15.7	13.4	17.5	16.9
Total	17.6%	17.6%	16.5%	19.4%	18.2%	20.5%	20.3%
Total United States	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note: Detail may not add to total due to rounding.

Source: Real Estate Research Corporation, based on data from Table 1.

Most multifamily units were located within metropolitan areas. More than 90 percent of all occupied multifamily dwellings in 1970 were inside Standard Metropolitan Statistical Area (SMSA's), as compared to 69.1 percent of all occupied housing units. The proportion of multifamily units within SMSA's was slightly higher for renter-occupied units than for owner-occupied units, most likely as a result of the number of condominium units in resort areas located outside of metropolitan areas.

According to the United States Department of Housing and Urban Development, there were 896.3 thousand conventional public housing units under management nationally in 1970. Of these units, 89.4 percent or 801.2 thousand units were occupied. Although there are no data available on the distribution of public housing units by structure size, the majority of such units were in multifamily structures. Nevertheless, it is clear that publicly owned units represented less than ten percent of the total occupied multifamily inventory in 1970.

Between 1971 and 1974, approximately 36 percent of all privately owned units started and completed in the United States were multifamily units. Table 4 shows that the total number of apartment dwellings completed during this time period equalled 2.7 million units. Over the same period, 39,000 publicly owned multifamily units started construction, of which an estimated 35,000 units were completed. Thus, the estimated gross addition to the multifamily housing inventory before adjustment for units removed from the stock because of fire, demolition, and other factors totaled 2.74 million units.

Table 3

METROPOLITAN LOCATION, 1970 OCCUPIED HOUSING INVENTORY  
(In thousands of units)

	Owner Occupied Units			Renter Occupied Units			Total Occupied Units		
	Multi-family		Total	Multi-family		Total	Multi-family		Total
	Total	as % of Total		Total	as % of Total		Total	as % of Total	
Total United States	39,885.2	463.7	1,2	23,564.6	8,490.1	36.0	63,449.7	8,953.8	14.1
Inside SMSA's	26,089.0	411.8	1.6	17,774.0	7,777.6	43.8	43,863.0	8,189.4	18.7
Percent Inside SMSA's	65.4	88.8	-	75.4	91.6	-	69.1	91.5	-

Source: 1970 U.S. Census of Housing; Real Estate Research Corporation

Table 4  
ADDITIONS TO THE PRIVATELY OWNED MULTIFAMILY HOUSING INVENTORY, 1970-76  
(in thousands of units)

	Units Started		Units Completed		Multifamily as a percent of Total
	Total	Multifamily	Total	Multifamily	
<u>1971</u>					
Total United States	2,052	784	1,706	516	34.3%
Northeast	224	103	226	77	34.1%
North Central	434	173	348	121	34.6%
South	869	305	727	225	30.9%
West	486	200	405	164	40.5%
<u>1972</u>					
Total United States	2,356	906	1,972	710	36.0%
Northeast	329	140	250	114	40.7%
North Central	443	162	405	152	37.5%
South	1,057	401	828	267	32.2%
West	527	204	458	177	38.6%
<u>1973</u>					
Total United States	2,045	795	2,014	719	35.7%
Northeast	229	105	235	114	39.9%
North Central	440	148	429	152	35.4%
South	639	384	846	204	39.6%
West	429	158	453	160	35.3%
<u>1974</u>					
Total United States	1,338	362	1,692	608	39.5%
Northeast	183	55	188	62	36.3%
North Central	317	77	369	132	35.8%
South	553	164	738	316	42.8%
West	265	85	359	137	35.2%
<u>1971-76</u>					
Total United States	7,792	2,864	7,384	2,653	36.3%
Northeast	1,033	403	1,018	337	38.0%
North Central	1,634	560	1,531	537	35.9%
South	3,378	1,254	3,139	1,102	35.1%
West	1,727	647	1,675	636	36.1%

Note: Detail may not add to total due to rounding.

Source: U.S. Bureau of the Census, C-20 and C-22 Construction Reports.

Based on estimates prepared by the U.S. Bureau of the Census of units removed from the inventory, the net increase in the multifamily housing stock from 1971 to 1974 is estimated to equal 2.3 million units.

B. Structural Characteristics

1. Units in Structure

In the United States as a whole, the distribution of multifamily units by size of structure is almost equally divided among the four structure sizes shown on Table 4. There are, however, significant variations among census divisions.

(Continued on following page)

Table 35'

NUMBER OF UNITS IN STRUCTURE, 1970 OCCUPIED MULTIFAMILY HOUSING INVENTORY  
(in thousands of units)

	Numerical Distribution					Percentage Distribution		
	5 - 9		10 - 19		20 - 49	50 and Over		Total
	5 - 9		10 - 19		20 - 49	50 and Over		Total
<u>Northeast</u>								
New England	214.6	139.3	87.0	65.4	506.5	42.4%	27.5%	12.9%
Middle Atlantic	551.9	540.4	740.9	1,103.3	2,936.5	18.8%	18.4%	37.0%
Total	766.7	679.7	827.9	1,106.7	3,443.0	22.3%	19.7%	33.9%
<u>North Central</u>								
East North Central	491.6	368.8	293.5	306.5	1,460.4	33.7%	25.2%	21.0%
West North Central	145.0	145.4	91.7	66.2	448.3	32.3%	32.4%	10.0%
Total	636.6	514.2	385.2	372.7	1,908.7	33.4%	26.9%	10.0%
<u>South</u>								
South Atlantic	316.3	366.5	172.7	255.9	1,111.4	28.5%	33.0%	15.5%
East South Central	81.6	64.1	35.9	33.3	214.9	38.0%	29.8%	16.7%
West South Central	107.9	123.3	93.7	136.6	463.5	23.3%	26.0%	10.0%
Total	505.8	553.9	302.3	427.8	1,789.8	28.3%	30.9%	16.9%
<u>West</u>								
Mountain	70.0	83.2	65.6	42.9	261.7	26.7%	31.8%	16.4%
Pacific	453.9	470.7	386.5	252.3	1,563.4	29.0%	30.1%	10.0%
Total	523.9	553.9	452.1	295.2	1,825.1	28.7%	30.3%	16.2%
Total United States	2,433.0	2,301.7	1,967.5	2,264.4	8,966.6	27.1%	25.7%	25.3%

Notes: Data based on sample. Totals do not correspond exactly to figures shown on Table 1.  
Detail may not add to total due to rounding.

Source: U.S. Bureau of the Census, 1970 Public Use Sample; Real Estate Research Corporation.

For example, both the New England and East South Central States show a high percentage of units in smaller structures of five to nine units and 10 to 19 units. Larger structures account for the greatest number of units in the Middle Atlantic States, equal to almost one-half of the United States inventory in this size category. The Mountain States have a high percentage of units in 10 to 19 and 20 to 49 unit structures, while the distribution of units in the West South Central States approximates that of the entire United States.

2. Year Built

As of 1970, almost one-half of the total United States inventory of multifamily units was constructed before 1950. The decade of the 1950's accounted for the construction of 1.2 million units, with almost three times that amount constructed during the 1960-1969 period. As indicated on Table 5, the Northeast region of the country contains the greatest number of units built before 1950, while the southern states have the largest number of units built after 1960. In fact, more than 50 percent of all multifamily units in the South Atlantic and West South Central states were constructed during the 1960's.

The increasing predominance of the southern states in the construction of new multifamily units continued during the 1971 to 1974 period. Table 8<sup>4</sup> above shows that 41.1 percent of all units completed between 1971 and 1974 were located in the south. The Northeast region, which has the largest total inventory of existing multifamily units, accounted for the smallest percentage of units completed over the corresponding time period.

Table 6

YEAR STRUCTURE BUILT, 1970 OCCUPIED MULTIFAMILY HOUSING INVENTORY  
(in thousands of units)

	Numerical Distribution				Percentage Distribution	
	Before 1950-		1950-1959		Before 1950-1959	
	1950	1959	Total	Total	1950-1959	1950-1959
<u>Northeast</u>						
New England	328.7	40.5	137.3	506.5	64.9%	8.0%
Middle Atlantic	1,003.2	362.0	671.3	2,936.5	64.8%	12.3%
Total	2,331.9	402.5	808.6	3,443.0	64.8%	11.7%
<u>North Central</u>						
East North Central	757.3	142.4	560.7	1,460.4	51.9%	9.8%
West North Central	218.8	40.5	159.0	448.3	48.8%	9.0%
Total	976.1	182.9	749.7	1,908.7	51.1%	9.6%
<u>South</u>						
South Atlantic	351.5	168.4	591.5	1,111.4	31.6%	15.2%
East South Central	78.6	33.5	102.8	214.9	36.6%	47.8%
West South Central	126.3	65.8	271.4	463.5	27.2%	14.2%
Total	556.4	267.7	965.7	1,759.8	31.1%	15.0%
<u>West</u>						
Mountain	102.6	41.4	117.7	261.7	39.2%	15.8%
Pacific	533.0	298.6	731.8	1,563.4	34.1%	19.1%
Total	635.6	340.0	849.5	1,825.1	34.8%	18.6%
Total United States	4,400.0	1,193.1	3,373.5	8,966.6	45.1%	13.3%
					37.0%	100.0%

Notes: Data based on sample. Totals do not correspond exactly to figures shown on Table 1.  
Detail may not add to total due to rounding.

Source: U.S. Bureau of the Census, 1970 Public Use Sample; Real Estate Research Corporation.

3. Number of Rooms in Unit

The overwhelming number of multifamily units in the United States contain between two and five rooms. Such units represent 87.4 percent of the occupied multifamily inventory in the country as a whole, as shown on Table 9. There is relatively little variation among census regions with respect to percentage distributions of apartment room sizes, although the Mountain and West North Central states have a higher percentage of occupied units in the one to three room categories than other census divisions. Only one census division, East North Central, has more than five percent of its occupied inventory in the six or more rooms per unit category. The lowest percentage of units in this category is evidenced in the Pacific States at 2.5 percent of occupied units.

C. Occupancy Characteristics1. Tenure

The vast majority of multifamily units in 1970 were occupied by renter households. Nationally, rental units equalled 94.8 percent of all occupied multifamily dwellings as shown on Table 8. Of the 463.7 thousand owner occupied multifamily units in the country, the greatest absolute number was located in the Middle Atlantic States, although such units as a percent of total occupied units were highest in the South Atlantic and Mountain States. The East South Central and West South Central States accounted for the smallest number of owner occupied multifamily units, both absolutely and as a proportion of total inventory in their respective census divisions.

Table 7  
NUMBER OF ROOMS IN UNIT, 1970 OCCUPIED MULTIFAMILY HOUSING INVENTORY  
(in thousands of units)

	f	Percentage Distribution				
		1	2 - 3	4 - 5	6 or More	Total
<u>Northeast</u>						
New England	50.9	212.4	219.5	23.7	506.5	10.0%
Middle Atlantic	204.2	1,334.6	1,266.7	131.0	2,936.5	45.4%
Total	255.1	1,547.0	1,486.2	151.7	3,443.0	7.4%
<u>North Central</u>						
East North Central	140.0	612.6	633.9	73.9	1,460.4	9.6%
West North Central	52.5	227.0	153.7	15.1	448.3	11.7%
Total	192.5	839.6	787.6	89.0	1,908.7	10.1%
<u>South</u>						
South Atlantic	89.5	445.8	525.4	50.7	1,111.4	8.1%
East South Central	12.8	85.9	106.4	8.8	214.9	6.0%
West South Central	34.1	213.3	201.4	14.7	463.5	7.4%
Total	136.4	746.0	833.2	74.2	1,789.8	7.6%
<u>West</u>						
Mountain	31.6	126.7	94.8	8.6	261.7	12.1%
Pacific	150.5	804.5	569.4	39.5	1,563.4	9.6%
Total	182.1	930.7	654.2	48.1	1,825.1	10.0%
Total United States	766.1	4,063.3	3,771.2	366.0	8,966.6	8.5%
						45.3%
						42.1%
						4.4%
						100.0%

Notes: Data based on sample totals do not correspond exactly to figures shown on Table 1.  
Detail may not add to total due to rounding.

Source: U. S. Bureau of the Census, 1970 Public Use Sample; Real Estate Research Corporation.

Table 8

TENURE OF MULTIFAMILY HOUSING OCCUPANTS, 1970  
(in thousands of units)

	Numerical Distribution			Percentage Distribution		
	Owner Occupied	Renter Occupied	Total Occupied	Owner Occupied	Renter Occupied	Total Occupied
<b>Northeast</b>						
New England	18.1	491.9	510.0	3.5	96.5	100.0
Middle Atlantic	166.2	2,771.0	2,937.2	5.7	94.3	100.0
Totals:	184.3	3,262.9	3,447.2	5.3	94.7	100.0
<b>North Central</b>						
East North Central	64.6	1,401.5	1,466.1	4.4	95.6	100.0
West North Central	19.1	430.7	449.8	4.2	95.8	100.0
Totals:	83.7	1,832.2	1,915.9	4.4	95.6	100.0
<b>South</b>						
South Atlantic	79.3	1,022.8	1,102.1	7.2	92.8	100.0
East South Central	6.2	205.5	211.7	2.9	97.1	100.0
West South Central	13.6	444.1	457.7	3.0	97.0	100.0
Totals:	99.1	1,672.4	1,771.5	5.6	94.0	100.0
<b>West</b>						
Mountain	18.2	243.6	261.8	7.0	93.0	100.0
Pacific	78.4	1,479.0	1,557.4	5.0	95.0	100.0
Total	96.6	1,722.6	1,819.2	5.3	94.7	100.0
Total United States:	463.7	8,490.1	8,953.8	5.2	94.8	100.0

Source: 1970 U.S. Census of Housing, Real Estate Research Corporation

In the United States as a whole, multifamily units represented 1.2 percent of all owner-occupied units and 36.0 percent of all renter occupied units. Only two census divisions, the Middle Atlantic and Pacific States, exceeded the national averages for both types of tenure, as shown earlier on Table 1. As a proportion of all owner occupied units, multifamily units ranged from 0.2 percent in the East South Central States to 2.5 percent in the Middle Atlantic States. As a proportion of the renter-occupied housing inventory, multifamily units equalled from 53.9 percent of renter-occupied units in the Middle Atlantic States to 15.9 percent in the East South Central States.

2. Number of Occupants in Multifamily Housing

Table 9 shows the estimated number of persons residing in multifamily housing units in 1970. As can be seen, 19,111,000 persons are estimated to have occupied multifamily units in that year, equal to approximately nine percent of the total population of the United States. Of the total number of multifamily occupants, 94.8 percent resided in rental units. Although there was some variation in mean household size by number of units in structure, the overall average number of occupants in both owner and renter occupied multifamily units equalled 2.1 persons per unit.

Table 9. MULTIFAMILY HOUSING OCCUPANTS, 1970  
(rounded to nearest hundred)

	Total Units	Estimated Number of Persons/Unit	Estimated Number of Occupants
<u>Owned-Occupied Units</u>			
<u>Units in Structure</u>			
5 - 9	149,800	2.3	344,500
10 - 19	90,500	2.0	181,000
20 or more	223,600	2.1	469,600
Total:	463,900	2.1	995,100
<u>Renter-Occupied Units</u>			
<u>Units in Structure</u>			
5 - 9	2,282,400	2.3	5,249,500
10 - 19	2,223,800	2.2	4,892,400
20 or more	3,987,000	2.0	7,974,000
Total:	8,493,200	2.1	18,115,900
<u>All Occupied Units</u>			
<u>Units in Structure</u>			
5 - 9	2,432,200	2.3	5,594,000
10 - 19	2,314,300	2.2	5,073,400
20 or more	4,210,600	2.0	8,443,600
Total:	8,957,100	2.1	19,111,000

Note: Data based on sample. Numbers do not correspond exactly to figures shown elsewhere on other tables.

Source: U.S. Bureau of the Census - 1970 U.S. Census of Housing, Real Estate Research Corporation

3. Household Income Levels

More than 70 percent of households residing in multifamily units in 1970 had incomes of less than \$10,000 per year. The distribution of multifamily households by income level shown on Table 11 indicates that less than 12 percent of such households had incomes of \$15,000 or more. The greatest percentage of higher income multifamily dwellers was recorded in the Middle Atlantic States, while more than 50 percent of multifamily households in the East South Central States had incomes of less than \$5,000 per year.

A comparison of the income levels of multifamily housing occupants to all households in the United States in 1970 indicates that multifamily households tended to have lower incomes. As can be seen below, 28.4 percent of all households in the country had incomes of less than \$5,000, while 39.0 percent of multifamily households had incomes in this category. In the higher income brackets, 20.7 percent of all households had incomes of \$15,000 or more, but only 11.6 percent of multifamily households had incomes at this level.

Table 10. PERCENTAGE DISTRIBUTION OF 1969 HOUSEHOLD INCOME LEVELS IN THE U.S.

	Under. \$5,000	\$5,000- \$9,999	\$10,000- \$14,999	\$15,000- \$24,999	\$25,000 & Over	Total
All Households	28.4	30.9	23.0	13.7	4.0	100.0
Households in Multifamily Units	39.0	32.8	16.7	8.8	2.8	100.0

Source: 1970 U.S. Census of Population, and Table above.

Table II HOUSEHOLD INCOME LEVELS, 1970 OCCUPIED MULTIFAMILY HOUSING INVENTORY  
(in thousands of units)

Numerical Distribution						Percentage Distribution					
	Under \$5,000	\$5,000-\$9,999	\$10,000-\$14,999	\$15,000-\$24,999	Over		Under \$5,000	\$5,000-\$9,999	\$10,000-\$14,999	\$15,000-\$24,999	Over
<u>Northeast</u>											
New England	221,2	165,8	76,3	34,9	8,3	506,5	43,76	32,7%	15,1%	6,9%	1,6%
Middle Atlantic	1,051,7	947,7	517,8	309,0	110,3	2,936,5	35,8%	32,3%	17,6%	10,5%	3,8%
Total	1,272,9	1,113,5	594,1	343,9	118,6	3,443,0	37,0%	32,3%	17,3%	10,0%	3,4%
<u>North Central</u>											
East North Central	547,8	480,1	262,0	132,0	38,5	1,460,4	37,5%	32,9%	17,9%	9,0%	2,6%
West North Central	210,8	145,1	63,3	22,6	6,5	448,3	47,0%	32,4%	14,1%	3,0%	1,4%
Total	755,6	625,2	325,3	154,6	45,0	1,908,7	39,7%	32,8%	17,0%	9,1%	2,4%
<u>South</u>											
South Atlantic	414,9	368,1	195,9	100,9	31,6	1,111,4	37,3%	33,1%	17,6%	9,1%	2,5%
East South Central	110,6	66,3	24,8	10,3	2,9	214,9	51,5%	30,9%	11,5%	4,6%	1,3%
West South Central	159,3	153,3	71,4	30,9	8,6	463,5	43,0%	33,1%	15,4%	6,7%	1,9%
Total	724,8	587,7	292,1	142,1	43,1	1,789,8	40,5%	32,8%	16,3%	7,9%	2,4%
<u>West</u>											
Mountain	121,9	89,0	34,3	12,7	3,8	261,7	46,6%	34,0%	13,1%	4,9%	1,5%
Pacific	620,1	523,6	250,3	131,8	37,6	1,563,4	39,7%	33,5%	16,0%	8,4%	2,4%
Total	742,0	612,6	284,6	154,5	41,4	1,825,1	40,7%	33,0%	15,6%	8,5%	2,3%
Total United States	3,498,3	2,939,0	1,496,1	785,1	248,1	8,966,6	39,0%	32,8%	16,7%	8,8%	2,8%

Note: Data shown are totals for each income level, as defined in Table I.

Percentages add to total due to rounding.

Source: U.S. Bureau of the Census, 1970 Decennial Census, U.S. State Personal Questionnaire.

D. Energy Usage1. House Heating Fuel

According to the 1970 U.S. Census, the major heating fuel for multifamily units in 1970 was gas. Almost 50 percent of all occupied multifamily units used gas for heating, followed by oil, electricity and other sources, as shown on Table 12. There were, however, significant variations in heating fuel usage by census division. For example, oil was the predominant heating fuel in the New England and Middle Atlantic States; these two census divisions accounted for 81.2 percent of all occupied multifamily units heated by oil. In the West North Central and Mountain States, more than three-quarters of all units were gas heated. Electric heated units accounted for the largest percentage of units in the southern states, equal to almost one-third of occupied multifamily units in each of the three southern census divisions.

2. Total Energy Usage

Table 13 indicates the number of occupied multifamily units using electricity, gas and other energy sources for any purpose in 1970. As can be seen, almost every multifamily unit in the country used electricity, and fully 84.0 percent used gas. As a proportion of total units, gas using units were highest in the Middle Atlantic States, where gas was not the predominant energy source for heat. Usage of energy sources other than electricity and gas was also highest in the Middle Atlantic States, followed by the New England and South Atlantic States. The smallest percentage usage of other sources occurred in the Pacific, East South Central and West South Central States.

Table 12

1970 OCCUPIED MULTIFAMILY UNITS BY HOUSE HEATING FUEL  
(in thousands of units)

	Numerical Distribution			Percentage Distribution			Total
	Electricity	Gas	Oil	Electricity	Gas	Oil	
<u>Northeast</u>							
New England	61.4	137.5	297.4	10.2	506.5	12.1%	27.1%
Middle Atlantic	111.4	859.6	1,620.2	135.3	2,936.5	3.8%	29.6%
Total	172.8	907.1	2,117.6	145.5	3,443.0	5.0%	26.3%
<u>North Central</u>							
East North Central	143.9	949.2	129.0	238.3	1,460.4	9.9%	65.0%
West North Central	42.0	350.6	34.7	21.0	448.3	9.4%	78.2%
Total	185.9	1,299.8	163.7	259.3	1,908.7	9.7%	68.1%
<u>South</u>							
South Atlantic	337.1	459.8	245.5	69.0	1,111.4	30.3%	41.4%
East South Central	67.9	131.3	2.8	12.9	214.9	31.6%	61.1%
West South Central	150.4	307.6	1.1	4.6	463.5	32.4%	66.4%
Total	555.4	898.7	249.4	86.3	1,788.8	31.0%	50.2%
<u>West</u>							
Mountain	45.3	199.9	7.8	8.7	261.7	17.3%	76.4%
Pacific	348.8	1,058.9	69.4	86.3	1,563.4	22.3%	67.7%
Total	394.1	1,258.8	77.2	95.0	1,823.1	21.6%	69.0%
Total United States	1,308.2	4,464.4	2,607.9	586.1	8,966.6	14.6%	49.8%
							29.1%
							6.5%
							100.0%

Notes: Data based on sample, totals do not correspond exactly to figures shown on Table 1.  
Detail may not add to total due to rounding.

Source: U. S. Bureau of the Census, 1970 Public Use Sample; Real Estate Research Corporation.

Table 13

ENERGY USAGE, 1970 OCCUPIED MULTIFAMILY INVENTORY  
(in thousands of units)

Households	Electricity		Gas		Other Sources	
	Total	Using Electricity	Percent Using Electricity	Total Households	Using Gas	Percent Using Gas
		Using Electricity	Percent Using Electricity		Households	Using Gas
<u>Northeast</u>	506,5	501,9	99.5%	505,5	356,2	70.3%
New England	2,936,5	2,927,2	99.7%	2,936,5	2,756,0	93.9%
Middle Atlantic	3,443,0	3,431,1	99.7%	3,443,0	3,114,2	90.5%
Total	8,349,5	8,358,2	99.7%	8,349,5	5,885,5	71.3%
<u>North Central</u>	1,460,4	1,451,9	99.4%	1,460,4	1,223,1	83.8%
East North Central	448,3	444,3	99.4%	448,3	365,4	81.5%
West North Central	1,508,7	1,856,2	99.3%	1,908,7	1,588,5	83.2%
Total	2,968,7	2,800,4	99.3%	2,908,7	2,811,6	95.7%
<u>South</u>	1,111,4	1,105,5	99.5%	1,111,4	850,8	76.6%
South Atlantic	214,9	212,5	98.9%	214,9	147,7	68.7%
East South Central	463,5	459,3	99.1%	463,5	402,6	86.7%
West South Central	1,789,3	1,777,4	99.3%	1,789,3	1,401,1	71.3%
Total	3,454,7	3,430,2	99.3%	3,454,7	2,664,5	76.0%
<u>West</u>	261,7	258,9	98.9%	261,7	204,0	78.0%
Mountain	1,563,4	1,552,3	99.3%	1,563,4	1,227,4	79.5%
Pacific	1,825,1	1,811,2	99.2%	1,825,1	1,431,4	78.4%
Total	4,210,2	4,175,4	99.2%	4,210,2	3,682,8	84.0%
Total United States	8,906,6	8,915,9	99.4%	8,906,6	7,535,2	84.0%
					8,966,6	8,900,9
					3,890,9	43.4%

Note: Data based on sample. Totals do not correspond exactly to figures shown on Table 1.

Source: U.S. Bureau of the Census, 1970 Public Use Sample, Real Estate Research Corporation.

3. Tenant Responsibility for Energy Costs

Tenant responsibility for the payment of energy costs varies by energy source and census division. Table 14 shows users of energy in renter occupied multifamily housing and the percentage of users who pay directly for energy costs. The table therefore indicates the percentage of households which do not have energy costs included in rental charges.

In the United States as a whole, 67.0 percent of all multifamily rental households using electricity were responsible for the payment of electricity costs in 1970. Almost one-half, 48.9 percent, of all gas users paid directly for gas charges. A much smaller percentage of other energy source users was responsible for the payment of additional costs for those energy types. Overall, 68.0 percent of all renter households in multifamily units using one or more sources of electricity paid directly for at least one type of energy.

Tenant responsibility for energy costs was greatest in the New England, Middle Atlantic, and Pacific States. In the southern states, a much smaller percentage of multifamily renters paid for energy costs directly. Among all census divisions, the West South Central States showed the lowest proportion of multifamily renters responsible for energy costs, with less than 30 percent of such households paying directly for one-or-more sources of energy.

Table 14

TENANT RESPONSIBILITY FOR ENERGY COSTS, 1970 OCCUPIED MULTIFAMILY RENTAL UNITS  
(in thousands of units)

	Electricity			Gas			f. Other Sources			One or More Sources		
	Total Rental Users	Percent Paying	Total Rental Users	Percent Paying								
Northeast												
New England	480.9	71.8%	333.2	57.2%	291.0	9.2%	481.8	72.7%	2,732.7	74.2%	2,214.5	74.0%
Middle Atlantic	2,728.2	72.7%	2,559.7	58.8%	1,810.5	1.8%	2,732.7	74.2%				
Total	3,209.8	72.6%	2,892.9	56.6%	1,101.5	2.9%	3,214.5	74.0%				
North Central												
East North Central	1,370.4	70.6%	1,141.6	39.8%	464.0	2.7%	1,373.0	71.3%	7,416.2	68.5%		
West North Central	415.3	67.9%	336.4	34.1%	107.1	12.0%	1,785.2	70.6%				
Total	1,785.7	69.9%	1,475.0	38.5%	571.1	4.4%						
South												
South Atlantic	1,022.7	55.7%	747.9	31.7%	350.6	9.2%	1,004.6	57.2%				
East South Central	200.5	65.8%	135.7	44.1%	25.0	16.0%	200.8	66.5%				
West South Central	436.4	28.5%	379.7	17.8%	60.3	4.3%	437.6	29.3%				
Total	1,639.6	49.8%	1,265.3	26.7%	435.9	8.9%	1,643.0	50.9%				
West												
Mountain	232.1	59.2%	177.2	29.3%	29.4	8.2%	232.8	59.6%				
Pacific	1,433.9	71.8%	1,059.0	63.8%	138.2	8.0%	1,436.4	72.6%				
Total	1,666.0	70.0%	1,236.2	59.0%	167.6	8.0%	1,669.2	70.8%				
Total United States	8,301.1	67.0%	6,920.4	48.9%	3,276.1	4.2%	8,315.9	68.0%				

Source: U. S. Bureau of the Census, 1970 Public Use Sample; Real Estate Research Corporation.

