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REPORT TO THE CONGRESS

National Standards Needed For Residential Energy Conservation

Department of Housing and Urban Development

BY THE COMPTROLLER GENERAL OF THE UNITED STATES

RED-75-377

JUNE 20, 1975

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

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To the President of the Senate and the
Speaker of the House of Representatives

This is our report on National standards needed for residential energy conservation. The report concerns various practices that impede the efficient use of energy in the residential sector.

We made our review pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53), and the United States Housing Act of 1937, as amended (42 U.S.C. 1401).

We are sending copies of this report to the Director, Office of Management and Budget; the Secretary of Housing and Urban Development; the Secretary of Commerce; the Secretary of Agriculture; the Administrator, Energy Research and Development Administration; the Administrator, Federal Energy Administration; the Administrator, Veterans Administration; and Commissioners of the Federal Trade Commission.

Comptroller General
of the United States

Contents

ABBREVIATIONS

EPA	Environmental Protection Agency
ERDA	Energy Research and Development Administration
GAO	General Accounting Office
HUD	Department of Housing and Urban Development
NBS	National Bureau of Standards
NSF	National Science Foundation
MIUS	modular integrated utility system
MPS	minimum property standards
VA	Veterans Administration

COMPTROLLER GENERAL'S REPORT TO THE CONGRESS

NATIONAL STANDARDS NEEDED FOR RESIDENTIAL ENERGY CONSERVATION
Department of Housing and Urban Development

D I G E S T

During January 1975, in response to congressional inquiries, GAO developed a package of energy proposals which included energy conservation measures that can be taken to improve energy efficiency in all sectors of the economy, including the residential sector. In March 1975, GAO presented its energy proposals to the House Committee on Ways and Means.

This report, by drawing upon numerous energy-related studies made over the last few years by various public and independent agencies, expands upon and lends support for those proposals GAO previously made concerning energy conservation in the residential sector; it also offers some additional proposals.

MATTERS FOR CONSIDERATION BY THE CONGRESS

The Congress currently has before it numerous bills that in some way affect energy efficiency in the residential sector. The various bills provide different ways to bring about energy savings.

Several major policy issues must be addressed by the Congress in determining what action should be taken to reduce energy consumption in the residential sector, including determining

--whether the energy problem is serious enough to warrant actions that require large cost outlays or lifestyle changes;

--whether housing should continue to be built on the basis of lowest initial construction cost or on lowest lifecycle operating cost; and

--the extent to which the Federal Government should provide incentives to industry to develop more energy-efficient housing subsystems, such as heating and cooling systems and appliances.

In enacting legislation addressing these issues, the Congress might wish to consider, as a means of conserving energy in the residential sector, such actions as

--establishing a national program for energy conservation, including national goals and priorities and defining the roles of the various key Federal agencies;

--requiring the establishment of national thermal standards

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or energy performance standards for all new housing;

--providing incentives (through tax credits, loans, etc.) to homeowners to encourage retrofitting of existing homes, such as adding insulation and storm doors and windows and properly caulking and weatherstripping around openings;

--requiring all existing homes to be financed directly or indirectly through any federally insured agency to meet minimum thermal standards for those conservation measures that can be reasonably added;

--requiring mandatory efficiency labeling of all major applicances;

--establishing a cut-off date when applicances meeting minimum standards of operating efficiency would be required to be installed in new homes; and

--establishing national standards or guidelines banning ornamental gas lights and requiring electric igniters instead of pilot lights on new appliances. (See pp. 26 to 27.)

GAO believes the construction of energy-efficient housing and the accomplishment of energy savings will not be fully realized unless comprehensive legislation is enacted.

The Department of Housing and Urban Development (HUD) agreed with GAO that a large amount of energy would be conserved in residential housing if the Congress would enact legislation providing for establishment of national thermal standards or energy performance standards for all new housing. HUD commented that energy conservation measures should be applicable across-the-board in order to be effective on a nationwide basis and equitable to all homebuyers, builders, and lenders.

RECOMMENDATIONS

The Secretary of HUD can take several measures, under current legislation, to promote energy savings through HUD activities. In the interim before the Congress enacts national energy legislation, GAO recommends that the Secretary of HUD

--make energy conservation an important objective in its minimum property standards by emphasizing operating costs as well as initial construction costs,

--establish thermal standards for existing housing to be insured under Federal programs, and

--contract with industry to develop more energy-efficient housing subsystems. (See p. 27.)

CURRENT IMPEDIMENTS TO ENERGY CONSERVATION

Of the 70 million existing housing units in the United States, over 40 million are estimated to need thermal protection improvements, such as ceiling insulation, caulking, weatherstripping, and the installation of storm doors and storm windows.

Despite the increasing seriousness of our Nation's energy deficiencies, construction of energy-efficient housing is still a low priority concern to nearly all participants involved in planning, designing, financing, and constructing residential housing. (See p. 5.)

Space heating and cooling and water heating account for about 76 percent of the residential energy used. Numerous studies have been made in recent years on the energy savings achievable by implementing various energy conservation measures in buildings.

The American Institute of Architects recently reported that, at this time, 30 percent and 60 percent energy savings for old and new buildings, respectively, are considered as very conservative estimates. (See pp. 1 to 4.)

Major reasons that residential housing has not and is not being built to make the most efficient use of energy include

--the housing industry's practice of building homes with emphasis on the lowest initial cost (see pp. 5 to 8),

--various obstacles to inducing technological changes to promote energy efficiency (see pp. 9 to 11),

--limited use of HUD's minimum property standards to encourage energy conservation (see pp. 11 to 20), and

--limited research to improve energy efficiency of a housing unit (see pp. 20 to 24).

GAO notes that there are various bills before the Congress that would provide for the Secretary of HUD to develop "prescriptive" or "component performance" standards for use in all new construction.

HUD's standards are generally considered to be component performance standards. HUD officials told GAO that, if any of the proposed legislation were enacted, HUD would probably initially make the current HUD standards applicable to all new construction and then promulgate a more inclusive set of standards. (See pp. 19 and 20.)

Tear Sheet

Problems limiting residential energy conservation today are very similar to those limiting control of auto-caused pollution before the Congress passed a more stringent automobile emission control program in 1970.

The goal then was to improve air quality and direct steps were taken to reduce pollution from one of the largest sources--automobiles. The automobile industry generally opposed emission control devices citing increased cost and lack of technology for meeting standards.

Similarly, the housing industry is very slow in making changes in its building practices to achieve more energy-efficient housing, primarily because of the increased initial cost to the housing unit. (See pp. 25 and 26.)

CHAPTER I

ENERGY CONSERVATION AND THE HOUSING INDUSTRY

The United States' energy demand has grown at an annual rate of about 4 percent during the last 10 years. Through 1950, the United States was totally self-sufficient--it was able to supply its own energy needs through domestic fuels and hydroelectric power. By 1973, the United States depended on imports for 15 percent of its energy. The President has asked the Congress to establish policies so the United States can become self-sufficient once again. There are two basic alternatives to alleviating our Nation's energy problem--(1) increase the supply of energy or (2) decrease the demand. The housing industry can contribute greatly to the second approach by adopting energy conservation measures.

