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CONFIDENTIAL

EXAMINATION OF IMPLEMENTATION STRATEGIES
FOR THE BUILDING ENERGY PERFORMANCE
STANDARDS

By
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MASTER

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U. S. DEPARTMENT OF ENERGY

Division of Buildings and Community Systems

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Examination of Implementation Strategies
for the
Building Energy Performance Standards

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I. Introduction

In 1975, buildings consumed 26.1 quadrillion BTUs of primary energy, accounting for 37% of total United States energy consumption. The vast majority of building energy use is for space conditioning and lighting. Recognizing that opportunities existed for improving the efficiency of this energy use, Congress passed the Energy Conservation Standards for New Buildings Act of 1976 (Title III of the Energy Conservation and Production Act, ECPA, P.L. 94-385). The objectives of this act, which focuses on new buildings, are to reduce the amount of additional energy that the nation will need in the future, and to reduce the impact of rising energy costs on building owners.

The Energy Conservation Standards for New Buildings Act directed that performance oriented building energy use standards be developed. After numerous delays, the Notice of Proposed Rulemaking (NOPR) concerning Building Energy Performance Standards (BEPS) was published in the Federal Register on November 28, 1979. Such standards specify energy consumption goals for entire buildings without specifying the methods, materials, or processes to be used in meeting these goals. This approach has the advantage of allowing the designer flexibility to make trade-offs between various components of the building so long as the design meets the appropriate overall energy budget. In contrast, so-called prescriptive energy use standards, which have been adopted by many states, place limits on specific building contents and thereby restrict the options available to the designer.

Because of the variation in operating conditions, the energy budget associated with a performance standard may not coincide with the actual energy use of any particular building. Therefore, the means of specifying an energy performance budget is in terms of a designed energy budget

which can be determined before the building is constructed. This designed energy budget (energy budget) is expressed in terms of thousands of BTUs per square foot of floor area per year (MBTU/sf/yr). Individual operating conditions will have a large impact on energy consumption. Thus, the compliance of a proposed building's energy consumption is determined using a set of operating conditions which were specified when the standards for that building type were developed.

Since the passage of the Energy Conservation Standards for New Buildings Act, research has been concentrated in two distinct but closely related areas. The first area of research has involved developing the energy budget standards for different building types and climatic conditions, and refining computer programs which will be needed to evaluate the energy consumption of proposed building designs. The second major area of research has been related to developing plans for implementing these standards once they are developed. This paper describes the approaches taken in each of these two areas and the problems that were encountered, and comments briefly on the proposed standards.

II. Standard Development

The question of where to set the building energy consumption budgets mandated by ECPA has been the subject of much technically sophisticated analysis over the past three years. Initially the standards were intended to apply to all new construction. But mobile homes will be dropped from consideration temporarily due to a lack of necessary data. With regard to all other new construction, two distinct analytical approaches have been pursued. Single family residence energy budgets are based on computer simulation of prototypical housing types. Energy budgets for all other building types have been developed through analysis of actual buildings which have been redesigned to conserve energy. The following two sub-sections outline the basic framework of each of these approaches and, where possible, make explicit the assumptions used.

A. Commercial Buildings

For purposes of Building Energy Performance Standards (BEPS) NOPR, the "commercial buildings" have been categorized into eighteen distinct building types. The building types are:

- 1) Clinic
- 2) Community Center
- 3) Gymnasium
- 4) Hospital
- 5) Hotel/Motel
- 6) Industrial
- 7) Multifamily High-Rise
- 8) Multifamily Low-Rise
- 9) Nursing Home
- 10) Large Office
- 11) Small Office

- 12) Restaurant
- 13) Elementary School
- 14) Secondary School
- 15) Shopping Center
- 16) Store
- 17) Theater/Auditorium
- 18) Warehouse

Due to difficulty in separating process energy from other energy uses, no standards have been proposed for Restaurants or Industrial. Baseline energy consumption estimates for commercial buildings were based upon a stratified random sample of 3,221 buildings constructed between 1974 and 1976. 1,661 usable responses were obtained to questionnaires covering building design, construction characteristics and energy use. These responses provided a representative sample of building types in various climatic regions. Energy performance of these buildings was estimated using the long form of AXCESS (Alternate Choice Comparison for Energy System Selection), a building energy analysis program developed by the Edison Electric Institute. A representative subsample of 168 buildings were then redesigned by the original architect-engineer teams. After being acquainted with the state of current energy efficient design techniques, the teams were asked to redesign the buildings using the same site, satisfying the original clients' functional needs and increasing capital costs only if the teams felt the cost would be offset by lifecycle savings. The goal of these redesigns was to achieve the maximum practicable reductions in non-renewable energy use. While the teams were not allowed to incorporate active solar systems they were encouraged to utilize passive solar design. Once the 168 buildings had been redesigned, the long form of AXCESS was used again to calculate the energy performance of the redesigns.

