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TO INSURE THAT CERTAIN BUILDINGS FINANCED WITH
FEDERAL FUNDS UTILIZE THE BEST PRACTICABLE TECH-
NOLOGY FOR THE CONSERVATION AND USE OF ENERGY

GOVERNMENT

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KANSAS STATE UNIVERSITY

HEARING
BEFORE THE
SUBCOMMITTEE ON ENERGY
OF THE
COMMITTEE ON PUBLIC WORKS
HOUSE OF REPRESENTATIVES

NINETY-THIRD CONGRESS

FIRST SESSION

ON

H.R. 11299 and H.R. 11565

TO INSURE THAT CERTAIN BUILDINGS FINANCED WITH
FEDERAL FUNDS UTILIZE THE BEST PRACTICABLE TECH-
NOLOGY FOR THE CONSERVATION AND USE OF ENERGY

NOVEMBER 27, 1973

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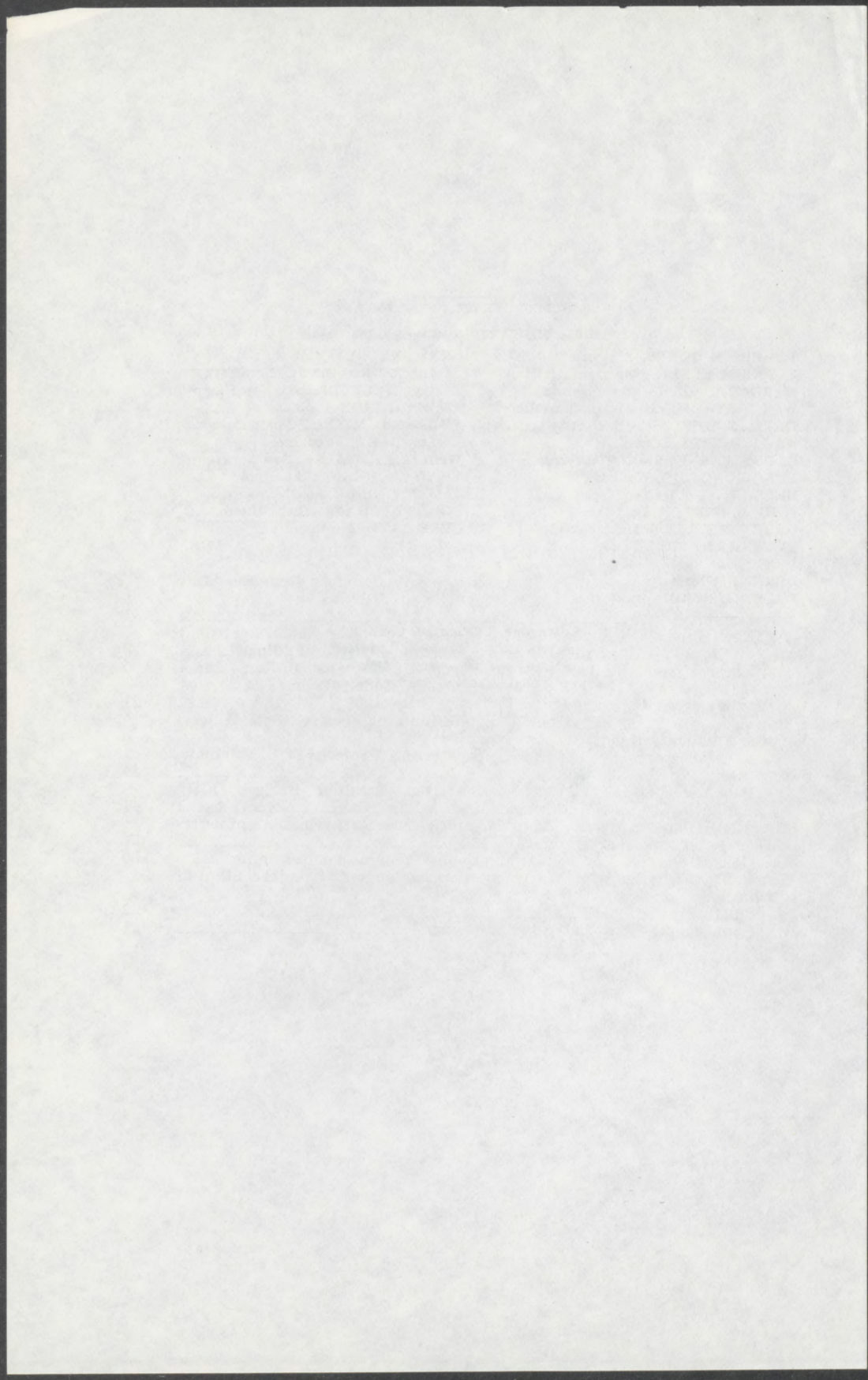
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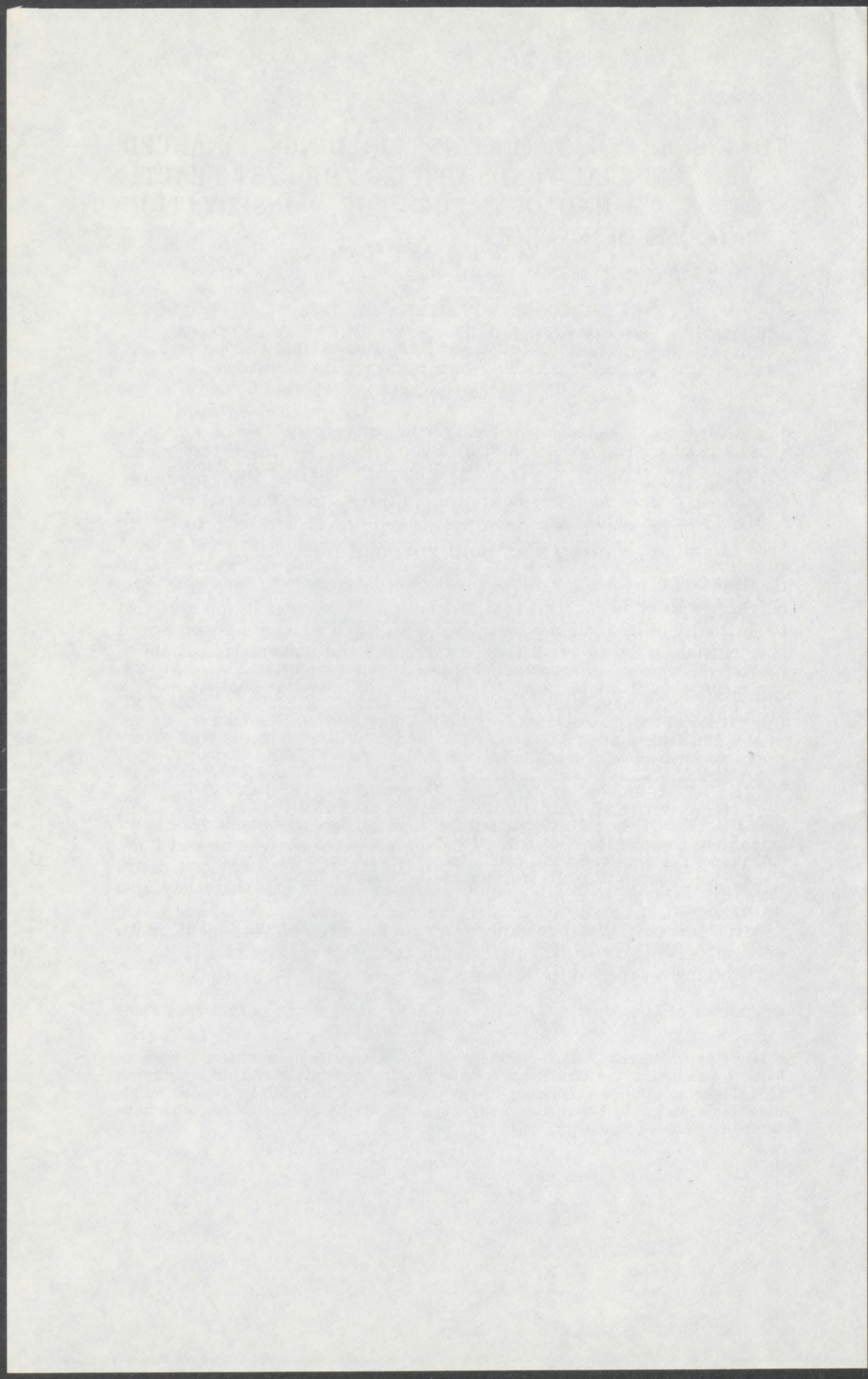
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TO INSURE THAT CERTAIN BUILDINGS FINANCED WITH FEDERAL FUNDS UTILIZE THE BEST PRACTI- CABLE TECHNOLOGY FOR THE CONSERVATION AND USE OF ENERGY

TUESDAY, NOVEMBER 27, 1973

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON ENERGY
OF THE COMMITTEE ON PUBLIC WORKS,
Washington, D.C.

The Subcommittee on Energy of the House Committee on Public Works convened at 4:02 p.m., in room 2167, Rayburn House Office Building, Hon. James J. Howard [chairman of the subcommittee] presiding.

Mr. HOWARD. This hearing concerns the bill H.R. 11299, to insure that certain buildings financed with Federal funds utilize the best practicable technology for the conservation and use of energy. The Chair would like to state its appreciation to Mr. Cleveland, Mr. Snyder, who helped with the staff to develop this legislation and also to the many other members of the subcommittee who have cosponsored the legislation. I do hope that we can get the information that we need from the people testifying and be able to report a meaningful bill, aimed toward conserving energy, at least where the Federal Government has a vital interest in Federal buildings.

We are very happy to have with us as the first witness this afternoon—

Mr. CLEVELAND. Mr. Chairman.

Mr. HOWARD. The gentleman from New Hampshire.

Mr. CLEVELAND. Before introducing the witness, I have a very brief statement to offer at this point. I have a prepared statement and I ask general leave that it be made a part of the record. Also, enclosures are with my prepared statement and I would like to ask that they also be made part of the record.

Mr. HOWARD. Without objection, your prepared statement, with enclosures, will be made a part of the record at this point.

[Statement referred to follows:]

STATEMENT OF HON. JAMES C. CLEVELAND, A REPRESENTATIVE IN CONGRESS FROM
THE STATE OF NEW HAMPSHIRE

Mr. Chairman and fellow members of the Energy Subcommittee, I wish to begin by thanking the Chairman for the prompt scheduling of this hearing on H.R. 11299, my bill to encourage energy conservation in federally funded buildings. I also wish to thank the many members of the Subcommittee who have agreed to join as cosponsors.

My opening statement will be brief so we can spend most of our time hearing from the witnesses. At this point, Mr. Chairman, I do want to ask that the record be kept open for comment from the firm of Dubin, Mindell, Bloome Associates, which has agreed to examine the bill and submit comments for the record, and others. Dubin Associates is under contract to the General Services Administration to produce design standards for energy conservation in public buildings, and is designing a demonstration building for Manchester, N.H., which involves a total conservation concept in design and construction, and use of solar energy as a supplementary heat source. Mr. Fred S. Dubin, with whom I have corresponded in the past, was unable to be with us on short notice, as was his senior associate John S. Barnaby, who is in charge of the "Manchester Project." As a reflection of the realistic opportunities for energy conservation contemplated by this bill, however, I wish to quote from a statement made by Mr. Barnaby recently in Manchester at a program sponsored by the New Hampshire Chapter of the Construction Specifications Institute. While the design objective is a 20 percent saving in energy consumption, estimates to date suggest far greater potential. "We have passed the 30 percent mark," said Mr. Barnaby. "We have passed the 35 percent mark and I don't dare go any further with a public statement but there is much more beyond that."

To me this means we aren't dealing with exotic technology of unknown promise. Rather the intent of this legislation is to require imposition of available, practical commonsense approaches to building design in recognition of the fact that the energy joyride is over. I have seen estimates that some 30 to 40 percent of all energy consumed in this country is devoted to the construction and operation of man made structures, and that a conservative estimate of potential savings is 25 percent. The approach is to build design standards into new buildings, and inventory existing structures for practicable, workable conservation procedures.

This effort will have the inescapable effect of reducing energy in facilities under federal jurisdiction, influence the private sector to follow suit, and offer the individual private citizen incentive to do his part in exercising restraint in energy consumption. By proving out the potential for savings over the life cycle of a building, it certainly should overcome the first-cost mentality which focuses design decisions on initial outlay rather than fuel-cost savings to be gained over a few years of operation.

I offer for insertion at this point the language of the bill H.R. 11299 and an article from the New Hampshire Sunday News of November 25, 1973; and an article from The Architectural Forum, July-August, 1973.

[H.R. 11299, 93d Cong. first sess.]

A BILL to insure that certain buildings financed with Federal funds utilize the best practicable technology for the conservation and use of energy

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That, as used in this Act the term—

(1) "new building" means any building or facility (other than a privately owned residential structure) which is (A) to be constructed or altered by or on behalf of the United States; (B) to be leased in whole or in part by the United States after the date of enactment of this Act after construction or alteration in accordance with plans or specifications of the United States; or (C) to be financed in whole or in part by a grant or a loan made by the United States after the date of enactment of this Act if such building or facility is subject to standards or design or construction or alteration issued under authority of the law authorizing such grant or loan; and

(2) "existing building" means any building or facility (other than a privately owned residential structure) owned or leased by the United States and substantially all of which is used on or after the date of enactment of this Act by or on behalf of the United States.

Sec. 2. The Administrator of General Services shall insure that all design criteria for new buildings provide for the best practicable use and conservation of energy. In so doing, the Administrator of General Services shall consider (A) architectural features and site orientation that will make the most efficient use of sunlight and other natural phenomena, (B) insulation and elimination

of excessive fenestration, (C) energy expended in the manufacture and transportation of building materials, and (D) new techniques for energy supply, generation, and transmission.

Sec. 3. The Administrator of General Services shall inventory and examine existing buildings to determine what improvements can be made to insure that these buildings will utilize the best practicable technology for the conservation and use of energy.

Sec. 4. (a) The Administrator of General Services shall report to the Congress the results of his survey inventory under section 3 no later than January 1, 1975.

(b) The Administrator of General Services shall report to Congress, not later than January 1, 1975, and from time to time thereafter, on his activities in carrying out section 2 of this Act.

Sec. 5. There is authorized to be appropriated to carry out section 2 not to exceed \$500,000, to carry out section 3, not to exceed \$500,000, and to carry out section 4, not to exceed \$500,000. Such sums shall remain available until expended.

[From the New Hampshire Sunday News, Nov. 25, 1973]

CLEVELAND BILL ORDERS ENERGY SAVINGS IN FEDERAL BUILDINGS

(By Edith K. Roosevelt)

WASHINGTON, Nov. 24—Legislation to encourage sweeping energy conservation measures in building construction and operation—in design, in production and transportation of materials and in heating, cooling and ventilation of completed structures—has been introduced by Rep. James C. Cleveland (R-N.H.).

Both short and long-term savings are the objectives of his bill, said Cleveland. It would require application of available energy conservation practices to existing Federally-funded building and development of new design standards for those to be built in the future.

NO SUBSTITUTE

"Nothing in my bill would substitute for individual restraint in the use of energy to offset this winter's shortage," said the New Hampshire Republican. "But by requiring government to meet its own responsibility, it can lend incentive to individual efforts to reduce consumption and minimize hardships and sacrifices as we move towards self-sufficiency."

Cleveland, a member of the House Public Works Committee's Energy Subcommittee, already has enlisted as cosponsors the Subcommittee's Chairman Rep. James J. Howard (D-N.J.) and ranking GOP member Gene Snyder of Kentucky. Additional Subcommittee cosponsorship is being rounded up for reintroduction of the bill, possibly this week.

The bill's direct application is to buildings owned, operated, leased or funded by the Federal Government through loan or grant programs, except for privately owned residences.

"Its main impact will be to encourage innovative concepts in the construction and operation of Federal buildings," said a joint Cleveland-Howard-Snyder letter to Energy Subcommittee members. "In addition to the energy savings from these Federal buildings, we will also be encouraging the private sector to adopt concepts and design features which will be demonstrated in these buildings."

Chief responsibility for the program would be lodged in the General Services Administration, which is sponsoring design of a demonstration building in Manchester, N.H. expected to achieve a 20 percent saving in energy compared with conventional buildings of similar function.

Energy conservation is being built directly into the initial design and selection of materials for the building, which is to use solar energy as a supplementary heating source.

But the effect of Cleveland's bill would go beyond the 26,000 buildings owned and operated by GSA and the 78,000 structures which the Agency leases and includes defense installations and facilities supported by a wide range of brick-and-mortar Federal assistance programs.

Cleveland said it would help also to build a market for energy conservation approaches and stimulate a fuel-economy consciousness to replace the "first cost mentality" with a "life cycle" approach.

NEW ERA

The New Hampshire legislator explained that during the now-ended period of energy abundance at low cost, spending decisions have concentrated on initial outlay rather than operating cost. There has been no incentive to apply energy conservation measures which may increase initial cost, even though that cost can be recovered through energy economies within a few years.

Cleveland also emphasized that savings in electricity have a particularly high payoff in terms of primary fuels conserved because of losses in energy resulting from generation and transmission of electric power. Roughly a quarter of all primary fuel is converted to electricity.

The Cleveland bill would require GSA to inventory and examine all existing buildings under Government jurisdiction to determine the best available conservation measures, giving the full force of law to GSA's current conservation efforts.

For new buildings, it would require architectural features and for positioning of structures on the building site to make best use of sunlight, maximum use of insulation, and elimination of excessive expenses of windows, energy economies in construction, and development of new sources.

Specific features could include selective rather than building-wide temperature controls, limitations on excessive lighting which creates a heat problem, recapture of heat lost through ventilation, and maximum use of outside air as climate permits.

[FROM THE ARCHITECTURAL FORUM, JULY-AUGUST 1973]

Architecture, embracing the entire built environment, is responsible for over a third of all energy use in the U.S. If we are genuinely concerned with understanding and possibly modifying this, we should have a detailed understanding of how we use and commit energy through our buildings.

1970 figures indicate we are using 69,000 trillion Btu's of energy. About one quarter is used for electricity. The balance

is in various direct uses, mostly in some form of fossil fuel. Electricity loses a significant amount of the energy necessary to produce it in the generation process. For example, the number of Btu's necessary to generate a kilowatt hour of electricity varies according to the efficiency of the generating equipment and the kind of generator—steam turbine, gas turbine, etc.—from about 10,000 Btu's to over 13,000. A kwhr

(kilowatt hours, one thousand watts delivered for an hour) has a theoretical heat content of 3,413 Btu's. After the loss in generation, there is a further loss in transmission of another ten percent or so as the power adjusts from higher to lower voltages. This efficiency loss does not occur in hydro-electric generators, but does occur in nuclear and geothermal generation where steam is used to operate turbines.

Methods reporting electrical use make it difficult to know precisely how it is divided among various users. In national reporting by the Edison Electrical Institute, for example, all residential is grouped together regardless of unit size—single family, multi-family, etc. Small commercial and industrial is linked in a single category as is large commercial and industrial. There is no precise designation of use by commercial office buildings for ex-

ample. And yet in New York City, more than half of Consolidated Edison's load is attributed to commercial customers. Transportation is a separate category. Other uses are lumped under miscellaneous. This, in a time of technical precision?

The electricity produced is part of the total energy in these various categories, and forms part of the supply required in manufacturing aluminum, electric steel furnaces, electric kilns and so forth. It is included in transportation for some trains, electric bus systems, subways and similar uses. For total energy used, electricity must be added to energy in other forms.

Of the other major categories in energy reporting, transportation requires 25 percent. Industry for process purposes requires 41 percent. Fossil fuel heating and cooling of buildings require about 20 percent. (E. Hirst and R. Herendeen, "A Diet Guide for Chronic Energy Consumption," p. 64FF—Saturday Review, 28 Oct. 1972.)

To understand the extent of energy use in and through buildings, the following rough percentages are helpful. Of the total Gross National Product, about ten percent is in the building construction industry. In the building process itself, energy uses amount to 22 percent of the electricity used by industry and about 7.5 percent of all electricity.

Of the 25 percent of all energy that electricity represents, about one half is for devices built into the buildings—the lighting systems, the ventilation systems, the air-conditioning, pumps, motors, elevators, escalators, and the electric heating systems. Going back to primary sources, this represents an additional 12 percent. And in the direct fossil fuel use for space heating and cooling, and for what is called process heating (the heating of hot water), there is another 20 percent.

This adds up to about 40 percent of all energy use.

Moreover, there is a certain amount of energy use for transportation that can be traced back to architectural and planning decisions about building groups—neighborhoods, towns, cities, regions.

Another area of energy use that is difficult to quantify has to do with demolition. We have unfilled needs nationally, in re-

gard to housing, schools, hospitals, cultural facilities, and other buildings. How does one evaluate the decision to replace a building with a useful anticipated life with one serving the same or another purpose, espe-

cially when the decision will require an energy commitment to demolish and dispose of the one building, an energy commitment to build its replacement and in some cases, a higher consumption of energy in main-

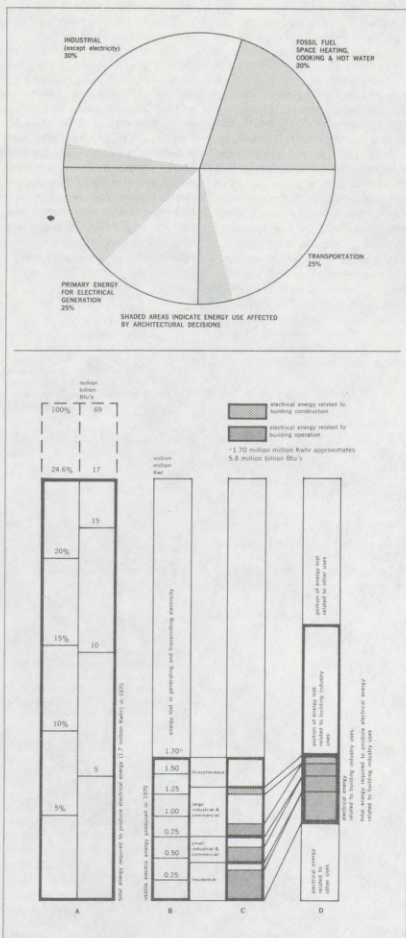
taining the new space?

Going from percentages to actual quantities, we see the magnitude of use and the potential benefits of less use.