During March 1975 we presented a package of energy proposals to the House Committee on Ways and Means. This package included energy conservation measures that can be taken to improve energy efficiency in all sectors of the economy, including the residential sector.

This report, by drawing upon numerous energy-related studies made over the last few years by various public and independent agencies, expands upon and lends support for those proposals we previously made concerning energy conservation in the residential sector; it also offers some additional proposals.

ENERGY USE IN THE RESIDENTIAL SECTOR

The residential sector consumes over 19 percent of the total energy consumed in the United States. Space heating and cooling and water heating account for about 76 percent of the residential energy usage, as shown below:

Residential Sector
Energy Consumption
1968

End use	Percent of total residential use	Percent of national use
Space heating	57.5	11.0
Water heating	14.9	2.9
Refrigeration and food freezing	7.9	1.5
Cooking	5.5	1.1
Air conditioning	3.7	.7
Television	3.0	.6
Clothes drying	1.7	.3
Other	5.8	1.1
Total	100.0	19.2

Source: Stanford Research Institute, "Pattern for Energy Consumption in the United States," prepared for the Office of Science and Technology, Executive Office of the President, 1972.

The Project Independence report that the Federal Energy Administration issued in November 1974 shows an expected 1.4 percent annual growth rate in residential energy demand through the year 1990.

Reducing the amount of energy necessary to heat and cool homes involves three different but complementary approaches: (1) improved building design and construction, (2) more efficient operating heating and cooling systems, and (3) use of renewal sources, such as the sun.

One measure for saving energy through improving building design and construction standards is by strengthening current thermal standards.[1] Increasing the thermal standards or requirements which must be met in housing construction offers the greatest opportunity for reducing energy usage in the residential sector. Installing increased thicknesses of insulation, double glazing of windows and the construction of "tighter" homes are examples.

The heat pump is an example of a more efficient heating system for use in all electric homes. Heat pumps are

[1] A design requirement or criteria for buildings that results in the efficient utilization of energy.

electric or heat-operated air conditioners operating in reverse. They use mechanical energy to bring in the outside air and warm it to useful temperatures. For every British thermal unit (Btu)[1] in electricity a heat pump consumes, it yields two or three in heating for a house. This compares with the one Btu of energy provided by electric resistance heaters for every Btu they consume. The use of the heat pump for space heating, and cooling when it is reversed, had been ecnomically feasible only in the South, but higher energy prices now make it economical in most areas of the country.

Until the recent energy crises, solar energy had been neglected. Solar heating has already caught the public's eye through widespread publicity of the relatively few solar homes around the country. Currently, much research is being done to explore the many institutional and technical problems that must be overcome before solar space heating and cooling can play a major role in the United States energy economy. Solar heating and cooling will probably achieve widespread use only in homes built after 1985.

Numerous studies have been made in recent years on the energy savings which could be achieved by implementing various energy conservation measures in buildings. Energy savings estimates have ranged from 10 percent to 50 percent for retrofitted buildings and up to 80 percent for new buildings initially designed to be energy efficient. At this time, the American Institute of Architects considers potential energy savings of 30 percent and 60 percent for old and new buildings, respectively, to be very conservative estimates.

In March 1973, Hittman Associates, Inc., issued a report on residential energy consumption in single-family housing in Washington, D.C., area. The study was initiated in 1971 and was jointly funded by the Department of Housing and Urb Development (HUD), the Environmental Protection Agency (EPA), and the National Science Foundation (NSF).

The Hittman report concluded that annual energy consumption of a good quality, single-family residence could be reduced up to 36 percent without affecting the occupants' lifestyle. The total incremental first costs to incorporate the energy-saving components into a house would be about $965 with a resultant annual operating savings of about $150.

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[1] The amount of heat needed to raise the temperature of one pound of water one degree Fahrenheit.

Principal energy conservation measures listed in the Hittman report included;

--reducing air infiltration through windows and doors and reducing conductive heat transfer through walls and windows by adding additional insulation to walls and ceilings, installing storm doors and windows, and reducing the window-glass area by 25 percent;

--using gas-fired appliances instead of electric appliances (we note that gas is not available in some sections of the United States);

--using high-efficiency lighting, such as fluorescent lamps;

--improving thermal design of appliances; and

--improving component design of heating and cooling units.

The study concluded that energy conservation modifications could result in large energy savings in different types of residential structures as shown below.

Annual Energy Savings
(Percent savings in primary energy over characteristic or "typical" structure)

Energy conservation modification	Single-family home	Town-house	Low-rise	High-rise
Combined structural	17.5	23.0	18.0	16.0
Heating and cooling systems	10.7	10.7	-	-
Internal factors (lighting, etc.)	8.0	11.4	10.3	7.7
Total	36.2	45.1	28.3	23.7

Cost benefit analyses were made of the energy conservation modifications on a single-family house. The report showed that using a constant cost of energy the initial investment would pay for itself in energy savings in about 7 years. The cost of energy has risen since the study so that the pay-back time is less.

CHAPTER 2

MAJOR FACTORS IMPEDING RESIDENTIAL ENERGY CONSERVATION

Construction practices in the past have led to the vast majority of United States residential housing being inefficient users. This resulted primarily because energy had always been considered a relatively cheap and abundant resource in the United States. What is now considered to be inefficient energy use was not economically inefficient while energy prices reflected an abundant domestic energy supply.

Despite the great deal of attention that has been generated in devising solutions to alleviate our Nation's energy deficiencies, energy conservation is still a low-priority concern to nearly all participants concerned with planning, designing, financing, and constructing residential housing. Energy conservation should be planned and designed into the construction of residential dwelling units from the very beginning. Yet the housing industry's traditional practices present serious impediments to such planning and designing.

CURRENT PRACTICES THAT IMPEDE ENERGY CONSERVATION

Emphasis on lowest initial construction cost

Energy conservation in the residential sector is a low-priority concern to nearly all participants concerned with planning, designing, financing, and constructing residential housing. Of the 70 million existing housing units in the United States, over 40 million are estimated to need thermal protection improvements, such as ceiling insulation, storm windows and doors, caulking, and weatherstripping. The housing industry generally builds houses with emphasis on the lowest initial cost rather than the lowest life-cycle costs.[1] This practice has contributed to inefficient use of energy in the residential sector.

In June 1973, during joint hearings in the House of Representatives before Subcommittees of the Committees on

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[1] Includes initial cost plus cost of owning and operating a house over an economic or specified length of time.

Government Operations and Science and Astronautics, HUD provided its views on the major constraints which impede implementation of energy-efficient methods in building design, construction, and operation. HUD stated that:

--Because of the speculative nature of both single-family and multifamily construction, first costs are given extremely high priority in all planning, building, marketing, and financing of the structures.

--The construction industry, with its associated financial institutions, is attuned to the market demands of residential construction where first costs are of overriding importance. Therefore, it responds to the needs for construction of buildings with techniques designed to reduce first costs.