The energy budget estimates for the redesigns were compared with the baseline energy budgets of the same buildings. The net preunit values (NPV) of the modifications were calculated from the perspective of the building owners, taking into account energy savings, the increased capital costs (as estimated by the architect-engineer teams), financing options typically available to owners of each building type and future energy price estimates. Values of parameters used in the NPV calculation are listed below.

<u>Parameter</u>	<u>Value</u>
Future Fuel Prices	EIA Mid-Scenario*
Discount Rate	10% Real After Taxes (25%-30% before tax rate assuming 7% inflation)
Number of Years	30
Income Tax Rate	46% (tax rate on increased income resulting from energy savings)
Depreciation**	150% Double Declining Balance over 40 years
Interest Rate**	4% Real (11% assuming 7% inflation)
Down Payment	20%
Property Tax Rate**	1.5% (tax rate on added costs of construction)
Insurance Rate**	.5% (of added construction costs)
Operating and Maintenance Costs	Same as Original Design

* Energy Information Administration Medium Price Projections, Average Annual Real price escalation rate approximately 2.76% for natural gas and .73% for electricity, December, 1978.

** Tax Deductible Item

While the NPV calculation results are especially sensitive to increased capital costs, the mean NPV of the redesigns was positive in all but the low-rise residential building category. The latter result was explained in part by good energy performance in the baseline designs. Mean energy budget and NPV of the conservation investment by building type are listed below for fourteen building categories used in early analyses.

Building Type	Mean Original Energy Budget (Primary Energy) BTU/ft ²	Mean Redesign Energy Budget (Primary Energy) BTU/ft ²	Mean NPV \$/ft ²
1) Assembly (Community Center/Theater)	84,546	47,177	1.53
2) Clinic	77,044	49,059	1.44
3) Hospital	243,172	161,025	3.39
4) Hotel/Motel	97,133	69,836	1.84
5) Mercantile (Shopping Center/Store)	92,541	62,739	1.26
6) Nursing Home	90,333	60,151	1.02
7) Large Office	67,806	40,015	.99
8) Small Office	73,720	38,847	.85
9) Restaurant	170,471	92,757	3.08
10) Elementary School	54,561	30,638	.34
11) Secondary School	86,174	50,431	1.36
12) Warehouse	62,260	31,748	.81
13) High-Rise Residential	60,567	46,090	1.64
14) Low-Rise Residential	45,638	31,975	-.06

Source: AIA Research Corporation, Phase II report for the Development of Energy Performance Standards for New Buildings, Washington, D.C., 1979.

The mean redesign energy budget by climate zone is the preliminary standard set in the Notice of Proposed Rulemaking with two exceptions:

- o A stricter standard is proposed for Large and Small Office Buildings (the energy performance level achieved by only 30% of the office building redesigns).
- o A more lenient standard is proposed for Hospitals and Low-Rise Residential buildings (the energy performance level achieved by 70% of Hospital and Low-Rise Residential building redesigns).

B. Single Family Residences

The BEPS analysis of energy budgets for single family residences has depended heavily upon computer simulation. The program DOE-2 has been used to estimate the hour by hour heating and cooling loads of prototypical houses in each of the various climate zones. The prototype house which has been used for most BEPS analysis is a slightly modified Hastings Ranch, a housing type developed by S.R. Hastings and the National Bureau of Standards for energy analysis. The Hastings Ranch, as modified for BEPS analysis, has the following characteristics:

Floor Area	1176 Square feet
Bedrooms	3
Roof Slope	22.6 degrees
Window Space	176 square feet (15% of floor area evenly distributed among 4 walls)
Wall Height	8 feet
Door Size	20 square feet