4. Average Annual Energy Expenditures

Table 4 indicates average annual per unit expenditures for various energy sources in 1970. The figures represent the average amounts spent by those multifamily renter households which paid directly for each energy source.

The last column shows the average total cost of energy for a multifamily renter household paying directly for at least one type of energy. Since all such households did not use every type of energy shown, the last column is not the sum of the previous three columns.

Overall per unit expenditures for energy were lowest in the Mountain and Pacific States and highest in the New England and South Atlantic States.

Electricity expenditures ranged from a low of \$99 in the Pacific States to \$152 in the South Atlantic States, and gas expenditures varied from \$64 in the Middle Atlantic States to \$130 in the New England States.

It should be noted that since tenant expenditures for energy were a function of both utility and fuel rates as well as consumption levels, the expenditure levels shown are not an exact indication of energy usage.

Table 15.

## AVERAGE ANNUAL ENERGY EXPENDITURES, 1970 OCCUPIED MULTIFAMILY RENTAL UNITS

	Electricity	Gas	Other Sources <sup>†</sup>	One or More Sources <sup>‡</sup>
<u>Northeast</u>				
New England	\$112	\$130	\$234	\$200
Middle Atlantic	\$122	\$ 64	\$258	\$172
Total	\$120	\$ 71	\$247	\$175
<u>North Central</u>				
East North Central	\$112	\$ 97	\$197	\$159
West North Central	\$106	\$102	\$ 81	\$149
Total	\$111	\$ 98	\$138	\$157
<u>South</u>				
South Atlantic	\$152	\$103	\$119	\$197
East South Central	\$133	\$102	\$ 86	\$180
West South Central	\$136	\$ 69	\$116	\$182
Total	\$146	\$100	\$115	\$192
<u>West</u>				
Mountain	\$107	\$ 99	\$174	\$146
Pacific	\$ 90	\$ 65	\$121	\$144
Total	\$100	\$ 67	\$131	\$144
Total United States	\$118	\$ 78	\$184	\$167

Source: U.S. Bureau of the Census, 1970 Public Use Sample; Real Estate Research Corporation.

IV. PATTERNS OF MULTIFAMILY ENERGY CONSUMPTIONA. Introduction

In order to define what incentives are most significant and which strategies have more potential, it is necessary to estimate how energy consumption might vary under differing circumstances. The pattern of energy consumption in multifamily housing at present sets the limits for effective application of incentives.

The approach that was used to derive variations in the pattern of energy consumption consisted of the following steps: derivation of total national multifamily energy consumption; derivation of average per dwelling unit national multifamily energy consumption; derivation of differences from that national average consumption according to various factors that are important to the multifamily housing market; and reference to a number of sources for a check on the reasonableness of the variations in per dwelling unit consumption that were derived.

B. Total Multifamily Energy Consumption

Energy consumption in the multifamily residential sector for 1970 is presented in Table . It was determined in the previous chapter that multifamily units were slightly less than 15 percent of the total residential dwelling units. Out of total energy consumed in the residential sector, multifamily housing constituted only 8.5 percent. This demonstrates the fact that multifamily housing is less consuming per dwelling unit than other types of dwelling units. It also must be repeated that multifamily housing is a relatively small portion of the total residential sector. Therefore, the potential for conservation of energy is small in absolute numbers.

Table

MULTIFAMILY ENERGY CONSUMPTION

Census Region	Energy Consumption, 1970 (10 <sup>12</sup> BTU)		
	Multifamily Residential	Total Residential	Percent Multifamily
Northeast	489	3,381	14.5%
North Central	225	4,039	5.6%
South	118	2,469	4.8%
West	132	1,522	8.7%
USA Total	965	11,411	8.5%

Source: Federal Energy Administration and Council on Environmental Quality, Project Independence Final Report: Residential and Commercial Energy Use Patterns, 1970-1990, Prepared by Arthur D. Little, Inc., November 1974, Table Ac.

The variations by census region reflect the climate differences, as well as the variations in numbers of dwelling units found in each region. The fact that the Northeast consumes over twice as much energy as any other region confirms that both factors contribute to the higher level of energy use, and also indicates where efforts at conservation might be concentrated.

C. Per Dwelling Unit Energy Consumption

During the course of the survey of current research and literature, it was found that a full set of consumption factors relevant to the multifamily housing market was lacking. In order to gear particular conserving strategies and incentives to this section of the market, it was necessary to derive such factors. It should also be pointed out, however, that for the purposes of this assignment, precise measures were not particularly required, but rather order of magnitude variations in consumption would serve equally well to define where emphasis or particular attention should be placed. It must be cautioned then that the factors that are presented here are intended to be descriptive only, and should not be taken as precise measure. It is our understanding that such refinement of existing measures as well as new data are being undertaken, but those measures were not available for this study. The factors presented show reasonable variations and are useful for this assignment but should not be used in other applications.

Table

## PER DWELLING UNIT CONSUMPTION FACTORS

	<u>Index</u>	<u>BTU (10<sup>6</sup>)/DU/YR</u>
<b>USA Average</b>	1.00	107.6
<b>Geographic</b>		
Northeast	1.315	141.5
North Central	1.091	117.4
South	.618	66.5
West	.673	72.4
<b>Age of Structure</b>		
Pre-1950	1.038	111.7
1950-1960	.954	102.7
1960-1970	.957	103.0
<b>Units in Structure</b>		
5 - 9	1.119	120.4
10 - 19	.982	105.7
20 - 49	.933	100.4
Over 50	.932	100.3
<b>Rooms in Unit</b>		
1	.836	90.0
2 - 3	.852	91.7
4 - 5	1.114	129.9
Over 6	1.503	161.7
<b>Building Profile</b>		
High-Rise	.928	99.9
Low-Rise	1.138	122.4
<b>Master vs Individual Meter</b>		
Master Meter	1.350	145.3
Individual Meter	.843	90.7
<b>Household Income</b>		
Under \$5,000	.957	103.0
\$ 5,000-10,000	.995	107.1
\$10,000-15,000	1.022	110.0
\$15,000-25,000	1.056	113.6
Over \$25,000	1.076	115.8
<b>Public/Private Ownership</b>		
Private	.948	102.0
Public	1.485	159.8

Source: Real Estate Research Corporation

Refer to text for derivation of consumption factors

The per dwelling unit consumption factors are presented in Table . . .

The details of the derivation are presented below, but in general, the nationwide average per dwelling unit consumption was calculated using the energy consumption as reported in Table . . . and the numbers of dwelling units from Chapter 3, Table 1. This national average figure was then set equal to 1,000 on an index and all other factors were calculated as a variation around that index number. Once all variations had been calculated, they were simply translated back into BTUs per dwelling unit per year. One advantage of this approach is that it allows isolation on a particular set of variables which can be translated to a common base without having to account for other differences in sources or bases of data.

The derivations of consumption factors consisted of the following:

- a. For the following factors -- age of structure, units in structure, rooms in unit, and household income, data from the Census of Housing were utilized.
1. Variations in the average dollar costs for utilities and fuels were analyzed for each of the four factors. Those average dollar costs were for rental units only, and included electric, gas, and fuel sources used within the dwelling unit.

2. All of the costs were related to the national average dollar costs for utilities and fuels, which are set equal to 1.000 as an index.
3. Variations for each factor around the national average were calculated according to the following formula:

$$\text{Index (variation in average cost)} = \frac{\text{Observed Avg. Cost} - \text{National Avg. Cost}}{6666} \quad \text{National Average Cost}$$

4. The index (variation in average cost) was assumed to equal the index (variation in energy consumption). This meant that the degree of variation in average dollar costs would represent the differences in energy consumption for each variable, and would allow conversion of dollar amounts to BTUs.
- b. For geographic variations and building profile, the FEA Project Independence Report cited previously was used.
  1. The same method outlined previously was used, but national average BTU consumption per dwelling unit was used as the basis of the index rather than average dollar cost for utilities.
  2. Using that base allows direct comparisons with all other consumption factors, and therefore shows the types of differences among factors that were required.

---

<sup>1/</sup> Federal Energy Administration and Council on Environmental Quality, Project Independence Final Report: Residential and Commercial Energy Use Patterns, 1970-1990. Prepared by Arthur D. Little, Inc., November 1974.

- c. For master versus individual metering, the research work for the Federal Energy Administration by Midwest Research, Inc. was used.<sup>2/</sup>
  - 1. The source related that master metered dwelling units consumed 35 percent more than the national average.
  - 2. Using the proportion of master metered units on a nationwide basis to total number of dwelling units, the consumption in individually-metered units was derived; this was done on the assumption that 31 percent of multifamily units in the United States are master-metered.
  - 3. The index was used to convert master-metered units with electrical service into BTU-equivalents that were assumed to represent all energy sources in master-metered units.
- d. For variations due to public or private ownership, data from Citizens for Clean Air, Inc. in New York City, comparing patterns of consumption in private and public multifamily projects, were used.<sup>3/</sup>
  - 1. The source related energy consumption in comparable projects on a per dwelling unit basis.

---

<sup>2/</sup>

Federal Energy Administration. Energy Conservation Implications of Master Metering. Prepared by Midwest Research Institute; currently underway.

<sup>3/</sup>

Citizens for Clean Air, Inc. Energy Use Patterns and Conservation Potentials for Existing High Rise Housing in the City of New York. Prepared by David Sage, Inc., May 1975.

2. Assuming a proportion of ten percent public housing and 90 percent private housing in the multifamily sector, the weighted average consumption was calculated and set as an index equal to 1,000.
3. The variations from that average on the index basis were calculated and then translated into BTUs, according to the procedure used for other factors.

In order to use this approach, several key assumptions were made:

- a. Since the Census data were available only for renter average dollar costs, it was assumed that the pattern of consumption for owners was not significantly different than for renters. This meant that the available data could be generalized to all multifamily units. If there is a bias in the data because of this assumption, the amount of distortion is small since the number of owner-occupied multifamily units is small in comparison to total numbers of occupied units -- around five percent. (Table 7 above.)
- b. It was assumed that the variations in per dwelling unit consumption that were calculated for 1970 data would represent present patterns of consumption. This means that if per unit consumption had increased from 1970 to 1975, as is likely, the variations in that consumption would have increased in direct proportion. The variations in the index would therefore still be useful and valid.

- c. It was also assumed that the increase in consumption was relatively small, so that the base consumption used in 1970 would be useful for 1975 as well, although a slight distortion is acknowledged. The price of energy has significantly changed since 1970, but the physical consumption has not changed significantly.
- d. The Census average cost data include only the energy consumed within the dwelling unit, and usage for common purposes within the building were not included. It was therefore assumed that total energy costs and hence energy consumption in the building were directly proportional to dwelling unit consumption. The relative consumption variations were applied against factors that included total-building consumption, so the BTU amounts stated have, in effect, been corrected for the exclusion of common area consumption in the Census data.
- e. All energy consumption factors cited are at the point of use, and losses in energy due to generation or transmission have not been accounted for.

Interesting patterns emerge among the per dwelling unit consumption factors. As was mentioned, among the four Census regions, the Northeast is the most consuming section of the country, on a per dwelling unit as well as a total basis; consumption per unit is over twice that in the South and West regions of the country.

Among more recently constructed structures, there appears to be little variation in energy consumption, while older structures (pre-1950) consume almost ten percent more per unit. For larger buildings, the number of units in the structure seems not to result in differences in consumption, while the smallest size structure that was analyzed consumes significantly more -- about 15 percent more. This finding is supported by the fact that dwellings in high-rise buildings consume about 20 percent less than units in low-rise buildings. These two factors reinforce the idea that larger buildings -- with less surface to volume ratios and perhaps economies in operation -- consume less on a per unit basis. It also suggests that larger buildings are more likely to be under professional and well-trained management, with more consciousness of energy costs.

There is a very great variation in consumption with number of rooms in the unit. As would be expected, the larger the apartment, the more energy that is consumed; the degree of variation may have been unexpected, however. It can be partially explained by the way in which the size categories were set. The most consuming group, over six rooms, consists of all apartments containing six rooms and over. Thus the consumption factor of  $161.7 (x 10^6)$  BTUs represents some average of all larger apartments, including but not limited to those with only six rooms. At any rate, one of the major contributions to energy consumption appears to be number of rooms in unit.

Another significant factor lies in how the dwelling unit is metered.

There is over a 60 percent difference in energy consumption between units that are master-metered and those that are individually metered.

That difference points out perhaps the greatest opportunity for energy conservation in multifamily housing.

There is less variation in energy consumption with household income than might have been expected, with consumption ranging from 103.0 to

115.8 ( $\times 10^6$ ) BTUs per dwelling unit, or about 12 percent difference.

That is less difference than found in number of rooms in the unit and indicates that perhaps a better focus would be physical characteristics of the unit rather than the income characteristics.

The second leading variation in energy consumption was found with public or private ownership. Publicly owned and operated housing was significantly higher than private multifamily housing. The reasons for this are discussed in the following chapter, but such a degree of difference suggests that the opportunity for energy conservation is great in the public housing sector.

V. CURRENT CONTEXT OF ENERGY CONSERVATIONA. Introduction

Present patterns and practices of energy consumption in multifamily housing have been established over a long period, during which energy costs were inexpensive and actual costs were declining. Because of the relative lack of concern about energy, multifamily housing was not designed or operated with any particular regard to energy efficiency. Over time, therefore, many obstacles or barriers to energy conservation have been created and maintained -- in terms of building structure, building systems within the structure, and the habits and lifestyles of consumers. Because such inefficiencies have been incorporated as part of existing multifamily residences, the obstacles to energy conservation will be difficult to overcome.

The present pattern of incentives and disincentives for energy conservation is the result of historical practices and customs relating to the costs of energy, the costs of conservation measures, the availability of information about energy consumption and conservation, and a number of exogenous issues relating to the economics of energy production, multifamily housing, or both. The most significant characteristics of such incentives or disincentives at present is their interrelationship and complexity, in that one factor is usually closely related to and dependent upon one or more other factors.

For purposes of analysis -- in the inventory of multifamily housing characteristics and the variations in consumption in previous chapters, as well as in the discussion to follow -- incentives and disincentives have been described as though they were individual factors, while recognizing that any understanding of present incentives and disincentives must acknowledge the inherent complexity.

The purpose of this chapter then is to describe how present factors operate either as incentives or disincentives for energy conservation in multifamily housing.

A general description of such factors will be presented, followed by sets of incentives and disincentives that work in specific cases but that do not generally prevail.

B. Factors Relating to Energy Conservation

1. Disincentives for Conservation

Disincentives to energy conservation relate to four sets of factors:

- The cost of conservation measures, whether real or assumed;
- The lack of directly realized benefits from conservation measures or expenditures;
- The absence of information about present consumption and about conservation options and their effectiveness; and
- Structural and economic characteristics of multifamily buildings and related regulatory practices.

Most disincentives are related to others and apply in varying degrees to owner and occupant. It is perhaps the fact that there is this set of complex interrelationships which makes many obstacles so difficult to overcome. Nearly all disincentives are related to the basic problem of hostility, suspicion, or lack of communication between owner and tenant.

a. Cost Related Disincentives

The cost of many conservation measures is a significant expenditure item for a building owner, especially those which involve retrofit of buildings or equipment. Current tax laws and the economics of buildings and their financing tend to restrict the accumulation of cash reserves, and most owners find it difficult to finance capital improvements in existing buildings from internal funds. Following the disappointing performance of their real estate portfolios during the past two years and the sharp reductions in profitability of many apartment buildings, many lending institutions are reluctant to make loans to apartment owners. High interest rates have added significantly to the real cost of capital investments.

The payout on conservation expenditures and investments varies largely in relationship to the cost of energy - and hence savings. In many cases the apparent or actual payout period is longer than owners find economic, and conservation investments are not made.

In other cases, information is not available readily which permits owners to calculate probable payout with the degree of assurance they require. While the time differs among situations, few owners are willing to consider an investment which will not pay for itself within 3 - 5 years.

The relationship between any individual action to conserve energy and any ultimate savings is difficult to determine, especially in those cases where the burden of the cost or the impact of the savings does not flow directly to the party taking the conservation action. When the increased cost of fuel can be passed on to tenants in annual rent increases, the owner frequently has no motivation to take actions which do not have an immediate savings for him.

The effectiveness of many capital expenditures - storm windows, insulation, rewiring, heating plant replacement - is dependent on complementary actions on the part of tenants. The inability of the owner to control certain consumption practices makes it uncertain that he will be able to recover costs through projected energy savings.

Owners are sometimes reluctant to make many capital expenditures or improvements, without particular regard to cost, because of the probability that the physical improvement will be ignored, misused, or vandalized. Individual meters, thermostats, and radiator valves are examples of such improvements.

b. Disincentives Related to Benefits

Tenants are usually unable to see the results of any conservation actions taken, especially on an individual basis but also those taken by the building owner, or to realize any significant benefits from such actions.

Many apartment tenants feel that conservation actions they would take will not significantly affect consumption in their building and further that their conservation efforts will only be negated by the profligacy of other tenants or will result in higher profits for the owner, not in any reduction in rent levels.

There is a basic skepticism on the part of the public at large about the nature of the energy crisis, the need for serious energy conservation, and the effect of conservation actions. Energy conservation in the individual apartment or building is related to conservation efforts in transportation, industry, and commercial and public buildings. The absence of a broader conservation ethic makes it more difficult to encourage necessary individual efforts.

c. Information Disincentives

In the predominant number of situations, the ultimate user of energy - the occupant - does not pay for his consumption directly, is not aware of the exact costs he incurs, and does not engage in the traditional economic marketplace relationship he does with most other expenditures. There is no readily identifiable "price tag" attached to most energy transactions.

Few owners or occupants are aware of their present consumption practices and the costs of those practices in relationship to possible conservation actions or their potential savings. They do not know which of their present practices are most wasteful and which offer the highest savings potential.

Apartment tenants are rarely aware of the total cost of energy which they consume - especially that part which is included in rent - or of the relationship of their consumption to any historic pattern or external standard. They do not know whether they are using "too much" energy or how to find out.

Many tenants lack even rudimentary information about how heating and cooling systems work, so that they over-control by setting temperatures much too high or low to achieve a temperature goal "more quickly," thus creating imbalances in the total system.

The typical response to an overheated apartment is to open a window, a response which makes apparent sense for the individual occupant but which tends to cause the total system to use even more energy.

Heating and airconditioning systems are complex, with many points of potential waste and, therefore, many points for conservation actions. The nature of the system is such that one action may require another action elsewhere in the system, including the way in which the system is used by the operator and the consumer. There are usually not simple, single actions which can result in significant improvements without other complementary actions. A boiler can be replaced, for example, but the system efficiency will be improved only marginally unless all radiator valves are brought to a state of necessary maintenance.

Building owners are often not aware of which conservation alternatives will be most effective for their property, or of the cost and benefit of taking alternative actions. Insulation in an apartment building may not appear to offer much potential for savings, yet its impact on the performance of the system may be much greater than would be expected, for example.

Many building managers lack the technical expertise necessary to analyze their energy systems and take appropriate corrective actions, and they must rely on suppliers of services and products whose recommendations may not be regarded as reliable or objective. They lack a source of information which they consider trustworthy.

d. Exogenous Disincentives

In many urban areas, property owners are beset with a number of cost problems, including energy, but also increased taxes, increased delinquencies, higher labor and operating costs, and greatly increased capital costs. The cost of energy then becomes only one of many economic pressures and is often one of the most difficult to affect without significant expenditure or change in operating practice.

The market for apartments is soft in many areas, causing owners to be extremely reluctant to take any steps which would tend to raise rents and potentially lose competitive position. There are still metropolitan areas in which "free utilities" are a significant competitive factor in the apartment market. A similar situation exists in many condominium markets where there is a significant oversupply of units - no builder or owner is likely to take any actions which will increase the cost of units in a soft market.

Building codes have traditionally lagged both current technology and larger public need. Energy conservation as such is a totally new consideration in most building codes, although some states have moved to take important corrective action vis-a-vis energy conservation as has the FHA. In many cases, however, these code changes will result in increased costs, further increasing the cost of housing, unless there is provision for other changes for cost reducing measures.

In many cities building codes are written and enforced in relatively inflexible ways, based on traditional considerations, which make it procedurally difficult at least, and economically and practically impossible at worst, to affect changes in heating, air conditioning, and electrical systems in apartments. The ability to change or obtain variances in building codes is typically limited.

Many environmental codes, often enacted within the past few years, have had the unintentional effect of reducing the efficiency of energy systems and thereby increasing overall energy consumption. Similarly, some changes in both building and environmental codes have been based on inadequate information and have not resulted in the extent of conservation intended.

In some cases consumer groups - including environmentalists, tenants, legal action groups - have taken strong and effective public stands on a variety of energy-related issues which have not been conducive to energy conservation practices. Tenant groups, for example, tend to press for ceilings on rents which may impair the ability of owners to take necessary conservation action and to insulate tenants from the necessity of sharing any burden of increased energy costs. Owners associations, on the other hand, have in some cases pressed to transfer the full increase of energy costs to tenants.

The rate structures of utilities tend to favor larger consumers.

In the specific case of master metering, conversion to individual metering in most cases would have the effect of increasing the per unit cost to individual occupants who will pay for energy at a different rate than their theoretical pro rata share of the energy cost of a total building. Some of the suggested changes in rate structures, designed to protect certain low-income consumers, could have the effect of encouraging excessive usage among consumers whose actual energy needs fell below a flat minimum rate.

e. Incentives for Conservation

Present incentives for energy conservation tend to relate principally to the cost of energy and the availability of valid, believable information about energy consumption and conservation.

The cost of energy to the tenant or building owner provides the greatest incentive for conservation; the higher the cost, the greater the tendency to conserve. In a study undertaken by the American Gas Association, it was found that energy use was generally <sup>1/</sup> more efficient in the high energy cost areas of the country.

---

1/

Applied Urbanetics, Inc., Technical Note, Residential Heating Energy Consumption Index, Prepared for Federal Energy Administration under Contract No. 14-01-0001-1676, August 1974.

In most cases, conservation takes the form of reduced levels of consumption for heating, air conditioning, and lighting - the most direct and least costly conserving measures.

The effectiveness of cost as an incentive is related to the burden of the cost, whether it falls on the owner of the building or the occupant of the apartment. In buildings in which electricity is individually metered (and charged) to each unit, consumption is typically less than in master metered buildings; a study by the Midwest Research Institute indicates that the difference is on the order of one-third.<sup>1/</sup>

When the increased cost of fuel can be passed along to tenants in rent increases, there may be a conservation incentive so that the added cost increase is also passed along to the user. Where such rent increases are not clearly identified or where the tenant has no reasonable expectation that reduced consumption in the future will result in rent reductions, there is no incentive to conserve and perhaps even a disincentive.

When residents can be informed accurately not only as to the amount (in physical units) of current consumption but also the comparison with a previous period, there can be an incentive to reduce or at least maintain consumption at previous levels. This is the so-called report card billing which presents the consumer with a documented record of his energy consumption pattern over time and, hence, a benchmark against which to set current consumption. Atlantic City Electric Company has had such a program for approximately two years, and believes that it has been important in reducing the growth of energy consumption. *V*

Many utilities have provided their customers with information on the consumption of various appliances in the home, so that the occupant can identify those which are large energy consumers and presumably limit their use.

Cengas in Lincoln, Nebraska has a program of identifying heat loss in individual homes through a graphic infrared thermal scanning technique which permits a visual comparison of structures from infrared photographs. The program has been successful in bringing to the attention of thousands of customers their apparent need for insulation and other thermal protection. The program appears to have

*V*

Kurt W. Riegel and Suzanne E. Salomon, "Getting Individual Customers Involved in Energy Conservation," Public Utilities Fortnightly, November 7, 1974.

been more successful in obtaining serious consumer interest than the pilot Project Conserve which provided residents with detailed cost and savings information about conserving measures for their own home. This limited comparison suggests that a greater incentive can be provided by a dramatic example than by logical economics.

Some utilities have provided an incentive for their customers to install insulation by providing for a discount in the price and/or a convenient installment credit method for spreading the cost over time. Both Brooklyn Union Gas and the gas utilities in Michigan have entered into such a program. While the number of customers using the plan in Brooklyn is relatively small, the company considers it an integral part of its conservation program. Cengas is considering a similar program to follow up its heat loss identification. While it is difficult to assess directly the impact of such "rebate" programs it is reasonable to assume that a meaningful number of the participants would not have installed insulation otherwise. The incentive to the utilities is to free finite energy resources at their disposal for other - and potentially more profitable - customers.

Some utilities have provided technical assistance to customers to identify specific conservation actions appropriate to their structure or unit. In New Hampshire, the state vocational education system has begun a program to train students in energy conservation and to make their skills available to lower-income families.

The Institute of Real Estate Management has developed a series of conservation measures for use by apartment managers and has now launched a pilot demonstration program in 10 regions in which actual experience will be recorded and compared with previous consumption. Publication of these results will provide an informal set of standards allowing for differences among building types, age, energy source, and location which others can use as a performance standard. The same sort of performance standard has been used in public housing, but in that case there is a strong bias toward increasing consumption standards which works as a serious disincentive to conservation.

Changes in utility rate structures which price energy in ways which make high consumption relatively more costly than low consumption will discourage use of those energy sources. In the recent Pacific Gas and Electric Company case the California Public Service Commission stated that a primary reason for adopting an inverted rate structure was that it is "essential to encourage residential <sup>1/</sup> conservation."

Many apartment owners provide bonuses for managers or maintenance employees which are based on their ability to reduce certain costs or meet certain performance standards, including energy consumption. In cases where such personnel are members of unions, such bonuses may not be feasible.

<sup>1/</sup> Wall Street Journal, "Pacific G&E Gets a Rate Increase of \$213.4 Million," September 17, '75.

C. Factors Relating to Specific Sectors

In addition to the general factors cited previously -- principally current incentives or disincentives to energy conservation, it is also useful to identify factors that work to encourage or discourage conservation in specific cases. Such description will prove useful for further discussion and for the creation of energy-conserving strategies in later chapters.

1. Building Owners and Managers

Building owners have responded to the higher costs of energy largely by reducing heating levels and by more efficient maintenance of heating and cooling systems. The strong public pressure to conserve energy in 1973-74 created an atmosphere of public acceptance which facilitated some of their actions. Owners, however, have been generally reluctant to incur major capital costs to reduce their energy consumption because of a lack of information about the effective steps for them to take, a lack of capital, and the uncertainty that the savings created would repay their investments adequately. Many building owners actually own a building for a relatively short time, ten years or less, both because the financing available to them is for such periods and because much of the profit in apartment buildings has been in appreciation over the past 25 years. Special provisions in the tax laws for accelerated depreciation and other tax shelters has tended to encourage ownership turnover, in turn discouraging investment beyond that to maintain marketability of a building. Thus, the time required for savings to amortize the cost of an energy conservation investment (including financing costs) is often longer than an owner's expected ownership of a building.