--A modification of the economic criteria which presently apply to building purchases is necessary (change from emphasis on initial cost to life-cycle cost) if the technical possibilities for energy conservation in buildings is to be fully realized.

The housing industry has been very concerned with the escalating cost of new housing over the last several years. The median sales price of new homes sold in 1974 had increased about 53 percent over the median sales price of new homes sold in 1970, rising from $23,400 to $35,900. This increase occurred because of factors other than putting more costly, energy-efficient features in the housing. Increasing new housing cost by incorporating more energy-saving features is contrary to the objective of lowering the initial construction cost, which is of primary importance in the housing industry.

Several studies have identified practices which impede efficient energy use in residential housing or have identified actions needed to achieve energy conservation.

During 1973, Princeton University made a research study funded by NSF involving energy conservation in the residential sector. The study team made the following observations.

--Energy conservation was a low-priority concern to nearly all participants who were concerned with planning, designing, financing, and constructing residential housing.

--The participants' prime goal was to construct and sell a dwelling unit in the quickest and least costly means possible.

--Energy conservation construction techniques did not bring about quicker construction nor did they lower initial development cost; therefore, there was no incentive for participants to become energy conscious.

--Financial pressures forced developers to select building materials and mechanical systems based on initial costs and not on long-term operational efficiencies.

--Conservation has to be planned and designed into the construction of residential dwelling units from the very beginning.

--Current building codes and standards do not give adequate consideration to energy conservation.

--The incentive for new energy consciousness may have to be brought about through energy efficient controls, standards, and building codes.

In its report entitled, "Energy and the Built Environment: A Gap in Current Strategies," the American Institute of Architects commented that

> "* * * it could become routine procedure to provide a client builder with a complete evaluation of the economic and other factors associated with the various energy conservation measures that he should employ. The principles of life-cycle costing should be brought to bear, in order to show the economic payout of various increased capital costs."

Subsequently, the Institute issued a second report entitled "A Nation of Energy Efficient Buildings by 1990." One of the report's key recommendations was that "the nation should proceed immediately toward a high priority national program to make the nation's building inventory energy efficient by 1990."

The National Bureau of Standards (NBS) issued a report in 1973 entitled "Technical Options for Energy Conservation in Buildings" which stated that, since few controls or regulations on using energy in buildings presently exist, many of the steps that can and should be taken to conserve energy have to be economically effective to be accepted on a wide scale. Therefore, it is imperative to have life-cycle costing as an integral part of the decisionmaking process and design process for new buildings.

In April 1974, the results of a research study funded jointly by HUD, EPA, and the Council on Environmental Quality were issued in a report entitled "The Costs of Sprawl." The study assessed the various costs associated with different types of development in varying types of communities (low, medium, and high densities). In relation to energy consumption, the report concluded that community "planning" alone could reduce a community's total energy consumption by 14 percent. Planning in combination with a cluster type "new community" rather than the typical suburban development (single-family housing) could save up to 44 percent of the energy consumed.

Recent surveys have continued to show that the majority of homebuyers still want to buy a single-family house. Indications are that single-family housing will remain economically possible only through change--a new approach to planning and design. Some of the potential changes most frequently discussed by participants in the housing industry are

--building smaller and more efficient operating houses to compensate for inflated building costs and energy shortages;

--placing housing closer together, leaving open spaces to be shared by everyone due to land shortages and high cost of providing the low-density single-family neighborhood; and

--making design changes in the single-family home to include (1) two or more stories to reduce roof exposures which account for a sizeable percentage of a home's heat loss, (2) lower ceilings to replace open rafters in homes and lowering bedroom ceilings to 7-1/2 feet or less, (3) use of 2- by 6-inch studs in construction to permit installation of thicker insulation, (4) smaller windows and using double and triple glazing to reduce heat loss, and (5) more use of heat pumps and multiple thermostats.

Additionally, surveys have shown that homebuyers are willing to pay more, initially, to get more energy-efficient houses. For example, in January 1975 the results of the Professional Builder's national consumer-builder survey were published. The results showed that about 78 percent of single-family homebuyers favored builders adding $600 to the sales price for energy-conserving features if the features would reduce operating costs by $100 a year.

Obstacles to introducing technological changes

The housing industry is made up of many organizations that generally have no incentive for maximizing energy efficiency in new housing. The traditional on-site homebuilding industry is extremely fragmented, comprised of over 110,000 builders--the majority producing less than 25 units each annually.

The housing industry is well aware of the methodology of constructing energy-efficient buildings, but cost factors are inhibiting broad acceptance of these practices. Various studies have shown that it simply costs more to build energy-efficient homes. A prospective homebuyer can be shown that spending extra dollars initially can save him money on utility costs in the long run. However, not all buyers are willing to pay more because they simply cannot afford any more capital cost or do not think they will be in the home long enough to realize any of the long-range savings.

A HUD report entitled "Housing in the Seventies" was issued in 1973 and stated that changes in the housing industry have been gradual--evolutionary as opposed to revolutionary. Rapid change in housing technology is inhibited in part by the inability to test or "prove" new ideas easily. Builders are reluctant to experiment with new products and techniques since innovations are perceived to be risky under many market conditions. Another reason for the relatively slow growth in housing technology is the existence of a vast number of divergent and restrictive State and local building codes. These codes usually specify hundreds of different construction requirements.

In its report entitled "Energy and the Built Environment: A Gap in Current Strategies" the American Institute of Architects commented that conservation opportunities are available within existing technology and knowledge and that the only stumbling blocks to current implementation of conservation opportunities are either economic, political, or attitudinal.

Industry's general practice of using the materials and methods that have worked well in the past was pointed out in the Hittman study in commenting on new construction in the Washington, D.C., area. The report stated that a large portion of new construction used "tried and proven" construction materials and methods. New or unique building innovations, such as metallic studding, plastic foam wall insulation, factory-built modular units, and spherical or cylindrical

shapes, represented a very small percentage of the total construction.

In January 1970, a panel on housing technology reported to the Secretary of Commerce that many obstacles hindered the application of technological improvements in the housing industry. The report stated that the building industry consisted of many relatively small organizations with a diversity of interests and that no one group was large enough to accomplish the needed changes.

The report stated that current practices provide little incentive for any of the parties to improve the process. For example, an architect's fees are not set up to encourage him to find improved techniques and designs for reducing the structure's operating and maintenance costs. Also, lending and insurance agencies discourage the use of unfamiliar building techniques. The report concluded that due to constraints and lack of incentives for change the participants in the building process will not likely introduce technological improvements.

In June 1973, HUD provided information in joint hearings in the House of Representatives, before Subcommittees of the Committees on Government Operations and Science and Astronautics, stating that there are technical options available to use energy more effectively for supplying the requirements of building services, but in most instances, implementing these techniques requires some additional initial investment which is to be justified by savings in operating costs. HUD stated that these techniques will be used by builders when they sense that the homebuying public is interested in long-term operating costs rather than first costs.