DOE-2 utilizes, as input, a full description of the buildings to be analyzed, including geometry, dimensions and U-values of materials. Additionally, DOE-2 considers the size and efficiencies of equipment within the building and hour by hour weather data (temperature,

windspeed and relative humidity). ASHRAE algorithms are used to calculate the heat flow through the building envelope walls. These algorithms also account for the thermal mass of the walls and solar gain on the walls and roof of the building. For each climate zone the prototype house was analyzed for a number of modifications involving different levels of energy conserving investments. Only conservation measures well known and commonly practiced in some regions were considered. Using the results of these simulations, it was possible to plot curves showing the trade-off between energy budget and the annualized life cycle cost for each successive conservation investment. For example, the annualized life cycle cost v. energy budget curve for a fossil fuel heated home in Chicago is shown on figure 1. The figures in the parentheses indicate the successive conservation investments. The first two figures are R values for ceiling and wall insulation respectively. The final figure indicates the number of window glazings. The energy budget figures are computed from DOE-2.

Thermal Assumptions:

- infiltration is .6 air changes per hour;
- unheated basements are adequately insulated;
- slab on grade houses are equipped with perimeter insulation;
- furnaces burn outside air and have insulated ductwork to achieve an overall efficiency of .7;
- windows and doors fit tightly.

Operating Assumptions:

- thermostat setting of 78° F for the cooling season and 70°F for the heating season (no night setback is used);
- internal loads (from people, appliances and lighting) are calculated assuming average saturations and use;

Figure
GAS SPACE HEATING - CHICAGO

6130
Heating Degree Days
(Base 65)

935
Cooling Degree Days
(Base 65)

- windows are opened when inside temperature is greater than 78°F and outside temperature is cooler than inside temperature.

Figure 1 also indicates an energy performance for a low infiltration rate equivalent to only .3 air changes per hour. This low infiltration rate is accomplished through building the house tight enough that only .2 air changes per hour occur naturally under average temperature and weather conditions. An additional .4 air changes per hour of controlled air flow is vented through a heat recuperator (a technology widely used in other countries) of 75% efficiency. Thus, the house has a total of .6 air changes per hour and loses heat to the outside air as if it had an infiltration rate of .3 air changes per hour.

Annualized life cycle costs (ALCC) include the annual fuel costs to the homeowner and the amortized capital cost of the conservation equipment assumed to exist. These cost computations were based on the following assumptions:

Energy Savings Calculation Period	30 years
Discount Rate	3% real (10% assuming 7% inflation rate)
Future Fuel Prices	EIA Mid-Scenario

These (high infiltration) minima are estimated to be generally 25% more stringent (in terms of energy performance) than the current HUD minimum property standards (MPS). None of the individual conservation "packages" evaluated may be at the exact minimum of the ALCC curve. But these packages have been chosen to conform with the types of insulation currently being sold. So as a practical matter, the package closest to the minimum point on the curve is chosen as the life cycle

cost minimum. The minimum ALC points are the basis of the standards in the Notice of Proposed Rulemaking. These standards vary by both climate zone and fuel type. The proposed energy budgets differ from the life cycle cost minimum only in that they include an additional component to account for domestic hot water.

III. Standards Implementation

A. Legislative Requirements

According to the Energy Conservation Standards for New Buildings Act of 1976, new residential and commercial buildings which do not meet the BEPS design energy budget standards could face the loss of all federal assistance. Federal assistance is defined in the law as,

"(A) any form of loan, grant, guarantee, insurance, payment, rebate, subsidy, or any other form of direct or indirect Federal assistance (other than general or specific revenue sharing or formula grants made to States) approved by any Federal officer or agency; or (B) any loan made or purchased by any bank, savings and loan association, or similar institution subject to regulation by the Board of Governors of the Federal Reserve System, the Federal Deposit Insurance Corporation, the Comptroller of the Currency, the Federal Home Loan Bank Board, the Federal Savings and Loan Insurance Corporation, or the National Credit Union Administration."

The law will not automatically evoke this harsh sanction. In order for this sanction to be enforced, both houses of Congress must approve of its use within 90 days of promulgation of the final regulations.

At present most building energy efficiency analysis, if undertaken at all, utilizes a component performance standard. ASHRAE 90-75 is a component performance code which is often the basis for energy efficiency analysis.

The component performance approach considers the separate components which form a building individually. A component is considered as a structural or mechanical element (e.g., windows, doors, or HVAC system). With this approach the building is treated as an assemblage of parts, each of which must meet a specific standard.

