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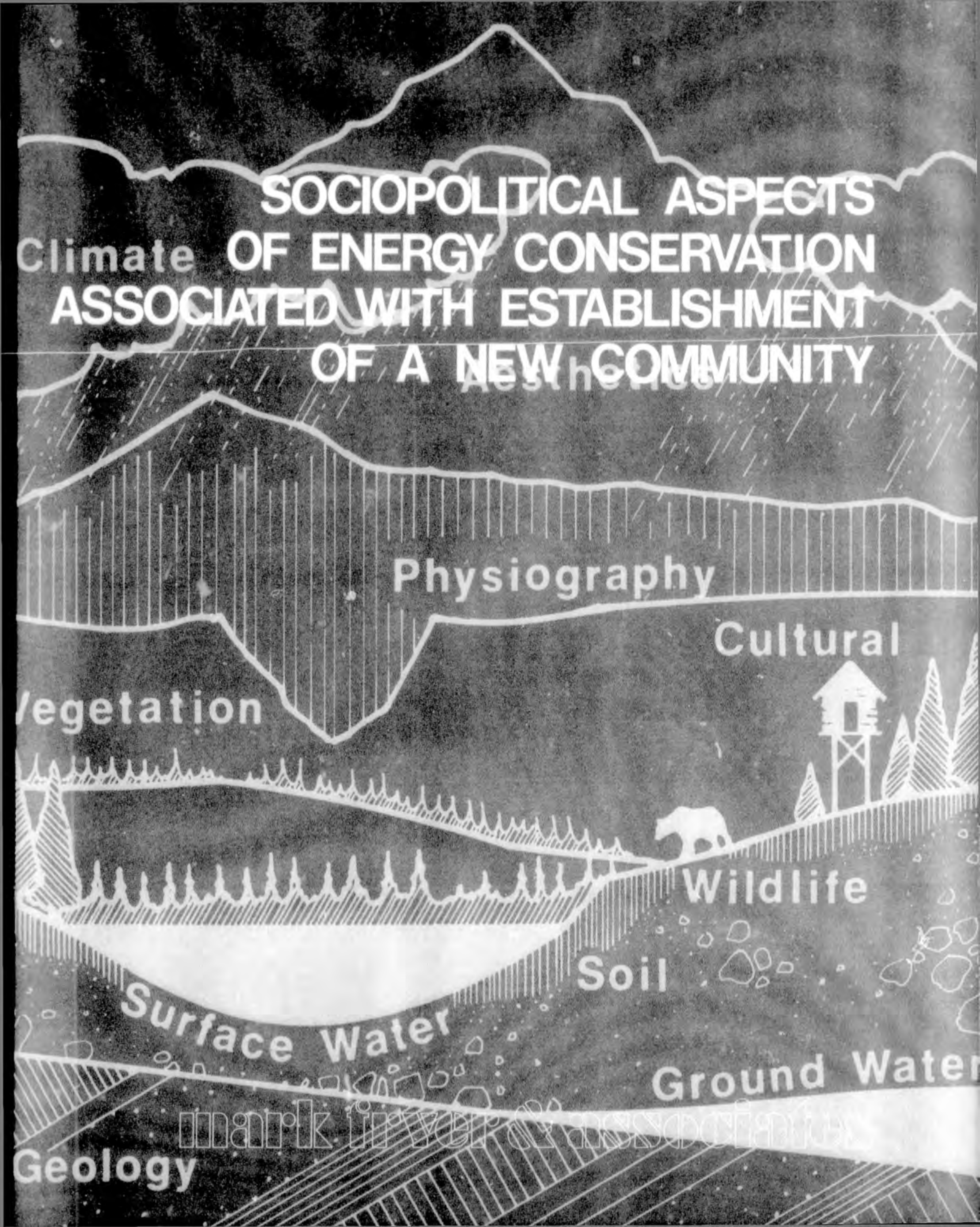
# SOCIOPOLITICAL ASPECTS OF ENERGY CONSERVATION ASSOCIATED WITH ESTABLISHMENT OF A NEW COMMUNITY



# FINAL REPORT
# ENERGY CONSERVATION TECHNOLOGY STUDY
## SOCIOPOLITICAL ASPECTS OF ENERGY CONSERVATION ASSOCIATED WITH ESTABLISHMENT OF A NEW COMMUNITY

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# ABSTRACT

THIS REPORT DISCUSSES IN GENERAL TERMS THE POLITICAL AND SOCIAL CONSTRAINTS ON THE APPLICATION OF ENERGY CONSERVATION TECHNIQUES IN A NEW TOWN, BOTH IN THE PRIVATE AND PUBLIC SECTORS. GENERALLY, THE TONE OF THE REPORT IS THAT ALASKA ALREADY POSSESSES MOST OF THE POLITICAL AND ECONOMIC TOOLS WITH WHICH TO APPLY SUCH TECHNIQUES, BASED ON THE ASSUMPTION THAT GIVEN THE NECESSARY INFORMATION AND THE WILLINGNESS TO CONSIDER RELATIVELY INNOVATIVE APPROACHES, ALASKA'S CITIZENS CAN BUILD A NEW TOWN THAT WILL, IN ENERGY CONSERVING TERMS, PRODUCE SOCIAL AND ECONOMIC BENEFITS BOTH IN THE PRESENT AND THE FUTURE.

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# FOREWORD

On November 2, 1976, Alaska's voters chose from among three alternatives offered them a 100-square mile site for their proposed new capital at Willow in the southwestern foothills of the Talkeetna Mountains. Willow is located at the juncture of the Matanuska and Susitna Valleys, approximately 30 air miles and 70 road miles from Anchorage. If the capital move goes forward, by 1980 approximately 19,000 persons can be expected to live and work there. This population is expected to grow and stabilize at about 30,000 persons by 1990.

The purpose of the move is to bring the headquarters of state government to a more central location than Juneau, thus increasing its accessibility to the voters. As such, state government employment is expected to make up the major portion of primary sector employment and is estimated at about 3,700 persons in 1980, growing to about 5,900 persons in 1990. Also, within the primary employment sector, federal government employment is expected to remain stable at about 300 persons from 1980 to 1990, persons in contract construction will go from 570 to 830 over the same period, and manufacturing will go from 140 persons to about 200.

Within the secondary employment sector, municipal government employment is estimated at about 660 persons in 1980, growing to 990 persons in 1990. Services are expected to account for 4,650 persons in 1980, and 7,075 in 1990. In total, it is estimated there will be 19,000 persons in the new capital in 1980, 10,000 who will be employed, and in 1990, there will be 30,000, of whom 15,000 will be employed.

Of the structures to be built between 1980 and 1990, it is estimated that 20 percent of them will be dedicated to government, 60 percent will be residential of varying densities, and the remaining 20 percent will be allocated to commercial uses. Of concern here is to what extent can energy conserving technologies and methodologies be applied, particularly in respect to the construction of buildings, which will also complement or influence similar applications in the design of transportation and energy delivery systems. The technical state of the art in all respects is such that major steps towards energy conservation can be taken, from a technical or scientific point of view. The techniques, methodologies, and methods currently are available and new applications are expected in the near future.

But the extent to which these innovations and methodologies will be applied is not so much a question of available technologies as it is one of what the persons who must approve, in the final analysis, the capital move and those who will live there will permit to be imposed. The extent to which such energy conserving constraints can be applied is translatable only in terms of what the citizenry <u>may</u> allow. And this choice, what they may or may not do from the energy conserving point of view, is measurable not so much in technical and engineering terms as it is in the political, economic, social, and cultural values of the persons who will be expected to live under such requirements.

Most of the land in the 100-square mile Willow site is vacant though there are a few small plots that are privately owned (mining claims and recreational sites). In fact, the Willow site contained more private holdings than the other two alternatives (Larson Lake and Mt. Yenlo) offered the voters. Although a condition of the capital move proposition was that there would be no land acquisition costs to the State, if it is determined at a later date that these private holdings should revert to public state ownership, this could be accomplished through the State's eminent domain powers, coupled with a fair price to the private owners.

Depending upon the location of the privately owned lands, there is a potential for the evolution of characteristics that may not lend themselves to the development of energy conserving systems. Landowners may wish to transfer the use of the land to commercially oriented ventures (trailer courts, shopping centers, bars and cafes, apartment complexes, etc.) which may in the future develop service demands (roads, utilities, etc.) that may not fit into a developed energy conserving scheme.

Once a plan has been developed for the construction and configuration of the new capital site, a determination will then have to be made whether the existing private ownership patterns will be allowed to continue. If it is decided that it is necessary to buy back the land, this may be done on either a selective, individual basis, for just a few sites, or, for convenience's sake, a general buy-back of all privately held land.

If there is to be a minimum energy conservation controls, a buy-back may not be necessary. In any case, in order to accomplish either a selective or general buy-back, it will have to be shown in the face of owner resistance that there is a public benefit and legitimate State use for the land. Seller resistance reasonably should be expected as the present owners of the land will not overlook the opportunity to transform the use of the land to greater economic benefit. These people are "in on the ground floor", so to speak, either by accident or design, and will probably fight to stay there.

It is not unreasonable to believe even at this point that attempts are already planned by those owners to "improve" the land, thus entitling them to a higher price in the event of a reversion to the State or else putting themselves into a position to reap legitimately expected profits once construction of the site gets underway by providing accommodations and services to the contractors and their crews and later to the workers in the new capital.

## LEGAL AND POLITICAL CHARACTER

It is not known at this time exactly what the legal and political character of the new capital site will be. It could be a first-class municipality within the confines of the Matanuska-Susitna Borough, or it could be a new type of government, a special district, physically located within the Borough but exempt from its powers and with special powers of its own. It is assumed for the purposes of this report, however, that the new capital will be self-governing with an executive and representative legislature and will have home-rule powers. Whichever the case, it should be expected that the capital site will have the planning, zoning, platting and the taxing powers similar to those given by State laws to all municipalities (see AS 29.33.070-090, and AS 29.48.010, 29.48.030, and 29.48.035).

In addition, it should be remembered that the State will own the majority of the land within the capital site. As such, whether it sells or leases that land, it is in a position to, if not absolutely require, at least positively influence the use of energy conservation methodologies in the private sector construction activities.

As owner of the land, the State can, if it decides to sell in fee simple, set up convenants running with the land which will govern in broad terms the types and siting of structures that might be built. Such covenants, once agreed upon by the buyer, are looked upon favorably in Alaska law. Any purchaser of a lot in a subdivision in Anchorage is aware of their enforceability.

Additional controls the State can exercise are through the platting, authority granted to both the State and local governments. In energy conservation terms, this probably is most applicable in the realm of building orientation. Just as subdivision plats must conform to road widths, set-backs, et cetera, so also can a platting authority encourage the orientation of buildings in ways that would be energy conservative, yet take into consideration the topography and aesthetics of a particular site.

It should be pointed out here, however, that for such methods -- platting zoning, code regulation, tax incentive schemes -- to withstand legal tests, they must conform to a PLAN, which has, through the legislative and political process, been adjudged acceptable both on Statewide and local terms. As is indicated below, particularly with reference to zoning, such regulations must be "in accordance" with a plan. It is assumed for the purpose of this report, that such a plan will be in existance once actual building on the site begins and prior to any disposition of property, whether by outright sale or through some sort of leasing method.

## ZONING:

Zoning regulations must be in accordance with a comprehensive plan, which is a compilation of policy statements, goals, standards and maps for guiding the physical, social and economic development, both public and private, of an area, and may include, but is not restricted to, statements of policies, goals, standards, a land use plan, a community facilities plan, a transportation plan, and recommendations for plan implementation. Energy conservation should be covered by these statements.

Uniform zoning regulations, even-handed in their application to classes or kinds of buildings, structures or land and water areas within districts (though the regulations may differ among districts) include, but are not limited to, restrictions on land use; building location and use; the height and size of structures; the number of stories in buildings; the percentage of lot which may be covered; the size of open spaces; and population density and distribution. Whatever formulas are devised, energy conservation should be one of the factors considered.

The purpose of such regulations is to provide for orderly development, lessen street congestion, promote fire safety and public order, protect the public health and general welfare, prevent overcrowding, and to stimulate systematic development of transportation, water, sewer, school, park, and other public facilities.

Recent changes in the law permit "contract zoning" where the owner, either through a[illegible]ment or covenant with the governing body, places restrictions on [illegible] use of the land beyond the zoning requirements generally attaching to the district in which the zoning is placed. This is in exchange for a less restricted particular use. An example within the energy conserving context is that a person might be allowed to build a Planned Unit Development in an area normally considered useful primarily for single-family dwellings in exchange for incorporating energy conserving design features in the structure, among other things.

Thus, zoning regulations, because of their possibilities of broad application, covering a multitude of considerations, make up one of the strongest tools with which to impose or encourage the use of energy conserving techniques. However, at the risk of repetition, for such zoning regulations to withstand legal challenges, they must be in conformance with a plan and must be applied with an even hand. And the plan on which they depend must be acceptable in real social, economic, and political terms. A plan, and the platting, zoning, and code requirements it might give birth to, would not be acceptable in such terms, even though it met the most visionary energy conservation goals, if it essentially made it impossible for the middle class homeowner or entrepreneur to build or develop except at exorbitant expense. Nor would a plan which attempted to surmount the financial obstacles by a list of exceptions to stated goals be acceptable, primarily because of the possibilities of uneven and arbitrary application.

It should be pointed out that zoning regulation is by itself a brush that paints in broad strokes, and goes to the general rather than the particular. Areas are zoned in degrees of residential and commercial density: one can build multi-residential here, but not here; a supermarket complex here but only a corner grocery there; large lots here but smaller lots there. Zoning alone cannot accomplish particular energy conservation techniques. But, in combination with platting regulations and building codes, it can determine and encourage the development of a community which, in the venacular "makes sense," that is, determine the gross patterns of development, and thus make the application of energy conservation in the particular -- an individual structure -- more acceptable.

## CODES:

It can reasonably be expected that whatever the actual technical formal structure of the government of the new capital site might be, it will share with other local governments of the State the power to develop and impose fair and equitable building, housing, and related codes. Ideally, from the energy conservation point of view, the standards of ASHRAE 90-75 would be adjusted for the climatic conditions of the Willow site and incorporated into the building codes there at the very outset of any construction. These code requirements most likely would have to be imposed by the State through the legislative process and should be an integral part of whatever particular governmental structure was adopted.

Even so, as this imposition would have to be done through the legislative process, the difficulties in adopting such a code as pointed out in the Arthur D. Little, Inc. Report (Energy Conservation in New Building Design -- An Impact Assessment of ASHRAE Standard 90-75, Conservation Paper Number 43B, Arthur D. Little, Inc., and Federal Energy Administration, U.S. GPO, 1977), would probably similarly apply:

> "Concerning code authorities, ASHRAE 90 faces two problems: implementation and enforcement. It would not be surprising if a standard dealing with an abstract objective - achieving national energy self-sufficiency - were not to succeed, since more concrete concerns with such visible problems as consumer and third-party health and safety have failed to motivate institutional change and code effectiveness. Those institutional barriers that have so far prohibited the adoption of a model code on a more limited basis, will continue to create barriers for the implementation of ASHRAE 90 or allow it to be implemented only in cannibalized form. These problems could be moderated with financial or economic arguments."

The A.D. Little Report went on to point out that because of limited resources, manpower, and commitment, enforcement of such codes is weak. The Report suggested that a combination of financial incentives built into utility rates and tied to energy-conserving construction methods, and of penalties aimed at excessive energy users, must be considered "if energy conservation in building design is truly to be achieved on a widespread basis." The Report also raised as an alternative, but did not discuss the possibility of, encouraging long-term financing institutions to demand energy efficient structures; in other words, devise a method to lower the first-cost syndrome threshold.

In the ideal world, strict, energy-conserving zoning ordinances and building codes could be imposed. In the real world, public sector structures might adhere to them, but the private sector, faced with the proposition: "Build this way or don't build at all," might take the latter course. More probably, the private sector would lobby to amend such a code. Imposition of the codes without at the same time offering direct and indirect inducements and incentives probably would not be successful.

According to existing State law, which may be modified depending upon the actual legal and political configuration of the new capital site, the government will have the power (within fairly broad Constitutional constraints) to design, develop, codify, and enforce energy conserving zoning and building codes. However, these codes will have to be politically "sold", probably to the State legislature, and thus, less directly, to the persons and special interest groups which make up each legislator's constituency. They are the ones, more than any other, who will decide upon the legal and political structure of the capital site and the powers which that governmental unit can exercise.

## POSSIBLE INDUCEMENTS AND INCENTIVES:

To sell the idea of practical energy conservation a spectrum of inducements and incentives is going to have to be offered. As already implied, only minimal adjustments will have to be made to existing zoning and code regulation schemes and powers to allow energy conservation considerations. It does appear, however, upon initial investigation, that more major modifications will have to be made in local government taxing powers, specifically the scope and extent of tax exemptions on real and personal property, in order to offer a set of inducements and incentives that will make the imposition of energy conserving applications more appealing.

## TAXING POWERS:

Municipalities of the class and order assumed for the new capital site already have taxing powers and can levy special assessments in service areas. However, State law seems to limit the power of municipalities to levy and tax for any purpose in any one year to three percent of the assessed valuation of property within the municipality. No municipality may levy taxes which will result in tax revenues from all sources exceeding $1,000 a year for each person residing within its boundaries.

In addition to required exemptions, such as property used exclusively for religious purposes, municipalities may exclude or exempt or partially exempt residential property from taxation by ordinance ratified by the voters at a regular or special election. However, according to State law, such exclusions or exemptions may not exceed $10,000 for any one residence.

## APPLICATIONS:

If authorized, such exemptions might be used as an inducement to residential builders to incorporate the energy conserving design features outlined in a proposed code. However, there may be due process and equal protection arguments which would have to be examined to see if such exemptions could be offered to one class of builders or landowners but not to others. Perhaps, because this would be a brand new city, there would be no distinction among types of builders as they would all more or less be in the same situation: i.e., all starting construction in the same area at roughly the same period of time.

It is noted, however, that this authorized exemption applies only to residential buildings, not to commercial structures which have the larger energy saving potential under the ASHRAE proposed standards. A particular effort should be made in setting up the legal and political structure of the new capital to give it the power to apply similar tax exemption or exclusion inducements to builders of commercial structures, as well as residential structures. This probably would require amendment of present State tax laws.

Another method of inducement through the taxing powers might be through the power given by the State to cities to establish, alter, and abolish differential tax zones to provide and levy property taxes for services not provided generally within the city or a different level of service than that provided generally within the city. Such power, coupled with the general zoning power, could be used to set up another range of inducements. For example, builders of commercial structures such as shopping plazas could be required to build only within certain zones, but in exchange for the incorporation of energy conserving techniques, which reduce the amount or quality of utilities the government might be expected to provide (the "different level"), the builders might be given some sort of tax incentive -- a "different level" of taxes (lower).

## TRANSPORTATION ASPECT:

We have so far concerned ourselves only with the possibilities and powers of the capital government as applied to the construction of energy-saving structures. There are other areas which have energy conserving aspects that are also subject to the usual regulatory powers given municipalities. Transportation is a prime example, and municipalities are given the power to regulate the licensing and operation of motor vehicles, as well as the licensing of buses and the setting of fares. It is not clear, but it could be made possible, even if it takes legislative enactment, that control of vehicular traffic could be accomplished through this regulatory scheme (and accompanying licensing fees) shifting persons to public transportation modes which are more energy efficient. This approach is feasible only where the actual design configuration of the entire capital site permits, along with the value assumption that public transportation is of such overall benefit that it deserves some kind of public subsidization.

## CONFIGURATIONS AND DENSITY LEVELS

Crucial to all the above considerations is the aspect in an energy-conserving context of the density levels of the proposed new capital site. In the report by Smith (Identification of Environmental Impacts of Energy Conservation Technologies...Task J), five site configuration options are considered: (1) Base Line Case, Low Density; (2) Neighborhood Clusters, Low Density; (3) Neighborhood Clusters, Medium Density; (4) Neighborhood Clusters, Medium Density (altered mix); and (5) Central Cluster, High Density. Of the five, the first, Base Line Case, is potentially the most energy wasteful, being as it is consistent with presently normal community develop patterns in Alaska, using currently applied state-of-the-art planning, and without consideration of energy conservation. This configuration is prophetic of what the new capital site would be like should there be no steps taken to apply energy conservation methodologies.

The last of the alternatives, a High Density, Central Cluster, is potentially the most energy conservative, dealing as it does with massive, integrated structures located in a central core and obviating the need for widespread transportation and utility service distribution systems.

## BASE LINE, LOW DENSITY:

Within the political and legal context, the first of the two is entirely possible if it is assumed (or decided) that no steps will be taken to introduce energy saving constraints on the planning, design and actual construction of the new capital. However, it is the subjective evaluation of this writer than even assuming a "worst case" construct of resistance to the imposition of energy saving technologies, the people of this State, through their legislators, will not allow the construction of the ill-designed capital. It should also be pointed out that Federal monies probably would not be available to assist in the planning, design and construction of a new capital site under those conditions. Nor does such a configuration fit into the concept of a "new", "model" capital.

There is already significant political opposition to moving the capital at all, especially from areas other than Anchorage, as daily review of the media and an awareness of the machinations of the legislature reveal. To allow to be built a sprawling, unplanned, wasteful community would be to strip away much of the justification for the new capital in the first place. All that would result under this configuration would be the opening up of new markets for a comparatively few Anchorage entrepreneurs, according to the perceptions of anti-move forces throughout the State. The question, "Why should it be moved at all?" would assume greater substance and authority than it presently has.

## HIGH DENSITY: CENTRAL CLUSTER:

When one deals with the other extreme, the technologically feasible high density, central cluster concept, one cannot help but to attempt to draw parallels with the Brazilia experience of 15 years ago. Such drawing of parallels should not be dismissed as being merely whimsical or blindly obstructionist. Such perceptions may be very real and are real, and therefore have real political effects, which, in turn, reflect real social and cultural apprehensions.

The political perception is that Brazilia did not work, and it is not a totally incorrect perception. There is in the popular view a notion of sterility, excessive direct and indirect regulation and control, overcrowdedness, and a loss of individuality -- where a person might come to think of himself (and be thought of by others) as merely a member of the mass. The suspected cultural and social apprehension among Alaskans, whether new arrivals or persons who have lived here for some time, probably is that, except for a small minority, they would not care to live that way.

It is from these real or perceived concepts that many of the persons who have come to Alaska fled. Though these values probably would be cited by most U.S. citizens wherever they might live, they appear to have a greater intensity in Alaska. Many persons who live here willingly accept a harsh climate and a certain lack of amenities in exchange for these values. The measurable values that persons cite when asked why they live in this State are the very antithesis of what they perceive might occur under the central core concept. It is the fecundity of Alaska and the Alaska life style that attacts them. It is the perception of a relative lack of direct and indirect controls that keep them here.

It is these and the relative lack of crowding and the idea of open spaces, a sense of not being labelled or arbitrarily stuck in some societal slot that gives to Alaskans a peculiar but identifiable sense of individuality -- the Alaskan's individual responsibility and authority for how he might manage to run his own life and "do his own thing", with a minimum of interference from others.

## THE POLITICAL ACCEPTABILITY OF NEIGHBORHOOD CLUSTERS:

The above factors are all very subjective value judgments on the part of the persons who hold them. Thus, any attempt to describe or define them also is a subjective exercise. Nevertheless, those subjective judgments will have real or objective effects, if only in a negative sense, as they translate themselves into political, social, and cultural resistance to the central cluster concept. This is not to say that these judgments cannot be changed, but the assumption for the purposes of this paper is that they cannot be so changed within the period of time allowed to begin construction of a new capital, not without changing the very character of the persons who can be expected to live and work there.

Thus, it would appear that the mid-range of configuration alternatives, those dealing with neighborhood clusters of varying density, would be the most acceptable and therefore politically, economically, culturally, and socially feasible.

These neighborhood configurations represent a compromise between the aforementioned possibilities. As such, they are demonstrative of a political truism, to wit: Politics is the art of the possible. Politics is itself a distillation of the economic, social, and cultural perceptions of the citizenry. The neighborhood configurations are of greater political acceptance because they meet the subjective assumption that the persons who propose, design, plan, and construct a capital and the persons who will be expected to live and work there probably will accept only a site configuration that actually gives them a range of choices as to how, where, and why they will live and conduct their daily lives. Within this grouping, a greater or lesser extent of energy conserving technologies may be imposed or applied, while at the same time allowing for the political decision making and participation that can realistically be supposed persons living within and without the proposed new capital site will insist upon.