During the past few years of high inflation, the housing industry has been faced with many problems. In the March 1975 testimony before the Senate Committee on Banking, Housing, and Urban Affairs, the President of the American Institute of Architects commented that the homebuilding industry is in a depression within the national recession. He cited some of the causes as high-interest rates, a shortage of mortgage funds, and increasing construction costs. The housing industry has also been faced with high unemployment during the past few years.

We believe that due to the many problems facing the housing industry, such as increasing construction costs, the industry's primary interest in building to the lowest initial cost, and the diversity of the housing industry, energy conservation will continue to be a low-priority concern to the

housing industry. To obtain maximum energy efficiency in the residential sector, energy conservation must be planned and designed into the construction of each new housing unit. Builders are likely to begin adding certain technical options to conserve energy when they believe the housebuying public is willing to pay extra for them. This is a slow and deliberate process that can be accelerated only by aggressive Federal action and/or legislation.

LIMITED USE OF HUD MINIMUM PROPERTY STANDARDS TO ENCOURAGE ENERGY CONSERVATION

HUD's minimum property standards (MPS) have had limited affect on conserving energy in homes. HUD requires that all properties financed with the aid of any of its mortgage insurance activities meet certain property standards. These are the minimum standards HUD considers necessary for a property to be insured by HUD. The standards that apply to energy conservation for new housing do not apply to existing housing.[1] The Department of Agriculture and the Veterans Administration (VA) also require that new homes insured under their mortgage insurance programs comply with HUD standards. Standards have been developed for one- and two-family units and multifamily dwellings. Federally insured new housing makes up about 28 percent of all new housing financed.

Energy conservation in housing units is not a primary objective of the MPS even though a few recent revisions, such as increased insulation requirements, have had that goal in mind. The MPS are intended to describe those characteristics in a property which will provide present and continuing utility, durability, desirability, economy of maintenance, and a safe and healthful environment. A property constructed to these standards would be considered "technically adequate." According to HUD officials. a dwelling unit built exactly to the minimum specifications of the standards would provide quarters that are just barely acceptable in terms of living and safety conditions. As demonstrated later (see p. 18) there are various barriers to achieving energy conservation through HUD's MPS.

The principal measures in the MPS that affect energy usage relate to thermal standards such as insulation, storm doors and windows, weatherstripping and caulking. The

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[1] In a report issued to HUD on January 3, 1974 (B-114860), we recommended that HUD establish thermal standards for existing housing.

insulation requirements vary according to climatic regions of the country as follows.

Winter-degree days (note b)	Inches of insulation (note a)			
	Ceilings			Walls
	Masonry construction (note c)	Wood-frame construction (note c)	Flat roof decks	
4,500 or less	6"	3-1/2"	2-1/2"	3-1/2"
4,501 to 8,000	6"	6"	3-1/2"	3-1/2"
8,001 or more	9"	9"	3-1/2"	3-1/2"

[a]Insulation standards in the MPS are stated in thermal transmittance ("U") values and have been converted to inches for clarity.

[b]Cumulative annual total of the difference between 65 F and the mean daily temperature.

[c]Nonflat roof decks.

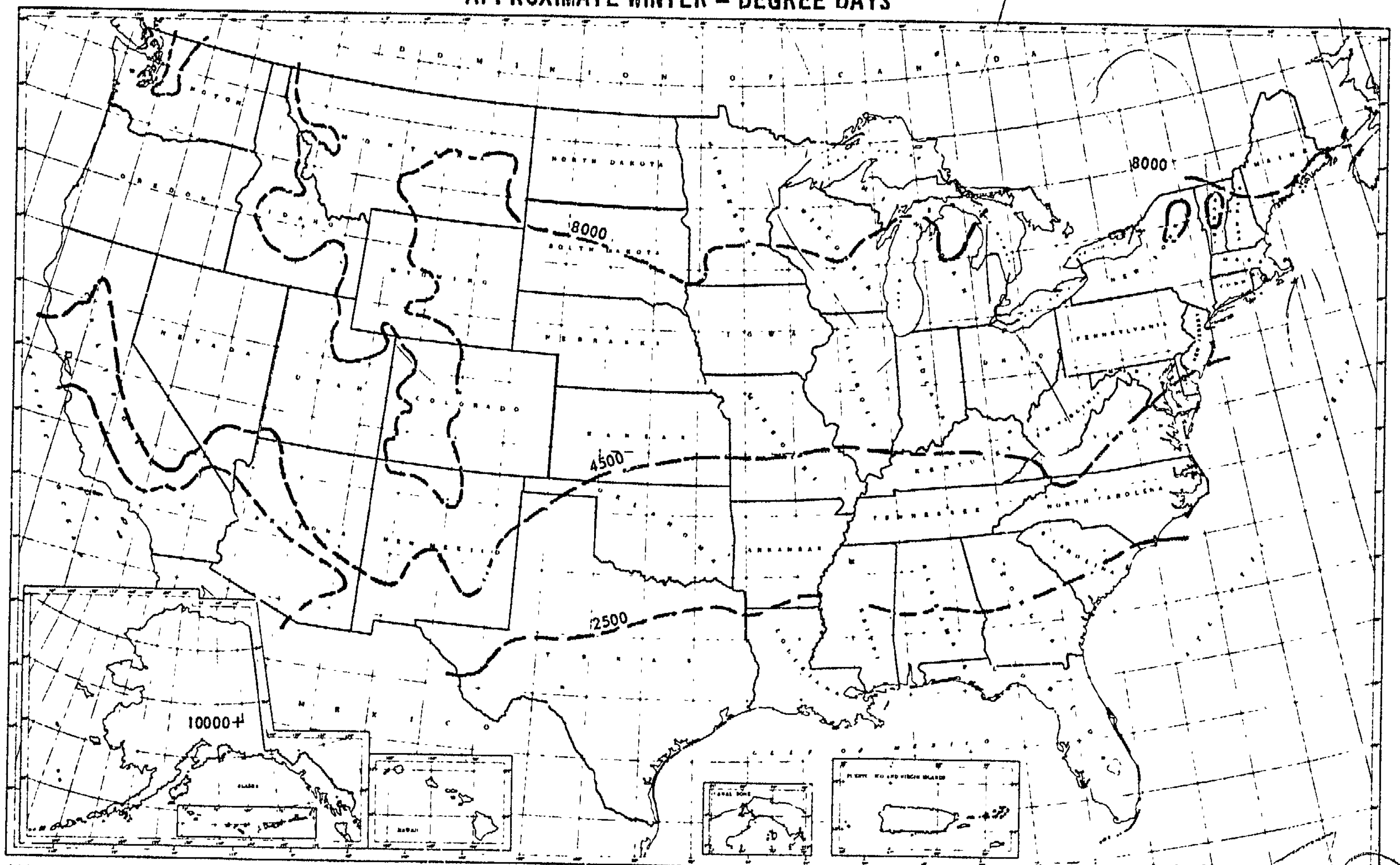
Housing that is mechanically cooled in areas of 4,500 or less winter-degree days and 400 or more summer cooling hours are to be insulated the same as housing in the 4,501 to 8,000 winter-degree day region. (See map on p. 13.)