This diagram (top) gives some indication of total energy use and the part of it that is consumed for electricity and, in turn, the part of that electricity used or committed through the architectural process. The figures given are for 1970. Below left, you will notice a bar graph that shows all energy used in the United States that year, for whatever reason—transportation, manufacture, illumination. We have not indicated what the sources of the various energy uses are but they include fossil fuel, hydro-electric and nuclear energy. Of the energy consumed, the total amount recorded in Btu's is 69 million billion. 17 million billion of these, or about 25 percent, are used for production of electrical energy and these 17 million billion Btu's produce 1.7 million million kwh's. In the course of producing those, there is a good deal of that energy, in fact about two-thirds of it, which is lost in the generation process, so that the amount of electrical energy produced is roughly the equivalent of 5.8 million billion Btu's (diagram bottom).

All the energy used in buildings is used wastefully. Lighting, the most obvious and visible use of electricity, represents about 25 percent of all electricity that is sold. In office buildings, lighting represents over 50 percent of the energy used. It is also a high energy user in schools—sometimes as high as 65 percent.

Incredibly, when the importance of efficient energy use is considered in terms of its ecological, social and political impact, it is hard to realize how we can persist in the wasteful practices we now find around us. According to *American School and University* (February 1973) the median expenditure per pupil in 1972-73 is \$1,046. Electricity, oil and gas represent \$20.88, just over two percent. Yet, in terms of energy use, educational facilities in 1970 represented seven percent of all construction put in place (*Statistical Abstracts* 1971, and can be assumed to use almost a proportionate part of energy, about six percent of the energy used by buildings.



In a year, we build about 165 million square feet of educational facilities. Each square foot will consume, on the average, about 15 kwh's a year. A saving of 50 percent would be a saving of about 1,000 million kwh's a year. In ten years, this would be 10,000 million. Stated in other terms, it would be the complete electric budget for two million families, or it would be the generating capacity to take care of all the needs of 20 Schenectadys, or it would be adequate for the residential requirements of New Mexico eight times over.

The typical non-electric energy load is of the order of 100,000 Btu's per square foot. A 20 percent reduction in new school buildings would produce a savings of almost 345 billion Btu's per year; or again, in a decade, almost three and a half trillion Btu's.

Energy Curve For Buildings

Every building can be considered an activity resulting in energy use throughout its life. The energy curve can be generalized, or it can be graphed, with all the variations that describe a cold winter, the installation of a new piece of equipment, an alteration that would change lighting levels. Characteristically, though the curve would respond to the energy used in building, the energy required to operate, maintain and, finally, demolish the building would all be graphed on a continuous time scale (diagram, below).

Building materials and the

construction process can be averaged as a straight line through the construction period. (This is an approximation since the energy required by products and their components can be expended in a time period unrelated to the period of building.) After the building is in use and through its life, the energy use can be described by an undulating curve which may have a high peak in midsummer and a lesser peak in midwinter with troughs at spring and fall. The line is composed of a series of daily peaks and troughs, with peaks during the afternoon in winter and at midday in summer. The whole undulating line climbs slowly, year by year, as equipment and assemblies become less efficient and as energy is used in replacements. It has a momentary peak at demolition, then drops to zero.

Considering building and average maintenance costs for high rise commercial buildings, as a broad generalization, for every million dollars of new building, there is now an electrical energy expenditure of 1.28 million kwhr. To operate and maintain that million dollars worth of building on an all electric basis one million kwhr per year are required, rising to 1.13 million kwhr per year as maintenance requirements increase.

There are tremendous variations in individual buildings, both in construction requirements and in operation costs. Dr. Charles Lawrence, Public Utilities specialist for New York City, conducted a survey of over 80 commercial office buildings

built after World War II and found variations of seven to one at the high and low extremes of energy use per square foot for buildings serving similar purposes. While this makes it necessary to be cautious about statistical generalizations, individual studies verify the susceptibility of all these installations to significant savings.

Also, if a national energy reporting system were set up, the summation of the annual energy use in all buildings—new ones under construction, buildings being operated and maintained, buildings being demolished and materials being extracted and processed for building—would add up to the total we have approximated from other sources and would give an energy profile for the year, showing how this use varied daily and seasonally.

Observation

Of all the appliances, artifacts and objects made to serve our daily needs, a work of architecture is among the longest-lived—longer than appliances, vehicles or the machines for business and manufacture. Where an automobile may last from five to ten years and a television set even less, the life of a building may well be more than half a century and the infrastructure, the streets and utilities, last for hundreds of years. You can still go to Italy and travel on the Appian Way, a road that is 2,000 years old.

The importance of this, of course, is that the architectural decision—the openings in a building wall, the width of the building, the orientation—establishes a pattern of energy use that is carried forward for decades. If there is a change in taste, legislation or gasoline availability within ten years or less, requiring a shift from 400 to 100 horsepower cars, there can be a virtually complete replacement of the entire stock of automobiles. If, on the other hand, the same attitudes questioned the sealed glass building, they would continue as an important portion of our urban life.

The Tall Building

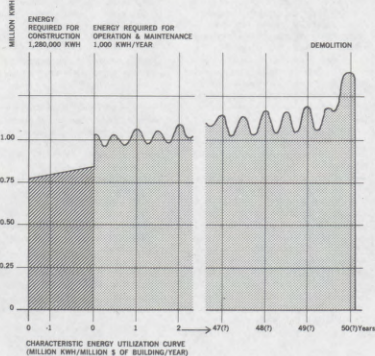
The tall building, particularly the tall, glass-faced, sealed commercial building, has become an identifiable building type, with standard equipment, catalogue components and design methodology. Since it has become a significant energy user in the service areas of most utility systems, it merits close analysis.

Its form results from the economics of real estate in central urban areas. In order to speed design, it seeks to avoid rather than exploit individualization of use, site and orientation. While there is a psychological groping by individuals to preserve their uniqueness, there is a continuing drive toward the further generalization of our world by building in the patterns that have been established in the last two decades.

For example, the large commercial building has become a typical sealed volume. It doesn't matter whether it is the World Trade Center in New York, which is still not completed, or the Chase Manhattan Building, completed 15 years earlier. Both disregard orientation and depend on massive use of mechanical cooling to compensate for the heat gain on the outside from sun and on the inside from lights and body heat. In the World Trade Center most of the area is interior space. The perimeter from the inside is a nervous alternation of slots and blank walls. The people working there have no individual choice about turning lights on and off. Since many of the interesting old restaurants in the area were demolished to make way for the new construction, not even the quality of urban eating has been enhanced in this "bargain."

Dr. Lawrence, in his study of energy use in the 80 post-World War II buildings, noted that it was characteristic that, decade by decade, energy use per square foot has been increasing, although the performance of the buildings, the services rendered for the tenants, has been largely unchanged. The average building in the more recent period has been larger, requiring more expensive and higher performance elevators. The light levels have been higher. There is more interior space requiring lighting and cooling more of the time. More money has gone into high level lobby lighting and facade lighting.

But in all this, the quality of life for the people who work in the building has not been improved. There is greater monotony, less individualization and greater disconnection between the environment people work in and the factors creating or influencing that environment. The sense of identity, of personal



worth is diminished in the ambience provided. It is not surprising that there has been such a disillusionment among white collar workers.

New York City alone has built 67 million sq. ft. of offices in the last 20 years and projects an additional 68 million in the next ten. The two towers of the World Trade Center require as much electrical generating capacity, about 80,000 kilowatts, as the entire city of Schenectady, a city of 100,000.

Since somewhere over 15 times this square footage is projected for New York City in the next ten years, it is worth seeing how this energy is used. With the help of Peter Flack, my office studied a hypothetical million square foot building with a typical configuration and used typical factors to see what both the demands and consumption of electricity might be. If we assume that something other than electricity is used for heating and for air-conditioning, the division in electrical uses is roughly as follows: Lighting is about 54 percent, advertising, display and merchandise lighting about seven percent, elevators about eleven percent, fans and air-handling equipment about 10 percent, pumps and motors about five percent and miscellaneous uses including office machines about 13 percent. The light levels can be considerably reduced both by computing the light loads according to more realistic light levels and by allowing for more specific localized variations. More selective switching can result in a substantial savings in electric use. The perimeter lighting that takes care of the outer ten feet of the building could be switched separately in response to outside light levels. This in itself would save about 25 percent of the original light level. In addition, it would result in about a ten percent reduction in the air-conditioned load. All told, there could be a 50 percent reduction in this item of light use.

Ventilation according to some codes is based on three air changes an hour, a magical determination that nobody that I have asked so far has been able to justify for any physiological or performance reason. Conflicting codes, non-ventilated buildings with windows that are never opened and fan systems that may remain unused by

maintenance personnel suggest that this figure be looked at critically. If the outside wall of the building were not sealed, outside air at a temperature sufficiently close to the temperature required could be introduced, with neither heating or cooling, for about 500 of the 3,100 hours of annual building use.

While advertising is completely dispensable, it need not be if attitudes toward light levels in advertising and merchandising were revised. The present tendency is to depend entirely on maximum light impact rather than on how light is used and what the message of the light is. If mandatory ceilings were placed on light levels for advertising and merchandising, the nature and also the effectiveness of advertising would be significantly upgraded.

There are many special factors that can dramatically change actual energy use, such as the operating temperatures for both heating and cooling. Lockheed was reported by *The New York Times* (June 3, 1973) to have raised the temperature to be provided by air conditioning from 72 to 75 degrees with a resultant saving of \$100,000 million a year. That could buy 50 million kw-hr of electricity. Heat reclamation devices (heat recovery wheels, for example) can capture heat that would otherwise be dumped outside for winter ventilation, or the cooled air in summer. Higher performance skins, control against summer solar gains, more selective thermal and light controls, avoidance of such wasteful practices as terminal reheats, and more efficient equipment are among the available options.

The question of energy savings for elevators raises more complicated problems. Lower buildings not requiring vertical transportation have greater surface area with attendant increases in heating and cooling loads. These can more than offset the saving gained by eliminating elevators. Moreover, lower buildings cannot be as well served by mass transportation and may require the extensive use of private automobiles. On the other hand, the super high-rise buildings are more a product of high land values than of their own inner logic. To oversimplify the reason, in creating a 100-story building, you cannot simply place one 50-story build-

ing on top of another. The great bank of elevators that serve the top 50 must be brought down inside the bottom building and alongside its elevators. Similarly, all its services and pipe systems take up a large amount of expensive space, merely to get where they are needed. Whereas a 50-story building has a roof area (with its heat loss) of two percent of its floor area, a similar floor area in three-story buildings requires a roof area of 33 percent. The difference between a 50 and 100-story building, however, is only the difference between one percent and two percent.

A Look At Structure

There has been a great national effort to recycle cans, papers and bottles. Certainly the energy saved is appreciable. The total annual energy used in mak-

Observation

While there is a growing body of data relating to energy use within high-rise buildings, there is a dearth of information about the indirect energy demands resulting from them. Since overall energy efficiency will become an increasingly important component of urban planning decisions, some speculation is in order. At least until hard data have been collected.

Aside from the cultural advantages of cities — museums, schools, theaters, concerts, variety of choice, the tolerance of the non-typical—there are at least, up to certain density, also advantages of economics and energy use. Certain things that are done individually in rural areas, such as water supplies and sewage systems, or with extended branches for electrical distribution, roads and infrastructure installations are reduced as buildings are grouped and as density increases. Energy use per capita also can be reduced up to the point where the vascular systems become so crowded, and the available land where systems originate so remote, that each new building cluster, intensifying an already dense area, requires a complete reworking of all service systems.

For example, what is the true cost, both in economic and energy terms, for the projected increases in density for downtown New York? The environmental impact of more power generation has already made it dubious that generating facilities can be built within 35 miles of the load centers. Even a site 35 miles away, Indian Point on the Hudson River, has been held up because of unsatisfactory handling of waste heat. The proposed Storm King pumped storage facility, 15 miles further, has also been delayed by unresolved environmental prob-

lem, and soft drink containers is 34 percent of the nation's total energy expenditure. By way of comparison, the major metal that goes into the building industry consumes around one and a half percent.

There is no doubt that our structures contain more material than stability and safety require. Almost every structural component is manufactured in a uniform linear manner—steel beams, timber, lally columns, prestressed concrete beams, roof planking, steel decking. Yet all these are subject to varying stresses throughout their lengths. Concrete is crudely placed to eliminate the complexity of formwork and steel placement that responds to varying load. The underestimation of the structural contribution of materials that are incorporated into a structure for other than structural reasons could reduce ma-

terials, in addition to its basic inefficiency in converting primary energy into electricity. In order to meet projected electric needs, Con Edison is using newly installed gas turbines, originally intended as peaking units (that is, reserve units that operate only when there are peak requirements) but now used more and more frequently for base load. They have contracted to buy power from Quebec Hydro. They got past a recent hot day, June 11th, with only an eight percent power cut and local outages in Westchester County by calling on power companies from Maine to Washington. The cost of installing the networks and the premiums for purchased power ought certainly be attributed to the new construction instead of being prorated across the entire system. In addition, new power lines have to be installed from the generating stations through the clogged arteries of city streets to handle the new load.

At the same time, similar problems have to be faced and overcome for the water systems, the sewage systems, the solid waste disposal systems and of course the transportation and service delivery systems. The strains on all of these, and the disruption and reconstruction of streets and parks, suggest that we have already passed the point of diminishing return.

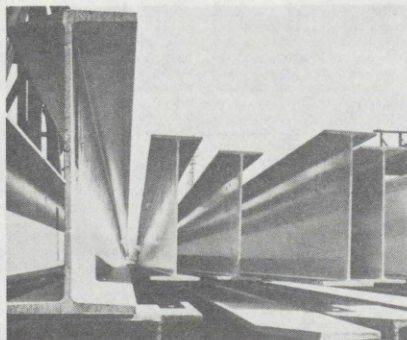
By breaking apart the organism at a certain density, it is possible to create more balanced systems, where the efficiency increases, resulting heat reclaimed from electric generation for heating and cooling, offsets the lesser efficiency of operating more smaller plants. Since one of the consequences of increasing density may be a major long-term commitment to significantly higher energy use, a study to correlate various densities and their energy requirements is urgently needed.

terials further—concrete fireproofing on steel, floor fills, continuous hung lintels, steel stairs, wood finish floors, lath and plaster membranes. The work of engineers like Dr. Jacob Feld, based on building failure studies, offers interesting grounds for reinvestigating computational methods. More rigorous structural analysis, eventually revised theory and codes, plus components responding in their cross-sections to varying structural demands, will immediately allow substantial energy savings.

The most characteristic piece of steel that goes into a building, the steel beam, is used inefficiently. A steel beam has a sophisticated cross-section. Even within the limitations of rolling mill practice, it works reasonably well. In practice, a specific beam is selected to satisfy the worst loading condition of a span, the maximum bending moment, for example. At all other points of the span it is excessive. The result is a vast overuse of steel. In contrast we can look to those structures where weight is a critical element or where the scale is great enough to warrant more structurally responsive forms. The boom of a mobile crane is one example, the structural ribs on a ship another, a bridge structure another and an airplane or high performance car another.

Open web steel joists suggest the kind of vocabulary that could result in material and energy savings.

An example: Safety factors tend to pyramid, becoming unnecessarily high. Let us consider a simple concrete beam computation as an example. In figuring the loading, liveloads (that is, loads other than the weight of the structure) are assumed to be simultaneously applied over all rooms, corridors, lobbies and stairs. A 750-sq.-ft. classroom for 30 pupils is computed to withstand a load of 40 pounds on every square foot, or a total of 30,000 pounds in addition to the weight of the structure. Thirty large children and a teacher might weigh 5,000 pounds. Thirty-one desks and chairs might add another 3,000 pounds. Adding another 1,500 pounds for friends, books, paraphernalia and miscellany would bring it to 9,500 pounds, less than one third of the figure used in the computation. In addition,

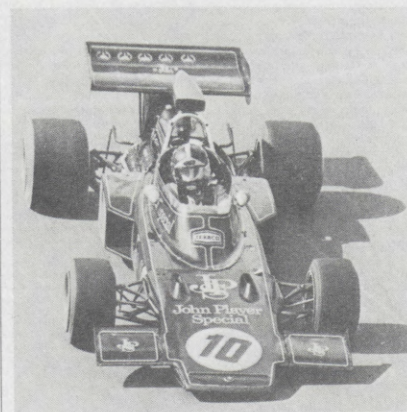


Steel structural sections.



World War II Supermarine Spitfire, a plywood monocoque plane (above).

Racing car—a John Player Special, (below).



the values given for the concrete have a 300 percent safety factor and for steel a 50 percent factor. Further, the structural designer will select available steel for reinforcement and overall dimensions for his beam cross-section at the first size above the size required by the computation, adding another five percent. In mixing concrete, the concrete plant will provide concrete above the design figure in order to avoid its rejection at the job, not infrequently 10 percent to 20 percent above the concrete value designed for. On top of this, concrete continues to gain strength for years after it has been assumed to reach full design strength. And as a final safety factor, no structural credit is taken either for such things as applied cement finishes or the capability of the structure to resist loads in a much more complicated and unified manner than is encompassed in the original calculation. A further overuse of material comes from the American economic pressure to reduce labor time even at the expense of more material.

It is quite obvious that reducing safety factors would permit concrete to be designed safely with less than half the material now used. Any structural engineer will confirm this under several provisos. First, that building codes be rewritten. Second, that there be enough in the budget to pay for the labor that is necessary to build formwork carefully, place steel carefully and to mix and place concrete carefully.

In addition to the saving in the individual members, there is a further cumulative saving since the weight of the building itself is substantially reduced. The size of the footings and foundations can be considerably reduced, with further savings in material, reflecting both the more realistic structural analysis and the reduced loadings that the foundations and footings are designed to support.

We have computed that in cement production alone this could result in energy savings of about 20 thousand million kwhr's a year. To make a comparison, a generous electricity usage budget per family is in the range of 5,000 kwhr per year. Thus, this savings alone would provide the electric power for four million families.

Wood, too, is used excessively.

For years every member has been designed as though it were disconnected from the rest of the structure. Where concrete is at least deemed to operate as a T-beam, a floor joist is assumed to be unaffected by the sub-floor and floor attached to it or the ceiling membrane below it. First steps are being taken by the plywood manufacturers to see that structural credit can be taken for the assembled structure. Although savings within part of the building's energy curve are small in comparison with the energy savings possible in the operation phase, they are of consequence in themselves.

Lighting

Lighting is also coming in for serious reinvestigation, and for good reasons. Lighting represents about a quarter of all electricity sold; that is, as noted in the *EEL Statistical Handbook* 1970, about 500 billion kWhrs. 15 years ago, recommended light levels were as much as two thirds lower than present recommendations of the Illuminating Engineering Society (IES) in some categories. 15 years ago, only about one third of present quantities of electricity were being generated. In the interior of buildings, air conditioning is a more frequent requirement than heating. Every two excessive watts of lighting requires one excessive watt of cooling.

While the IES professes a primary interest in the quality rather than the quantity of light, all the quality related tests—Visual Comfort Probability, Equivalent Sphere Illumination, Effective Foot Candles—tend to downgrade the effectiveness of the light computed to satisfy the IES' recommended minimal standards, making higher intensities inevitable if the entire methodology is embraced.

Spot analyses indicate that lighting can be reduced by large percentages. There is an advertisement of a lamp manufacturer in the IES magazine *Lighting Design and Application* (Nov. 1972, pp. 58-59). The heading reads, "Part of this lighting story is a lot of hot air." Across the top of the page is a picture of an office with a number of ceiling luminaires, people working below, a stretch of glass wall toward the right of the photo and a text that says, "Over

25,000 Sylvania Curvalume lamps light up the interior of S.S. Kresge Corporation's new headquarters in metropolitan Detroit. With two Curvalumes to a fixture, Kresge got the lighting they were after—and much more. The heat from the U-shaped lamps and ballasts is saved and recirculated into the building. It's a conservation of energy concept with Curvalume lamps at its heart. The bent lamps make it possible to use two by two foot fixtures that can be evenly spaced over the modular ceiling. This makes for even distribution of air as well as light. In Kresge's contemporary building, these long-lived fluorescents last even longer. They are never turned off, which lengthens their life. The constant circulation of air around them increases their efficiency. This handsome installation gives lighting levels of 100 footcandles or more in the general offices and the color of the lamps blends in beautifully with the interior decor."

Now let's see what they are really saying. If 25,000 40-watt lamps are in use 24 hours a day, there are one million watts in use for 8,760 hours a year; or in kilowatts, 8,760,000 kilowatt hours per year. If all the lamps are on from 8 a.m. to 6 p.m., that would mean there are 14 hours of unnecessary time for five days of the week. A million watts times 14 hours is 14,000 kilowatt hours per day times five days of the week, or 70,000 kilowatt hours. On the two days you do not need the lights on at all—that is 48 hours times one million watts, or 48,000 kilowatts. This means that there is an unnecessary expenditure of 118,000 kilowatt hours per week times 52 weeks a year which means that 6,136,000 kilowatt hours per year out of 8,760,000 kilowatt hours are unnecessary.

The waste, just in dollar terms, not to mention energy, at two cents per kilowatt hour, is \$122,720 per year. As described, instead of using the tubes 2,500 hours per year they are used 8,760. More than three times what they should be. The ad states, "They're never turned off which lengthens their life."

Let's see what this means. If the lamp is turned off once in ten hours, according to the IES Handbook, it will last 140/190 times as many hours as one

burning continuously; that is, 75 percent as many hours. If its lamp life is 10,000 hours (the figure given for medium loading) it would last four years if burned ten hours a day for five days a week. If it is on continuously with a life expectancy of 13,300 hours, the additional 25 percent lamp life, it will last about a year and a half. In other words, while the lamp lasts longer it has to be replaced almost three times as frequently.

It is interesting to see in the ad's photo that there are some 15 people at work in the section of the office covered in the photograph. The ceiling above them has 181 fixtures each with 80 watts without counting the power load for ballast, a total of 14,480 watts, or about a thousand watts per person. The lighting is distributed indiscriminately, or should we say uniformly, over banks of files, desks, corridors, storage spaces and aisles. There are 40 fixtures over a bank of files with one person filing.

Also there are floor to ceiling windows that would appear to throw a high level of light for a distance of three ceiling modules or about 15 feet from the window. Yet the lights there are continuously on. Obviously all this adds to the summertime heat load for air-conditioning as well as the power load that the lamps themselves consume.

Next, according to the text the basic light levels provided are above 100 footcandles. According to an article by Mr. Robert Dorsey, then President of The Illuminating Engineering Society, in the *AIA Journal* (June 1972), this is satisfactory for reading a fifth carbon, which requires ten times as much light as the original for equal visibility. And since lights are always left on, there is no provision for selective switching even if there were an attempt to cut down on energy use.