BEPS mandates the development of a performance energy efficiency standards for application to new buildings. The performance approach

views the building and site as a single system. The interrelationships between all subsystems, site, and their effects on one another are considered in determining the building's overall efficiency. A performance standard is much more complicated to evaluate than a component standard. Implementing a performance standard will involve computer simulation of a building's design, operating conditions, layout, orientation, HVAC system, and local climatic conditions. The time, expense, and problems associated with computer modelling would make simulation of all new building designs very difficult.

Fortunately, once energy budgets, (M BTUs/SF/Yr), are set for given types of buildings it will be possible to develop component performance specifications, similar to ASHRAE 90-75, which will be equivalent to the performance standards in terms of energy efficiency. The advantage of this approach is that it will make meeting the standard easier for designers and also facilitate inspections for compliance since inspectors are already somewhat familiar with the component approach. Designers will, however, have the option of having their designs evaluated using the performance approach, should they so choose.

With regard to the actual implementation of the standards, three options are available:

- 1) Exemption. The Secretary may grant buildings in some areas exemptions from the Building Energy Performance Standards. These exemptions will be given to areas upon petition of the States. They will be awarded if new construction in such areas is of too small a magnitude to warrant the costs of implementing BEPS.
- 2) State Compliance. States may be certified that they are implementing the regulations. States will be certified if they can show that the units of general purpose local government are implementing a building

code or other construction control mechanism which meets or exceeds the requirements of the final performance standards. States will also be certified if they show that the State has adopted and is implementing a building code or other laws and regulations which provide for the effective application of the final performance standards.

3) Building Compliance. Even if a state is not certified, construction which would meet the standards can proceed if individual building compliance can be determined under an applicable approval process. The agency of local government which grants building permits and has jurisdiction over where the new construction is proposed can have the authority to determine whether or not the proposed building is in compliance with the standards. If this agency is not willing or able to administer the process, any other agency of the local unit of government may administer the process. If no agency of the local unit of government is willing to administer the process, the State may administer the process.

Figure 2 outlines the options which could be taken in the evaluation of a building design. The shaded areas on the diagram indicate the certification process for both the simulation approach and the "traditional" approach. The actual energy performance certification can be made by a local building official, a state building official, or by any agency authorized to do so under the applicable approval process.

Should the designer choose to have his building evaluated on the basis of its overall energy performance, he would use a computer simulation technique. Such programs presently exist. However, they are not fully developed and still require further refinement. DOE-2 is the program which could be used to evaluate commercial buildings. Residential

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EVALUATION PROCEDURE

LJR 7/18/79

buildings will probably be evaluated using a program which will combine two existing programs, D-ROB and TRANSIM. These programs calculate the hour by hour energy use of a building considering the building's location, construction, operation and HVAC system. Any State developed energy evaluation program which is approved by DOE could also be used as the evaluation technique.

It is anticipated that the complexity involved with the computer simulation techniques will prompt most builders to choose the component performance approach. In this case the evaluation tool will be either approved state/local energy codes or the Manual of Accepted Practice to be published by DOE.

Figure 2 outlines several options should a design fail to meet the energy performance criteria. All of these options assume that the sanction will be evoked by Congress. The builder can give up plans for construction, construct the building without using any Federal assistance, challenge the validity of the evaluation techniques in court (this would be the case especially with controversial or innovative designs which may not be modelled accurately at first) or redesign the building so that it is in compliance with the standards. Should the standards be voluntary, the construction process can continue regardless of the energy budget analysis.

B. Potential Problems

Problems related to BEPS implementation can be grouped into six areas; compliance issues, computer simulation issues, manual of accepted practice issues, applicable approval process issues, home rule issues, and sanction issues.

1. Compliance Issues

States may be in compliance with BEPS through implementing a building code or construction control mechanism, at the state or local level, which meets or exceeds BEPS. Three problems are immediately apparent.

The first problem is technical; the implementation plans must establish some method of determining the equivalency between existing prescriptive or component performance standards and the overall building performance standards established by BEPS. Research in this area is presently being carried out by several contractors (MIT, RPI) for DOE. In situations where the state or local government adopts the Manual of Accepted Practice, (once developed), as the relevant code this problem will be minimized.

