BY THE COMPTROLLER GENERAL

Report To The Congress

OF THE UNITED STATES

Improved Data And Procedures Needed For Development And Implementation Of Building Energy Performance Standards

Building Energy Performance Standards are intended to increase the energy efficiency of new buildings. However, problems in the program's development and implementation have prevented the Department of Energy from meeting the original legislative deadline of February 1980 for standards issuance. More work is needed before sound standards are possible.

Based on energy conservation resulting from high fuel prices, it is doubtful that the strong sanction the Congress originally considered will be appropriate.

This report contains recommendations to the Department of Energy for developing data that will aid the sanction decision and help complete the standards development program.

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

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

This report discusses energy conservation standards for new buildings being developed by the Department of Energy. Specifically, it addresses: (1) what still needs to be done before sound standards can be issued, (2) the need to transfer implementation responsibility for the standards from the Department of Housing and Urban Development to the Department of Energy, and (3) the inappropriateness of the proposed sanction for noncompliance in view of the large decrease in expected energy savings.

We are sending copies of this report to the Director, Office of Management and Budget, the Secretary of Energy, and the Secretary of Housing and Urban Development.

Elmer B. Staats
Comptroller General
of the United States

COMPTROLLER GENERAL'S
REPORT TO THE CONGRESS

IMPROVED DATA AND PROCEDURES NEEDED FOR DEVELOPMENT AND IMPLEMENTATION OF BUILDING ENERGY PERFORMANCE STANDARDS

D I G E S T

Residential and commercial buildings currently account for about 40 percent of the total energy consumption in the country, and it is generally agreed that they could be designed to use considerably less. In recognition of these potential savings, the Congress enacted the Energy Conservation Standards for New Buildings Act of 1976. The act requires the development of Building Energy Performance Standards. These standards will set limits on the total amount of energy buildings may be designed to use but will not prescribe the details of how this is to be achieved. (See pp. 1 and 20.)

The act gave the Department of Housing and Urban Development (HUD) responsibility for this program. However, in 1977 the Department of Energy (DOE) Organization Act transferred the responsibility to develop and promulgate the standards to DOE, leaving the implementation responsibility with HUD. (See p. 1.)

PROBLEMS IN DEVELOPMENT AND IMPLEMENTATION

DOE has been working on the complex task of developing the standards. The development process has not been smooth and problems have surfaced with respect to completeness and ease of implementation. This has prevented DOE from meeting the original legislative deadline of February 1980 for final issuance of the standards. Areas which require more work before a sound energy conservation standard is possible include:

--Basing the methodology used to develop the commercial and multifamily building standards on minimum life-cycle costs.

--Expanding the data base used for the single-family standards to include more cities.

--Basing weighting factors used to account for energy consumed in the refining of fuel and generation of power on local data, not national averages.

--Developing standards for mobile homes, restaurants, and industrial buildings.

--Developing means such as computer programs, manuals, and model building codes for designers, builders, and local code officials to determine if a building complies with the standards.

--Considering recent improvements in building design practices when updating the estimate of expected energy savings from the standards.

DOE believes that in most of the above areas further development is needed before the standards are issued in final form. (See pp. 6 to 12.)

The recently enacted Housing and Community Development Act of 1980 modified the timetable for the standards by requiring the testing of interim standards starting in August 1981 and issuance of final standards in April 1983, thereby providing DOE more time to resolve the problems. (See p. 3.)

Since implementation responsibility for the standards remains with HUD, GAO believes this responsibility should be transferred to DOE so that total responsibility for the program will rest with one agency. DOE has acquired expertise while developing the standards and implementing earlier standards contained in 1975 legislation. (See pp. 17 and 18.)

SANCTIONS AND ENERGY SAVINGS

The act contains a sanction for noncompliance with the standards, which, if imposed, would in effect make them mandatory. The sanction

is to be imposed against States and local jurisdictions only if the Congress, after reviewing the standards in their final form, decides that it is needed.

The decision on the sanctions has vast implications for the building community. The sanction would withhold a major portion of construction financing in areas that do not comply with the standards. Because of these implications, the estimates of potential energy savings and costs of implementation will be key factors when the Congress decides whether or not to impose sanctions. (See pp. 2, 3, and 13.)

At the time the act was passed, the energy savings from the standards were projected to reach 12 quadrillion British thermal units a year in 1990--almost a 40-percent reduction. Such significant savings would probably justify the strong sanction. However, the situation has changed. DOE's current savings estimate is much less. It anticipates savings of only one-half quadrillion British thermal units in 1990. The lower estimate is due to factoring in the effect high fuel prices have on energy conservation. (See p. 13.)

DOE believes that a prime reason some energy savings are still anticipated is because in many cases homeowners and building operators are not aware of the optimum level of conservation practice. In view of this lack of awareness, coupled with the fact that the high price of energy is a motivator to conserve independent of the sanction, GAO believes that DOE should consider whether a voluntary program would be a suitable alternative to the sanction. Such a program could provide information on what constitute cost-effective energy conservation techniques and provide the knowledge that is lacking. (See pp. 13 to 15, and 18.)

RECOMMENDATIONS TO THE SECRETARY OF ENERGY

The Secretary of Energy should:

--Continue to work on improving the standards for the commercial sector so that the basis of the standards is the minimum life-cycle cost to the building owner, as is true for the residential sector.

--Base estimates of energy savings on current construction practices, and also, in computing the savings, include the expected amount of noncompliance with the standards.

--Develop procedures and cost estimates for implementing voluntary building energy performance standards, and also estimate the energy savings that could be expected from such a voluntary program. (Recent legislation, when implemented, would carry out the intent of this recommendation.)

RECOMMENDATION TO THE CONGRESS

The Congress should transfer implementation and enforcement responsibility from HUD to DOE.

AGENCY COMMENTS

The Department of Housing and Urban Development concurred with GAO's recommendations. DOE comments were not received in time to be included in this report without delaying the report's issuance.