Let me recapitulate. If the lights were on for an average of ten hours a day, five days a week, this 8,760,000 kWhr load would be reduced to 2,624,000 kilowatts per year. If the maximum overhead level were 50 footcandles (which is higher than the 30 footcandles cited by Mr. Ringgold of IES as adequate for the reading of printed matter), if offices where interviews are carried over there would

20 footcandles (both generous since every typist using an electric typewriter has a connection nearby that could also permit portable light in the typist's area), then the above figure could be reduced by 60 percent. If we add a five percent factor for local lighting, the saving would be 55 percent, reducing the overall power requirements to 1,062,720 kilowatt hours.

Selective switching could turn off unused sections of the office. Conservatively, another 10 percent could be saved. The reduced requirement is now 956,450 kilowatt hours. This total obviously permits a significant reduction in air-conditioning requirements. The capacity of the plant can be substantially reduced and the operation will require many fewer kilowatt hours per year. Without considering the air-conditioning saving, however, there is a direct saving of about 7,800,000 kWhr's per year against the present expenditure of 8,760,000. This is enough to keep a village of 6,500 people supplied with a budget of 5,000 kWhr's per year for each family.

Since this was reported, there have been some changes. According to *Electrical World* (January 1, 1973), the lights are no longer kept on 24 hours a day, and there is some selective switching.

Existing lighting installations can be modified more easily than exterior walls, complex heating and cooling systems and ventilation systems.

A 50 percent reduction in electric usage for lighting would be a three percent reduction in nation-wide energy use. This is equivalent to the output of over 30 1,000-megawatt generating plants.

The question has been discussed in some detail for the past couple of years. The spokesmen for the Illuminating Engineering Society and their sponsored research arm, the Illuminating Engineering Research Institute, have insisted their findings have been misinterpreted and misapplied. Nevertheless, there is no literature coming out that shows how to design and provide controls for lighting that will significantly reduce electrical consumption. It is time to call on the industry to produce some illuminating components that perform quite differently from those that fill our new schools and buildings.

It is encouraging to learn that the American Institute of Architects has disaffiliated itself from the joint committee on school lighting with the IES, and will work toward a new approach to school lighting design with the Educational Facilities Laboratory.

The IES has such a long standing commitment to the light evaluation system based on the 1958 Blackwell Report that a fresh overall investigation of how to provide a satisfactory seeing environment for carrying on our daily activities at the lowest energy cost is almost impossible to expect.

The characteristics of the new lighting: A more efficient light source; a lighting component capable of being easily plugged in and removed as requirements change; one capable of delivering a number of levels of light; one easily controlled locally; one fitted with a light-sensitive device that will turn it off if the ambient light level is adequate; and one that will accept screening devices when necessary.

The lighting design standards will eliminate the shibboleth of more than three to one contrast. This is not only contrary to the activity of the eye in nature, but also counters the experience of people watching a drama or film where the task (the stage or screen) is brilliantly lit and the surrounding area is without light. The contrast between the light from the sky and the light in shadow areas under trees can be 20 to 1 (or more) without causing discomfort or loss of discrimination. In contrast, an unrelieved snowfield can be fatiguing, disorienting and can produce such physical symptoms as headaches and nausea.

The idea of lighting designed for specificity of delivery is certainly not new. Moreover it works effectively wherever it is installed. Examples are an operating room light, the light on a drafting table, the small lamp attached to a sewing machine, the built-in lamp in a study carrel, the individual lights over airplane seats, the light over a pool table, the illuminated instruments in an automobile. In commercial buildings there is no area that cannot accommodate an electric typewriter, a desk computer or an electric coffee maker, which means the area

can also accommodate local lighting, either attached to the equipment or free-standing to serve it.

The remote-control device for changing television channels suggests a type of control by which a person could selectively turn lighting on and off, or change its intensity.

In a universal ceiling grid, fixtures could be plugged in or removed to change the light delivery system for different programmatic requirements. The animated movable electric signs in Times Square hint at the variety of levels and points of illumination we could have in a space.

Since there is so much to be gained nationally by reducing unnecessary electric use, the reduction of unnecessary lighting, as well as other technological possibilities, should be immediately investigated (low voltage switching systems, for one).

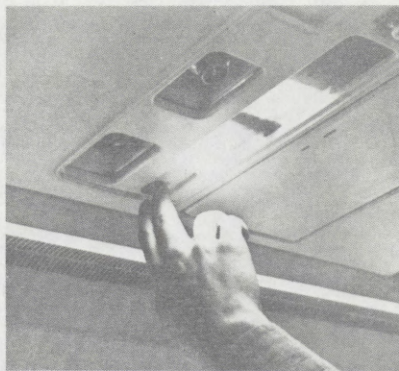
The great benefit of the modified approach to lighting design—differentiated spaces, contrast and lowered ambient levels—is the improved architectural quality. The building begins to respect and respond to changing human needs, and to variations of climate and weather.

Two recent findings may have



Versailles chandelier.

some bearing on performance requirements. First, the report on job dissatisfaction among assembly line and production workers. This stated that despite "efficient" work conditions, psychological factors caused reductions in productivity which could be offset by less routine work assignments and less undifferentiated environments. In place of assembly lines, experi-



Airplane reading light.



Globes—New York University housing (I.M. Pei).

ments with assembly teams, putting together SAABs and Volvos in Sweden, resulted in dramatic reductions in absenteeism and defective workmanship. Second, it was reported by a CBC radio interviewer that a Canadian school found that reducing light levels in a new school noticeably reduced psychosomatic headaches and fatigue.

In looking critically at energy

use, the amount of energy used for advertising purposes is generally lost in the commercial category reporting. Aside from giving information—the name of a hotel, the number of a building, similar messages, most merchandising lighting is either excessive or superfluous. During the war years of 1942 to 1945, the extreme situation of no advertising lighting pertained.

While it was by no means a relaxed and joyful setting (one of the environmental tunes of the day was "When the Lights Go On Again All Over the World," as an equation of lights and peace) it did demonstrate that we could indeed survive without advertising lighting.

The ironic part about advertising is that a high light level, if it is used to overwhelm the message of its neighbors, is only effective if it is the highest light level around. As soon as a new high is established, the tendency is for others to seek a still higher level. This is kilowatt one-upmanship.

The light level intensities can mount from 100 to 200 to 300 to 400 (and higher) footcandles, and do so very rapidly. Each advance cancels out the merchandising advantage of the one before it. The only way to avoid such an escalation is by having a limit on intensity that is either voluntary, or enforced. When this is done, ingenuity will replace sheer brute brightness.

The wonderful effect of tiny lights strung in trees was demonstrated in New York last Christmas as an increasingly popular technique for decorative lighting. Blocks along Park Avenue and the Avenue of the Americas were given a magical scintillating quality. All told, about one half watt was used per square foot. By contrast, the business streets in Las Vegas have so much wattage that the various messages are virtually cancelled out in the glare.

Lighting in residences has remained closer to light levels people enjoy, especially since there is no one goading them to increase levels for sake of performance. As a result, home lighting was considered under-saturated; that is, it had the potential for being appreciably increased and, energy shortage or not, there are promoters in the electrical industry who want to push up the amount of electricity for home lighting.

In an account of Edison Electric Institute's 1971 Annual Marketing Conference, *Air-Conditioning, Heating and Refrigeration News*, a trade weekly, ran a report about Edwin Vennard, former managing director of the Institute, commenting on residential lighting: "Lighting always stands out as one of our

best builders of percent return." Mr. Vennard mentioned that the electric industry had failed to sell higher lighting levels at the residential level where, he continued, "We give them about 20 foot-candles." By raising the average wattage of all electric bulbs used in houses just 30 watts, there would be more net income for utilities "than in all existing house heating. I'm not saying neglect house heating, but why not have both?"

It is ironic that if we attempt to describe the most pleasantly lighted spaces we can think of, our thoughts turn to certain residences. Softly lighted restaurants, theater lobbies and other spaces whose performance requirements have escaped the foot candle escalation process. Judging from the above quotation the watt salesmen are zeroing in on these.

Electric Heating

In considering Mr. Vennard's last sentence we come to another emotionally charged subject, electric heating. It would be wonderful to find that it really uses less energy than all those other crude, primitive and expensive systems. It is obvious that costs of installation are generally less than for hydronic fossil fueled systems. No boiler rooms are necessary, no chimneys; instead of conveying heat as a liquid or a gas in pipes, it is transmitted through copper wires that can turn corners more readily and don't require pitches for drainage. Controls operate an on-and-off switch instead of a valve or pump.

Unfortunately the basic production of electricity is so inefficient in converting heat to electricity (which can be converted back to heat) that the advantages of electric heating are offset by the cost of operating it.

In the years 1963-70, it is possible to see the result of the promotion of electric heating on the residential use of electricity. For a decade residential use represented about 30 percent of the total sale of electricity. On a per capita basis, the average increased at the same rate as the general increase in electric usage. That is, it doubled while the population increased by 15 percent. In 1957 there were 167,758,000 people, using 161 trillion kwhr for residential use.

In 1967 197,374,000 people using 332 trillion kwhr. Each average family used 3,660 kwhr per year in 1957 compared with 6,420 kwhr in 1967. Suddenly, in 1968 there was a sharp increase in the amount of electricity used in residences, beyond the general rate of increase for electricity. Residential use of electricity within two years jumped to 32 percent of all electricity sold.

If this merely represented a shift from one source of energy to another with no other consequences, it would be interesting as a technological shift. It has more serious results however and complicates the problem it purports to solve.

It may be worth repeating that electric heating is basically wasteful of primary energy, largely due to the three to one inefficiency in converting primary fuel to electricity. The 11,000 (plus or minus) Btu's required to generate a kwhr have a heating value of 3,413 Btu's at 100 percent efficiency in the re-conversion process. If primary fuel (oil or natural gas) is burned directly, even if it is burned at only 60 percent efficiency, it will use only half as much fuel as the needed heat supplied by electricity.

The different fuels are interchangeable and interdependent. In the New York City area, for example, gas turbine peaking units are providing some of the base load. These units, basically jet engines, operate on kerosene or No. 2 oil. As they convert it into electricity, used for heating, they contribute to the shortage of fuel oil for heating.

According to New York City officials, one quarter of Con Edison's generation is now in gas turbine units, over 2,000 megawatts worth. Originally planned as peaking units, they now are part of the base load supply. They use No. 2 fuel oil, the oil used in home heating furnaces and boilers. The shortage is being worsened since electricity for home heating drains off twice the No. 2 oil from the market that would be required for direct combustion at the houses.

Similarly, where natural gas is available, it is used to generate electricity which, in turn is being used for heating that could be done more economically from a fuel use point of view by using the gas directly.

A rationale of the utilities for using electric heat is that it is required at a time when operations are below their peaks which occur, excepting a few northerly areas, during the summer air conditioning period. There are two flaws in this. First, we are faced with shortages in all primary fuels—oil, gas, fissionable material and available low-sulphur coal. Predictions for the exhaustion of these resources suggest that they had better be used carefully until alternative power sources have been developed and made available in sufficient volume to replace the present generating and petroleum refining capacities. The absolute reduction in primary fuel use becomes more important than the more profitable use of generating facilities on a year round basis. The result of burning less fuel (and still providing the same basic performance standards) is also the reduction in pollution. The second point, however, is that the promotion of electric heat does not affect only the winter loading. The all-electric home is given more favorable rates year round than the non all-electric home. For over 360 kwhrs per month, the service classification for electric heating lists only 60 percent of the non-heating customer's cost during the eight heating months and only 75 percent of the non-heating customer's cost in the remaining four months. As a result the favorable rate structure makes electricity attractive for cooking, clothes drying, and hot water heating in addition to the space heating. It also encourages the use of more air conditioning. These additional electric uses tend to drive the summer peak still higher, resulting in still more winter time capacity to be exploited for electric heating.

If the controls and delivery of fossil fuel systems were as effective as those in electric systems, there would be no basis for discussion. The difference would be three and a half to one in favor of the fossil fuel. As the result of the losses in combustion and delivery, and of less specifically responsive controls, the edge drops down to about two to one. Even with boiler inefficiencies and chimney stack losses, direct use of fossil fuel is generally twice as efficient as electric heat, and does

not cut into generating capacity.

The only promising use of electricity for heating under present methods is the heat pump. In the past this has been so beset with poor performance equipment that it has not been actively pursued.

The impact of additional electric heating on overburdened generating capacity can be appreciated by looking at actual quantities. In New York State, depending on location, between 10 percent and 50 percent of new homes have electric heat. In other areas of the country, that figure is higher. According to figures from Pennsylvania Power and Light, the average all-electric house in 1971 used 28,000 kWhrs, while the non-electric one used 5,600. That leaves an average of 22,500 kWhrs for heating. Applying this figure to the one percent of New York State's 5,300,000 residential customers, who now use electric heat, it turns out that 1,200,000 megawatt hours went into electric heat last year in this state—the total output of a 240 MW plant such as Indian Point 1. The amount of fuel which went into generating power to heat these residences could have heated about two and a half times the number of residences directly, given the same standards of construction.

In 1970, with a seven and a half percent saturation of the residential market, electric home heating used about 66,000 million kWhrs of electricity. This represents almost four percent of all electrical energy produced and sold. In other words, if the ratio of capacity to consumption of the Con Edison generators is used, a total of about 16 million kWhrs capacity is required—the equivalent of twice the total capacity of all of Con Edison's generators.

According to "Electric World", the preference for electric heating has increased from 22 percent to 36 percent during the last six years. The electrical industry projects that the number of electrically heated residential units will be 19 million by 1980 and 25 million by 1985.

The annual electric consumption, if this prediction came true (assuming established 22,500 kWhrs per unit per year), would be 562.5 billion kWhrs. In primary energy, this would require about 6.5 billion (10^{13}) Btu's, and would be the equivalent of

a 50 percent importation of petroleum in 1985. This is obviously a matter to be decided on something other than first construction cost.

In addition, there has been a successful campaign on the part of the utility companies to increase substantially the amount of electrical heating in office buildings and other commercial installations. In 1969, of all new non-residential construction, 23 percent was electrically heated, a total of almost 40,000 buildings of which 5,400 were new office buildings.

A governmental policy, expressed in codes and power use regulations, is necessary to stop this tendency, one that permits electric heat only in installations where fuel deliveries cannot be made or where the presence of an open flame in an unattended building would be either unsafe or undependable.

The Mechanical Plan

In analyzing building demands on energy systems the most common practice has been to analyze each energy consuming activity and find ways to lessen the demands of the building and improve the performance of the equipment. The equipment analysis has been especially fruitful since it can be isolated and examined. While this approach tends to perpetuate some of the attitudes that produce the crisis of direction our buildings now face, the improved knowledge of system performance is most useful.

The crisis referred to is the fragmentation of building decisions—the consideration of mechanical systems as something separate from the basic building design. In reestablishing a unified approach to building design, it is obviously essential to incorporate all that has been learned about improving the plant. Without attempting to re-record all the things that have been listed in some excellent recent articles, it may be worth looking at a few that deal with principles.

The underlying idea of total energy is so fundamental, so sound, that it is incredible to think of it as a new concept. The idea of the interrelationship between various energy uses only needs the next expansion. The inclusion of the natural (non-mechanical) energy ex-

changes begin to be a true total energy system. Certain misunderstandings about terminology bear correction.

The American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRA) describes Total Energy as follows: "Total energy is a term designating on-site electrical generating systems arranged for the maximum utilization of input fuel energy by salvaging by-product or waste heat from the generating process."

When described as a steam turbine electrical generating system, one using some of the lower temperature steam for such processes as heating or steam cooling, the overall thermal efficiency of the system is improved, although the direct production of electricity from the steam may be somewhat diminished. In order for such a system to maintain the theoretical efficiency it can achieve, there must be an economical use for all the low temperature steam at the time the electrical generation is required. There are systems that also incorporate waste heat from refrigerators, lighting fixtures, vented heat from cooking equipment, the heat from burning wastes, and other heat that would otherwise be considered waste.

One principle that affects mechanical equipment has to do with the efficient performance of the equipment itself. While it seems embarrassingly obvious to say it, there are hundreds of thousands of boiler installations in large structures that have been designed with such safety factors that they never operate at maximum capacity. Modular boilers, which accommodate only a part of the total maximum load, can operate closer to design capacity more of the time, with savings of 20 percent and more in fuel consumption. The idea of using modular boilers merits wider investigation.

There is a large overuse of energy resulting from an under-use of selective controls. One of the disadvantages of central systems is the inability to respond to local variations. Many air conditioning systems that are quite efficient in operating central equipment lose that efficiency because the system blows a pre-determined amount of cooled air into all spaces, regardless of whether they are in, whether there is heat-producing equip-

ment and whether the sun is striking that part of the building.

With their inefficiency as generators, individual through-the-wall-units are sometimes more efficient on an overall basis because they can be turned on and off selectively. A trade-off situation exists that merits study of improved local controls for central systems.

The problem of inadequate cooling controls can be exacerbated by providing controls that do not reduce the amount of cooling when it is not required but instead add heat to warm up the too-cool spaces. These systems, called terminal reheat systems, make the comfort controls a little easier, but are wildly extravagant in energy use. The introduction of only the necessary amount of cooling (a logical enough idea) has only recently received the attention of mechanical engineers. It has been described as a variable volume system and, not surprisingly, has been found to be considerably less energy-expensive to operate.

In the past, and in the present as well, refinements have been ignored since they tend to increase first costs. Construction costs in themselves are so important to clients, whether public or private, that long range savings are given up in order to keep visible first costs as low as possible. The concept of life cycle costing can demonstrate the basis for both eventual dollar savings, and lessened energy use—a concept we'll discuss a little farther on.

The efficiency of units is under considerable investigation at the moment and, contrary to general experience in most fields, not only is there no advantage in oversized individual units, there is actually a collective disadvantage. Over-sized air-conditioning units tend to satisfy the cooling requirements more rapidly than those designed very close to proper capacity for their job. As a result they tend to cycle much more frequently. When you have a situation, as you do in New York, where almost a quarter of a million new units are purchased annually, the additional draw that this more frequent cycling requires becomes a significant additional user of electricity. Further, the difference in the delivery of cooling per kilowatt of energy going into the

units themselves varies by almost two to one from unit to unit. Since this information is not generally known to purchasers of equipment, and since first costs often take precedence over the actual operation and maintenance costs, there is a tendency to purchase less efficient air-conditioning units that consume, over the long run, considerably more electricity than they need. New York City has led in making this information available to purchasers.

The Mythology of Ventilation

Progressively more complex systems are still being installed in buildings because, at one point, there was a popular concern for some health or safety requirement which assumed a life of its own after its incorporation in regulations. Ventilation standards come into this category.

Ventilation, a large energy consumer in sealed buildings—on the order of ten percent of all energy used in the building—is generally determined by completely unsubstantiated standards such as air changes per hour or air changes per occupant, with great variants from code to code and according to described space use. Probably only NASA or the submarine service have gone into true physiological studies of air needs. Yet these are not applied to building problems. Moreover, no consideration is given to the quality of the outside air that is introduced into the interior—conditions that vary from satisfactory to unsatisfactory in atmospheric classification.

An old building with theoretically operable windows needs no supplementary air system unless it has interior toilet rooms. Even with windows painted shut, the air moving through the buildings comes in by infiltration through cracks, doors to the outside, or air intakes for combustion, and is distributed through the building by the stack action in stairwells and elevator shafts. The building itself has a certain respiration rate. The great problem in designing sealed buildings is to frustrate that natural respiration rate by better caulking, tighter seals and so forth and then instead of having the air permeating the face of the building it is introduced at one place near the mechanical room,



Cluster development plan, Alberobello, Italy.

pushed through the building with fans, distributed through a whole network of ducts and brought to the same place that it wanted to be in the first place. All this requires extensive mechanical intervention. A more controlled and reasoned version of this might sharply reduce the electric energy use that is represented by ventilation equipment.

Aside from the direct energy required to operate fans, motorized dampers and other ventilating equipment, there is a major energy loss in dumping heated or cooled air outside of a building and then heating or cooling the replacement air. Ironically no one evaluates the quality of the outside air that will be brought in. Furthermore when there is the possibility of introducing outside air through windows or louvers on exterior walls, the internal ventilating systems can be eliminated or reduced. The choice then rests with the occupants of the space either to introduce outside air or not. Since this item represents ten percent of the electrical usage in a high-rise commercial building, or five percent of the total energy consumption, a 50 percent saving would contribute significantly to its reduced energy consumption.

First-cost Mentality

The overuse of energy is made inevitable and is exaggerated by first-cost economics, overstated performance standards and fear of liability. These have com-

bined to distort the planning process.

In referring to buildings, magazines, clients and architects always cite construction costs—so many dollars, so much per square foot, so many dollars per pupil or classroom. There is never a reference to the cost of energy per square foot or Btu's per square foot or kw/hr's per pupil. In reality, many buildings spend a dollar and more per square foot per year for energy costs. As a rule of thumb a reduction in actual carrying costs can offset ten times that amount in original costs. For example, if the building mentioned above were to reduce operating costs for energy by twenty-five cents per square foot, it would permit an additional \$2.50 per square foot in construction costs. And, in the continuing escalation we face, operating costs increase from year to year while paying for construction remains constant from the year of financing.

Part of the problem stems from the method of financing selling and renting. Municipal and governmental agencies separate capital budgets from operating budgets. Capital expenditures are generally paid for by bonds, while operating revenues come from annual tax funds. As a result, the interconnection between the two is usually lost or ignored.

An approach that begins to bridge the gap has been developed. Bids for heating systems are in two parts, one for

installation, the other a guaranteed bid for the maintenance and fuel costs for a five-year period. The job is let on the basis of both.

Life cycle costing, the projection technique that considers costs through the life of the building can often demonstrate the speed with which a well-designed, well-insulated building can ultimately save money through higher performance.

A study by John Moyers at Oak Ridge National Laboratory made some comparisons between residences with minimum insulation and those with full wall and ceiling insulation, and with storm sash. An annual cost was developed for the interest and amortization on the cost of the insulation and double glazing. This was offset against the annual energy saving. With electric heating, the upgraded building paid for itself in less than four years. With gas heating the differential was not as great. In the two years since the study, however, the cost increases for natural gas and the projected fuel increases reflecting higher well head prices and the considerably greater cost of liquefied natural gas brought in by tankers and stored, sharply change the economics to make added insulation even more desirable. The original study was made before the FHA upgraded the insulation requirements in its new minimum property standards.