The capital cost of retrofitting buildings and equipment is frequently beyond the financial resources and inclinations of most building owners. Few of them have the necessary cash, and all find financing to be costly. The payout for such investment is generally viewed as too long or too uncertain to warrant the investment. Many owners are sufficiently uncertain about what steps to take and how to implement conservation measures to preclude their doing anything. Savings which can be achieved by capital investments are at least in part contingent upon the system being operated efficiently by both employees and occupants, and many owners are skeptical that such complementary actions will occur. In addition to the cost of major retrofit actions, they often involve considerable inconvenience or disruption of building operation.

Cost reduction is the principal incentive for altering the operating practices or standards in a building. Because these actions can be accomplished quickly at relatively low cost, most owners have taken a number of such steps, sometimes with the encouragement and assistance of utilities and industry and professional associations. Common conservation actions have included reducing the level of lighting in common areas; reducing heat and cooling in individual units and in common areas; reducing the temperature of domestic hot water; improving maintenance on heating, cooling and hot water systems; and making greater allowances for variations in consumption by time of day and season of year. The principal obstacle in taking such steps is simply the lack of information, and, in some cases, lack of adequate technical assistance in carrying them out. Maintenance employees may sometimes be reluctant to depart from their established

routines, and building tenants often complain about the changes being made.

2. Building Tenants

Whether the occupants of individual dwelling units will take conservation actions depends largely on whether they are charged directly for the cost of the energy they consume. If they are, their incentive to reduce energy costs results in their reducing temperature levels (or increasing in hot weather), reducing lighting levels, using appliances more efficiently and less frequently, and other similar steps within their control. Occupants who are not charged directly for their energy consumption have cooperated in many cases as a matter of public responsibility, often following requests by building owners. These actions have been short lived for the most part, however, and continued reminders are required. The general public understanding of and reaction to the energy crisis is a strong factor in their energy consumption, absent of any cost considerations. In many cases, occupants believe that there is little or nothing which they can do individually to affect total consumption in their building, so they are motivated to do little or nothing.

Recognition of the national need to conserve energy has provided an incentive for occupants to accept lower comfort levels and to cooperate in conservation programs, whether they pay directly for utilities or not. Distrust of owners' motives and actions has worked in the opposite direction, however, and caused some occupants to disregard conservation actions.

Failure to receive or understand appropriate information about conservation programs has served to increase tenant distrust in many instances.

3. Utilities and Other Suppliers

Utilities and other energy suppliers have an indirect role in conservation. They have been motivated by a number of economic factors to work with their customers to reduce consumption. The need to reduce peak load requirements, to ensure more adequate supplies for a growing customer base, and to have some flexibility to provide for priority customers have served as incentives together with the desire to contribute to the alleviation of a national problem. As a result, the utility industry has become a major source of information about energy conservation and, in some instances, technical assistance. A number of utilities began such programs well before 1973, and all have eliminated programs to promote high levels of consumption.

4. Regional and Geographic Variations

The cost of energy, which varies substantially among regions, is a predominant factor in whether conservation actions will be taken by any group - owner, occupant, or utility. In the lowest energy cost regions, there is typically neither the economic nor the psychological incentive to take significant conservation actions. Areas of the country which are dependent upon imported fuels, those distant from domestic natural gas supplies and hydroelectric sources, and those isolated from major energy networks have been affected most by higher costs and are

most sensitive to a range of incentives in order to reduce their consumption. A special study by the American Gas Association found that states in the Southwest, Louisiana, and Florida are the least efficient users of energy for residential heating, with appropriate correction for heating degree-days.<sup>1/</sup> At a different level, Detroit Edison found that consumption tended to be somewhat higher in suburban apartments than those in the central city.<sup>2/</sup> The difference in consumption is associated partly with differences among tenants and structural characteristics of apartment buildings, but for whatever reasons suburban apartment dwellers apparently use more energy than do their urban counterparts.

5. Building Characteristics

The principal characteristic of a building related to energy conservation is whether or not energy is delivered to residents in a way which permits costs to be calculated and charged directly to each unit. In most apartment buildings, electricity is sold to the building at a commercial rate and provided to individual tenants as part of their rents. This practice is known as master metering and has been found to be associated with significantly higher levels of consumption than comparable apartments in which the cost of electricity is metered for each and charged accordingly,

1/

Applied Urbanetics, Inc., Technical Note, Residential Heating Energy Consumption Index. Prepared for Federal Energy Administration under Contract No. 14-01-0001-16/6, 8/74.

2/

Ronald Daniels, Profile of Low Use Customers, Paper Presented to Edison Electric Institute Rate Research Committee, September 1973.

usually at a higher per kwh rate. Owners of older buildings often have a greater incentive to take conservation actions than those in newer buildings because they may be able to realize greater savings more quickly, because inefficiencies of equipment or buildings may be greater than in newer buildings. In the case of many older buildings, however, the cost of effective actions is so great that it is beyond the owner's financial means. Many older buildings require major structural renovation to become energy efficient. For example, in newer buildings the addition of storm windows may create a significant savings, in some older buildings, the existing window units may have to be replaced in addition to adding storm windows. High-rise and high density buildings use less fuel for heating and water heating than low-rise buildings, reflecting the fact that they have a smaller relative surface exposure where heat loss will occur.

#### 6. Management Arrangements

The ownership of an apartment building - whether it is public or private - and the management of the building - whether by the owner, a resident manager, or a managing agent - is related to the effectiveness of various conserving actions and the incentives appropriate to encouraging them. Most public housing and much publicly assisted housing is financed in ways which have not tended to create economic and psychological incentives for cost savings: they do not have to operate at a profit. The practice of utility allowances and payment of excesses by renters according to a standard established by HUD appears to act as a disincentive for energy

conservation since it provides for automatic escalations of the allowances as energy consumption increases. The manager is regarded by many as the key to energy conservation - whether in a private or public building - since it is he who implements the conservation actions, maintains the efficiency of the system, interacts most closely with the tenants. The rapidly growing practice of including tenants in the management of buildings - through tenant management corporations - may provide a substantial incentive for conservation as tenants obtain a better understanding of the financial implications of high energy consumptions levels.

7. Income Variations

The socioeconomic characteristics of occupants appears to be related to consumption patterns, although the reasons for differences are not clear or well understood. A study of customers of the Pacific Gas and Electric system found that lower income customers were consistently higher consumers <sup>1/</sup> than average of natural gas and often higher consumers of electricity. The low quality of housing, appliances, and maintenance among lower income buildings is a major reason for the differences. In the study of Detroit Edison customers it was determined that there is a significant relationship between energy use and the combination of income and dwelling type. The range of consumption within each income group, however, was greater than the difference between classes of income/dwelling type.

<sup>1/</sup> Pacific Gas and Electric Company, "A Summary of the Pacific Gas and Electric Company Study of the Usage of Gas and Electricity by Low Income Consumers," undated.

Income was found to be a significant factor in determining average use among customers. Multifamily customers used significantly less energy - 100 kwh or more per month - than comparable single-family home customers.

VI. INCENTIVES FOR ENERGY CONSERVATIONA. Introduction

Although a number of incentives were introduced in the previous chapter, as well as disincentives that currently apply to energy conservation, it was not attempted to identify formally what types of incentives are possible. If incentives are defined as measures to induce various groups (actors) to take certain steps (actions) to conserve energy, then it might be possible to combine actors and actions into logical groupings so that incentives may be targeted into clusters (strategies), those combinations that will yield most in terms of energy savings might be identified and evaluated. This is the process that will be used in this report, and will be carried out in this and the following chapter.

B. Incentive Formulation

The first step, then, is the formal classification of types of incentives in an analytical framework, which will allow the formulation of incentives and the evaluation of alternative strategies for energy conservation. Incentives may be classified according to whether they may be voluntarily applied or may require legislative changes. If the types of incentives are seen as a continuum from legislative to voluntary actions, then it is possible to further classify the incentives into the following framework:

1. Regulatory: Those strategies that require direct intervention by public authorities; types of activity would include building codes or performance standards.

2. Fiscal: Those strategies that are undertaken by public authority where some adjustment of the tax structure is used to enforce energy conservation.
3. Economic or Financial: Those strategies that may be undertaken by public authority, but not necessarily; changes are brought about by market mechanisms and are indirectly influenced by pricing factors; examples would be subsidies or loan guarantees.
4. Informational: Such strategies would be directed at specific classes of actions, and would include provision of technical data and/or assistance.
5. Educational: Strategies designed to relay information, but without the directed aspect of informational strategies; general awareness of energy conservation would be sought, but with no specific conservation action.

The types of incentives that relate each of these categories are summarized in the following table:

---

#### INCENTIVES FOR ENERGY CONSERVATION IN MULTIFAMILY HOUSING

---

1. Regulatory Measures

- ⊖ Changes in building codes to meet energy-conserving standards
- ⊕ Require or permit installation of individual metering
- ⊖ Changes in building codes to ensure energy efficient performance (so that structures are regulated as to the number of BTU-equivalents consumed, rather than specific design features)
- ⊕ Mandatory temperature settings and hours of operation

## (-) Fuel-energy quotas or allocations

- ⊕ Revisions in utility rate structures, with graduated rates according to consumption

2. Fiscal Measures

- ⊕ Deduct costs of retrofitting from property tax assessments
- ⊕ Alternatively, defer increases in assessments based on value of retrofit
- ⊕ Increase capital investment tax credit for retrofit actions
- ⊕ Adjust accelerated depreciation schedules for retrofit investments
- (-) Levy personal property tax on heavy usage appliances

3. Economic Measures

- ⊕ Provide direct subsidy to underwrite expenses of retrofit improvements by capital grant
- ⊕ Provide indirect subsidy by providing loan guarantee for improvements
- ⊕ Provide direct subsidy by subsidizing market-rate loans with differential payments or extended terms
- ⊕ Establish revolving loan fund for improvements
- ⊕ Provide direct salary compensation or bonus for energy consumption?
- ⊕ Provide non-monetary incentive for conservation (such as merchandise, added fringe benefits, or vacation)
- ⊕ Adjust rent levels (where utilities are included in rent payment) so that consumption over a certain base amount is billable at higher rates
- ⊕ Allow a premium on rent levels for energy conservation, in the form of a rebate or reduction in rent
- ⊕ Charge for hot water heating and air conditioning use at an increasing rate per unit of consumption
- ⊕ Install individual metering at cost to utility; tenants reimbursed for cost out of monthly bills

4. Information Measures

- Provide information on savings and costs from specific retrofit actions
- Provide information on consumption, identifying areas of potential reduction
- Provide format for energy-efficiency analysis
- Provide a checklist of energy-conserving options available for both structural changes and operating procedures
- Provide information on new technologies that might replace existing equipment or structural components
- Provide technical assistance for energy consumption and conservation analysis
- Provide standard performance criteria for energy use
- Provide explicit costs and consumption data on monthly bills where such data may be attributed to individual dwelling units; where such data are not available, provide "prototypical" or average costs on consumption data
- Require labeling of appliances for energy efficiency, as well as provide information to interpret and search for such labeling

5. Education Measures

- Organize demonstration projects for building and equipment retrofit
- Organize demonstration projects for implementing new conserving technologies
- Provide case study compilations as examples of successful energy management or conserving investment
- Provide information for course on energy management by IREM or CPM (with use of seminars or self-study, programmed texts)

- Provide generalized information on energy consumption in the household -- for appliances, lighting, and heating
- Provide estimates of consumption and costs savings due to conservation
- Provide demonstration of energy conservation by use of mobile units used to tour various apartment projects

VII. STRATEGY FORMULATION AND EVALUATIONA. Introduction

As described in the previous chapter, the process that will be used to derive strategies for applying and evaluating incentives for energy conservation will consist of a series of sequential combinations of factors, selecting with each iteration those actions or strategies that will yield the most in terms of actual reductions in energy consumption in the multifamily housing sector. In each case, some options will be rejected while others will be retained and carried forward to the next stage. The reasons for such selections will be stated. It should be noted that this selection process as well as the final set of recommended strategies that emerge from it will be useful. If there are possible strategies that were not considered or were rejected, it is a relatively simple task to subject them to the same type of analysis detailed here and to evaluate them as well.

B. Action-Actor Groups

The first step in the process was related in the previous chapter, namely the organization of incentives into five categories. The second step occurs in parallel to that step, in defining unique sets of conserving actions and action groups. There are four possible types of actors or audiences relating to energy-conservation: building owners, building managers, tenants, and other groups not directly related. Since this latter group is ill-defined and can be accommodated in other ways, the actor groups will be restricted to the three mentioned. In the case where a tenant happens to own the dwelling unit, that tenant bridges two groups and incentives apply from two directions. A similar case arises when the owner and manager are not

two distinct persons, but the same; in that instance, the motivations are considered those of the owner.

There are three general types of conserving actions: structural actions involving building and equipment retrofit; operational actions involving the building itself and common equipment and appliances; and operational actions relating exclusively to the dwelling unit itself. If the action groups are combined with the actor groups, then three useful combinations occur, as follows:

- structural retrofit -- owners
- building and equipment operation -- owners and managers
- dwelling unit operation -- tenants

There are other combinations, but they present illogical or less meaningful groups and will not be considered. These three action/actor groups then constitute the major audiences where energy-conserving incentives may be applied and toward whom strategies will be directed.

C. Strategy Formulation

A further useful aggregation is possible by combining the action/actor groups with the types of incentives listed in the previous chapter. Although there are a number of combinations of the types of incentives themselves (for example, regulatory incentives could be coupled with any and all of the others, in four combinations), it again becomes useful to limit those possibilities to the most useful. This is done by considering the various audiences that will be addressed. By these means the following relative importance of incentive emerges when the incentive types are taken one at a time. These relationships are suggested in

the following table, the intent of which is to demonstrate that while single incentive types may be important, combinations of those incentives may yield more. (Table . .) The strategies that were selected for further consideration consist of the following, with regard to particular audiences:

Audience	Strategies
Structural Retrofit- Owners	A. Information measures only B. Fiscal-economic measures C. Regulatory measures D. Regulatory-fiscal-economic-information measures
Building and equip- ment operation -- owners and managers	A. Information measures only B. Economic measures only C. Economic-information measures D. Regulatory-economic-information measures
Dwelling Unit Operation Tenants	A. Information measure only B. Economic measures only C. Regulatory measures only

In every instance, the possibilities of using information measures only were considered, given the desire to use non-legislative and short-term means of achieving energy conservation. That alternative is posed in order to concentrate on those objectives. The education incentives that were listed in the previous chapter were omitted outright. Such efforts, it was believed, are useful, but a number of public and private initiatives in that area are already underway so it was desired to avoid duplication of effort. In addition, it is felt that targeted measures will prove more useful for the particular requirement of the multi-housing sector.

Table 5-2

## RELATIVE IMPORTANCE OF INCENTIVES

Action/Actor Group	Type of Incentive				
	Regulatory	Fiscal	Economic	Information	Education
Building Retrofit/Owner	●●	●●●	●●●	●●	●●
Equipment Retrofit/Owner	●●	●●●	●●●	●●	●
Building Operation/Owner-Mgr.	●●	●	●●●	●●●	●●
Dwelling Unit Operation/Tenant	●●	●	●	●●●	●●

●●● Very important

●● Important

● Less important

Source: Real Estate Research Corporation

#### D. Strategy Evaluation

The selected strategies were subjected to an evaluation procedure consisting of qualitative measurements of what the particular advantages and disadvantages of each strategy would be; this was intended to at the least provide an organized format for identifying the trade-offs involved with each strategy, and at the most provide a basis for choosing among the strategies. A second type of evaluation will follow in the next section, where a quantitative measurement of the potential impact on various market segments is presented, so that the "optimal" strategies might be targeted where the energy savings potential is the greatest. Finally, special consideration is given to a number of high-priority areas, where opportunities for conserving action and application of incentives are particularly strong.

##### 1. Qualitative Assessment

The criteria used in the qualitative assessment consisted of the following:

- Market Penetration
- Cost Considerations

This criterion is an estimate of the likely impact that a particular strategy will have in terms of energy conservation; in a sense, it is a measure of the overall likelihood of that strategy having a positive effect on energy consumption; this is not a measure of the potential impact, but of the actual likely impact.

##### Cost Considerations

The major concern in this instance is twofold: who bears the cost of developing and implementing the particular conservation strategy and how much will it cost.

- Time Frame

Three time periods are relevant without a precise duration for each period; the rough approximations of immediate (within six months), near-term (six months to two years), and long-term (over two years) are used; this measure relates to the amount of time required before conserving actions and incentives can be implemented

- Institutional Context

The legal, administrative, or other institutional activities that are necessary for implementation are considered here; the role of the Federal Energy Administration is particularly important, but the involvements of Federal, state and local governments, as well as utilities and financial institutions, are included

- Feasibility

This criterion relates to the overall practicality and likely acceptance of the strategy, especially when it is considered in the context of other incentives or disincentives

The results of the assessment of strategies for each action/actor group are recorded in the following three tables (tables      to      ).

Although the exact reasoning behind each statement has not been supplied, the trade-offs should be self-explanatory. By way of summary, however, the following major conclusions result from the qualitative comparisons of alternative strategies:

- a. Group 1: Structural Retrofit -- Owners
  - No single type of incentive is appropriate for this action/actor group, but several types must be considered as a group to have any significant influence. At a minimum, fiscal and/or economic measures will be required to provide any incentive for capital investment on the part of building owners
  - Information and regulatory actions will broaden the appeal and reinforce the effects of economic and fiscal actions

- Two factors may prove prohibitive and thereby limit the potential for energy conservation -- the costs of economic and/or fiscal incentives, and the sheer time and difficulty involved in implementing the incentive.
- b. Group 2: Building and Equipment Operation -- Owners and Managers
  - Economic incentives in large measure provided by desire by owner or manager to preserve profit position; energy reductions are a consequence of cost reductions
  - The potential for information measures of a variety of types therefore is enhanced; particular knowledge of costs and savings, conservation measures, technical assistance, and demonstration projects become more feasible.
  - Conservation efforts may be limited by the limited slack in energy use, so that major effort at belt-tightening will result in only small or marginal gains.
- c. Group 3: Dwelling Unit Operation -- Tenants
  - Economic and regulatory measures only have limited influence over tenant behavior, so those types of incentives are limited in effect.
  - Information would be useful, if only because prospects for other actions or strategies are relatively limited. Divulging the hidden costs of energy consumption would be useful, but it implies that some measure of consumption can be made, and the energy costs are substantial enough to warrant alteration to lifestyles and consumption habits.

## STRATEGY EVALUATION

ACTION/ACTOR GROUP 1: STRUCTURAL RETROFIT - OWNERS					
STRATEGY	MARKET PENETRATION	CONSIDERATIONS	TIME-FRAME	INSTITUTIONAL CONTEXT	FEASIBILITY
A. Information measures	5% or less	Cost of developing information not excessive for prospective situations considerably more costly. Cost of dissemination less than other measures, but still a large audience.	Immediate to near term	FEA could develop information in conjunction with professional organizations; and disseminate through organizations or directly.	Limited potential by itself. Most building owners are aware of higher energy costs, if not aware of specific conserving actions. Information would be useful, but savings potential not great.
B. Fiscal-Economic measures	20-30%	Cost clearly borne or underwritten by public agency, most likely by Federal government. Cost would be almost prohibitive unless spread over longer period.	Long-term	Requires legislative action at federal and/or other levels. Likelihood of specific action for energy-conservation is small role for FEA in monitoring action. Role for financial institutions in any loan guarantee program or other economic action.	Fiscal and economic measures are feasible, but relatively unlikely. Even if implemented, would involve longer time than might be desired.
C. Regulatory measures	100% if implemented, but low chance of implementation, 5-10%	Cost borne by building owners; would abandon or neglect building before making capital investment for energy conservation if excessive demands placed on them. Cost of enforcement and monitoring would be excessive.	Near-term	Requires legislative action at Federal and/or other levels. Enforcement by FEA possible, but might involve other agencies instead.	Mandatory requirements operating in a vacuum will result in no change and will create considerable ill feeling. Likely effects will be counter-productive and not result in energy savings.

## STRATEGY EVALUATION

ACTION/ACTOR GROUP 1: STRUCTURAL RETROFIT - OWNERS					
STRATEGY	1. MARKET PENETRATION	2. COST CONSIDERATIONS	3. TIME-PERIOD	4. INSTITUTIONAL CONTEXT	5. FEASIBILITY
D. Regulatory - Fiscal - Economic - Information measures	30 - 40%	Costs considerable but possible to pass costs on to tenants, while initial burden is either on government or is limited on owners.	Near to long-term	Comprehensive actions mutually reinforce each other. Competitive differences among owners maintained by overall regulation. Unwillingness or inability to invest capital aided by fiscal or economic means. Implementation assisted by means of information.	Actions provide adequate incentive for owners to retrofit on own initiative. Role of FEA is to monitor, coordinate, and provide information to owners. Other institutions' involvement is also required, so that coordinating activities might become a problem.

STRATEGY EVALUATION  
ACTION/ACTOR GROUP 2: BUILDING AND EQUIPMENT OPERATION - OWNERS AND MANAGERS

STRATEGY	1. MARKET PENETRATION	2. COST CONSIDERATIONS	3. TIME-FRAME	4.	5. INSTITUTIONAL CONTEXT	FEASIBILITY
				INSTITUTIONAL CONTEXT		
A. Information measures	10 - 15%	Cost of developing information not excessive for prototype situations. Information for specific situations considerably more costly.	Immediate to near term	FEA could develop information in conjunction with professional organizations, and disseminate through organizations or directly. Utilities could prove helpful in implementation.	Virtually all owners and managers suffer from higher operating costs due to energy, but not all are equally aware of where opportunities for conservation exist.	Economic measures may have limited effect, since cost squeeze operates already as an incentive.
B. Economic measures	10 - 15%	Cost of subsidy or direct grant is unwarranted. Cost of incentives or bonuses for efficient operating must be borne by building owner; such costs must be offset by demonstrated savings in operating costs to even be considered.	Long-term	Those actions requiring legislative action not particularly favored. Best opportunity lies with owner or manager initiative and imagination for cost-cutting.		

STRATEGY EVALUATION  
 ACTION/ACTOR GROUP 2: BUILDING AND EQUIPMENT OPERATION - OWNERS AND MANAGERS

STRATEGY	1. MARKET PENETRATION	2. COST CONSIDERATIONS	3. TIME-FRAME	4. INSTITUTIONAL CONTEXT	5. FEASIBILITY
C. Economic - Information measures	30 - 40%	Economic costs must be borne by building owner; little prospect for assistance from other sources. Information costs can be borne by Government or other private sources. Actual cost requirements not excessive.	Near to long-term	Requires direct action by FEA in developing and disseminating information.	Prospects are increased when successful management programs are widely publicized. Use of economic incentives with demonstrable results should prove useful.
D. Regulatory - Economic - Information measures	40 - 50%	Cost considerations not adhered except that more owners or managers are encouraged to adopt conserving actions.	Near to long-term	Requires direct legislative action, principally by local governments. FEA could suggest codes or ordinances to local governments for adoption.	Prospects for savings increased since regulation gives added dimension to incentives; required actions coupled with voluntary actions would encourage conservation. Prospects for implementation are less promising, however.

Source: Real Estate Research Corporation

## STRATEGY EVALUATION

## ACTION/ACTOR GROUP 3: DWELLING UNIT OPERATION - TENANTS

STRATEGY	MARKET PENETRATION	COST CONSIDERATIONS	TIME-FRAME	INSTITUTIONAL CONTEXT	FEASIBILITY
A. Information measures	10 - 30%	Information costs are not excessive, but must be borne entirely by Government. Contribution of parallel effort by utility, tenant groups or owner-managers might be encouraged.	Immediate (but will fluctuate in intensity of action.)	Development of basic information could be undertaken or sponsored by FEA; other agencies or organization can assist if resources and coordination provided by FEA.	Requires periodic efforts at specifically targeted audiences. Conserving information will not be successful without direct knowledge of consumption although generalized information would be useful.
B. Economic measures	5% or less	Requires some reward (rent reduction or other economic compensation) for consideration. Costs would not be borne by owners-managers; would require some subsidy by governmental source.	Long-term	Incentives must be developed and administered by building owners or managers although FEA guidance might be useful.	Requires direct measure of dwelling unit consumption for individual tenant action; this measure is often lacking. Alternatively, requires some group incentive for conservation on a building basis; prospects for such cooperation are negligible. Question exists as to impact of economic incentive since costs are relatively small and hidden.

STRATEGY EVALUATION					
ACTION/ACTOR GROUP 3: DWELLING UNIT OPERATION - TENANTS					
STRATEGY	1. MARKET PENETRATION	2. COST CONSIDERATIONS	3. TIME-FRAME	4. INSTITUTIONAL CONTEXT	5. FEASIBILITY
C. Regulatory measures	5% or less	Costs would not be excessive but would require monitoring and enforcements. Burden of such costs is not clear but would be resented by owners-managers or tenants.	Immediate	Mandated actions or requirements by some authority (government, utility, or other) is necessary.	Requires intervention in consumer decisions by mandate, not be economic action. Would be resented in all likelihood and unworkable. Minor regulations in operation of common appliances might be feasible.

2. Quantitative Assessment

A second type of measure of the potential for energy conservation is also necessary. In order to target strategies and incentives, some sense of the size of the audience and the potential for energy savings must be determined.

In order to evaluate fully the usefulness and impact of particular conservation strategies, perhaps the best rationale for deciding among alternative courses of action is the potential for saving energy.

This is not the only rationale, since energy conservation must take place in a larger context in which a number of other factors are considered and weighed against conservation. That process of weighing was intended by the qualitative comparisons undertaken in a previous section. But clearly savings potential will have considerable part of Federal Energy Administration estimates of the costs and benefits of various conservation programs.

There are a large number of possible combinations of actors, action groups, market segments, incentive types, and strategies. The number is unwieldy for any systematic or formal analysis. What is possible is to describe how savings potential might be determined for any set of combinations, and then to work through an example of a particular set of actions. With the basic data supplied in this report and the methodology described, the Federal Energy Administration should have sufficient means to undertake any number of similar analysis and to evaluate alternative courses of action.

In theory, the factors that contribute to an estimate of savings potential would be combined as follows:

- a. number of dwelling units X per dwelling unit consumption factor.  
= total consumption
- b. total consumption X savings factor (from a particular conserving action)  
= maximum savings potential

(Note: The savings factor can relate to a specific conserving action, such as adding insulation to structure or maintaining heating and cooling equipment; in such cases, the actual amount of savings can be used--so that for adding insulation, annual savings of about 35 to 40 are possible. Alternatively, the generic conserving options can be used for illustrative purposes, realizing that wide variations can exist by such a procedure. In either approach, data are lacking, but rough estimates may be useful enough).

- c. maximum savings potential X market penetration estimates (from the strategies, above)  
= actual savings potential

This procedure may be used for particular market segments, or aggregations up to the total multi-family housing market. If aggregations are used it is important to use the appropriate numbers of dwelling units with the appropriate consumption factors. The three-step sequence gives more refined estimates, but it is also possible to do the first or first and second steps only to get rough order of magnitude estimates that might prove equally useful. The third step is necessary because just carrying the analysis through the second step will only give the savings potential if all dwelling units in a particular class have a given conserving action applied to them. In fact, the likelihood that

every single unit being affected is remote; it is more likely that a given set of incentives will affect only a portion of a class of dwelling units or market segment. The way in which the strategies were constructed then shows that if different types of incentives are combined, there is a commensurate increase in the level of market penetration. This means that as a strategy is refined, the number of dwelling units likely to be affected is increased and the savings potential that will be achieved will be greater. As was pointed out in the qualitative assessment, the increasing benefit of energy savings begins to encounter rising costs however after some point.