Contents

ABBREVIATIONS

ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
BEPS	Building Energy Performance Standards
Btu	British thermal unit
DOE	Department of Energy
FHA	Federal Housing Administration
FmHA	Farmers Home Administration
GAO	General Accounting Office
HUD	Department of Housing and Urban Development
Quad	Quadrillion British thermal units

CHAPTER 1

INTRODUCTION

Energy conservation measures for new buildings offer major opportunities for reducing the Nation's dependence on foreign oil. In recognition of the potential and need to conserve energy, the Congress enacted the Energy Conservation Standards for New Buildings Act of 1976 (title III of P.L. 94-385, Aug. 14, 1976) for the purpose of developing, promulgating, implementing, and enforcing energy performance standards for new buildings which would achieve the maximum practical level of energy savings. 1/,2/ The legislation, which seeks to eliminate inefficient building design, was based on findings that (1) large amounts of energy are wasted in operating newly constructed residential and commercial buildings because such buildings lack adequate conservation features, (2) Federal performance standards for newly constructed buildings can prevent such waste of energy, and (3) performance standards can be implemented through State and local building codes with a minimum of Federal interference.

BUILDING ENERGY PERFORMANCE STANDARDS

The legislation placed responsibility for Building Energy Performance Standards (BEPS) with the Secretary of the Department of Housing and Urban Development (HUD). However, the Department of Energy Organization Act (42 U.S.C. 7154) transferred the responsibility to develop and promulgate BEPS from HUD to the Department of Energy (DOE), leaving the implementation and enforcement responsibility with HUD. At that time, HUD was substantially into the development effort and the two Departments agreed to work cooperatively toward an

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1/The term "performance standards" means an energy consumption goal to be met, but does not dictate how it is to be met. This approach is contrasted to "prescriptive standards" which specify how construction is to be accomplished, for example, wall or insulation thickness. A more detailed description of performance standards is contained in appendix I of this report.

2/"New buildings" means all residential, commercial, industrial, and public buildings.

orderly transition of responsibility for the development and promulgation of BEPS. The transfer occurred and DOE now has sole responsibility for the BEPS development and promulgation. Also, in March 1979, DOE and HUD signed a Memorandum of Understanding transferring implementation and enforcement responsibility to DOE. 1/

For fiscal years 1977 through 1980, BEPS received funding of $33 million which was expended for various studies and research projects. The DOE and HUD staffs assigned to the program were small.

Anticipated savings

When the BEPS legislation was enacted, the energy savings were expected to be substantial. The Conference Committee Report, dated August 5, 1976, estimated that BEPS would account for energy conservation savings of up to 12 quadrillion British thermal units (Quads) of energy a year by 1990. 2/ However, the more current DOE estimate of about one-half Quad a year is considerably lower than originally anticipated. This occurred because the original estimate did not consider the Government's gradual decontrol of domestic oil and gas prices and the resultant energy conservation provided by the market mechanism of higher energy prices. (See p. 13.)

Sanctions

The legislation contains a sanction which could be imposed on State and local jurisdictions which do not comply with BEPS. The sanction would withhold financial assistance 3/

1/The Senate version of the Housing and Community Development Act of 1980 (hereinafter called the 1980 Housing Act) (S. 2719, May 15, 1980) provided for the transfer of implementation and enforcement from HUD to DOE. However, when the bill was finalized as Public Law 96-399, October 8, 1980, it did not contain this provision.

2/A Quad is equivalent to 180 million barrels of oil annually.

3/Any form of loan, grant, guarantee, insurance, payment, rebate, subsidy or any other form of direct or indirect Federal assistance, or any loan made or purchased by any bank, savings and loan association or similar institution subject to Federal regulation.

for the construction of any commercial or residential building in any area of any State. Since the sanction had such potential impact, the Congress wanted to know how BEPS would work before imposing them. The legislation provides that the sanction cannot be imposed unless both Houses of the Congress, after reviewing BEPS in their final form, agree.

The sanction has generated a great deal of interest because if imposed, it would in effect make BEPS mandatory by withholding a large percentage of all construction money in the country. Such action could effectively stop most construction in the country if BEPS were not complied with. (See ch. 3.)

Timetable

DOE has twice published proposed standards in the Federal Register and subsequently held public hearings on the standards. An Advance Notice of Proposed Rulemaking was published in November 1978, and a Notice of Proposed Rulemaking was published in November 1979.

There were substantive comments raised in the hearing process, particularly with respect to the standard-setting methodology and the completeness of the effort. Because of the public comments and further study now underway by DOE, the standards, when issued, will be different from those previously proposed. DOE had planned to repropose BEPS for public comment in February 1981 and issue the final rules in August 1981. However, the recently enacted 1980 Housing Act changed the timetable for BEPS. This act requires DOE to issue interim standards in August 1981. The interim standards are to be tested in demonstration projects and the results of the demonstrations studied and reported to the Congress before the issuance of final standards in April 1983.

HOW DO BEPS WORK?

BEPS are stated as the maximum amount of energy, expressed as British thermal units (Btu's) per square foot per year, a building is designed to use. The building design will be analyzed to determine whether its expected energy use complies with BEPS. If the design is judged to be in compliance, a building permit would be granted and construction could proceed.

The performance standard will be expressed as a number, or design energy budget, that the building cannot exceed at the design stage. It does not attempt to control how the building is actually operated after construction. For example, a design energy budget of 104 for a small office building means the building must be designed to use no more than 104,000 Btu's per square foot of building space per year. 1/

DOE is developing the design energy budget numbers using separate approaches, one for single-family residential construction and a different approach for multi-family and commercial construction. These are

--a minimum life-cycle cost approach for single-family residences, and

--an informed judgment approach for commercial and multi-family buildings which estimates the level of energy efficiency the building community could reasonably be expected to attain.

BEPS includes design energy budget numbers for each of 18 building classifications such as hospitals, hotels, office buildings, schools, residences, etc., and for each of 78 climate areas in the country.

The setting of performance standards to be incorporated into local building codes is a task for which the Government, building industry, and local building code officials have little experience, since building codes have traditionally been State and local government issues, and existing standards are generally "prescriptive"--not "performance."

The advantage of using a performance standard is that it allows a building designer the freedom to decide how a structure should be built and what materials are used, as long as the end result is a building that meets the standard.