Although the low density cluster option is probably the most pleasing concept for most Alaskans, the medium density cluster and the altered mix cluster should still be acceptable, yet provide the most opportunities for energy savings. Design and planning, as well as actual construction, of such configurations can be accomplished with little modification to existing planning and zoning, taxation, and regulation powers that, as discussed above, are expected to be within the political and institutional authority of the capital site and the State. Such configurations also have the advantages of flexibility and time responsiveness.

In other words, though it is hoped that the new capital site will be "locked in" to a policy and plan of energy conservation, and will have developed or have developed for it the codes and ordinances, zoning regulations, taxation schemes, etc., that will accomplish those goals, the neighborhood concept allows for the political and institutional framework to respond, without unduly limiting, the free choice of individuals as to where and how they wish to live on the larger scale. The neighborhood concept allows for the Adam Smithian play of the "invisible hand" of free enterprise, yet it can channel the fields in which the hand will play to the greater overall public welfare in energy conserving terms.

It is the position of this paper that the neighborhood cluster concepts - both medium and altered mix - offer a chance of achieving energy conservation, yet within terms that are politically, economically, culturally, and socially acceptable. For example, the structures housing and directly serving the State and local governmental units can be built and their energy supplies accommodated to the most rigid possible applications of existing technologies. In fact, in order to be eligible for the Federal money and State bonding authority necessary to fund construction, there may be no other choice within this sector. Yet, at the same time, individuals can be allowed to build (within code and zoning restrictions) at sites they determine they desire on the basis of subjective considerations (a "good" financial deal, aesthetic values, closeness to friends or acquaintances, access to recreational activities, a perceived need for some kind of neighborhood service - a laundry, a bakery, a bar, an ice cream or pizza parlor).

However, any person so desiring to build would have to conform to the energy conservation requirements spelled out in the code for the structure itself, and, if this site location did not fall within the zoning regulations, he would have the burden of proving to the appropriate governmental unit (probably a legislative authority) the legitimacy of his choice.

In other words, he would have to put forward a case for an exception. Any political structure within the State of Alaska constitutionally would have to set up a forum where he could voice those arguments with a reasonable expectation that those arguments would be given real consideration.

## THE LEASING ALTERNATIVE:

The same degree of inexactitude with which the legal, institutional, and political structures of the new capital site are discussed above also applies to the land ownership patterns in the new capital. The underlying assumption has been throughout that traditional fee ownership will be the ruling regimen for the majority of the area. But, just as the exact political and institutional configuration has yet to be set, so also has the land ownership pattern to be formulated.

Thus, it is useful to mention, at least in passing, the possibility that land could be leased, rather than transferred in traditional fee title. Such leases could be of either short or long-term, with periodic options for renewal. Although opposition to leasing is predictable, in line with the traditional American and particularly the Alaska ethic of the individual desire to own one's own piece of land, such opposition should not be assumed to be insurmountable.* Persons will still want to build

* For instance, the dense central core concept implies some sort of leasing scheme, both for residences and commercial spaces, especially the "tower" concept.

at least their own homes, despite the fact they may rest on leased land, and entrepreneurs will still be attracted to the area in order to take advantage of the new markets there.

Though a similar even-handedness of application will have to apply to leasing decisions and concurrent controls as are constitutionally required in the application of zoning, code, and taxation regulations, leasing would give more power to the leasing authority to impose and require energy conserving technologies in construction. In other words, leases cannot be granted or withheld in an arbitrary or discriminatory manner, but the length, rates, and terms of the lease can be used to penalize or reward builders who incorporate energy conserving techniques in their designs and structures, whether private residential of any particular density, or of commercial buildings.

The possibility of leasing land and/or space should be given particular consideration during the construction phase, if not to the operational phase of the new capital site. It may be too much to require that the structures and facilities required to house and service the initial intensive construction phase of the new capital should conform to strict energy saving constraints. Many such structures, viewed in the long-term, can be seen as relatively temporary. Short-term leases of two, three, four and five-year durations should be offered to those wishing to build accommodations for workers, supply facilities, fabrication yards, etc. Such facilities could be expected to be removed at the end of the construction phase, or, if their owners desire to remain in place with a greater degree of permanency, renewal options requiring conformance with energy conserving constraints can be built into the leases.

Whether under a leasing scheme the leasing authority or private enterprise should build the actual structures is not determined at this time. Neither is the actual structure of the scheme and/or authority discussed in any depth or detail (e.g., would it be structured along the lines of ASHA?; or a quasi-public/private organization?). However, the feasibility of a leasing scheme and authority should be investigated rather than being dismissed out of hand. Such a scheme may provide means and methods to insure all aspects of energy conservation, including transportation and utility delivery systems in both a demand and time-responsive way.

It should be pointed out that for such a scheme to be acceptable and to work, it cannot be completely insulated from the same political, cultural, economic, and cultural constraints that will affect the traditional methods of control. To make a leasing scheme acceptable, citizen participation in formulating the policy itself, the method of its implementation, and any major changes or amendments should be allowed, just as it is on major zoning changes or exceptions, code application, and local taxation schemes, most of which traditionally must be made by legislative ordinance after public hearings.

## TRANSITION ASPECTS:

Most of the foregoing speaks to the long-term aspects of the construction and eventual operation of the new capital site. It is a discussion of the political and institutional framework that eventually could be put in place and fully operating, within the energy conserving context, by 1990, when the new capital stabilizes at roughly 30,000 population.

It must be assumed that the normal social, economic, and cultural expectations will, in the broad sense, be as generally pervasive in the new capital as they are elsewhere in the nation. It is hoped, however, and can also reasonably be expected, that a certain Alaska "character" arising out of the value systems we attribute to this State, will dilute or mitigate these expectations to at least some degree. At least to the degree that the new capital will reflect Alaska's physical and temperamental environment, rather than being just a replica of a new city or town that could be built anywhere Outside,* a "Holiday Inn" type city that is almost exactly like those stamped out across the nation.

Still, however, these general expectations can be expected to be nurtured by many, if not most, of the residents of the new capital, when considered in their roles of government worker, entrepreneur, secondary service worker, house owner, condominium sharer, apartment dweller, mobile home resident. And these expectations will compete against one another in a desire for fulfillment much as they do in other areas of the country. In short, the conflicts and stresses between the property owner and the rent payer, the boutique shopper and the mall or plaza aficionado, the restaurant goer and the McDonald's denizen, the small car owner and the large car driver, will be much the same in the new capital as the public prints and television depict them elsewhere. The resolution of these

* "Outside," as used in this report, refers to the contiguous lower 48 states, where the problems of energy conservation may not be so capable of solution as they might be "Inside," or in Alaska.

conflicts is the major interest, other than actual work, of most of the citizenry, and is the prime item of business of the governments they create and the focus of the laws those governments write.

Many of those expectations can be expected to take on an Alaska character to the extent that the persons holding them are willing to make or accept trade-offs. People may choose parks and undeveloped open spaces within the new capital as opposed to more capital and labor intensive forms of recreation facilities. They may be willing to emphasize the aesthetics of their environment over the convenience of fast food emporiums and a surplusage of shopping malls. However, the extent of these possible preferences is presently unknown.

One thing that should be noted, however, is that there is a significant proportion of Alaskans who proclaim themselves as advocates of a life style that rejects many of these normal expectations. Though they probably compose a numerical minority, they are highly articulate and reasonably successful in getting their point of view across and have reasonable support among the State's legislative bodies. These persons have been perjoratively characterized as "anti-development" or "anti-growth" by the mainstream. Though this characterization is probably unfair (they are not anti-growth or development in black and white terms) they can be expected to resist strongly many of the developmental characteristics they perceive to be part and parcel of the fulfillment of the normal expectations held by the majority.

It should be reasonably expected that the conflict in the expectations and aspirations of these two groups will be one of the major stress points in the development of the new capital. The extremes of each group have already staked out their positions. Those favoring the capital move want it accomplished as quickly as possible with few controls and tend to ignore cost data that promotes questions concerning the overall expense of the proposed move. Those on the opposite side of the fence tend to emphasize the possible costs and insist upon the kind of planning that will best reflect their "environmentalist" values.

Neither of the two positions necessarily take into account practical energy conserving aspects in the construction of the new capital, though the environmentalists might be expected to be more amenable to proposed energy conserving measures, expecially in the realm of transportation, being as they are advocates of comprehensive (including mass transit system) planning and strict zoning and code regulation. The developers, advocates of free enterprise and minimum governmental interference, can be expected to resist "over planning" and strict regulation as being unnecessary. (Already at the cutting point of this latter group, the concept of life-cycle costing for new buildings is dismissed as ephemeral nonsense, as an unnecessary accounting manipulation, as articulated by a major advocate of the capital move in public hearings).

Unfortunately, the leaderships of the two groups have already adopted positions, even solely within the Anchorage context, that can only be characterized as doctrinaire. Especially in the construction of a brand new capital in a relatively "unspoiled" location, each group can be expected to take even more dogmatic stands unless they are carefully informed of the possible energy savings options and induced to compromise their positions in order to reach realistically possible and practical solutions to the energy conservation problem.

It is not intended in this short discussion to characterize either group or point of view as good or bad, right or wrong. The implications of particular aspects of each point of view may or may not be energy wasteful over the long run. For instance, the environmentalists (for want of a better word) might resist taxing schemes and utility rate structures used as incentives for the builders of commercial spaces to incorporate energy conserving measures, perceiving them as unnecessary breaks given a dimly perceived power elite at the expense of the public at large, thus ignoring the long-run benefits.

The stress between these two groups can be expected to be more visible and more heated during all phases of the planning, design, and construction of the new capital. To resolve this conflict, intensive efforts will have to be made to educate each of the groups to the long-term rationales for the imposition of energy conserving constraints across all ranges of application.

Another major focal point of stress in the construction of the new capital lies within the two distinct phases of its creation - the construction phase and the operation phase. A different type of person and different types of institutional interests will inhabit the capital site during the five year intensive construction phase than will be there when the capital moves into its operation phase.

During the construction phase, many workers can be expected to live in camps or commute from Anchorage and already established areas in the Matanuska-Susitna Valley, Palmer for example. Supporting services, such as lumber, concrete, and fabrication yards will be temporary in nature. However, the secondary industries that can be expected to spring up - cocktail lounges, food and hardware suppliers - probably will not be so temporary. These demands for services will be different from those required when a new type of population, the government workers themselves, move into the capital site during the operation phase.

During the interface between the two phases, the population characteristics will shift from seasonal workers employed for long hours at higher average salary rates than those for the government workers and who maintain their permanent homes elsewhere. As the operation phase begins, the population will take on the characteristics of the average government salaried worker, making about $1,700 to $1,900 a month, more family oriented (1.8 children of school age), who will plan to live in the area on a more or less permanent basis.

The stress will come at this interface and will be particularized in the problem of what to do with the relatively uncontrolled facilities and amenities that have been introduced to serve the construction phase on a temporary, basis. The question is, which of these facilities should be allowed to stay, in what form, and subject to what energy conservation constraints.

The construction phase leasing configuration mentioned above may serve to mitigate the worst aspects of this problem. But, available data does not provide a basis upon which any hard solution to this stress problem, within energy conserving terms, can presently be based.

## SUGGESTED ADDITIONAL EVALUATION WORK

An obstacle to any definitive solution to the possible problems stated throughout the above subjective analyses is the lack of refined demographic data. Steps should be taken as soon as feasible to investigate, in the greatest detail possible, the social and economic characteristics of the anticipated population of the capital during each distinctive phase - construction intensive and permanent operation.

It should be realized that such data is inexact itself and will not provide the hard line basis upon which definitive conclusions or approaches can be made. However, such data could provide a broad general context from which general policies can be drawn. How much people earn and how they hope to spend those earnings, directly and indirectly, is a major determinant of what the people will expect and accept.

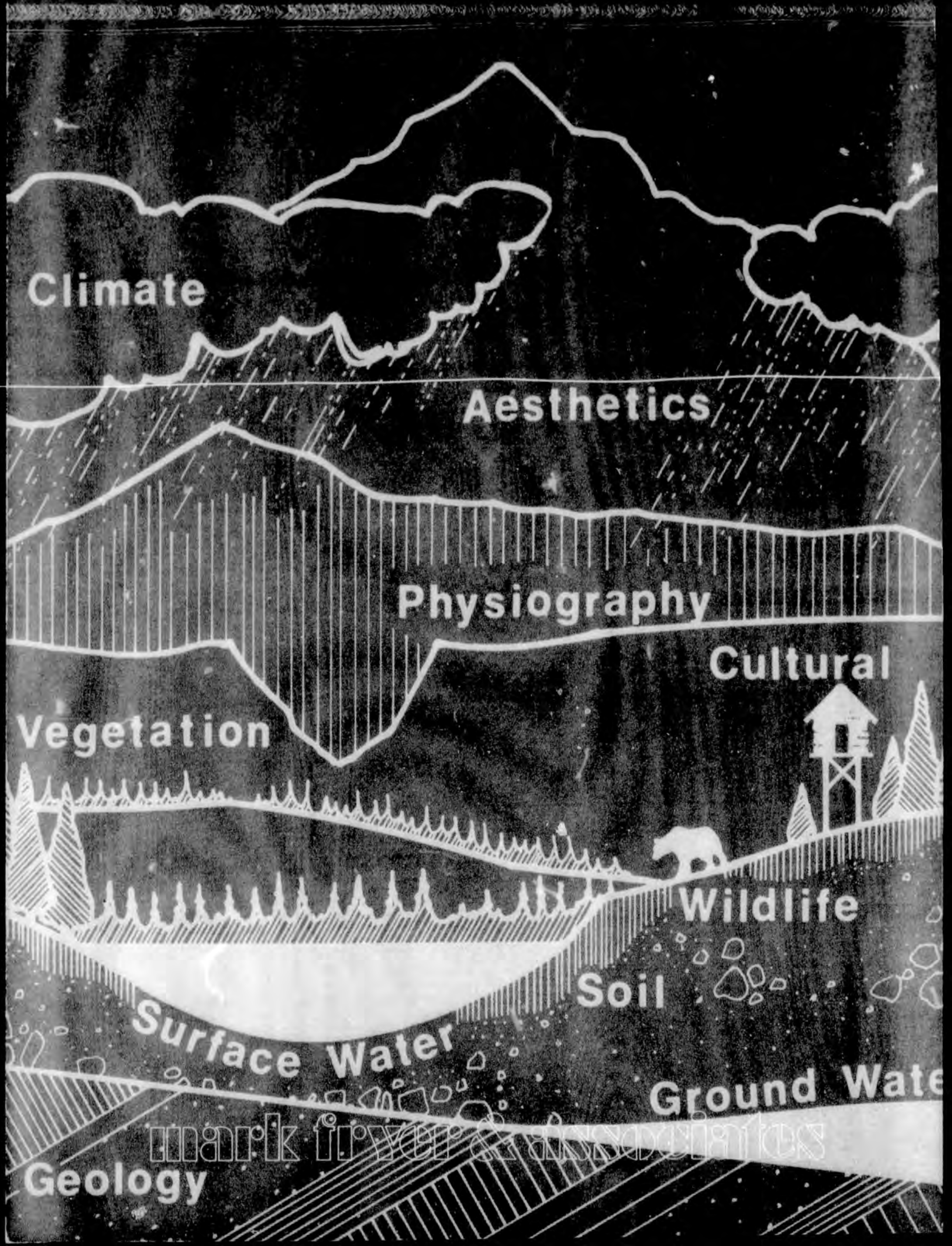
Additionally, investigations should be made of the stresses experienced in similar situations, in Valdez for example, in order to get an idea of what actually happens in stress situations. Such information may be applicable to the new capital, especially during the construction phase.

In addition, the imposition of energy conservation is not new to the nation. Within the past few years, at the instigation of the federal, state and local governments, many communities have attempted, through the classical methods mentioned above, to make themselves less energy wasteful. It would be very instructive to examine a few of these communities to draw indications of what legal and institutional forms work and do not work, the difficulties of formulating such schemes, and the difficulties of applying them in a fair and equitable way. Particular attention should be paid to time frames, and as much attention should be paid to non-conformance with these schemes as to conformance. In other words, attention should be paid to the instances where energy conserving regimens are broken or amended and the reasons why they have worked or not worked.

As the Little report pointed out, codes and regulations represent a compromise between the various forces and influences operating in the particular jurisdiction which develops those codes and regulations. The report warns that too often, the resulting legislation and requirements represent a "conservative compromise" that is competent in its engineering requirements but often is unimaginative and perhaps even uneconomic.

The report concludes that energy conservation standards cannot be simply imposed from above but will only be achieved gradually by a combination of innovative measures. The report emphasizes the necessity of intense educational efforts aimed at energy consumers to make them aware of possible cost/benefit advantages. And the report reiterates the necessity for providing financial incentives in both the public and private sectors.

However, most of the literature in this field deals with the problems of imposing energy conserving schemes on towns and cities already in place and that already have a history of zoning and code regulations. We here are dealing with a brand new town, starting off from square one so to speak. The concept of a new capital site is almost radically innovative in itself. Though there will be substantial resistance to the imposition of energy saving measures, it is not unreasonable to conclude that there is a chance the new capital can start off from ground zero in the right direction with innovative energy conserving schemes. There is empirical evidence concerning what works and does not work in energy conserving terms elsewhere. That evidence should be examined; lessons can be learned from what other jurisdictions have attempted in this field. Those lessons should prove valuable in developing energy conservation legislation and requirements for the new capital.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# ANALYSIS OF ENERGY USAGE ON LONG ISLAND FROM 1975 TO 1995 THE OPPORTUNITIES TO REDUCE PEAK ELECTRICAL DEMANDS AND ENERGY CONSUMPTION BY ENERGY CONSERVATION, SOLAR ENERGY WIND ENERGY AND TOTAL ENERGY SYSTEMS

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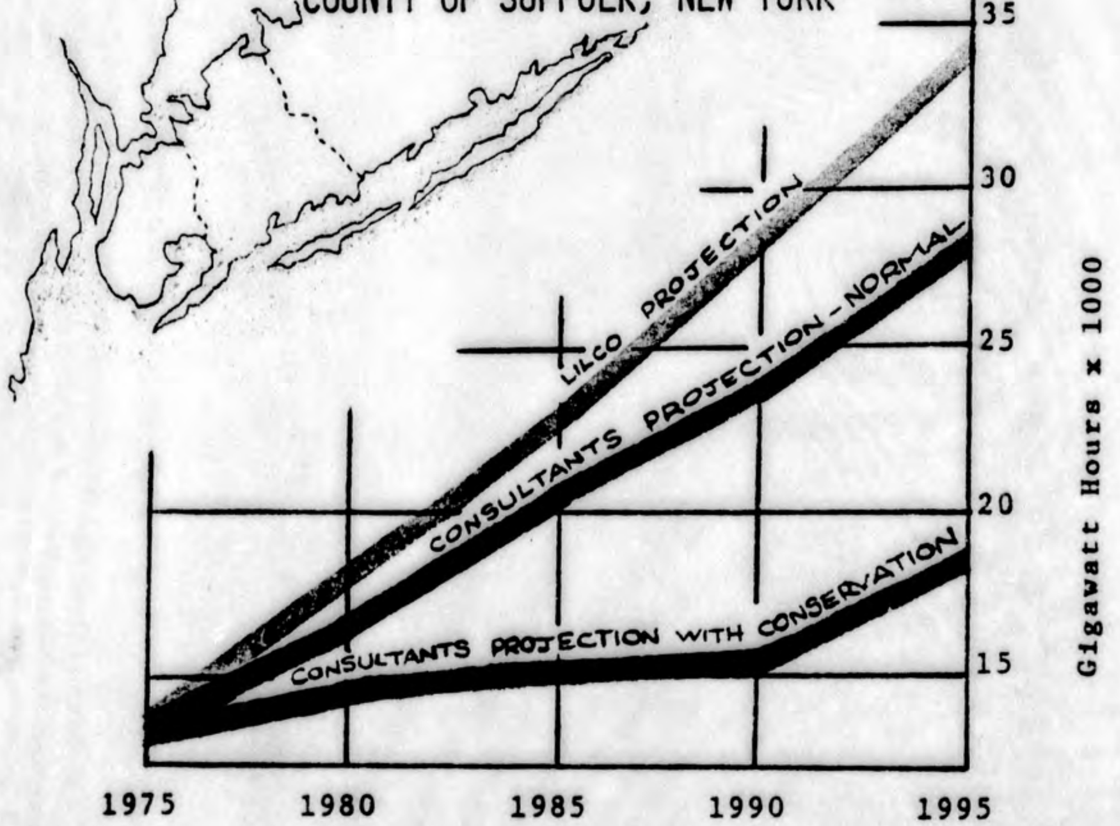

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(A CONDENSATION OF A COMPREHENSIVE STUDY
DATED OCTOBER 31, 1975 DONE FOR THE
DEPARTMENT OF ENVIRONMENTAL CONTROL
COUNTY OF SUFFOLK, NEW YORK)

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**AN ANALYSIS OF ENERGY USAGE ON LONG ISLAND FROM 1975 to 1995 AND THE OPPORTUNITIES TO REDUCE PEAK ELECTRICAL DEMAND AND ENERGY CONSUMPTION BY ENERGY CONSERVATION, SOLAR ENERGY, WIND ENERGY AND TOTAL ENERGY SYSTEMS**

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ABSTRACT

The Long Island Lighting Company (LILCO), serves virtually all of Long Island, New York, and a small section of Queens, New York, with electricity and gas. The company has under construction one nuclear powered, 830 megawatt electric generating plant, the Shoreham, scheduled to come on-line late in 1978; in addition, LILCO has made application to construct two new nuclear plants in the town of Riverhead in Suffolk County, Long Island, Jamesport I and Jamesport II, each with a capacity of 1150 megawatts are planned to come on-line in 1982 and 1984 respectively. LILCO's justification for these two new plants is based on the system required to meet the loads which, according to their forecasts will occur during the period 1975 - 1995.

This paper is a condensation of a more comprehensive report[1] of the study commissioned by the Suffolk County Department of Environmental Control and conducted by Dubin-Mindell-Bloome Associates, P.C., Consulting Engineers and Planners, under the direction of Fred S. Dubin, P.E.

The projection of the peak electric demand and the yearly consumption of electricity and the method of forecasting (exponential smoothing analysis), by LILCO are analyzed. An alternative method of forecasting, devised by Dubin-Mindell-Bloome Associates, P.C., is presented, and indicates that the yearly electric energy consumption and peak electric demand for the "normal" case will be lower than LILCO forecasts, and the proposed new Jamesport nuclear powered plants, or their equivalent, are not likely to be required until 1986 and 1992 respectively.

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1. "A Study of Existing Energy Usage on Long Island and the Impact of Energy Conservation, Solar Energy, Total Energy and Wind Systems on Future Requirements," dated October 31, 1975, the testimony of Fred S. Dubin, P.E., before the Public Service Commission, on December 10, 1975.

An intensive energy conservation program is anlyzed in detail. Suggestions are made for reducing energy consumption through operation and maintenance of a) buildings, b) mechanical/electrical systems, and c) energy intensive industrial processes; the implementation of energy conservation measures for existing and new buildings using hardware, equipment, materials, and systems which are now commercially available, and for instigating a load management program. A modest utilization of solar energy for domestic hot water and space heating and cooling, coupled with the energy conservation program is shown to have the potential of reducing the normal loads to the extent that not only could the Jamesport I and II plants be cancelled, but also that the completion of the Shoreham plant could be delayed.

In addition, the energy in the winds, offshore and over Long Island, is shown to exceed all of Long Island's energy requirements for the next twenty years or more, and the potential for converting wind energy into electricity and heat with arrays of wind generators is developed by Dr. William Heronemus who was under contract to DMBA to examine this alternative; recommendations are made for further research in this area.

On-site total energy systems and the use of solid waste for fuel are cited as two additional measures to further reduce the need for raw source energy (fossil fuel or nuclear), for central electric generating plants.

Outlined are institutional constraints and the actions required, individually or in combination, by the N. Y. State Public Service Commission, LILCO, Suffolk, and Nassau Counties, the N. Y. State and U. S. Federal Governments, and by consumers on Long Island to implement and realize the full potential of these alternatives to to erecting new central utility electric generating plants and the economic benefits in doing so.