The following example of the calculation of savings potential illustrates many of these points, as well as describe the methodology for making similar types of calculations.  
(See Table)

CONSERVING ACTION - RETROFIT  
 SAVINGS ESTIMATE - 20%  
 BUILDING AGE - BEFORE 1950

<u>Number of Dwelling Units</u>	<u>Per d/u Consumption (10<sup>6</sup>btu)</u>	<u>Total Consumption (10<sup>6</sup>btu)</u>	<u>Maximum Savings Potential</u>	<u>Strategies</u>	<u>Market Penetration</u>	<u>Potential Savings (10<sup>6</sup>btu)</u>
				A. Information		
4,400.0	111.9	492,360	98,470	B. Fiscal	5%	4,923
				C. Economic	25%	24,617
				D. Regulatory	5%	4,923
				Combined	35%	34,464

3. Economic Impact Calculations

The cost of conserving actions can only be estimated roughly, since such costs vary because of a large number of factors as in the case of savings potentials, meaningful estimates require the development of adequate information about specific conservation cost. For purposes of illustration it is possible to continue with the methodology used to determine savings potential. If the retrofit action could be accomplished at an average cost of \$100 per dwelling unit, the total cost would be \$897 million if all buildings were to be affected. However, since the estimate of probable application, the market penetration factor, was estimated at 35%, the total cost would be approximately \$135 million. A subsidy of \$100 maximum per dwelling unit would require an appropriation of the full amount. The btu savings could be converted into the equivalent of barrels of imported oil, or other factors, and a determination made of the relative value to the nation of the conserving action. A revolving loan fund would require an appropriation or special borrowing which would peak at approximately \$125 million and which would be repaid within seven years (assuming 5-year loans). An interest rate could be set which could cover administrative costs of handling the program, but an interest rate which also covered the cost of borrowing by the government would probably be too expensive for owners. The net cost of the program would be roughly equal to the cost to the government of the borrowed funds.

If the cost of the program were to be born wholly or in part by the owners, their cash flow would be reduced by the \$100 per dwelling unit during the year of initial implementation and increased by the amount of the energy cost

savings in future years. If the amount of savings were less than \$25, the owner would almost certainly need to increase rents in order to make it possible for for him to achieve the 3 - 5 year payout on the investment, which most owners would require if they were to make the investment at all. Since the average cost of energy is still a relatively small part of total costs, under 10% in most situations, the amount of potential dollar savings to the owner is not great in relationship to manu retrofit costs.

It is probably that fiscal-economic incentives required for operational changes will be modest, if required at all, and only an amount to supplement the savings required to create an acceptable payout period for the owner. The principal concern about the economic impact of various incentives should be to endure that regulatory incentives or strategies do not require expenditures which either jeopardize an owner's cash flow or create an incentive to increase rent sufficiently to create hardships on tenants. Determination of whether conservation expenditures require financial incentives must be made on the basis of the analysis of specific retrofit costs, measured against the economics of the building category involved.

#### 4. Priority Savings Areas

In terms of per dwelling unit consumption, three characteristics show significant variation in consumption of energy and, hence, are logical "special markets" for conservation programs. They are public housing units, apartments which are master metered, and units in the northeast and north central states.

##### Public Housing Units

The average public housing unit uses 160.1 million btu's of energy annually, compared with 102.2 for comparable private units. The reasons for these differences relate to the operation of the buildings, the buildings themselves, and the nature of the tenant group.

In public housing projects a utilities allowance is calculated for each apartment on the basis of a formula developed by HUD in the early 1960's. That allowance is revised periodically as use patterns change; when more than 20% of the tenants are above the allowance, it is raised. This upward bias has tended to serve as a disincentive for tenants to conserve. In a recent case in Cleveland, new allowances were established which appear to be significantly higher than consumption based on findings by the utility companies. 1/

There is less economic motivation for owners, tenants, or operating personnel to take rigorous energy conservation measures than for their private sector counterparts, since their goals are more social in nature. The nature of the subsidized operation does not eliminate the need for or the desire to be efficient, but it does

1/ Correspondence with Cuyahoga Metropolitan Housing Authority, August 1975

tend to reduce the urgency for savings programs. Employees of housing authorities are often civil service so that bonus arrangements for meeting performance goals are not likely. The growth of tenant management corporations and similar arrangements may offer a mechanism for greater leverage in implementing successful conservation programs.

Many public housing projects were constructed at costs lower than many other structures, a possible source of structural differences which result in less energy efficient units. Maintenance in public housing is sometimes not as good as that found in private units because of the lack of necessary funds, a higher level of required remedial maintenance, and the lack of marketplace pressures to attract tenants.

Tenants in public housing are necessarily lower income, a factor which is often associated with lower levels of education. Other socioeconomic characteristics, such as a rural background, combine to create a lack of familiarity with apartment living, heating systems, and appliance usage which may result in excessive levels of energy conservation. The lower income levels preclude the ownership of newer or more efficient appliances.

Any set of incentives directed toward public housing must take into account the special characteristics of that market. In order of priority they should include:

Any set of incentives directed toward public housing must take into account the special characteristics of that market. In order of priority they should include:

1. Creation of performance standards which have energy efficiency as a major criterion, together with equity and comfort of the tenant. These standards should be established on the basis of a study of housing authorities and should include the participation of the authorities and their tenants as well as professionals from HUD and FEA.
2. Financing mechanisms should be created to permit necessary capital improvements to be made in buildings and systems to provide for higher efficiencies. There is some precedent toward such financing in recent Congressional action to provide subsidies for conservation in low income and elderly housing.
3. A tenant education program is needed which will acquaint tenants both with the mechanics of using energy more efficiently and the costs of failing to practice conservation. Such a program should include ways for tenants to participate in or benefit from such savings, perhaps through the funding of other facilities or services they desire. Special education programs directed at tenant children could be a strong reinforcement to a more general program. The education program should be related to the performance standards appropriate for tenants in their own buildings and directed toward an understanding of the cost of present consumption and the potential savings, together with the tenants' role in effecting those savings.

4. A program of technical education and technical assistance should be instituted to aid operating personnel in achieving greater system efficiency and, if appropriate, in working with the tenant education program and subsequent assistance to them.

The cost of all but the financing mechanisms would not be great. Performance standards are computed periodically as a matter of course, and the addition of energy conservation criteria should not impose significant extra costs. Most housing authorities have a great local need to take actions to reduce their costs and should be willing to cooperate fully. The tenant and personnel education programs can be developed as part of a larger or more general education program, tailored to individual situations with the cooperation of local housing authorities and educational institutions. The most logical financing mechanisms for the capital improvements would be those currently used by the authorities, perhaps with a special Federal guarantee or interest subsidy to reduce the burden of the conservation action.

While public housing represents less than 10 % of the total multifamily inventory, the large variation in consumption suggests that significant conservation is possible, and the relatively small number of housing authorities accounting for the bulk of the units is small enough to be a manageable audience for FEA. Higher energy costs have become a critical factor for public as well as private managers, so that there should be a readiness to participate in conservation programs. Some authorities, such as New York City, have already initiated conservation programs which are showing large

savings in fuel consumption. The difficulties of raising capital for public authorities today strongly suggests that some additional Federal assistance will be required.

Master Metered Buildings

Units in buildings which are master metered for electricity consume an average of 145.5 million btu's per year, compared with 90 million for apartments which have individual meters and pay their cost directly, not as a part of rent. The opinion is widely held in the apartment industry and among utilities that conversion from master metering to some form of individual metering would be the most important single step which could be taken to reduce energy consumption in multifamily dwellings, not only because of the immediate reduction in consumption of electricity, but also because of the impetus it would give energy conservation generally.

The principal reason attributed to the higher consumption in master metered buildings is, of course, that the tenant is neither aware nor concerned about his consumption since he does not pay directly for it. He is usually aware that the building owner is purchasing electricity at a low rate and often tends to believe that his own consumption is such a small part of the whole that it is inconsequential. Many owners, and tenants, have suggested that the careless use of electricity is sometimes related to a general hostility toward owners.

The cost of conversion to individual meters is often relatively high if extensive rewiring is required; the MRI analysis indicates that it could

run as high as \$1,000 per unit. In buildings which are adequately wired, conversion can be accomplished in some instances for under \$100 per unit, perhaps as low as \$40 in some cases. Local building codes and utility practice also affect both the cost of conversion and the burden of cost.

Except when conversion is low cost, owners seek to share the costs with tenants, a move which is strongly resisted. As in the case of most capital investments, owners do not have the cash or financing required, and for higher cost conversions, the payout period can easily exceed the 3 - 5 years most owners consider feasible.

Tenants have typically fought conversion attempts because they believe that their total cost of housing will increase, that their new basic rent will not reflect the owner's reduced cost and that they will have the additional burden of purchasing electricity at a higher individual rate.

Two basic kinds of incentives seem appropriate to encourage conversion to individual meters in multifamily buildings:

1. Changes in utility rate structures, and
2. Assistance in financing the conversion.

Rate structures can be changed in two ways to facilitate conversion. If apartment owners were required to purchase electricity at the equivalent of single family residence rates, their costs would increase and the savings from conversion would be greater, reducing the payout time for the investment.

The differential to the tenant in his real cost of electricity between the two methods would be eliminated, reducing his feeling of inequity. An alternative would be to permit the apartment occupant to purchase electricity at the equivalent of the commercial rate paid by the owner. Such an arrangement would preserve total housing cost to the tenant at existing levels, but would require a subsidy from other purchasers in the system, unless it could be demonstrated that the electricity could be provided at smaller expense due to reduced need for distribution facilities.

In those cases in which conversion can be accomplished at a cost of \$100 or less per apartment, it should be possible for the owner to justify the expenditure on the basis of avoiding future cost increases through rate increases and/or increased tenant consumption. It should be possible to finance the investment, if necessary, through the utility which would benefit from a reduction in load requirement and from adding a greater part of the load to a higher part of the rate structure (if the structure were not changed). To be acceptable to the tenant, it would be necessary for the rent to be reduced by a prorated amount for his previous assumed consumption. Because not all apartments use electricity at the same level, reductions should take account of size and other factors as far as feasible, but some inequities will result which favor excessive users and penalize efficient users. Tax credits could be used effectively with both owners and occupants to help offset the increased cost for a one year period. Such credit might be for 50 % of the increased cost with a limit of \$50 or \$100.

In buildings where the cost of conversion is high, the same kinds of financing mechanisms would have to be created which would apply to other capital improvements. The most attractive of these would be a source of low cost financing, made possible by a direct government loan and/or subsidy program. A second alternative would be a special loan fund provided by normal lending institutions and electric utilities with some form of government guarantee or subsidy.

#### High Consumption Areas

Apartments in the northeastern states consume 141.8 million btu's each annually, more than twice as much as those in the southern and western states. This high consumption factor, combined with the fact that energy costs in the region tend to be the highest in the nation make the region a prime area for intensive conservation programs. The basic economic incentive is strong. While the AGA study shows that energy is used more efficiently than in the low cost areas, the potential for savings is great because of the heavy concentration of apartments.

In addition to the high level of consumption, the northeastern states are heavily dependent on imported fuel oil as a basic energy source. The region's distance from major domestic energy sources suggests that its costs of energy will remain relatively high.

The Northeast has a concentration of smaller and older apartments, sometimes obscured statistically by the large number of high rises in New York City. Smaller units use approximately 20 % more energy than larger ones and pre-1950 buildings approximately 10 % more than newer structures. Management in smaller, older buildings is generally not as sophisticated as others, and is

probably more in need to technical assistance. The size of the buildings means that they are low rise, which consume over 20% more energy than high rise.

Smaller and older buildings tend to have higher operating costs than others, making them highly susceptible to the rapidly rising costs of the past few years. In many cases they do not generate the cash flow necessary for capital improvements, or even extensive maintenance. Their ability to finance such improvements is limited. In some cities - such as New York and Boston - many buildings are subject to some form of rent control which limits the owner's ability to increase rents. A recent study in New York showed that the profitability of rent controlled buildings had dropped sharply since the 1973 rise in oil prices, severely limiting their ability to make improvements in the efficiency of their heating systems.<sup>2/</sup>

A concentrated conservation program by FEA in the Northeast should have a relatively greater payoff than equivalent expenditures in other regions. The need for and awareness of energy conservation is established. A large proportion of the buildings are in categories which are least efficient. Such a program should include two principal types of incentives: technical information and assistance for building owners, and a financing mechanism to make capital available.

2/ Real Estate Research Corporation, A Policy Review of Rental Housing in New York City, prepared for Coalition to Save New York, April 1975.

Limited discussions in the region suggest that there is a great need for technical information and assistance which is not being met in spite of the efforts of some utilities. Such private efforts could probably be strengthened by strong FEA programs. The setting of consumption and efficiency standards and goals could be an important part of a tenant education program and in assisting state and local authorities better judge the need for rent increases.

In addition to the incentive of a strong program of technical information and assistance, it will be necessary to provide for a source of capital. Anecdotal information suggests that the inefficiencies of boilers and burners is such - given the high cost of fuel - that relatively short payout can be obtained, usually in less than five years. In cases where a short payout is possible, access to low cost loans should be a sufficient financial incentive. Some utilities in the region are now assisting in the financing of insulation, and such programs could be expanded through limited assistance to the utilities with a revolving loan fund, loan pools including lending institutions, or the repurchase of loans above a certain limit by Federal financing sources. The financing of other smaller capital investments relating to the efficiency of the heating system - new radiator valves, storm windows, thermostats - would require a similar pool of capital. The level of these expenditures would be on the order of \$ 200-400 per apartment. The potential for keeping costs low can be enhanced by the fact that building managers can perform many of the repairs themselves, after receiving limited

instruction. In some cases, they could be performed as part of summer employment or special vocational education programs. In each case it would be necessary to develop a building audit program in which the savings and conservation potentials could be clearly identified followed by an appropriate conservation program designed to meet the deficiencies found. Such a program should be carried out by technically qualified persons at little or no cost to the building owner, since he will probably be reluctant to incur the initial expense. It would be important that local governments agree to defer any property reassessment which would reflect investment in energy conservation equipment; many owners are highly sensitive to the possibility of increased property taxes resulting from such investment.

Such a program could subsequently be expanded, and modified, to the North Central region which has relatively high energy costs and consumption. If the cost of natural gas increases dramatically in other areas of the country, the basic cost consciousness will be changed in a way to cause great interest in and support for major conservation programs.

## APPENDIX

## 1970 Public Use Sample

## Computer Printouts

Notes: The Public Use Sample is a one percent file. All unit tabulations shown (excluding average costs) equal one percent of estimated totals.

The column "total occupied units" includes owner and renter-occupied units, as do the columns "occupied households by house heating fuels." However, data on utility and fuel usage and average costs are presented for renter-occupied units only. Owner-occupants were not asked to estimate average utility and fuel costs in this sample.

APPENDIX

BIBLIOGRAPHY

## BIBLIOGRAPHY

Most published literature in both energy consumption and energy conservation has stressed other sectors, so that there is very little directly relevant material on multifamily housing. The absence of published Census information means that there has been little analysis of the structural aspects of the multifamily market. The information related to energy conservation falls into these general categories:

- o Overall studies like those which are a part of the Energy Policy Project;
- o Studies targeted to related areas such as general residential, commercial, public buildings;
- o Check lists of conservation measures;
- o Studies of limited aspects of energy consumption; and
- o Technical studies of energy conservation measures, often emphasizing new construction.

Very little ongoing research was identified which relates closely to multifamily dwellings and their energy consumption.

To supplement the limited information available from conventional published sources, RERC conducted a series of interviews with 50 persons throughout the country. While the information obtained is almost entirely anecdotal, the sources of information are knowledgeable - expert in some instances - and represent a number of points of view. A number of conclusions from the interviews could be verified or substantiated from other interviews, from the literature, and from analysis of available data.

## INTERVIEW INFORMATION SOURCES

Greg D. Root, Cuyahoga Metropolitan Housing Authority, Cleveland, Ohio  
Utility allowances in public housing, conservation incentives

Victor Syng, FEA Conservation and Environment Regional Director, Kansas City, Missouri  
Conservation practices

George Dworak, State of Nebraska Energy Office, Lincoln, Nebraska  
Statewide infrared scanning program

Clancey Woolman, Cenex, Central Telephone and Utilities, Lincoln, Nebraska  
Infrared scanning program, customer response

Richard J. Trieste, Brooklyn Union Gas Company, Brooklyn, New York  
Consumption and conservation practices, incentives, utility programs

Robert Bridges, FEA Regional Office, Conservation and Environment, Atlanta, Georgia  
Consumption patterns, conservation efforts

Lamar Cobb, Georgia State Energy Agency, Atlanta, Georgia  
State and City programs to encourage conservation measures, public attitudes

John Keyser, Pacific Gas and Electric Company, San Francisco, California  
Current conservation practices, incentives, rate structures, insulation programs

Jim McCool, FEA Conservation and Environment Regional Director, Denver, Colorado  
Current consumption and conservation attitudes

Stacy Swor, FEA Conservation and Environment Regional Director, San Francisco, California  
Conservation programs, consumption patterns

Gil Haselberger, FEA Regional Office, Conservation and Environment, Seattle, Washington  
Conservation awareness, response to conservation seminars

FEA Regional Office, Conservation and Environment, Boston, Massachusetts  
Conservation efforts, winterizing program, vocational-technical education program

FEA Regional Office, Conservation and Environment, Philadelphia, Pennsylvania  
Conservation measures, role of social organizations

Mike Robinson, House and Home, New York, New York  
Financial problems in conservation programs, Arkansas pilot program

FEA Regional Office, Conservation and Environment, New York, New York  
Winterizing program, incentives for conservation

Joseph Rizutto, New York Public Service Commission, Albany, New York  
Utility conservation programs, winterization program, State conservation program

Charles Achilles, Institute of Real Estate Management, Chicago, Illinois  
IREM energy conservation guidelines publication, experimental program, conservation practices

Alan Smith, Brooklyn Union Gas Company, Brooklyn, New York  
Proposed survey of energy use in apartment buildings

Jeffery C. Cohen, Citizens for Clean Air, Inc., New York, New York  
Energy consumption in public and private multifamily housing

Sidney Furstman, Aerospace Corporation, Los Angeles, California  
Energy conservation project with four public housing authorities

Ralph Johnson, NAHB Research Foundation, Washington, D.C.  
Energy conservation publications, industry conservation practices

Frank Yanaros, Florida Power and Light Company, Miami, Florida  
Utility conservation programs, results

William Moses, Community Housing Improvement Program, New York, New York  
Owners' conservation activities, building codes, incentives

Alex Bul, Henry S. Miller Company, Dallas, Texas  
Conservation obstacles, incentives

Joseph Murray, Shannon and Luchs, Washington, D.C.  
Conservation incentives, current programs

Sidney Glassman, Charles E. Smith Companies, Washington, D.C.  
Current conservation practices, incentives

David Taylor, Rental Housing Association, Boston, Massachusetts  
Industry conservation activity, incentives

Jerry Evans, Fax and Varshodon, Menlo Park, California  
Analysis of incentives, conservation measures

Daniel Balk, New York City Housing Authority, New York, New York  
Current conservation programs, incentives

Arnold Taras, Crow, Pope and Land Management, Atlanta, Georgia  
Energy cost impact, incentives

William D. Sally, Beard Warner Company, Chicago, Illinois  
Conservation obstacles, incentives

Bud Thomssen, Clapp-Thomssen Company, St. Paul, Minnesota  
Conservation measures, incentives

Bob Hartman, William Walters Company, Los Angeles, California  
Energy conservation manual, incentives

Richard Morgan, Environmental Action Foundation, Washington, D.C.  
Effectiveness of incentives, rate structures for electricity

M. Pintar, Municipal Energy Conservation Program, New York, New York  
Local conservation activities

Alan  
Freeman, Environmental Education Project, New York, New York  
Energy-related education programs

John Hampton, National Tenants Organization, Washington, D.C.  
Tenant attitudes and needs, public housing consumption

West Side Tenants Union, New York, New York  
Conservation possibilities, tenant attitudes

Joe Browder, Environmental Policy Center, Washington, D.C.  
Conservation attitudes, tenant attitudes

Gordon Gross, Midwest Research Institute, Kansas City, Missouri  
Master metering, energy consumption patterns, conservation measures

Clarence Roeder, Guardian Management Company, Shawnee Mission, Kansas  
Conservation measures, incentives

Richard Ulf, Office of Housing Programs, HUD, Washington, D.C.  
Energy consumption in public and assisted housing, conservation potential

~~Quinnie Laughlin~~, National Governors Conference Energy Project, Washington, D.C.  
State energy conservation programs

James Dlugosh, Minnesota Housing Finance Authority, St. Paul, Minnesota  
State energy conservation programs

Michael Murphy, Upper Midwest Council Energy Project, Minneapolis, Minnesota  
Energy conservation programs, incentives, disincentives

Chicago Housing Authority, Chicago, Illinois  
Energy conservation programs

~~FEA Regional Office~~, Conservation and Environment, Chicago, Illinois  
Conservation measures

Matthew Hobbs, Massachusetts Housing Finance Agency, Boston, Massachusetts  
Energy Consumption in assisted housing

Dr. Evelyn F. Murphy, Secretary, Executive Office of Environmental Affairs, Commonwealth  
of Massachusetts, Boston  
State energy conservation programs, incentives

---

---

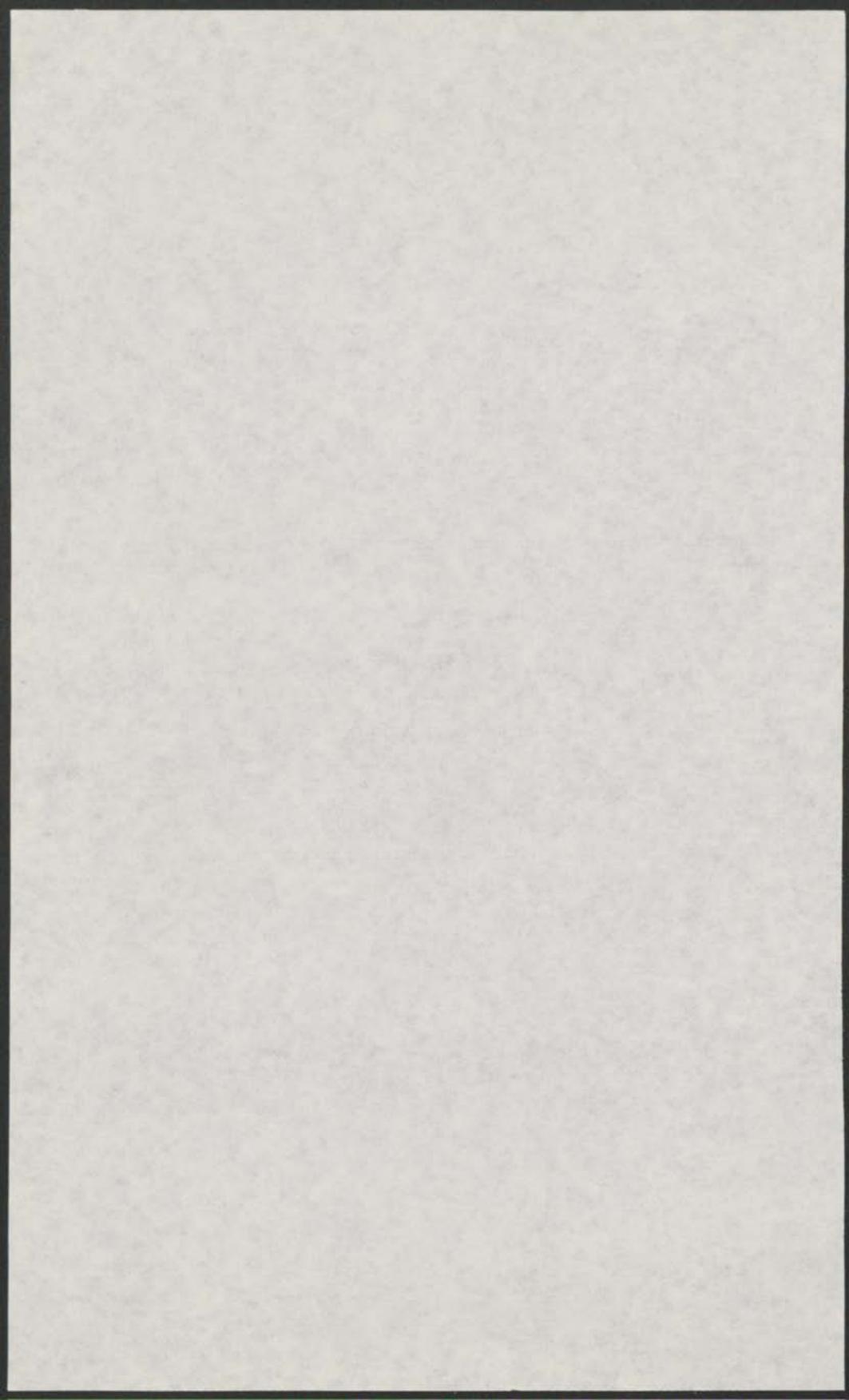
APPENDIX D

---

SELECTED ARTICLES

---

---



# energy conservation

309

**Federal Energy  
Management Program**

First Quarter Report

Fiscal Year 1975



**Conservation Paper  
Number 2**

Energy Conservation in the Federal Government  
First Quarter, Fiscal Year 1975

During Fiscal Year 1975, the Federal establishment was charged by the President to reduce energy consumption by 15 percent below energy consumed in Fiscal Year 1973. For the first quarter of Fiscal Year 1975 the response has been a reduction of 21 percent below energy consumption in the first quarter of Fiscal Year 1973. This savings is equivalent to 19.7 million barrels of oil and \$181 million in energy costs.

This continues the impressive performance achieved during Fiscal Year 1974, when departments and agencies of the Federal Government reduced their energy consumption by 24 percent--more than tripling the original 7 percent reduction goal directed by the President.

As the Federal Energy Management Program moved into its second year, the number of Federal units being monitored by the Federal Energy Administration under this program was increased to 26. The 10 newcomers are the Postal Service, Tennessee Valley Authority, Panama Canal Company, Civil Aeronautics Board, Civil Service Commission, Federal Communications Commission, Interstate Commerce Commission, Federal Power Commission, Office of Management and Budget, and the Small Business Administration.

Each of the departments and agencies listed below exceeded the overall 21 percent reduction achieved this quarter.

	<u>Percent Reduction</u>
(1) Civil Service Commission	32.9
(2) National Aeronautics & Space Administration	31.2
(3) General Services Administration	27.6
(4) Small Business Administration	23.1
(5) Department of Defense	21.8

Two energy sources, jet fuel and diesel and petroleum distillates, accounted for the bulk of the savings. In addition to the savings listed below, reductions also occurred in the use of automotive gasoline, fuel oil, and liquified petroleum gas.

<u>Fuel</u>	<u>Volume Saved (in Trillion Btu's)</u>	<u>Percent Reduction</u>
Jet Fuel	69.7	28.8
Diesel & Petroleum Distillates	29.0	37.6
Coal	4.5	30.8
Navy Special	4.1	39.6
Natural Gas	2.4	8.3
Aviation Gasoline	2.3	28.8

These results confirm the belief that energy conservation is indeed becoming a firmly entrenched part of the Federal way of life and that the Federal establishment is taking into account the cost of energy in all of its operations. Moreover, these continuing results show conclusively that the conservation ethic can be developed in a significant segment of the national population.

Detailed information showing the performances of the individual participating departments and agencies and the amounts and types of energy used and saved can be found in the tables and figures that follow.