1/The amount of energy is measured from the "source," not the building line, through the use of weighting factors. For example the design energy budget number includes the energy used to generate electricity at the powerplant, and therefore includes electricity lost in generation and transmission to the building line. For more details see pp. 7 and 21.

The disadvantages are that builders, designers, and code officials are generally not familiar with the techniques of converting construction practices into equivalent Btu's, and that this conversion is still an inexact science.

OBJECTIVES, SCOPE, AND METHODOLOGY

The objectives of our work for this report were to evaluate DOE's efforts in developing BEPS, identify problems being encountered, and provide information to the Congress to assist in its decision on whether or not to impose sanctions for noncompliance with the standards. These objectives required us to:

--become familiar with DOE's concepts and plans for BEPS,

--monitor DOE's actions in the BEPS development process,

--evaluate the projected savings anticipated from BEPS, and

--consider alternatives to the sanction for noncompliance.

Since BEPS are still under development, our review could not include a review of the program's effectiveness. In addition, since the purpose of our work was to evaluate DOE's efforts in developing BEPS, the report does not include a technical analysis or verification of the research data supporting the standards.

In doing our work, we (1) interviewed Federal and building community officials, (2) reviewed the public comment record of various segments of the building community and the concerned public, (3) reviewed reports and records of DOE and HUD, and (4) attended DOE's public hearings on BEPS.

We did our work at DOE and HUD headquarters in Washington, D.C.; the National Institute of Building Sciences, Washington, D.C.; the National Bureau of Standards, Gaithersburg, Maryland; and a Building Community Energy Seminar in New York, New York.

CHAPTER 2

PROBLEMS IN BEPS DEVELOPMENT AND IMPLEMENTATION

DOE has been working on the complex task of developing BEPS, which are an innovative approach to establishing an energy conservation standard. The development process has not been smooth and problems have surfaced with respect to completeness and ease of implementation and the validity of the energy savings estimate. These problems have prevented DOE from meeting the original legislative deadline of February 1980 for final issuance of BEPS.

BEPS DEVELOPMENT IS INCOMPLETE

A number of problems surfaced as BEPS were being developed and these problems must be solved before BEPS can be considered a sound energy conservation standard. Among the areas requiring additional work are

--improved methodology for developing commercial standards,

--expanded data base for developing residence standards,

--improved energy use weighting factors, and

--development of standards for restaurants, industrial buildings and mobile homes.

Commercial methodology needs improvement

The methodology used to develop the standards for commercial and multifamily buildings needs to include data on minimum life-cycle costs.

DOE used a minimum life-cycle cost basis to develop the standards for single-family residences. (See p. 22.) This sets the standard at the level of energy use that results in the lowest total cost to the homeowner, which is initial construction costs coupled with future fuel costs discounted to the present. However, for commercial and multifamily buildings, the standards were set by using informed judgment on what level of energy use could reasonably be attained. The informed judgment was based on surveys, studies, and expert opinion, but with little cost data.

DOE has been aware of the need to change the commercial and multifamily building methodology, but did not because it would require a lengthy study and data-gathering effort that would not have been completed in time to meet the original legislative deadline for promulgation of the standards.

Since the commercial and multifamily building standards were based on informed judgment and limited cost data, particularly with respect to minimum life-cycle costs, there is no assurance that the standards provide the maximum practicable level of energy savings required by the legislation.

"Single-family" only covers 10 cities and needs local cost information

The development of standards for single-family residences requires data from additional cities in order for the standards to be appropriate for each locale.

The data used to select design energy budget numbers for the 78 standard metropolitan statistical areas in the country consisted of prototype house designs in 10 cities. The fuel and construction costs used were national average costs. The results from the 10 cities were projected to cover the 78 standard metropolitan statistical areas; however, this resulted in standards that were clearly too high or too low for some statistical areas.

Prior to proposing new standards, DOE plans to strengthen the single-family house base by expanding the original 10-city sample to a 33-city sample. Also the cost data used to calculate minimum life-cycle cost will be changed from national average costs to localized costs for fuel and construction.

Weighting factors need improvement

Energy use weighting factors have been the subject of much controversy and need some improvement.

DOE developed weighting factors to account for energy at its source rather than when the energy enters a building and did so by reflecting the economic value of fuels. The factors, in effect, account for the Btu's expended in the oil-refining process and in electricity generation and transmission. DOE proposed the following weighting factors to be used nationwide:

	Natural gas	Oil	Electricity
Single-family	1.00	1.22	2.79
Commercial/multifamily	1.00	1.20	3.08

For example, electricity entering a commercial building is multiplied by 3.08 because only about one-third of the Btu's expended in generating and transmitting electricity actually reached the building.

The controversy about weighting factors stems primarily from the concept of accounting for energy use at its source rather than at the building line, and partly from DOE's use of national average data which was inappropriate for many localities. For example, some public comments on the standards state that weighting factors would prevent the construction of buildings in areas where electricity is the only energy source because a building could not be constructed within the limit of the standards. In addition, a public utility company stated that the weighting factor for electricity in the company's locale was 1.70, not the 3.08 national average weighting factor proposed by DOE.

We believe that the concept of measuring energy consumption at the source of its generation, rather than at the building boundary, is valid because the standards are intended to conserve energy and therefore it is reasonable for DOE to consider all energy consumed. However, since the efficiency of generation and transmission varies so much from locality to locality, the weighting factors need to be based on local data to make them appropriate. In the reproposal of the standards, DOE intends to change the format of the weighting factors and calculate separate ones at least for each State, but probably not for each locality.

No standards for restaurants, industrial buildings, and mobile homes

DOE has not yet established standards for restaurants and industrial buildings as part of its commercial standards development because of the difficulties in separating the energy needs for heating and cooling from the energy needs to serve the building's purpose, such as cooking and manufacturing. The research needed to support a standard for mobile homes has not been completed. DOE does not expect to have a standard developed for restaurants and industrial buildings in the near future, but does anticipate a mobile

home standard shortly. Because these buildings account for about 10 percent of the expected construction in the country, it is important that they be included in BEPS.