The MPS requires new housing in all areas in which winter degree days exceed 4,500 to have storm doors and windows. The MPS also provides guidelines requiring weatherstripping and caulking around windows, doors, and other openings. The MPS contains no energy efficiency requirements for use in selecting appliances and lighting. The standards establish the minimum acceptable level of construction, but do not prohibit items such as ornamental lighting which are known to very energy inefficient.

During April and May 1975 we interviewed 39 builders who were currently building new homes in various United States climatic regions to find out what conservation measures they were incorporating in the new housing. Some of the results of this work are summarized in appendix I and presented below.

We found that, generally, builders were installing ceiling and wall insulation similar to HUD's standards in their new housing. For example, 23 builders were incorporating the

UNITED STATES
APPROXIMATE WINTER – DEGREE DAYS



SOURCE: DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

same ceiling insulation as required by HUD; 10 builders were exceeding HUD's requirements; and 6 builders were installing less insulation than required by the HUD standards. Similarily, for wall insulation, 29 builders were installing the same wall insulation as required by HUD, 3 builders were exceeding the HUD standard, and 7 builders were installing less wall insulation than required by the HUD standard.

The major differences between the HUD standards and those being used by the 39 builders related to insulation used between floors and unheated areas, insulation in crawl spaces, and insulation used on ductwork running through unheated areas. The results showing the number of builders that incorporated the same as the HUD standard, those exceeding the HUD standard, and those installing less than the HUD standard are summarized below.

	Number of builders		
Features (note a)	Same as HUD standard	Exceeding HUD standard	Less than HUD standard
Insulation--between floors and unheated areas	19	6	11
Insulation--crawl spaces	8	2	17
Insulation--ductwork in unheated areas	11	4	12

[a]Some of the builders did not use these features in homes and, therefore, they are not included in this summary.

The HUD MPS requires new housing in all areas in which winter-degree days exceed 4,500 to have storm doors and windows. We found that 11 of the builders made storm doors and windows optional items for those homes not financed through the federally insured programs.

In summary, we found that even though the MPS are required only for the federally insured new housing, builders are generally building all their housing to HUD standards to qualify their housing for any type of financing (Federal or private) that a homebuyer chooses. This makes it even more important that the HUD standards place a higher priority on energy efficiency. As pointed out, the HUD standards are minimum standards and do not have energy conservation as a primary objective.

The Arkansas Power and Light Company of Little Rock, Arkansas, has an energy conservation program to show the energy savings achievable by incorporating various conservation measures in new all-electric homes. According to a HUD official, the conservation measures are much more energy efficient than the current HUD minimum property standards. The principal conservation measures which the company is encouraging builders to incorporate in the new housing include:

--improving workmanship in installing a vapor barrier throughout the house to provide a continuous barrier,

--using 2- x 6-inch wood studs to allow installation of 6 inches of wall insulation instead of the typical 3-1/2 inches,

--using 12 inches of attic insulation compared to 3-1/2 inches for framewall construction and 6 inches of masonry-wall construction, and

--installing a power ventilator (attic fan) to remove hot attic air.

A combination of the above measures permits a developer to install a smaller-sized heating or cooling unit which generally costs less to install and operate.

The company compared the operating cost for a 1,200-square foot house built according to HUD's minimum property standards in effect during August 1974 to that of a house built to incorporate the additional energy conservation measures. The operating costs were as follows.

Operating Cost Comparison

Cost	House constructed to HUD standards	House constructed with additional conservation measures
Heating and cooling		
Annual	$362.07	$141.77
Monthly	30.17	11.81
Heat pump (note a)		
Annual	$278.82	$113.29
Monthly	23.24	9.44

[a]Reflects the operating cost when a heat pump is used instead of a furnace and air conditioner.

The company estimates that the additional initial net cost required to [illegible] the more stringent standards above the standards [illegible] by HUD to be about $300. The company estimates [illegible] operating savings of about $220.

In November [illegible] HUD revised the thermal standards in the MPS requiring insulation and additional storm windows in some parts of the United States.[1] A HUD official said that the MPS standards are about 10 to 15 percent more energy efficient compared to the superseded standards. He said that the energy conservation house would still have large energy savings over a similar house build in accordance with HUD's current standards.

In December 1973, the HUD Little Rock Arkansas area office requested from HUD headquarters authority to strengthen its local minimal construction requirements to promote energy conservation. Various measures suggested included

--installing storm windows or insulated glass,

--installing storm doors with tempered glass,

--installing power-roof ventilators (attic fans) to remove hot air from the attic,

--eliminating placing any part of the heating and cooling units in the attic space,

--requiring more energy efficient air-conditioning systems,

--requiring that maximum glass area should not exceed 10 percent of the floor area of each room and that minimum glass area should be 7-1/2 percent, and

--providing a shading device for houses with glass exposed to the sun's direct radiation.

The request stated that the conservation measures would reduce operating cost, reduce equipment and system size, and reduce environmental pollution and provide for more comfort as well as energy conservation. HUD headquarters wrote back to the area office in January 1974 and stated:

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[1]In a report issued to HUD on January 3, 1974 (B-114860), we recommend that HUD strengthen its thermal standards for new single-family homes.

"* * * while we cannot support your proposed level of thermal protection as a minimum standard for the climatic conditions in your area, you may wish to encourage such protection by demonstrating the potential savings in specific cases."

In March 1975 an official in HUD's Columbus, Ohio, area office wrote to HUD headquarters requesting authority to modify certain provisions of the MPS to obtain more energy efficiency. The request stated that the changes would provide for a "maximum reduction in operating cost with a minimum, if any, increase in construction cost." HUD headquarters denied the changes and replied in April 1975 that "although most of the items submitted are energy saving, it is more effective to have the market dictate the additional thermal requirements." We believe HUD's general attitude of letting the market dictate energy efficiency will continue unless the Congress requires HUD to take a more direct role in achieving energy efficiency in the residential sector.

In December 1974, NBS issued a report entitled "Retrofitting Existing Housing for Energy Conservation: An Economic Analysis." This report showed that the amount of insulation and other conservation measures needed to give a homeowner the largest long-run net saving was higher than generally believed. For example, the report shows that in the Washington, D.C., area an electrically heated and cooled 1,200-square foot single-story house to be cost effective needs 12 inches of attic insulation, 10 inches of floor insulation (over an unheated area), 8 inches of duct insulation, and storm windows. In comparison, the HUD minimum property standards for new housing in the Washington, D.C., area require 6 inches of attic insulation, 3-1/2 inches of floor insulation (over an unheated area), 1 inch of duct insulation, and storm windows.

HUD officials told us that HUD has no program for developing new innovative standards or methods. Instead, HUD takes standards and methods that are being used and generally accepted by industry and modifies these to incorporate in the MPS. HUD continually revises and updates the MPS. Although revisions are made on a quarterly basis, HUD officials said there are no formal procedures to insure that all sections of the MPS are being kept current. In addition, HUD has no formal procedures or timetables for receiving, acting on, evaluating, or implementing suggested changes to the MPS.