---

NOTE: In the tables that follow, the figures for the first quarter of Fiscal Year 1973 (the baseline used for comparison purposes) will, in some cases, differ from comparable baseline figures shown in previous reports. These differences are the results of adjustments made to reflect changes in the level of agency programs.

Table 1a-First Quarter - Fiscal Year 1975, Energy Conservation Performance by Department/Agency  
(Btu's x 10<sup>9</sup>)

Department/Agency	Baseline <sup>1/</sup> First Quarter FY 73	Consumption First Quarter FY 75	Savings	Percent Reduction
Agriculture	2,969.4	2,399.7	569.7	19.2
Atomic Energy Commission	23,856.0	20,284.2	3,571.8	15.0
Civil Aeronautics Board	.267	.314	(.047)	(17.6)
Civil Service Commission	34.4	23.1	11.3	32.9
Commerce	1,020.6	839.6	181.0	17.7
Defense <sup>2/</sup>	449,179.8	351,299.5	97,880.3	21.8
Environmental Protection Agency	159.3	132.9	26.4	16.6
Federal Communications Commission	9.3	8.0	1.3	13.9
Federal Power Commission	.323	.278	.045	13.9
General Services Administration	14,664.6	10,621.9	4,042.7	27.6
Health, Education & Welfare	2,077.6	1,779.0	298.6	14.4
Housing & Urban Development	101.4	85.9	15.5	15.3
Interior	3,135.1	2,503.0	632.1	20.2
Interstate Commerce Commission	6.0	5.6	.4	6.7
Justice	2,079.9	2,077.1	2.8	.1
Labor	325.5	285.7	39.8	12.2
National Aeronautics & Space Administration	9,468.6	6,512.3	2,956.3	31.2
Office of Management & Budget	.214	.237	(.023)	(10.7)
Panama Canal Company	2,541.4	2,360.8	180.6	7.1
Postal Service <sup>3/</sup>	14,805.5	13,251.4	1,554.1	10.5
Small Business Administration	2.6	2.0	.6	23.1
State	9.9	9.5	.4	4.0
Tennessee Valley Authority	238.1	198.4	39.7	16.7
Transportation	7,340.7	6,113.5	1,227.2	16.7
Treasury	1,030.2	917.6	112.6	10.9
Veterans' Administration	<u>8,755.5</u>	<u>7,935.8</u>	<u>819.7</u>	<u>9.4</u>
Total	543,812.2	429,647.3	114,164.8	20.99

<sup>1/</sup> See note, page 2.

<sup>2/</sup> Does not include GSA vehicles.

<sup>3/</sup> Postal Service figures based on approximately two-thirds of its energy consumption (data not available for all installations).

Note.—Consumption figures below 1.0 have been carried to three decimal places.

( ) = Increase

Table 2-First Quarter - Fiscal Year 1975, Energy Use by Type

Type of Energy	Base Line <sup>1/</sup> First Quarter FY 73	Consumption First Quarter FY 75	Savings	Percent Reduction
Electricity, in megawatts per hour	10,491,730.0	10,618,556.0	(126,826.0) <sup>2/</sup>	(1.2) <sup>2/</sup>
Fuel oil, in thousands of gallons	120,898.4	108,471.0	12,427.4	10.3
Natural gas, in millions of cubic feet	27,473.0	25,182.6	2,290.4	8.3
LPG or propane, in thousands of gallons	25,485.8	23,897.9	1,587.9	6.2
Coal, in short tons	589,425.4	407,641.6	181,783.8	30.8
Purchased steam, in Btu's $\times 10^9$	771.1	987.2	(216.1) <sup>2/</sup>	(28.0) <sup>2/</sup>
Automotive gasoline, in thousands of gallons	173,576.9	157,881.9	15,695.0	9.0
Diesel & petroleum distillates, in thousands of gallons	555,911.7	346,710.6	209,201.1	37.6
Aviation gasoline, in thousands of gallons	64,619.8	45,991.7	18,628.1	28.8
Jet fuel, in thousands of gallons	1,361,225.0	1,325,113.0	536,112.0	28.8
Navy special, in thousands of gallons	75,273.0	45,682.0	29,891.0	39.6

<sup>1/</sup> See note, page 2.<sup>2/</sup> As part of its energy conservation program, the United States Navy has reduced operations of many of its vessels. The result is a reduction in the use of oil but an increase in the use of steam and electricity at dockside connections.

( ) = Increase

Table 3--First Quarter - Fiscal Year 1975, Energy Use by Type  
(Btu's x 109)

Type of Energy	Baseline <sup>1/</sup> First Quarter FY 73	Consumption First Quarter FY 75	Savings	Percent Reduction
Electricity	121,703.7	123,174.8	(1,471.1) <sup>2/</sup>	(1.2) <sup>2/</sup>
Fuel oil	16,768.6	15,044.9	1,723.7	10.2
Natural gas	28,324.7	25,963.3	2,361.4	8.3
LPG or propane	2,433.8	2,282.2	151.6	6.2
Coal	14,488.1	10,019.8	4,468.3	30.8
Purchased steam	771.1	987.2	(216.1) <sup>2/</sup>	(28.0) <sup>2/</sup>
Automotive gasoline	21,697.1	19,735.3	1,961.8	9.0
Diesel & petroleum distillates	77,104.6	48,088.8	29,015.8	37.6
Aviation gasoline	8,077.4	5,748.9	2,328.5	28.8
Jet fuel	241,959.2	172,264.6	69,694.6	28.8
Navy special	10,482.0	6,336.1	4,145.9	39.6
Total <sup>3/</sup>	543,810.3	429,645.9	114,164.4	20.99

<sup>1/</sup> See note, page 2.

<sup>2/</sup> As part of its energy conservation program, the United States Navy has reduced operations of many of its vessels. The result is a reduction in the use of oil but an increase in the use of steam and electricity at dockside connections.

<sup>3/</sup> Data may not add to totals shown in other tables due to rounding.

( ) = Increase

Table 4-First Quarter - Fiscal Year 1975, Energy Savings by Major Categories  
(Percent)

Department/Agency	Building and Facility Operations	Vehicle and Equipment Operations	Total
Agriculture	12.8	22.9	19.2
Atomic Energy Commission	15.0	12.6	15.0
Civil Aeronautics Board	1/	(17.6)	(17.6)
Civil Service Commission	1/	32.9	32.9
Commerce	17.3	18.7	17.7
Defense	(6.4)	30.8	21.8
Environmental Protection Agency	11.1	35.3	16.6
Federal Communications Commission	9.6	15.4	13.9
Federal Power Commission	1/	13.9	13.9
General Services Administration	27.6	19.1	27.6
Health, Education & Welfare	12.9	24.3	14.4
Housing & Urban Development	1/	15.3	15.3
Interior	20.9	18.9	20.2
Interstate Commerce Commission	1/	6.7	6.7
Justice	1.0	(2.6)	.1
Labor	12.4	11.5	12.2
National Aeronautics & Space Administration	31.2	31.6	31.2
Office of Management & Budget	1/	(10.7)	(10.7)
Panama Canal Company	11.7	(8.5)	7.1
Postal Service 2/	14.4	7.8	10.5
Small Business Administration	1/	23.1	23.1
State	1/	4.0	4.0
Tennessee Valley Authority	27.2	7.7	16.7
Transportation	16.7	16.8	16.7
Treasury	19.7	1.4	10.9
Veterans Administration	9.2	16.0	9.4

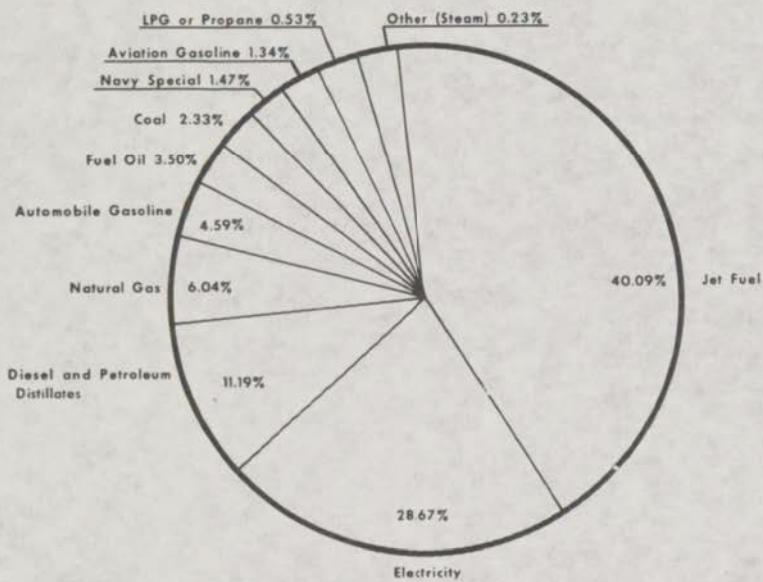
1/ Included in GSA totals.

2/ Postal Service figures based on approximately two-thirds of its energy consumption  
(data not available for all installations).

() = Increase

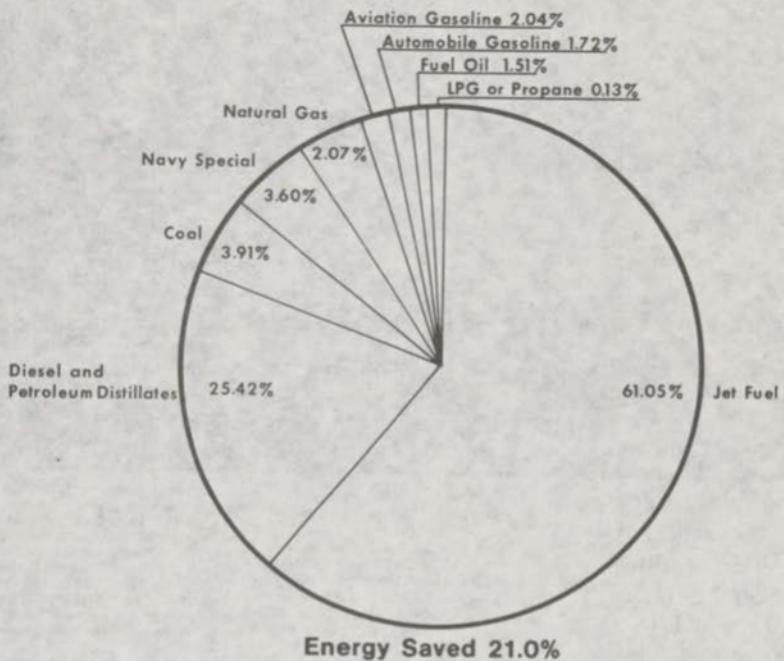
Figure 1

## Federal Energy Consumption by Source FIRST QUARTER Fiscal Year 1975

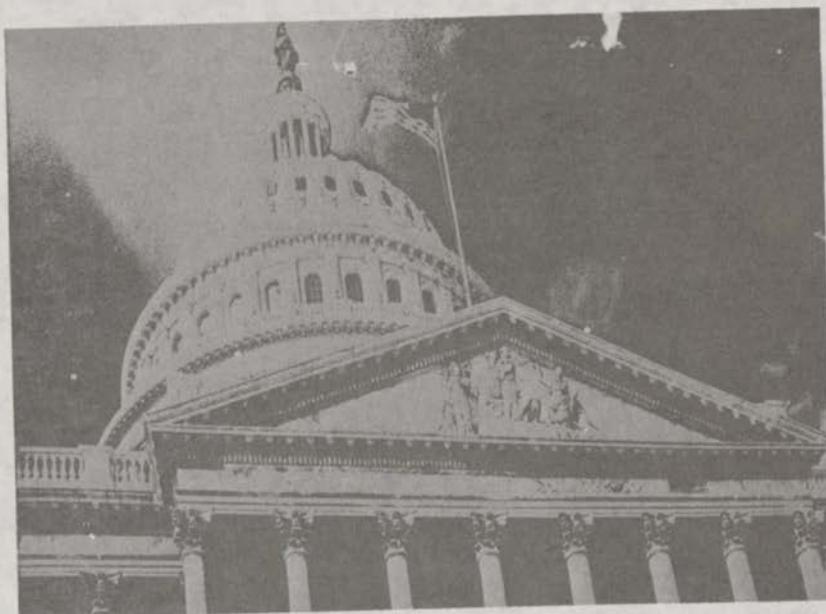


Energy Use Expressed as Percentage of the  
429,647,300,000,000       $(429,647.3 \times 10^9)$   
Total BTU's Used by Federal Agencies

Figure 2  
**Federal Energy Savings by Source**  
**FIRST QUARTER Fiscal Year 1975**



**Savings Are Expressed as a Percentage of the**  
**114,164,800,000,000       $(114,164.8 \times 10^9)$**   
**BTU's saved in Total by Federal Agencies**



## Energy Conservation in the Built Environment, Product Labeling: Congress Bites a Modest Bullet

By Matthew Heyman  
PE Staff Writer

*Factoring energy conservation into building design can have a large-scale impact on the nation's energy position and on the entire building community. Congress has recently made some basic though less than bold decisions affecting the built environment, and it will be up against tougher nuts-and-bolts conservation questions in the near future. Latest developments on the energy conservation scene include mandatory appliance labeling and efficiency targets and federal funding for state conservation initiatives, such as mandatory thermal standards for buildings.*

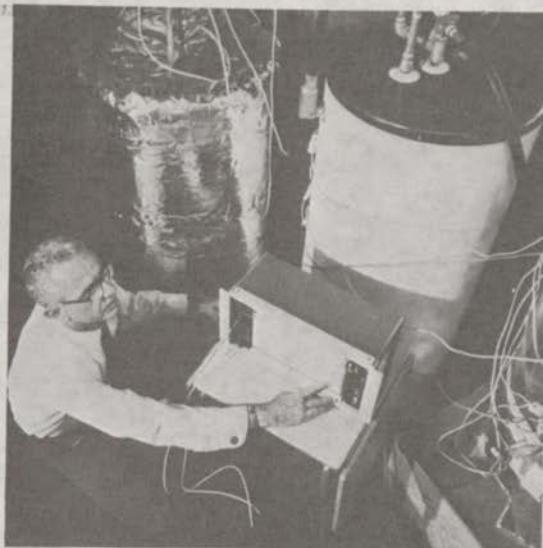
Though still a long way from coming of age, the energy conservation ideal seems to be maturing in this the year 3 AE—After the Embargo. The nation's energy controversies over the past several years inevitably demanded and have brought about an increased recognition of the importance of making more efficient use of available fuel resources. It is clear, however, that energy production questions—whether they be couched in terms of selecting the most desirable fuel, the financial incentive requirements, or the environmental impact—still grab the energy spotlight.

Slow at getting a grasp on the import-

tance of the built environment to federal energy policy planning and the nation's future energy position, Congress is just now beginning to take action to deal with the political, economic, and technological complexities associated with energy conservation in buildings.

Residential and commercial buildings consume fully one-third of the U.S. energy pie. Of this amount, space heating grabs the largest chunk—about 53 percent, according to the National Bureau of Standards (NBS). Though uses will fluctuate according to building type and climate, NBS also figures that water heating accounts for twelve percent, air-conditioning eight percent, refrigeration seven percent, lighting and other electrical tasks ten percent, and ten percent for cooking and other miscellaneous uses. Estimates of the potential energy savings achievable through more energy-efficient designed and constructed buildings vary widely but typically fall into the 30 to 50 percent range for old and new buildings, respectively.

With the advent of the energy supply and price crunch, a steadily growing number of proposals having a direct impact on energy consumption and efficiency in buildings—and on the entire community—have been offered for Congressional consideration. Building design standards, life-cycle costing, solar heating and cooling, tax incentives and grants to retrofit existing buildings, innovative energy conservation technology demonstrations, appliance la-



beling and efficiency standards, and strengthened federal research and development funding for energy conservation in buildings and appliances are among the suggestions which have appeared of late on Capitol Hill desks.

Until now, except for the rash of activity involving solar heating and cooling, little has been done by the lawmakers in the way of definitive decision making. With President Ford's reluctant approval of the highly controversial Energy Policy and Conservation Act in the closing days of 1975, some basic but certainly not bold steps aimed at improving the built environment's energy efficiency have been taken. Though national attention was primarily focused on the law's oil control aspects, the new act contains a number of conservation provisions which have been dangling in Congressional limbo for several years along with some ideas plucked out of President Ford's own energy package sent up to Capitol Hill a year ago.

The new law offers states the opportunity of dipping into a \$150 million federal fund established to encourage energy conservation planning on the state level. Each proposal sent to Washington for federal assistance in this planning effort must include, among other things, consideration of mandatory thermal efficiency standards and insulation requirements for new and renovated buildings. Mandatory lighting efficiency standards for any building which is open to the public during normal business

hours are also to be considered.

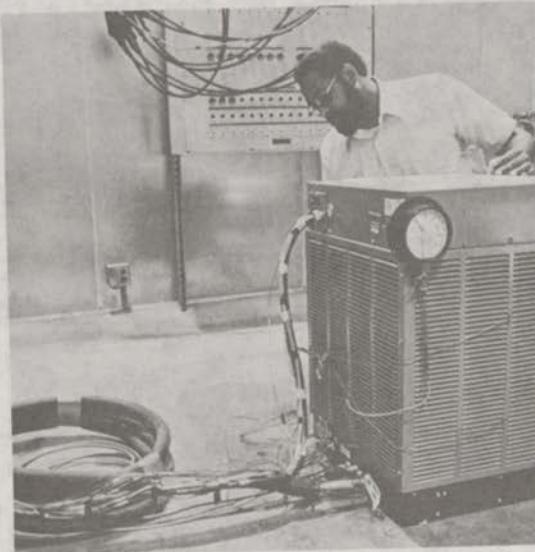
In addition, the President is given the responsibility of creating and implementing a ten-year plan for conserving energy in any buildings owned or leased by federal agencies. Mandatory lighting efficiency standards, mandatory thermal efficiency standards and insulation requirements, restrictions on hours of operation, thermostat controls, and other alternatives are to be included in the federal planning.

Labeling of certain consumer appliances to reflect energy cost and efficiency becomes mandatory with passage of the act. Relying on the National Bureau of Standards for technical expertise, the Commerce Department has had a voluntary program under way for several years now. Labels for room air conditioners, refrigerators, freezers, and refrigerator-freezers have already been completed. Water heaters were assigned a proposed label, and the Commerce Department had central air-conditioners and central heating equipment down on its list for future labeling. The Congressional action now adds humidifiers and dehumidifiers to that list, and will require all manufacturers to use the labels unless the Federal Trade Commission determines that such labeling "is not technologically or economically feasible."

Last year, President Ford called for a voluntary efficiency improvement effort by appliance manufacturers with the prospect of federal standards if such compliance was not forthcoming. The aim of

the efficiency improvement program was a 20 percent average reduction in the 1972 levels of energy consumption of new household appliances by 1980. Also run by the Commerce Department, the voluntary offering—and the threat of mandatory federal standards—had already attracted manufacturers who accounted for about 93 percent of the retail sales of the appliances covered in the program. Those included electric room airconditioners, refrigerators, freezers, and combination units along with gas and electric water heaters. Congress added central airconditioners, furnaces, humidifiers, and dehumidifiers to this list and gave the federal government the power to impose efficiency standards if a 20 percent improvement was not achieved, despite the mandatory labeling and the efficiency targets.

What effect the newly-passed appliance laws will have on industry and on energy efficiency remains to be seen. The Commerce Department's voluntary programs seemed to be moving steadily along and gaining the acceptance of manufacturers. The Washington impact may be the most immediate; the appliance program lead now changes hands from the Commerce Department over to the Federal Energy Administration and the Federal Trade Commission. The Commerce Department's National Bureau of Standards will remain the prime technical resource, so it is not likely that much of the measurement methodology will change drastically. De-



1. Experiments at Oak Ridge National Laboratory indicate that energy savings can be realized by wrapping an water heater with insulating material. The un-wrapped water heater (right) used over 20 percent more electricity than the same sized heater (at left) which was wrapped with 3 1/2-inch thick insulation commonly used in building construction. The tests were carried out as part of the Residential Energy Conservation Program under the sponsorship of the National Science Foundation and the Federal Energy Administration in cooperation with ERDA.

2. Heat pumps are an alternative means of heating and cooling homes that is under study at the National Bureau of Standards (NBS) in Gaithersburg, Maryland. A team of engineers led by Dr. David Didion (shown in photo) in the NBS Center for Building Technology is investigating the laboratory performance of heat pumps. The laboratory study is part of a larger effort at NBS aimed at developing test methods for heating and cooling equipment and systems.

3. Mechanical engineering technician at NBS adjusts instrumentation on heat pump in an environmental chamber. Temperature and humidity patterns anywhere in the U.S. can be simulated in the chamber.

pending on how the FEA goes about its new task, the new law could mean a lot more paperwork for industry. It could also mean some time in court; any person may commence a civil action against manufacturers or federal agencies for non-compliance with the law.

The building and appliance conservation provisions included in the energy act hardly represent a new, strong federal intervention into the building design and materials and equipment manufacturing world. The Congressional actions have been criticized by some who say Congress has skirted the critical aspects of energy conservation which confront the nation by passing off the nitty-gritty energy consumption reduction decisions to the state governments—which may or may not find the federal dollars sufficient incentive to take any action at all. The appliance labeling and standards provisions do not constitute a major departure from current government-industry programs. The Congressional directive to the White House for a ten-year plan does not provide direction on the details of such planning, such as the relative emphasis properly placed on life-cycle costing—despite the fact that Congress has already considered that particular topic at some length.

Those who contend that Congress has not faced up to the energy conservation challenge with the directness exhibited by the Ford Administration find ammunition in the Congressional response to the Presi-

dential proposal for mandatory building design standards. The Congressional reaction to that offering also illustrates the problems which Congress still has in understanding energy conservation complexities.

Proposed as the "Building Energy Conservation Standards Act of 1975," the original administration bill called for federally developed prescriptive energy conservation standards for new residential buildings. In briefings with other government agencies and with private representatives to discuss the bill, Federal Energy Administration officials made it clear that the prescriptive standards (later referred to as component performance standards) were likely to be modeled after the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) proposed energy conservation design standard, ASHRAE 90-P. Since approved in large part by ASHRAE as "90-75," that standard evoked strong reaction within and without the engineering community. (For a report on 90-75 impact, see page 35, this issue of *PE*.)

Also to be written were performance energy conservation standards for residential and commercial structures. To be based on results from ongoing federal and private research and testing, the performance standard was expected to embody the "energy budget" concept.

The President's bill would have prohibited any federal entity—including those re-

sponsible for supervision, regulation, or insuring of banks, savings and loan associations, and other similar institutions—from providing financial assistance "for the construction of any building in any area of a state" unless state or local building codes included energy conservation provisions at least as stringent as federally developed standards. Several years were to be allowed for federal development and state and local adoption of the standards. All federal construction would be required to meet or exceed the standards.

Reflecting the divergent views within the engineering, architectural, and manufacturing sectors about energy conservation ways and means in general, reaction from the private sector to the bill was mixed. Criticism was voiced by those who: 1. objected to the prescriptive standards; 2. resisted and opposed the bill's "blackjack" technique of tying all financial assistance for construction to code adoption; or 3. feared what was really being put forward was a back door national building code.

Without the benefit of in-depth hearings on the building standards question, the Senate adopted the administration proposal with some modifications as part of an emergency housing measure. There was no debate on the Senate floor despite the considerable controversy surrounding the bill. The House objected to the inclusion of the standards section in the housing bill, however, claiming it had not yet been able to consider the issue.

Mobile home being studied for energy efficiency in a National Bureau of Standards environmental chamber.

NBS engineer Max Hunt examines thermocouples used to monitor temperatures in mobile home energy study.



When the House Banking, Currency, and Housing Committee held hearings in July—which amounted to the first serious Congressional look at the proposal—it discovered a swarm of still-unanswered questions about the bill's aims and implementation. Ultimately, the House rejected the Ford Administration proposal and elected a voluntary approach to energy conservation design standards. Federal restrictions on financial assistance for construction were ruled out. Rather, state and local progress in adopting conservation codes would be monitored for possible unspecified action by Congress in the future. No federal prescriptive, or component performance standards were to be developed. The Department of Housing and Urban Development was assigned the task of coming up with performance standards for energy conservation.

When the Senate Banking Committee took a look at the House changes, it decided that perhaps it had been too hasty in considering the President's bill. After reconsidering its previous vote, the committee became deadlocked on whether or not to take the administration-preferred or House-favored route. As the Congress was busy passing the Energy Policy and Conservation Act, which included building standards only as a state option and federal construction consideration, the Senate Banking Committee finally settled on dropping the component performance standards. Mandatory federal performance

standards were retained, however.

Assuming quick endorsement of the committee's decision by the full Senate, the Congressional timetable suggests an attempted resolution between House and Senate differences on federal sanctions in the near future—possibly later this month.

Most Congressional detractors and supporters alike will agree that Congressional performance in terms of understanding and dealing with the buildings sector as an integral but complicated factor in the energy equation has been something less than spectacular thus far. The manner in which Congress has considered the administration's building standard proposal is a case in point. Regardless of whether or not federal standards for energy conservation in new buildings are viewed as a proper action for Congress to take, the lawmakers on Capitol Hill have been confronted with the task of making that important judgment. Handicapped by a lack of solid information about the potential effects of contemplated federal actions and by an incomplete understanding of basic building technology and design facts of life, Congressional consideration proceeded down the energy conservation standards path without a clear reading of what lay ahead.

Richard Grundy, a Congressional staffer and engineer who has been intimately involved with Capitol Hill efforts relating to energy conservation in buildings through both the Senate Public Works and the Interior and Insular Affairs Committees, ad-

mits that the new Energy Policy and Conservation Act "in no sense represents a definitive policy." Grundy sees the recently enacted energy conservation provisions as a preliminary expression of the energy conservation concepts which have developed from the Congressional experience over the past three years. Recognizing the vagueness of some of the new law's provisions, Grundy says, "You have to build on what you have done before. At the same time, all of the pieces don't necessarily fit together. It is a matter of first getting them and perfecting them later."

With energy supply problems not likely to vanish soon, the next round of Congressional decision making on specific issues affecting energy conservation in the built environment is bound to get tougher. **pe**

## ASHRAE Standard 90-75 Seen to Affect Design Engineer, Building Product Industry

A PE staff Report



*A federally-funded study of ASHRAE Standard 90-75, "Energy Conservation in New Building Design," foresees important changes in traditional building design, product manufacture and marketing, and energy consumption ways of life. Among other things, the study by Arthur D. Little, Inc., predicts that 90-75 will help the design engineer become a more important member of the design team. At the same time, the energy conservation standard will demand a major overhaul in the design industry's fee structure, the report claims.*

A just-completed study by Arthur D. Little, Inc. (ADL) performed for the Federal Energy Administration (FEA) spells out the expected impact of ASHRAE Standard 90-75, "Energy Conservation in New Building Design." The 90-75 route has already been taken by several states and will probably be followed by others in 1976. The recently enacted Energy Policy and Conservation Act of 1975 and legislation now under consideration would encourage further adoption by state and local governments by providing federal funding support for such activity. (See page 31, this issue of *PE*.) The ADL study provides some insight into what the building community

SUMMARY OF ECONOMIC IMPACTS DUE TO ASHRAE 90

	Total Annual Market (\$MM)	Market Affected by ASHRAE 90 (\$MM)	Percent of Total Market (%)	Maximum Potential Impact by ASHRAE 90 (\$MM)	Percent of Affected Market (%)
<b>Building Materials Suppliers:</b>					
Insulation	1,000	595 (60)	+18	+179	+30
Bit	470	270 (57)	+5	+45	+10
Rigid Board	465	286 (61)	+12	+128	+26
Loose Fill	70	45 (64)	+5	+9	+13
Siding Materials	1,000	850 (85)	+12	+12	+1
Flat Glass	1,247	148 (12)	+7	+7	+5
Windows	903	720 (80)	-19	-19	-2
<b>Building Equipment Manufacturers:</b>					
Electric Lamps	1,177	178 (15)	-16	-1	-9
Lighting Fixtures	1,450	830 (57)	-12	-175	-21
Gas and Electric Meters	173	189 (92)	+3	+3	+2
Hot Water Heaters	289	117 (40)	+4	+4	+3
<b>HVAC Systems Manufacturers:</b>					
HVAC Equipment	2,308	1,720 (75)	-6	-185	-11
HVAC Controls	550	410 (74)	+4	+21	+5

SOURCE: Arthur D. Little, Inc., estimates.



can expect with adoption of the ASHRAE standard.