## BACKGROUND AND SCOPE

Up until 1973, the consumption of raw source energy through conversion of fossil fuels to electrictiy and by combustion of fossil fuels for thermal end use in buildings increased annually at an accelerated rate in Long Island. In 1973, the rate of growth began to slow down; it further declined in 1974 due to a number of factors including the oil embargo, rapidly escalating fuel and electricity costs, a slow down in the rate of economic growth, at the adoption of limited energy conservation measures and practices. This pattern held true for oil consumption, gas consumption, electricity consumption (Kwh), and to a lesser extent, peak electric demand (Kw). Then in 1975, with the lifting of the oil embargo and a somewhat slower escalation of fuel and electircity costs, along with a small measure of economic recovery in Long Island, the rate of growth of electrical consumption and demand rose especially in residential buildings; the 1975 rise, however, was still at a lower rate than the rate of growth prior to 1973.

Since Long Island produces no primary energy, such as oil or gas, both are imported for use in generating electricity and for on-site use in boilers, for heating buildings and for industrial heat processes.

If the demand for electricity, even at the current 1975 growth rate (4% to 5%), continues unabated on Long Island, additional electric generating capacity will be requried. In anticipation of such increased demand, LILCO plans to bring on-line, new generating plants of approximately 400 megawatts, mainly fossil-fuel fired, in 1977 - 1978; in addition, the 820 megawatt Shoreham nuclear-powered plant which is now under construction will become operable in late 1978. Predicting demands further into the future, LILCO applied in 1974, for permission to construct two new nuclear powered electric generating plants, each with a design capacity of 1150 megawatts. Both plants would be built at LILCO's Jamesport site in Suffolk County, New York, on Long Island Sound, in the town of Riverhead; LILCO's current plans call for completion of the Jamesport Unit 1 in 1982, with Jamesport Unit 2 to be in operation in 1984.

LILCO has predicated the need for the new cuclear-fueled generating plants on several factors. Basically, LILCO predicts a) that the population on Long Island will continue to increase and that additional non-residential buildings will be constructed, and b) that the need for electricity will increase not only in proportion to the increase in population but also in accordance with an increased use per capita, a trend that has held true in the past. The increased use per capita, in the past has been due to a greater penetration into the market of appliances, air conditioners, and other equipment in existing facilities. LILCO also predicts that increased use of electricity for space heating and water heating will prevail in the future partly because the shortage and increased costs of fossil fuels followed by the eventual unavailability of gas and oil for domestic use. As an example, LILCO predicts that the use of electricity for space heating and hot water will increase 10 fold on Long Island in the next twenty years while the population is predicted to increase by only 25% in the same length of time.

As a matter of reference, LILCO predicts that the annual consumption of electricity will increase at a compound rate of 4.7% from 1975 to 1995 (down from the compound rate of 7% prior to 1973); other predictions are that summer peaks will increase at the compound rate of 4.4%, winter peaks at the compound rate of 4.8%.

In making these predictions, LILCO employed a modified version of the traditional method of forecasting electric loads. The traditional method, known as "load forecasting based on regression analysis" uses recorded increases of the recent past to anticipate the increases for the near future. In the present situation, LILCO based its forecasts on "an exponential smoothing analysis", a method in which some of the components leading to load growth were selectively weighted.

One further important item in the background of utility company practices is the issue of "peak demand". In order to accomodate the few hours in the year when a very high generating capacity is required, a utility company must construct and maintain facilities capable of generating at that capacity all year long. In other words, peak demands set the requirements for new generating plants! And once the peak demand has been forecast and the generating plant constructed, the utility company, in order to operate economically, must promote a greater use of electricity in off-peak hours. Therefore, in the past, electrical need has grown, symbiotically, according to the utility company's capacity to provide service.

Long Island, like the rest of the United States, is at a crossroads in its history of power production. Fossil fuels, traditionally used for generating electicity and heat both centrally and on-site, are running short. The utility company has made its predictions and has applied for permission to construct nuclear powered electric generating plants with all their inherent faults and potential hazards. Is there an alternative?

Perhaps the first concern, in considering an alternative to nuclear power production, should address the current need for an over all energy policy--an energy policy sensibly arrived at, to govern future uses of energy and to be based upon genuine needs of the area and realistic assumptions about fuel supplies. Such a policy could eliminate or interrupt the perpetual interaction of supply determining demand determining supply determining demand...which otherwise may continue until the final and ultimate energy crisis.

To begin to develop an energy policy, the issue of load forecasting must be thoroughly examined and an accurate forecast must be made of the annual fossil fuel requirements and, in the use of electricity, the annual consumption and the peak hourly demand for each week, month, and season.

Load forecasting was relatively simple and reliable in the past because the major factors affecting load growth changed at a fairly constant and predictable rate, and regression analysis, based on recent historical performance, could be employed with confidence to forecast the future. Unde present conditions however, even a forecast based on an exponential smoothing analysis which selectively weights some of the components contributing to load growth and therefore may be more dependable than a simple regression analysis, is not reliable enough to base the serious decisions which must be made in formulating energy policy and planning for the facilities to implement it; no longer do the major factors affecting growth--i. e., construction activity, appliance and air conditioning sales, fuel costs, and fuel supplies, educational programs, building and construction codes, the performance standards of equipment and appliances, shortage of capital, and other local, regional, national and international influences--neatly conform to historical patterns, for all have been greately altered by recent events.

Since the prediction of both the quantity and type of energy required on Long Island is an essential ingredient in the evaluation of the alternatives available, the importance of load forecasting beccmes more evident when the alternative for energy supply and most directly, electrical energy supply, are weighed.

In formulating an energy policy for Long Island, two major alternatives exist: first, central lutility electrical generating capacity may be increased as it has been in the past, or secondly, demand may be reduced, and new alternative sources of energy introduced, thereby reducing the capacity of, or eliminating completely the need for new central utility electric generating plants. Each of these major alternatives may be effected through a number of possible options, some of which may well be eliminated in the near future by Federal Government policy nevertheless, the options--choices that will have to be made--are set forth here under each of the major alternatives.

I. <u>Increase Central Utility Electrical Generating Capacity</u>.

a) Expand LILCO's, or municipal fossil fueled central electricity generating plants; continue to import greater amounts of fossil fuel, and/or increase domestic fuel oil production by measures which include off-shore drilling. Continue to utilize oil fired boilers for space heating, hot water, and industrial heat processes in existing and new facilities.

b) Convert existing large industrial, commercial, and the central electric utility boiler plants from oil or gas to coal fired equipment and build additional coal fired plants as Long Island's energy requirements grow; and utilize electric heat to a greater extent in existing and new buildings.

c) Increase nuclear powered electrical generating capacity with new plants to handle the growing demand for electricity, and utilize electric heat and air conditioning to a greater extent in new buildings and by conversion of oil and fired heating and domestic hot water heating systems to electric heating in existing buildings--LILCO has opted for this alternative.

II. Reduce the Capacity of, or Eliminate Completely, New Central Utility Electrical Generating Plants.

a) Reduce the demand for electricity, both annual consumption and peak hour demand, and reduce consumption of electricity and fossil fuels, in existing and new buildings through operation, better maintenance, and the use of energy conserving equipment, materials, and systems in buildings, street lighting, industrial process, and public transit. Use fossil fuels for heating and air conditioning in place of electric resistance heating.

b) Improve the utilization of existing and new power plants by extensive load management measures including time-of-day metering, load shedding, peak shaving and energy storage, so that peak hour demand is reduced and less generating capacity is required.

c) Utilize solar energy for space heating, cooling, and domestic hot water heating now and as the technology matures and capital costs decrease, wind energy for thermal and electricity end-use, photo-voltaic conversion of solar energy to electricity, and solar heat powered thermal engines for air conditioning and electric power generation.

d) Finally, supply some of the electrical energy and thermal energy requirements for buildings by on-site total energy systems, truncated power systems, peaking cycles, bottoming cycles, and decentralized fuel cells instead of an equal amount of electricity generated in central plants and fuel used in separate on-site boilers.

While the options are clear, the environmental, economic, financial, social, legislative and technological factors which are inter-active for each option have not heretofore been well identified, quantified, or qualified. All of the considerations must be viewed from many points--the short term interests versus long term interests, private interests versus public.

In an evaluation of the above alternatives, many factors must be evaluated for the primary and secondary impact which each exerts--for example, dependence to a greater extent upon fossil fuel imports contains the implications of unfavorable balance of trade; dependence upon foreign energy sources at unpredictable prices, the effect upon national security and foreign relations; and also upon the escalating rate of inflation. While these factors have not been fully quantified or evaluated, they are generally accepted by the Federal Government knowledgeable economists, scientists, and an informed public to be serious enough so that alternatives must be and are being sought.

The opportunity to increase the production of domestic oil and gas in the North East rests mainly on new offshore oil wells. The cost for these new resourees will certainly be greater than present domestic fuel costs and involve technical cal, political, environmental and social decisions for which there is no consensus, as yet. Additionally, increased combustion of oil lead inevitably to greater air pollution.

A policy to increase the use of coal for generating plants and and large boiler installations immediately brings to fore the problems of transportation, strip mining implications, the high capital costs of converting existing fossil fuel equipment to burn coal, and the problems of air pollution control and the cost to accomplish it.

As for nuclear power plants, escalating capital costs, decreasing availability and increasing costs of uranium, operating difficulties, anti-sabotage control measures, long lead time for construction, dissipation of waste heat, and transportation and disposal (storage), of radio-active wastes are all matters of concern.

In evaluating an intensive energy conservation option, the availability of equipment and systems and the technical know-how to use them for a large scale energy conservation program, combined with the efforts required by the consumer and legislative bodies to implement those measures which are immediately practicable, must be qualified.

Finally, the stage of technological development, captial costs, aesthetic considerations, institutional constraints, commercialization, design developments, and methods of financing--all are factors which influence large scale use of each of such alternative energy sources--solar energy, wind energy (reform of solar energy), on-site power generation, and the use of solid waste as fuel.

In analyzing the alternatives, the following objectives are paramount, although not necessarily of equal importance, nor are they listed in the order of priority:

a. Health and safety.

b. An adequate supply of energy in all forms for the necessities of life and desireable amenities.

c. Clean air, pure water and unblemished recreational, agricultural and other land-use and water areas.

d. Full economic opportunity - jobs.

e. Agriculture to provide produce and goods for consumption at home and for trade.

f. Aid and abet consistent with a national energy and resources policy (when it is finally promulgated).

The Suffolk County N. Y. Department of Environmental Control is concerned that LILCO's current plans for expansion of their electrical generating capacity may not be in the best interests of the citizens of Long Island, may not be in harmony with the objectives listed above, and question whether construction and operation of the Jamesport plants or their equivalent are needed in the time frame suggested by LILCO, if at all. For those reasons, in February 1975, they commissioned Dubin-Mindell-Bloome Associates, P.C., Consulting Engineers and Planners, to perform an eight month study culminating in an engineering report to include the following:

1. An examination of the historical growth pattern of peak electric power demand and annual electricity consumption in the LILCO service area as outlined in published and unpublished data furnished by LILCO.

2. A review of the LILCO forecast of system growth in as much detail as they have available--i.e., daily and seasonal peak and consumption load characteristics for various classes of buildings and facilities, and, where available, sub-systems within buildings.

3. An evaluation of existing a) master plans, b) land use development plans, c) demographic data, d) economic forecasts, and e) data on the physical characteristics and energy usage, where available, of existing buildings; the preparation then of a separate forecast of peak loads and annual energy consumption under normal conditions from 1975 - 1995, using the same data base as LILCO's, insofar as it is feasible, for saturation of appliances and air conditioning, street lighting, transportation, distribution and transmission losses, and utility company in-house use of electricity.

4. A selection of energy conservation and load management measures which are now technologically and economically feasible for existing buildings to the extent that they can be implemented in stages and for immediate use in all new building construction, to determine the reduction in electrical energy consumption and peak demand that would result from an intensive energy conservation and load management program.

5. A calculation of the effect that solar energy and wind generating systems as alternative energy sources, and total energy systems (on-site power generation), would have on reducing the net electrical energy load that LILCO would be required to supply by central utility power plants for the period 1975 - 1995 if the alternative sources of energy were used.

6. An outline of the practices, policies, and institutional changes required of consumers; state, federal, county, and municipal agencies; the N. Y. State Public Service Commisision; and LILCO, in order to realize the full potential of energy conservation, load management, and alternative energy sources.

The final report entitled "A Study of Existing Energy Usage on Long Island and the Impact of Energy Conservation, Solar Energy, Total Energy and Wind Systems on Future Requirements," was completed on October 31, 1975. On December 10, 1975, in Suffolk County, N. Y., Fred S. Dubin, P.E., presented the findings in testimony before the examiners in the Public Service Commission Hearings, Case 26292, in Suffolk County, Long Island.

This paper, prepared for public presentation in Suffolk County, N. Y., on February 19, 1976, was made possible by an additional grant from the Suffolk County Department of Environmental Control. It is a condensation of the complete report, and is prepared to assist the public in deciding which policies they should support in their short and long term interests.

In order to provide as much information as possible within the scope of this paper, some of the sources of the data, and the calculations which support the findings are not included herein. For additional information consult the complete report which is available from the Suffolk County Department of Conservation.

ACKNOWLEDGEMENTS

Fred S. Dubin, P.E., was the principal investigator for Dubin-Mindell-Bloome Associates, P.C., and many other members of the firm participated in the study, principally David L. Hartman, Yvonne McDougal, Bernice Beharry, Selwyn Bloome, Linda Yowell, Vaughn Bradshaw, and Kathie Whipple.

Many other individuals made significant contributions to the study. It is not possible to name all of them, but we are grateful to them and particularly to Dr. Harris Fischer of the Suffolk County Department of Environmental Control; Regina Armstrong of the Regional Plan Association of New York; Robert Romancheck of the Pennsylvania Power and Light Co.; Earl Taylor, Jan Sayko, and Stu Gillespie of Northeast Utilities Service Co.; T. Owen Carrol of Brookhaven National Laboratory; Parker Mathusa of the Public Service Commission; Lee Koppleman of the Nassau Suffolk Regional Planning Board, and Irvine Like, Counsel to Suffolk County--for their valuable contributions and generous donation of their time.

## LILCO SERVICE AREA

The Long Island Lighting Company serves an area of about 1230 square miles consisting of Nassau and Suffolk Counties,(hereafter referred to as Long Island or Bi-County area), plus a portion of Queens in the Rockaway Peninsula. Of the 846,000 LILCO electric customers in 1974, some 22,900 or 2.7% were located outside the Bi-County in Rockaway. At the same time, some 23,400 electric customers within the Bi-County area in 1974 were not served by LILCO, but were supplied with electricity by two municipal utilities, Rockville Centre and Freeport. LILCO did f rnish a small portion, about 7%, of the electricity sent out by the two municipal utilities in 1974.

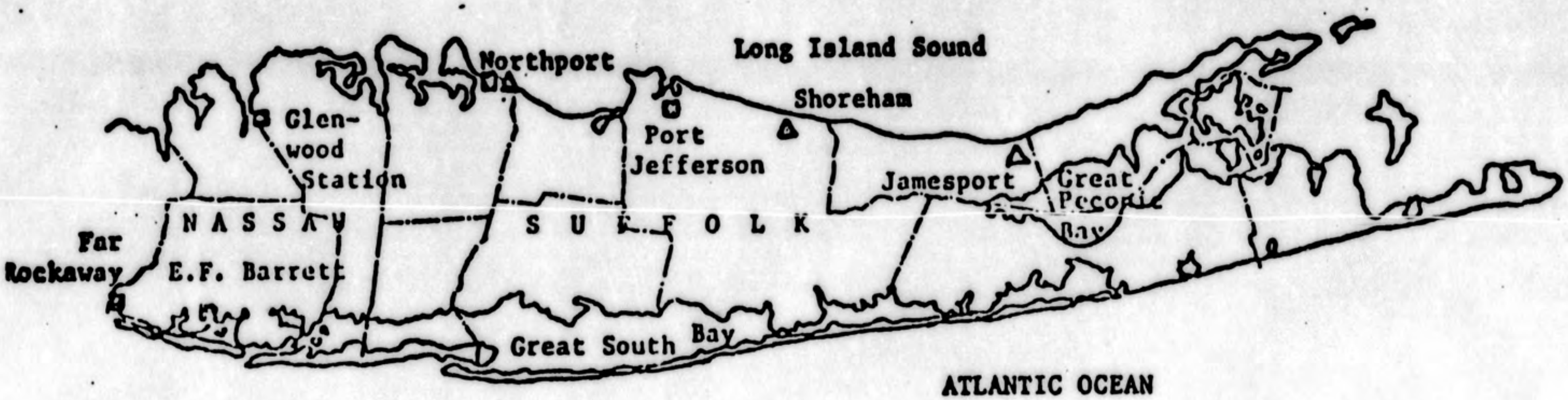
In 1972, Nassau and Suffolk counties were designated as a new Standard Metropolitan Statistical Area (SMSA), by the Federal Government. As a result of this designation, additional economic and demographic statistical data became available for the Bi-County area as a unit. The Nassau-Suffolk Regional Planning Board also provides data for the Bi-County area, as does LILCO. Due to the close correlation between the LILCO service area and the Nassau-Suffolk SMSA, some of the analyses made in this report have assumed an identity between the LILCO service area and the SMSA, rather than attempting to adjust the available data to account for the very small proportional of LILCO customers outside the SMSA.

In 1975, there were about 2.7 million persons living in the Nassau-Suffolk SMSA. This was a gain of 4.7% over the 1970 U. S. census count. However, this was a much slower growth rate than occurred in the booming 1950's and 1960's, when the rapid suburbanizing Bi-County area was one of the fastest growing places in the U. S. The slower growth rate has been reflected in the number of residential building permits issued in recent years (about 10,000 in 1974 versus 18,000 in 1971). Although multiple-family units have accounted for about a quarter of all residential building permits issued in 1970's, the Bi-County area remains overwhelmingly an area of single-family homes. In 1970, 80% of Nassau's housing units, and 90% of Suffolk's, were accounted for by detached single-family houses.

The aerospace industry, electronics, and research and development dominate the manufacturing base of the region, but most of the jobs located in the SMSA are white collar jobs in the sales and services category. Agriculture is also an important activity. Suffolk County is a leader in the state in the value of its farm produce.

The location of the Nassau-Suffolk SMSA within the giant New York-New Jersey-Connecticut megalopolis has tended to obscure the fact that on its own the SMSA is one of the largest in the U. S. It ranks ninth in 1970 population and seventh in per capita income among the ten largest SMSA's. However, the 1974-1975 recession has had a serious impact, as elsewhere, on the Bi-County economy driving up unemployment, sharply curtailing new construction and lowering retail sales.

Figure 1 is a map of the region, and shows the locations of LILCO's generating plants.




▲ PROPOSED STATIONS
■ EXISTING STATIONS

LOCATION OF LILCO POWER PLANTS

FIG 1

A. **NEITHER THE TWO PROPOSED 1150 MEGAWATT NUCLEAR POWERED GENERATING PLANTS NOR THEIR EQUIVALENT WILL BE NEEDED IN LONG ISLAND UNDER NORMAL CONDITIONS, UNTIL LATE 1985 and 1991, RESPECTIVELY.**

LILCO has predicted that Jamesport 1 and 2 will be needed as early as 1982 and 1984 to satisfy the future requirements for electrical energy in their service territory. However, LILLO's load projections were based on traditional historical methods of forecasting which are no longer appropriate.

LILCO's Forecast

DMBA analyzed LILCO's forecasts through 1995 from data included in the 1975 report of "Member Electric Corporations of the New York Power Pool and the Empire State Electric Energy Research Corporation pursuant to Article VIII, Section 149-b of the Public Service Law updated April 1, 1975." The general method of forecasting used by LILCO was detailed in that report, but further information was provided to DMBA by LILCO in meetings, through correspondence and through subsequent testimony at public hearings. LILCO employed two methods of forecasting loads, a) regression analysis, and b) an exponential smoothing analysis. LILCO had more confidence in the exponential smoothing analysis and based their final forecasts on that method.

LILCO first prepared a short term forecast for the years 1975 thru 1979 for summer peak loads, winter peak loads and annual energy consumption based on extending historical data and trends, modified by a series of judgemental factors of the future, including estimates of the net number of new electric customers, appliance and air conditioning sales and market saturation; also additional electric space heating and domestic hot water installations in new buildings and by conversion of existing fossil fuel installations in dwelling units, a modest amount of energy conservation and load management, and the general economic outlook based on "stated observations of leaders in the financial and building community." The forecast of annual consumption and and seasonal peak demand for residential customers was more detailed than the estimate for non-residential customers, which was based mainly on an "estimate" of the number of new customers in the five year period and their per capita requirements.

LILCO's long range projections, 1980 - 1995, of peak demand and annual consumption are mathematical extrapolations of historical trends and the short range forecast. Past data can be adjusted and/or short range values weighted to add emphasis to the implicit effect of energy conservation on the long range trend line, but for LILCO's forecasts, crucial stage for representing the impact of conservation remains the short range forecast (1975 - 1979). Neither further reduction in the growth rate of specific activities and facilities, nor any other judgemental factor can be inserted into the long range analysis and forecast; developments that will be occuring in the post 1979 period simply cannot be represented unless they are artificially introduced into the short range analysis. Thus LILCO's analysis cannot account for new energy conservation factors due to new equipment, building and appliance standards, cost and availability of fuels, or a national energy policy, which arise after 1979.

The exponential smoothing method provides emphasis on certain elements of the data entered without resorting to artificial adjustments of past history, by employing a smoothing constant in analysis. In the past, this statistical technique for predicting future electricity and power requirements has proven to be a fairly reliable system, given the consistent growth that characterized electric usage during the sixties and early seventies. However, the extraordinary events of the last two years have raised serious doubts about how reliable this approach will be in predicting future conditions. There is now a vast array of new developments that raise a danger signal in accepting even modified projections based on historical trends. To name just a few: a) quantum leaps in price of all forms of energy have occured, providing real incentive for saving energy through operational changes in buildings (the verdict is not yet in on how "elastic" or "inelastic" the demand for electric energy is (it may prove to be far more elastic than it has been in the past), b) a slow-down in economic growth on Long Island, which a recent article in the "Wall Street Journal" has suggested might last for a decade, c) huge cost escalation and time delay in building central generating facilities d) the forecast of future decline in the school and college age population, e) possibilities of mandated energy performance standards[1] for appliances, equipment, and buildings, both old and new, and f) the glut of office and commercial space on Long Island due to overbuilding in the past eight years.

In addition, there are factors which will reduce the rate of growth of electrical energy consumption and peak demand, which LILCO did not fully take into account. For instance, a) more and more new energy conserving equipment is offered in the market place, and even without an intensive energy conserva tion program, a greater percentage of sales will be fore the more efficient equipment, b) energy conservation standards[2] and guidelines[3] for building construction have been promulgated

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1. The Federal Energy Bill, S-622, dated 12/7/75, which President Ford has just signed into law contains these provisions.
2. ASHRAE 90-75 Energy Conservation Standard for New Buildings.
3. See References D, 1, 2, 3.

and architects and engineers are designing more efficient buildings now, c) a greater percentage of new housing are multi-family dwelling units which use less energy than single family units. Under these conditions, neither regression analyses nor exponential smoothing analysis methods of forecasting based mainly on an econometric approach are appropriate.

Given the new situations, DMBA felt it was appropriate and necessary to expand the methodology to provide explicit proceedures for analyzing the impact of such factors as technological changes, shift in behavioral patters, divergent growth rate of air conditioning, appliances and equipment each with a unique unit energy demand, and the varying growth rates of each building type and their individual contribution to peak demand. The peak load requirements are particularly important since they are the major factors which determine the need for new electrical generating plant capacity.

DMBA's Forecasts for "Normal Conditions

DMBA developed a proceedure of forecasting which is based on the loads which will accrue to each building type, appliances, equipment and system which are likely to be in use each year, under "normal" conditions. "Normal" conditions for the purposes of this study are defined as the loads which are most likely to occur if demographic projections, master land use plans, building construction activity, appliance and air conditioning sales and operation and maintenance of buildings and systems follow the predicted trends and some energy conservation measures are practiced, but without an intensive energy conservation program and without wide-spread utilization of alternative energy sources.

While the effort required to establish even the limited data base which is necessary for this type of forecast was time-consuming and tedious, it was important to do so in order to more accurately determine future energy requirements under "normal" conditions, and most important, disaggregating energy use by building type and sub-system provided the basis for developing a priority action program by identifying and measuring those systems and factors which might have the greatest impact in curtailing energy consumption growth or peak loads. In addition, it provided the data which enabled DMBA to estimate the potential for reducing fossil fuel consumption as well as electrical energy on Long Island. DMBA undertook five essential measures to forecast future loads:

1. Review of relevant literature: DMBA studied a wide range of published and unpublished data by LILCO and other sources such as consumers, fuel suppliers, planning authorities, and U. S. Census describing the demographic, land use, and economic characteristics of Long Island and the New York Metropolitan area. DMBA prepared an energy-use questionnaire and sent it to more than 200 building operators and owners in

Long Island, to obtain historical data on peak loads,annual consumption, and building characteristics. The data obtained from the questionnaires and the interviews with many of the respondees was not used directly in load calculations, but was used to authenticate the assumptions and the load calculations which were performed.