The second problem is institutional. Once it has been determined that the state or local building code in effect meets or exceeds the requirements of BEPS, in some manner it must be determined that the applicable building inspection office is actually enforcing the provisions of the energy code. The problem should be especially critical in offices already short on staff; these offices may not check building specifications for BEPS compliance thoroughly, since non-compliance is not likely to endanger human life.

The third problem relates to the actual construction process. It will be necessary to monitor the construction process to determine whether or not buildings with designs that meet or exceed BEPS are actually built to those specifications. Inspections of this type already occur for mechanical and electrical systems during construction. Again, this additional requirement may strain staff capabilities.

2. Computer Simulation Issues

The energy use programs have been developed recently and have not been demonstrated to be accurate in estimating energy consumption in all cases. Controversy related to their accuracy is especially likely to arise over evaluations of new and innovative designs. Other questions will arise over specific assumptions used in the models, such as the amount of heat lost through basements.

The computer simulation techniques are also likely to create problems with regard to their utilization. The implementation regulations should make clear who is qualified to use these computer models to estimate building energy consumption. In many areas this could create problems due to the lack of qualified technicians and/or computer facilities.

3. Manual of Accepted Practice Issues

A manual of accepted practice will be developed to simplify the processes of designing and evaluating buildings in conformance with BEPS requirements. BEPS is required by law, (P.L. 94-385), to promote the utilization of renewable energy resources. A performance standard, by its nature, is neutral with regard to promoting any specific energy conservation measures. It is the Manual of Accepted Practice which must be utilized to meet this requirement of the law.

4. Applicable Approval Process Issue

The Applicable Approval Process as outlined in P.L. 94-385 leaves an obvious question. What if the State is not willing or able to administer the approval process? Presumably DOE would hope that the matter would be resolved in a lawsuit between the builder and the State, with the outcome being that the State be required to implement the

process. It doesn't seem impossible, however, that this provision of the law could make DOE responsible for inspecting the energy efficiency of buildings located in areas where no one is willing or able to administer the Applicable Approval Process.

5. Home Rule Issues

Implementation of BEPS is likely to create a host of institutional problems. Some states and localities may resent any intrusion of the Federal government into the local building process. Some states which lack of familiarity with the standards or disagree with the standards in concept. Some will no doubt argue that since the standards are based on minimum life cycle costs the market will independently force the necessary improvements in building construction. Any implementation strategy should clearly state the necessity for the standards, implementing the standards.

6. Sanction Issues

The harsh sanction written into P.L. 94-385 is bound to cause some problems if it is enforced. The extent of the negative impact of the sanction, in terms of stifling construction, will depend to a great extent on the operation of the Applicable Approval Process. If the sanctions are not enforced, then incentives may be required to achieve the full benefits of BEPS.

C. Tentative Approach

By pointing out some of the problems which could arise with any BEPS implementation scheme it is possible to create a checklist of what a BEPS implementation plan should consist of, at the minimum. A BEPS implementation strategy should:

- establish a mechanism for determining which building codes meet or exceed BEPS.
- provide some form of verification to assure that the specifications of designs approved are in compliance with the code
- provide for monitoring the co-construction process to determine that the actual construction is to specification.
- specify who is qualified to use a computer simulation technique
- make provisions for utilization of the computer simulation approach where qualified technicians or computer facilities are not available.
- promote the utilization of renewable resources through the Manual of Accepted Practice
- maximize the flexibility given to states and localities in the implementation process in an effort to minimize disruption of home rule
- provide incentives for adoption of the standards should the sanction not be enforced

The NOPR does not formally propose an implementation strategy for BEPS, but states that a proposed rule on implementation will be issued at a later date. The following subsections summarize current thinking about how BEPS will be implemented. The information presented here is based on conversations with Sue Sicherman of Building and Community Systems and is subject to revision.

1. State Certification

The implementation regulations, (regs), will provide guidance for determining whether or not a given building code meets or exceeds the requirements of BEPS. The regs will also publish a list of "prequalified" codes which have already been determined to meet or exceed the BEPS requirements. Before certifying a state, DOE will have to determine that the state or local building code meets or exceeds BEPS, and that the code is actually being enforced.