IMPLEMENTATION AIDS NEEDED

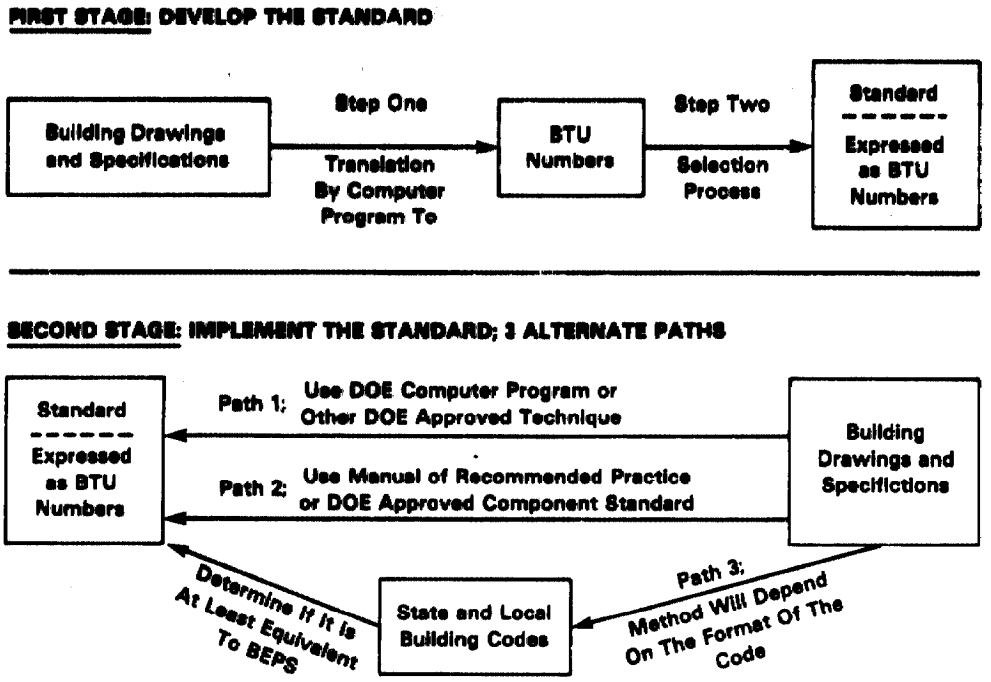
In order for BEPS to be implemented, aids will be needed in the form of computer calculation methods, manuals, and model codes so that designers, builders, and local code officials can determine if a planned building will comply with BEPS. This will not be easy because BEPS will be significantly more complex to comply with than present thermal efficiency standards.

Under the existing State Energy Conservation Program, 1/ each participating State is responsible for implementing mandatory thermal efficiency standards. Most States have adopted or plan to adopt the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) 90-75 building standard to comply with the State program's requirements for such standards. (ASHRAE 90-75 is not a performance standard; instead, it is generally described as a component and/or prescriptive standard.) The building community and code officials are generally familiar with such standards.

DOE recognized that designers, builders, and code officials could not readily implement a performance standard expressed in Btu's and therefore began to develop methods to translate the Btu's into language and format that was familiar to them. DOE is developing manual and computer calculation models which are expected to be able to determine and verify (1) whether a proposed building design meets BEPS requirements and (2) whether thermal efficiency standards in place are equivalent to BEPS.

The following chart is an illustration of the steps involving the translation of data from one format to another in development and implementation of the performance standards.

1/Established under the Energy Policy and Conservation Act (P.L. 94-163, Dec. 22, 1975).



DOE has the following work underway concerning aids for implementation. The "paths" refer to the above chart.

1. Path 1 - DOE is testing the computer program and adding features that will simplify its use and reduce its cost. DOE is also developing a hand calculation method as an alternate to using the computer program.

2. Path 2 - DOE is preparing two alternate standards that are to be equivalent to BEPS but will be written as prescriptive and component standards, rather than as performance standards. A manual of recommended design practice, which will be a prescriptive standard, is being developed because it is expected that most residential builders will prefer this method to the more costly and complicated alternate method of using a computer program. Also being developed is a component standard similar in format to ASHRAE 90-75, but stricter, that is expected to be used for commercial buildings.

3. Path 3 - DOE, in conjunction with the National Conference of States on Building Codes and Standards, is developing a model building code which States and local jurisdictions could adopt as an equivalent to BEPS.

4. Path 3 - DOE, in conjunction with the National Institute of Building Sciences, is developing a method of determining the equivalency of BEPS with existing State and local building codes so that an alternate method of complying with BEPS can be pursued through compliance with the State or local code.

ENERGY SAVINGS ESTIMATE NEEDS MODIFICATION

The energy savings estimate initially prepared by DOE is now outdated and assumes a compliance level higher than could reasonably be expected. DOE prepared an estimate of the energy savings that BEPS would generate based on the design energy budget numbers proposed in November 1979. However, now that DOE plans to propose new design energy budget numbers, a new estimate will be necessary. Because of the importance of this estimate to Congress' sanction decision, all relevant factors should be considered.

The original congressional estimate of expected energy savings from BEPS, 12 Quads in 1990, was significantly higher than DOE's November 1979 estimate of one-half Quad in 1990. (See discussion on p. 13.) The building community criticized the November 1979 estimate because the "baseline" from which improvements were measured was 1975-76 construction practice, and therefore did not give adequate credit to improvements in construction practice that occurred between 1975-76 and 1980. There seems to be little doubt that improvements in construction practices have occurred and DOE should include an updated baseline of construction practice in future estimates.

The November 1979 estimate also assumed that there would be 100-percent compliance with BEPS by the States and municipalities. Although 100 percent is the goal, estimates of savings at lower levels of expected compliance would be useful information to the Congress when deciding the question of sanctions and future funding of the program. In a prior

report 1/ we noted that many States and municipalities had not adopted or enforced energy efficiency building standards. Based on this experience, it is not likely that there would be 100-percent compliance with BEPS.

1/Report to the Congress: "Uncertainties About the Effectiveness of Federal Programs to Make New Buildings More Energy Efficient," EMD-80-32, Jan. 28, 1980.