2. Projection of non-residential square footage and number of residential dwelling units: DMBA conferred with local and regional planning groups, and compiled, on a bi-county basis, historical data of building floor area; then projected future square footage for each of 10 categories cf non-residential buildings in five year increments. The projected number of single and apartment house dwelling units were obtained from the 1975 149-B report.

3. Estimate of the unit peak demand and annual energy consumption for appliances and equipment for residential and non-residential buildings: DMBA drew on its own experiences as well as published data on energy use patterns to establish the unit peak demand in watts per square foot at utility company peak hours (both summer and winter), and the annual energy consumption in kilowatt hours per square foot for characteristic space heating, water heating, lighting, cooling, industrial process and miscellaneous energy uses for non-residential Long Island buildings. Similarly, unit peak demand and annual energy consumption were established for residentail equipment and appliances.

   The efficiency of air conditioning, appiances, lighting fixtures, industrial process equipment, and miscellaneous equipment, as well as average hours of operation, were projected, based on performance data of commercially available equipment in average use.

4. Resultant DMBA "Normal Case" Projections: The contribution to annual energy consumption and peak hour demand of each appliance type, window air conditioners, central air conditioning systems, electric space heating and domestic water heating systems, and miscellaneous motors and equipment was obtained by multiplying the unit demand and unit yearly annual consumption respectively, by the saturation of each system in the existing and estimated number of new structures; in residential buildings by number of dwelling units, in non-residential units on a number of square feet. For residential units the existing and predicted saturation rates of electrical equipment was based on LILCO's estimates. For non-residential buildings the existing and future saturation rates were calculated by DMBA. The unit energy consumption and demand in all cases was based on published data of Edison Electric Co., measures data by Con-Ed, LILCO, North East Utilities Co., Pennsylvania Power and Light Co., and design calculations and historical data from DMBA files.

5. **Authentication of forecasting method:** Using the available data for population, number of dwelling units, square footage of non-residential space, and the disaggregated values of Kw and Kwh loads for each building type and individual appliances and services such as for lighting, domestic hot water, power, heating and ventilating, air conditioning, and industrial processes in each building type, and the saturation rates in 1970, DMBA performed a decrement analysis using 1974 historical data as a base. They then calculated what the loads would have been in 1970 using the disaggregated load method. The calculated loads were within 1% of the actual system load in 1970. Because of this close correlation, the same method of forecasting the loads for the future warrented confidence.

The major difference between historical trend extrapolation and the DMBA approach is that in trend extrapolations most of the assumptions are implicitly burried in the forecast, whereas in the DMBA approach all the component assumptions are separated out (disaggregated), identified, and individually quantified.

A more extensive data base which includes an accurate analysis of the characteristics of each existing building and the current energy usage and peak hour demand related to the type of structure and mechanical and electrical systems and industrial process in use is necessary to further refine forecasts and provide a deeper insight into the potential for controlling load growth without adversely affecting commerce and social structure.

It is important to understand why electrical energy consumption and peak demand has grown in the past on both an absolute and on a per capita basis, and the factors which will modify, reduce, or reverse the growth patterns in the future under "normal" conditions. DMBA estimated the magnitude of the load due to each factor and included them in their forecasting proceedures, to a) estimate future loads under "normal" conditions, and b) to calculate the impact on future loads that could occur if the modifying factors are purposely intensified through a more extensive and purposeful energy management program.. "Energy management" includes energy conservation through better utilization of resources, load management, and selective use of fuels, such as switching from one fuel source or type to another depending upon availability, cost, heat value, and efficiency of utilization.

A partial list of the factors and their effect on load growth are listed below. They can be viewed in two contexts, a) existing buildings, and b) new construction:

A. Existing Buildings - Loads Increase

1. Air conditioning units, appliances, and motors deteriorate with age, and consume about 2% more energy each year

they are operated; peak demand increases by a slightly lower percentage each year.

2. Each year, the sales of major appliances, air conditioners, business machines, and motor driven equipment exceed the number taken out of service.

3. A percentage of the new appliances, which are sold to replace existing models, especially in single family dwelling units, are larger, and for that reason, consume more electricity for each hour of operation and have a higher peak power demand.

4. Improper maintenance of filters, condenser coils and evaporator coils in refrigeration units increase operating time and energy consumption of the unit and raise the utility company peak hour demand because the longer hours of operation are, in part, at the time of peak hour demand.

5. Additional lighting is added in sub-standard buildings to bring them up to par with modern facilities.

6. Increased saturation of electric water heaters and resistance space heating resulting from replacement of oil or gas heaters and/or installed for the first time in summer homes which have been winterized and are occupied year-round.

7. Greater use of instant-start television sets which consume energy even in the off-positions; and increased saturation of color TV.

8. Creeping deterioration of building materials creating a greater rate of infiltration through leaks and poorly fitted and warped windows and doors. The additional leakage of outdoor air into the building increases the heat loss in the winter and heat gain in the summer; hence, a) electrically heated buildings consume more electricity for space heating, b) peak demand is increased, c) pumps and fans must operate longer and more electricity is consumed by these auxilliaries in oil or gas heated buildings,& d) air conditioning units and their auxilliaries operate longer.

9. During periods of expanded business activity, existing equipment is used longer, and large new energy consuming process equipment is purchased and operated.

10. Alterations and additions to existing buildings, such as finishing off basement rooms and attics to provide additional occupied area, increase energy usage and peak hour demand.

In addition to the end use increase in consumption and demand, the total burden on the utility plant is increased by another 8-1/2% to 9% of the increased loads due mainly to distribution and transmission losses, and to a smaller extent, in-house use of electricity in the utility plant.

B. Existing Buildings - Loads Decrease

1. Buildings abandoned due to obsolescence, fire, or structural deficiencies--usually less than one half of one percent per year on Long Island.

2. Buildings vacated due to a lower demand for rental (or owner occupied), space--cyclic economic conditions.

3. Some appliances and air conditioning units are replaced when they become obsolete or inoperative, with more efficient units which have become available.

4. Because of escalating fuel and energy costs and a greater consumer awareness, some voluntary energy conservation measures are undertaken.

C. New Buildings - New Loads are Added

Of course, new buildings increase the amount of energy consumed each year and the peak demand as they are constructed and come on-line each year. Compared to existing buildings, new buildings in general use more energy in non-residential buildings per square foot of space and per dwelling unit of residential construction for the following reasons:

1. A larger percentage of new buildings are air conditioned. The increase in LILCO's annual peak demand is due mainly to the added load incurred by air conditioning.

2. New homes and apartments have a greater saturation of major appliances, i.e., more dryers, freezers, washing machines; and more window air conditioners, central air conditioning and a greater number of smaller appliances,fans, dehumidifiers and electrical equipment. The electrical service entrance equipment has greater capacity than in the average older building, and when it is available it is usually utilized.

3. The excessive and injudicious use of glass in new construction and the "quick" construction methods using panel walls increase electricity consumption and peak demand for heating and air conditioning conduction use, and infiltration losses are greater. In spite of somewhat better insulation standards, new buildings with panel wall construction are more energy intensive than

many of the older buildings which have been constructed with brick or masonry walls which provide thermal mass.

4. Increase saturation of electric heat and electric hot water heating in residential and non-residential construction. So far, these have only added to the winter peak which is now below the summer peak on Long Island; however, they do increase energy consumption and eventually could change LILCO to a winter peaking system if the trend continued. In fact, LILCO projects a 4.8% compound growth rate for winter peaks, and a 4.4% rate for summer peaks. The DMBA "normal" forecast compound growth rate, tho lower than LILCO's, also predicts a greater compound growth rate in the winter.

5. New industrial plants are generally more energy intensive rather than labor intensive, and the energy loads per square foot for processes are greater in new buildings.

D. New Buildings - Factors Which Will Modify Growth Rate

There are several conditions which will modify the load growth rate for new construction beyond 1975 as compared to the recent past. These "normal" conditions can be greatly enhanced by an intensive energy conservation and load management program.

1. A greater percentage of new housing will be multi-family dwelling units, with fewer occupants per unit. Reduced heat loss and heat gain, smaller appliances, and community laundry facilities will reduce energy consumption and demand per dwelling unit.

2. There will be fewer hospitals, universities and public school building constructed after 1980.

3. Energy conservation will be more extensively practiced, since construction standards for new buildings are changing--better and more insulation, double glazing, load limiting control systems, more light switches to control artificial illumination, and more efficient equipment and systems. Architects, engineers, and owners are becoming increasingly aware of the techniques and opportunities to conserve energy in the design of new buildings and are undertaking energy conservation programs now[1] which will impact on future demand. Energy conservation requires a

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1. Some examples include the energy conservation studies by DMBA performed for the Kings Point Merchant Marine Academy, and underway at Brookhaven National Laboratories on Long Island.

smaller initial investment in new buildings, compared to existing structures.

4. There will be an increasing number of solar domestic water heating solar space heating, and cooling systems in new buildings.

5. There will be an increase in the use of heat pumps in place of systems which might normally be resistive heating.

LILCO and DMBA forecasts under "normal" conditions are tabulated below for summer and winter peak demand, and annual electricity usage.

| | 1975 | 1980 | 1985 | 1990 | 1995 | Compound Annual Growth Rate |
|---|---|---|---|---|---|---|
| | SUMMER PEAK DEMAND (MW)[1] | | | | | |
| LILCO | 3,120 | 4,170 | 5,250 | 6,330 | 7,430 | 4.4% |
| DMBA--"Normal" | 3,138 | 3,933 | 4,513 | 5,185 | 6,073 | 3.4% |
| | WINTER PEAK DEMAND (MW) | | | | | |
| LILCO | 2,470 | 3,310 | 4,240 | 5,220 | 6,240 | 4.8% |
| DMBA--"Normal" | 2,522 | 3,147 | 3,905 | 4,728 | 5,531 | 4.9% |
| | ANNUAL ENERGY USE (GWH)[2] | | | | | |
| LILCO | 13,474 | 17,590 | 22,670 | 27,850 | 34,140 | 4.7% |
| DMBA--"Normal" | 13,431 | 17,189 | 20,302 | 23,703 | 27,439 | 3.6% |

Figures 2 through 7, curves A, B, and C, indicate LILCO's present and projected generating capacity and LILCO's and DMBA's projections of peak power loads and electrical energy usage under "normal" conditions. Curves D are DMBA's projections if an intensive energy conservation program were to be implemented a) alone, and b) coupled with solar energy utilization as later described herein.

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1. (MG), one megawatt = 1,000,000 watts, or 1,000 killowatts (Kw).

2. (GWH), one gigawatt hour = 1,000,000 killowatt hours (Kwh).

**B. NEITHER JAMESPORT I NOR JAMESPORT 2 WOULD BE REQUIRED IN THIS CENTURY IF AN INTENSIVE ENERGY CONSERVATION AND LOAD MANAGEMENT PROGRAM WERE TO BE UNDERTAKEN.**

In fact, the Shoreham Plant, or its equivalent, would not even be required until 1993.

Energy conservation does not mean unmitigated curtailment of goods and services, nor restricted use of energy for essential health, educational, economic, social, governmental, recreational and pleasureable activities. It does involve eliminating, or at least, greately reducing waste by utilizing all resources more wisely, taking critical stock of our real and perceived needs, and in some instances, substituting human effort for mechanical and electrical energy. Conservation requires improved maintenance and operating procedures utilizing the energy conserving equipment, systems, and materials which are now available; and in the longer run, developing more efficient equipment.

Given the environmental and health hazards of all types of central electrical generating palnts, escalating fuel costs, growing dependence upon foreign sources for fuels, and the high capital costs of conventional and alternative energy sources, it would appear that reducing demand by energy conservation and load management, which can be rather quickly implemented at costs which are much more favorable than increasing supply by the same amount, is the most rational energy policy for the short and long term. Coupling reduced demand with increased supply through alternative renewable sources of energy are options that are available now--in Long Island and in the nation.

DMBA selected a series of energy conservation measures and calculated the cummulative impact that those measures, in aggregate, could have on annual electricity consumption and peak demand on Long Island. The conservation measures which were selected from hundreds of available options, and the conditions governing their use, meet the following criteria:

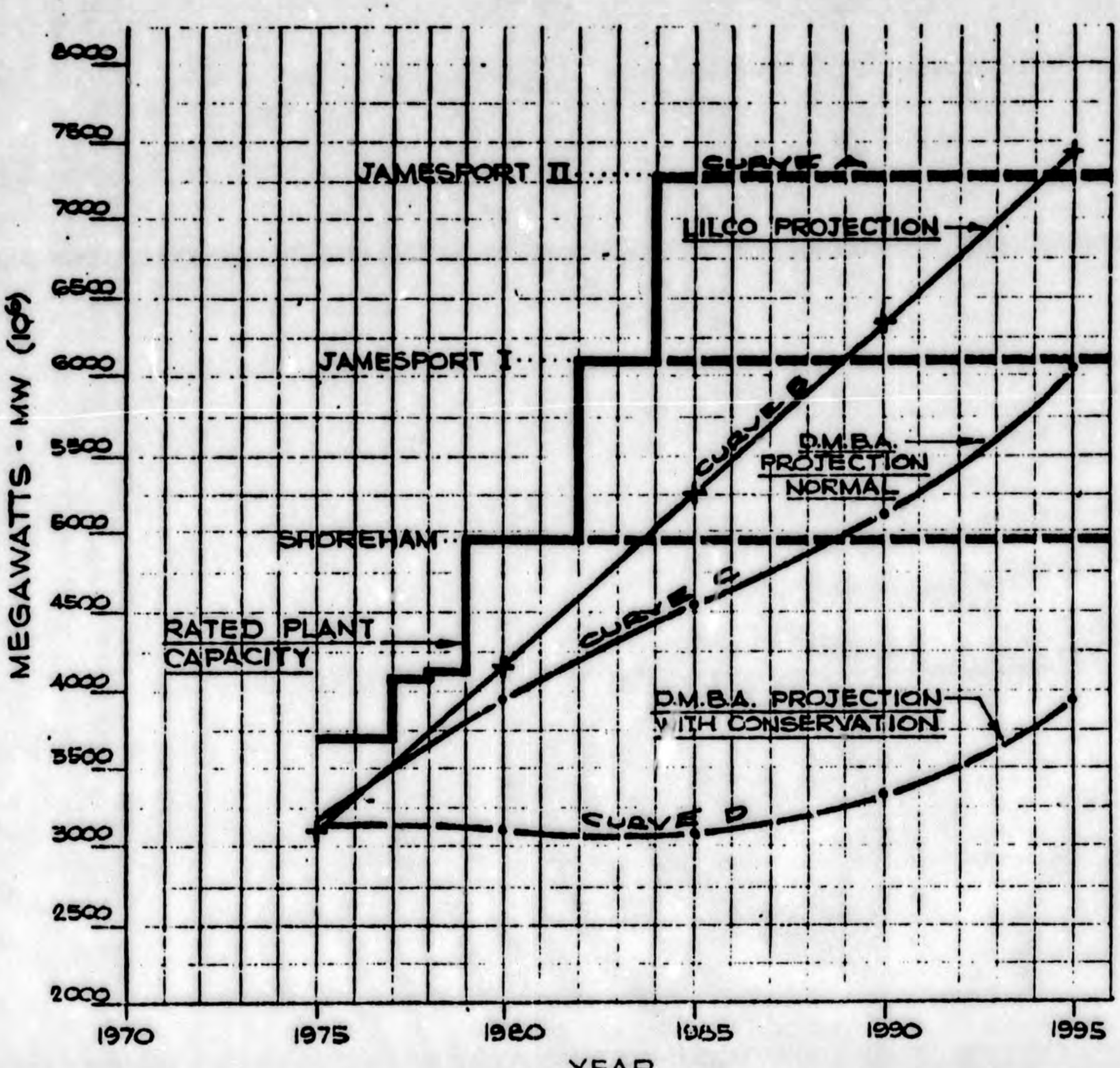
- The maintenance and operating procedures and systems are well known, have been widely publicized and depend only upon further incentives and continuous dissemination of information to insure that they are followed. They are applicable to existing buildings as well as new construction.

- All hardware, equipment, materials and systems are commercially available now.

- The engineering and architectural design considerations and methodology are well documented.

- All of the measures are currently being implemented to various degrees in the United States.

# FIG 2




D.M.B.A. PROJECTIONS OF SUMMER PEAK DEMAND AND CONSERVATION POTENTIAL

PREPARED BY:

DUBIN-MINDELL-BLOOME AND ASSOCIATES, P.C.
CONSULTING ENGINEERS AND PLANNERS
NEW YORK, NEW YORK

11.

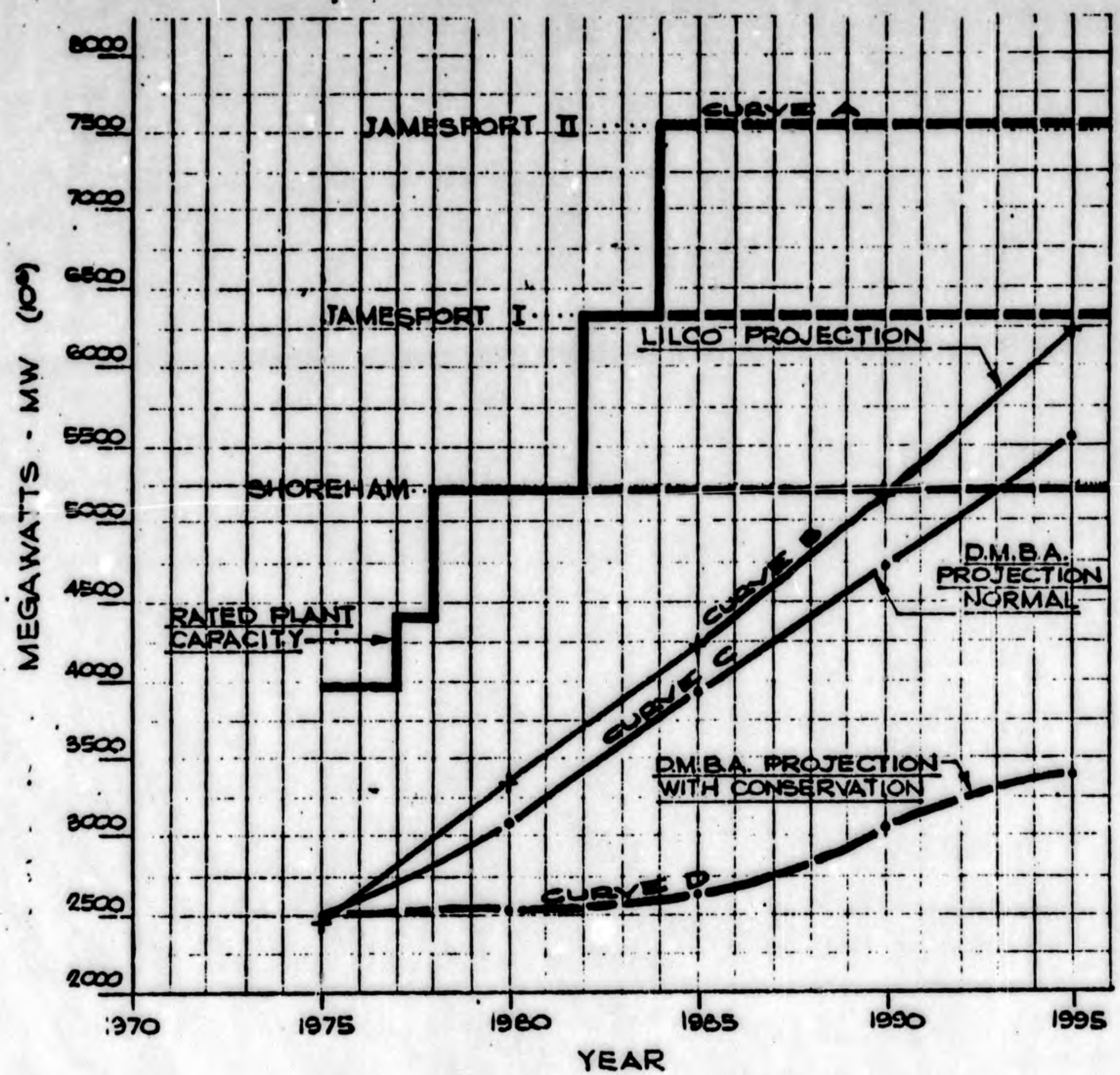



FIG 3

D.M.B.A. PROJECTIONS OF WINTER PEAK DEMAND AND CONSERVATION POTENTIAL.