ADL assessed the expected maximum impact of widespread voluntary adoption of the ASHRAE design standard by comparing conventional buildings with "ASHRAE 90-75 modified" structures in four areas of the U.S. Five building types were looked at: single-family detached residence; low-rise apartment building; office building; retail store; and school building. For study purposes, ADL assumed a strict interpretation of the ASHRAE standard. For instance, where 90-75 only makes recommendations, ADL assumed that those items were required. Actual operating conditions for the buildings were based on construction conditions before the oil embargo. Where design alternatives for complying with 90-75 were available, ADL selected that choice with lowest initial cost. ADL used 1976 construction industry projections for its study.

The ADL study concluded that "The initial construction costs of these buildings modified under the standard's prescriptive/performance approach were shown to be less than those of conventional buildings. Unit savings range from four cents to 94 cents per square foot, with the greatest savings experienced in office buildings." Though increasing costs for exterior wall, floors, roof, and domestic hot water systems, ADL concluded that "unit costs for lighting, and particularly HVAC

equipment and distribution systems, were significantly lower and tended to offset the increase in other costs."

Design costs would doubtless increase under the ASHRAE code, but ADL computed that except for single-family residences, "... the straight payback of design services due to energy cost savings was found to be less than one year, and less than six months in most cases." Even in single-family residences, the payback was contemplated to take only 2.9 years.

On the whole, the ADL study suggested that "... it appears that the ASHRAE 90 modified buildings should cost no more to build and will have significantly less annual energy costs. Furthermore, even if total initial cost did increase, the savings in operating cost (over those of conventionally-designed buildings) would then recover such costs in a couple of months."

ASHRAE 90-75 was declared to be an effective energy conservation tool. According to the study, "Under a strict interpretation of the standard, ASHRAE 90 is very effective in reducing annual energy consumption in all building types and locations." Results of ADL's investigation showed the following unweighted percentage reductions in annual energy consumption when 90-75 buildings were compared to conventional structures: office building, 59.7; school building, 48.1; low-rise apartment, 42.7; retail store, 40.1; and single-family residence, 10.7. In general,

space heating requirement reductions were responsible for 60 to 75 percent of total energy consumption reductions.

"If instituted by all states, ASHRAE 90 could reduce the annual energy consumed in new construction by about 27 percent," the ADL report concludes. If instituted in 1976, the standard could reduce the growth of energy consumption in the building sector 2.3 percent to 1.4 percent over the period 1976 to 1990, according to ADL.

Even with the standard's favorable impact on energy consumption, ADL found that the lowest unit-energy consumption after applying 90-75's prescriptive performance approach was 67,000 to 72,000 Btu per square foot. The U.S. General Services Administration has set a 55,000 Btu per square foot target, and ADL researchers did not think use of 90-75 alone could satisfy that goal.

Building materials and building equipment markets would be widely affected by ASHRAE 90-75. "In general, the adoption of ASHRAE 90 will create opportunities for suppliers of commodity building materials at the expense of reducing those markets for general building equipment and HVAC systems." Building insulation suppliers could gain \$179 million in new markets, amounting to an 18 percent increase in their overall annual sales. At the same time, HVAC equipment manufacturers' market could drop off by \$185 million, or eight percent of their total market. Sim-



1. The Bowman House at the National Bureau of Standards in Gaithersburg, Maryland, where studies on energy conservation in homes are being carried out. Among the studies is one on the benefits to be expected from retrofitting an existing residence with insulation, storm windows and doors, caulking, and weatherstripping. Studies on the field performance of heat pumps are also being carried out in the house.

2. & 3. Blowing in insulation in the attic (photo 2) and exterior walls (photo 3) of the Bowman House.

4. Installing insulation in the crawlspace.

ilarly, lighting fixture producers could lose \$175 million, which accounts for twelve percent of their market.

The cutbacks in revenue sustained by HVAC equipment manufacturers—due largely to drastic reductions in HVAC system capacities—could be moderated if manufacturers “adopt,” the ADL report suggested. Even so, the 90-75 researchers grimly predict that this sector will “be adversely affected by any type of effective energy conservation legislation, be it ASHRAE 90 or some similar design standard.”

A major market for energy-oriented computer programs and services is foreseen by ADL with adoption of 90-75, reflecting a tendency to “load-up” the front-end of the design process. The study claims the standard “will result in more calculations, further technical and economic evaluation of systems, additional internal and external meetings of the design team, and more interaction with code authorities.”

Perhaps more than any previous event in the design industry, the advent of ASHRAE 90, or some similar standard, will demand a major overhaul in the industry’s fee structure, particularly for mechanical/electrical design engineering services which historically have been based on a percentage of the mechanical systems cost of the project,” the ADL report states. Furthermore, the report forecasts that “From a professional standpoint, perhaps

the most significant impact of ASHRAE 90 is that the design engineer will become a more important and integral member of the design team.

Trouble is predicted for those who suggest that state and local governments will move quickly toward wholesale adoption of 90-75. ADL expects code authorities to be a problem for 90-75 in both the implementation and enforcement aspects. Looking ahead, the study notes, “It would not be surprising if a standard dealing with an abstract objective—achieving energy self-sufficiency—were not to succeed, since more concrete concerns with such visible problems as consumer and third-party health and safety have failed to motivate institutional change and code effectiveness.” The report continues, “Those institutional barriers that have so far prohibited the adoption of a model code on a more limited basis will continue to create barriers for the implementation of ASHRAE 90 or allow it to be implemented only in cannibalized form.” ADL holds out the possibility that financial incentives could moderate that problem.

The ADL findings will likely attract close scrutiny by most segments of the building community. Far from being the last word on component standards and their impact, the ADL report’s shortcomings—such as failure to consider the energy costs in building materials’ manufacture—will probably spur further assessments. With growing

numbers of state and local governments considering energy conservation provisions for their building codes and the prospect of federal dollars to hasten code consideration, the ADL study is sure to be of interest to engineers, code authorities, manufacturers, and government officials alike.

Information about the availability of the ADL report, *Impact Assessment of ASHRAE Standard 90-75, “Energy Conservation in New Building Design,”* will be carried in a future issue of *PE*. **pe**



## A U.S. Senator Views Energy Costs & Long-Term Economy

*We can put so much insulation into the walls of a building that we can hardly afford to build the building. If we use less, and energy prices go up, have we still made the right decision?*

We are discovering that the operating costs of a building simply overwhelm the costs of its construction. The problem is that all the cost relationships involved can change. Right now, energy costs are running neck-and-neck with financing costs—a situation unheard of several years ago. When these costs are projected over a 40- or 50-year period, even slight changes in such things as energy prices make a very great difference. So, what is that going to mean to us now, when we have to make a decision as to which heating, ventilating, and air conditioning system to use, and what to do about insulation?

We have a choice of using more or less insulation. We can put so much insulation into the walls that we can hardly afford to build the building. If we use less, and energy prices go up, have we still made the right decision?

We on the Public Works Committee recently had to pass on the General Services Administration's proposal to build two enormously expensive buildings in Baltimore for the use of the Social Security Administration. This taught me just how hard it is, even for those of us who really care about the long-term economics of buildings, to come to any conclusions we can sleep with. I had to vote against the proposal, despite the threat that inflation would make delay prohibitive. Other members of the committee were not willing to take that risk, and the prospectus was approved.

But I was very disturbed by what was proposed. The GSA advocated using its so-called "integrated buildings systems" approach in the Baltimore buildings. This would be the second time out for the systems approach, the first application being in three other Social Security buildings, in Philadelphia, Chicago, and Richmond, California.

As it was explained to us, there is supposedly a problem when building components are chosen "off the shelf", from many contractors. The components would be, it was said, "in aggression with each other," which I took to mean they would be at cross purposes with each other as to providing long-term economic benefits. To get around this, the idea was to declare

"performance specifications" in lieu of design specifications or product specifications and let the contractor design a system of components which would be the most economical over the long haul. There was another assumption involved in all this: the notion that only a really big corporation would be able to do the innovating required, and that therefore the first three of these multi-million-dollar buildings ought to be let as a single contract, to make the deal attractive enough to big operators.

Another element of the package, as used in the three buildings and proposed for the Baltimore project, is of interest here. The products designed in accordance with the performance specifications would have to do their jobs over specified periods of time. And, moreover, the contractor was to be given a nine-year maintenance contract.

Whether these approaches actually will mean greater long-term economies in the three initial Social Security buildings, we cannot yet say. This was to be an experiment, and the results are not in.

Why did I vote against using this approach at Baltimore, even though I was very concerned that we buy something for the taxpayers which would be economical over the long haul? This might be instructive to those of you who are involved with engineering buildings for buyers in the marketplace. In the first place, I was not convinced the systems approach had produced very much innovation. It appeared to me that the products resulting from the process could have been matched by conventional construction techniques, and the only new item we were getting was a combination lighting and sprinkler system, in which cooled sprinkler water was to cool the fixtures. Is this a good long-term economy?

In the second place, I objected to the assumption that only a huge corporation could produce the necessary innovation. It seemed to me that we were putting so many eggs in one basket, and putting such a huge project out for bids, that we would discriminate against relatively smaller contractors, who might be quite efficient, but unable to win the financing battle.

By Senator Robert Morgan (D-N.C.)  
 Chairman, Subcommittee on  
 Buildings & Grounds  
 Senate Public Works Committee

*Senator Robert B. Morgan (right) discusses with NSPE Director of Legislative and Government Affairs James Hughes several energy conservation bills under study by the Senator's subcommittee which has held hearings on energy conservation in federal buildings.*

I recognize the argument for the supposed abilities of big corporations to do research—we see it frequently enough in the advertising on our television sets, usually on behalf of big corporations. Yet I cannot help but think that the electric light, and the airplane, and the car—the very items which got these corporations started—were invented in laboratories not much better than barns. In any case, the figures on the project did not convince me that it was going to be any cheaper to build in the first place, the long-term economies themselves being rather unpredictable.

In the third place, it seemed to me absolutely absurd for the proponents of the systems approach to argue for all these long-term economies, and to pay lip service to life-cycle costing, and then propose to build the Baltimore project by purchase contract—in other words by issuing bonds. The federal government is supposed to operate by direct appropriation, and after the end of this fiscal year, the purchase contract method will no longer be used.

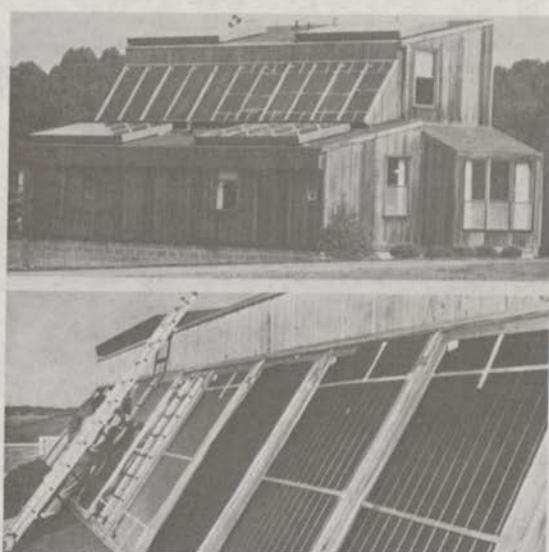
The Baltimore project will cost, according to the prospectus, \$161 million—to build the largest project ever to come before the public works. But because of this deficit financing of capital improvements, the real cost, with financing, will be just under \$420 million. Is this long-term economy? I hardly think so.

There is going to be many a slip between the computer model of optimized long-term economies and what actually gets sold in the marketplace. I agree that life-cycle costing looks like a very good way to go. But I am disturbed when a consulting engineer tells me he can make his life-cycle cost figures come out about any way he wants. This concerns me very much. **pe**



National Bureau of Standards (NBS) captures the sun to provide heating, cooling, and domestic hot water for four-bedroom townhouse on the NBS grounds in Gaithersburg, Maryland. NBS engineers will test the house and solar system for selected periods while the weekly living pattern for a family of six is simulated. This is one of the first studies in which the same building will have been tested with both a completely conventional as well as an integrated heating and cooling solar system. The project will furnish state-of-the-art data and contribute to evaluation procedures for total solar systems.

Solar panels being installed on NBS townhouse.



## Conservation: The Only Way Out of the Energy Shortage Maze

*What the U.S. sorely needs to meet its energy challenge, says this engineering educator, is a real conviction on the part of both the public and our government and industry leaders that the problem is both serious and urgent and an earnest commitment to take the drastic action necessary to bring it under control. He calls for a program of drastic energy conservation, fully backed by Congress and the Administration to buy the time needed to develop alternate energy sources.*

By Lewis D. Conta, P.E.  
Professor of Mechanical Engineering &  
Dean  
College of Engineering  
University of Rhode Island

Although not the only critical problem facing mankind, the energy problem is, in many ways, the most urgent; yet as a nation we are idly dallying while irrecoverably precious time is lost.

Recent estimates by the National Academy of Sciences and the U.S. Geological Survey—both highly respected agencies independent of the energy industries—have lowered substantially the predicted amount of undiscovered petroleum, both domestic and worldwide. It now appears that U.S. production will begin to drop drastically by the mid-80s, and even world resources will be approaching depletion in 25 to 30 years. By that time the remaining petroleum will be reserved, either by law or

by economics, for purposes such as the production of fertilizers, pesticides, and plastics, and for essential transportation uses.

As an example of the seriousness of the supply problem, consider the Alaskan North Slope strike at Prudhoe Bay. This find, the largest on the North American Continent in some time, was made several years ago, but as yet no oil has reached the market. A \$7 billion pipeline is now under construction across Alaska, and in another year or two oil will finally begin to reach the outer world. Yet the Prudhoe Bay field holds only a two-year supply of oil at the current U.S. consumption rate.

Thus to become independent we need to make a Prudhoe Bay strike every two years, and at current rates of increase in consumption, in another 15 years the required interval will be reduced to only one year. We clearly will not be able to do this; hence the prospect of being able to continue our petroleum-based technological society is dim indeed. Since we now consume over 17 million barrels of petroleum per day in the United States, in order to make an orderly conversion to other energy sources over the next 20 to 25 years, we should be reducing consumption by nearly a million barrels per day each year. We are, instead, committed to a program calling for the expansion of domestic resources to enable us to remain on a petroleum economy. Since the total supply



*The Clinch River Breeder Reactor Plant, the first large-scale breeder reactor demonstration plant in the U.S., is planned for construction on the Clinch River in Oak Ridge, Tennessee. Site work is scheduled to begin this year.*



*Construction progress on the Fast Flux Test Facility (FFTF) near Richland, Washington. The 400 megawatt thermal reactor is a liquid sodium-cooled, fast flux reactor designed specifically for irradiation testing of fuels and components for the liquid metal fast breeder reactors. Bechtel Power Corporation is architect-engineer; Advanced Reactors Division of Westinghouse Electric is lead reactor designer.*

is finite and the end is now in sight, we are clearly in great danger of continuing on our current course until the pipeline runs dry and then inquiring, "What do we do now?" By then it will be too late to do anything and the effect on our technological society will be catastrophic.

#### *The all-electric-nuclear economy*

Our major national effort in addition to the maximum exploitation of domestic petroleum reserves is the development of nuclear power. Since nuclear energy is only transmitted and used in the form of electrical energy, this thrust leads to the all-electric nuclear economy in which as many of our energy needs as possible will be filled electrically, i.e., making maximum use of electric vehicles, electrical space heating, and electrically supported industrial processes.

There are, as I see it, two problems with this picture. First the supply of fissionable uranium, U235, is limited, and its exhaustion is predicted for not much later than the exhaustion of our petroleum resources. A stable, long-lasting nuclear economy will only be possible if the breeder reactor or the fusion process becomes commercially useful and takes over most of the load. The breeder has, however, come under serious question for many reasons and, rightly or wrongly, is receding farther into the future.

Suppose, however, that breeders do come on line early enough to insure a long-lasting supply of nuclear fuel or that some other technological breakthrough insures the availability of adequate energy for the all-electric economy. Will that solve the problem? I fear that it will not. The growth curve of electrical energy consumption which we have been following for all of this century has resulted in a doubling of consumption every eight to ten years. A simple continuation of this growth rate, even without the move toward an all-electric economy, would result in the need for an installed capacity of over 2.5 million megawatts by the year 2000.

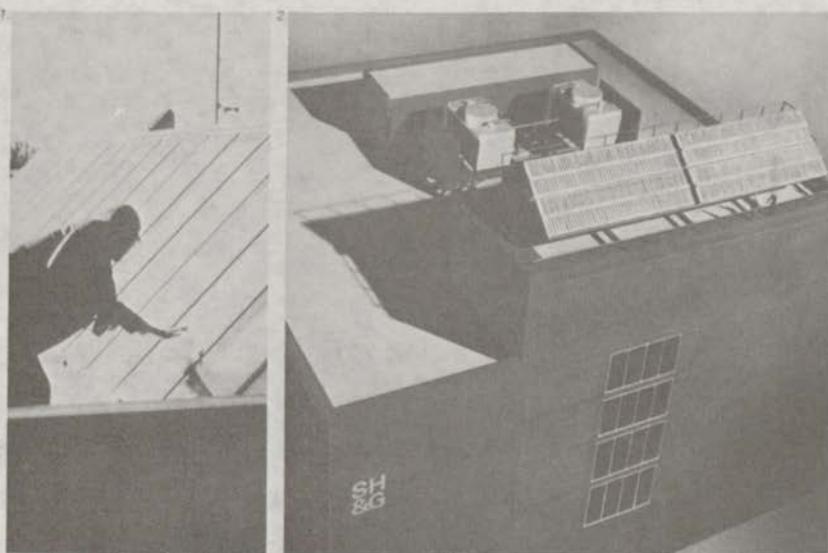
We are accustomed to large numbers, and this requirement may not be very impressive. It translates, however, into 2500 thousand megawatt power plants, or more than 50 of these giant plants in each state of the contiguous United States. How many of our states can find sites for 50 such plants, when each plant requires a flow rate of nearly a million gallons per minute of water for once-through cooling, or 15 to 20 thousand gallons per minute of expendable water to supply the evaporative and blowdown losses of cooling towers? Where also can we find the trillions of dollars that would be needed to build the plants and their associated transformer, switching, and transmission systems, and to carry out the very expensive search for and development of the energy supplies to

keep them going?

Incidentally a conversion to coal, our most abundant energy source, would not solve the problem either. Even neglecting the costs and hazards of deep mining, the environmental degradation resulting from strip mining, and the air pollution problem resulting from the combustion of coal, this fuel, like nuclear fuel, must be transmitted and used as electrical energy, and the plant siting and cooling water requirements would be little better than those associated with nuclear power plants. If, furthermore, we remain on our past curve of expansion in the use of electrical energy, and if we depend only on coal to meet our needs, then a 2000 year supply of coal as measured at current rates of consumption would be exhausted in about 70 years. And if we work very hard, and improve our mining and related technologies to produce another 2000 years' supply, this addition would only keep us going for another ten years.

#### *Are we on the right track?*

In the face of this problem what can we do? Many people believe that we are already making substantial progress—that the conservation measures already adopted will see us through. I believe this is a serious error which must be countered as vigorously as possible. The rate of growth in energy consumption has been



arrested, or at least greatly reduced, but the effect is, in all probability, due more to the business recession than to effective long-term conservation.

For at least the last 25 years a close correlation has existed between energy consumption and gross national product—at a rate of approximately 90,000 Btu/1958 dollar of GNP. For the past six quarters the GNP has decreased, but energy consumption has not followed it down. It seems extremely likely, therefore, that when business activity returns to normal and the GNP again increases, we will find we are not far from our historic growth curve in energy use. Unless we change our ways, the dire predictions presented above will become the realities of tomorrow.

What we sorely need, and what is conspicuously lacking, is a real conviction on the part of both the public and our government and industrial leaders that the problem is both serious and urgent, and an earnest commitment to take the drastic action necessary to bring it under control. The disagreements between Congress and the administration over an energy policy, and the hope that the operation of the marketplace can induce the necessary action have already robbed us of irreplaceable time—time which we cannot afford to lose. Because we are dealing with a finite and irreplaceable commodity which is essential to our technological civilization, and because the real problem is still several

years in the future, I fear that normal economic motives will not produce the drastic action needed in the time available.

In spite of the recent increases in cost, energy is still cheap compared with most of the things we need and use. On a cross-country automobile trip, for example, the costs of motels and food are each substantially higher than the out-of-pocket automobile expenses, and gasoline accounts for only a small part of the true total automobile costs. Gasoline prices have already increased approximately 25¢ per gallon with little effect on total consumption. Would another few cents per gallon make a bigger difference? Heating oil consumption will be even less elastic. Last winter many people learned to live with thermostats set at 65° to 68° instead of the more normal 72° to 74°, but it will not be possible to go much lower, regardless of cost.

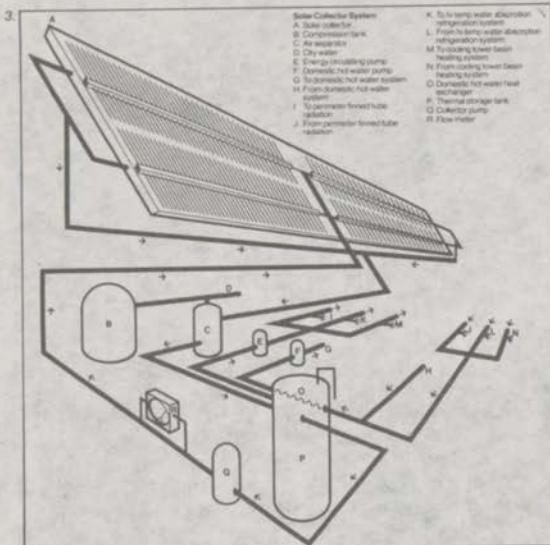
#### *A national energy policy based on conservation*

What kind of an energy policy is needed to cope with the impending crisis? In the long run only a technology based on solar energy in all its forms—direct thermal, voltaic, wind, sea thermal—or on the fusion process if this should prove feasible and economical will solve the problem. The short-range actual need, however, is for a program of drastic conservation, fully backed

by Congress and the administration, to buy the time needed to develop alternate sources. Unfortunately, the urgency results from the time needed to convert in an orderly manner from a petroleum-based technology to one based on inexhaustible sources, rather than from current shortages, hence the incentive to get on with the task will not arise naturally. It must instead be mandated by government action—action which thus far does not seem to be forthcoming.

Because we have been so preoccupied in the use of energy the potential for dramatic reductions exists in all phases of our lives. In the transportation area the private passenger automobile is the prime villain, both in terms of low occupancy per vehicle and high fuel consumption. The obvious solutions are greater use of mass transit and reduced fuel consumption per vehicle. Since the construction of an adequate mass transit system will be a long and expensive undertaking, the most rapid results can be obtained by car pooling and by producing more energy-efficient vehicles.

In pursuing the latter goal strict limits on size, weight, power, or fuel consumption for each vehicle would be, in my opinion, a poor strategy. Instead a mandated minimum number of miles per gallon, measured by standardized EPA tests, as a fleet average for each manufacturer would, I believe, produce effective savings far fast-



1. Two arrays of 20 solar panels provide heat for home in Denver, Colorado.

2. & 3. A 1000-square-foot solar collector is providing heating, cooling, and hot water to the downtown Detroit headquarters building of Smith, Hinchman & Grylls, Architects, Engineers, Planners. In operation since November, the research solar energy system is providing 27 pieces of data every 15 minutes to the firm's computer.

er and with less social stress than other suggested alternatives. Such a scheme would make it possible for each manufacturer to produce a wide range of vehicles, from small and austere to large and luxurious, as long as the fleet average met the fuel consumption requirements. It would, in addition, provide a powerful incentive for each manufacturer to improve the efficiencies of his engines, transmissions, running gear, and accessories in order to be able to produce the maximum number of high performance or luxury cars, and thus gain a competitive advantage in the marketplace.

The continued excessive heating, lighting, and air-conditioning found in most public and commercial buildings makes it clear that large savings should also be possible in this area. Again the recent dramatic increases in energy costs have had little effect, since they still represent only a small fraction of total costs, and are easily passed on to the consumer. Hence in this area too mandatory controls seem to be the only way to produce results in the time needed. An energy section in all building codes, most easily accomplished by incorporating ASHRAE Standard 90-75 and its future modifications in each code would go a long way toward producing more energy-efficient buildings in the future.

However, unlike the automotive case where the turnaround time is only about

ten years, the annual addition of new buildings is only a small fraction of the total. For this reason retrofitting old buildings may be even more important than controlling new construction. The problem, here, however, is the need for capital rather than mandatory rules, and the role of the federal government should be directed toward meeting this problem: Low interest loans, tax rebates, and freedom from increases in assessed value are examples of the kinds of incentives that would make possible the installation of insulation, solar collectors, and other energy-conserving features in existing structures.

Industrial processes are the third major source of possible savings. In this area more than any other high energy costs may have an effect on consumption, and many of the steps that can be taken with little or no investment have already been implemented. Unfortunately the major savings which can be made as documented in the published reports of the Ford Foundation Energy Policy Project require process changes which demand research and development effort and, most importantly, substantial capital inputs. The current high cost of capital and the very short capital recovery time demanded by industry mitigate against the possibility of acceptable increase in energy costs providing an effective incentive toward energy conserving changes in industrial processes. Again government action to make capital funds

more readily available for conservation is urgently needed.

It seems clear to me, then, that only strict conservation in all phases of our lives, mandated by local, state, and federal authorities rather than by simple economics, will give us any hope of avoiding catastrophe. Some will object that this path will lead to economic stagnation and increased unemployment. I firmly believe that the opposite is true. Exploring for additional coal, oil, and uranium, opening mines and drilling oil wells, and building giant nuclear power plants are all capital-intensive enterprises with little manpower input per dollar of capital invested.

Furthermore the manpower needed for these enterprises is highly skilled and specialized. The same dollars invested in building more efficient structures or in retrofitting older buildings for conservation would produce more jobs, requiring less skill, and the end effect would be a permanent reduction in energy consumption, rather than a continually escalating and expensive search for the energy needed to feed a growing number of central power plants. **pe**

## Engineers at Grassroots Tackle Energy Management, Conservation

By M. C. Ziemke, P.E.  
Manager of Technical Support  
Auto Check Diagnostic Project  
University of Alabama in Huntsville  
and  
A. I. Reisz, P.E.  
President, Reisz Engineering

*A group of Alabama engineers in the Huntsville Chapter of the Alabama SPE are injecting energy conservation and management ideas into local and state energy programs. Their conclusion: Such grass roots efforts can have a surprisingly significant effect on energy matters.*

Since the energy crisis impacted two years ago, many engineers have felt a certain amount of frustration about their inability to take an active role in this major technical era. The problem, it seemed, was that the principle technical activists solving the energy crisis were to be the "energy experts." By definition, an energy expert is a scientist or engineer who has worked in the field of energy production or conservation for the past ten years or more. Obviously, few individuals can qualify for this distinction.