CHAPTER 3

SANCTIONS--THERE IS AN ALTERNATIVE

The decision of whether or not to make BEPS mandatory (i.e., to impose a sanction for noncompliance) has vast implications for the building community. The sanction would withhold a major portion of construction financing in areas that do not comply with BEPS. Because of these implications, the estimates of potential energy savings and costs of implementation will be key factors when the Congress decides whether or not to impose sanctions.

WHY SANCTIONS?

At the time BEPS legislation was passed, it was expected that energy savings from BEPS would be significant and accordingly the Congress proposed a strong sanction for noncompliance. The conference report that accompanied the legislation discussed the possibility of saving the equivalent of 12 Quads of energy in 1990. This amounts to almost 40 percent of the total energy to be consumed by the residential and commercial sectors in 1990. Such significant savings would probably justify the strong sanction. However, the situation has changed since DOE now projects significantly lower savings resulting from BEPS.

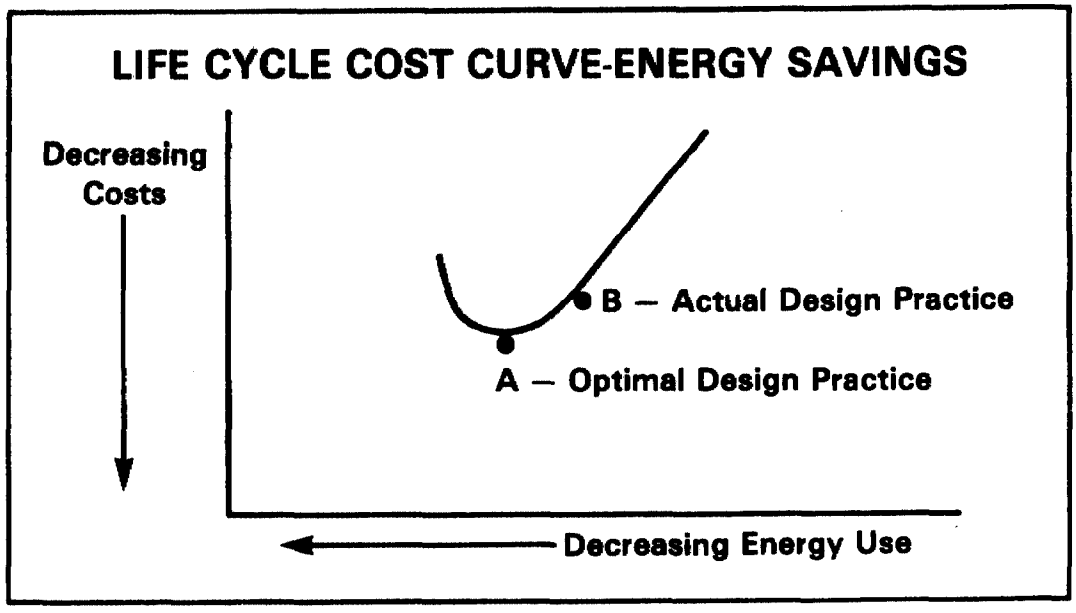
A November 1979 DOE analysis of the potential savings from BEPS showed that only about one-half Quad of energy a year would be saved in 1990. This significant reduction in the level of anticipated savings lessens the justification for the proposed sanction. The original savings estimate was realistic in recognizing the potential reductions in energy use, however, it apparently did not anticipate the energy conservation that would take place due to higher fuel prices from the Government's gradual decontrol policies and increases in the cost of imported oil. DOE believes that a reason some energy savings are still anticipated from BEPS is because in many cases homeowners and building operators are not aware of the optimum level of conservation practice.

Optimum level of conservation practice

The current energy savings expected from BEPS were calculated by determining two levels of energy consumption: the first level was the amount of energy consumption that

would occur if BEPS were in force, which is the optimum level of conservation practice used in the calculation; the second level was the amount of energy consumption that would occur if BEPS were not in force. The estimated savings represents the difference between the two levels of consumption. This resulted in an estimate of 29 Quads of cumulative energy savings for the 40-year period from 1980 to 2020.

The following is an illustration of the method used to calculate savings for the residential sector.



Note: Point A is optimal--the minimum life-cycle cost point which is BEPS. Point B is actual--the point that would be achieved by economic market forces.

The energy savings attributable to BEPS is the difference between points A and B. The reason that "actual" and "optimal" are not the same, even though a buyer would normally strive to reach "optimal", is described as an area of market imperfections. For example, a buyer does not have the precise knowledge of how future fuel prices should affect his current decisions, or what level of insulation and glazing is needed to maximize cost effectiveness.

ALTERNATIVES

Closing of the gap between optimal and actual construction practice is the goal of BEPS and could be accomplished by imposing a sanction for noncompliance. An alternative approach in attempting to close this gap would be to provide information and education through a voluntary BEPS program.

The primary effect of the proposed sanction is to enforce BEPS in all jurisdictions. At the time the sanction was proposed, potential savings of 12 Quads were projected for 1990. This represented a large gap between current practices and potential improvements. The sanction was proposed to assure that the gap would be closed. This assumes, however, that there is little motivation on the part of building owners and operators to demand more energy-efficient buildings. Since the price of energy has risen substantially, it has become clear that homeowners and building operators are anxious to conserve energy because they are paying higher fuel prices.

The cost of implementing a mandatory BEPS is tentative at this time since DOE had not finalized the implementation methods and procedures; however, indications are that States and municipalities would have to increase the size of their building code staffs. In addition, since BEPS is a performance approach which is new to building code officials, DOE estimates that $40 million would be needed to train the State and local staffs.

An alternative that will still be available

Some mandatory compliance was already in the law until recently and the Congress may wish to consider its use in the future, as an alternative to the sanction contained in the authorizing legislation.

The National Energy Conservation Policy Act (P.L. 95-619, Nov. 9, 1978) provided that BEPS be adopted as the minimum property standards for Federal Housing Administration (FHA) and Farmers Home Administration (FmHA) insured mortgages. The use of BEPS as the minimum property standard could have considerable impact because FHA and FmHA insure large numbers of mortgages on homes and the minimum property standards must be met in order for the agencies to insure mortgages under their programs. DOE estimated that about 40 percent of new residential construction would comply with BEPS because of these two programs. (Many builders construct homes in accordance with these standards because they anticipate buyers may need an FHA or FmHA insured mortgage.)