The life cycle cost problem is not easy to overcome. Many

school building referendums have been defeated when the buildings appeared to be more than minimal. Even where the economics can be demonstrated to be favorable, there is an immediate tendency to think only of the lowered first cost. A merchant builder in Minneapolis, talking to an energy conference, stated categorically that he would be unable to build and rent office space competitively if he added first costs that exceeded those of other builders and that he would lose the opportunity to build on prearranged contracts if his unit costs were higher than those of his competitors.

Our tax structure also favors the separate consideration of building and maintenance. Corporate capital improvements are conspicuously isolated. Operation, including energy usage, is buried among a large number of unrelated expense items. The interrelationship is often lost.

The sale of speculative houses, and rentals with tenant-supplied services both encourage lowest first cost, regardless of the ultimate extravagance in maintenance. For example, a recent ad in *The New York Times* offered apartments in a condominium in New Jersey. The text: "This 2-bedroom, 2-bath apartment home costs \$373.44*/month. . . ." (The asterisk is in the ad.) The footnote: "Based on 7½ percent 30-year mortgage following 20 percent down payment. . . includes estimated real estate taxes, estimated common expense. Estimated cost of electric heating and cooling not included. . . ." (My emphasis.)

The statistics of energy saving are easier to establish mathematically than to verify in actual practice. After careful determination by computer simulations that different methods of supplying services vary by a precise percentage, we learn of gross variations that must be attributed to the personal factor. A study is being undertaken in Princeton, New Jersey by Professors Socolow and Grot to measure actual consumption of energy in a new community of 1500 dwelling units in Twin Rivers, New Jersey. Their preliminary findings show a variation of two times the energy use in identical units. A similar study of two identical schools in Michigan showed the same

variation. The implication of this is that human nature and habit may be another really critical factor in energy consumption. The variations in statistics, however, are averaged in use. Cumulatively, if they were implemented, they would extend the time available to develop alternative energy sources and remove the immediate necessity for expanding energy production, allowing decisions without the hysteria of near-crisis breakdowns. Rediscovering the real world of seasonal changes and sunshine would be an added bonus.

THE ARCHITECT'S POSITION

Buildings reflect architectural decisions as incorporated in working drawings, bid documents and field instructions. These decisions determine configuration, materials and the basic energy use patterns required to operate buildings through their lives, as well as the additional materials required to maintain or modify them for new uses.

These decisions are not made unilaterally by the architect. They are modified—sometimes even predetermined—by a variety of participants: The client, the lending or financing agency, public opinion, current stylishness, available materials, and economic priorities. Regardless of where the credit or blame lies, the end product, the buildings, are responsible for about a third of all energy use in the United States, a good part of which is used unnecessarily. There is no part of building or operational procedure which is as efficient as it could be in its use of energy.

Even assuming that all the projections, assumptions and statistical bases are excessively pessimistic, the underlying message requires some decisive shifts in our customary design philosophy. The decisions made by architects and engineers can reduce energy expenditures in our buildings by at least 50 percent with no penalty to the quality of life in our buildings—possibly even enhancing them. By taking a fresh look at our stock of existing buildings we can reduce their energy expenditures up to 25 percent on the average.

All this brings us back to the point that fundamental changes in attitude will be required of all of us.

As an architect, I find the whole concept completely consistent with what I had been educated to believe and have since held firmly. The nature of the generative process of architecture is that every component, everything we deal with, everything we use in architecture must be used precisely, intelligently, effectively and economically to do the tasks that are required of it. For the last couple of decades I have been disturbed at what I consider to be an unfortunate tangent that has developed. Buildings of really poor performance have been built, buildings have been built unnecessarily, various configuration complications and protuberances on buildings have been justified as creating visual interest. One result has been the demeaning of the role of architecture.

The reinvestigation of energy use in buildings is part of investigating how buildings use all materials.

The architectural mission can no longer be looked at as one that thoughtlessly fills every maximum desire, nor can it be considered as purely responsive to the economic pressures that lead to building for profit. It must be looked at as an activity that consumes energy and material, a consumption that further reduces the irreplaceable reservoir of resources.

This suggests the problems we face and the decisions required. My own feeling is that there are going to be increasing restraints on energy commitments and sharp changes in the ways buildings are planned. Obviously, the simplest way to avoid unnecessary energy use in buildings is not to build. In many cases that is probably a good answer. If there are buildings that are not necessary and if, on the other hand, there are unfilled needs, it may require establishing building priorities, what materials are available for buildings in comparison with other products, which things are done and which things are not.

The architect's adjustment of attention to solving building problems, with intense concern for the use of materials and the impact of environment, is in the long tradition of the profession.

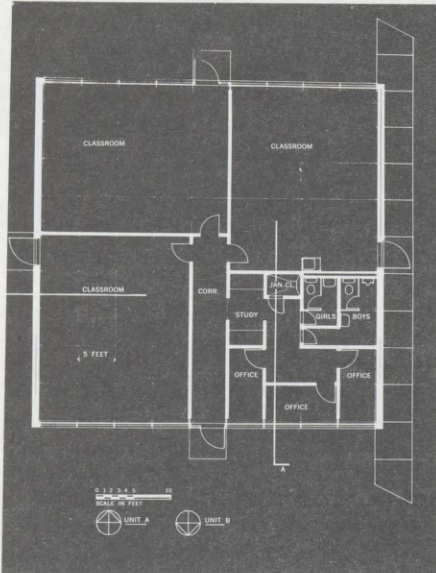
Architecture has evolved from the response to programmatic and environmental constraints expressed within available technological means.

An area that is often discussed between architects and environmentalists concerns what and how to build, how or whether to reshape the natural environment for man's uses. Essentially this is the whole course of civilization, from the time the first trees were felled, the first cave cleared and the first stream diverted. The landings and orchards along New York's Hudson River, the piers and clusters of houses along its banks, and the fine old mansions with their panoramic views, all bear testimony to the skillful reshaping of the terrain for human use in the past.

Where building forms were once produced with abundant, cheap labor, somewhat costly materials and very costly machinery, the situation has shifted to the point where everything is costly, but especially field labor, resulting in changes in prevailing design criteria.

Now, rapidly rising energy costs alone point to a reversal of the trend. Based simply on the anticipated cost of maintaining the building, it is in the best interest of the client as well as in the best interest of the public for us to redefine our criteria, becoming more specific and more exacting in the performance we require from our buildings themselves.

One area worth considerable additional study is the reinvestigation of building components in order to redefine their functions. For example, if the building wall is considered as an energy transmitting mechanism, then it will be designed very differently from the way it is now. A recent publication showed the study that went into the design of the curtain wall for the World Trade Center in New York. Aside from the fact that nine million pounds of aluminum (a high energy metal) went into this wall, the major functional job given to the wall was to blunt and turn back the winds, the penetrating vapors and the other atmospheric intrusions of the world outside, so that a completely controlled interior environment could be achieved by air conditioning and heating. Actually, if the performance were redefined to per-



Oakwood School floor plan.

mit outside air and ventilation to be introduced in the quantities required, and to allow the air temperatures outside to be taken advantage of when they were within the temperature range that was being provided by the mechanical systems, a very different sort of skin would have resulted. It is quite probable under those circumstances, without any change in the size of the building, that a significant percentage of electrical generation could have been eliminated instead of ended up with enough to supply Schenectady.

This sort of design direction suggests a parallel attitude in designing mechanical systems. The relationship and work arrangements between architect and engineer are one key to the success of this effort. Their various decisions are interdependent and must be generally clarified before the building design is committed.

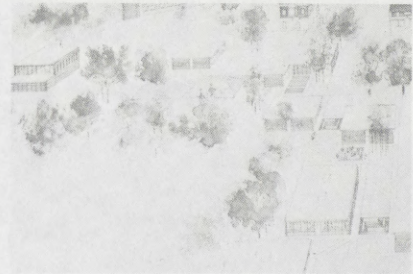
The schematic phase becomes critical in regard to eventual energy consumption. It no longer suffices to think of it merely as the general arrangement of spaces to satisfy an owner's

requirements. The engineer must be involved more fundamentally at this earliest stage so he is not presented with a pre-fixed condition which reduces his job to somehow making it work mechanically. While such a relationship has always been desirable, it has not often been adhered to.

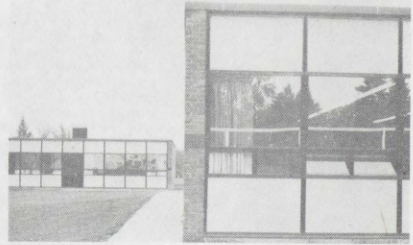
More exact mechanical systems would necessitate such additions as a responsive control system—something generally desirable but often eliminated because of visible initial cost.

The matter of visible initial cost merits more comment because, interestingly enough, if savings (often invisible) are taken into account, many higher performance requirements can be provided with no penalty to first costs. In fact, there may be savings.

For example, we recently designed some small classroom buildings for the Oakwood School, a Quaker school north of New York City. We had designed a master plan permitting them to add incremental units of about 2,500 sq. ft. each, self-contained buildings that could



Master plan, Oakwood School, Poughkeepsie, N. Y.



New buildings viewed from the south.

be built as money became available and would fit into the overall mosaic.

The plan concept was extremely simple. The structure was supported on masonry bearing walls. The non-bearing walls admitted light and air, through a curtain wall assembly. The program required air conditioning for year round use. The least expensive curtain wall placed a heavier dependence on the air conditioning and heating system and required a base heating element at the curtain wall. A higher performance curtain wall, also permitting natural ventilation, was designed with double-glazing in neoprene gaskets, well-insulated infill panels, and selective ventilation in heavy weather-stripped steel sash; heat reducing glass was used on the south. The openings were oriented north and south to avoid uncomfortable east and west heat gain.

These decisions eliminated the supplementary heating at the exterior walls and reduced the size of the heating and cooling plant for each unit. This constituted an overall savings in

first cost, in operating cost, as well as a higher performance.

However, the increased cost in the exterior wall construction was visible. The savings in mechanical plant and operating costs were not. In many instances the decision is made on the basis of removing visible expenditures even though it results in greater expense elsewhere in the construction budget.

Along with redefining the function of building parts goes a reevaluation of physical requirements. Optimum and variable lighting levels, as previously discussed, are one area of concern. Optimum and variable heating levels are another.

In schools, for example, most heating levels are set to satisfy the teacher's requirements rather than the children's. Unfortunately there are metabolic changes that cause us to expect somewhat higher temperatures as we grow older. I know the suggestion may be controversial, but might it not be sensible for teachers to dress more warmly?

Where the class pattern is one of activity and movement, a lower temperature of several de-

grees may be required, compared to a class activity that is basically sedentary. Moreover, the heat contribution of active children and the time lapse and temperature overrides of most systems indicate that our provision of temperature conditions in class rooms is startlingly crude and wasteful.

In all types of buildings, we generally seem to have a capacity as a nation for overheating in winter and overcooling in summer to the point that it is now more comfortable to wear summer clothes in winter and heavy

clothes in summer.

In redetermining our physical requirements, we will again realize that we live in an environment in which natural elements can be exploited.

Such a strong reliance on mechanical systems has developed that performance possibilities of the building itself have been downgraded. Air conditioning has been made mandatory 12 months a year even in climates where outside temperatures are delightful most of the time. While we profess interest in visual continuity between in-

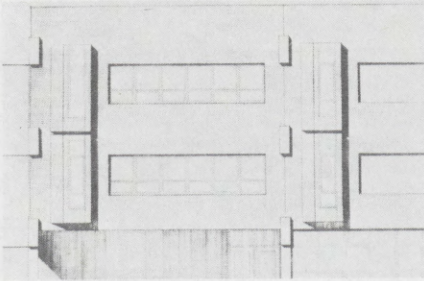
doors and out, we eliminate glass in some areas, overuse it in others, set up intolerable heat gain and glare conditions, and often cut out light switches in naturally lit sections. In other words, one often can't take advantage of natural elements even when they are so readily there.

An elementary school we designed for New York City in Staten Island has a fenestration system designed to provide a usable strip of natural light adjacent to the exterior wall. The lighting fixtures above this strip are separately switched. In order to have light without glare, a light scoop is provided at the front of each classroom throwing light on the chalkboard well into the room. The light scoop is baffled to eliminate the point of sky glare that sometimes negates the effect of natural light. The sash permits controlled ventilation through

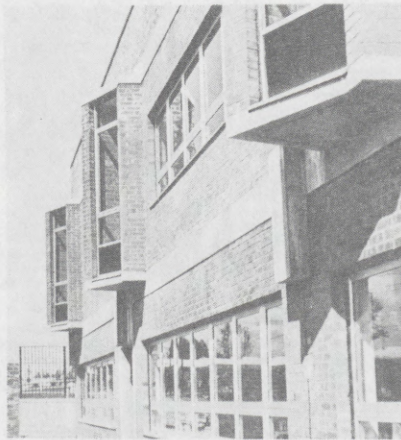
hoppers and projected sash.

There are two basically different approaches being followed to achieve energy savings in buildings. One is stabilizing the inside environment by a tight skin with minimal thermal transfer and with the minimum surface area to contain the required volume. By refining mechanical performance and taking advantage of the interdependency of various systems, it is assumed that the greatest efficiency will be achieved.

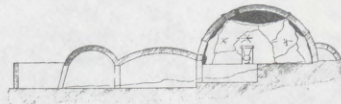
The second approach assumes that the outside environment is not hostile, certainly not at all times. It contains many features that can be understood and exploited—admitted when they contribute to the inside comfort and performance quality, excluded when they are undesirable. Among these are solar heat, cooling outside air, natural light, wind energy, water. By positioning and dimension-



P.S. 55 Staten Island.



P.S. 55 south facade.



The Eskimo Snow house, built in the unfriendly climate of Hudson Bay, provides comfort with a minimal input of energy. Very little outside air is introduced—only enough to support a small fire. It comes in through the triple set of portals, each about three feet high and protected with double hangings of skins. The main room under the larger dome has a complete hung lining of sewn skins to retain heat and keep snow from melting. The heated air to be replaced by fresh air for the fire is exhausted by gravity through a small hole cut into the wall near the top. Aside from body heat, there is heat from a small fire of burning blubber in a soapstone container. A wick of reindeer moss burns with a low, horizontal flame. In addition to providing heat, the flame provides light, serves for cooking and dries wet mittens and clothing. It is just hot enough to melt a little more blubber to keep the wick saturated. Clear ice is set into the dome over the entrance to let in light. In its simplest form, it is built of available material (snow) in about two hours, by two men.

ing buildings to take full advantage of these impacting forces, a major part of the energy requirements can be taken care of without mechanical intervention. The mechanical systems will be installed to provide the difference that cannot be provided non-mechanically.

The question is not academic. It determines the shape of our cities and variations from region to region. It will affect what components are developed and what wall assemblies we can work with.

In addition to reducing energy consumption through developing more precise building requirements and function, we can reduce the demand for energy for space conditioning further by taking advantage of the environment. The basic principles involved can be seen in practice everywhere man has had to live without the benefit of cheap and readily available power. In these places human ingenuity has been brought to bear on ways of using the materials at hand in order to take advantage of the benefits of sun, shade and wind, while being shielded from their negative aspects.

We are better advised to observe those countries which have technologies and life styles akin to ours but which have not been able to consume energy with our prodigality.

In all the Mediterranean countries building walls are surfaced in white or light colors to reflect heat. Grillwork and shutters allow air to flow freely while providing shade and privacy. The mass of the heavy masonry construction achieves a delicate balance with the daily heat flow. It continues to pick up heat during the day, but the heat

just begins to penetrate into the space at nightfall. It continues to lose heat to the inside space during the cool night and is then ready to begin its diurnal cycle again.

In the northern European countries the same principles apply. In Switzerland, for example, there is wide use of rolladen, an exterior shading device which combines the function of the awning, the window shade and the venetian blind.

The possible variations in admission of light and air with these shades lower the air conditioning demand or obviate it.

The same sort of approach is seen in this country where energy costs are high or where we have been conditioned to believe that the particular environment is beneficial and one which we ought to experience directly. Somewhere we have lost track of the notion that it would be best to do things simply.

House on Martha's Vineyard

When we designed this house in 1965, energy conservation was not a goal per se. However, adhering to an architecture attuned to its environment and to the essentials of program, the building takes advantage of the natural phenomena of sun and wind for part of its heating and all of its ventilation. (Intended basically for summer, it has been used in early spring and into late fall.)

- The system of sliding doors and shutters permits maximum flexibility in admitting or excluding both sun and breezes.
- The open porch in the center makes it possible to open either end of the house to the outside on all four sides.

Observation

Around New York City, in the 3,000 out of some 8,000 hours a building is occupied during the year, about 500 hours of outside temperatures are suitable for introduction into a building. At these times it ought to be done so you don't disregard the lovely weather outside while manufacturing similar lovely weather inside.

Of course, the less a country or culture is able to depend on mechanical solutions, the more specific its architecture is in dealing with its particular environmental problems. While the specific problems will be somewhat different from ours, the approach remains the same; basically, that of stabilizing interior temperatures and controlling air flow.

In Ethiopia, for example, a typical method of construction is packed mud walls on a lattice-like framework of eucalyptus branches. The roof is thatch. Although there are doors and windows built into the walls, additional ventilation is provided by leaving off the mud in some places. Here, where a hot dry season alternates with a torrential rainy one, and where the wind direction is predictable, it is possible to find houses with only one solid wall. All that is needed is a rain shield.

We can learn from this. There is nothing that says that the south wall and the north wall have to be identical any more than there is anything that says that a building in Montreal has to look like a building in Houston. By readdressing some of these problems a number of things will occur: The question of regional differentiation will begin to manifest itself out of necessity. In addition to regional differentiation, the building itself will no longer repeat a single wall section—head, jamb, sill, floor and corner, but will begin to change sharply. A diversity of form and solutions will develop, but a diversity tied together through its unity of purpose. This won't be the diversity we now equate with bizarreness, but the diversity which differentiates one tree from another.

- All openings are screened and can be closed by plywood hinged panels (in the projecting windows) and by wood barn doors elsewhere. The roof is insulated and reflective to avoid an overhead radiant panel. The living room wing (slab on grade) is designed for fall use since it does not have through-the-floor heat loss.
- Supplementary heating for cold evenings or sunless fall days is provided by a small wood-burning stove, cast in concrete to retain and radiate heat.

The Integrity of Natural Systems

Through determining mass, ma-

terials and openings, certain vernacular building types have achieved a delicate balance. The gifts of a more technologically advanced culture to a more primitive one often include new materials which are more convenient or more readily available than the accustomed one, but which tend to destroy the natural balance of some traditional forms.

In applying the products we now produce, we must be aware of the full set of demands they make and be ready to meet them. A Navajo in Arizona was complaining that the new hogans with asphalt tile roofs were far less comfortable both in summer and winter than the old ones with their heavy adobe domelike roofs. The loss of building mass with its time component changed the environment of the structure.

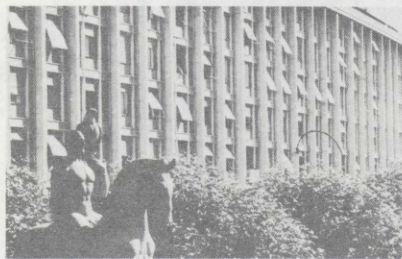
The hogan no longer had a massive roof that delayed the penetration of the sun's heat until the cool evening or the mass that kept interior heat despite sudden drops of winter temperature.

WHAT TO DO

The first, most immediate adjustment in design is to conserve energy by designing the building as an object affected by sun, wind, rain, snow, lightness and darkness, determining when and where each is to be admitted or excluded. Bring the building as close to a natural balance with these forces as program, technology and skill will allow. Then make up the imbalances with mechanical interventions. In this sense, the building becomes an element among (even of) other elements—more than an isolated object.

Some equipment decisions affecting energy use without going into program or layout:

- Reuse and reclaim waste heat from exhaust systems and various processes. Cooling systems for walk-in refrigerators remove large quantities of heat. Exhausts from hoods and ranges contain heat that can be recaptured. Lights give off heat. Electric generators use only a small part of the heat to drive them, dumping the rest.
- Modular boilers can increase efficiency of steam production by 20 percent and more. Over-sized boilers, designed to oper-



The rolladen, for individual window control, as shown here at the Hotel du Rhone, Geneva, are stock items in Switzerland.

ate below peak, but with a safety reserve for a once a year cold spell, will operate most often at under 25 percent capacity. The efficiency is down by 20 percent at these times. By having two or more boilers sharing the load, each can operate closer to capacity when it is required, and with significant increase in efficiency.

- Electrically driven air conditioning equipment has varying efficiency ratios (kwhr's required per Btu of cooling). These vary by two to one or more. Checking equipment for energy efficiency is revealing.

- Terminal reheat can be avoided. Reheating cooled air to modulate temperature is wasteful on the face of it. Try variable volume systems.

- As controls are increased and zoning subdivides areas for control, energy use becomes more efficient since it can be called for only when and if it is required. This leads to certain contradictions in comparing centralized and decentralized systems. For example, while central air conditioning plants are more efficient than individual through-the-wall units, the fact that such units are turned on and off, space by space, can offset their mechanical inefficiency. Careful comparisons must be made.

Little attention has been paid to developing devices to reduce energy requirements of existing buildings; yet these are responsible for almost one third of our total energy use. We can identify how and where energy is being used unnecessarily and can even describe ways to curb these wastes. In many instances standard products are not available or designed for easy use. Among the things that can be done are the control of solar gain through sun control devices, use of reflective glazing and elimination of badly placed fenestration.

- Infiltration and connected heat transfer can be modified by double glazing, caulking, weatherstripping, or the application of various membranes. Thermal characteristics of exterior skins can be improved by adding insulation, or new layers of finish inside or out.

- On the interior of the building, reexamination of light levels, light delivery devices and the switching and control patterns can produce major reduc-

tions in electrical consumption.

- Most existing mechanical systems can appreciably improve their economy of energy use. The level of maintenance depends on trained personnel. Timely replacement of filters, adjustment of equipment, the setting of controls, the insulation of pipes and ducts, the curtailment of services to spaces that are not in use and similar prudent actions result from well informed maintenance attitudes. In addition, many elements of mechanical systems can be replaced with more efficient ones. Cost-benefit analyses can justify many of these substitutions immediately. Normal replacement scheduling will often provide the opportunity for upgrading a system with no increase in the long term capital cost pattern.