HUD unilaterally makes minor revisions to the MPS. Before major revisions to the MPS are made, HUD asks up to 200 organizations to review and comment on the changes and the proposed changes are printed in the Federal Register.

Organizations commenting on major revisions include construction firms, building trade associations, architectual firms, insurance companies, governmental agencies, and consumer groups. HUD officials told us that industry generally is opposed to upgrading the MPS. Industry views the MPS as maximum standards which are difficult to meet.

HUD in 1974 proposed establishing certain thermal requirements relating to insulation and storm windows to be applicable to existing houses which they insure. The comments HUD received from other governmental agencies and lenders on the proposal were so negative that HUD did not implement the changes. According to a HUD official, the principal reasons cited against the proposal were (1) lack of procedures on how to apply the proposal, (2) scarcity of materials, (3) possible delays in selling houses, and (4) lack of support from other governmental agencies and the Federal Home Loan Bank Board. HUD stated that they are considering establishing certain thermal standards for existing housing.

Barriers to achieving energy conservation through HUD's MPS

Many technical options could be incorporated into HUD's minimum property standards to promote energy conservation in homes. However, various practical, economical, and legislative reasons limit the usefulness of the MPS as a tool for energy conservation in the residential sector. Among the reasons are:

--Energy conservation is only an indirect objective of MPS. The standards are minimum standards, not the most efficient standards

--HUD officials told us that HUD's MPS only applies to a small part of the housing market. For example, in 1973 about 72 percent of the new single-family homes sold were financed conventionally compared to 28 percent (10 percent for the Federal Housing Administration, 12 percent for VA, and 6 percent for Farmer's Home Administration) that must comply with the MPS. In addition, provisions of the MPS that affect energy do not apply to existing housing that is financed or insured through the Federal agencies. However, as pointed out on p. 14, the 39 builders we talked to were generally constructing all their housing to the HUD standards to qualify their housing for any type of financing that a homebuyer chooses.

--Statutory maximum first-cost limitations for HUD-insured or subsidized projects may force a developer to incorporate low first-cost equipment and/or delete certain energy conserving equipment, such as storm windows. For example, the maximum single-family mortgage that can be generally insured under HUD programs is $45,000.

--The MPS place primary emphasis on initial cost. HUD is reluctant to add more expensive energy-saving options to its MPS because the price of new homes have increased greatly in recent years. For example, median price of new homes rose about 53 percent from 1970 to 1974.

--Standards are not consistently updated.

--Changes to the MPS must be evaluated to determine industry's capability to implement the changes.

--HUD relies heavily on industry's comments before changing the MPS. Industry generally views the MPS as maximum standards and is opposed to strengthening the MPS.

--General belief of various HUD officials that stricter standards to promote energy savings, if needed, should be applicable to all new homes, not just those financed under the federally insured programs. This belief relates primarily to the additional cost generally required to implement stricter standards and the belief that higher cost houses will reduce the marketability of federally insured homes compared to conventionally financed homes.

There are various bills before the Congress that would provide for the Secretary of HUD to develop "prescriptive"[1] or "component performance"[2] standards for use in all new construction. The MPS are generally considered to be component performance standards. HUD officials told us that, if any of the proposed legislation were enacted, HUD would probably

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[1]A standard that describes the means, such as materials and methods, to be used to meet the standard.

[2]A standard that establishes a criteria (total energy consumption for part of a house) that cannot be exceeded but does not prescribe how to achieve the standard.

initially make the current MPS applicable to all new construction and then promulgate a more inclusive set of standards. As pointed out, the MPS do not have energy efficiency as an objective. As of April 25, 1975, HUD had no projects or research underway for improving the energy efficiency of the MPS.

LIMITED RESEARCH TO IMPROVE ENERGY EFFICIENCY OF A HOUSING UNIT

HUD has funded limited research to develop more energy efficient materials and other components that make up a housing unit. HUD relies primarily on industry or other Federal agencies to develop more energy-efficient materials and appliances that are used in a house. There is currently no Federal agency with a comprehensive program for developing more energy-efficient components or subsystems that make up a housing unit.

The Energy Reorganization Act of 1974, Public Law 93-438, was enacted on October 11, 1974, to establish an Energy Research and Development Administration (ERDA). ERDA was given the responsibility for encouraging and conducting research and development in energy conservation to be directed toward the goals of reducing total energy consumption to the maximum extent practicable. A HUD official told us that any research to improve the energy efficiency of materials or components that go into a house is the responsibility of ERDA. As of May 12, 1975, ERDA had no projects underway to improve the energy efficiency of materials or subsystems currently being used in constructing housing. ERDA plans to submit by June 30, 1975, a comprehensive plan to the Congress on energy research, development, and demonstration. An ERDA official told us that this plan would include projects relating to energy efficiency of materials and subsystems used in housing.

HUD's energy research has been involved primarily with (1) conserving materials and energy and (2) utility and energy systems. Funding for research efforts in these two areas is shown below.

Research area	Fiscal years			
	Actual 1973	Actual 1974	Estimate 1975	Estimate 1976
	(000 omitted)			
Conserving materials and energy	$ 140	$ 477	$ 274	$ 500
Utility and energy systems	3,863	5,254	4,384	5,335
Total	$4,003	$5,731	$4,658	$5,835

As shown by the funding levels above, utility and energy systems have received most of HUD's energy-related funding. Research in this area is still in the pilot demonstration stage and there is no hard data on the likelihood of success or acceptance and use by the building industry.

Conserving materials and energy

The objectives of the major research done for conserving materials and energy in recent years are to

--evaluate an occupied prototype home heated and cooled by solar energy including architectural construction and maintenance, thermal and acoustical performance, economics and occupant satisfaction;

--design, construct, and document an Optimum Value Engineered house to demonstrate to builders how to save lumber and other materials;

--identify ways to reduce lumber needed for framing and sheathing in home construction;

--identify and quantify the total energy requirements in single-family and multifamily dwellings in the Washington, D.C., area and to evaluate various technical innovations potentially capable of minimizing energy consumption; and

--investigate and report on all feasible methods of insulating various types of existing housing. A homeowner's guide on energy conservation will be published.

The Solar Heating and Cooling Demonstration Act of 1974, Public Law 93-409, requires HUD to demonstrate solar energy systems for home heating in 3 years and combined heating and cooling in 5 years. HUD expects this effort to greatly conserve materials and energy.

As shown above, HUD's efforts to develop new materials, methods, and standards to bring about energy efficiency has been limited in scope. For the most part, developing new materials and conserving national resources is left up to industry.

Utility and energy systems

Most of HUD's research funding related to energy has been directed to a total energy and modular integrated utility system (MIUS). The concept for total energy is to provide onsite electrical generation and waste heat recovery for use in heating and cooling and water heating in a community. MIUS expands on the total energy system concept. MIUS recycles energy by packaging into one processing plant five utility services necessary for community development--electricity, space heating and air conditioning, solid waste processing, liquid waste processing, and residential water purification.