The 1980 Housing Act, however, eliminated this requirement. Thus, when the Congress considers the question of imposing sanctions, one alternative will be to reimpose the requirement that BEPS be adopted as the minimum property standards for FHA and FmHA insured mortgages. This action would insure that a significant amount of residential construction would conform to BEPS.

CHAPTER 4

CONCLUSIONS, RECOMMENDATIONS AND AGENCY COMMENTS

DOE has done considerable work in the complex task of developing BEPS; however, there is more to be done before BEPS can be considered a sound energy conservation standard. In addition, how BEPS are implemented will depend on whether or not the Congress imposes a sanction for noncompliance.

DEVELOPMENT AND IMPLEMENTATION

Based on the work already accomplished and underway, DOE has the foundation for sound standards in the residential sector, but the commercial and multifamily sector standards need substantial improvement.

The use of the minimum life-cycle cost approach for residential properties sets BEPS at the point of energy use that maximizes cost effectiveness. On the other hand, the standards for the commercial sector are not as sound. Since they are based on informed judgment, DOE does not know whether they are too strict or too loose in relation to minimum life-cycle costs. Accordingly, DOE cannot demonstrate that the maximum practicable level of energy savings, as intended by the authorizing legislation, will be achieved.

The estimate of energy savings that can be expected from BEPS will be a key factor when the Congress decides on the sanction question. Accordingly, DOE will need to make future estimates of energy savings based on current construction practices and projections of the degree of compliance that can be expected from States and municipalities.

Since DOE has not finalized procedures for implementing and enforcing mandatory BEPS, a firm cost estimate is not available at this time. However, the cost would probably be significant since the States and municipalities have said that the enforcement of BEPS would require additional personnel and DOE estimates that the initial training of State and local building officials could cost $40 million.

Implementation and enforcement responsibilities for BEPS still rest with HUD, since the Department of Energy Organization Act transferred only the development and promulgation

responsibility to DOE. We believe that implementation responsibility should be transferred to DOE so that total responsibility for the program will rest with one agency. This would allow DOE, which acquired expertise while developing the standards, to use it in the implementation phase. Further, DOE is currently implementing the building energy standards required by the Energy Policy and Conservation Act and therefore has direct experience with State and local building code jurisdictions. This experience would aid DOE in the implementation of BEPS. Also, we have maintained for some time that energy functions should primarily be the role of DOE. Transferring implementation responsibility to DOE would be consistent with this view.

SANCTIONS

The legal sanction is so pervasive and strong that it would curtail a major portion of the construction financing in States or municipalities that do not comply with BEPS. The energy savings of 12 Quads in 1990 that were anticipated when the law was enacted may have justified such a strong sanction; however, the more recent estimate, which accounts for the energy conservation occurring from increases in fuel prices, is much lower.

DOE believes that a prime reason some energy savings are still anticipated from BEPS is because in many cases homeowners and building operators are not aware of the optimum level of conservation practice.

In view of this lack of awareness on the part of homeowners and building operators, and the fact that the high price of energy is a motivator to conserve independent of the sanction, we believe that DOE should consider whether a voluntary BEPS would be a suitable alternative to the sanction. A voluntary BEPS could provide knowledge to the building community and consuming public on what constitutes cost-effective energy conservation techniques, an awareness that is lacking. Information on the feasibility of such a program could aid the Congress in making the decision on sanctions.

RECOMMENDATIONS TO THE SECRETARY OF ENERGY

We recommend that the Secretary of Energy:

--Continue to work on improving the soundness of the standards for the commercial sector so that the basis

of the standards is minimum life-cycle cost to the building owner, as is true for the residential sector.

--Base estimates of energy savings on current construction practices, and also consider the expected amount of non-compliance with the standards in computing the savings.

--Develop procedures and cost estimates for implementing a voluntary BEPS and also estimate energy savings that could be expected from such a voluntary program. This effort could assist the Congress in making its decision on sanctions. 1/

RECOMMENDATION TO THE CONGRESS

We recommend that the Congress transfer implementation and enforcement responsibility from HUD to DOE.

AGENCY COMMENTS

The Department of Housing and Urban Development submitted comments on this report and concurred with the recommendations. (See appendix II.)

DOE comments were not received in time to be included in this report without delaying the report's issuance.

1/The 1980 Housing Act, which requires the issuance of interim standards and the testing and study of these interim standards through demonstration projects, would in effect carry-out the intent of this recommendation because the study of the interim standards will include implementation procedures and expected energy savings for alternate approaches.

APPENDIX I

HOW BEPS ARE BEING DEVELOPED

The development of BEPS has involved considerable research, study, and data-gathering by DOE and HUD. The process involved such organizations as the American Institute of Architects Research Corporation, the Oak Ridge, Lawrence Berkeley, and Batelle Pacific Northwest National Laboratories, and the National Institute of Building Sciences. The National Bureau of Standards was also consulted at certain stages of the development. In addition, DOE held extensive public hearings on BEPS throughout the country.

The standards proposed by DOE are in the form of a design energy budget for each of 18 building classifications, in 78 climatic areas, expressed as thousands of Btu's per square foot per year. To meet the standard the building must be designed to use no more than the design energy budget for that type of building, in that climatic area. The following two tables show proposed budgets for a sample of standard metropolitan statistical areas.

Design Energy Budget Numbers
for Single-Family Residences (note a)
(thousands of Btu's per sq.ft. per year)

Standard Metropolitan Statistical Areas	Single-family detached			Single-family attached		
	Gas	Oil	Electric	Gas	Oil	Electric
Minneapolis	56.9	68.3	80.2	45.4	54.6	64.0
St. Louis	38.0	44.2	42.7	28.4	32.9	32.7
Washington, D.C.	31.2	35.7	32.4	23.1	26.3	24.3
Miami	34.3	34.4	37.1	29.0	29.1	29.1
Dallas	31.7	33.9	32.5	25.1	26.6	24.7
San Diego	15.2	15.5	14.4	12.7	13.0	10.7
Portland	25.3	30.5	26.0	17.8	21.4	19.2
Boston	36.3	43.2	42.1	26.9	32.0	32.2

a/The design energy budget for domestic hot water is not included. It is calculated separately and added to these numbers.