Many of these suggestions depend on having available materials to do the work. It would be useful to have a system similar to an exterior scaffold that could be an adaptable sun shielding device for different orientations, sun conditions and window spacings. It would be also useful to have a reliable kit for injecting foam insulation in existing wall cavities of all sorts. This would ease loads if there were an available spray of a light colored or reflective coating specifically made for and easily applied to existing roofs, or a ventilating unit that can be cut into fixed glass installations. (The whole field of roof fitting could produce an interesting series of products and techniques with a tremendous potential market.)

Organizational Action

Encouraging things that are happening throughout the profession—not fast enough to assure that the architects will take full advantage of their potential for ameliorating the unfavorable energy situation, but certainly much more than would have been predicted 18 months ago.

- American Institute of Architecture Task Force on Energy Conservation has laid the ground work for more positive leadership in the field, including participation in several national research efforts of the Institute.

- Local chapters have developed committees that have participated in hearings, held meetings, written publications, designed exhibits and set up working re-

lationships with sympathetic non-architectural groups.

- Cities, states and national government agencies have conducted and sponsored research, published material and begun to use their regulatory powers to see that energy use in building is reduced. Among those from my own experience (by no means a comprehensive list) are New York City, New York State, Minnesota, Rhode Island, Wisconsin, Seattle and such federal agencies as the General Services Administration, the Government Accounting Office, the National Science Foundation, and the National Bureau of Standards.

- Architectural schools throughout the country are developing curricula and sponsoring talks and meetings: Among them MIT, Columbia, City College of New York, Ohio State, Minnesota, Wisconsin, Pennsylvania, University of Arizona, University of New Mexico.

- Groups interested in special building types have begun investigations in their own areas—for example, regional meetings have been conducted by educational facility planners, as well as national meetings of urban school planners.

- Manufacturers of building materials are beginning to assess the relationship between their products and energy use. Production of more energy efficient products has begun in mechanical fields, lighting and thermal performance. There also has been a trickle of useful information (hopefully to increase) and a great amount of advertising with such evocative words as Ecology, Environment and Energy Crisis in large type.

- The non-architectural press along with the radio and television networks have devoted a great deal of time and space to the architectural aspects of the energy problem.

- Our allied professionals, in their organizations and committees, have begun assessing the manner in which they can affect energy use. So have the American Association for the Advancement of Science and the National Academy of Sciences.

This list is not intended to be comprehensive. It does suggest, however, that the energy issue is of wide concern. And there is already a network for the development, exchange and publication of information.

ARCHITECTURE ON TRIAL

We are beginning to see a number of experimental buildings designed to be as independent as possible of outside utilities and energy sources. Houses have been designed, or are being designed, to take advantage of solar heat for both water and space heating, to use wind for electric generation, or use methane gas from sewage digestion as a fuel and minimize waste with its attendant pumps and equipment. These include the Zomeworks people in Albuquerque, Richard Blazej's development in Vermont, Graham Caine's experimental house in England, the solar experiments at the University of Pennsylvania and others. MIT has a number of solar heated houses built and analyzed. It should be pointed out that although these projects have been brought up in the context of energy conservation, they all suggest answers or alternatives to most of our other environmental problems as well.

Something called "the house for the natural man" by its designer, Graham Caine, a London architectural student, is now being built. Mr. Caine intends to live in it for two years while testing its systems. The house and greenhouse combination is designed to produce its own fuels for heating and cooking, collect its own washing and drinking water, grow its own food and recycle its own wastes.

The core of the house's systems is the sewage digestion plant which converts all organic wastes into methane gas for cooking and liquid nutrients for the greenhouse, where vegetables and fruit will be grown by hydroponics agriculture. A solar heat system will provide space and water heating. Water will come from a roof rain collector. In order to work, this system presupposes a great deal of economy in the use of its facilities. Caine is also a vegetarian, which helps. The house is admittedly experimental, and there will be standby power and water available if needed. However, should it all work, the only outside power necessary will be electricity for lighting and supplementary heat.

And Caine intends to bypass this by also adding a wind-powered generator and power storage system later on.

There are several studies in process attempting to provide firmer data than is now available. Some, such as the GSA Office Building in Manchester, New Hampshire, take the form of a building designed specifically to be energy conserving.

Our office is now discussing the possibility of a similar research building and evaluation project for the New York City Board of Education.

Following a period of research (technical in regard to energy use systems and performance, programmatic in reinvestigating the energy use required by the activities to be housed), the building will be done with monitoring and recording instrumentation built in. There will be a two-year evaluation period based on monitoring the energy consumption after the building is in operation. And the project will have the support of several Federal agencies as well as that of the City.

The interesting observation suggested by these experiments is that the new look at energy use results in an expansion rather than a contraction of the building vocabulary. It becomes apparent that there is no single answer to the complex problem we are facing, and that the overall solution takes advantage of many varied, dissimilar methods. What is suitable in New Mexico may not be suitable in Vermont. Yet there is no reason to dismiss it as unimportant. The amount of sunlit hours in New York, compared with Southern Arizona, does not mean that solar energy ought to be disregarded in New York.

It will be useful to learn more about the successes and failures of the various proposals now being carried out. Stating the problem and pointing out the possibility of coping with it in no way assures that the necessary steps will be taken in time or, in fact, at all.

There are strong counter-pressures. As a national characteristic, we prefer to provide large scale, generalized solutions that operate far below their potentials in order to have the high performance capability that will occasionally be required, rather than specifically identifying

those occasional peak demand requirements.

Examples are all too familiar. The 400 horsepower car. The indiscriminately high light levels over the whole floor of an office building. The one switch that turns a whole floor on or off. The structural beam that is unchanged in cross-section from one end to the other. The glass facade that introduces light uniformly over its entire face. The same facade that excludes air uniformly. The Music Hall Rockettes. The broad area spraying of DDT. The same buildings springing up in Montreal, New Orleans and Paris.

The result of this lack of specificity is a deterioration in the quality of life at the same time that there is some increase in its physical abundance. Changing the delivery pattern to one that responds to clearly identified needs and problems has economic benefits as well as psychological benefits in economic terms.

By being specific in application, energy use may be reduced by 25 percent to do the same tasks it is now called on to perform. The improved sense of tautness and precision in our full environment, however, may be an equally important result of these reinvestigations.

Even if energy were suddenly abundant (an unlikely supposition), I believe its consciously limited, precise use would bring our architecture back in to the historic stream of great architecture of the past. Five years ago it was possible to advocate the intelligent, controlled use of resources and materials as a matter of choice. For the period immediately ahead of us it becomes one of necessity.

There is also a momentum in the present industrial and commercial commitments that tends to perpetuate the familiar form of architecture and building. Many forms, materials and assemblies will have to be phased out of building lines and catalogues. Just as the utilities have found it necessary to disband their sales promotion forces and develop educational programs on better use of their products, so will the manufacturers and suppliers of building components.

Over the past several decades, with increased stress on reducing building site labor, there has been the parallel increase in generalized solutions. We may

now require a reevaluation of how our buildings are erected. We may need greater craftsmanship on the site, more trained construction workers. Unemployment in the building trades unions has resulted in restrictive entrance practices. In reality, there are many persons, particularly in minority groups, who are unemployed or underemployed and who would be most eager to enter the construction field. Our present procedures reflect and depend on an unlimited abundance of inexpensive energy. The situation never really pertained. The illusion does not, any longer.

Although there is a nominal commitment to efficient planning in the profession, there are too many structures that are wastefully planned. If more efficient planning reduces the area that will require heating and cooling, it is an obvious method of reducing energy consumption. We can look at many of the award winning buildings in the architectural press and realize that energy utilization or plain efficiency had little bearing on the solution.

The architect is the one person in the building design team who can make a comprehensive decision, synthesizing the various requirements of owner, engineer, site, orientation, budget, energy analysis and esthetics. He can be assisted with data developed by all his consultants, by computer analyses and simulations, and by tentative trial solutions. Since all the requirements are intimately related to the use-value of the building, the architect's energy-based decisions become extraordinarily complex.

The architectural profession needs a framework in which the energy values of different materials and assemblies are listed. Its use would permit choice of equally adequate materials based on the energy impact in manufacturing each of them. Such a framework would also establish the tradeoffs between energy required in the production of a material and energy required in the operation of the finished building. My office expects to prepare such a framework in connection with the AIA Task Force on Energy.

A new evaluating technique must be developed that considers the energy implications of extending the life of a structure

or demolishing it. In addition to the purely economic considerations, there are many structures in existence, the result of measurable energy inputs, that can continue to serve needs usefully. The architect must learn the techniques of reuse, the modifications necessary, the method of upgrading the performance of mechanical systems and the useful incorporation of existing space in new projects where energy savings would result. At various levels, frames, total structures, exterior closures, interior partitions and mechanical systems can be reused.

The experience of Dr. Lawrence—New York City's utility expert on the survey which revealed seven to one differences in energy use in the most extreme post-World War II office buildings—leads to the desirability of determining a theoretical energy use index for all buildings designed. If the index is at sharp variance with the building's, it would call for reinvestigating to establish whether the causes for the special condition were justified.

Bringing the whole question back into perspective, I believe it is necessary to stress one thing. Energy use is a means to accomplish certain tasks that are related to human survival and comfort. It cannot be considered as having an existence apart from what it permits us to do. These tasks are extensive and worldwide and their needs, rather than trend projections, should establish energy growth. In view of their urgency we cannot afford the squandering of energy use. The architectural profession, its decisions and products determine about a third of all our energy use, of which a quarter may be unnecessarily expended. An architecture responsive to the physical universe and our infinitely varying human requirements may indeed be an architecture of heightened inherent quality and one that diminishes the damaging impact of the present energy crisis.

NEW YORK, December 1973.

Re a commentary in favor of the bill H.R. 11299.

To the Honorable James C. Cleveland and the Committee on Public Works:

As an energy consultant, and also as a private citizen interested in seeing that the United States Government sets the example for energy conservation in buildings over which the Government has jurisdiction, I wholeheartedly support H.R. Bill 11299.

Having had considerable experience with the Government agencies, I am in agreement that the General Services Administration is the logical agency to administer the matters contained in this bill. I am aware of the accomplishments of the GSA in energy conservation in buildings and the progress they have made in sponsoring demonstration buildings which gives the agency a good and deep background in the matters to which this bill addresses itself. As you may know, my firm was engaged by the GSA to research the energy needs of the demonstration building (now in design) in Manchester, New Hampshire. I was greatly impressed with the integrity and general competence of the people affiliated with the GSA.

With specific reference to Section 2 of the proposed bill, the funds called for, i.e. \$500,000, is not, I believe, really adequate to accomplish the specified objectives. I believe that a minimum of \$1,500,000 will be required since the design criteria becomes a very involved task requiring extensive computer work and calculations to establish the quantitative values of energy conservation which would accrue under (A), (B), (C), and (D) of Section 2. This type of analysis should be made for each of, at least, seven separate and distinct climatic zones in the United States and for perhaps five major building types in each of these zones. I feel that eventually, such an effort would require upward of \$5,000,000. There are currently some such projects under way and these can possibly be coordinated with the efforts called for in this bill.

With respect to Section 3 of the proposed bill, a minimum of \$5,000,000 is needed to complete a thorough inventory and examination of existing buildings.

Section 4 of the proposed bill appears to require an adequate means of reporting the findings of the surveys conducted by the GSA. On the other hand, it would be useful if some means could be provided for disseminating the information to the general public—or at least to professionals charged with providing design services to the public—to promote energy conservation among the citizenry at large.

From our experience with GSA on an energy conservation building in Manchester, New Hampshire, as well as with somewhat similar projects with the New York Botanical Gardens, a condominium unit in Vermont and energy conservation studies we are currently undertaking for the Connecticut General Life Insurance Company in an existing building, we have been able to gain considerable insight into energy conservation goals that can be reasonably attained and such an effort as the one suggested by this bill is required to dig out the information that is absolutely necessary to architects, engineers and building owners for future design. Since existing buildings for a long time will be the major users of energy, the effort devoted to existing buildings is timely and one that is often neglected.

Respectfully submitted.

FRED S. DUBIN, P.E.

Dubin-Mindell-Bloome Associates, P.C.

Mr. CLEVELAND. One of the reasons I don't think it is necessary for me to make my opening statement is the fact that Mr. Vanik is aware of the building in Manchester, N.H., alluded to in his remarks. This legislation is designed to give impetus to precisely this sort of innovation.

That is all contained in my opening statement, but I will skip over that now, because we are now running late. This is something that Mr. Vanik is going to testify to, in any event.

Mr. HOWARD. I thank the gentleman. And, without objection, any other members who wish to have statements placed in the record of these hearings, those statements will be made a part of the hearings at this point.

Mr. DORN. Mr. Chairman.

Mr. HOWARD. The gentleman from South Carolina.

Mr. DORN. Before stepping into the room with my distinguished and able colleague from New Hampshire, I do want to welcome my colleague from Ohio to the committee.

We always consider very seriously any recommendation from the gentleman from Ohio. We join with the chairman in welcoming him to the committee.

Mr. VANIK. Mr. Chairman, I want to thank the distinguished chairman.

Mr. HOWARD. Mr. Vanik, without objection, your prepared statement will be made a part of the record at this point. You may please proceed as you wish.

[Statement referred to follows:]

STATEMENT OF HON. CHARLES A. VANIK, A REPRESENTATIVE IN CONGRESS FROM
THE STATE OF OHIO

Mr. Chairman, members of the committee, I appreciate this opportunity to present testimony to the committee on the importance of energy conservation in public buildings.

There is going to be no "quick-fix" solution to our energy shortages. Turning down thermostats, driving slower, and using our cars less will help in meeting our immediate crisis—but these measures will do little to solve the energy problems which lie five and ten years down the road.

I commend the committee in taking a leadership role in examining the Federal contribution to solving our long-range energy crisis. The committee's legislation, H.R. 11299, proposes an excellent program to inventory and evaluate the energy characteristics of all federally owned and leased buildings. However, I would like to recommend to the committee two specific proposals from my bill, H.R. 11542, which would strengthen our commitment to energy conservation in Federal buildings.

First, the General Services Administration should file with the committee and make public an *energy use statement* for each proposal to build, alter, or acquire a Federal building. This statement would not be just an annual report and inventory. It would be a detailed description of the sources of heat gain and heat loss and the ways and means that the building has been or can be made as energy efficient as possible. It would be a means of active congressional oversight and a working paper, a blueprint for others.

Congressman Cleveland, who is the sponsor of H.R. 11299, will soon have some first hand experience in his State with the possibilities of an energy efficient building. I believe that the GSA is designing a Federal office building in Manchester, New Hampshire which they expect will use only 50 or 75 percent as much energy as most modern buildings. But as fine as I am sure this building will be, it will only be "the first generation" energy efficient building. Many such model designs are needed, throughout the country. The design of Federal buildings should be varied to explore the full range of energy saving possibilities.

The simple fact is that making Federal buildings energy efficient will make little impact on our overall energy needs. But by leading the way, by demonstrating how buildings can be designed and built to save fuel—the Federal Government can provide the impetus for increased efficiency in residential homes and private buildings. By improving the technology and helping to create a market for energy efficiency devices, the Federal Government can help create a true conservation philosophy.

Second, the bill should include specific language to insure that solar energy is used in Federal buildings to the fullest extent that it is economical and efficient.

A company in my community has developed a solar turbine that they contend will provide 40 percent of total energy needs for a two story, eight suite building at a cost of \$100,000. We should be willing to try such plans in Federal structures.

We have most of the needed technology to tap the sun's energy. Again, Mr. Chairman, what we do not have is the standardized equipment and the production lines to make solar energy equipment available to the public at reasonable

prices. By requiring that Federal office buildings, whenever possible, employ solar equipment, we can spread the concept of using clean, inexhaustible and cheap solar energy and we can encourage the development of the industries necessary to supply such equipment in all new construction.

The Federal Government and the GSA have already taken a leadership role in demonstrating solar heating and cooling technology. But more than just one or two demonstration buildings are necessary. Solar energy and building energy efficiency must become a part of our daily life.

I believe that your legislation, with strengthening amendments, can help obtain the answer to our energy problems.

STATEMENT OF HON. CHARLES A. VANIK, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF OHIO

Mr. VANIK. Mr. Chairman, in order to save the time of the committee, I just want to say that I commend the committee in moving forward on the legislation, H.R. 11299, which has been inspired by our distinguished colleague, Mr. Cleveland.

I would simply like to direct attention to two specific proposals in a bill that I have prepared, which would, I think, strengthen our commitment to energy conservation in Federal buildings.

First, the General Services Administration should file with the committee and make public an energy use statement for each proposal to build, alter, or acquire a Federal building.

Now, this statement would not be just an annual report or an inventory. It would be a detailed description of the sources of heat gain and heat loss and the ways and means that the building has been or can be made as energy-efficient as possible. It would provide for active congressional oversight as well as a working paper and a blueprint for others in the construction industries.

Now, our colleague, Congressman Cleveland, who is the sponsor of H.R. 11299, is having the first experience with the GSA building in Manchester, N.H., which they think will use only 50 or 75 percent as much energy as most modern buildings, in an area with a climate that is very much like the climate that we have in Cleveland, Ohio.

But I am sure that this will be only the first generation of energy-efficient buildings. Many such models are needed throughout the country. And I think that the design of Federal office buildings should be varied to explore the full range of energy-saving possibilities.

The simple fact is, that making Federal buildings energy-efficient will make little impact on our overall needs. But by demonstrating ways to save fuel, the Federal Government can provide impetus for increased efficiency in residential homes and in private buildings. By improving the technology and helping to create a market for energy-efficient devices, I think the Federal Government can really help to create a true conservation philosophy.

Second, the bill should include specific language to insure that solar energy is used in Federal buildings to the fullest extent that is economical and efficient.

Now, I have a company in my own district which has developed a solar turbine, which they say will provide 40 percent of the total energy needs of a two-story, eight-suite office building at a cost initially of \$100,000. They say they are ready to produce this for \$100,000 a unit.

Now, I think we should be willing to try such plans in Federal buildings. We have the technology to tap the energy resources of the sun. And what we need to do now is to get standardized equipment and production lines going to make this kind of equipment available to the general public at reasonable and lower prices.

I have also pending before my committee a bill which would provide for a tax deduction in order to provide an incentive for the use of this kind of equipment. This legislation would be comparable to our legislation to provide for fast writeoff of pollution-control devices.

But by requiring that Federal buildings, wherever possible, employ solar equipment, we can spread the concept of using clean, inexhaustible, and cheap solar energy and we can encourage the development of industries which are necessary to supply such equipment in all new construction.

The Federal Government and the GSA have already taken a leadership role in demonstrating solar heating and cooling technology. But I think we need many demonstration projects. I think that solar energy and building efficiency must become a part of our daily life.

I would just like to add one other thing that occurs to me, as we are here in a contained hermetically sealed building, you know, with a completely controlled climate atmosphere, I think we ought to resort again to usable windows which let us use outside air when it is comfortable. This is one of the things that I would like to add over and beyond my testimony.

I drive to work in an automobile which operates both heating and cooling on hot and cold days. Everything runs. In the summertime we overcool and then we heat to cool off the air-conditioning, and in the wintertime we heat and then the air-conditioning comes on automatically to bring your heat down to the desired level.

We do the same thing in buildings. I think it is terribly wrong. I think it was a terrible mistake to ever eliminate the automobile vent that provided a manual system of air-conditioning that worked about 75 percent of the time. And I think that in the construction of buildings we should again resort to what was the conventional type until recent years, where we did utilize the outside atmosphere as much as possible in order to permit comfort and suitable working and riding conditions.

That is the substance of my testimony, Mr. Chairman, and I certainly want to commend your committee for its very prompt and expeditious movement, leading by far in our efforts to conserve energy.

Mr. HOWARD. Thank you, Mr. Vanik, for coming here and certainly for your words about Mr. Cleveland and the others who developed this legislation, which may be just a little bit out of step this week in that it is truly long-term legislation, something that will help us in the future, not just for an emergency situation to help us the next few months or the next year or so.

And we certainly do agree with you that this is something we must move on now and not, as you said, attempt a quick fix to get us out of the vital situation today.

And this subcommittee and the Committee on Public Works intends to work in many areas in this direction. Certainly we appreciate your statements concerning solar energy. Of course, what could be used

soon, the ultimate in solar energy, as I have learned it in speaking with people who have been concerned with this in other countries around the world, is capturing the solar energy above the atmosphere before it is diluted, as 86 percent, I believe, is lost coming through the atmosphere.

So we do get a very minor amount, maybe 14 percent, by the time it reaches the surface.

But certainly many things can be done if we work on them, as you suggest and as this bill would indicate, in a way that would become more and more economically feasible, so that we will not be tapping the finite resources of this planet.

So we are very appreciative of your support of this legislation. And there are questions that we have concerning amendments—as you suggested, it might even be strengthened a little bit more, perhaps we could even be doing more in this field. And we certainly will discuss this in the markup of the bill.

One question that no one touched, but has come up, is about the word “facility.” This is in our bill, and there are several technicalities as to whether or not it might be feasible to include facilities—might we also be including all the operations of the Department of Defense, for instance, and might we strictly stick to buildings in the general public Federal field.

Mr. VANIK. There is no suggestion that I can provide on this issue, because I have no expertise on it. But I would also like to point out to your committee that what you suggest with respect to Federal buildings will be a model out of which we can probably incorporate language to place in the Federal Housing Act and extend some of these things to conditions with respect to FHA loans.

But the Federal building becomes the experimental showcase, the demonstration project on which we base and develop experience.

Mr. HOWARD. Thank you. The gentleman from Kentucky.

Mr. SNYDER. Thank you, Mr. Chairman. I want to congratulate the gentleman on a very good statement. I certainly think his first recommendation should be incorporated into any legislation we pass out of here.

I would ask a question or two about the second recommendation. You refer to a company in your area that has developed a solar turbine that they contend will provide 40 percent of the total energy need for a two-story eight-suite building at a cost of \$100,000.

Do you have information where you could transpose that into cubic feet. In other words, are those one-room suites or two-room suites—what are we talking about? You are talking about \$12,000 per suite.

Do you have any information on that?

Mr. VANIK. I can't give you the breakdown on cubic footage or any of the space heat or conditioning involved, but I would certainly be glad to make the information that this company can provide available to your staff.

I didn't come here to advertise a company. I left the name of it out deliberately.

Mr. SNYDER. I don't want you to think that I am inferring that in any way, sir. Certainly I am not. I think that anyone bringing innovations of this kind that can be brought to the attention of any com-

mittee of the Congress that has to do with this type of thing, is rendering a service to the committee, to the Congress, and to the country. And I would commend you for bringing the information, but I am just trying to get a little bit more detail on it, you know, if I could.