HUD selected the Summit Plaza Operation Breakthrough site in Jersey City, New Jersey, to demonstrate for the first time in the United States a HUD-funded total energy plant. Summit Plaza is a HUD-insured development located in a 6.5-acre project that includes 488 dwelling units in three high-rise, two medium-rise, and one low-rise structure. Also included is 45,000 square feet of commercial area, an elementary school, and an indoor swimming pool.

Diesel engines are used to generate electricity for distribution to various buildings in the development. Waste heat from the generation process is recovered and used to supply (1) heat for all buildings and domestic hot water and (2) energy for absorption refrigeration machines which in turn provide chilled water for air conditioning of all buildings in the development. If enough waste heat is not available to meet needs of the site, boilers provide supplemental thermal energy.

NBS, under contract from HUD, made a feasibility study to assist in selecting the demonstration site. Also, NBS provided performance specifications for the energy plant at Jersey City. HUD paid NBS about $1.5 million for these activities. Equipment at the project totaled about $2.7 million. During fiscal year 1975, HUD plans to award contracts for about $1.2 million for evaluating the total energy system in operation.

HUD's utility and energy systems effort is in its preliminary phase. Future use of utility and total energy systems may be limited because, as presently envisioned, (1) the systems will raise the initial construction cost of

a project up to 5 percent more compared to conventional systems and the developers or builders traditional emphasis on lowest initial construction cost would tend to inhibit wider systems acceptability, (2) the systems will not be as economically feasible for residential complexes with less than 100 dwelling units, (3) the systems require mostly cluster-type housing, and (4) the systems require some type of fuel, such as diesel, which may become scarce.

HUD estimates that MIUS recovers more than 50 percent of the energy that conventional methods of generating electricity waste. This recovered energy is used for space heating, air conditioning, water treatment, and waste treatment. Additionally, HUD cites a 5 to 10 percent fuel saving achieved by recycling solid waste.

HUD estimates the following costs for the MIUS development:

MIUS Cost Summary (note a)

	Through 1974	Estimate 1975	Estimate 1976	Through completion	Total estimates
	(000 omitted)				
Phase I--analyses and evaluation	$5,267	$1,100	$ 235	$245	$ 6,847
Phase II--method MIUS demonstration	1,420	1,500	3,800	600	7,320
Total	$6,687	$2,600	$4,035	$845	$14,167

[a]HUD estimates there could be an additional $11.2 million for a possible demonstration of an advanced technology MIUS.

MIUS contains three primary phases: the first phase is planning technology assessment, the second phase is demonstration, and the third phase is commercialization. HUD plans to place the demonstration phase in full operation during fiscal year 1975.

MIUS, like the total energy system, requires a larger initial outlay of funds than conventional systems. To consider using a MIUS system, a developer or builder must be concerned with life-cycle costing. Escalating operating

costs, especially utility cost, will encourage more owners and/or developers to require that new buildings contain the latest technology for reducing operating costs. The commercial acceptance of both total energy and MIUS is yet to be determined.

ENERGY EFFICIENCY OF APPLIANCES AND LIGHTING

Appliances and lighting used in houses differ greatly in their energy efficiency. For example, studies have shown that self-defrosting refrigerators use about 30 percent more energy than a comparable manual defrosting refrigerator. Likewise, studies have shown that fluorescent lamps are over three times as efficient as incandescent lamps. A study entitled "The Potential for Energy Conservation" which was prepared in October 1972 for the Office of Emergency Preparedness stated that minimum acceptable efficiency standards for appliances should be established by the Federal Government in consultation with trade associations. The study also suggested that continuous gas pilot lights be replaced with an electric switch operated igniter.

The Hittman study outlined several ways to conserve energy in houses, including:

--converting from incandescent to fluorescent lighting to save about 75 percent in energy consumption,

--eliminating ornamental gas lights that consume about 10 percent of the total natural gas used, and

--substituting electrical igniters for pilot lights, together with better oven insulation, to save up to 30 percent of the energy consumption of a gas kitchen range.

We found that the 39 builders we talked to considered factors such as the lowest initial cost or their affiliation with a particular manufacturer as the major reason for selecting one appliance over another. Only one of the builders placed energy efficiency as a factor in selecting appliances.

CHAPTER 3

CONCLUSIONS, MATTERS FOR CONSIDERATION BY THE CONGRESS, RECOMMENDATIONS, AND AGENCY COMMENTS

CONCLUSIONS

A national program is needed to achieve the maximum energy efficiency in the residential sector. It should establish goals and priorities and define the roles of the various key Federal agencies. Because of industry's practice of building with emphasis on lowest initial cost and because of industry's fragmentation, the housing industry will be slow to adopt those energy conservation measures that cost more initially but save energy operating costs over several years.

Various studies have shown that the greatest potential for saving energy in the residential sector is through improving building design and construction standards by strengthening thermal standards. Installing increased thicknesses of insulation, double glazing of windows, and constructing "tighter" homes are such examples.

The HUD MPS have had limited impact on bringing about energy efficiency in the residential sector. The MPS were not established with energy conservation as a primary objective.

Federal agencies are currently doing very little research to bring about energy efficiency in housing that is being constructed today. Most of the Federal research effort is in solar energy and total energy systems which offer potential for general use in the residential sector sometime after 1985.

Problems limiting residential energy conservation today are very similar to those limiting control of automobile-caused pollution before the Congress passed a more stringent automobile emission control program in 1970. The goal then was to improve air quality and direct steps were taken to reduce pollution from one of the largest sources--automobiles. The automobile industry generally opposed emission control devices citing increased cost and lack of technology for meeting standards. Similarly, the housing industry is very slow in making changes in its building practices to achieve

more energy-efficient housing, primarily because of the increased initial cost to the housing unit.

MATTERS FOR CONSIDERATION BY THE CONGRESS

The construction of energy-efficient housing and the accomplishment of large energy savings will not be fully realized unless comprehensive legislation is enacted. The Congress currently has before it numerous bills that in some way affect energy efficiency in the residential sector. The various bills have different ways to bring about energy savings. Several major policy issues must be addressed by the Congress in determining what action should be taken to reduce energy consumption in the residential sector, including determining

- --whether the energy problem is serious enough to warrant actions that require large cost outlays or lifestyle changes;
- --whether housing should continue to be built on the basis of lowest initial construction cost or on lowest lifecycle operating cost; and
- --the extent to which the Federal Government should provide incentives to industry to develop more energy-efficient housing subsystems, such as heating and cooling systems and appliances.

In enacting legislation addressing these issues, the Congress might wish to consider, as a means of conserving energy in the residential sector, such actions as

- --establishing a national program for energy conservation, including national goals and priorities and defining the roles of the various key Federal agencies;
- --requiring the establishment of national thermal standards or energy performance standards for all new housing;
- --providing incentives (through tax credits, loans, etc.) to homeowners to encourage retrofitting of existing homes, such as adding insulation and storm doors and windows and properly caulking and weatherstripping around openings;
- --requiring all existing homes to be financed directly or indirectly through any federally insured agency to

meet minimum thermal standards for those conservation measures that can be reasonably added;

--requiring mandatory efficiency labeling of all major appliances;

--establishing a cut-off date when appliances meeting minimum standards of operating efficiency would be required to be installed in new homes; and

--establishing national standards or guidelines banning ornamental gas lights and requiring electric igniters instead of pilot lights on new appliances.