2. Applicable Approval Process

The regs will specify the operation of the applicable approval process. This process will involve the issuance of a yellow ticket declaring that the building under consideration has met or exceeded the requirements of the BEPS energy budget. The regs will list who is qualified to issue a yellow ticket. Should a traditional evaluation technique, (component performance) be used a certified architect or engineer will be qualified to inspect the design for compliance. Should the building's design be evaluated using a simulation approach, additional expertise, described by the regs, will be required. Once a building's design has been awarded a yellow ticket, the agency administering the applicable approval process will issue the builder a pink ticket. This ticket will indicate that the building has been designed in compliance with BEPS. A pink ticket will be required before any financial institution receiving Federal assistance can lend money to the builder for construction.

3. Exemptions

The regulations will only grant an exemption from BEPS if the magnitude of construction in an area is so small that the costs of implementing BEPS would be prohibitive.

4. Enforcement

The question of how to assure effective application of BEPS is still being considered. Possibilities include requiring sworn statements from builders, providing DOE staff to conduct spot inspections or funding states to inspect enforcement at the local level.

Plans at this point leave construction inspection as a matter to be resolved completely between the consumer and the builder.

IV. BEPS Energy Savings and Costs

Implementation of the Building Energy Performance Standards at approximately the levels suggested at the conclusion of sections II.A and B is estimated to save (Draft BEPS Economic Analysis). This estimate was reached through a comparison between estimated future energy consumption with the standards in effect and estimated future energy consumption without the standards. The estimated future energy consumption without the standards, or baseline, was developed through the use of existing Oak Ridge National Laboratory residential and commercial energy use models.* These models estimate future construction by building type and the energy consumption of that new construction. This baseline estimate considers improvements in energy conservation which are likely to result from other governmental programs and economic incentives. The estimated future energy consumption with the standards was then developed, assuming that the standards would be completely promulgated and implemented by 1984, that they would not change thereafter, and that the standards would be complied with by 100% of the new construction. Finally, this estimate was adjusted to reflect differences between design and actual energy consumption to compensated for the operational and maintenance assumptions made in the standard development process.

Buildings designed to the proposed standards will have higher initial costs than the energy efficient structures. It is estimated that capital costs will increase between \$750 and \$1,500 for residential buildings and between 3 and 5 percent for commercial buildings. (44F.R. 68129, 68149). However, this initial outlay will be more than recovered through future energy savings since these standards have been developed to be cost-effective with respect to building owner/occupants. The higher down

* Pacific Northwest Laboratory, et.al., Draft Report of Economic Analysis of Proposed Building Energy Performance Standards, June, 1979.

payment associated with this increased initial cost may force marginal purchasers from the housing market. This negative effect will be balanced, however, by lower default rates for future purchasers, since their utility bills will be reduced.

V. Conclusions

Federal intervention into the local building code process by these regulations was justified on the basis that isolation of the eventual building owner/occupant from the construction process (via the builder) created a market failure. According to the reasoning, builders were assumed to be motivated by pressures to minimize the first costs of the buildings they constructed. Low initial costs were often achieved at the expense of high utility operating costs to the owner/occupants, the majority of whom lacked the information and ability to influence builders. The BEPS regulations were intended to assure that builders would have to consider the energy efficiency of the buildings they constructed.

When this legislation was passed little was known about building energy consumption and how that consumption could be reduced in a cost-effective manner. The massive research effort undertaken in order to establish the energy performance standards has to a large degree corrected this situation. The continuing research program appears well directed and will most likely come to grips with the many difficult problems still existing. We do, however, have some specific concerns regarding the inclusion of hot water heating in the residential standards and the implementation of BEPS.

A. Residential Hot Water

The decision to include domestic hot water within the energy budget for single family residences will no doubt have a positive impact upon the adoption of active solar systems for domestic hot water. This effect will occur since active systems will contribute to domestic hot water without adding to the design energy consumption of the building. While the domestic hot water component to be added to the energy budget is fuel specific it is fixed with regard to both regions of the country

and size of the residence. The estimate is based upon an average number of occupants per residence. (44F.R. 68135). While this may be a valid initial estimate this component of the energy budget could use further refinement. Intuitively it seems possible that hot water usage may vary with the size of residential units. Since residence size is no doubt correlated with housing unit value there may be a positive relationship between size and hot water usage on the basis of a correlation between housing unit value and the likelihood of the presence of hot water intensive appliances such as washing machines and dishwashers.