The other question—and perhaps again you would want to try to find out—is whether or not this \$100,000 cost is perhaps the cost of a prototype or experimental unit and if production would bring that cost down considerably.

Mr. VANIK. They talked about this as a production cost. In other words, this is one of the problems. With sufficient development, this cost could be brought down. This was what they felt would be the production cost today.

Mr. SNYDER. I think certainly that is something that we ought to look into; whether or not I would say that we ought to adopt that as a part of this bill I think would depend somewhat upon the cost per cubic foot as opposed to our energy shortage, whether or not we could justify \$12,000 per suite for a small office unit suite. I don't know.

Mr. VANIK. What I would suggest in response is that perhaps your legislation should be drafted in such a way, that there would be an override permitted related to the total cost of the building up to a certain percent that could be set aside for the utilization of solar devices or other devices that might help reduce the energy needs. Label it as a demonstration, so that if it proves to be more costly than we had anticipated, legislation would allow for it.

Mr. SNYDER. You made reference to your bill, and I took it from your testimony that the bill that you have offered has been introduced and that it has some language relating to the use of solar energy.

Mr. VANIK. Now, my bill—I might just refer to it by number, H.R. 11542—and it has these two variants that I have discussed before the committee.

Mr. SNYDER. What committee is that before?

Mr. VANIK. It is referred to this committee, to the Public Works.

Mr. SNYDER. It is before this committee?

Mr. VANIK. Yes.

Mr. SNYDER. I certainly think we ought to take, Mr. Chairman, a good look at Mr. Vanik's bill, and certainly his first recommendation sounds to me to have considerable merit. His second seems to, too, but—

Mr. CLEVELAND. Would the gentleman yield at this point?

Mr. SNYDER. Well, just a second. But I do think that we need to take a hard look at that cost factor on that solar aspect.

Mr. VANIK. Well, the language that I use is: "To any extent to which the use of solar energy is economical or efficient."

Mr. SNYDER. I see.

Mr. VANIK. So I think there is some safeguard language in there that we have drafted to put some limitation on the expenditure.

Mr. SNYDER. Yes, sir.

Mr. CLEVELAND. What committee was your bill referred to?

Mr. VANIK. Public Works.

Mr. CLEVELAND. Has it been referred to a subcommittee?

Mr. HOWARD. It may very well have been referred to the Subcommittee on Public Buildings and Grounds. I have discussed these matters with the chairman, Congressman Gray of Illinois, specifically on the legislation before us.

Mr. Gray has been very gracious to permit the Subcommittee on Energy to handle energy-related legislation that has been submitted concerning public buildings and grounds.

Mr. SNYDER. I am through with questions. I just want to again compliment and thank Congressman Vanik for his contribution on this legislation and on the previous bill. On the many occasions that he comes before this committee he always makes a good contribution and is a substantial help to us. I commend him and thank him again today and I yield the floor.

Mr. HOWARD. The gentlewoman from New York.

Ms. ABZUG. I am pleased to see you here and to hear your innovative urgings on this committee and on the House. I just wanted to ask, in connection with your bill, do you have any limitations of money with respect to your proposal?

Mr. VANIK. With respect to the solar energy question?

Ms. ABZUG. Yes.

Mr. VANIK. No, I provide that the committee shall not approve any project unless such project provides for the use of solar energy to meet the heating and cooling requirements of such building, to any extent to which the use of solar energy is economical and efficient.

I think that you have to, in this nebulous area, you have to put in what limitations you can. And I think that is about as much language as you can practically write to make a limitation.

I think this committee, when it deals with specifics, can use this kind of language and fix it to a dollar limit or by some percentage limitation, so that it meets criteria of both a dollar or percentage limit and the extent to which it is economical and efficient.

Ms. ABZUG. I notice that you mentioned in your testimony, the project in Cleveland and the one in New Hampshire.

Do you have any knowledge as to whether this has been utilized at all outside of these areas for Government buildings?

Mr. VANIK. I don't know about the specifics of the extent of the use of solar energy. The Manchester project and one in Saginaw, Mich., happen to be the only ones that I know of that deal with a Federal public building in the United States.

But there are other examples around the world. I think the French have a number of buildings that use solar energy. There are some structures in Delaware, Colorado, Florida, and the District of Columbia. There are some private structures around the country that have suitably demonstrated the capability of using solar energy. The Audubon Society building in Massachusetts is one of the most famous.

Ms. ABZUG. Well, I agree with you. I believe the whole area of solar energy is a very important one. There are some programs in certain areas of the country where it has been instituted—and in other countries it is considered a very important source of power.

I just came back from Israel where we had a discussion of energy and power and water and so on. The Israelis are placing a great deal of emphasis on solar energy as a much cheaper way of dealing with our fuel needs.

I want to commend you for bringing this to our attention. I hope that we can exercise some impact on encouraging this use, which has been underemphasized in this country, together with other alternate sources of power, which we have not explored.

Mr. VANIK. I might point out that when I asked our Cleveland people about the climate in my community, they said that that was based on the inclement weather that we sometimes have. While we are not one of the tropical sunshine places of the world, the science editor of the Cleveland Press just estimated that the amount of solar energy striking the surface of Lake Erie each day could supply the entire Nation's daily electrical needs. And if you take 400 square miles of desert—an area 20 miles by 20 miles—you create enough solar energy to meet all of the electrical needs of the United States today. It has the potential for creating sufficient kilowatt strength to equal all of the electrical energy used in the United States today.

I am not an expert on that. I am just quoting something that has been stated to me by some scientists.

Ms. ABZUG. Thank you. Thank you, Mr. Chairman.

Mr. HOWARD. The gentleman from Mississippi.

Mr. COCHRAN. No.

Mr. HOWARD. The gentleman from South Carolina.

Mr. DORN. No questions.

Mr. HOWARD. The gentleman from Illinois.

Mr. HANRAHAN. No questions.

Mr. HOWARD. Mr. Vanik, we certainly appreciate your testimony. In developing this legislation we will certainly take into consideration very seriously your legislation as well as what we are talking about, so that we can get moving with GSA, which has apparently, from your testimony, been active in this area already. In this way we can begin not only the short-range but the long-term energy conservation methods.

And certainly the Federal Government, through its public buildings and grounds, ought to be in the forefront on this matter. So thank you very much for your time and thank you for your extra added statements concerning the speed-limit bill. That was an extra plus for the subcommittee.

Thank you.

Mr. VANIK. Thank you very much, Mr. Chairman.

[Subsequent to the hearing, the following was received from Mr. Vanik:]

CONGRESS OF THE UNITED STATES,
HOUSE OF REPRESENTATIVES,
Washington, D.C., November 28, 1973.

Congressman ROBERT E. JONES,
Rayburn House Office Building,
Washington, D.C.

DEAR CONGRESSMAN JONES: I appreciated the opportunity to testify before your Energy Subcommittee on Tuesday concerning improved energy efficiency in public buildings.

During my testimony, I urged that the legislation make reference to the possibilities of using solar energy for the heating and cooling of public buildings.

In follow-up to questions raised in the Committee, I am enclosing some material which describes some of the tremendous potential of solar energy for the heating and cooling of buildings. In particular, solar energy will be used in a commercial building being constructed by the Audubon Society in Massachusetts. The University of Delaware has constructed a large house run on solar energy. Finally, the new Saginaw Federal Office Building being constructed by the GSA will use solar devices to provide all hot water for the building and approximately 70 percent of the building's heat.

Sincerely yours,

CHARLES A. VANIK,
Member of Congress.

SOLAR HEATED AND COOLED OFFICE BUILDING FOR THE MASSACHUSETTS AUDUBON SOCIETY

I. SUMMARY

A. Purpose and Scope

The purpose of this study was to assist the Massachusetts Audubon Society (MAS) in a preliminary definition of a solar space conditioned office building at their headquarters at Lincoln. This report is to serve as a planning document which allows MAS to judge the merits of the solar building and as a guide to the design and construction phase. The initial planning study consisted of establishment of design criteria, preliminary engineering and architectural studies, planning for the design and construction phase, and estimation of design and construction costs and schedules.

B. Results

1. A building configuration has been selected which permits a reasonably large solar collector area (3,500 ft²) facing south at an angle of 45° and which accommodates the MAS requirements for office space, a library and a lecture hall—for a total floor space of approximately 8,000 sq ft.

2. A site for the solar building has been chosen adjacent to the present Audubon Society building which is convenient in terms of proximity to both the existing building and an area available for parking. This location has a good southern exposure and the presence of the solar building will have minimum adverse environmental or esthetic impact. In particular, the design of the solar building is such that the roof height and exterior finish on that side adjacent to the current headquarters (Gordon Hall) will be compatible with that building.

3. The design winter heat load for the solar building is estimated to be in the range of 135,000 to 220,000 Btu/hr depending on the choice of certain ventilation and/or infiltration options. It is estimated that a solar system with a 3,500 ft² collector of relatively conventional design (a two-pane collector with black absorber such as was used in the MIT house in Lexington) and compatible thermal storage should be able to supply from 65% to 85% of the total seasonal heating load.

4. The summer design heat gain is estimated at about 15 to 20 tons, a large part of which is due to internal heat generation (i.e., lighting and people). By making skillful use of natural ventilation, perhaps augmented by the chimney effect of the warm collector, it should be possible to minimize the time when artificial air conditioning is required. It appears that a lithium bromide absorption machine in the 15 ton (or possibly 25 ton) size driven by the solar collector should be able to supply a substantial portion of the air conditioning requirements. Absorption machines of this type modified for hot liquid drive can be currently purchased. The basic machines are quite reliable; however, little operating experience with solar drive has been accumulated to date to establish the control characteristics of the coupled solar collector absorption machine system. The lithium bromide absorption machine is water cooled, and will require a small (6' x 6' x 4') cooling tower or cooling pond. In the years ahead it is likely that air cooled machines, either air cooled absorption machines or Rankine cycle devices, will be available.

5. For the near term, thermal storage can most simply and economically be provided with an insulated tank of water. A 7,500 gallon tank is sufficient for storing nearly two days of average winter heating load, and less than one day of design air conditioning load.

6. Evaluation of system options suggests that both a seasonal storage scheme where the storage is hot in winter and cold in summer, and continuously hot storage system, have advantages. The hot storage system is simpler, and may be more efficient. On the other hand, the seasonal storage system permits the use of the storage as a load leveling ballast with an undersize auxiliary electric air conditioner. Although the seasonal storage system has been considered the base point system for the purpose of current planning, the final choice of system option will not be accomplished prior to the follow-on design effort.

7. Energy conservation measures, such as minimization of artificial lighting and maximum use of natural ventilation, may substantially reduce the need for mechanical air conditioning.

8. Preliminary estimates indicate that the cost of the basic building, with conventional heating and cooling, and including allowance for furniture, landscaping, etc., would be about \$388,000. On a prototype basis, the incremental cost

for the design, construction, and installation of the solar equipment is estimated at \$154,000. Therefore, on a prototype basis, the estimated overall cost is \$542,000. Projecting to volume production, the incremental cost of the solar equipment is estimated at \$31,500, resulting in an overall total cost of \$419,000.

C. Conclusions

1. Solar technology is sufficiently advanced that a solar heating system carrying a substantial portion of the building heating load can be considered technically feasible. Its performance is amenable to prediction and the risk of failure and/or substantial difficulties in maintenance and/or operation is minimal.

2. Solar air conditioning also appears technically sound, but the degree of operating experience is much less than that for heating. However, recognizing this, careful system design can provide adequate (and energy conserving) auxiliary back-up for the solar air conditioning and also permit accommodating future developments in solar air conditioning equipment.

3. Preliminary estimates of operating performance and first costs projected to volume production indicate that the life cycle costs for the solar space conditioned building compare very favorably with conventional systems employing electric resistance heating and in the near future should be competitive with systems employing fossil fuel heating.

4. As a demonstration of solar climate control, the building is not expected to be an attractive economic investment. Its purpose is to experimentally show to the membership and to the public at large that when solar equipment is available on a value basis, favorable life cycle costs can be accrued.

However, in using solar heating and cooling the experiment will demonstrate that substantial savings in energy consumption and fuel costs can be achieved.

D. Recommendations

1. Proceed toward design and construction on the basis of the building type described herein incorporating solar heating and cooling.

2. Defer to the follow-on design effort decisions as to final component size, system arrangement (i.e., seasonal vs. hot storage) and the type and installation timing of heat actuated air conditioning.

For conventional construction of this type, a typical schedule would be:

Task:	Months
Design development.....	2
Detail design.....	3
Contract negotiation.....	1
Construction.....	6
Total.....	12

E. Costs and Schedules Associated with Solar Climate Control

1. Initial Prototype Situation

The initial prototype design and construction costs include both increased design effort and relatively high construction costs reflecting, in most areas, a one-of-a-kind construction. The estimated cost breakdown for the *incremental* design and construction costs associated with the solar climate control equipment are as follows:

Cost Element	Cost
System Design:	
Mechanical components.....	\$5,000
Architecture.....	5,000
Overall system.....	5,000
Subtotal.....	15,000

Detail Design:	
Collector.....	15,000
Cooler.....	5,000
Storage.....	3,000
Other mechanical systems.....	10,000
Architecture.....	15,000
Performance prediction.....	8,000
Subtotal.....	56,000
Construction:	
Fabricate, install collector.....	30,000
Modify, install cooler.....	8,000
Fabricate, install storage.....	10,000
Other mechanical equipment.....	10,000
Architectural supervision.....	10,000
Engineering supervision.....	10,000
Subtotal.....	78,000
Instrumentation.....	5,000
Total.....	154,000

The estimated overall cost for the basic building with the prototype solar climate control system is, therefore, \$388,000 plus \$154,000=\$542,000.

The schedule associated with the building incorporating the prototype solar climate control system is as follows:

Tasks:	<i>Months</i>
Design development.....	3
Detail design.....	4
Contract negotiation.....	1
Construction (including lead time).....	12
Total.....	20

2. Projected Costs Assuming Volume Production

In projecting costs to volume production and standardization of techniques, all specific design and design supervision tasks would be omitted as such since these would be included in the standard architectural fee. In addition, equipment costs would be less (in particular, the collector cost estimated as \$8.00/sq ft at the prototype level is taken as \$3.50/sq ft for volume production). The projected estimated incremental costs for a volume production solar climate control system are now as follows:

Cost Element:	<i>Cost</i>
Collector.....	\$12,000
Cooler.....	6,000
Storage.....	5,000
Other mechanical equipment.....	5,000
Subtotal.....	28,000
Architectural fee (12½%).....	3,500
Total.....	31,500

The estimated total cost for the solar building, projecting volume production of solar equipment is, therefore, \$388,000 plus \$31,500=\$419,000.

Assuming volume production, the schedule should not be much different from that of the basic building, i.e., a total of 12 months.

INDUSTRIAL RESEARCH NEWS

EMPHASIS GROWS ON SOLAR ENERGY

NEWARK, DEL.—With discussion of the energy supply becoming more heated each month, both energy experts and environmentalists are looking with increasing favor on the sun as a source of energy.

At an international meeting in Paris in July, for example, scientists from Japan, France, Greece, West Africa, Australia, and other nations presented reports from their countries on applications of the sun's rays to tasks as diverse as heating bathwater, melting alloys for industrial purposes, desalinating water from the sea, pumping well water, and drying industrial timber.

While sun energy has been applied less extensively in the United States, a few thousand householders in Florida and California now use solar-powered heaters for their swimming pools. And the U.S. government has tripled financial aid for research into uses of solar power to more than \$13-million in the current fiscal year. It was less than \$5-million last fiscal year.

The most obvious sign of U.S. interest in the sun as a source of energy is the growing use of the sun's rays to heat and air condition houses. Although few commercial units are available for achieving this, experts suggest that a typical 3-bedroom house can be heated and air conditioned by the sun at a capital cost of some \$3,000—a relatively low figure that appears even lower in view of the lack of maintenance required.

One important factor in the extensive use of solar power is that extremes of sunshine are not necessary for working solar-heated houses. One experimental house has been warmed by the sun near Washington, D.C., for more than a decade, and now the Massachusetts Audubon Society is planning to heat and air condition an extension to its office building in Lexington, using solar panels.

A more extensive application of the sun's rays involves production of electricity in addition to heating and air conditioning. In Newark, the University of Delaware has just opened up an experimental house that will obtain up to 80% of its total power needs from the sun.

The house, named "Solar One," has been designed by a group under Dr. Karl W. Böer. It is believed to be the first house that directly converts sunlight into both heat and electricity for domestic purposes. According to a University spokesman, Solar One has been erected to provide data that will lead to improved designs for other prototype buildings of this type.

To outside appearances, Solar One is a conventional modern house notable mainly for the two skylights in its 45-deg inclined roof. These skylights protect the panels that collect solar heat for heating and powering the house.

For heating and cooling purposes, the heat gathered by the black-coated panels is transferred to air, which is forced through the panels and then led by ductwork to the cellar. There it yields its heat to a storage system, consisting of a eutectic salt that melts at 50 C.

During evenings and nights, as the house cools, air from the interior is circulated through the eutectic salt, and extracts the heat of fusion from the salt as it freezes. Alternatively, the salt can be linked with a heat pump to freeze another eutectic salt which can then cool the house's interior air and air condition the residence.

The electricity is produced in Solar One by cadmium sulphide cells, which convert solar energy directly into electricity. It is conducted by conventional electrical wiring to household lights and domestic appliances.

To compensate for a series of gray days, the house also is connected to the line of the local utility, Delmarva Power and Light Co. The Delaware designers believe that any demand on the utility will occur at off-peak hours, and they also have equipped the link in such a way that the house itself can provide power to the utility in emergency—when the risk of blackout or brownout is present, for example.

Further, into the future, solar energy proponents such as Adam Meinel of Arizona State University and Peter Glaser of Arthur D. Little Inc., foresee the possibility of large-scale generation of electricity from solar heat. This could be either in huge "solar farms" of collectors located in suitably sunny climes, or via satellite-based solar panels that would beam the energy to earth in the form of microwaves.

For the present, the most promising application of the sun as a source of power appears to be in the domestic area. Many experts now forecast that, within the next decade, at least one new house in every 10 constructed will receive its power and heating from the sun's solar energy.

GENERAL SERVICES ADMINISTRATION,
Washington, D.C., October 9, 1973.

HON. CHARLES A. VANIK,
House of Representatives,
Washington, D.C.

DEAR MR. VANIK: Your recent speech to the House of Representatives relative to the energy problems facing our country was read with great interest. Further, we are pleased to respond to your letter of September 18, 1973, concerning the General Services Administration's activities related to solar energy and energy conservation.

GSA's interest in energy conservation began many years ago. It's good business to minimize fuel and energy costs, even if energy sources were plentiful. The recent energy problems have only served to intensify our efforts and to make those we serve, by providing office space and transportation, more receptive to energy conservation undertakings.

You are already aware of the two GSA Demonstration Projects (Federal Office Building, Saginaw, Michigan, and Federal Office Building, Manchester, New Hampshire) which are planned for early construction. The investigations being made concurrent with these designs will lead to new guidance for more energy efficient buildings. Factors being considered include such things as fenestration, orientation, mass and insulation of the exterior walls, as well as the selection of more efficient heating, air-conditioning and lighting systems.

Your speech and letter indicated a special interest in solar energy systems. Both of the GSA Demonstration Projects are being designed to incorporate large solar collector and energy use systems. Funds have been requested for the construction, instrumentation, and evaluation of these collectors from the new energy research and development effort announced by President Nixon on June 29, 1973, for fiscal year 1974 and fiscal year 1975 through fiscal year 1979.

We believe it vital to promptly construct and operate a limited number of large solar collectors using current technology. The information gained should prove invaluable in the further development of this vital, renewable, nonpolluting energy resource.

The enclosures will provide you with additional information on some of GSA's activities in the energy conservation and solar energy areas. Please advise if you require additional information.

Sincerely,

ARTHUR F. SAMPSON,
Administrator.

Mr. HOWARD. The final witness this afternoon is Mr. Larry F. Roush, Commissioner of the Public Building Service of the General Services Administration.

Mr. Roush, we are very grateful for your appearance here today, especially on such short notice.

Do you have a prepared statement for the subcommittee?

Mr. ROUSH. No, Mr. Chairman, however, I have some notes that I will be speaking from.

Mr. HOWARD. We certainly understand that. We did not give you a great deal of time. So if you would please, for the record, introduce by name and title the gentlemen who are with you.

And proceed as you wish.

STATEMENT OF LARRY F. ROUSH, COMMISSIONER OF PUBLIC BUILDING SERVICE, GENERAL SERVICES ADMINISTRATION; ACCOMPANIED BY ROBERT RICE, ASSISTANT GENERAL COUNSEL, AND JOHN MCCARTHY, DIRECTOR, OPERATIONS DIVISION, P.B.S.

Mr. ROUSH. Thank you, I have with me Mr. Robert Rice, the assistant general counsel, and John McCarthy, our director of the operations division.

I am Larry F. Roush, Commissioner of the Public Building Service, General Services Administration.

It is a pleasure for me to have the opportunity to comment on a bill, H.R. 11299, "to insure that certain buildings financed with Federal funds utilize the best practicable technology for the conservation and use of energy."

Many of you may know that the General Services Administration has moved forward in rapid fashion with a comprehensive energy-conservation program for existing buildings, and that we have under design a new facility in Manchester, N.H., which has been discussed here in the last few minutes in some limited detail, which we call our energy demonstration project.

Mr. Chairman, the subcommittee may be interested to know that on November 2, 1973, page E6993, the Congressional Record, contained a detailed statement of our energy conservation program. We in GSA are proud of our initial efforts to achieve the President's energy-conservation goals which as of last week have resulted in a 9-percent reduction in GSA energy usage over the past 3 months, when compared to the same time frame last year.

H.R. 11299 would give Arthur F. Sampson, Administrator of General Services, the authority to insure that all design criteria for new Federal buildings provide for the best practicable use and conservation of energy.

We consider this authority to be in full accord with our role as the chief construction agency of the Federal Government and we have already instituted several projects which will affect design criteria for new buildings. These projects include:

(1) The development of Federal design criteria for energy conservation, which are being prepared in conjunction with the American Institute of Architects' Research Corp. It is presently underway.

(2) The instrumentation of the Manchester building to substantiate the National Bureau of Standards computer design model, which we will use to assist in designing the energy-saving features of this building.

(3) The development of an air-change rate study which is underway.

(4) Centralized computer control of buildings on energy use is being studied.

(5) A study of lighting levels and use of task-oriented lighting.