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NEW YORK, NEW YORK

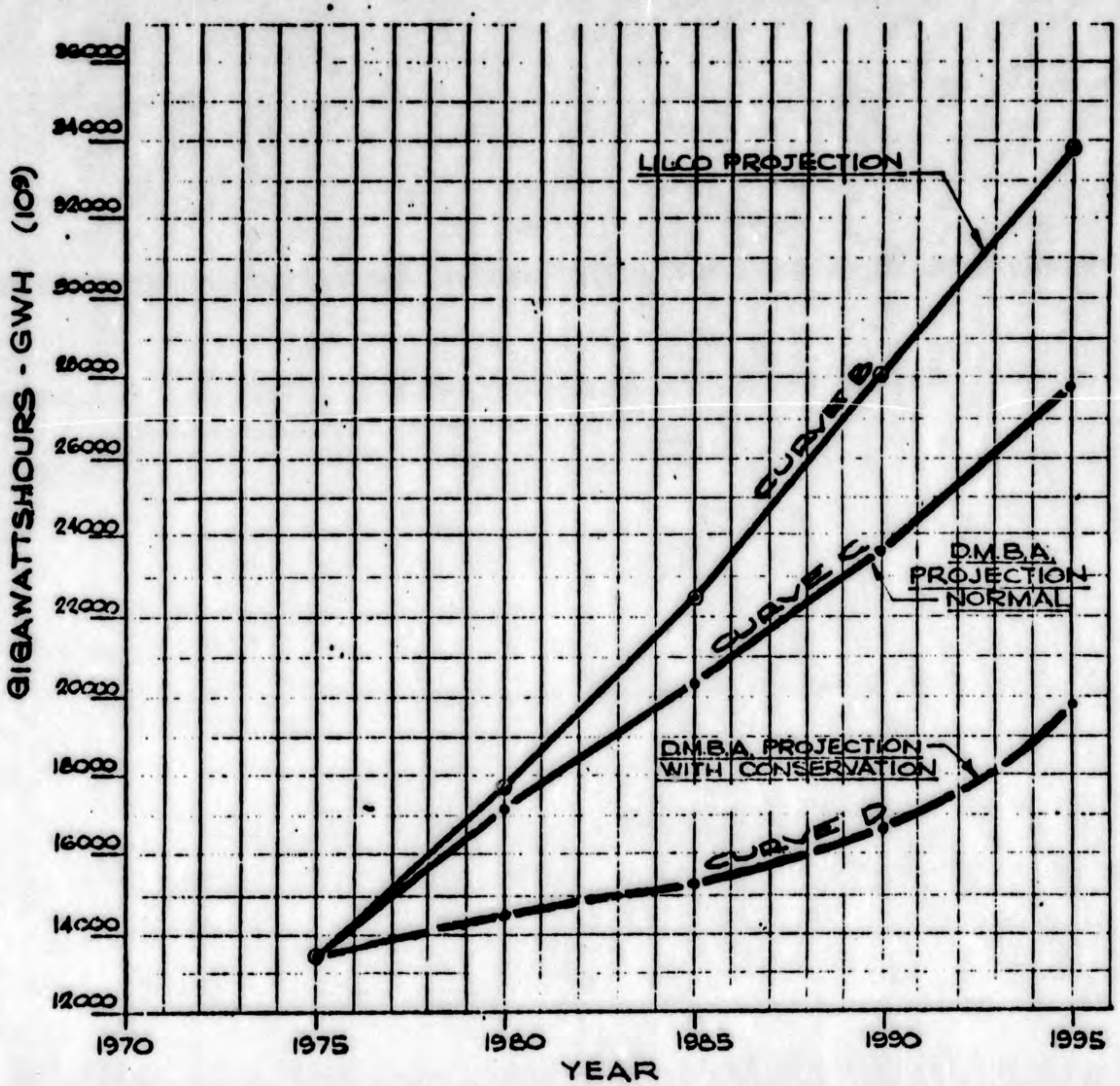


FIG 4

D.M.B.A. PROJECTIONS OF ANNUAL ENERGY CONSUMPTION AND CONSERVATION POTENTIAL

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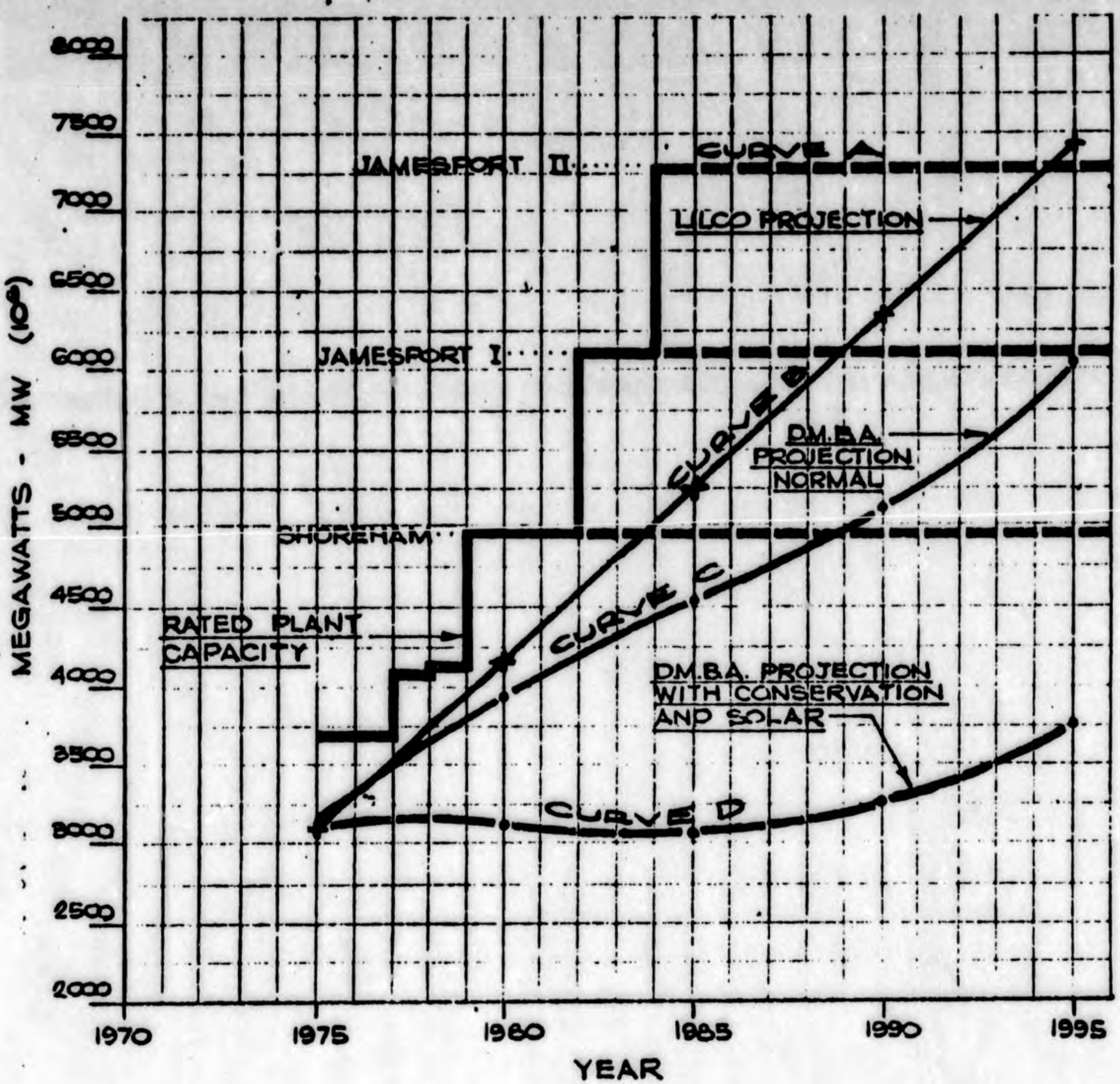
NEW YORK, NEW YORK

FIG
5




D.M.B.A. PROJECTIONS OF SUMMER PEAK DEMAND AND CONSERVATION PLUS SOLAR ENERGY POTENTIAL.

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NEW YORK, NEW YORK

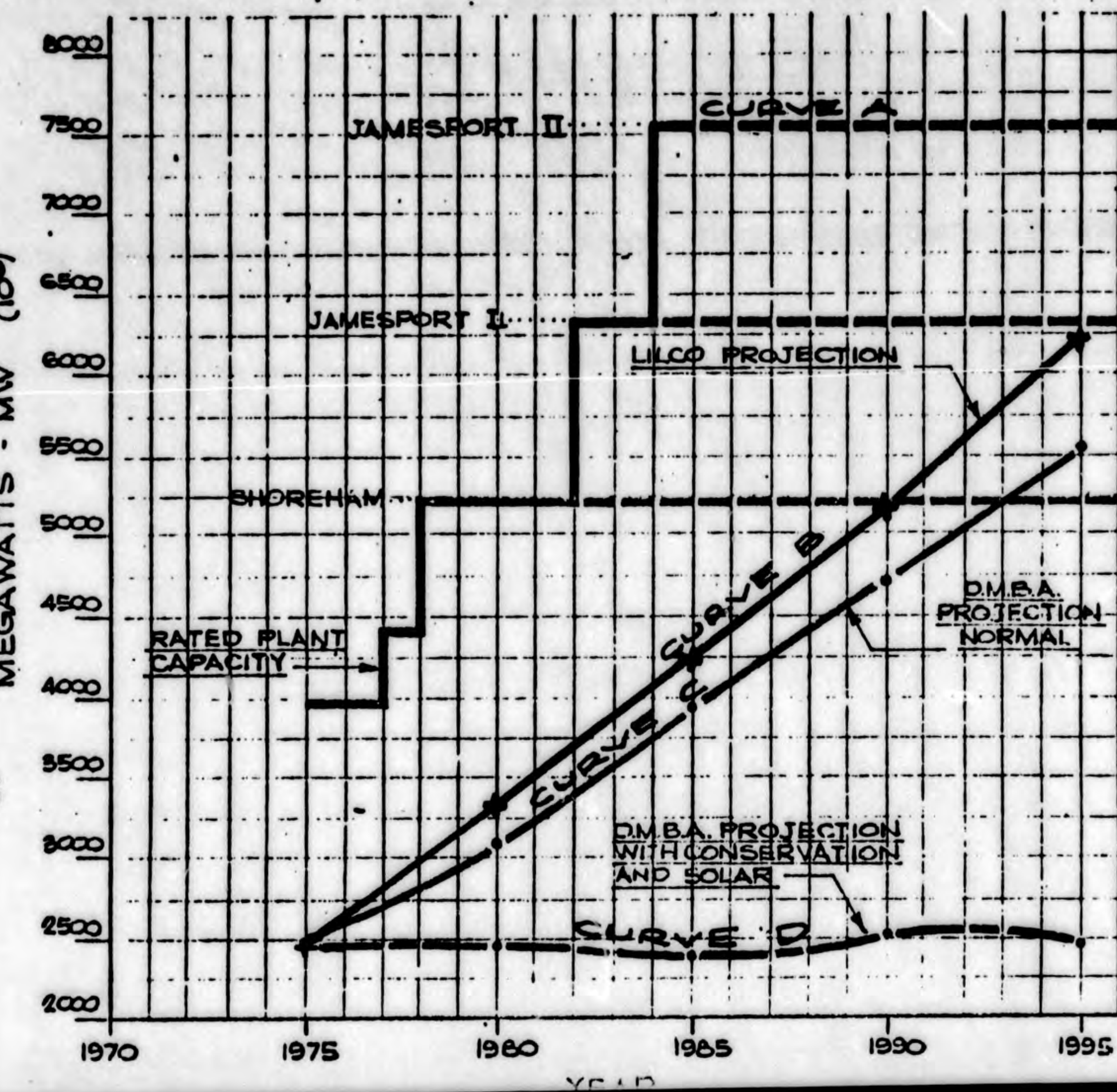


FIG 6

D.M.B.A. PROJECTIONS OF WINTER PEAK DEMAND AND CONSERVATION PLUS SOLAR ENERGY POTENTIAL

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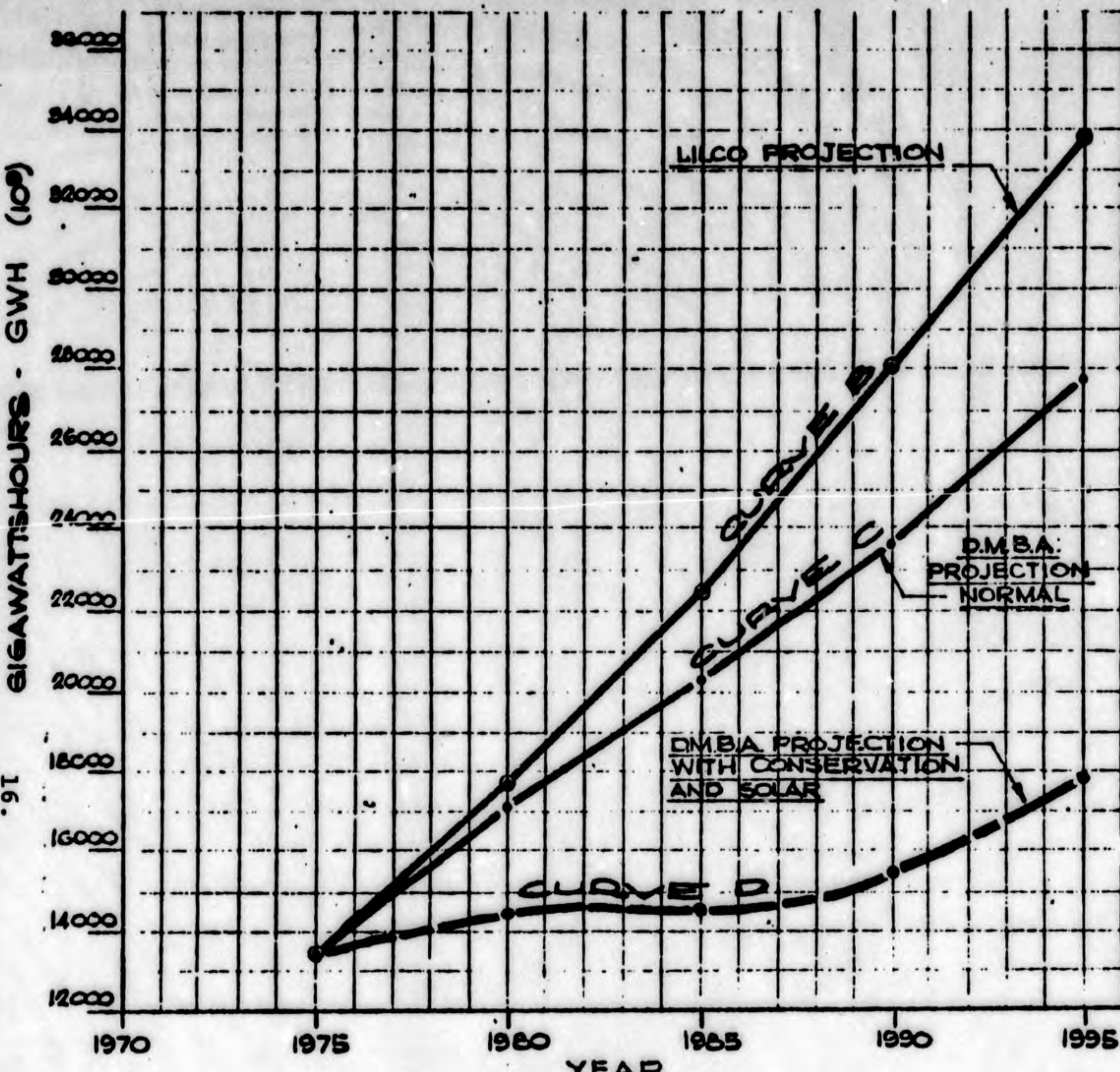


FIG 7

D.M.B.A. PROJECTIONS OF ANNUAL ENERGY CONSUMPTION AND CONSERVATION PLUS SOLAR POTENTIAL

PREPARED BY:

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- The measures involving building construction and mechanical and electrical system design, which are appropriate for each building type, would be implemented to the fullest extent in all new construction.

- The measures which are suitable for existing buildings, but require retrofitting, would be done progressively within ten years, except that increasing the insulation in roofs and walls of existing electric space heating buildings would be done within a twenty year period.

- All existing inefficient appliances and mechanical and air conditioning equipment would be replaced by the most efficient equipment available progressively within a fifteen year period.

- Labor and materials are available or can be imported into Long Island within the time-frame selected for implementation.

Energy conservation through operation and improved maintenance will reduce annual energy consumption to a greater extent than lowering the peak demand, although most of those practices will have an impact on both loads. There is ample evidence now from operating experiences and case history reports that electricity consumption and demand loads can be reduced from 10% to 20% by these measures alone. The actual amount varies with the conditions that prevail before implementation, and the extent and continuity of the effort exerted. Building modifications and more efficient mechanical and electrical systems and controls will result in a further reduction in peak demand (reducing the need for new power plants), and annual energy usage.

Since buildings differ from one another in configuration, materials, orientation, usage, solar heat gain control, insulation, amount and type of lighting, and very widely, in heating, air conditioning and ventilation system types, sizes, and controls, all energy conservation measures are not suitable for, nor will they exert the same impact on every building. EAch building and program must be separately evaluated. Since this was obviously impossible to do within the scope of this study, assumptions were made of average existing conditions based on observations, limited surveys in Long Island, data from other areas, national records, and calculations performed previously for individual buildings and complexes. Operating records and data from a number of existing buildings, including supermarkets, residences, universities, municipal buildings, public schools, commercial buildings and industry were also obtained to confirm the order-of-magnitude of loads and typical construction details.

The calculations,based on assumptions and historical data, were made to estimate the impact, which an intensive energy conservation program would have on annual electricity consumption and peak demand.

Figures 2, 3, and 4, Curves D, indicate what the peak hour demand and annual electric energy requirements would be with an intensive energy conservation program. Since the values plotted for Curve D were based on a calculated percentage reduction of DMBA's "normal" forecast, the same percentage reduction would also apply to LILCO's projections, and the net result is that Curve D would not change very much even if LILCO's forecasts for "normal" conditions were to be used as the base. (The same percentage reduction applied to a larger value, results in a greater decrement.)

The resultant peak demand and annual energy usage with an intensive energy conservation program are tabulated below:

| | 1980 | 1985 | 1990 | 1995 | Compound Growth |
|---|---|---|---|---|---|
| | SUMMER PEAK DEMAND (MW) | | | | |
| DMBA-CONSERVATION | 3,211 | 3,106 | 3,359 | 3,964 | 1.4% |
| | WINTER PEAK DEMAND (MW) | | | | |
| DMBA-CONSERVATION | 2,578 | 2,678 | 3,058 | 3,412 | 1.9% |
| | ANNUAL ENERGY USE (GWH) | | | | |
| DMBA-CONSERVATION | 14,662 | 15,152 | 16,627 | 19,882 | 2.1% |

## Details of the Intensive Energy Conservation Scenario

### Group I Energy Conservation Measures - Little or No Capital Costs Required

Energy conservation begins at home (business, industry, institution). No new standards, codes, laws, studies, nor design manuals are required for the operational and maintenance measures suggested below. They are all cost effective. Many will apply to all buildings; most of them to most buildings. Consider the following which is a partial list of those which were evaluated.

1. During the heating season, set thermostats back to 68°F during occupied periods and 8° to 10° lower during unoccupied periods. In commercial and industrial buildings do not operate the cooling system during the heating season.

2. During the cooling season, maintain indoor temperatures at 78°F during occupied periods and shut off air conditioning completely during unoccupied periods.

3. In buildings that have wasteful reheat systems, operating changes can be made to reduce the impact of reheat; in those cases summer temperatures should be maintained at temperatures lower than 78°F.

4. In the winter time, do not maintain relative humidities above 20% except where needed for process or for special health care facilities. In the summer time, do not control humidity in air conditioned buildings until it reaches 60% or more.

5. Reduce the rate of ventilation in non-residential buildings to about 5 cfm per person during occupied periods and shut off ventilation completely when buildings are unoccupied. At present many buildings are operated with 15 to 100 cfm per person, and often for 24 hours per day, 7 days per week.

6. Reduce hot water temperatures to 110°F, or below, except for dish washing and sterilization. Most buildings now provide hot water at 140° or more. Also, reduce the rate of flow by careful operation, or by installation of restriction valves, low flow rate shower heads, or orifices.

7. In buildings with chilled water air conditioning systems raise the chilled water temperature from the usual settings of 42°F, 44°F to 46°F, 48°F, or even 50°F when the air conditioning load is not at peak (this can be done during most of the operating hours).

8. Reduce the level of illumination by changing lamps to lower wattage and/or to those which provide more lumens per watt and remove excess lamps and disconnect ballasts. The greatest opportunities occur in corridors, lounges, and other areas where there are no critical reading or writing tasks which extend beyond one hour's time.

9. Turn off all unnecessary lights and use natural illumination when available. Shut off exhaust fans, escalators, elevators, appliances, TV sets (unplug instant-on), vending machines and other electrical appliances when not required during occupied periods and at all times during unoccupied periods. These measures will save approximately 10% to 20% in electricity consumption and about 10% in peak electrical demand without requiring any investment.

10. Additional and more frequent maintenance such as cleaning oil burners, boilers, radiators and air filters; oiling motors; cleaning light bulbs; repairing torn insulation;

cleaning condenser and evaporator coils in air conditioning units; and repairing steam leaks and hot water leaks, provide an opportunity to save as much at 15% or more in energy consumption and can easily reduce peak electrical loads by 5%.

11. Reduce the number of elevators in service during hours when the majority of persons are not leaving or entering the building.

12. De-energize transformers supplying unused offices or other areas.

13. De-energize refrigeration chiller transformers during the heating season.

14. De-energize heating equipment transformers during the cooling season.

It is beyond the scope of this paper, and indeed beyond the scope of the full report to list, much less quantify all of the energy conserva on options and opportunities in Group I, operation and maintenance measures, listed above and in Group 2, investment opportunities through retrofit and system modifications in existing buildings and energy conservation design in new buildings. Refer to references D-1, D-2, and D-3 for a more comprehensive list of the conservation options which are available now in both groups.

Reference 2, ECM-2, includes charts, graphs, calculations, and instructions for quantifying each of the many energy conservation measures which are available now. The operating cost savings which accrue from them are also shown. Some of the energy conservation measures, and the extent to which they were considered in the study are enumerated below under the Group 2 listing. As examples of the concepts which were considered and quantified, three specific systems, i.e., domestic hot water, lighting and electric space heating are first described.

## Group 2 - Energy Conservation Measures

A. Domestic Hot Water

### Reduction of Annual Energy Consumption

The annual energy consumption for heating domestic or service hot water will be reduced if:

1. The generation, storage and utilization temperatures of hot water are at lower levels.

2. The quantity of water usage is reduced.

3. The thermal losses from the systems are reduced.

4. The seasonal efficiency of the hot water generation system is improved.

5. Alternative sources of energy such as solar, and wind energy, or waste heat from other processes are used in place of electricity or fossil fuels.

The first three options are common to all domestic and service hot water systems, regardless of fuel used. The fourth option is more applicable to the systems that heat hot water with gas, and particularly with oil, since electric hot water heaters have a conversion efficiency of nearly 100%.

By supplying domestic hot water at 110°F, instead of 140°F, consumption of energy can be reduced by about 20%. By reducing quantity of flow, e.g., showers, hot water taps, kitchen sinks, and other uses, there is an opportunity to save 25% to 30%. These two measures are not additive, but do result in a combined savings of about 40%. With proper insulation on hot water piping and storage tanks, more than 15% of the annual energy consumption required to heat hot water can be saved in the average installation. The aggregate of these would amount to more than 2,000 Kw saved per year in the average Long Island house using electric water heaters. Approximately 300 gallons of oil per year can be saved in houses with oil water heaters and the equivalent for gas.

Using the building's space heating boiler to heat domestic hot water, is particularly inefficient in the summer time, but with proper boiler maintenance and frequent adjustments of the oil burner, 10% to 15% additional savings in fuel are possible. A separate water heater will be a good investment.

Reduction of Peak Electric Demand

Reducing hot water temperature and quantity, and improving the thermal efficiency of the storage and distribution systems, reduces electric peak demand for these heaters in about the same proportion (slightly less), as the reduction in consumption. The demand due to electric water heating can be virtually reduced to zero at the utility peak demand hours by time-of-day metering, employing time clocks, central control or other available hardware, but does not reduce electrical consumption, whereas the other alternatives conserve energy as well as reduce peak demands.

Using waste heat from industrial processes, hot water drain lines, and hot gas heat exchangers in refrigeration units or heat pumps are additional methods of reducing energy consumption and peak demand.

## B. Lighting

### Reduction of Annual Energy Consumption

The consumption of electricity for lighting can be reduced by 20% to 40% in the average existing building, and by 40% to 50% in new construction as compared with current practice. Greater utilization of natural illumination to replace place electric lighting, more efficient lamps, more efficient lighting fixtures, and the design and installation of systems to provide selective lighting levels with only the amount of illumination provided, as necessary and when necessary, for specific tasks and functions within buildings, are the major options available to reduce energy consumption for lighting. Most of these can be done with very little investment in existing buildings, and frequently at a savings in capital costs in new buildings.

By proper design, only 1-3/4 to 2 watts per square foot are required to provide illumination of adequate intensity and good quality in office buildings. However, most new buildings are designed for 3-1/2 to 6 watts per square foot with inadequate switching facilities to turn off unnecessary lights for portions of the day where little if any lighting is required. Providing fluorescent lighting for homes, in place of incandescent lamps will reduce the consumption of electricity for illumination by about 40%.

### Reduction of Peak Electric Demand

Virtually all of the measures which reduce electricity consumption will reduce peak electric demand as well, and almost in the same proportion. Utilization of natural illumination, and switching off lights for portions of the day do not have as great an impact on reducing peak loads as they do on reducing energy consumption. Generally, peak load reduction will be 60% to 80% of the energy consumption savings--still a sizable amount. In addition, reducing power for lighting, also reduces the load on the air conditioning system, with additional savings in consumption and reduction of peak loads.

## C. Electric Heat

### Reduction of Annual Energy Consumption

Electric heat will comprise a greater proportion of electric energy usage and contribute a greater proportion to the LILCO peak winter demand as the saturation of electric space heating increases. The consumption of electricity for heating can be reduced to zero (except for small motors for pumps and fans), if no electric heating is used. The amount of oil saved in the electric generating plants will exceed the amount of oil required for heating the same buildings with on-site boilers. If power is generated by nuclear energy, and fossil fuels are substituted for electric space heating, the nuclear plant capacity can be reduced and the fuel for heating the buildings can easily be supplied by the savings in fossil fuel through energy conservation of existing fossil fueled buildings: The average oil heated house in Long Island uses 1600 gallons of oil per year, and the average non-residential oil heated building uses about 1 gallon of oil per square foot. But, if the 250,000 new dwelling units predicted to be built on Long Island in the next twenty years were to be built in an energy conserving manner, with efficient oil heating systems in place of electric resistance heating, they would use about 200,000,000 gallons of oil per year for heating. If an intensive energy conservation program were undertaken, the oil consumption for the existing 760,000 residential dwelling units and the 440,000,000 sq. ft. of non-residential buildings would be vastly reduced and the savings in fuel would amount to more than 600,000,000 gallons per year--3 times as much the energy required to heat the new homes.

The most effective way to reduce consumption of electrictiy for electric heated buildings is to install efficient heat pumps in place of electric resistive heating. Air-to-air heat pumps are available with a coefficient of performance of 3[1] at optimum conditions--and at 2.0 or higher at the outdoor design conditions in Long Island of 10°F. The total system COP of heat pumps and supplementary electric heating could readily attain an annual COP of 2.5 resulting, in a 60% reduction of electricity consumption for space heating. There are other heat pump systems, including the use of ground water or well water as a heat source, closed loop heat pumps in commercial and industrial buildings, using excess heat from interior areas of the buildings or from the sunny side of the building, double bundle condensers used in the heat pump mode, or solar energy as a heat source. The COP of heat pumps in these codes is higher than air-to-air heat pumps--up to 5 on a seasonal basis--and the annual electricity can be reduced by 60% to 80% as compared to resistance heating.