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DESIGN ENERGY BUDGET NUMBERS
FOR COMMERCIAL AND MULTI-FAMILY BUILDINGS
(THOUSANDS OF BTU'S PER SQ. FT. PER YEAR)

SMSA	Clinic	Community Center	Gymnasium	Hospital	Hotel/Motel	Multi-Family Hi-Rise	Multi-Family Low Rise	Nursing Home	Office (Large)	Office (Small)	School Elementary	School Secondary	Shopping Center	Store	Theater Auditorium	Warehouse
Minneapolis	142	109	144	335	180	140	110	176	123	117	122	138	196	166	157	93
St. Louis	133	110	136	353	176	128	112	163	119	108	105	128	192	160	149	72
Washington, DC	127	107	129	353	168	120	109	164	116	104	96	121	186	144	142	83
Miami	152	142	161	406	203	133	147	201	140	125	103	141	219	179	178	41
Dallas	131	116	136	358	176	119	119	171	120	107	94	124	190	152	150	50
San Diego	114	103	117	364	158	104	106	153	107	92	76	107	172	134	128	40
Portland	119	98	120	353	161	116	99	154	108	97	91	115	176	135	131	66
Boston	126	101	126	338	166	121	102	159	111	102	99	121	181	140	139	72

Source: Department of Energy, Notice of Proposed Rulemaking, Nov. 28, 1979.

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Key features of BEPS include:

--Whole-building performance--BEPS regulate the building as a whole, not specific components of the building, and does so without specifying the methods, materials, or procedures to be used.

--Design standard--BEPS apply to the design phase of the building, not actual operation. DOE has developed a normalized building-operating profile that must be used as a constant when calculating the buildings' design energy use.

--Excludes renewable energy--solar and other nondepletable energy planned to be used in a building are not included in the calculation of its design energy use.

--Weighting factors--design energy use is not measured at the building boundary. Instead, weighting factors are applied in order to consider energy lost in generation and transmission combined with price and policy considerations. The following weighting factors are applied to the design energy use measured at the building boundary in order to arrive at total design energy use:

	Natural gas	Oil	Electricity
Single-family	1.00	1.22	2.79
Commercial/ multifamily	1.00	1.20	3.08

--Standard Evaluation Technique--as part of BEPS, DOE has developed a computer program to be used as a method for calculating the design energy use of a building and to be used as a benchmark against which other calculation techniques can be compared.

Two separate approaches have evolved for the development of the design energy budget numbers:

--The minimum life-cycle cost approach for single-family residences selects the budget number that corresponds to the point on a scale with the lowest combination of initial construction costs and future energy costs discounted to the present.

--The statistical approach for commercial and multifamily buildings selects the budget number by using informed judgment on what level of energy efficiency the building community could reasonably be expected to attain. The informed judgment is based on surveys, studies, and expert assessment.

Minimum life-cycle cost approach

This approach sets the design energy budget number at the point on a life cycle cost curve (see chart on p. 14) that will result in the lowest total cost, which is initial construction costs coupled with future costs discounted to the present.

The minimum life-cycle cost 1/ for single-family residences was calculated using ten cities as the baseline. Single-family houses and townhouse prototypes were used based on National Bureau of Standards models. Design energy usage was determined for each of the prototypes by modeling the effects of various conservation measures, such as changes in ceiling, wall and floor insulation, and multiple window glazings. Ceiling insulation was increased to a maximum of R-38 2/ from the 1975 average building practice of R-19 in most parts of the country. Wall insulation was increased from R-11 to R-19, and to R-25 in the coldest climates. Floor insulation of R-11 and R-19 was considered. Double and triple window glazings were included.

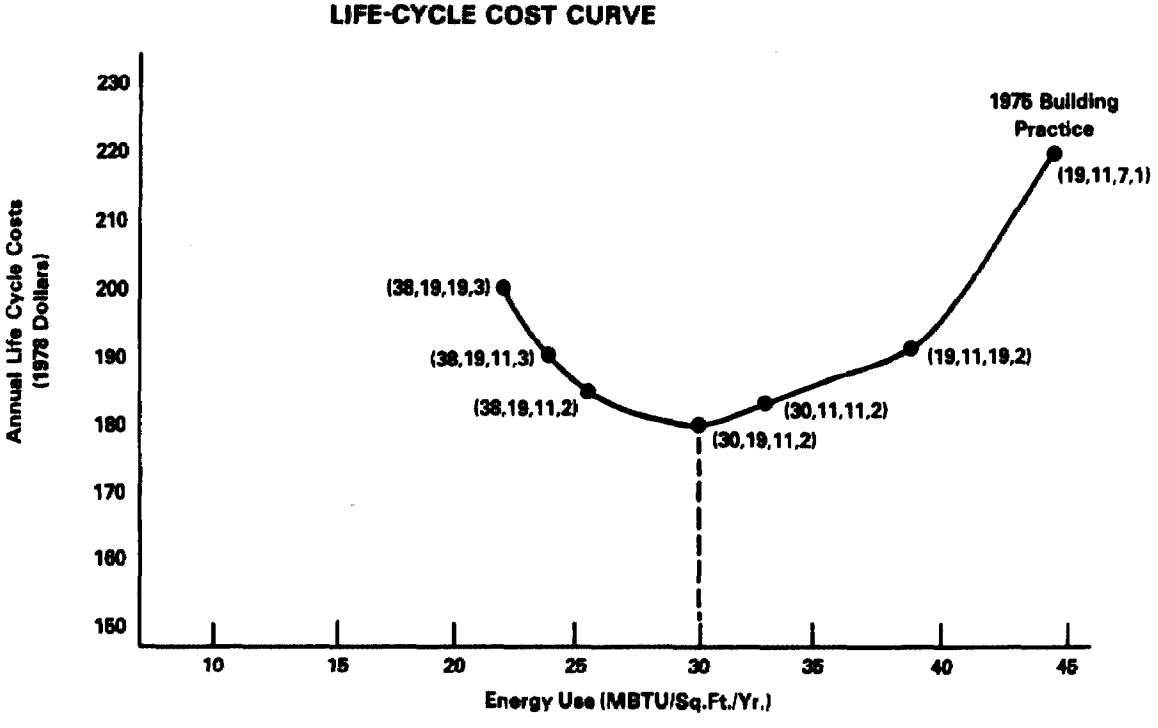
The life-cycle costs were computed using different combinations of these measures. The results are expressed as curves mapping the resultant life-cycle cost against the estimated design energy requirement for each combination of measures.