(6) The development and use of integrated ceiling systems, which I will speak to in a few moments.

(7) The evaluation of the Saginaw environmental demonstration building, which is another building, by the way, where we are utilizing solar sources.

(8) The development and use of various energy conservation systems included in the Manchester project.

(9) The design of solar collectors for the Manchester and Saginaw buildings. Mr. Chairman, I have fact sheets on these two buildings which I can provide for the record.

Mr. HOWARD. Without objection, they will be made a part of the record, following your testimony. (See page 45.)

Mr. ROUSH. We are proceeding with these projects as they relate to buildings under the jurisdiction of the General Services Administration.

However, I would like to point out that the bill, H.R. 11299, and its definition of a "new building," and "an existing building," is all-inclusive and unclear as to GSA's area of jurisdiction. We question whether or not the bill means that the Administrator would inventory and examine existing buildings and new construction projects under the auspices of the Department of Defense, Department of Health, Education, and Welfare, Veterans' Administration, and the Department of Housing and Urban Development.

If the language in the bill intends for our evaluation to encompass all federally funded buildings, we would consider this a most challenging endeavor and feel that our initial efforts in energy-conservation technique would be a tremendous asset in getting the program off the ground quickly.

In this regard, Mr. Chairman, you will be interested to know that the General Services Administration, in conjunction with the National Bureau of Standards, is already in the process of systematically analyzing 230 existing major Federal buildings to determine:

- (1) The reasons for the variance in energy usage between apparently similar buildings,
- (2) What elements of energy usage are manageable, and,
- (3) What improvements in design and operating practices will reduce energy usage.

We anticipate the analysis will be complete in late February of 1974 and thereafter expect to have a basis to learn what modifications can be made both to the physical structure of a building and changing its operating procedure to further reduce energy consumption.

On new structures we already do energy usage analysis during the design phase.

As I have mentioned, the most immediate energy conservation impact of the bill is section 3. And because this directly relates to the cost of such an analysis, we feel the appropriation authorization limitation specified in section 5 of H.R. 11299 will make it impossible to achieve the purposes of the proposed legislation within the time frame specified.

An inventory and examination of all existing buildings, as currently defined in the act, would cost considerably more than \$500,000. The number of buildings owned by the Federal Government is estimated to be in excess of 400,000.

Mr. HOWARD. If I may stop you there just for two clarifications. One, talking about certain sections, would it be possible for you to operate under this legislation if, rather than specifying each section, that the total amount were made for the total job and you would have the flexibility of using whatever amounts under section 2, section 3, or section 4—or are you going to develop the fact that that would also be insufficient to carry out the concerns. That is one question.

The second question also has to do with that. Is that under the overall definition of new buildings that you referred to before? If that should be cut down more specifically to buildings under GSA alone, then would that amount of money be sufficient, either section by section or in total?

Mr. ROUSH. I am prepared in the next few moments to speak to that matter.

Mr. HOWARD. Thank you.

Mr. ROUSH. As I mentioned, the number of buildings owned by the Federal Government is estimated to be in excess of 400,000. And this is the all-encompassing definition that you were questioning in the United States alone.

The number owned by the Department of Defense for its military functions outside the United States is not reported. The number outside the United States owned for nonmilitary functions is estimated to be more than 10,000 additional installations. The number of buildings leased in whole or in part is estimated to be in excess of 40,000 installations worldwide.

We have no means of estimating the number of buildings which are included in section 1(c) under the definition of "financed by grant or loan." Therefore, for purposes of this legislation, section 1(c) may have to be redefined or deleted and dealt with at a later time.

Based on a sample study of GSA-owned buildings—and I think this is a critical part of the answer to your question—we estimate the minimum expenditure—and I stress again the minimum expenditure—to be \$500 per building to handle this type of survey.

To consider 450,000 locations, therefore, would cost approximately \$225 million to inventory, examine the building and determine the improvements necessary for energy conservation.

More appropriate language for section 5, therefore, would be, "There is authorized to be appropriated the sums necessary to carry out the purposes of this act," without specifying dollar limitations for each section.

And section 3 might more appropriately read, "Only those buildings that the Administrator deems necessary should be surveyed."

In the interest of economy, section 4 should read, "The Administrator of General Services shall report on the results to date of his survey inventory under section 3 no later than January 1, 1975, and from time to time thereafter."

This would allow a continuous program effort and allow GSA to attack the most obvious problems at the earliest date.

It should be further pointed out that such a bill could mean considerable escalation of rental costs to the Federal Government and difficulty in locating space that meets specific energy-conservation criteria, unless sections relating to leased structures are made to read so that some requirements may be waived by the Administrator, when appropriate.

Mr. Chairman, the General Services Administration appreciates the opportunity to comment on this bill and feels that its intentions would greatly assist in the coordination of energy-conservation efforts by the Federal Government.

We would be pleased to accept this challenge and continue in our efforts to meet the energy crisis we now face.

Our assistant general counsel, Mr. Rice, also has some suggestions regarding clarification of the wording of several sections, which I would like him to present at this time, if you so please.

Mr. HOWARD. I think that would be very helpful to the subcommittee. If you will proceed, please.

Mr. RICE. Thank you, Mr. Chairman. My comments relate to subsection (2) of section 1 of the bill, which is found on page 2 of the bill.

As written, subsection (2) would seem to exclude Government-owned buildings which were not substantially all used by or on behalf of the United States. If that is the intent of the committee, fine. I believe, though, that you might consider having it apply to Government-owned buildings whether or not used, substantially all used, by the Federal Government.

If you wish to make it apply to Government-owned buildings whether or not substantially all used, you could clarify it by adding, in line 8 on page 2, after the word "owned," the language "by the United States,".

My second comment relates to the phrase which is found on line 8 and 9 of page 2, which is "substantially all," which is a formula that would have to be applied to determine whether or not the definition of existing building is met.

I would suggest that a more concrete definition might be used, and to that end I suggest deleting the phrase "substantially all" on lines 8 and 9 of page 2 and substituting for that the language "more than 66 percent of the net assignable square feet."

I believe those two suggested modifications would clarify the bill and would determine a definitive workable formula for determining whether a building was an existing building for purposes of the act.

Thank you, Mr. Chairman.

Mr. HOWARD. Thank you very much. The Chair recognizes the chief sponsor of the legislation, the gentleman from New Hampshire, Mr. Cleveland.

Mr. CLEVELAND. Thank you, Mr. Chairman. I had to go back to my office. I was not able to speak to Mr. Vanik more than briefly about his bill.

Have you people had an opportunity to take a look at that bill he referred to in his testimony? I assume you were here when he testified.

Mr. ROUSH. We were here when he testified. Unfortunately, we have not had an opportunity to look at his bill, although I do recall that we have had some limited contacts with the firm that he mentioned regarding some of the efforts that we have underway in the solar collection field.

Mr. CLEVELAND. This is the firm that has the solar turbine?

Mr. ROUSH. Yes, sir. My recollection at the moment is very hazy on that. I couldn't tell you the name of the firm. We have had contact with several of them, that have been brought to our attention, and we certainly intend to pursue all of the possible efforts in the solar area.

Mr. CLEVELAND. One thing troubled me about Mr. Vanik's statement. As I say, I regret that I wasn't in a position to ask him about it.

Mr. HOWARD. The gentleman from New Hampshire, I would just like to state for his information that we have requested reports as of yesterday from GSA, OMB, and Commerce on Mr. Vanik's bill, H.R. 11542, with the request that they please expedite that.

Mr. ROUSH. We will certainly do so, Mr. Chairman.

Mr. CLEVELAND. I still want to speak to Mr. Vanik about his bill, that could come later when we have hearings on it. But he speaks about this company that has developed the solar turbine, which contends that it will provide 40 percent of the total energy needs of a two-story eight-suite building at a cost of \$100,000.

He suggested that either our bill be amended or his bill or some bill like it be passed which would include specific language to insure that solar energy is used in Federal buildings to the fullest extent that is economical and efficient.

Now, as I understand solar energy at this stage of its development, might not be economical and efficient on a cost basis compared with conventional alternatives—electricity or the use of fossil fuel.

This raises the question as to whether or not the Congress and the GSA should be willing in some areas on a pilot basis to try to use one of these concepts, even though it were not economical and efficient. Because until it is given an opportunity to be tested and you can go into mass production, it never really could be economical on a comparative basis.

Do you understand my question?

Mr. ROUSH. Yes, sir; I think I do.

Mr. CLEVELAND. Will you address yourself to it?

Mr. ROUSH. Yes, sir. You are quite correct. That is exactly why we have undertaken the Manchester and the Saginaw projects where we will utilize the solar collectors and where we are putting instrumentation in place so that we can measure accurately and without doubts exactly what the efficiency is and what is most cost-effective.

Mr. CLEVELAND. In other words, you are doing this on something of a pilot basis as part of a broader testing program?

Mr. ROUSH. Yes, sir. We have a two-prong program going at the moment. One is in what we might refer to as instant savings, those things which we can do immediately. And then we have a secondary program going which is long-range, such as the Manchester building, where we are learning a great deal as we go through the design and begin to get ready for the construction phase, so that we are applying those things we are learning in the new building to existing structures.

I am pleased to say that it has been extremely helpful for us to go into this mode of operation on an experimental building that we are discussing.

Mr. CLEVELAND. But at this time, if the Congress were to enact legislation as suggested by Mr. Vanik, requiring that this solar energy be used in Federal buildings to the fullest extent that it is economical, this actually might impede the program you have underway, if you were strictly to construe that language.

Mr. ROUSH. Let me say this first. In designing a new building, we do currently do an analysis of the energy usage as part of our analysis of what would be best and most efficient for the U.S. Government.

Mr. CLEVELAND. Excuse me, that analysis, is that the construction cost analysis or do you go into the future and crank into your factor of cost to operate it over the life-expectancy of the building?

Mr. ROUSH. Yes, we are cranking in the future, and most recently we are using total life cycle as the basis of an award on the Social Security Administration payment centers, which are being built in Philadelphia, Chicago, and San Francisco.

Mr. CLEVELAND. Are you familiar with the article in a issue of—I believe it is the American Architectural Form—are you familiar with that article that addresses itself to that point, of projecting costs over the full life cycle of a building?

Mr. ROUSH. I am not sure which article. There have been several recently. I am familiar with several of them.

But we are deeply interested in it and going into it in great depth at this point. In fact, we are working on a life-cycle model, which would be utilized for the analysis in our new design work. So that we are getting into it in great depth.

Mr. CLEVELAND. Just getting back now to my initial question about the suggestion of Congressman Vanik that we use this solar energy to the fullest extent that is economical and efficient—you would have no problem with that statement?

Mr. ROUSH. I have some concern, and perhaps our counsel could speak to that. In particular instances, where we are running experimental projects, demonstration projects, that certainly could impede or certainly raise a question as to our ability to go into demonstration projects, no matter what it might be.

And we feel that there is a very strong need to be able to do that and stay up with the building technology, as GSA currently owns 3,000 buildings, and we own, operate, or occupy in one fashion or another 10,000 buildings.

So, it is critical that we stay up with what is going on in the industry. And any restrictive type legislation would be quite unfortunate, I believe.

Mr. RICE. May I add an additional comment, Mr. Cleveland?

Mr. CLEVELAND. Yes, by all means.

Mr. RICE. I have not seen the bill, but my initial reaction would be that such a bill might result in two things, either a delay in a number of construction projects until reliable data were developed on solar heating, or, secondly, the Administrator might be faced with the problem of concluding that, because it could not be proven that solar energy was more economical and that he would have to make the judgment to move ahead with the project, using other forms of energy.

Mr. CLEVELAND. Well, that is exactly what I think. I agree with your statement. That is why I wanted to explore this with Mr. Vanik. I am sure he would be willing to temper his suggestion, in view of the fact that to get some of this off the ground you are going to have to have a pilot or experimental models.

I have no further questions. I would like to thank the gentlemen for their testimony and their very refreshing attitude toward innovative changes in these areas of concern. Thank you.

Mr. ROUSH. Thank you very much.

Mr. HOWARD. The gentleman from South Carolina.

Mr. DORN. No.

Mr. HOWARD. The gentleman from North Carolina.

Mr. MIZELL. Thank you, Mr. Chairman. I think we are all pretty well in agreement that now is the time for action such as this and I was interested in your testimony that we have about 400,000 buildings that would probably come in under the language in the bill. Is it correct that the estimated cost to do the job would be about \$250 million to run the surveys and gather other information?

And I was wondering if you have done this type of survey on any buildings now, that you could give us some kind of an idea of the type of savings that you might be able to come up with by doing it on just an experimental basis.

Mr. ROUSH. I am not sure that I can come up with a number like that. We have, as I say, 230 buildings currently under study, but we don't expect to have that study completed until February 1974, at which time I will be able to give you a much better assessment of the figure.

In some cases, it may cost considerable amounts of money, once we do the assessment, and we need to face that fact; 400,000 buildings are a lot of buildings, as the language currently reads.

Mr. MIZELL. You have answered my other question, then. Once a survey has been made and you determine the things that could be done to conserve energy, what would the cost be—and I am sure it would differ from building to building—what would be the cost in order to accomplish those savings?

Mr. ROUSH. That is the reason that I suggested that the one section be changed to read in such a fashion that GSA could proceed with those projects that were most urgent at the earliest occasion.

As you may be aware, we have building managers across the country who are aware of those issues which are most obvious in a matter like this that we could very quickly get some assessment of where we should look first, so that we do not hit the Congress with a request for an appropriation of \$225 million to accomplish this project in 1 year.

As I suggested in my testimony, this has become an ongoing program, that we take on the most obvious and difficult projects first. The legislation should be written in such a fashion as to allow the Administrator to make those judgments, since we have already begun with 230 projects.

Mr. MIZELL. Did I understand you to say that that study will be completed in February?

Mr. ROUSH. We expect to complete the first 230 buildings that we are looking at in February; yes, sir.

Mr. MIZELL. And you anticipate that this will give us the facts that—

Mr. ROUSH. We will be glad to provide what facts are available, if we do wrap it up in February—and I expect we will.

Mr. MIZELL. Thank you very much. Thank you, Mr. Chairman.

Mr. HOWARD. The gentlewoman from New York.

Ms. ABZUG. My recollection is that there was a considerable amount of money authorized for research and development in the area of solar and thermal energy, and I wondered whether—if that were made available, this would considerably improve your operation?

Mr. ROUSH. The answer to your question is—if I understand the question—we have been working with the National Bureau of Standards, which may be the recipient of some of those funds. We have been working with the Atomic Energy Commission on some of their efforts and with the National Science Foundation on some of their efforts, so that we believe that we are well-coordinated with those organizations which are developing alternate sources of energy, such as the atomic energy or solar energy.

And in fact we are hoping that some funds will become available to GSA to assist in the Manchester solar segment of that project.

Ms. ABZUG. My recollection also is that about \$20 million of that has been impounded.

Mr. ROUSH. I have no knowledge of that.

Ms. ABZUG. I just wondered if this research has already been authorized and funds made available, wouldn't it be easier to execute a bill like this?

Mr. ROUSH. I am sorry, I cannot answer that question. I really don't know what is available from other than the source that I mentioned.

Ms. ABZUG. You don't know, as a matter of fact, that there is this impoundment of \$20 million, is that right?

Mr. ROUSH. That is correct, I do not know.

Ms. ABZUG. This is an important thing to know.

Mr. ROUSH. Yes, madam.

Ms. ABZUG. So if we are really serious about a program for energy, which we have finally become serious about, it would be important to know these facts, so that we can proceed on many levels where the basic research has to be done on the alternate uses of energy, including the best technology, solar energy, geothermal energy, and other forms, which would make it easier for us to have a bill like this and for GSA to be able to function more broadly on the issues.

Would you agree with that?

Mr. ROUSH. I believe that I would have to agree with that. I don't know that anyone could disagree with it.

Ms. ABZUG. Otherwise it is a nice program, but if there are no funds for it, then we are back where we have been for some years now.

Indicating particularly with reference to your comments about the amount or the scope of your jurisdiction and the amount of money it might cost, it seems to me that this would be another piece of legislation which might sound good on a piece of paper, but not actually mean anything.

We have funds that are already authorized that are impounded. If we add to that another program of this kind, as proposed in this bill, requiring a large sum of money, that might be impounded, also denying the benefits of the program.

Do you have any feeling about whether or not the sums that will be necessary for this would be expended?

Mr. ROUSH. To the best of my knowledge—and certainly if these funds are made available to GSA, they would be expended in the most efficient fashion that we could determine.

Ms. ABZUG. Thank you. I have no further questions.

Mr. HOWARD. The gentleman from Mississippi.

Mr. COCHRAN. I have no questions, Mr. Chairman.

Mr. HOWARD. Counsel, Mr. Gilbert.

Mr. GILBERT. Referring to other departments, I understand you said the Veterans' Administration, HUD, the Department of Defense, Department of Health, Education, and Welfare.

Would you have any objections to the Post Office Department also having an input or the Department of Commerce and the Bureau of Standards?

Mr. ROUSH. I can say at this point in time that we would have no objection, if the funds were available, to attempting this type of survey. We believe we have taken the lead, we very seriously and we honestly believe we have taken the lead in the field. We are interested in continuing to do so.

I might add that as long as the resources are available, we have no difficulty in recruiting the talent. We certainly have the technical know-how available, and we know how to go about doing it.

Mr. GILBERT. For the record, Mr. Chairman, we have requested the American Institute of Architects' Research Corp. to testify, and they were unable to do so, with the short notice they received, but they will be submitting material for the subcommittee files.

Mr. HOWARD. Without objection, that material will be made part of the committee file. So ordered.

Mr. GILBERT. On the question of the time frame necessary for you to accomplish this, what sort of time frame would be reasonable in order to conduct this survey?

Mr. ROUSH. If I may, I would like to make two points on that. No. 1, I would like, if you want a realistic assessment—because of the short notice we had on this testimony, to provide the answer to that for the record.

I think we need to make a better assessment of exactly what the inventory of buildings would be. I think we need a good definition of what you are asking that we cover.

If it is the full scope of the bill as written and if you are including such things as the Post Office Department, that all impacts definitely on the time frame.

And, secondly, I will go back to my earlier comment, in that I think there are some economies that can be reaped very quickly if this is organized as an ongoing program rather than as a one-shot terribly expensive job because obviously we can't build up a staff to survey 400,000 or 450,000—maybe more, if you are talking about Post Office also—buildings in 1 year, and build it up and dispose of it in a year's time, that would be very difficult to manage and very expensive.

Mr. GILBERT. Of those 400,000 buildings how many are directly under GSA control?

Mr. ROUSH. GSA owns, operates, or occupies in one fashion or another under lease 10,000 of those buildings.

Mr. GILBERT. So 390,000 are not?

Mr. ROUSH. I believe the number is—the 400,000 that you are talking about does not include leased buildings, so the total is 450,000 locations. In other words, 440,000 would not be under GSA control at this point.

Mr. GILBERT. I see. Where would the bulk of them be?

Mr. ROUSH. Again, I could probably provide an estimate. Our best knowledge of that, for the record, if you choose—but I might cite some examples for you. For instance, the Agriculture Department has many small buildings in many portions of the country. Likewise, the National Park Service.

Have you any other thoughts on that, John? The Veterans' Administration hospitals, Departments of Defense installations. Huge numbers. But particularly Department of Defense would be a very large one.

Mr. HOWARD. That would be a large number of leased buildings?

Mr. ROUSH. Government-owned basically.

Mr. HOWARD. There is a building in New Jersey at Fort Monmouth, approximately \$18 million, for the Electronic Command, which is a leased building off post that the Army is going to use.

GSA has not yet accepted it. Should this be—

Mr. ROUSH. It is under construction in our region II.

Mr. HOWARD. They are moving in. Now, would this come under your jurisdiction of buildings that GSA either owns or leases, even though the Army will have control over it?

Mr. ROUSH. Yes, sir, it would.

Mr. HOWARD. Thank you.

Mr. ROUSH. In other words, generally, the general office space in the continental United States that is off post would come under GSA jurisdiction.

Mr. GILBERT. How many buildings of these 450,000 are outside the continental United States, let's say, outside the territory controlled by the United States, as in foreign countries?

Mr. ROUSH. As I indicated earlier, I have to review the number myself—the number outside the United States owned for nonmilitary functions is estimated to be more than 10,000 additional installations, and the number of buildings leased in whole or in part is estimated to be in excess of 40,000 installations worldwide.

So, again, we come back to the number, a total of 450,000 buildings.

Mr. GILBERT. That excludes the military.

Mr. ROUSH. No, that includes the military, sir.

Mr. GILBERT. But does not include military buildings that are owned in some way by the United States. What is the status, say, of a military post that was built by the United States on, say, Belgian soil or German soil?

Would that be included in your figures?

Mr. ROUSH. No.

Mr. GILBERT. Are they included in the 400,000?

Mr. RICE. The 400,000 only includes buildings owned by the Federal Government, including the military, in the United States.

Mr. GILBERT. I see.

Mr. ROUSH. That is not reported, the example you cited.

Mr. GILBERT. On the question of facilities—you notice that we use the word—that is your view about retaining the word "facilities." Would you prefer to have it in there or not?

Mr. ROUSH. I believe that would make the legislation, to my knowledge at this point in time, extremely difficult to administer.

Mr. GILBERT. On the definition that was offered by Mr. Rice concerning replacement of "substantially all" with "more than 66 percent of the net assignable square footage," is there any reason why you choose 66 percent rather than, say, 50 percent?

Mr. ROUSH. No, sir. But we feel it is important that you decide a definite figure rather than a generality, which is currently included in the legislation—rather than leave it open to interpretation. If we occupy two-thirds of a facility, it gets to the point, particularly in a leased facility where we have more leverage with the owner to secure the energy-conservation materials that we need in a building, or the energy-conservation equipment that we need in a building; where we would attempt to move into 10,000 square feet of a 100,000 square-foot building and tell the owner that because we are occupying 10,000 square feet, you will do one, two, three, four, five for energy conservation in your building and he says to you the price is \$15 a square foot and the price to everyone else who uses the normal facility is \$5.

And that is why I caution that if there is not some provision for waiver, when appropriate, by the Administrator written into the legislation, we could find ourselves in situations in some of the smaller communities where space would not be made available to us, or at least it would be made available to us only at an excessive price.

Mr. GILBERT. Just two further questions, Mr. Chairman. Is there a size of building under which your experience would indicate this might not be suitable?

Mr. ROUSH. That is one of the things we hope to find from some of the demonstration projects that we are working on now.