RECOMMENDATIONS

The Secretary of Housing and Urban Development can take several measures, under current legislation, to promote energy savings through HUD activities. In the interim before the Congress enacts national energy legislation, we recommend that the Secretary of HUD

--make energy conservation an important objective in its minimum property standards by emphasizing operating costs as well as initial construction cost,

--establish thermal standards for existing housing to be insured under Federal programs, and

--contract with industry to develop more energy-efficient housing subsystems.

AGENCY COMMENTS

HUD agreed with us that a large amount of energy would be conserved in residential housing if the Congress would enact legislation providing for establishment of national thermal standards or energy performance standards for all new housing. HUD commented that energy conservation measures should be applicable across-the-board in order to be effective on a nationwide basis and equitable to all homebuyers, builders, and lenders.

CHAPTER 4

SCOPE OF REVIEW

We reviewed HUD's efforts to promote energy conservation in the residential sector through its program administration, including the applicable legislative history, energy-related research, and HUD's minimum property standards. We also reviewed numerous Federal and private energy-related studies completed during the last few years.

Our review was made at HUD headquarters in Washington, D.C. We held discussions with builders who were building housing in the District of Columbia or in one or more of the following States:

California	Minnesota
Georgia	Nevada
Indiana	Virginia
Illinois	Wisconsin
Maryland	

COMPARISON OF HUD ENERGY-RELATED
MINIMUM PROPERTY STANDARDS TO PRACTICES
BEING FOLLOWED BY SELECTED BUILDERS

	Ceiling insulation	Outside wall insulation	Insulation between floors and unheated areas	Insulation crawl spaces	Insulation on duct work in unheated areas	Storm windows and doors
	(inches)					
HUD standard (more than 8,001 winter-degree day areas):	9.0	3.5	3.5	4.5	1.0	Yes
Builder:						
A	[a]6.5	3.5	0.0	Not used	Not used	Yes
B	4.0-6.0	3.0	3.0	6.0	[b]N/A	Yes
C	10.0	3.5	0.0	Not used	Not used	Yes
D	8.0-10.0	3.5	0.0	0.0	Not used	Yes
E	[a]6.0	3.5	3.5	Not used	Not used	Yes
F	8.0	3.5	[b]N/A	3.5	0.0	Yes
G	10.0	3.5	3.5	0.0	6.0	Optional
H	6.0	3.0	0.0	0.0	0.0	Yes
I	6.0	3.5	3.5	6.0	0.0	Optional
HUD standard (4,501 to 8,000 winter-degree day are :)(note c):	6.0	3.5	3.5	3.5	1.0	Yes
Builder:						
A	6.0	3.5	3.5	3.5	0.0	Optional
B	6.0	3.5	3.5	Not used	[b]N/A	Yes
C	6.0	3.5	0.0	0.0	1.0	Yes
D	6.0	3.5	3.5	1.0	0.0	Yes
E	6.0	3.5	[b]N/A	3.5	2.0	Yes
F	[a]6.0	2.5-3.5	0.0	[b]N/A	0.0	Yes
G	6.0	3.0	0.0	0.0	0.0	Yes
H	[a]6.0	3.0	3.0	Not used	Not used	Yes
I	[a]6.0	3.5	0.0	3.5	0.0	Optional
J	6.0	4.0	4.0	1.0	Not used	Optional
K	6.0	2.0	0.0	Not used	Not used	Yes
L	6.0	3.5	[b]N/A	1.0	0.0	Optional
M	4.0	3.6	3.6	3.5	1.0	Yes
N	8.8	3.5	3.5	[b]N/A	2.0	Optional
O	8.8	3.5	3.5	1.0	1.0	Optional
P	8.8	3.5	3.5	0.0	1.0	Yes

APPENDIX I

	Ceiling insulation	Outside wall insulation	Insulation between floors and unheated areas	Insulation in crawl spaces	Insulation on duct work in unheated areas	Storm windows and doors
	(inches)					
HUD standard (4,501 to 8,000 winter-degree day areas)(note c):						
Q	6.0	3.5	3.5	3.5	0.8	Yes
R	6.0	3.5	3.5	3.0	Not used	Yes
S	6.0	3.5	3.5	Not used	[b]N/A	Yes
T	6.0	3.3	3	3.3	3.3	Optional
U	6.0	3.5	3.5	0.0	1.0	Optional
V	6.0	3.5	3.5	3.5	1.0	No
W	6.0	3.5	3.5	3.5	1.0	No
X	8.0-10.0	3.5	3.5	0.0	1.0	No
Y	6.0	3.5	3.5	0.0	0.0	No
Z	8.0-10.0	4.0	4.0	Not used	1.0	Optional
AA	6.0	3.5	3.5	0.0	[b]N/A	No
HUD standard (4,500 or less winter-degree days):	(6.0 Masonry; 3,5 Frame)	3,5	[d]3.0	[d]3.0	1.0	Optional
Builder:						
A	8.8	3.5	3.5	0.0	1.0	Optional
B	6.0	3.5	3.5	[b]N/A	1.0	[b]N/A
C	4.0	3.5	3.5	Not used	1.0	Optional

[a]Builder installs additional insulation when homes are electrically heated

[b]Not readily available.

[c]Builders constructing housing in areas having less than 4,500 winter-degree days but more than 400 summer cooling hours are included in this section.

[d] 2501 to 4500 winter-degree days; there is no requirement for insulation between floors and unheated areas and in crawl spaces when winter-degree days are less than 2501.

APPENDIX I

APPENDIX II

PRINCIPAL OFFICIALS OF THE DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT RESPONSIBLE FOR ADMINISTERING ACTIVITIES DISCUSSED IN THIS REPORT

	Tenure of office	
	From	To
SECRETARY OF HOUSING AND URBAN DEVELOPMENT:		
Carla A. Hills	Mar. 1975	Present
James T. Lynn	Feb. 1973	Feb. 1975
George W. Romney	Jan. 1969	Feb. 1973
ASSISTANT SECRETARY FOR HOUSING PRODUCTION AND MORTGAGE CREDIT--FHA COMMISSIONER:		
David de Wilde (acting)	Nov. 1974	Present
Sheldon B. Lubar	July 1973	Nov. 1974
Woodward Kingman (acting)	Jan. 1973	July 1973
Eugene A. Gulledge	Oct. 1969	Jan. 1973
ASSISTANT SECRETARY FOR POLICY DEVELOPMENT AND RESEARCH (formerly Research and Technology):		
Michael H. Moskow	Mar. 1973	Present
Theodore R. Britton, Jr. (acting)	Jan. 1973	Feb. 1973
Howard B. Finger	Apr. 1969	Dec. 1972

BEST DOCUMENT AVAILABLE