We engineers who cannot qualify as energy experts are presumably limited to switching off lights, resetting thermostats, and joining car pools to help attack the energy crisis. However, several Alabama professional engineers have recently found that grass roots efforts can have a surprisingly significant effect on energy matters.

Approximately two years ago, M.C. Ziemke and A.I. Reisz, members of the Huntsville Chapter of the Alabama Society of Professional Engineers, determined that they might be able to use their technical capabilities to get involved in energy activities at more than the personal conservation level. Both of the writers are mechanical engineers with considerable design experience, although neither can meet the "energy expert" qualifications stated herein.

### Solar energy

The writers have been interested in solar energy for several years, and have recently done considerable literature research in solar energy in order to become knowledgeable about current developments.

From this effort, it became obvious that the southeastern states were ripe for solar energy development, although most of the development work in this field had been done in the Northeast and Southwest. However, to focus attention on solar energy potential in the Southeast, a broad-based conference on solar energy applications was needed in this area. Because Huntsville, Alabama, is centrally located in the southeastern states, we determined that this would be a good location for the first Southeastern Conference on Applications of Solar Energy.

To initiate this project, we approached officials of the University of Alabama in Huntsville (UAH). We received considerable interest and encouragement, but it became obvious that for this type of project we needed broader-based technical interest and support. Fortunately, A.I. Reisz had membership and/or acquaintances in several of the leading technical societies. Therefore, we were able to obtain support from such organizations as ASPE, IEEE, ASME, ASCE, and AIAA. We formed an ad hoc steering committee, of which M.C. Ziemke was elected chairman.

Shortly after the committee was formed, Mr. Reisz was forced to withdraw because of out-of-state business activities. However, the steering committee was working smoothly by this time and able to tackle a new requirement: the need for a solar energy short course to complement the conference. Mr. Ziemke provided the first outline for a two-day short course and UAH agreed to accept the financial responsibilities for both the short course and the conference.

We were off and running. The short course and conference were presented in March 1975. Each was both a technical and financial success. Over 50 papers were presented, including one by each of the authors of this article. Apparently, we have initiated a whole series of Southeastern Solar Energy Conferences, the second one of which will be presented next spring in New Orleans, sponsored by LSU.

An interesting sidelight to our solar energy efforts is that Mr. Reisz has since been retained as a consultant for alternative energy systems by the Research Institute of UAH. Similarly, Mr. Ziemke has devised a method for converting wind energy to heat through adaptation of an automotive dynamometer.

**Automotive research**

In the Spring of 1974, the federal government decided to fund the creation of five multi-million dollar automotive diagnostic demonstration projects. The projects were to use the latest technical equipment and techniques to inspect thousands of automobiles to allow a higher degree of safety, emission reduction, and energy efficiency. When the state of Alabama needed a proposal to compete for a project award, Mr. Ziemke led the technical proposal effort. Pete Redding, P.E., recruited an engineer candidate for the position of project director, and August Ries, P.E., also assisted the proposal effort. Alabama won a \$3,000,000 project award, the first in the USA.

### State energy conservation

During the early months of the energy crisis, the Federal Energy Administration asked the major engineering societies to compile state-by-state lists of engineers who had some expertise in matters related to energy. Mr. Reisz arranged to provide a combined list of appropriate members of ASPE, ASME, and IEEE. This effort led to creation of the Alabama Energy Utilization Committee. Mr. Reisz was named chairman. Other Alabama professional engineers on the committee included: George Shofner, Carl Nagle, Guy Dunnivant, Al Pardue, John Boggess, August Ries, and Gaines Gravlee. This committee advises various groups in the state on energy conservation.

### Assistance to the Alabama Energy Management Board

The current major effort of the Alabama Energy Utilization Committee is in assisting the Alabama Energy Management Board (AEMB) in developing an energy

**Powdered Coal Home Furnace  
Developed by Student Engineers**

By Robert Ebsch  
University of Wisconsin  
Science Writer

conservation plan for the state, a project for which the committee formed a special task force. The staff director of AEMB, Ed Hudspeth, has met with the task force and outlined his request. The objective of this task force of Alabama professional engineers is to write a report on energy consumption for Alabama with recommendations to the governor. This report will include an energy conservation plan.

The task force has been divided into subcommittees to write the energy conservation plan. For example, George Shofner, P.E., a NASA civil engineer, and Guy Dunnivant, P.E., a facilities engineer with the Corps of Engineers, head a subcommittee on building standards (e.g. insulation). They get assistance from other qualified persons as needed. Carl Ziemke heads subcommittees on heating and air-conditioning and automotive fuel consumption.

In addition to the subcommittee activity, the task force is gathering and reviewing information from governmental agencies, and educational and research institutions. Technical papers pertaining to energy conservation, including some written by members of the task force, are being used. Energy conservation plans from other states are being reviewed. The task force's immediate objective is to develop an effective energy conservation plan that can be quickly implemented. The task force can also serve as an influential voice of the engineering profession to state and local governments on the formation of energy policies.

**Future plans**

Encouraged by the results of their recent efforts in the energy field, the authors have plans for continuing this type of technical activity. They are considering another type of energy conference for the near future. Each is also engaged in supporting new concepts for federally funded energy research projects. The authors conclude that there is room in the growing energy field for competent engineers who wish to make technical contributions. **pe**

A home coal furnace that compares favorably with oil and natural gas heat has been developed by a team of engineering students at the University of Wisconsin-Madison. The furnace is clean, convenient, and cheaper to operate than an oil furnace.

Beginning with a commercially available oil furnace, the students added a mechanical system that allows the furnace to burn powdered coal. The students say that such a conversion would only cost the average consumer about \$200 and would save that much in fuel bills during the first winter. "No such conversion system is available to our knowledge," emphasizes Ken Kriesel, student in charge of the project. "But there are no reasons why systems shouldn't be produced. Technically it's pretty simple."

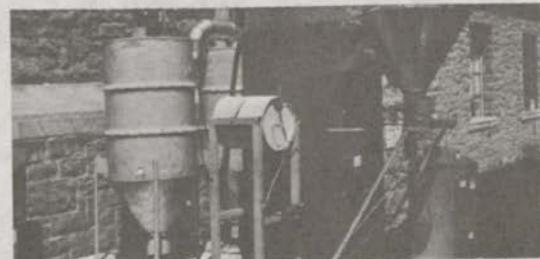
With oil prices rising and future shortages promising to be severe, the conversion to coal is an attractive prospect. By supplying all energy needs from domestic coal sources, the United States could be self-sufficient for at least two hundred and possibly five hundred years.

The new furnace is convenient because it requires no attention beyond setting the thermostat. When the thermostat demands heat, the furnace uses an oil flame to ignite the coal, and mechanically feeds itself from the bin. Ashes collect in a residue container, which the coal supplier would empty on each delivery visit.

The furnace is clean because the coal is handled internally. The delivery truck would pump coal into the bin through an airtight opening, and the ashes would be pumped out in a similarly sealed stream of water. Air pollution through the chimney would be negligible. When the coal feed is shut off after each burn, the oil flame comes on again for 30 seconds to burn away most of the remaining gases. The air is then passed through "scrubbers" and cleansed by a fine spray of water. The oil required to start each heating cycle and do the final cleanup burning would amount to only five gallons of water per winter.

Last September the Wisconsin research team won the first prize for coal use at an international competition in Albuquerque, New Mexico. This confirmed their conviction that such a furnace could lift a large energy burden from weakening petroleum reserves.

"The only real problem is the coal distribution system," says mechanical engineering professor Ali Seireg, who worked with the students on the project. "Right now there are no coal suppliers that deal in powdered coal, and it's too inconvenient for everyone to pulverize coal in their homes." Services grow to meet demands, however, and Dr. Seireg believes that powdered coal delivery services can be as commonplace as oil distributors or water-softerner maintenance industries.



## editorial

### ERDA's Energy Conservation Program Draws Criticism in Congressional Assessment as Timid, Underfunded

As a selection of *PE* authors this month points out, there is an active energy conservation dialogue currently under way in the U.S., even though the total amount of energy actually conserved may be considerably less than it could or ought to be. So where does this leave us? Are we going to go through 1976 with mostly a dialogue over energy conservation or are we going to buckle down and get serious about management applications which will be necessary to bring about a significant reduction in U.S. energy consumption?

At least one operating arm of the Congress has already concluded that the energy conservation plans and funding of the Energy Research & Development Administration (ERDA) are too modest to make much of a dent in energy saving over the short term. Congress' Office of Technology Assessment (OTA)—a new Capitol Hill entity which NSPE strongly supported from concept to final reality—has looked at ERDA's energy conservation program and finds it funded at only two percent of the agency's total budget.

In its analysis, OTA finds that ERDA's energy conservation planning represents a departure from Congressional mandate "in the emphasis of both the ERDA plan and program on options directed toward increased energy supply relative to the programs in end-use demand reduction. In Public Law 93-577 (Sec. 5 (a) (1)), the Congress defined energy conservation as meaning 'both improvement in efficiency of energy production and use and reduction in energy waste. The law requires energy conservation be 'a primary consideration in the design and implementation' of the

ERDA program. Yet only two percent of ERDA's budget appears to be allocated to conservation programs."

OTA's analysis of ERDA's conservation efforts continues: "It is well recognized that expansion and conversion of our large energy supply systems will be very costly and cumbersome, but that our dwindling oil and gas reserves dictate such modification. By contrast, successful widespread implementation of conservation programs with increased efficiency or waste reduction objectives can have both a rapid and a continuing effect. Such improvements need not be technologically complex; they may include merely removing jurisdictional or institutional constraints, such as building codes which require energy-inefficient designs."

If ERDA is to provide near-term and mid-term energy problem solutions, conservation through efficiency and waste-reduction programs should be an essential ingredient. The present ERDA program orientation toward developing complex technological supply options for the long-term overshadows the importance of less-complex solutions with near-term potential.

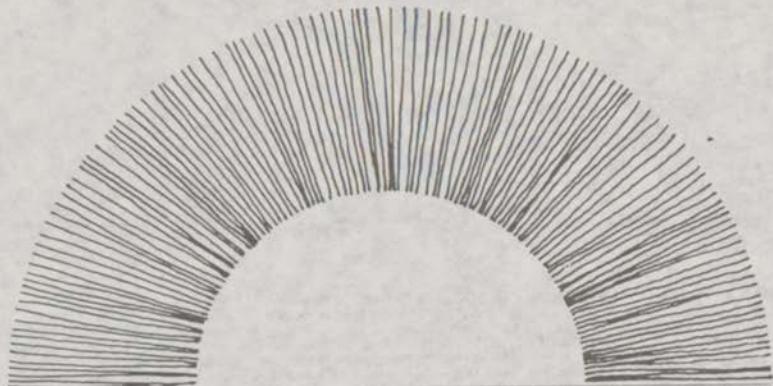
OTA, in its first major technology assessment, finds that in addressing energy goals, "ERDA adopted a narrow, hardware-oriented approach. RD&D effort is designed primarily to develop technologies . . . rather than to explore solutions to energy problems." OTA recommends that in its solar heating and cooling program, "ERDA should consider giving increased emphasis to: user incentives, standards for measurements of equipment performance, and impact on utility peak demand of solar systems. . . . ERDA's program and budget do not give adequate attention to social, economic, environmental, and behavioral research needs, even though the legislative record makes clear that ERDA is given responsibility beyond technical R&D. . . . Unresolved nontechnological issues—from inadequate incentives for commercialization, through environmental demands, competitive use of resources, to community resistance—could block the most sophisticated engineering achieve-

ment."

What OTA appears to be getting in its evaluation of ERDA's energy conservation approach is the latter's underemphasis on a public acknowledgement of the limitations of technology applications per se in bringing about large-scale energy demand reduction. OTA's evaluation reflects a widely-held point of view on Capitol Hill that conserving energy calls for significantly increased socio-economic inputs in relation to the purely technical.

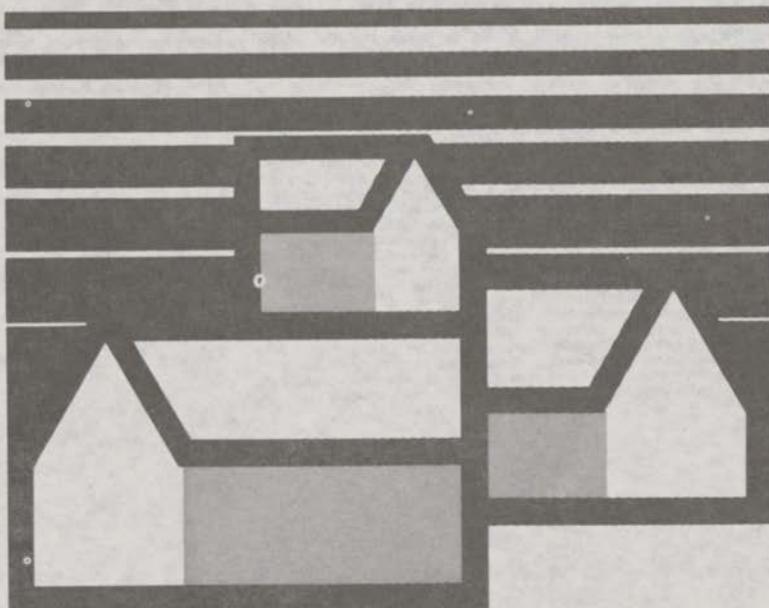
Another recent study, "Toward Project Interdependence: Energy in the Coming Decade," has its Library of Congress authors concluding that "Short of draconian measures to be taken by the executive and legislative branches of government, Project Independence goals now seem unattainable." The report concludes that for a variety of reasons, the contributions of coal and nuclear power—the only viable alternatives to petroleum during the next decade—are expected to fall considerably short of earlier estimates made by FEA and other executive agencies for the next ten years.

To date, there is little evidence of any "draconian measures" being put into an action mode for energy conservation in the U.S. Oil imports are steadily increasing. Marketplace factors at the moment appear to be not nearly draconian enough to stimulate energy conservation programs to a level which would cut into U.S. oil imports.

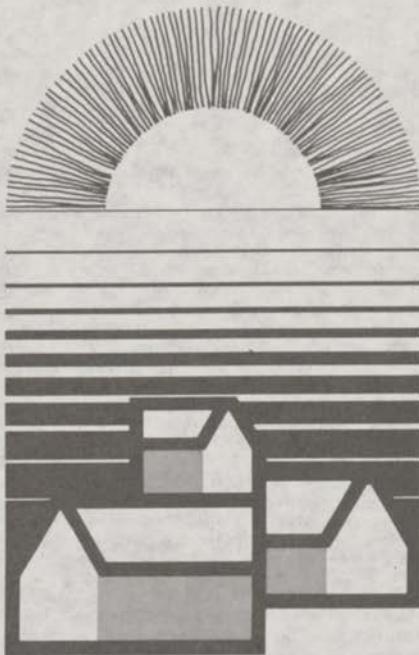


# RESIDENTIAL ENERGY FROM THE SUN

# A DESCRIPTION OF THE SOLAR HEATING & COOLING DEMONSTRATION PROGRAM



U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT  
OFFICE OF POLICY DEVELOPMENT AND RESEARCH



**HARNESSING THE SUN'S ENERGY**

**A Description of HUD's Solar Heating  
and Cooling Demonstration Program**

Prepared by the  
**U.S. Department of Housing and Urban Development,  
Office of Policy Development and Research,  
Washington, D.C. 20410.**

A Federal research, development, and demonstration effort is underway to determine how best to harness the power of the sun to provide Americans with energy for heating and cooling in the places where they live and work.

No longer an exotic and distant concept, the practical and widespread application of solar energy for residential heating and cooling demands is now on the horizon.

This booklet describes HUD's role in the new National Solar Energy Program. A mail-back coupon on the last page will enable you to obtain more specific details of this multi-stage undertaking.

#### OUR NEED FOR SOLAR ENERGY

Until recently, most Americans would have pictured a program to draw energy from the sun as an imaginary plan from the pages of science fiction. Even periodic news of small-scale successes has not persuaded many that the sun might provide energy that they could use in the places where they work and live.

After all, energy from traditional fossil fuel sources was plentiful and reasonable in price. So the question of solar energy received low priority. But a rapid succession of events has moved the entire energy problem into sharp national focus.

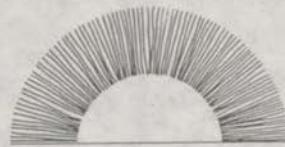
Concern about current and future energy needs and supplies, as well as changes in national environmental policy, have caused us to explore alternative energy sources as essential to our well-being.

One of these sources, solar energy for heating and cooling, is no longer a visionary dream. The technology is becoming available. What is now required is a serious, all-out effort to adapt this technology to practical demands in the next few years.

#### WHY SOLAR ENERGY?

- It is a promising alternative with important short and long term implications for solving America's energy problems.

- Technology for solar space and hot water heating is proven and available; for solar space cooling, some added development is required but no



new scientific breakthroughs seem necessary.

- Compared with other energy alternatives, solar energy for building requires a relatively low capital-intensive technology.
- Studies indicate that the short term application of solar energy is fast becoming economically feasible.
- In residential and commercial applications, solar energy is environmentally clean and non-polluting.

- Delivered at the point of use, no major investments in central station equipment or distribution networks are required.

- With proper equipment and procedures, solar energy could reduce the peak load problems of utilities and increase their average load factors.

#### THE FEDERAL EFFORT

As a result of four public laws enacted during the 93rd Congress, a major National Solar Energy Program is now under way.

Overall administration of energy research programs undertaken by the Federal Government rests with the new Energy Research and Development Administration (ERDA). The Department of Housing and Urban Development has joint responsibility with ERDA for a residential demonstration program to investigate the practical application of solar energy in heating and cooling.

Other participants at the Federal level include: the Department of Defense; the National Aeronautical and Space Administration; the General Services Administration; the National Bureau of Standards; the National Science Foundation; the Department of Agriculture; the Department of Health, Education, and Welfare; the National Oceanic and Atmospheric Administration; the Agency for International Development; and the United States Postal Service.

A National Plan for Solar Heating and Cooling (Residential and Commercial Applications) has been prepared and published by ERDA, in cooperation with HUD and other participating Federal agencies.\*

Major elements specified in the Plan include:

- demonstrations of solar technology in both commercial and residential buildings, initially utilizing available systems;
- development of solar technology to support such demonstrations, initially using available sub-systems and components;
- research and development of advanced heating and cooling technology;
- dissemination of information on the results of the above efforts.

#### SCOPE OF HUD'S RESPONSIBILITIES

HUD, through its Office of Policy Development and Research, Division of Energy, Building Technology and Standards, will carry out four activities in implementing the residential demonstration of the solar heating and cooling program:

- residential demonstrations in which solar equipment will be installed in both new and existing dwellings (Field Testing);
- development of performance criteria and certification procedures for solar heating and cooling equipment (Standards);
- market development efforts to encourage the rapid and widespread acceptance of solar technologies by the housing industry (Utilization);
- dissemination of demonstration and market development results (Information and Education).

Responding to the urgent need for practical, alternative sources of energy, HUD will conduct and complete several cycles of residential demonstrations using solar heating technology by the end of Fiscal Year 1977, and combined solar heating and cooling technology demonstra-

\* Interim Report: National Plan for Solar Heating and Cooling (Residential and Commercial Applications), ERDA Technical Information Center, PO Box 62, Oak Ridge, TN 37820; Document ERDA-231.

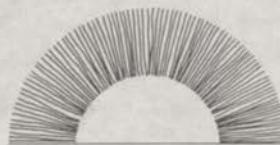
heating and domestic hot water heating systems. The third, fourth, and fifth cycles will concentrate on combined solar heating and cooling systems. All projects will utilize systems ready or "available" for demonstration. In general, a "project" will consist of from one to twenty dwelling units.

#### Integrated Project Solicitations

One series of demonstrations will involve integrated projects. These are residential projects which have been designed to incorporate a particular solar energy system, or which have been designed so that the building structure utilizes passive measures within the structure to collect, store and distribute solar energy. Normally, an "integrated project" will have been developed to the point that financing has been identified, approvals have been received, and construction is imminent. Developers interested in submitting proposals for such projects should return the form on the last page.

#### Solar Energy Systems Solicitations

The second series of demonstrations will entail separate solicitations of solar energy systems and specific proposals for local demonstration projects. This series will begin with an ERDA solicitation of solar energy systems and subsystems through a Program Opportunity Notice. An interagency evaluation panel will select those systems which are considered ready for demonstration use, and will recommend to other system proposers the developmental work which still needs to be done. Systems requiring additional development may request support funding from ERDA. Systems considered ready will be provided an opportunity for demonstration in various parts of the program—in the HUD residential demonstration program, in the ERDA commercial demonstration program, or in federally owned projects through DOD, GSA, USPS, USDA, or other agencies. Systems manufacturers interested in submitting proposals in response to the forthcoming Program Opportunity Notice should return the form on the last page immediately.



#### HUD Residential Project Solicitations

HUD residential demonstration projects will be selected on the basis of a location matrix which correlates climate, type of housing units, local building codes and zoning regulations, financing practices, construction procedures, market conditions, local demography, and architectural preferences.

Beginning in late 1975, using potential locations identified in the matrix and the results of the first cycle of solar energy systems evaluation, HUD will request specific residential project proposals on a local basis from builder/developers, State and local agencies, and other qualified parties. In general, proposals will be accepted from developers who are constructing residential projects and are willing to use one or more buildings for solar energy systems, while maintaining other, similar buildings within the project as experimental controls with conventional energy systems.

HUD will select the projects to be used based upon the qualifications of the developer, the quality of design of the proposed project, and the degree to which the project will support the program objectives. The proposers will be required to demon-

strate their ability to provide the land and financing, to integrate the solar energy system into the building design, to obtain necessary approvals, to construct and market the buildings, and to provide suitable warranties to the purchasers.

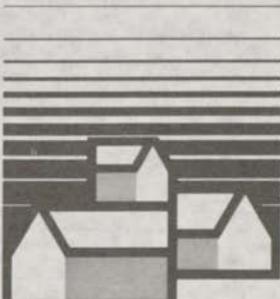
The successful proposer will receive a limited contract to integrate the solar hardware in the house, and will be required to award a subcontract to the solar system manufacturer to assist in this design effort. This procedure is analogous to the normal relationship between a builder and his mechanical contractor. The result of the design integration process will be a complete set of construction plans, specifications, and cost estimates.

If the design and cost estimates are acceptable, the developer will be awarded a contract to construct the project, purchasing the solar energy system from the system manufacturer. HUD's financial support for the project will not exceed the difference between the cost of the solar-equipped unit and a similar conventionally-equipped unit.

#### Unsolicited and Private Proposals

Because of the need to select the best proposals on the basis of the program criteria and requirements, HUD must evaluate all proposals against these criteria in a competitive procurement. For this reason, HUD will be unable to accept unsolicited project proposals for this first cycle. This policy decision will be reviewed for each succeeding proposal cycle.

One of the prime objectives of the residential demonstration program is to develop cost and operational comparisons between solar energy and conventional systems and installations. A second objective is to develop marketing experience and procedures for solar energy systems. It is unlikely that projects involving individual private residences will provide sufficient data addressing these issues. HUD, therefore, does not expect to select private projects for awards unless they present unique demonstration opportunities. Retrofit projects will be limited to publicly-owned housing units.



tions by the end of Fiscal Year 1979. This represents an intense and compressed search for practical answers in a few short years.

To accomplish these objectives as rapidly as possible, HUD's key strategies include:

- a series of functional demonstrations;
- the active involvement of the housing industry;
- the rigorous study of various potential barriers—economic, social, legal—to widespread utilization of residential solar energy systems;
- determination of methods to stimulate market demand for such systems at all stages;
- investigation of needs and types of possible incentives to promote the marketplace supply of standard systems, sub-systems, and components.

#### THE PHILOSOPHY BEHIND HUD'S EFFORT

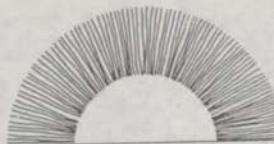
The magnitude of the national need and the complexities of this developmental task require a philosophy which:

- understands and seeks to utilize the existing housing industry's structure and capabilities;
- views solar energy as an alternative to other energy sources;
- applies to the greatest degree possible conventional or slightly modified technology;
- schedules field demonstrations in a cyclical approach to encourage continuing improvements to the solar energy concepts.

HUD believes that the Government's role is to provide an appropriate stimulus to industry and potential users of solar energy systems and equipment, and to assist in demonstrations which will lead to early and widespread marketplace utilization of solar energy for heating and cooling applications.

#### HELPING TO MAKE A MARKET FOR RESIDENTIAL SOLAR ENERGY

Even when reliable solar energy systems are developed and successfully tested in a variety of living situations, the public can reap the benefits only if a functioning marketplace for such products is established



and in operation.

To help build this marketplace, HUD will direct efforts toward a series of interrelated market development tasks. These will include:

- The development of performance criteria and the establishment of procedures for product certification

To initiate the process of developing uniform standards to assure industry-wide acceptance and product quality, Interim Performance Criteria for solar heating and cooling systems have been published.\* During the demonstration phase, demonstration projects will be equipped with instruments to measure the performance of the solar energy equipment and the contribution of this equipment in meeting the building energy requirements. The results of these studies will be used to develop definitive performance criteria as a basis for industry-wide standards.

Procedures for the certification of solar energy systems based on such definitive performance criteria will be designed using the results of the demonstration program and the evaluation of the technical performance of the various systems. Appropriate industry and trade organizations will be involved in the establishment of the certification process.

- Development of detailed financial procedures and recommendations

Studies have shown that the financing of residential units employing solar energy systems will require balancing operating cost savings against the greater first costs for such equipment. Results from the field demonstrations will provide such cost information. Recommendations for appropriate mortgage instruments and related

policies will be developed to encourage consideration of operating cost savings in establishing original mortgage amounts.

#### • Appraisal and tax assessment considerations

Studies will be made of various appraisal procedures and new standard appraisal and assessment techniques for use in connection with setting tax rates and valuations on residential units containing solar energy systems.

#### • Residential occupants' attitudes

Surveys of the occupants of demonstration units will be conducted to determine their likes and dislikes toward solar heated and cooled housing. Similar attitudinal surveys will include visitors to and potential purchasers of such units.

#### • Predictions of savings potential

Techniques of economic analysis will be developed to predict the savings potential of solar energy based on data from the field demonstration program.

#### • Study of barriers to widespread acceptance of solar energy

A study of institutional factors which may affect the broad introduction of residential solar energy systems will look at: local building industry and trade practices; alternate forms of ownership and financing; provision of supplemental back-up service by utility companies; and local building codes and zoning ordinances.

#### • The possible need for financial incentives

Financing incentives, through grants, loans, and tax allowances, have been suggested by the Congress and by industry. Various approaches to such incentives will be studied.

#### HOW THE HUD RESIDENTIAL DEMONSTRATION PROGRAM IS STRUCTURED

Two parallel series of demonstrations are planned. Each series will consist of five cycles, repeated at intervals of 9 months to 1 year. Those potential participants who may not be ready for the earlier cycles will have the chance to participate in later cycles, thereby assuring dynamic technological growth during the entire series of demonstrations.