We have discovered that there is a point of some of the newer techniques becoming noneconomic. For instance, I have some question in my own mind—and this is strictly off the top of the head, if you will—whether for a, say, apartment location and 12 suites, someone could afford to put in a \$100,000 solar collector.

You would take the economics of the situation and price it out of the market, so that you may install it and you may build it, but it would never be used or would never meet market requirements.

Mr. GILBERT. Do you think you would need an authority to classify buildings, if you were to proceed with this program?

Mr. ROUSH. I would hope that the legislation would be written in such a fashion that the Administrator would be able to make the determination as to which are the most important first and where the need exists. And, in that fashion, we could touch on this in the most economical manner.

Mr. GILBERT. One last question. We did invite the Office of Management and Budget to appear today, but apparently they couldn't make it.

Was this figure of \$225 million coordinated with the Office of Management and Budget?

Mr. ROUSH. The Office of Management and Budget informally saw the figures and there was no comment made at that time. So I would have to say OMB has no comment at this time.

Mr. GILBERT. Thank you, I have no further questions.

Mr. HOWARD. The gentleman from North Carolina.

Mr. MIZELL. Thank you, Mr. Chairman. This is a question that I wanted to ask earlier.

In discussing the Manchester building, where you are installing the solar receptors, do you also have a study going at this time as to how feasible it would be to install one of these in one of the existing buildings, such as the Labor Department, the Pentagon or Commerce?

Mr. ROUSH. We have not attempted at this point in time to utilize solar collectors in an existing building or at an existing location. I certainly expect that we will be going into that very rapidly. But the resources that we have for the demonstration project at the moment are quite limited.

Mr. MIZELL. Would you have any suggestion for the committee in order that we may be helpful in helping you to conduct such a study?

Mr. ROUSH. I don't believe I could make a suggestion that would fill the bill at this point in time.

Mr. MIZELL. I see. Well, thank you. My thought was that we are constructing very few new buildings, but we have a great many of the older buildings, and this might be the area that we could have the greatest savings—that was my thought.

Mr. HOWARD. Mr. D'Amico.

Mr. D'AMICO. I just want to inquire, Mr. Chairman, if these gentlemen would be available later in the week for further discussion with the staff.

Mr. ROUSH. No difficulty whatsoever.

Mr. HOWARD. Just one academic question. Should we modify the coverage or extend the time on this operation? Do you feel that if you are given enough money you can do the job?

Mr. ROUSH. Yes, sir. No question whatsoever.

Mr. HOWARD. Thank you very much. We certainly appreciate your testimony and the subcommittee will stand adjourned pending call of the Chair.

[Whereupon, at 5:11 p.m., the subcommittee adjourned.]

[The following were received for the record:]

ENVIRONMENTAL DEMONSTRATION PROJECT FOB—SAGINAW, MICH.

SELECTION

The new Federal Office Building to be constructed in Saginaw, Michigan, was designated by Mr. Arthur F. Sampson, Head of the General Services Administration, as the GSA Environmental Demonstration Building on June 19, 1972.

PURPOSE

The purpose of this project is to: (a) Dramatize the firm commitment of PBS/GSA to environmental concerns in the design, construction and operation of Federal buildings; (b) provide a laboratory for the installation of both recognized and innovative environmental features/equipment; and (c) inspire others in the building industry toward environmental improvement.

DESCRIPTION

Approximate Gross Area : 51,600 sq. ft.

Principal Occupants :

U.S. Postal Service

Department of Agriculture

Department of the Treasury

Department of Health, Education and Welfare

Approximate Building Population : 177.

Total Site Size (Originally 80,450 sq. ft. ; being increased to 125,500 sq. ft.¹)

Estimated Construction Cost : 3,786,000 (October 1973)

DESIGN APPROACH

The original professional services contract with Smith, Hinchman and Grylls, Associates of Detroit, Michigan (A/E), to design the FOB, Saginaw, Michigan, as a conventional building was amended in October 1972 to cover additional services necessary for this to be a demonstration project. GSA and the A/E actively sought ideas for features/systems/equipment which might be included in the project. Fifty-nine (59) colleges and universities responded to our request by submitting 250 brainstorming ideas for possibly inclusion in the project. These ideas were considered, along with the recommendations from the GSA/PBS Environmental Conference on Building Construction and Use, GSA/NBS Energy Conservation Roundtable, and ideas originating with the A/E, GSA, manufacturers, technical societies, etc. As expected, many ideas submitted were duplications or variations of other ideas.

¹ Early in the design phase, it became apparent that the original site was so small that it would drastically restrict the design flexibility needed for a noteworthy environmental demonstration project.

SCHEDULE AND CURRENT STATUS

Because of the nature of the project and the limited design time, a flexible schedule was established for the idea collection, research and evaluation, and preliminary design through tentatives. The remainder of the schedule follows:

Idea Collection and Evaluation Complete: January 19, 1973.

Concept Drawings Approved: January 17, 1973.

Public Advisory Panel Approval: January 29, 1973.

Begin Working Drawings: February 21, 1973.

Complete Working Drawings and Specifications received in Region 5: September 10, 1973.

Contract Award Date:²

Complete Construction:²

FEATURES/CONCEPTS INCLUDED IN APPROVED DESIGN

*A. Enhance the environment**1. Outdoor*

(a) Design creates a park for residents of area with planting around the building and planting an approximately one-third of the roof. Roof landscaped area will be accessible at all time from the surrounding sidewalks—not through building.

(b) All parking is hidden from view from surrounding streets and sidewalks. (Exception: 12 spaces for short term parking for Post Office patrons and visitors.) Additional roof area can be landscaped if parking can be reduced in future.

(c) Post Office maneuvering area, loading platform and trucks screened from view to prevent image of an industrial facility.

(d) Parking areas on portions of the roof designed for play area for neighborhood children after hours. Arrangement will probably include provision for tether ball and people moving monopoly. Portions of parking could also be used for public parking after hours.

2. Indoors

(a) Excellent working environment. Large open spaces with few columns to facilitate office excellence layout.

(b) Full window walls at most locations to provide open vista to outside for building occupants.

B. Use of recycled materials

1. Wall surfaces near entrances, both inside and outside building, will be of panels made from rubble of demolished buildings.

2. Paving surface in certain parking areas will be made of recycled rubble.

3. Walkways on landscaped portion of roof will be made of porous panels made from recycled brick set in resinous materials. Porosity of panels will eliminate necessity of special drainage system to accommodate water runoff.

4. Aluminium used in the building construction will be either recycled or from the national stockpile. In either case, the energy needed for production will be less than for aluminum refined from new ore.

C. Water requirements and recycling

1. Rainwater will be collected from around building and possibly from roof parking areas (if oil and salt is found to present no serious problem) for use for lawn sprinkler.

2. Design of flushing system for toilets and urinals is expected to eliminate need for municipal water for this purpose.

3. Requirements for municipal water will be minimal—for drinking and lavatories only.

4. Single-pipe, single-temperature water will be supplied to lavatories.

D. Solar energy

1. Large, flat plate type solar collector will be included. Solar energy system is expected to provide all the domestic hot water required for the building and approximately 70 percent of the building heating, thus saving normal fuel sources while operating pollution-free.

² These dates depend on the availability of funds for construction.

ENERGY CONSERVATION DEMONSTRATION PROJECT FOB—MANCHESTER, N.H.

SELECTION

The new Federal Office Building to be constructed in Manchester, New Hampshire, was designated by Mr. Arthur F. Sampson, Head of the General Services Administration, as the GSA Energy Conservation Demonstration Building on October 3, 1972.

PURPOSE

The purpose of this project is to: (a) Dramatize the firm commitment of PBS/GSA to the conservation of energy in the design, construction and operation of Federal buildings; (b) provide a laboratory for the installation of both recognized and innovative energy conservation techniques/equipment; and (c) inspire others in the building construction industry to pursue energy conservation as a goal.

GENERAL DESCRIPTION

The building will probably be 7 floors in height and have a two level parking garage.

Approximate Gross Area : 175,000 sq. ft.

Approximate Net Area : 131,000 sq. ft.

Principal Occupants :

Veterans' Administration.

Department of Defense.

Department of Housing and Urban Development.

Department of the Treasury.

(Plus 7 additional minor occupants.)

Approximate Building Population : 418.

Approximate Site Size : 40,000 sq. ft.

Estimated Construction Cost : 6,563,000 (April 1973).

DESIGN APPROACH

A professional services contract was awarded to Nicholas Isaak and Andrew C. Isaak (A/E) of Manchester, New Hampshire, for the design of the project on November 7, 1972. In addition, the firm of Dubin-Mindell-Bloome Associates, was engaged on December 4, 1972, to serve as Energy Conservation Consultants (ECC) for this project. Further, the National Bureau of Standards (NBS) was made part of the design team to perform detailed computer studies and to participate in the instrumentation and evaluation of the building. The ECC is responsible for the collection, evaluation, and selection (with GSA concurrence) of energy conservation features to be included in the project. He works closely with the A/E, NBS and GSA.

Brainstorming ideas, relative to energy conservation, were solicited from 20 professional groups, trade associations, Federal agencies, utility companies and manufacturers. Energy conservation ideas have been assembled from the recommendations of the GSA/PBS Environmental Conference on Building Construction and Use, GSA/NBS Energy Conservation Roundtable, the A/E, ECC, GSA and colleges and universities.

SCHEDULE

Provide Energy Conservation Input for Concepts : March 20, 1973.

Complete Tentative Drawings : August 6, 1973.

Complete Working Drawings : January 2, 1974.

Printing Bidding Documents and IFB : February 20, 1974.

Bid Opening Date : March 20, 1974.

Award Construction Contract : April 17, 1974.

Construction Complete : ³ July 18, 1975 (Earliest). December 18, 1975 (Latest).

WHAT WE EXPECT TO ACCOMPLISH

The eventual design is expected to make a positive contribution to its urban surroundings and provide a pleasant interior environment for employees and visitors.

³ Date depends on complexity of innovative features and unusual climatic conditions.

The completed building is expected to operate with at least 20 percent less energy consumption than other comparable existing buildings. We hope to demonstrate Energy Conservation Features in the following areas/systems:

Basic Architectural Design—Configuration, Orientation, Fenestration, Insulation. (Small site may limit possibilities in configuration and orientation.)

Mechanical-Space Conditioning.

Electrical and Lighting.

Plumbing.

Various systems may be installed on different floors of building.

Full field evaluation of the innovative features after occupancy, based on built-in instrumentation and occupant reactions. Successful innovations will be publicized to encourage use elsewhere.

FEATURES AND SYSTEMS PLANNED FOR INCLUSION IN PROJECT⁴

1. Building configuration, orientation, fenestration including shading; insulation; wall mass, etc., will be controlled to reduce the energy required to operate the building.

(a) Building will be as near square and as large per floor (approx. 135' x 115') as site will reasonably permit. Lower office floor will be immediately over basement garage levels thus avoiding exposure of underside of lowest floor to full effects of outside weather extremes.

(b) Window areas on East, West and South walls will be limited to 5-15 percent range. Double glazing and shading will be utilized. There will be no windows in the North wall.

(c) Walls and roof areas will be insulated better than the current normal practice.

(d) Building core elements, which do not require close environmental control, will be located adjacent to the North exterior wall.

2. Mechanical, electrical and lighting systems will be carefully selected and coordinated to minimize energy consumption. Further, different types of mechanical, electrical and lighting systems will be provided on the various floors of the building to permit direct comparisons of performance and energy usage after building occupancy. Examples follow:

(a) Several lower floors will be served by a unitary closed loop water-to-air heat pump system. 2nd floor, exterior will have unitary heat pumps under the windows on ten-foot spacing. Heat pumps will utilize variable volume distribution system.

(b) Several upper floors will be served by a central chiller with air handling units and variable volume air distribution systems. Variations of the system will be utilized on different floors.

(c) If funds permit, a solar collector will be provided on the building roof with solar energy utilized for heating and cooling of several upper floors.

(d) Heat recovery and use system will include large, insulated, storage tank to store hot water. Heat will be reclaimed from many sources, including, rejected heat from heat pumps and chillers; heat from water-cooled transformers; possibly heat from burning trash; possible heat from engine generator. In addition, heated water from the solar collector, if included, can be stored in the same insulated tank for use during periods when there is no solar energy collection.

(e) Modular pumps, boilers, etc., will be utilized to maximum practical extent to permit operating only units needed for best efficiency for the varying loads.

(f) Economizer cycles are planned for all air handling units to take maximum advantage of outside air when appropriate.

(g) Heat recovery provisions will be included to permit transfers between exhaust and intake air.

(h) Different types of lighting systems will be provided on the various floors. One floor will be designed for conventional uniform lighting; other floors will be designed for non-uniform, task-oriented relocatable lighting; another floor will be designed to take maximum advantage of natural light; while other floors may be designed for polarized lighting and lights incorporated in the furniture.

(i) Air filters with low-frictional resistance will be utilized.

⁴ The project is in the early design phase. Therefore changes may occur as plans develop. List includes only some of the more significant items.

3. Operation of building will be planned to minimize energy usage. Examples follow:

(a) Normal operations and custodial work will be confined to the normal workday.

(b) All ventilation fans may be shut off 10 minutes of every hour.

(c) Temperatures of corridors, restrooms, equipment and storage rooms will be allowed to vary to 65 degrees F in the winter and 80 degrees F in the summer.

(d) Temperature set back (5 to 10 degrees) may be utilized one hour before closing time in the winter, in addition to other energy savings by not maintaining comfort conditions at night.

(e) During periods when cooling is required, higher temperatures than current standard design practice will be accepted.

(f) The building will be flushed out with 100 percent cool night air (down to 65 degrees) when appropriate conditions exist during the summer season.

5. Evaluation of Building Performance and Energy Usage.

(a) The building will be instrumented to facilitate the collection of data and evaluation of the energy requirements of the building as a whole and of the various mechanical, electrical and lighting systems installed on different floors of the building.

(b) An evaluation will be made of employee reaction to the building and its environmental systems.

NOTES ON FEATURES INCLUDED IN MANCHESTER PROJECT

1. Building Shell

(a) As near square as site will permit (135 feet by 115 feet).

(b) U-Value for walls—.06 (Normal .04-.02)

(c) U-Value for roof—.06

(d) U-Value for floor directly over basement garage—.06.

(e) No windows in North Wall.

(f) Windows on East, West and South walls limited to an area in the 10-15 percent range.

(g) Exterior wall mass—100 lbs/sq. ft. (normal 20-30 lbs/sq. ft. for curtain wall construction).

(h) Exterior wall incorporates shading for windows—designed to minimize summer radiant energy load.

(i) Windows; double glazed, designed to minimize infiltration.

2. Location of Building Core Elements.

(a) Core elements located adjacent to North exterior wall—do not require close environmental control.

3. Mechanical-Electrical Systems.

(a) Different systems on various floors to permit direct comparison of performance and efficiency. All systems included are expected to be energy efficient. We were unable to include all systems considered energy efficient in a single small demonstration project.

(b) No reheat air-conditioning system included.

(c) Types of systems by floors.

(1) Floors 1, 2 and 3.

Exterior zones served by unitary closed loop water-to-air heat pumps, with Variable Volume boxes in branches from main distribution supply ducts.

Interior zones served by similar packaged heat pumps, with variable volume control.

Economizer cycle provided with outdoor air controlled by an enthalpy controller which senses both temperature and humidity.

All variable volume systems of the "bypass" type so there is full air flow across refrigerant coils at all times.

Rejected heat from all pumps operating on the cooling mode during occupied periods piped to large insulated hot water tank, which serves as the heat source for heat pumps operating on the heating mode at night, etc., when heating is required.

(2) Floors 4, 5, 6 and 7: Variable volume system in roof to serve interior zones of all four floors.

Floors 6 and 7, provided with four pipe perimeter units, but arranged to operate as either two-pipe or four-pipe system. Units draw air from air ceiling plenum to make use of heat-of-light for heating during occupied periods.

Floors 4 and 5 provided with a separate air handling units for perimeter zones, arranged for variable volume, with vaned inlet fan control.

(d) Central chillers for floors 4 thru 7 normal driven by a gas engine generator. Waste heat from engine generator used to operate an absorption chiller. Condenser water from both chillers piped to heat storage tank and to cooling tower. Heat will be used to maximum extent possible; otherwise condenser water will be cooled by tower.

(e) Water heat used for space heating at night, and for domestic hot water.

(f) Gas engine generator disconnected from chiller and used to provide emergency power for building during emergency blackout situation.

(g) Chillers undersized to carry peak load. Operated at night when electrical load light and production of chilled water more efficient to store up chilled water in insulated tank for use next day during peak load period.

(h) Boilers and pumps of modular type to permit operation of only required number to gain maximum efficiency.

4. Solar Energy System.

(a) If funds become available, solar collector will be provided on roof.

(b) Flat plate, saw tooth type.

(c) Weather station included for development of data.

(d) Utilize same hot water storage tanks, etc., already included for waste heat.

5. Lighting.

(a) Different systems on various floors to permit direct comparison of performance and efficiency.

(b) One floor with uniform lighting; another floor probably with polarized light; another floor *possibly* with lights in furniture; remaining floors with non-uniform, relocatable, task-oriented lighting (our ICB System).

(c) One floor has larger windows for experiment with natural light for perimeter of building.

6. Operation.

(a) Special procedures will be followed in operation of building to maximize energy savings.

7. Evaluation.

(a) Building will be fully instrumented and NBS will make full performance evaluation after occupancy.

UNITED STATES POSTAL SERVICE,
Washington, D.C., November 27, 1973.

Hon. JOHN A. BLATNIK,
Chairman, Committee on Public Works,
House of Representatives, Washington, D.C.

DEAR MR. CHAIRMAN: This responds to your request for a report on H.R. 11299, a bill "To insure that certain buildings financed with Federal funds utilize the best practicable technology for the conservation and use of energy."

The bill would authorize and fund programs by the Administrator of General Services designed to promote energy conservation in new and existing buildings. The new programs would not directly apply to the Postal Service. Under 39 U.S.C. § 410(a) and 40 U.S.C. §§ 474(15), 615(2) [as amended by the Postal Reorganization Act, P.L. 91-375, section 6(m)(2), (3)], the Postal Service is responsible for its own procurement and construction and is no longer under the jurisdiction of the Administrator.

Nevertheless, we believe that the Postal Service would profit from the proposed legislation. In keeping with our independent responsibility in this area, we have taken steps on our own to conserve energy resources. Just recently, the Postal Service has been able to reduce its energy consumption by an average of six percent per year over the past three years. In addition, we have taken prompt action to cooperate in the implementation of general federal agency programs for energy conservation. For example, when the President ordered federal agencies earlier this year to cut energy consumption by seven percent, the Postal Service adopted that target for its own conservation planning.

NOTE.—We have entered proposals in the Energy R. & D. Program established by the President and monitored by AEC, for funds for Solar Collector.

This bill, if enacted, would enable G.S.A. to shed additional light on problems that have so far received too little attention. The Postal Service would be happy to cooperate with the Administrator in any way possible and to make full use of the results of his study. Accordingly, we support H.R. 11299 and hope that it will receive rapid and favorable treatment.

Sincerely,

ROGER P. CRAIG,
Deputy General Counsel.

GENERAL SERVICES ADMINISTRATION,
Washington, D.C., November 28, 1973.

HON. JOHN A. BLATNIK,
*Chairman, Committee on Public Works,
House of Representatives, Washington, D.C.*

DEAR MR. CHAIRMAN: It is a pleasure for the General Services Administration to have the opportunity to comment on H.R. 11565, "to insure that certain buildings financed with Federal funds utilize the best practicable technology for the conservation and use of energy."

As you may know, the General Services Administration has moved forward, in rapid fashion, with a comprehensive energy conservation program for existing buildings and that we have under design a new facility in Manchester, New Hampshire which we call our energy demonstration project. Because of the committee's concern with the energy issue, you may be interested to know that on November 2, 1973, page E6993, the Congressional Record contained a detailed statement on our energy conservation program as it relates to Federal office buildings.

We are proud of our initial efforts, to achieve the President's energy conservation goals, which as of last week have resulted in a 9% reduction in GSA energy usage over the past three months when compared to last year.

H.R. 11565 would give the Administrator of General Services the authority to develop design criteria for new Federal buildings providing for the best practicable use and conservation of energy. We consider this authority to be in full accord with our role as the chief construction agency of the Federal government and we have already instituted several projects which will affect design criteria for new buildings. These projects include:

1. The development of Federal design criteria for energy conservation which are being prepared in conjunction with the AIA Research Corporation.
2. The instrumentation of the Manchester building to substantiate the National Bureau of Standards computer design model.
3. The development of an air change rate study.
4. A study on a centralized computer control of buildings on energy use.
5. A study of lighting levels and use of task oriented lighting.
6. The development and use of an integrated ceiling system.
7. The evaluation of the Saginaw Environmental Demonstration Building.
8. The development and use of various energy conservation systems included in the Manchester project.
9. The design of solar collectors for the Manchester and Saginaw buildings.

We are proceeding with these projects as they relate to buildings under the jurisdiction of the General Services Administration and feel that our efforts to date have been very rewarding.

Although the bill now authorizes a survey of only GSA-controlled buildings, we would hope that the survey would prove that the bill should be extended to cover all federally funded buildings. We would consider this a most challenging endeavor and feel that our initial efforts in energy conservation techniques would be a tremendous asset in getting a more encompassing program off the ground quickly.

In this regard, you will be interested to know that the General Services Administration, in conjunction with the National Bureau of Standards, is already in the process of systematically analyzing 230 existing major Federal buildings to determine:

1. The reasons for the variance in energy usage between apparently similar buildings,
2. What elements of energy usage are manageable, and

3. What improvements in design and operating practices will reduce energy usage.

We anticipate the analysis will be complete in late February 1974 and thereafter expect to have a basis to learn what modifications can be made both to the physical structure of a building and changing its operating procedure to further reduce energy consumption. On new structures we already do energy usage analysis during the design phase.

The most immediate energy conservation impact of the bill is Section 3. We feel that adequate appropriation authorization would make it possible to achieve the purposes of the proposed legislation within the time frames specified. An inventory and examination of the 10,000 existing buildings subject to GSA custody and control would cost approximately \$5,000,000, based on a sample study of GSA-owned buildings, which estimates minimum expenditures of \$500 per building.

The General Services Administration appreciates the opportunity to comment on H.R. 11565 and feels that it could greatly assist in the coordination of energy conservation efforts by the Federal government.

We would be pleased to accept this challenge and continue in our efforts to meet the energy crisis we now face.

Sincerely,

ARTHUR F. SAMPSON,
Administrator.

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