Reducing the heat loss of the building by additional insulation, double or triple glazing or storm windows, by reduced ventilation loads and reduced infiltration rates will reduce the seasonal energy requirements for space heating by an amount equal to the reduction inhheating load. Even in electric heated buildings, which are better insulated than

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1. COP is the ratio of the work performed (expressed in BTU's), to the power expended (expressed in the BTU equivalent). The COP of electric resistance heating is 3,413 BTU's per 1 Kwh of electricity. With a COP of 3, 10,239 BTU's are produced per 1 Kw (3,413 BTU's), imput.

the average fossil fuel heated building, opportunities exist to retrofit existing buildings to reduce heat loss by 15%, and in new buildings by about 25%. Thermal barriers such as insulated shutters or slides alone can reduce heat loss by 12% to 15%.

Reduction of Peak Electric Demand

Any measure which reduces heat loss, will also reduce peak electric demands by about the same percentage or a little more. Although it would appear that the use of heat pumps would not materially reduce peak demand (LILCO stated that they took no credit for reduction of peak demand on the utility system peak hour, for heat pumps in place of electric resistive heating in their forecasts), in reality, analysis shows that peak demand can be reduced by 50% or more with heat pumps for the following reasons:

a) A customer's peak electric heating demand occurs from 6 to 8 A.M. on the coldest days, whereas LILCO's system winter peak demand occurs on somewhat milder winter days and from 5 to 6 P.M.

b) While the winter peak demand is, and will continue to be lower than the summer peak demand, given a greater saturation of electric heating, the system peak demand could eventually occur in winter, and at somewhat lower outdoor temperatures, and at earlier hours than at present. However, the coefficient of performance of good quality heat pumps at LILCO winter peak hours is greater than 2.5, Heat pumps, sized for the buildings' cooling load, will be large enough to handle m more than 75% of the heat loss of the building at the LILCO system peak demand hours--thus requireing supplementary heat for only 25% of the load at that time. If electric resistance heating is used as the supplementary source of heat, the system COP in this case would be approximately 2.15, resulting in a 45% reduction in peak demand for air-to-air heat pumps. With water-to-air, or water-to-water heat pumps, the reduction in peak load will be even greater.

Heat storage systems alone, using either hot water or ceramic heaters, could reduce the electric peak heating demand to zero at LILCO's peak hours, but they will not reduce energy consumption.

The major energy conservation measures and the rate of implementation which were used to determine the impact of an intensive energy conservation program on annual electricity consumption and peak demand are detailed below. All measures which reduce the heat loss and improve the efficiency of the heating system in fossil fuel heated buildings will reduce the number of gallons of oil or cubic feet of gas required each year.

DMBA selected specific energy conservation measures which are most appropriate to each individual building type from a comprehensive list of energy conservation measures which a) DMBA previously identified, quantified, and analyzed, and b) are noted in existing studies, reports, and literature, and are representative of the work of recognized authorities. Many measures are common to all geographic areas. Where studies had been performed for other climatic zones, adjustments were made for the Long Island climate for those measures which are sensitive to climate, i.e., heat loss, heat gain, solar radiation, wind, etc.

I. For Existing Buildings

A. Modification of the Building Envelope:

| Measure | Effect |
|---|---|
| It is assumed that 50% of all electrically heated dwelling units are equip-equipped with storm sash or double glazing. | |
| 1. Provide double glazing for the remaining electrically heated dwelling units at the rate of 10% of the buildings per year. | 1a. Reduces electrical consumption and peak demand for space heating by reducing heat loss and infiltration. Also reduces the cooling load slightly, thereby reducing both electrical consumption and peak demand. |
| It is assumed that 10% of all fossil fuel heated buildings have storm sash. | |
| 2. Provide storm sash or double glazing for the remaining 90% of dwelling units at the rate of 10% of the the buildings per year.<br><br>Optionally, provide thermal barriers to insulate windows at night at a rate of 10% per year of the buildings per year. | 2a. Reduces fossil fuel consumption and peak demand for fan and pump motors in the winter time (fan speed and pumps should be adjusted in accordance with lighter loads). The cooling load is also reduced slightly, thereby reducing both electrical consumption and peak demand in the summer time. |

| Measure | Effect |
|---|---|
| It is assumed that the roof or ceiling insulation for the average electrically heated house has an average R value of 10 and a wall R value of 7. | |
| 3. Provide insulation to raise the R value of the roof or ceiling to 20 and the R value of the wall to 10 at a rate of 5% of the buildings per year. | 3a. Reduces electricity consumption and peak demands for space heating in the winter and for cooling in the summer. Wall insulation has less effect in summer than winter. |
| It is assumed that the average fossil fuel heated house has an average R value of 6 for roof or ceiling and walls. | |
| 4. Provide insulation to raise R value of walls and roof to an average of 20 for all fossil fuel buildings at a rate of 10% of the buildings per year. | 4a. Reduces fossil fuel consumption for space heating, and electricity consumption and peak demand for fan motors and pump motors in the winter time; reduces electrical consumption and peak demand for air conditioning in the summer time. |
| 5. It is not known how many existing buildings are built with uninsulated floors over a crawl space, therefore no credit was taken for floor insulation in the existing buildings. However, where applicable, insulation with an R value of 7 should be added to the floors over crawl spaces, or to basement walls. | 5a. Same as 4a. |

| Measure | Effect |
|---|---|
| It is assumed that 20% of all existing buildings are equipped with weather stripping to limit infiltration to .2 cfm per linear foot of crack area, and 30% of all exterior doors are provided with weather stripping. | |
| 6. For the remaining buildings provide caulking, and weather stripping to reduce in-infiltration to an average rate of .2 cfm per linear foot of crack area at a rate of 10% of the buildings per year. Also, limit infiltration by reducing the amount of exhaust air for ventilation, shut fire place dampers, seal cracks in building construction, install vestibules, remove window air conditioners in winter or cover them with plastic cover.<br><br>Install door closers on exterior doors and seal elevator service shafts. Caulk openings around pipes, louvres or other openings which penetrate the building envelope. Install odor absorption devices and recirculate exhaust air rather than introducing new makeup air. | 6a. Reduces heat loss for all buildings, and electricity consumption and peak demand for space heating in the electrically heated buildings. Reduces oil or gas consumption of the fan and motor horse-power for fossil fuel heated buldings. In all buildings, latent heat gain is reduced in the summer, thereby reducing electrical consumption and peak demand for air conditioning. |
| It is assumed that in air conditioned buildings the glazing has an average shading factor of .7 in combination with venetian blinds, awnings, shades, reflective glazing, or reflective coatings, overhangs, trees, or sunscreens. | |
| 7. Provide devices which will reduce the shading factor to .35 at the rate of 10% of the buildings per year. Also | 7a. Reduces heat gain due to solar loads. Reduces electricity consumption and to an even greater extent, |

| Measure | Effect |
| --- | --- |
| provide reflective roof covering for 25% of the existing commercial space at a rate of 5% of the buildings per year. | peak demand for air conditioning. |

B. Modification of Lighting:

| Measure | Effect |
| --- | --- |
| 1. For residential buildings change 80% of the incandescent lighting in dwelling units and in all non-residential buildings, except where incandescent or other lamp sources are requred for special effects, to fluorescent lamps at the rate of 10% per year; provide more efficient incandescent lamps such as krypton for all incandescent lighting which must remain.<br><br>For high bay areas, provide mercury vapor and high intensity lamps in place of lamps with lower efficiency. | 1a. Reduces yearly electrical energy consumption and summer and winter peak demand for lighting, and reduces consumption and peak demand for air conditioning because of lower internal heat gain. |

Under normal conditions, it was assumed that an average of 3 watts per square foot was installed and operated for lighting in non-residential buildings.

| | |
| --- | --- |
| 2. Modify the lighting system by more efficient lamps, additional switching, more efficient fixtures, multilevel ballasts and task lighting to reduce the average lighting load to 2 watts per square foot at the rate of 10% of the buildings per year. | 2a. Reduces yearly electrical energy consumption and summer and winter peak demand for lighting and during the cooling season, for air conditioning. |

## C. Electric Power

There is no data on specific conditions in all buildings on Long Island to provide a base for a precise analysis of the total impact of conservation measures to reduce energy consumption and peak demand for power systems within buildings. However, there are many opportunities to reduce power requirements, and an individual analysis of each building is required to identify them.

The effects on the power system, by reducing heating, cooling and lighting loads have already been discussed, and their impact has been taken into account in the analysis. In addition, the following can be accomplished to a varying degree in existing buildings to further reduce consumption and demand:

- Install manual or automatic controls to disconnnect loads when they are not requried.

- Install remote control manual or automatic load shedding devices to reduce the peak loads due to electric water heaters, clothes and dish washers and dryers, air conditioning units, elevators and escalators, industrial drying processes, fan and pump motors.

- Correct low power factor with capacitors or synchronous motors to reduce $I^2R$ losses.

- Change oversized motors to improve the system power factor and motor efficiency.

- De-energize MG elevator sets, or use SCR controllers. Select more efficient elevators and control devices when replacing elevators or expanding elevator service.

- When new additions or major remodelling involving the installation of new equipment, including entrance equipment, use 480/277 volt systems instead of 120/208 where the electric service is in the vicinity of 300 KVA or more. When using 480/277 volt systems, use as much 480 and 277 volt equipment as possible.

- Reduce copper losses in the wiring by ventilating transformer banks to maintain lower temperatures.

D. Heating and Air Conditioning Equipment:

| Measure | Effect |
|---|---|
| A majority of buildings with electric heating systems are also equipped with window air conditioners which will deteriorate. It is assumed that 10% of all units are replaced per year. | |
| 1. Replace the window air conditioner cooling units with heat pumps, with an EER of at least 7 (7 BTUs per watt), for units below 5,000 BTUs, and 9.0 for larger units for residential use, and 12 for commercial, institutional and industrial units. | 1a. Reduces the electrical consumption due to space heating by about 60% and reduces peak demand during the winter by about 30%. Reduces the electrical consumption and peak demand in the summer for air conditioning, each, by about 33%. |
| The average window air conditioner now installed has an EER of 5 to 6. It is assumed that 10% of all units are replaced each year. | |
| 2. When replacing or adding new window air conditioners, provide units with an EER of 7.0 or more, for units below 5,000 BTUs, and 9 for larger ones. | 2a. Reduces the electricity consumption and peak demand for air conditioning. |
| The same efficiency is assumed for residential central air conditioning systems and for commercial package type equipment. It is assumed that 7-1/2% of all units are replaced each year. | |
| 3. Provide all new and replacement central air conditioners with units having | 3a. Reduces the electricity consumption and peak demand for air conditioning. |

| Measures | Effect |
|---|---|
| an EER of 9 for residential units, and an EER of 12 for non-residential air conditioning systems larger than 25 tons. | |
| 4. It is not known how many or the size of the HVAC systems that employ some type of reheat system such as terminal, reheat, dual duct, multizone systems, or induction in peak demands and consumption by modifying these systems. However, there are probably 10% or more of these systems now installed in non-residential buildings. By modifying them in accordance with the options listed in ECM-2, the consumption of electricity can be reduced by about 15% and peak demand by about 5%. | 4a. Reduces the electricity consumption and peak demands for air conditioning. There will also be savings in fuel oil or gas used for reheating. |
| 5. For HVAC and industrial systems, provide central control systems to replace manual control systems where applicable. Many central control systems have been ininstalled in new and existing buildings, and the payback periods have been from one to ten years, depending upon the complexity of the system. | 5a. Reduces annual electricity consumption and peak demand (both summer and winter). |

E. Industrial Process

It is assumed that the efficiency of industrial processes have been increased

| Measure | Effect |
|---|---|
| by about 5% on an average, since 1973. In reality, there is a potential of 15% to 30% improvement. | |
| 1. Provide heat recovery equipment for exhaust air systems, hot water drains, and heat processes.<br><br>Provide more efficient equipment for electric drive, electric furnaces, air compressors, etc. | 1a. Reduces electricity consumption and peak demand for air conditioning, and processes. Will result in reduction in fossil fuel used for heating. |

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## II. For New Buildings

It is assumed that all new buildings will be operated and maintained in the energy conservation mode as note in ECM-1 and summarized in "I" above for "Existing Buildings," and that they will be constructed and equipped in accordance with energy conservation opportunities and options detailed in Energy Conservation Measure 2, and "Energy Conservation Design Guidelines for New Office Buildings," prepared by Dubin-Mindell-Bloome Associates, P.C., the AIA Research Corporation and Heery and Heery, Architects, for the General Services Administration. A partial list of the energy conservation measures are listed below. Where the effects of each measure are similar to the equivalent measures for existing buildings, the effects are not repeated.

### A. Building Envelope and Plan

1. Design to optimize energy conservation by reducing heat loss and heat gain through proper orientation, configuration, window size and location, double glazing and weather stripping, thermal mass, exterior colors, insulation type and thickness and location, and selective facade treatment to take maximum advantage of solar heat gain in the winter, maximum wind shielding, and reduced solar heat gain in summer, as follows:

-Window U factor, .55

-Thermal barriers over windows at night, U factor, .1

-Infiltration rate, .15 cfm/linear foot of crack

-Wall U factor, .06

-Combined wall-window U factor, .17

-Roof and ceiling U factor, .05

-Edge insulation, 2" foam board

-Vestibules or revolving doors

-Wall mass for commercial and industrial buildings, 80 p.s.f.

-Shade factor, summer, .15

-Shade factor, winter, .6

-Maximum utilization of space

A combination of these conservation measures will conserve about 35% of the annual energy usage for heating, and about 25% of the annual electricity consumption and peak demand for air conditioning (somewhat less in large buildings with high internal heat gain).

In electrically heated buildings, the peak electric demand for heating will be reduced by about 25%.

2. Provide landscape planning in office buildings in place of more numerous smaller rooms in order to reduce the power for illumination. Walls absorb energy as well as reflect it. In the study for G.S.A., landscape planning was shown to reduce the power required for illumination by 25%. Electricity consumption will also be reduced by about the same amount.

3. The reduction in energy consumption for heating and cooling due to increased saturation of apartments in accordance with Suffolk-Nassau County master plan was taken into account in assuming the "normal" case. If a greater percentage of the new dwelling units are high density multi-housing units, additional peak load reduction and savings in energy consumption would be accomplished. For instance, the heating and cooling loads for a two story house are approximately 20% less than a single family house; a four dwelling unit garden apartment, about 30% less than a single family house; forty dwelling unit apartment house about 45% less, and larger apartments even lower.

B. Lighting

1. Use fluorescent lighting for 90% of the lighting requirements for each dwelling uit, with a maximum connected load of one watt per square foot.

2. Use H. I. D. lamps first where ceiling heights, visual task requirements, and color rendition permit, then use fluorescent and/or mercury vapro lamps, rather than incandescent for other applications.

Low pressure sodium lamps provide 4 times more lumens than fluorescent tubes for the same wattage input. Other high efficiency H.I.D. lamps are also available in smaller lamp sizes for indoor applications, where previously they were available only for outdoor lighting.

3. Provide task lighting, instead of indiscriminate uniform lighting; photo-cell control for maximizing natural illumination, and luninaires with maximum coefficient of performance.

Multi-level ballasts, with integral switch, are available to vary the output of a luminaire from 100% to 50% or 20%. Individual lamps in the luminaire can be turned off or on at will to meet specific task requirements as needed, with lower levels of illumination provided from the same luminaire when tasks are less critical.

4. Design for a maximum of 1-3/4 watts per sq. ft., average intensity,for commercial spaces, with warehousing and other areas which are not critical at lower levels and reduced wattage.

C. Power:

1. Use more efficient transformers to save about 5% of the transformer losses.

2. Provide higher voltage distribution systems such as 277 volts fluorescent lighting for non-residential buildings and higher distribution voltages ranging from 480 volts to 13.5 Kv depending upon the size of the project, for universities, shopping centers, industrial buildings and other large building complexes.

3. Provide automatic demand limiters,and load leveling and peak shaving controls for non-residential buildings.

4. Provide time-of-day metering to reduce the contribution to utility peak demand hours for all electric water heaters, dishwasher and dryers, clothes washers and dryers, electric heating using forced air ceramic storage heaters integrated with heat pumps, one chiller in multiple chiller operations, and approximately 15% of all other motor and equipment loads (including lighting), in industry and in commercial and institutional buildings.

D. Heating, Ventilating, Air Conditioning, Domestic Hot Water

1. Provide heat pumps in place of all electric resistance heating. Heat pumps can be air-to-air, water-to-air or double bundle condensers and evaporators. The minimum seasonal COP shall be 2.5 for air-to-air heat pumps, 3.0 for water-to-air heat pumps under 5 HP, and 4 for all larger units to reduce electrical energy consumption 60% 70% and peak loads by 40% 60%.

Some of the ways to increase the C.O.P. of various heat pump systems include the following:

- Where available, use well water or ground water as a heat source for water-to-water heat pumps instead of ambient air-to-air heat pumps. For the U.S. Home Resource Savings House, the water-to-water heat pump, using ground water as a heat source (it averages 72°F year round in Clearwater, Florida), reduces the annual electricity requirements for heating by 22% as compared to air-to-air heat pumps.

- Raise the temperature of an air source heat pump by using exhaust air from the building or processes as a heat source. Waste heat from engines, hot water drains, flashed steam, condensate, exhaust hoods, kitchen equipment and incinerators are all condidate heat sources. When the waste heat is warm air or warm gas, it can be mixed with colder outdoor air to raise the COP of air-to-air or air-to-water heat pumps. When the waste heat is liquid, it can be recirculated in coils in the air stream of air source heat pumps; or water-to-water heat pumps can be used with the warm liquid used directly as the heat source.

- In larger sizes, use double bundle condensers and evaporators in series with a basic chiller (cascade system), to transfer energy from interior areas of a building, which may require cooling all year round, to the perimeter of the building where heat is required simultaneously. If the perimeter does not require all of the heat available, excess heat can be stored in hot water tanks. Heat from storage can be used for heating at night, warm up periods in the morning, or for reheat for humidity, or zone temperature control. Heat pumps can be engine driven as well as electric. For instance, in the G.S.A. Energy conserving Office Building in Manchester, N. H., the emergency diesel engine driven generator will drive a centrifugal heat pump. The waste heat from the engine will be recovered and used as a heat source for additional absorption cooling. Solar energy will be used to supplement the heat from the engine to power the absorption unit. In case of engine breakdown, the utility company power will supply the heat pump in an emergency.

- Solar assisted heat pumps can supply as much as 85%[1] of the yearly energy requirements for space heating and domestic hot water, providing the building is first designed or retrofitted, as the case may be, to reduce heat loss. In all solar heating and cooling installations the loads should first be reduced through building design. By reducing heat loss, smaller collectors can be used (the most expensive item in the system), as well as smaller heat pumps. Also, the building can be heated with water or air at lower supply temperatures without requiring excessively large heating coils or air quantity.

2. As an alternative to heat pumps, when no cooling system is required for the building, use ceramic storage heaters, if electric resistance heating is used, to reduce the peak demand to zero at utility company peak hours.

3. Design the domestic hot water system in accordance with the standards for water temperature and quantity as outlined in ECM-2. Provide the storage tank large enough to carry loads through peak use periods.

4. Provide variable speed pumps, and modular pumps, boilers, and refrigeration units to optimize part-load operation.

5. Avoid systems which simultaneously heat and cool the same space. Terminal reheat systems, dual duct systems, induction units, and even variable volume systems (VAV), in some modes, are all forms of terminal reheat when designed in the conventional manner. VAV systems are generally more efficient than other types of reheat systems. For new buildings, VAV systems can be designed to optimize energy conservation by using separate air handling units for each of the perimeter zones and one for the interior zone. Each unit should be equipped with a heating and cooling coil and VAV boxes arranged to modulate in both the heating and cooling modes. Fan speed should be reduced in accordance with the static pressure reduction which reflects the variable air quantity.

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1. The Carey Arboretum solar assisted heat pump installation, Millbrook, N.Y.

Where dual duct systems are required, separate air handling units for each exposure can virtually eliminate the "reheat effect" by permitting the highest cold duct temperature and lowest hot duct temperature required by any zone rather than the extreme temperatures which might be required for any one of the 5 zones (east, west, north, south, interior).

For new buildings, the HVAC system can be selected and designed for optimum energy conservation, such as VAV systems with zone air handling units. In existing buildings, reheat type systems can be modified and provided with operating controls to approach the standard of systems selected for new buildings.

6. Consider all opportunities to recover waste heat (or cooling), using run-around coil systems, thermal wheels for sensible and/or latent heat recovery, heat pipes, or even heat pumps. 1,000 CFM of outdoor air requires the equivalent of 200 gallons of oil per year for heating per 1000° days, or up to 1,000 gallons of oil per year in a 5,000° day zone (Long Island). Heat recovery units are 50° to 80° efficient, and their use has the effect of reducing the heat required for tempering outdoor air by the same percentages.

7. It is often feasible to provide uncooled or slightly tempered air to direct supply hoods (auxilliary air hoods), and save energy for both heating and cooling. Hoods must be carefully designed with supply air from top and sides to be effective and protect workers at hood faces from fumes. Hoods of proper design for direct air make-up are commercially available now, and should be considered for new installations in laboratories, hospitals, and industrial plants.

8. Heat exchangers are available to recover heat from air compressor after-cooling water, for use as boiler water make-up, saving the equivalent of 2 gallons of oil per 1,000 gallons make-up.

9. Return all possible condensate to the boiler. For each 1,000 pounds recovered, an equivalent of 10,900 gallons of oil per year can be saved. Safety tube heat exchangers should be used to eliminate possible contamination where solvents or hazardous fluids are steam heated.

10. Even in small residences, there are opportunities to recover waste heat or, in the case of refrigeration units, heat from the hot gas heat exchanger in a 3 ton heat pump circuit will provide virtually all of the domestic hot water requirements year-round, saving some 4,250 Kwh per year and 50,000,000 Btus of raw energy per year at the power plant. Hotels, hospitals, laundries, industrial plants with large service or domestic hot water

requirements, coupled with large air conditioning or heat pump systems are good candidates for such systems.

11. Use heat pipes to transfer heat from a boiler stack to a space to be heated, or to make up combustion air. A sound boiler with many years of life, even though inefficient, can be retained in service without penalty so long as the stack heat is recovered.

12. Recover heat from hot water drains with heat pipes or fluid heat exchangers in:

- -hospitals
- -hotels
- -kitchens
- -apartment houses
- -industrial plants
- -commercial or institutional laundries

13. Design boiler-burner installations for a minimum of 80% instantaneous efficiency and a minimum of 70% seasonal efficiency using improved combustion controls, economisers to heat boiler feed and combusiton air, recuperators, viscosity controls, fuel oil emulsions, oil additives, and other measures listed in ECM-2.

14. For large installations, consider piggy-back steam driven centrifugal refrigeration units in combination with absorption refrigeration units instead of direct electric driven units. The steam driven chiller, in combination with a double effect absorption chiller using extracted steam for the heat source can provide a ton or refrigeration with less than 9 lbs. of steam under some conditions. A single-effect standard absorption unit alone requires about 18 lbs. of steam per per ton of refrigeration, and the newer double effect high pressure absorption units about 13 lbs. of steam per hour. The piggy-back system uses no more raw source energy than electric driven units, and can reduce peak electric demand by significant amounts.

15. Consider using evaporative cooling in place of, or in conjunction with refrigeration. Air handling units are available with both cooling coils and sprays to permit operation of evaporative cooling without refrigeration for a substantial number of hours (savings in horse power), and refrigeration alone (for fewer hours), when outdoor wet-bulb temperature is excessive. In many cases it will be economic to operate the evaportive cooling unit for the entire cooling season by installing a dessicant to lower the relative humidity. Solar heat or waste heat from the building or processes can be used to regenerate the dessicant.

16. Consider the installation of enthalpathy controllers, as well as an economizer cycle control, to reduce the energy required for air conditioning from 20% to 80% depending upon the ambient outdoor wet bulb conditions. Wet bulb cooling degree hours rather than cooling degree days should be used as a basis for design.

17. Increase the efficiency of refrigeration systems The efficiency increases 1-1/2% to 2% for each 1°F rise in chilled water temperature, and increases about 1-1/4% for each 1°F reduction in condensing temperature.

- Provide an automatic control to "follow the load" to permit operation at higher chilled water temperature. Most systems need the minimum chilled water temperatures less than 5% of the time. The average chilled water temperature can be 4° to 8° higher than that required for peak loads most of the time.