In both series, the first two cycles will focus primarily on solar space

\* Interim Performance Criteria for Solar Heating and Combined Heating/Cooling Systems and Dwellings (Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20410; Stock Number 003-003-01388, Class C-13.6/2; SO 4; price \$1.90.)

[From Professional Engineer, December 1974]

#### ASHRAE STANDARD 90-P CONFRONTS ENERGY CONSERVATION IN NEW BUILDINGS

By Jack E. Tumilty, P.E., Principal, Jack E. Tumilty, Consulting Engineer

*The new standard presently being written by an ASHRAE committee provides the designer with a method of calculating the energy requirements for a building using U-factors and temperature differentials to determine heat gain and loss of the building envelope plus the internal load imposed by the power distributions system and the illumination system.*

A standard that could change the way buildings are erected in the future in the United States and possibly much of the rest of the world is presently being written by a standard project committee of the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE). The first draft of the proposed standard has just undergone open review, and the project committee is presently considering the comments that have been received on that draft.

ASHRAE Standard 90-P is the "Design and Evaluation Criteria for Energy Conservation in New Buildings". The purpose of the standard is to provide the designer with the criteria which, if properly applied, would result in a building of good thermal quality and equipment and systems in the building which would be efficient in the utilization of energy. In addition, the designer is provided with flexibility in the use of innovative concepts when applying the criteria to the design of buildings and systems.

The need for this standard is evidenced by the rising costs of fuels and energy that are utilized in buildings. As these costs continue to increase, the expense to the owner when operating the building will make it imperative that it be properly designed thermally and the systems installed be as efficient as possible.

Whether we like it or not, Americans are great wasters, but now it's becoming too expensive to be wasteful. Therefore, it is imperative that the direction of the American "way of life" be changed not only because the cost of the energy, in whatever supply, will continue to rise but also because it may finally reach a point where its cost is beyond the economic capability of the consuming public.

In the summer of 1973 the National Conference of States on Building Codes and Standards (NCSBCS) recognized the need for some type of standard in the building industry which would, in fact, reduce the energy consumed by buildings. NCSBCS is a group composed of representatives of state and local governments whose purpose is to seek uniformity in codes and standards throughout the United States. Realizing the need for a uniform standard for building construction they sought the help of the National Bureau of Standards (NBS), and finally ASHRAE, in the writing of such a standard. NBS first responded with its document which was completed on February 27, 1974. ASHRAE started at that time and used that document as a basis for Standard 90-P.

Standard 90-P covers all facets of building construction including: the building envelope made up of solid walls, fenestration, roofs, and floors; building systems design; equipment selection; domestic water heating; power systems design within the building; and illumination. By properly evaluating these six areas the designer can reduce to a minimum the amount of energy that a building requires for its operation and thereby make the building energy efficient.

ASHRAE is recognized as the expert organization in the technical field of heat transfer. It has utilized its technical committees and task groups as well as other ASHRAE standards in preparing the sections on the building envelope, systems, equipment, and water heating. ASHRAE acknowledges that it is not, in fact, expert in the field of power distribution and illumination. Therefore, it has worked with the Electric Energy Association in the preparation on the section on building power distribution and with the Illuminating Engineers Society in the preparation of the section on illumination. These two groups are recognized as authorities in their areas of expertise and these two sections of the standard reflect the best thinking of these experts.

ASHRAE Standard 90-P provides the designer with a simple method of calculating the energy requirements for the building using U-factors and temperature differentials to determine the heat gain and loss of the building envelope, plus the internal load imposed by the power distributions system and the illumination system. After this calculation is complete the designer may then design an efficient system for the building according to the standard and further select efficient equipment to serve the system as designed. The standard also provides the designer with an alternative. Once having calculated the energy requirements for the building he may evaluate the building through reorientation or change of geometry or building construction to develop a building having a smaller energy requirement but of an innovative design. This type

of evaluation would require a computer analysis of the building design but would provide the designer with all of the innovative capabilities he desires.

The designer has an additional alternative that would provide him with the opportunity of further reducing the energy entering the building. This alternative would recognize the use of wind or solar energy as a part of the energy utilized within the building. Through proper evaluation of these sources of energy, the designer can further reduce the amount of energy used by the building from sources outside the building site boundary and thereby make the building even more energy efficient.

This standard is not yet complete but is in the final stages of preparation following public review. Once it becomes an ASHRAE standard it is anticipated that it will require a more frequent revision schedule than is normally provided in ASHRAE standards. It is expected that it will be reviewed on an annual basis for the first four or five years and, in fact, on a six-month basis for the first year. Normally ASHRAE standards are reviewed and revised on a five-year cycle. Due to the fact that the technology will change rapidly within the next several years, it is recognized that frequent updating of this standard will have to occur if it is to stay abreast of the state of the art and truly provide for energy efficient buildings and a reduction in energy consumption.

ASHRAE realizes that when completed, Standard 90-P may well be incorporated into local and state building codes. This is not unusual because ASHRAE standards have been referenced and incorporated by reference in many building and safety codes. It is therefore imperative that ASHRAE Standard 90-P be technically correct and that when properly applied will truly provide for a reduction of energy consumed by the many buildings that are yet to be constructed.

[From Professional Engineer, September, 1975]

#### THE ENERGY AUDIT: PRIME MANAGEMENT TOOL FOR ENGINEERS IN INDUSTRY

By Paul C. Greiner, Vice President, Conservation and Energy Management Division, Edison Electric Institute

There is a long-term trend toward greater use of electric power. In 1930 about 10 percent of the primary energy consumed in the United States was used to generate electricity. Today it is about 27 percent, and by the year 2000 it is expected to be about 50 percent.

While in 1974 there was essentially zero growth in kilowatt-hour output, it is expected that output will be up about 5 percent in 1975. A recent EEI study—"Economic Growth in the Future"—concluded under conditions of moderate economic growth, electric energy consumption over the next 25 years will grow at an average rate of 5.3 to 5.8 percent per year.

This growth trend is anticipated because the application of electricity will be increasing, not only in new uses but in substituting for other forms of energy. A great deal of activity will be in the industrial area. Those industries switching to electricity include metal processors and fabricators, glass makers, and automobile manufacturers. Others experimenting with methods of substituting electricity for oil or gas include manufacturers of paper, cement and ceramic products.

In these times, the concept of "energy management"—a term now widely used by the electric utility industry to denote wise use of energy—is playing a major role. As professional engineers look to what they can do to provide energy management in the industrial area, it is essential that they first make an energy audit.

Why conduct an energy audit? In this way an engineer can analyze all of the various major energy consumption areas in the plant—heating and air conditioning, process heating, lighting—and with this information can then look at ways to better manage these users of energy.

If personnel or cost limitations make conducting an audit difficult, that's where the professional engineer can come in and help the plant personnel review their requirements. The point is, without an energy audit, it will be very difficult to determine the steps needed to conserve energy or to measure the success of the conservation program. On the other hand, with an audit the plant manager will know what and where he is spending and he can then evolve creative, innovative conservation measures tailored to the specific operation.

Once the engineer has determined where the plant stands on energy consumption through an energy audit, ways can be pointed out to improve efficiency. This means setting conservation goals for every phase of operations. In setting goals, here are five major areas to consider.

1. Fabricating/processing. Energy waste is often the result of long, unquestioned plant practices that, upon analysis, can be shown to have no effect on employee performance or product dependability.

2. Energy used for heating. This represents about 18 percent of the nation's energy consumption and, according to the National Bureau of Standards, approximately 40 percent of the energy used for heating is wasted.

3. Cooling systems. These represent 42 percent of the nation's energy needs for building operations during the summer. According to NBS, energy requirements for cooling can be reduced one-third with little sacrifice in comfort.

4. Energy consumption for lighting. This can effectively be reduced 15 percent in most existing buildings by better switching control, turning off lights when not needed, paying more attention to matching the amount of lighting used to jobs being done, and using more efficient light sources that require less energy. However lighting as a whole utilizes only 5 percent of the electric energy produced and significant savings must come from less efficient energy consuming sectors.

5. Remodeling and new construction. Applying advanced heating, cooling and illumination concepts, when combined with better insulation, ventilation, fenestration, and illumination techniques, materials, and equipment, can reduce energy consumption in buildings by as much as 40 percent overall.

A recent study, "The Data Base—The Potential for Energy Conservation in Nine Selected Industries," is concerned with the potential for energy consumption in the industrial sector. It was prepared by Gordian Associates for the Office of Industrial Research and Demonstration, Conservation and Environment, of the Federal Energy Administration. One table in this report presents the primary energy used to produce each product, the breakdown of primary energy by resource type, and the total energy used in the industry in 1970 to produce the specified product.

From the table it can be seen that, in terms of total energy use, raw steel by far uses the most energy. This is followed by petroleum refinery products, primary aluminum, portland cement, and corrugated containers. Another pertinent table summarizes energy conservation measures by pinpointing the equipment or system, items involved, and steps to be taken. The point which can be drawn is that to get the greatest effect from energy management one should look at the largest energy users first, for they will have a larger impact on the results.

There are many ways industry can curb wasteful use of energy and thereby improve overall efficiency.

#### I. SPACE CONDITIONING

Install or upgrade insulation. Rapidly increasing fuel costs have made insulation more cost-effective than ever.

In hard-to-heat areas such as high-bay and highly ventilated spaces, space heating energy can be reduced by putting the heat only where it is needed or by using heat recovery devices.

Reduce heating or cooling when the space is unoccupied. Where cold or freezing temperatures will not cause a problem, turn off electric heating equipment when a building area or room is not occupied.

Use properly sized equipment for heating and cooling. Engineers can help determine to what extent the heating, ventilating, and air conditioning equipment is suited for the job being performed.

Set thermostats in occupied areas at the lowest comfortable temperature.

Start air conditioning before production equipment is in operation, thereby reducing electric demand.

Provide ventilation in crawl spaces, between ceiling and roof. Some companies have found it is practical to spray water on building roofs to mitigate the effects of solar heat.

Clean filters in air conditioning equipment regularly to assure maximum operating efficiencies.

Cut leakage from the building by installing weather stripping, caulking, and so on to seal cracks around windows and doors.

On thermostats, where practical operate on a time clock; position thermostats on an inside wall away from drafts or sources of heat; and lock them to avoid resetting by unauthorized personnel. Also take advantage of the thermal flywheel effect by adjusting thermostats prior to closing time. The stored energy in the buildings will tend to maintain temperature for a period of time.

## II. PROCESS ENERGY CONSERVATION

Insulate steam and hot liquid pipes, furnaces, and other heated containers where possible. Keep openings in equipment closed and sealed and use reflective heat shields where openings are necessary.

Avoid short runs on thermal process equipment and shut down idle equipment during production interruptions. Use time clock controls on heating devices or motors, where practical.

Electricity can often be used more efficiently and more economically if some use can be diverted to off-peak periods.

## III. CORRECT USE OF LIGHTING

Make maximum use of modern, efficient light sources. A system can be upgraded to metal halide or high-pressure sodium, and produce the same or more light for less energy.

The lighting system should be properly designed so that it delivers light where it is needed yet produces a pleasing balance of brightnesses. (The new concept is called non-uniform lighting.)

Where safety or security is not a factor, turn off luminaries in areas not being used, such as inactive storage areas or boiler rooms.

Outdoor lighting systems or indoor security lighting systems which are controlled manually may be wasting valuable operating dollars by being on when not needed. A photocell control will insure that lights are on at dusk and off at dawn.

To effectively manage energy in a plant one must understand how to use the hardware. Of particular importance is the use of HVAC systems. These systems can be categorized into four areas: Exhaust air heat recovery, refrigeration heat recovery, lighting heat recovery, and other systems.

Powered ventilating systems exhaust conditioned air from inside a structure and replace it with up to 100 percent outside air, which must then be treated to bring it within the design limits for temperature and humidity. This exchange of conditioned inside air for outside air represents a considerable expenditure of energy. And in well-insulated structures in which heat gains and losses through the exterior of the structure are diminished, ventilation losses loom proportionately larger. There are, therefore, decided economic advantages to be realized by providing some means for reclaiming the conditioning effect of exhaust air. Among the proven methods for doing this are those employing heat wheels, runaround systems, static heat exchangers, and heat pipes.

There are two types of heat wheels. The first transfers only sensible heat while the second handles latent heat as well. Each consists of a motor-driven wheel frame packed with a heat absorbing material such as aluminum or stainless steel mesh, or a corrugated asbestos-type material. The wheels are designed to be installed in the ventilation air system, with the outside air and exhaust air kept separate.

A limitation in the application of exhaust air heat recovery concepts is that inlet and exhaust ducts must be close to one another. The requirement is avoided in the runaround system which employs two heat exchangers connected to one another by a loop of pipe. The runaround system can be as efficient in energy transfer as the heat wheel, provided the heat exchangers have sufficient capacity. However, if a heat exchanger's capacity is increased by adding rows of finned tubing, the pressure drop through it increases considerably. The gain in efficiency, therefore, must be partially offset by the higher fan power required.

The air-to-air heat exchanger represents a static means for transposing heat between exhaust and outside air streams which pass through it in a counterflow fashion. It resembles an open-ended steel box with a rectangular cross section that is compartmented into a multiplicity of narrow passages in a cellular format. Every other passage carries exhaust air, alternating with those carrying makeup air.

A transfer of energy between incoming and outgoing air can be accomplished by banks of devices known as heat pipes. These are installed through the adjacent walls of inlet and outlet ducts and have their opposite ends projecting into the air stream. A heat pipe consists essentially of a short length of copper tubing, sealed at both ends, which contains a snug fitting porous cylindrical wick and a charge of refrigerant. These units are highly efficient and because they are sealed with no moving parts, maintenance is minimal.

By virtue of its name alone, the heat pump deserves the attention of engineers concerned with optimizing energy use through heat transfer. The heat pump is essentially a heat-transfer refrigeration device that puts the heat rejected by the refrigeration process to good use. It offers the engineer a single equipment installation that can provide either heating or cooling, can switch from one to the other automatically as needed, or can supply both simultaneously if so designed.

In a refrigeration-type heat recovery system, the double-bundle condenser is constructed with two entirely separate water circuits enclosed in the same shell. Hot refrigerated gas from the compressor is discharged into the condenser shell where its heat is absorbed by either one of the water circuits or by both simultaneously, depending on requirements of the system at a given time.

Other heating systems which can provide energy management are waste heat recovery from processes. Many processes such as ovens, furnaces, vats, salt baths, and so on, expel large amounts of heated air to the plant environment or it is exhausted. Much of this heat can be recovered and reused for pre-heating products or processes or for space heating. Heat recovery devices similar to those previously described for space heating, but designed to operate at different ambients may be utilized. The concept is to use and re-use each BTU of energy to reduce the over-all energy requirements.

In the process heating area there is a new device called the templifier—or temperature amplifier—which employs the same basic principles as the residential heat pump. But by using a much larger compressor and working at higher temperature levels, it can be applied to produce hot water using low-level heat from a process or the heat source.

An addition to the basic concept is a man-made pond near an industrial plant. It collects heat from the sun which is then available as input to the templifier. A plastic cover is used to reduce heat loss from the pond from convection, re-radiation, or evaporation. This heating pond may be an answer for the plant with a steam requirement in the 140 degrees F to 230 degrees F range but without a low-temperature heat source.

Another tool which engineers should find useful is computer programs which simulate the operating conditions of a building or process and determine the costs of alternate methods of heating. There are several such programs. One, called AXCESS, was developed by EEI. It consists of two sections: The energy analysis computer program, a method for predicting the energy usage of a building, and the financial analysis section which ties cost information into an evaluation based on the client's criteria.

[From *Changing Times*, March 1976]

#### SOLAR POWER FOR YOUR HOUSE—HOW PRACTICAL NOW?

Harnessing solar energy is no longer the far-out dream of a few. We have learned to make direct use of the sun's rays to heat swimming pools, to heat water for bathing and washing, and to warm homes, schools and business buildings. There have also been some successful experiments in solar air-conditioning.

Actually, small solar devices for heating household water have been in use in Florida and the Southwest since the 1920's; as many as 8,000 of them may be in current operation. It is reported that there are 100,000 solar water heaters in Israel and more than a million in Japan.

Today there is absolutely no doubt about the feasibility of using solar energy in our homes. Beautiful modern solar houses are spotted around the country, some in such seemingly unlikely locations as New England, Michigan and Minnesota.

Neither is there any doubt about the wide interest in possible applications. In the early 1970's there was no real solar equipment industry, except for water heating. Now a recent search by ERDA, the federal Energy Research and Development Administration, turns up some 225 manufacturers building more than 400 different solar products. The companies include many small new firms but also some of the best-known names in American industry—Dow, 3M, PPG, GE, Honeywell, Revere, Westinghouse, among others.

No, the feasibility of solar energy is not the problem today. The problem is whether a solar-powered household heating-cooling system is practical—practical in the sense that most engineers use that word, meaning "cost effective." In other words, can we devise a system that will save enough in conventional fuel bills to pay for the initial investment within a reasonable period?

#### THESE ARE THE BASICS

In practical household application heat must be collected, transmitted to storage, stored, recovered from storage, and redistributed where and when needed—all with minimal losses.

The simplest solar heating system—sun-heated water for bath, kitchen and swimming pool—is a subsystem connected to the hot-water plumbing. One pipe carries water from the tank to the collector panel, usually on the roof, and another pipe returns

it from the panel to the tank. Circulation may be provided by a small electric motor or generated thermodynamically (warm water rises), with all energy supplied by the sun.

The panel itself may be a box covered with glass or plastic panes, painted flat-black inside, containing serpentine piping through which the heating water circulates. One late-model design is made entirely of black plastic a fraction of an inch thick, with vertically molded channels running from a horizontal input pipe, or manifold, at the bottom to a similar output manifold at the top. These panels can be combined according to volume requirements. Other glass- or plastic-faced panels are available in carbon steel, stainless steel, copper, aluminum and other metal bases. Each material has advantages and disadvantages from the standpoint of cost, durability, resistance to corrosion and ultraviolet rays, heat absorbency, heat retention, weight and ease of construction.

Most solar collectors use water or other liquids to transport heat to the storage area. For simple household water heaters, the water may go directly to the hot-water tank. But where necessary, antifreeze is added to the collector circuit and the solution is then circulated into a heat exchanger, similar to a car radiator, that is immersed in the hot-water tank.

The same basic setup—collector to heat exchanger—may be used to bring heat indoors to warm a building. The "furnace" is merely a blower that circulates air over the warm, liquid-filled heat exchanger. In other designs the hot liquid itself can be circulated within the building through baseboard radiators or air may be used as the heat-transfer medium.

Most solar heating-cooling systems require a massive amount of storage material in which collected heat can be stored for nighttime and cloudy-day use. So far, only two storage materials have received serious attention from manufacturers: water and crushed rock. Water readily accepts heat but also easily and quickly gives it up and must therefore be kept in a large insulated tank. Rock, on the other hand, is slower to warm up but holds its heat much longer.

Crushed rock can be stored in a tank, but it is more usual to keep it in a large underground pit. Heat is recovered by pumping filtered air through the rock for redistribution throughout the house.

At present, an expensive part of a solar heating system may be a sophisticated control network needed to coordinate it with a backup system using conventional fuel. An array of automatic, thermostatically operated electric switches, valves, duct doors and other regulators may be needed. When the collector begins to cool in the afternoon or on a cloudy day, for example, the system must be switched automatically to draw upon its stored heat.

Solar air-conditioning, using an absorption chiller, the system that has received the greatest attention, is most likely to be practical where it is needed the most—in extremely hot, sunny climates. This method works similarly to gas refrigeration and air-conditioning systems, but solar heat is used instead of a flame.

#### CLIMATES AND CLOUDY DAYS

A school building in England was provided with a complete solar system and a backup fossil-fuel system when it was built 15 years ago. The backup system has never been used. In Arkansas there are private residences without backup systems. In warm climates some solar homes get along with occasional use of the fireplace on crisp evenings.

By and large, though, solar homes need backups. Where you live affects the use you make of the backup, although not as much as you might think. North of about 35 degrees latitude (that's an east-west line drawn close to Little Rock) heating matters most. Below that line air-conditioning is the dominant need. However, solar-assisted heating or air-conditioning systems can be used in every one of the 48 contiguous States and Hawaii, and even in some parts of Canada.

High altitude helps. Insolation, which means solar radiation received, is much greater where the air is thin and clean. It's insolation that makes Colorado such a popular site for solar building experiments.

The most important climatic factor is the customary amount of cloud cover. Check the cloud charts for your locality. The cloudier your area is, the larger—and more expensive—your collector installation will have to be.

Compared with typical prices for a conventional gas, oil or electric heating system for a single-family home, a solar installation is expensive—averaging about \$8,000. Add the cost of the conventional backup system that almost every solar installation demands—another \$1,500 to \$2,000 or so—and the price of nature's free heat seems even higher.

Estimates on how long it would take a homeowner to get his money back range from several years to several decades. But one enthusiast believes that this misses the point. "You can get a home-improvement loan, invest it in the house and increase its value. And for as long as you live in that house, you can enjoy the benefits of its improvement."

On the other hand, a detractor says he could invest what a solar system costs in a savings account, earn interest, pay his utility company for conventional fuel and still pocket a considerable difference, assuming that fuel remains available.

ERDA officials say that solar home heating at this time is competitive only with electric resistance heating where rates are 4 cents or more per kilowatt-hour, although it is competitive for water heating and for swimming pools. They consider solar cooling experimental as well as very expensive at the present time.

#### NEW HOUSE OR OLD?

Anyone contemplating building might investigate what solar equipment is available to him and whether it is right for his particular locality.

Installing a solar plant in an existing building—retrofitting—is a different matter, and there is considerably less information to go by. Studies done for the government have been pessimistic about the practicality of retrofitting, but research is continuing.

One company, International Solarthermics Corp. (ISC) of Nederland, Colo., has made sizable inroads in this field. Its design is highly controversial. ISC uses three sizes of a small backyard collector, which it claims has high heat-gathering capability, and stores heat in about 25,000 to 45,000 pounds of crushed rock housed in a small A-frame shed, of which the collector forms one side. Warm air from the heated rock is blown into the ductwork of a conventional home heating system, which is on standby duty. John H. Keyes, ISC chairman, says the system can be installed in an average three-bedroom home for under \$6,000. With ISC-specified insulation, which includes 18 inches of fiberglass batts (or the equivalent) in ceilings, the company says these "furnaces" will supply up to 90 percent of a home's heating requirements. The specific percentage depends on such factors as climate, size and location of the house, and the size of the collector shed.

Critics doubt that the specified insulation can be installed in many existing homes, and some say the units can't provide enough heat and savings to make the cost worthwhile. Consumer evaluation isn't possible yet because most ISC installations are now weathering their first winter.

For now, the homeowner thinking of buying solar equipment, either original or retrofitted, should proceed with extreme caution. Seek a contractor who has experience in the field and ask for names of customers so that you can find out whether they're satisfied. It's a good idea to hire an experienced professional engineer, licensed in your state, to check the contractor's claims. Have your lawyer read the contract to determine exactly which construction and installation costs are covered and what warranties on performance and equipment are included.

You may find that your house is not suitable for conversion to solar heating-cooling. Many times the usual amount of insulation is generally required for the promised performance. Some houses cannot be properly retrofitted, or essential changes, such as roof reconstruction, may not be practical from a cost standpoint. Actually, additional insulation may save more on fuel bills than installing a solar heating system, and even with solar heat, proper insulation should come first.

Above all, don't count on recouping your solar investment from fuel savings. You might not live long enough.

Remember, too, that although 100 percent solar heat is technologically possible, it is usually not economically practical because it necessitates a prohibitively costly investment. In most cases, it's better to have an auxiliary heating system.

There is one final point to be made. If our fuel and energy situation ever becomes as desperate as some pessimists fear, the cost-effectiveness considerations applicable to solar energy today may become moot. All values in the trade-offs would change, and man may yet be grateful that he has found the technology to take his warmth from the sun.

#### SOME SOLAR, ALL SOLAR

Most solar heating-cooling systems use electricity in addition to solar energy. The electricity drives pumps to deliver the heating and cooling medium to various parts of a building and also works the switches and solenoids that operate valves and doors for draining, redirecting air or fluid flows, and other functions.

Solar energy purists label these as "active" systems in contrast to the "passive" systems they prefer. In passive systems all energy is supplied by the sun—no electrici-

ty—and ingenious devices employ thermodynamic and other physical principles to cause the components to perform without any other source of power. This is true conservation, their proponents say, not merely a trade-off of one form of man-made power for another.

An open-plan house in New Mexico is an example of a passive system. Large, water-filled barrels are placed in racks against the inside of windows facing south. Aluminum-faced insulating doors, operated by hand cranks and nylon ropes, lie on the ground in front of the windows on winter days so that the aluminum acts as a reflector to intensify the sun's heat. The doors are raised to cover the windows after sundown during the winter to prevent heat loss and in the summer to shield them from the sun. In winter heat radiates from the warmed water to the house, with auxiliary heat provided by wood-burning stoves. Curtains inside the house help control the flow of air.

Another design uses electricity only for a few minutes a day to move insulation panels to shield or uncover flat tanks on the roof. Uncovered, the tanks absorb winter sun and heat the house through the ceiling by radiation; the tanks are covered at night, holding in the heat. This system can also be used for cooling by closing the panels during the day and opening them at night. The design requires no supplementary heating or cooling in one-story buildings in the Southwest. Concrete floors and walls are preferred, but frame construction may be used.

#### Some examples of active systems:

A demonstration house in Tucson, using collector panels made with blackened copper sheets and tubes covered with glass, is said to capture enough solar energy to supply about 75 percent of its cooling needs and 100 percent of its heating needs.

The waste water treatment plant at Wilton, Me., employs solar collectors and heat pumps in a design projected to save about \$3,600 a year in heating oil costs and close to \$900 in electricity costs.

A school building in Atlanta and another on the campus of New Mexico State University in Las Cruces, both dedicated last fall, became the first experimental combination of solar cooling and heating designed into buildings of their size. The Atlanta school, which uses 10,000 square feet of collectors to heat and cool 32,000 square feet of floor space, is said to be the largest solar project of its type to be undertaken to date. Sixty percent of the building's cooling requirements are accomplished with a 100-ton lithium-bromide absorption chiller powered by solar-heated water. Funds for construction of the solar system were provided by ERDA.

A proposed solar demonstration fire station in Kansas City, Mo., is expected to meet about 65 percent of its annual heating load with a solar design that incorporates heat storage in 72 tons of dry pebbles in a concrete box with a cloudiness reserve capacity of two and a half days, and a conventional auxiliary heating system for backup.

An award-winning design for a federal building in Saginaw, Mich., has an 8,000-square-foot tilted flat-plate collector on a parklike roof, which is also used for recreational purposes, and two 15,000-gallon water-storage tanks.

#### PRETEND SOLAR AND SAVE

For successful solar heating you need a special kind of house—either one originally designed for solar energy or one that can be retrofitted for it by careful engineering. If neither option is open to you, do the next best thing. Save by living by the solar rules.

1. Insulate walls, attic floor, windows and doors to the maximum for your area.
2. Find every air leak and patch it. Caulk every crack, especially around windows and doors, to minimize leakage of warm air in winter and conditioned air in summer.
3. Practice energy conservation by limiting the frequency and duration of door openings.
4. In the winter let natural heat in by lifting or removing awnings and by opening blinds and curtains when the sun shines. Hold the heat in at night by closing blinds, curtains and drapes.
5. In the summer close blinds and curtains against the sun's heat.
6. Use kitchen and bathroom ventilators sparingly. They can exhaust hundreds of cubic feet of warmed or cooled air in a couple of minutes.