1/The minimum life cycle costs were calculated using national average energy prices; therefore, since energy prices are widely divergent between localities, the BEPS may not be the point of minimum life-cycle cost for any particular locality. Because of this, what are cost effective energy conservation measures in one locality may not be in another. In addition, construction costs are not localized.

2/R-value is a measure of a materials resistance to heat flow. The higher the R-value, the less energy will be used in heating and cooling that building.

APPENDIX I

The life-cycle cost curve displayed below is an example of DOE's approach. The lowest point on the curve is the minimum life-cycle cost. Each point on the curve is described in terms of applicable conservation measures by the values specified in the brackets. The first three numbers correspond to the "R" values of ceiling, wall, and floor insulation, respectively, and the final number corresponds to use of single, double, or triple glazing.



Note: The Design Energy Budget in This Case Would Be 30.

Statistical approach

The statistical approach used for commercial and multi-family buildings selects the design energy budget number by making an informed judgment on what level of energy efficiency the building community could reasonably be expected to attain.

APPENDIX I

The first step of this approach was to determine a baseline of energy efficiency by computing the level of design energy usage of buildings designed in 1975 and 1976. The baseline amount of energy usage became the point from which design improvements and energy savings could be measured.

The first step in the computation of the design energy use for each of 1,968 commercial buildings and apartments was to collect details on the buildings' characteristics from the architects and designers of the buildings and interface these details with a computer program designed to compute energy use. The schedule on page 26 shows the results of step one, consolidated for all climatic regions. The schedule shows only the mathematical mean of energy use. However, the range of design energy use from building to building in the sample is quite large. In other words, some buildings were designed for considerably more energy efficiency than others. The usefulness of this data is hampered because a determination was not made of the features of the buildings that make them efficient or inefficient, and little cost data was gathered. The data simply provides a profile of the total energy use of buildings designed in 1975 and 1976.

The second step in the standard-setting process was to determine the extent of improvements that could be made to the design of the baseline buildings. This was done for a sample of buildings by contracting with the original architects and designers to redesign the original buildings with the goal of decreasing the energy usage. The redesigned buildings were about 40 percent more energy efficient than the original designs.

APPENDIX I

Comparison of Results of Steps One and Two Mean of Design Energy for Various Building Types Consolidated for All Climatic Areas (note a)

	Step one		Step two		
	Sample size	Mean energy (note b)	Sample size	Mean energy (note b)	Percent improvement
Office	237	73.0	22	40.6	44
Elementary schools	157	58.1	11	31.2	46
Secondary schools	171	86.2	11	50.4	41
University	57		-		-
Hospital	40	243.2	10	146.9	39
Clinic	113	87.1	11	51.8	41
Assembly	167	86.6	12	47.2	45
Restaurant (note c)	196	176.0	16	94.6	44
Stores	176	92.7	19	63.0	32
Warehouse	81	62.3	10	29.2	53
Hotels/motels and nursing homes	162	93.2	22	65.6	30
Hi-Rise apartments	104	63.0	10	47.0	25
Lo-Rise apartments	307	51.8	14	36.3	30
Totals	1968	97.3	168	58.7	40

a/Table does not include weighting factors. Consequently, it cannot be compared to budget numbers on p. 20.

b/The mean energy usage of the building in the sample expressed as thousands of Btu's/sq. ft./year.

c/Design energy budget numbers were not selected for restaurants and industrial buildings because DOE did not consider the data adequate to support a standard.

Source: HUD/DOE, "Phase Two Report for the Development of Energy Performance Standards for New Buildings."

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The redesign sample included 168 buildings, covering various building types such as office buildings, warehouses, schools, hospitals, etc., and also covered multiple climate regions. Because of the various types of buildings and multiple climatic regions, the sample size for a particular type building in a particular climatic region is very small. The sample size was kept small because of the high cost of contracting with the architects to redesign buildings.

Because of the small sample size, DOE does not claim that the results are respresentative of actual building community practice. However, the redesign information was used in conjunction with economic analyses and expert opinion as the basis to select the design energy budget numbers. For most commercial and multifamily residential building classifications, DOE generally selected the levels corresponding to the average redesign in the sample as the proposed design energy budget numbers and then used regression techniques to establish the budget numbers for each of 78 climatic regions.

APPENDIX II

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
WASHINGTON, D.C. 20410

September 26, 1980

OFFICE OF THE ASSISTANT SECRETARY FOR
NEIGHBORHOODS, VOLUNTARY ASSOCIATIONS
AND CONSUMER PROTECTION

IN REPLY REFER TO:

Mr. Henry Eschwege
Director
Community and Economic Development Division
General Accounting Office
Washington, D. C. 20548

Dear Mr. Eschwege:

Your letter of August 20, 1980 addressed to the Secretary of Housing and Urban Development which transmits a proposed report to the Congress entitled: Building Energy Performance Standards Need More Work and a Decision on Their Implementation has been referred to me for reply.

The Department of Housing and Urban Development concurs with the recommendations of the General Accounting Office. However, we find the use of the term "Housing" in the digest to represent the Department to be confusing, since there is an Office within HUD with that name. We believe that it would be less confusing to use the acronym "HUD" throughout the digest and the report.

Thank you for the opportunity to comment on this draft report.

Sincerely,

Gene C. Baroni
Assistant Secretary

(003481)

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