- Reduce condensing water temperature with flow control and/or variable pitch blades on cooling tower or variable speed condenser water pumps. Automatic control to sense condensing temperatures, outside wet bulb temperatures, and load provides immediate control adjustment without delay.

- Pipe two or more chillers, with properly designed evaporators to reduce frictional losses, in series rather than in parallel. The average suction temperature of the compressors will be higher.

- Use blow-thru built-up air handling units, field assemble if necessary, to permit chiller to operate at higher suction temperatures.

Use chilled water storage and operate chillers at night storing chilled water for use during the day whenever outdoor wet bulb conditions are low enough to reduce energy requirements by operating refrigeration units at lower condensing temperatures. Chilled water storage also reduces peak loads during the day, and can result in substantial cost savings thru lower electricity demand charges.

18. Generate electricity on-site in combination with process steam. A steam turbine driving an electric generator can produce 1 Kwh of electricity for every 20 lbs. of process steam at 150 psi extracted from the turbine. Such a system can produce electricity at a heat rate of 5,500 Btus per Kwh. The most efficient central generating plants require 9,000 Btus per Kwh.

19. **Return all possible condensate to the boiler.** For each 1,000 lbs. recovered, an equivalent of 10,900 gallons of oil per year can be saved. At 3M, they use flash steam to heat boiler make-up water, saving about 72,000 gallons of oil per year fore each 1,000 lbs. per hour of flash steam. Safety tube heat exchangers should be used to eliminate possible contamination where solvents or hazardous fluids are steam heated.

20. Use central control systems, with or without computers are available now to monitor and control systems and optimize energy conse vation in heating, air conditioning, ventilating, illuminatio and power systems, for all buildings or groups of buildings of 50,000 sq. ft. or more.

E. Appliances:

Under the "normal" case, the efficiency and the number of operating hours for all applicants were assumed to be the same through 1995, although the saturation of units which might normally be sold, are offset by the number of larger units which replace older models. However, appliances are available with higher efficiencies; and all new and replacement sales are assumed to comprise the newe with efficiency increased over the average unit now in place as follows:

| Appliance | Increase in Efficiency |
|---|---|
| -Refrigerators | 40% |
| -Small motors | 10% |
| -Miscellaneous Appliances | 10% |
| -Ranges | 25% |
| -Freezers | 25% |
| -Clothes dryers | 25% |
| -Dishwasher | 30% |
| -Clothes washer | 0% |

Refrigerators and Freezers: A number of manufacturers are producing substantially improved units. Most or all of the following features should be included to achieve the 40% improvement in efficiency: 3" foam insulation, no electric resistance heaters in the door, power saver switches which turn off wall heaters when outdoor humidity is low; adequate, but not excessively sized (approximately 14 cu. ft. refrigerator for a family of four), separate refrigerator-freezer section doors to eliminate the need to open the refrigerator compartment door for access to the freezer, casters for ease in moving the refrigerator to clean the condensor, and manual or cycle defrost units where available in the size required.

Small Motors and Miscellaneous Appliances: The improvements include smaller motors for furnace fans and hydronic system pumps, solid state television, no instant-on feature for televisions, and other small improvements in household equipment. Some small motors are less than 50% efficient. Select motors in the 70% to 80% range.

Ranges: Increase oven insulation from an average of 1-1/2 inches of fiberglass to 3 inches; use of "pyrolytic" self-cleaning ovens not more than once per month; use microwave ovens, which use about 75% less energy for baking operations than conventional ovens; use cook-tops containing "calrod" elements with improved thermal contact with the pan bottom.

Clothes Dryers: Use dryers with a moisture-sensing shut-off control to turn off the dryer as soon as clothes are dry; and a variable temperature control to avoid wasting large amounts of heat on clothes that will dry with low heat or no heat at all.

Dishwasher: Since the over-riding factor in dishwasher energy consumption is the amount of hot water used (the average is about 15 gallons for a regular wash cycle), provide all machines with short wash cycle feature, using a maximum of 10 gallons per wash; include an air dry cycle which eliminates the need for resistance heat drying.

Clothes Washers: Use a variable water temperature control switch to allow cold water washes; and a "sudsaver." With a sudsaver, when the normal wash cycle is completed, the wash water is diverted into a laundry tub next to the washing machine instead of down the drain. At the next wash, the water is pumped back into the machine to wash a second load. This saves 20 gallons of the 35 gallons of hot water normally used.

## F. Codes and Standards

The energy intensive conservation program becomes more of a reality as energy conservation codes and standards, which governmental agencies in more than thirteen states have already adopted, proliferate. In addition, 27 states are considering legislation incorporating new energy codes for building such as the ASHRAE 90-75 Building Standards. There also have been numerous bills in Congress to impose building standards with energy limitation budgets for both new and existing buildings. The General Service Administration has adopted a target of a maximum of 55,000 Btus per square foot per year of energy consumption for all services for new office buildings, and 75,000 Btus per square foot per year for existing buildings to be retrofitted. Experience to date indicates that targets can and are being met.

In summation:

The intensive energy conservation scenario was based on the following overall energy budgets in Btus per square foot per year:

| | Existing Buildings | | New Buildings | |
|---|---|---|---|---|
| | At the Building Boundry | Raw[1] Source Energy | At the Building Boundry | Raw Source Energy |
| Office & Commercial Bldg. w/o process | 75,000 | 160,000 | 55,000 | 110,000 |
| Mfg. Bldg. w/o process | 75,000 | 160,000 | 55,000 | 110,000 |
| Public Schools | 50,000 | 105,000 | 35,000 | 75,000 |
| Colleges | 70,000 | 150,000 | 50,000 | 100,000 |
| Hospitals | 250,000 | 500,000 | 175,000 | 350,000 |

1. Calculated as follows: $A + \frac{B \times K}{E}$

where, A = Btu equivalent of gallons of oil or cubic feet of gas per square foot of building area.

B = Kwh/square foot.

E = .3 (average electrical generating plant and transmission efficiency).

K = 3413 Btu/Kwh.

## C. SOLAR ENERGY CAN SUPPLY A LARGE PORTION OF LONG ISLAND'S ENERGY REQUIREMENTS

The sun is an inexhaustible energy supply that delivers the equivalent of 120 Kwh per year on each square foot of land on Long Island. The technology for using this energy is more advanced than most people realize, and solar energy systems are effectivee and, for some applications, cost effective as compared to alternative systems in the north western part of the United States as well as in warmer and sunnier climates.

It is important to differentiate between the use of solar energy for heating and cooling, and solar energy to generate electricity. More research is needed before reliable solar cells, or heat actuated engines driven by high temperature fluids heated by solar collectors become feasible alternatives for generating electricity. However, the solar energy system hardware - collectors, storage systems, and controls - are commercially available now. Using off-the-shelf hardware, a large proportion of the energy required for a) heating domestic hot water, b) space heating, c) tempering ventilation and make-up air, d) preheating oil and air for combustion, and e) to a lesser extent, operating absorption type air conditioning can be supplied by solar energy. Utilizing solar energy for these functions would reduce consumption of electricity, gas and oil, and reduce peak electrical power demand on Long Island,

The components of a solar system can fit harmoniously on the roof or walls of existing houses, apartments, and non-residential buildings. They can also be attractive elements integrated into the design of new buildings. Solar collectors can also be mounted on the site, free standings from the building, on a garage, carport, or parking structure. They can be mounted vertically and used as a fence surrounding a patio or other enclosed areas.

The conventional flat-plate collector, now manufactured by dozens of companies in the United States, consists essentially of a box or series of metal boxes with one or two layers of glass or other transparent material as cover plates, a metallic absorber plate, and insulation on the sides of the box and behind the absorber plate. Water or air flowing in passages in contact with the absorber plate, is heated by the solar radiation which has been absorbed and retained by the absorber plate.

The collector can be mounted in a fixed position facing due south, or within 15$^{o}$ either side of due south, and at a tilt angle from the horizontal ranging from 30$^{o}$ to 60$^{o}$ in Long Island, depending upon the use. The higher angles are for heating only, the lowest angle for cooling only; for a combination of both services, the angle is somewhere in between. Air collectors are applicable for tempering outdoor air or combustion air and for heating residences and small buildings. Liquid collectors can be used for all functions.

Manufacturers have recently started to produce evacuated collectors wherein the absorber plate is enclosed in a vacuum to reduce conduction and convection losses. Evacuated collectors are 30% to 90% more efficient on a seasonal basis than conventional flat plate collectors. On a BTU per dollar invested, they are more economic than flat plate collectors, and in many cases, are the only type of collector which can provide temperatures sufficiently high to operate absorption refrigeration units at full capacity for cooling.

Storage systems are required with all types of collectors to store excess collected heat for later use when solar radiation is not abailable. Hot water, stored in tanks, is most commonly used today with liquid systems because of the ease of charging and extracting energy from the storage system. The costs of warm water storage systems are lower, and the reliability greater, than alternative emerging storage technologies employing the use of phase changing materials and paraffins. However, there is no question that the latter type of storage systems will be further developed and will be commercially available within the next five years. The small amount of storage volume required with these systems is an attractive feature. With solar air collectors a simple rock storage bed is effective and economical.

While it is technically possible to provide collectors and storage systems of sufficient size to handle 100% of the seasonal energy requirements for hot water and space heating, or cooling, the costs are prohibitive and the size of the required collectors would be so great that the area to accommodate them is not available on most buildings or sites. Therefore, supplementary sources of energy, either electricity or full size back-up fossil fuel heaters, are used with solar energy systems. In existing buildings, the HVAC systems can usually be used intact; in new buildings, the choice of the supplementary fuel depends upon availability, costs, and design constraints.

Utilize Solar Energy For Heating Domestic Hot Water

The utilization of solar energy for heating domestic hot water for dwelling units, and for service hot water for non-residential buildings is the most cost-effective application of solar energy at present. The hot water load is year-round, so that the added investment for the solar collectos and associated equipment can be amortized through fuel and/or electricity savings each month in the year.

Solar water heaters are commercially availabe in separate components or in complete packages. They have been used for more than 30 years, mainly in Australia, Japan, and Israel. In the United States, solar water heaters were widely used in Florida, but were abandoned when they began to require extensive repairs because it was more economical to install gas or water heaters--and energy costs and availability were no problems. Solar water heaters are particularly suitable for hospitals, motels and hotels, laundries, apartment houses, car washes, chemical industries and laboratories, as well as for single and two family residences.

Before purchasing solar energy water heaters it is most cost effective to first reduce the energy requirements by lowering the generation, storage and utilization water temperatures, reducing the flow rate, and improving the insulation on piping and storage tanks.

With a reduced load a typical flat plate solar water heater can supply 60% - 70% of the hot water requirements in the winter and 80% to 90% in the summer for a family of four in Long Island with 60 to 70 square feet of collector area, and an 80 100 gallon storage tank. The use of a reflector surface (could be aluminized mylar), mounted in front of the collector to reflect more solar radiation on to the collector will increase the annual thermal performance by 20% or more, and could supply a greater volume of hot water or permit a reduction in collector area. Using a tubular evacuated collector, the equivalent collector area could be reduced by about 30% to provide the same amount of hot water as a flat plate collector.

A number of manufacturers are offering a complete solar water heating packaged system, including the collector, tank, heat exchanger, and controls, ranging in price from $500 to $1,000 plus installation.

DMBA made a "wind shield" survey, and studied aeriel photographs of Long Island and concluded that more than 50% of all existing buildings on Long Island are suitable for solar water heating (all new buildings could be equipped with solar water heaters). If those existing buildings were retrofitted for solar water heating at the rate of 5% per year, and all new buildings were equipped with solar water heaters, by 1958 there would be a savings of more than 500 million Kwh per year and an annual savings of approximately 200 million gallons of oil per year (or equivalent gas) on Long Island. In addition, the peak electric power demand would be reduced by about 300 megawatts. By 1995, the savings would reach 780 million Kwh per year, and the peak power demand reduction 820 megawatts--the equivalent of the Shoreham plant.

The supplementary fuel with solar water heaters can be oil, gas, or electricity. When electricity is used the storage tank can be charged at off-peak periods to reduce the demand due to water heaters to zero at LILCO's peak demand hours

There is little doubt that further development of solar equipment will produce more efficient collectors and heat exchangers so that future systems will be able to supply 100% of the hot water requirements on Long Island with solar energy at costs competitive with electricity (3 year pay back). Present pay back periods for solar hot water systems to supply 70% of the yearly requirements are five to seven years at present cost of electricity, still a good investment.

## Utilize Solar Energy For Space Heating

Up until 1972, only about twenty solar heating installations had been made in the United States, and most of them are now inoperative. However, in the past three years, the use of solar energy for space heating has escalated and there are three hundred or more installations either completed, under construction, or in the design phase for many types of buildings, from small residential single family dwelling units to apartment houses, schools, libraries, museums, industrial buildings and small and large office buildings.

LILCO, with a grant from the Electric Power Research Institute, will build five residences on Long Island, equipped with solar assisted heat pump systems to gain knowledge of the fuel and energy savings and peak load power reduction potential for solar heated homes.

At the present price of fuel, and of solar collectors and storage systems, it is most cost-effective to provide about 50% to 70% of the yearly energy requirements, rather than 100%, by solar heating systems for existing buildings which are retrofitted and new buildings which are designed and constructed in accordance with conservation standards. Solar heating systems will reduce annual electrical energy consumption and peak load demand in those cases where electric space heating would have been the conventional system. Equiping existing fossil fuel heated buildings with solar systems, or substituting solar for oil or gas heat in new buildings will reduce the annual oil or gas requirements - an important objective.

Solar collectors are more efficient - produce more useful BTU's work - when the heated fluid can be used at lower temperatures. The efficiency varies inversely with the temperature. It is advantageous to design the heat distribution system in the building for low temperature fluids, air or water, so that the solar collector which interfaces with the system can be as small and inexpensive as possible. The slight increase in cost of the distribution and conversion system - larger coils, convectors, blowers - is more than offset by the savings in the capital costs of the solar energy system components.

Solar assisted heat pump systems are particularly viable in cold climates like Long Island. In such systems the fluid, warmed in the solar collector, can be used directly in a properly designed heating system whenever the fluid temperature exceeds 110°F to 110°F,but is used as a heat source for the heat pump when the fluid temperature is too cold - 60°F to 100°F - to be used directly in coils or radiation or air distribution systems. The heat pump extracts heat from the fluid and delivers 110°F water or air to the building. The heat losses are lowest from the collector when the collection temperatures are low, and the collector heat pump combination can supply 70% to 80% of the yearly energy requirements of a well built structure. Only 20%

to 30% of the energy need be supplied by the supplementary back-up system. The heat pump can be used in the summer for cooling purposes. Even if the supplementary energy source is electricity, a solar-assisted heat pump system could reduce peak power demand by as much as 60% (compared to electric resistance heating), and by 90% to 100% if the storage tank is charged during off-peak hours. It is essential to retrofit an existing building for energy conservation and reduce heat loss in new building construction before considering solar heating, otherwise the size and costs of the solar energy system will be excessive and the supplementary heating systems must be more rugged and more costly; and the consumption of conventional energy supplement too great. Based on the survey, DMBA concluded that approximately 25% of all existing residential units and 50% of all existing non-residential buildings could be retrofitted with solar heating systems to provide 50% to 60% of the annual energy requirements for heating. Solar radiation data monitored in Central Park, New York, was used to estimate the average monthly insolation available on Long Island. Test data from solar collector manufacturers and measured performance data from existing solar energy installations were used to calculate the seasonal potential performance of the solar heating systems.

If these systems were designed to provide only 50% of the yearly heating energy requirements, and were installed in 5% of the existing candidate buildings each year, and if solar energy heating systems were installed in new buildings to provide 60% of the annual heating energy requirements, at a saturation rate in new residential dwelling units of 25% in 1980, and 50% in 1985, 1990, and 1995 respectively; and in non-residential construction at a saturation rate of 25% in 1980, 50% in 1985, and 75% in 1990, and 1995 respectively; the savings in electricity on Long Island could exceed 255,000,000 Kwh per year in 1985 and 940,000,000 Kwh per year in 1995. The winter peak demand load could be reduced by more than 400 megawatts in 1985, and approximately 1000 megawatts in 1995.

Solar collectors cost $3.00 to $12.00 per square foot and storage tanks cost approximately $0.40 per gallon. With continued rapid development of more efficient solar collectors, the savings in energy in the decade after 1985, for the same number of solar installations would be considerably larger than these conservative estimates.

The required area of solar collectors will vary from 20% to 40% of the floor area of the building, and approximately 2 gallons of hot water storage is required per square foot of collector (water systems). In the design of new homes, "passive" solar energy systems and solar air heating systems can be made an integral part of the building structure with considerable savings as compared to "active" liquid systems with collector modules.

LILCO's forecasts predict that there will be 224,000 additional electric space heating installations in residential units on Long Island by 1995. If all these dwelling units were heated with solar energy to provide 70% of their annual requirements, and fuel oil were used as supplement, the savings would exceed 2,225,000,000 Kwh per year and the reduction in peak hour demand would exceed 1,225 megawatts.

## Solar Cooling and Dehumidification

The common means for utilizing solar energy for cooling and dehumidification are with:

1. Absorption chillers
2. Chemical dehumidification
3. Heat actuated engines, such as the rankine cycle engine.

With absorption systems, solar collectors provide hot water to the absorption generator. The energy source is heat, rather than electricity as in most other types of air conditioning systems. However, the lower cost conventional flat plate solar collectors are not capable of supplying sufficient hot water at the temperatures required by standard absorption units to operate at full load capacity for any appreciable lengths of time. Better flat plate collectors with selective surface coatings on the absorber plate which can absorb over 90% of the solar energy which strikes it, but emits only 5% to 15% (black paint absorbs over 90%, but emits about the same), can collect more usable heat at higher temperatures, but costs some what more than the "standard" units. However, even with improved flat plate collectors, it would not generally be possible to operate a standard absorption unit in Long Island for a sufficient number of hours in the year at capacities which are required to provide at least 50% of the yearly energy requirements for cooling.

A number of new technological developments are significantly enhancing the feasibility of using solar energy for cooling. Evacuated collectors do provide higher temperatures and are more suitable for cooling with absorption units than conventional flat plate collectors. Three manufacturers are now providing absorption units for use with solar collectors and are in the process of developing units which will operate at full capacity with lower generating temperatures (about $195^{o}F$ instead of $230^{o}F$) making solar absorption cooling more feasible and more economical. Heat actuated engines, using solar energy as a heat source, and dehumidifiers, using a desiccant, with solar energy providing the heat for regenerating the desiccant are in the development and demonstration stage at present, but are likely to be in commercial use within the next five years.

Air conditioning comprises a significant portion of LILCO's system peak demand, and will contribute an even greater proportion of the summer demand within the next twenty years, unless specific measures are taken to reduce the amount of electricity used for air conditioning. Solar cooling systems are particularly effective, since desiccant dehumidifiers or heat actuated chillers use only a small fraction of the electrical energy (small pumps and auxiliaries), that electric refrigeration units use. It is not likely however, that there will be a sufficient number of solar air conditioning systems in Long Island within the next ten years to materially affect peak electrical demand or annual consumption, since the solar cooling systems have not yet been developed sufficiently to be at all competitive in cost with alternative systems. After 1985 it is expected that solar cooling could be utilized in a great many existing and new buildings. DMBA estimated that by 1995, 25% of the buildings which existed in 1975 could be retrofitted with solar cooling systems, and 50% of the new buildings constructed between 1975 and 1995 could be equipped from the start with solar cooling systems.

Curves D in Figures 5 and 6 show the resultant reduction in peak hour loads, and Figure 7, the resultant reduction in annual energy usage for the solar energy program described above using solar water heaters and solar assisted heat pumps and to the lesser extent, solar cooling, coupled with an intensive energy conservation program.

Solar Energy for Industrial Process

The solar energy system hardware suitable for water heating and space heating, can also be used for industrial heating processes including drying operations, boiler feed water heating and process water heating. DMBA estimated that in 20 years about 5% of the electricity used annually for heating in industrial process could be saved by using solar energy systems in suitable applications.

Other Solar Energy Applications

Other solar energy applications include a) tempering make-up air for exhaust systems for hospitals, laboratories and industrial plants, b) preheating air or materials for industrial processes, and c) preheating heavy oil and combustion air in boiler plants. Many of these systems will be installed within the next twenty years, and will further reduce consumption and demand below the levels which are forecast for Long Island and detailed in this report.

D. LOAD MANAGEMENT CAN FURTHER REDUCE PEAK DEMAND AND PERMIT EXISTING GENERATING PLANTS TO HANDLE ADDITIONAL LOADS.

Load management includes the techniques and measures to conserve energy and to improve the load factor of the utility system. Annual load factor is expressed as a precentage, and is the ratio of the annual average hourly demand (Kw) to the peak hour demand (Kw). The average annual hourly demand is calculated by dividing the gross annual Kwhs generated by 8,760 hours. The annual load factor for LILCO is approximately 49% and based on LILCO's forecast through 1995, would increase to only 50%. In other words, on an annual basis, only about one half of the installed electrical generating plant capacity is used, and the electric rates must be high enough to amortize the capital costs of idle equipment. In addition, the peak power demand is usually supplied by inefficient units so that excessive amount of fuel are consumed.

Improving the power factor of existing plants by reducing the peak demand and allowing controlled consumption to increase as further development on Long Island takes place, will permit the existing plants to handle the increased load efficiently without the costs and other problems associated with new plant construction.

Improving the load factor by selling more electrical energy during off-peak hours to compensate for high peak demand is economical for the power company, but is an unsconsable use of resources and a burden on the customer.

Load management is currently practice in Long Island, although in a passive manner, and to a limited extent, through the electricity rate schedule which includes a demand charge as well a consumption charge for some classes of non-residential customers. While there is an economic incentive for a customer in these cases to reduce his peak demand, especially since he pays for a portion of this demand each month whether he reaches it or not, the incentives are insufficient to significantly reduce the utility system peak, especially since the time of the customer peak may not coincide with the utility system peak hours. Certain of LILCO's largest customers do schedule the operation of some of their electrical equipment to avoid LILCO's peak periods. Incentives to further extend this practice would be very beneficial to LILCO and all of their other customers who bear the brunt of high energy costs to amortize new generating plants.

Load management can be defined under the following major categories:

1. Peak Shaving: The customer curtails operation of major electrical equipment for selected periods during the day in order to reduce his peak demand. This practice also results in reduced consumption, since some of the larger sized electrical equipmnet is inoperative for periods of time. Peak shaving is now practiced particularly in industry, but not to the fullest potential since

very few industrial companies have conducted the thorough energy audit of their own operation to identify the opportunities for peak shaving.

2. Time-of-Day Metering: The objective of time-of-day metering is to influence the periods in the day when customers operate specific appliances and electric equipment, in order to limit the electrical demand for those periods which coincide with the utility company system peak hours. Generally, time-of-day metering can be most easily accomplished by controlling the operation of electric water heaters, but dishwashers, clothes washers and dryers, and other loads in residential and non-residential buildings as well can be shifted from periods when they would normally operate to off peak hours. Time-of-day metering results in peak load reduction, but generally not in energy conservation, since the loads accrue at other times; they are simply deferred, not eliminated.

At present there are no incentives for a large class of LILCO customers to implement time-of-day metering, since the rate structure does not make it advantageous for them to do so, and the capital costs for control equipment and/or the inconvenience of manual operating equipment at inconvenient times is unattractive to them. There are pilot installations now underway in Vermont and in other utility systems to test the effectiveness of time-of-day metering on a voluntary basis, with rates structured to reward conformance and penalize non-conformance. Time-of-day metering can be voluntary, or it can be mandatory with central ripple control cycles or radio controlled operation. The resistance to mandatory control is understandable, but given an identifiable energy and capital crunch, mandatory control with fiscal and legislative policies, which will alleviate the burden on the customer for the capital costs of the the control system, is an option which should be considered.

3. Load Leveling: Load leveling is a combination of peak shaving, demand limiting, and time-of-day metering, and involve one or all of the three concepts. LILCO has projected reduction in peak dmenads each year through 1995 through a modest amount of time-of-day metering, and the DMBA "normal" forecast assumed the same percentage reduction of peak loads by time-of-day metering. However, the LILCO time-of-day metering program was spread out over 20 years and did not contemplate a time-of-day metering program extensive enough to even shift all of the domestic hot water load, which would be relatively easy to do. An analysis of the deferrable loads, and opportunities for load leveling in LILCO's territory, indicate that a concerted additional load management program could further reduce peak demand, and to a lesser extent, consumption, if the financial, institutional and technical options to do so are implemented.