The addition of domestic hot water into the energy budget for residences should also be analyzed to determine whether the policy may undermine the intent of the energy performance standards. A hypothetical 1,500 SF single family detached residence in Atlanta would have an energy budget of 26.3 MBTUs/SF/Yr. for heating and cooling according to the proposed standards. Assuming the water in that house was heated by gas, an additional 19.7 MBTUs/SF/Yr would be added to the energy budget, $(29,500/1,500)$, for a total of 46.0 MBTUs/SF/Yr. Were 50% of this building's hot water to be supplied by an active solar system this residence would technically be in compliance with the standards if it used 46 MBTUs/SF/Yr $(26.3 + 9.9)$ for heating and cooling. This energy performance level could be achieved by a house with R19 ceiling, R11 wall, and R11 floor insulation and double glazed windows. (See Figure 2).

In other words, this level of energy consumption for heating and cooling could be achieved over 1975 practice by merely upgrading floor insulation to R11 and adding storm windows.

Figure 2

GAS SPACE HEATING - ATLANTA

The house would be in compliance with the proposed standard. But several conservation investments, yielding an additional, cost-effective, 27% reduction in energy use, could still be made. The Draft Economic Analysis determined that R38 ceiling, R19 wall and R11 floor insulation along with double glazed windows would be the optimal conservation investment for the owner/occupant of a single, gas heated family home in Atlanta. The impact of including domestic hot water into the energy budgets will vary regionally. It should have little consequence in regions where active solar systems are not feasible or only supply marginal amounts of domestic hot water. Conversely, in areas where active solar systems can supply a major portion of domestic hot water needs, the possibility exists that residences with sub-optimal conservation investments will comply with the standards.

B. Implementation

Promulgation of the Building Energy Performance Standards will provide both builders and prospective building owner/occupants with information about optimal levels of energy conservation investments. If this information is made widely available consumers will no longer purchase sub-optimal designs due to lack of information. Increased demand for energy efficient buildings would exert pressure upon builders to design buildings in compliance with the standards. This would be the case especially with commercial buildings where owner/occupants are likely to explicitly consider future operating costs. While initiation of programs to instruct builders in energy efficient design would be beneficial, the existence of a Manual of Accepted (Recommended) Practice, which will express the standards in a form already familiar to design professionals, will minimize the need for instructional programs. The

proposed use of lending institutions as a regulatory mechanism for checking compliance with the standards appears likely to be burdensome and may receive institutional resistance. Lending institutions do, however, appear as an excellent prospect for disseminating information with regard to locally cost-effective conservation investments.

Implementation of the standards as outlined in this report would entail staff cost for monitoring compliance at both the design and construction stage. Although no enforcement mechanism has been formally developed, the Draft Economic Analysis estimates that it will cost 40 million dollars annually over and above existing building code enforcement expenditures to enforce these standards. This estimate is based on experience in California with implementation of a performance standard. (Draft Economic Analysis, Table 5.15, p. 5.23). Since the vast majority of informed consumers will want to purchase buildings designed in compliance with the standard, builders will have no reason not to comply with the standards voluntarily. Indeed, from a national perspective whatever the cost of implementation, those funds would be better spend in an effort to induce the design of buildings with specifications exceeding the established standards. One possible approach would be to provide tax credits to builders whose design specifications exceed the standards.

Even without a separate implementation scheme for the energy performance standards once promulgated, a good deal of new residential construction will be forced to comply with the standards. HUD's Minimum Property Standards, (MPS), and FmHA's energy efficiency standards currently apply to a total of approximately 46% of annual housing starts. Both these standards will be revised upward to become equivalent to the

Building Energy Performance Standards once promulgated. (National Energy Conservation Policy Act (NECPA) P.L. 95-619, section 252).

The suggestion that market forces will provide the impetus for adoption of the energy performance standards is based upon the fact that the proposed standards will be cost-effective to building owner/occupants. Were this not to be the case the need for some implementation scheme would be greatly increased. Were the standards to be set to achieve the maximum practicable energy conservation from a national perspective, (through the use of replacement fuel prices in the analysis which would account for environmental, intergenerational, and national security costs as well as the costs of new and more expensive energy sources that will be developed), the standards would be more stringent. Compliance with the standards in that case would force consumers to make uneconomical conservation investments from their individual perspective. Energy performance standards developed from a national perspective would probably require an extensive implementation scheme including severe sanctions for failure to comply with the standards. Such a scheme would undoubtedly meet resistance from large segments of the public and effective implementation at the local level is likely to be spotty at best.