Heat storage, and chilled water storage, are forms of load management, since they defer peak hour operation to other periods of the day or night. The extent to which peak loads can be reduced by load leveling is dependent upon the load profile of the system on the peak days. By reducing consumption at off-peak periods, the opportunities to reduce the peak demand by shifting loads to those periods is enhanced. The LILCO system annual load factor is approximately 50%. On peak days, the daily load factor for the 24 hour period is about 62%, now, in the LILCO system, and the "valleys" can accomodate a shift of 19% of the peak demand without creating a new peak period. Some utility companies enjoy a load factor of 80% or more on peak days. In those systems the opportunity to reduce peak demand is limited to a maximum of 10% since shifting the peaks by a greater amount would simply produce a new peak at a different hour. Reducing the hourly demand at times other than peak hour, creates some valleys which can accomodate loads which have been shifted from the peak demand hour, so the relationship between energy conservation and peak demand can plainly be seen. The peak electrical demand for the LILCO system could be reduced by an additional 15% over and above the conservation and solar scenarios, with a vigorous program of load management.

LILCO has sought approval from the N.Y. Public Service Commission for implementing a time-of-day metering program for 160 of their largest customers--a very modest request. The Federal Energy Administration proposed to the N.Y Public Service Commission that they set up a rate schedule under which the customers would pay less for electricity at off-peak periods and penalties for use at peak periods for customers who chose a special rate for energy conservation that also includes a special penalty for failing to conserve electricity. The PSC is considering the suggestion. While such a system would avoid large capital costs for control equipment, and is worth implementing on a trial basis, a more positive system which actively controls the load would cost far less than the new plant construction required to meet new peak demands.

Of course, load management techniques need not wait for any of the conservation or solar options to be exercised,since they are relatively independent of each other, although they could be well integrated in a total systems program. Where the peak demands have already been reduced by energy conservation, load management can be measured only against the reduced peak, and not against the loads which would have accrued without the conservation program. The following table indicates the additional peak load reduction resulting from a load management program after the effects of conservation and solar energy have been realized. The reduction in peak demand from the "normal" base, without the intensive energy conservation and solar energy scenarios, would be considerably greater since the two scenarios include a major load management program:

REDUCTION IN PEAK DEMAND BY LOAD MANAGEMENT (MW)

| 1980 | 1985 | 1990 | 1995 |
|---|---|---|---|
| 55 | 63 | 176 | 115[1] |

In addition, a relatively simple radio control could be used to sequence the operation of window and central air conditioning units, staggering the operation for various groups of customers to effectively reduce the peak demand due to the air conditioning.

## E. TOTAL ENERGY SYSTEMS CAN REDUCE THE REQUIREMENTS FOR CENTRAL GENERATING PLANTS AND SAVE OIL AND GAS.

Even with the proposed Jamesport 1 and 2 Nuclear Plants, LILCO projects that more than 40% of all electrical generating capacity would still be done with fossil fuel fired central plants. However, alternatives should be considered. The most efficient use of fossil fuels for electricity generation is with Total Energy ("TE"), Plants, for they consume 25% to 40% less energy than the combination of fossil fuel central utility electrical generating plants, and on-site boiler plants for heating and cooling.

Even if all electricity were to be generated with nuclear power, on-site total energy plants could replace a portion of the central plant capacity at 65% of the capital costs, of such generating systems; and the fossil fuel for the TE plants could be supplied from the oil or gas which is saved by the intensive energy conservation program for fossil fuel heated buildings.

A TE system generates electric power in a building or at a group of buildings and the heat, which is rejected by the prime mover in the generation process, is recovered and used. The waste heat from an engine when used in a TE plant is generally recovered from jacket cooling water and from exhaust gases. The waste heat from a gas turbine is recovered by means of an exhaust waste heat boiler. In either case, the recovered heat is used for space heating and/or absorption cooling, domestic hot water heating and/or for industrial process. The recovered heat can be used either simultaneously with power generation, or can be stored for utilization at another time. A TE system can be designed to meet the peak electricity requirements of a pro-

1. The small reduction is due to the cumulative effects of solar energy system's large contribution to load reduction in 1995.

ject, including adequate reserve capacity, so that it can operate independently of the electric utility. "Selective energy" systems can be designed to be linked with the LILCO transmission and distribution system. With TE plants, the actual requirements for electricity are reduced since a) air conditioning is produced with heat actuated equipment, rather than with electrically driven equipment and b) the distribution and transmission losses for an on-site plant are less than from a central utility station, which is more remote from the customer.

The prime mover of the TE facility may be an engine or a turbine. The selection of the appropriate equipment depend upon the load characteristics of the building(s) which they serve. Turbines, used in LILCO's central generating facilities are generally only 20% to 25% efficient in producing electricity. However, when these same turbines, or newer and more efficient units are used in a total energy application, a large portion of the energy, which is not converted into electricity, is available for useful work by recovering the waste heat. With heat recovery, engine-driven and turbine-driven TE systems have about the same efficiency on a seasonal basis, when the load profiles for electrical and thermal requirements are in proper balance. Turbines have the lower shaft efficiency and, ironically, this fact which makes turbines unattractive for central utility systems from a raw source energy use standpoint, are appropriate for selected on-site TE applications when the building thermal loads are relatively high in relation to electrical loads. However, if the electrical loads are relatively higher than the thermal loads, engine-driven generators, which have higher shaft efficiencies, are more likely to result in a more efficient total system. With a proper balance of heat and power requirements, seasonal efficiencies for engine-driven TE systems may be as high as 75%. Under these circumstances, for every Kwh delivered to the site from the central system, a TE plant would provide that Kwh plus 5,000 additional BTUs from the same amount of primary fuel expended. The 5,000 BTUs utilized for heating or absorption air conditioning, saves an equal amount of "new" on-site energy that would have to be provided if the TE plant were not used.

Existing and new buildings which, individually, or in a complex, comprise 50,000 or more square feet of area and can utilize at least 50% of the waste heat which would be produced from an on-site electrical generating plant, are good candidates for TE systems. The building types which are most likely to meet this criteria are shopping centers, industrial plants, universities, large apartment houses, office buildings, hospitals, high density housing and low or high rise housing. These buildings require heating, and have a large year-round domestic hot water load and/or are air conditioned.

Total Energy systems can also be operated with on-site fossil fuel or solid waste fired boilers or incinerators, and with steam turbine driven generators, as well as with diesel or gas engines and combustion turbines. There are other variations of on-site power generating systems, including bottoming cycles, peaking cycles and combinations of all of these systems.

TE is far from experimental. In fact, several plants are in operation in the New York area. Rochdale Village, an apartment complex in Queens, has a TE plant with a generating capacity of 20,000 Kw. Summit Plaza Apartments, a HUD sponsored development in Jersey City, New Jersey of 486 apartments, 45,000 square feet of commercial space, and an elementary school, is powered by a total energy system, and the IRS Building on Long Island also has a TE plant. There are about 600 TE plants in operation in the USA and about 16% of all process steam generated in the USA is provided in combination systems.

Some examples of savings in energy and operating costs for TE plants were cited by the author in his prepared testimony before the State of New York Public Service Commission, Case 26292, on June 13, 1973 as follows:

"In a study which we did under the auspices of the New York State Health and Mental Hygiene Facilities Improvement Corporation (HMHFIC), for the proposed Kings County Hospital and School in Brooklyn in 1967, our engineering and feasibility study indicated that the seasonal efficiency of the TE plant, using engines as the prime movers, would be 66.5% and would result in a 39% source energy savings over the most efficient conventional system. We assumed 10,300 Btu/kwh for the central plant including distribution and transmission and in-plant usage, which is even somewhat lower than that predicted now by Con Edison. For this installation, we estimated that the TE plant and supplementary boilers would require 411 x $10^9$ Btus at the source on an annual basis, whereas a conventional plant utilizing purchased electricity and on-site boilers for heating and cooling, would require 672 x $10^9$ Btu input, or a difference of 261 x $10^9$ Btus. That difference is equivalent to annual savings of 261,000 MCF of gas, or 1,870,000 gallons of No. 2 oil. The economics were attractive enough to th HMHFIC to authorize design for the TE installation, which showed a calculated yearly owning and operating cost savings of over $146,000, after deducting interest and amortization, for an increased initial investment of slightly under $1.8 million. If energy conservation had, at that time, been the only factor, and some of the economic advantage discounted, the savings in fuel could have been almost 10% higher by selecting different equipment and modes of operation.

"In another study and design for the proposed new campus for Brooklyn Polytechnic, which we did in 1966, the calculated seasonal efficiency of a TE plant, using engines as the prime movers, was 52.5%, and the annual fuel savings at the source was approximately 30%. The higher yearly system efficiency of the Kings County Hospital Project compared to the Brooklyn

Polytechnic Project reflects the greater use of domestic hot water and longer periods of daily occupancy of a hospital as compared to a college.

"We did a similar study for the new medical school at the University of Connecticut, Farmington, Connecticut. Using steam turbines for the TE plant and comparing the fuel savings with the proposed all-electrical conventional plant, calculated source fuel showed savings of over 50% and a cash flow profit of $4,874,000 in a 30 year period.

"I have reviewed HUD's performance projections in its report on the proposed TE installation at the Jersey City Operation. The report indicates that the TE system will show a source fuel savings of about 34%, compared to a conventional plant for the same project. The conventional plant was based on purchased power with a central on-site HVAC plant using oil. If the conventional plant was to have electric resistance heating and through-the-wall air conditioners, the savings in energy with TE was estimated to be closer to 50%."

When a number of buildings, each with different functions, such as a large office building and an adjacent apartment complex can be served by one TE plant, the diversity of loads make TE more economically feasible. During the day, the electrical load in the office building is high, but its heating requirements and domestic hot water requirements are low, so the waste heat which is produced when generating electricity can be diverted to the apartment complex which has higher heating and hot water requirements but relatively small electricity requirements. At night the demands are reversed. With heat pumps and storage, the combination TE systems serving both facilities could show a system efficiency approaching 75% utilization of fuel source energy.

The DMBA estimate of the potential peak load reduction in central generating plant facilities if total energy plants were to be more widely used on Long Island is based on an analysis of the following table, adopted from LILCO data in the 1975 149-B Report.

| Load Class | Average Load Per Customer (Kw) | Total Load for Customer Class (Mw) |
|---|---|---|
| Residential: | | |
| General | 2.24 | 1691 |
| Space Heat | 6.35 | 47 |
| Commercial Kw Demand: | | |
| 0-7 | 1.50 | 54 |
| 7-50 | 10.10 | 296 |
| 50-800 | 85.00 | 631 |
| 800-1600 | 930.00 | 94 |
| 1600+ | 1620.00 | 68 |
| Hi-Volt | 5625.00 | 68 |
| Other | | 80 |
| TOTAL Load | | 3029 |

3090 megawatts is the coincident peak load at approximately 6 P.M. on LILCO's 1975 summer peak day.

From this data, it was concluded that there were approximately 350 Mw of peak load contributed by customers whose individual peak loads were 500 Kw or more. Therefore, if all of these customers were to convert to total energy plants, 350 Mw (350 + transmission losses), of LILCO's peak load would be eliminated.

For new buildings we estimated that of the 2,900 Mw of additional new load projected in our "normal case" from 1975 to 1995, at least 500 Mw could be served by total energy plants, based on an estimate that of the 500 Mw of new load attributable to new apartment complexes, and of the 500 Mw attributable to new commercial industrial complexes, at least half of all construction could be organized in complexes with peak loads of 250 Kw or larger, which would be the minimum size suitable for a total energy plant. Consequently, it is reasonable to assume that by 1995, approximately 850 megawatts of power could be supplied by total energy plants, thus reducing the capacity of the LILCO central system by 925 megawatts (customer load plus transmission losses). The reduction of 925 Mw of peak load, and reduction in central plant sale of electricity could eliminate the need for one of the proposed Jamesport Plants at that time. (The availability factor of a 1150 megawatt nuclear powered plant is less than 70%, resulting in a firm capability of only 805 Mw.

The fossil fuel for the TE plants could be supplied solely by the fuel which could be saved by the intensive energy conservation program and by utilizing solar energy to the extent and in accordance with the time schedule suggested in this report. The reduction in loads and fuel usage which can accrue through the TE program are predicated on the assumption that conservation and solar energy systems are first implemented. Of course, TE systems can be installed without first implementing any or all of the conservation or solar options, and in reality, a program for an area as large as Long Island would include a mix of conservation, solar, load management, and total energy applications in varying degrees, depending upon individual circumstances. The reduction in peak loads which have been calculated and tabulated in this report are based on the measures being done sequentially, simply to avoid duplication of measures which are not additive and to present the most conservative case.

Clearly, the type of land use which leads to the most effective use of fossil fuels for power generation is cluster development of residential communities with schools, office and shopping centers, as well as large industrial, hospital and university complexes. Such concentrated developement enhances TE installations, offers other energy-saving opportunities and preserves open spaces as compared to sprawl development.[1] Some examples

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1. LILCO, too, has shown support for this principle. See LILCO Almanac, April/May/June, 1974, page 17: "The concept of

of locations in Nassau and Suffolk where such cluster development exists are:

- -The Nassau County Offices in Mineola
- -The Suffolk County Offices in Riverhead or Hauppage
- -Roosevelt Field Shopping Center
- -Downtown Hempstead: apartments, offices, shopping
- -State University at Stony Brook Campus

Several areas are planned for cluster development in the near future. Parr Village in Yaphank is a "planned unit development" of 1,200 dwelling units (over half are townhouses), with a shopping center, industrial park, and offices. The Regional Plan Association[1] has singled out two potential areas for concentrated growth in Suffolk: South Stony Brook/Smith Haven and Holtenvilla/Holbrook. The Brookhaven Master Plan[2] proposes two new planned concentrated centers: Rocky Point and Manorville, as well as residential development adjacent to Brookhaven Memorial Hospital. All of these are potential candidates for total energy systems. Finally, there are a number of potential benefits for LILCO to own and operate total energy plants:[3]

(a) Gain additional revenue from the sale of steam or hot water.
(b) Greatly reduced lead time to provide needed generating and distribution losses.
(c) Lower costs/Kw for power generation facilities.
(d) Enhanced capability of meeting EPA emission standards based on Kwh or work output, compared to central station equipment, especially those using old, simple cycle gas turbines without waste heat recovery.
(e) Improved load factor.
(f) Reduced line voltage drop, and elimination of some booster transformer stations.

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cluster housing, in which traditional single-family homes are built close together, creating additional green space, is meeting less and less resistance on Long Island. The great advantage to clustering is in its savings: fewer streets to build, fewer trees to cut which can be passed on to the home buyers."

1. Regional Plan Association, The Future of Suffolk County, Nov. 1974, Pages 34 thru 40.

2. The Brookhaven Master Plan, March 25, 1975, Pages 29 thru 30.

3. Testimony of Fred S. Dubin, P.E., before the New York State Public Service Commission, Con Edison Hearings, Case 26292, World Trade Center, N. Y., June 19, 1973.

## F. THE ENERGY IN THE WIND IS SUFFICIENT TO PROVIDE MORE THAN TWENTY TIMES THE ELECTRICAL ENERGY CURRENTLY SUPPLIED BY ALL LILCO GENERATING PLANTS

The off-shore and on-shore winds could be harvested with wind generators which are general derivatives of machines which have been built and operated in the United States and abroad to provide more than 300 billion Kwh per year. LILCO's present production is approximately 13.5 billion Kwh per year and in their 20 year forecast is predicted to reach about 33 billion Kwh per year. The DMBA "normal" forecast for 1955 is less than 28 billion Kwh per year and with conservation and solar energy, approximately 18 billion Kwh per year.

While the basic technology is well known, wind generators are not yet commercially available in the sizes which would be necessary to impact on Long Island's requirements for electrical energy supply. The Federal Energy Research and Development Agency has funded research projects to develop equipment and data to hasten the commercial application of wind power. A 100 Kw unit has just been completed in Ohio, and work is progressing on the development and testing of other wind generator configurations (the Darrius unit with a vertical shaft and "egg beater" blades as compared to conventional horizontal shaft, 2 or 3 blade propellor types). The Smith-Putnam 1500 Kw wind generator, built in Vermont in 1949 at Grandpa's Knob, operated successfully until it experienced structural failure; and Units have been built in England, the 100 Kw Costa Hill, Orkney project; in Denmark, the 45 Kw (SEAS), wind generator at Bogo and others.

Utilization of wind energy would be most economical in combination with energy conservation, solar energy, and total energy systems. The combination of systems would assure the lowest capital costs, and would smooth out the variations in availability of solar radiation and wind. Based on wind power studies for Honolulu, and others by DMBA, NASA-Lewis at Cleveland, General Electric Co., United Technologies, and Dr. William Heronemus who made the major contribution to the DMBA report, DMBA has concluded that the engineering and economic feasibility of utilizing wind energy to supply a major portion of Long Island's energy requirements is sufficiently attractive that further studies and development work should be undertaken to produce the necessary hardware, systems components and design, and more definitive economic analyses. A summary of the analysis made for Long Island follows. The scenarios which are presented were selected for analytical purposes and are not to be construed as firm recommendations. However, they have proved to be very useful as a base-line to examine the potential performance and costs of wind powered systems.

Wind data from ten weather stations bordering, and on Long Island were analyzed for energy content, for selecting different wind generator locations at different heights in each station regime, and for calculating the productivity at each level for various sized wind generators. The ten stations are aligned in three different lines, all generally parallel to the long axis of the Island which is also the axis of the prevailing westerly winds. The northernmost line runs from Newark through Bridgeport to Providence. The middle line runs from Kennedy International through Brookhaven through Block Island to Nantucket. The southern line starts at Atlantic City, then runs offshore through the site of Texas Tower Four on to the site of Texas Tower Three at Nantucket Shoals. The variation in productivity can be summarized by stating that one 20 Kw wind generator, 60 feet above ground, near Long Island's geographical center could produce 57,000 Kwh of electricity per year; that same machine out near Montauk would produce 70,000 Kwh per year; and if placed at sea at Texas Tower Four, its productivity would increase to 120,000 Kwh per year. Wind generators of larger sizes placed higher in the air would produce larger amounts of electricity. Very tall arrays of multiple generators, comprising 500 tall towers evenly spaced on Long Island could produce electricity measured in the billions of Kwh per year; less tall arrays placed similarly afloat at sea could produce even more Kwh per year. There are a vast number of options employing wind generators from 40 to 1,500 Kw in size, which appear to be more economic than central utility plants. Wind could be utilized in one or both of two ways: a) use wind generated electricity which in turn could heat buildings. The thermal storage would be a relatively inexpensive buffer between the random wind resource and the patterned heating demand; b) use wind generated electricity, coupled with a storage subsystem, to provide electricity, firm power-on-demand. Three system acquisition and product utilization scenarios were prepared, two selling energy for heating, the third selling frim power on demand. The scenarios were proposed as sequential steps in a grand scale plan for utilization of the available wind resource.

The least expensive process for utilizing Long Island's wind would have wind generators feeding resistance heaters immersed in water filled thermal storage tanks to supply part or almost all of the space heating load.

Scenario One suggests that as many as two hundred fifty tall towers (up to 1,000 feet tall), each carrying numbers of 40 to 50 Kw wind generators, all located in air rights over existing roads or streets, could produce half of the heating now required by Long Island's existing 780,000 residential units, and all of the heating if the buildings are retrofitted for energy conservation first. When coupled with solar flat plate collectors, placed on all available flat roof space, an even higher percentage of the nearly 24 million barrels of oil equivalent heating load for residential and non-residential buildings culd be met by this combination wind-solar energy scheme.

Scenario Two suggests that additional wind generators be placed afloat at sea, tied by cable to an expanded array of thermal storages. An expanded system, capable of providing from 50 to 80% of the heating load of the one million residential units predicted by the turn of the century is proposed for 100% of all existing and proposed electrically heated buildings. Again, coupling, wind generators with solar collectors plus energy conservant design in the additional quarter million residential units is suggested.

Scenario Three proposes the construction and placement of additional numbers of wind energy systems off-shore to the south capable of providing up to 300 billion Kwh of firm-electricity-on-demand per year to produce hydrogen by electrolysis. A hardware design and development period, plus an industry creation period totaling four years is suggested--by the end of which, production-line wind stations and storage subsystems could be coming out of existing underutilized facilities; with fabrication and assembly by unemployed workers. In addition, production coud be expanded in 5 years to 2,500 units per year. As a hedge against those who doubt that the desired hydrogen storage subsystem components could be developed and deployed that quickly, the first few years' worth of wind stations could be matched megawatt for megawatt with anchored coal burning power plants, 60 miles offshore at the edge of the continental shelf, configured to burn the cheapest of coal delivered by ship from the Newport News Coal pier. Thus, this system could start out with windpower needing to do nothing other than that which it has done in the past. The hydrogen storage linke could be added a few more years later. With the expected continued rapid advances in in-ground high voltage d.c. transmission technology, cryogenically cooled or otherwise, the offshore windpower resource could be led to more and more distant markets as time passed, with total and instant control over any adverse environmental impact that might be found if the system expanded too far. Hydrogen could be stored and used as fuel for fuel cells which are rapidly reaching commercial stages.

Wind alone, windpower plus off-shore coal burning power plants, but preferrably windpower carefully joined to solar collector systems, total energy systems and energy conservant design, could supplant any and all needs for future oil, coal or nuclear central stations in all of New York State plus much of the Middle Atlantic market, and this without robbing resource from a proposed New England Windpower System to the east. Thousands of employment opportunities and abundant economic energy, indefinitely renewed, would result from execution of the proposed scenarios.

For those who are interested in pursuing the wind energy utilization concept in greater depth, it is recommended that you read the full report of this study.

## G. UTILIZING SOLID WASTE AS A FUEL COULD PROVIDE A SIGNIFICANT AMOUNT OF ELECTRICAL ENERGY.

A pound of mixed urban waste in the U. S. has a heating value of about 5,300 Btu/pound. By comparison, burning a pound of coal releases 12,000 Btu. A ton of mixed waste can provide about the same amount of energy as 65 gallons of #2 oil. Many tests have indicated that the sulpher content of waste is much lower than that of coal and many grades of oil.

The main limitation that in the past has held back conversion of waste to energy was that the potential value of the energy that could be obtained did not justify the extra capital and operating costs required to obtain it. However, the situation is changing drastically, for several reason, among them:

1. The costs and environmental problems associated with conventional methods of disposal (incineration and landfilling), have been mounting. By providing a community its needed "disposal" service, a recycling or energy conversion operation can expect to earn considerable revenue disposal fees.

2. Revenue from the sale of energy derived from waste continues to rise due to the escalating costs of fossil fuels and electricity.

3. Most of the combustible material in waste is cellulose fibre from paper and cardboard; this is a renewable resource, as opposed to fossil fuels, or uranium.

4. The trend today is not merely to convert all or some of the combustible part of the waste into energy, but to combine energy recovery on the same site in an integral operation with extraction of other useful components from waste, such as iron and steel, aluminum and glass. These salvaged materials can be sold, also adding to revenues. By combining several activities as a single operation, processing and handling costs per ton can be reduced.

There are many technologies available for extracting energy from waste. Conventional waste incinerators have long been equipped with heat recovery capability for making steam, which can be used as a direct heat source or to generate electricity. Two existing waste incinerators in Hempstead generate their own on-site electric power in this manner. In Nashville, Tennessee, a water-walled incinerator with waste heat recovery supplies steam to a central heating and cooling plant that serves 28 downtown government buildings.

Another approach is to separate out and treat the combustible portion of the waste for direct use as a fuel in a boiler. Many power plant boilers have been fired with pulverized coal for decades, and it has been found that pulverized organic refuse can be successfully used as a supplementary fuel in this type of boiler. Demonstration project using this approach has been run in St. Louis by the Union Electric Company. Several pilot projects and feasibility studies are being carried out using variously treated waste in oil-fired power plant boilers.

Energy from waste can be obtained from thermal decomposition and gasification through pyrolysis. This is the process of chemically decomposing an organic substance by heating it in a low oxygen atmosphere. The gas produced in this manner can be used as a substitute for natural gas, althought it has a much lower Btu value. In addition, some of the heat used in the pyrolysis process can also be recovered through a heat exchanger.

Several waste-to-energy conversion proposals in Long Island a are in various stages of progress. These are reviewed below:

1. <u>Hempstead, Long Island</u>

The town of Hempstead has contracted with Black Clawson to engineer and construct an integrated resource recovery facility that will both separate out non-combustibles for salvage and convert the organic wastes into energy. The plant is designed to process 2,000 tons of mixed refuse per day. Unlike most of the resource recovery operations being developed in the U. S., this facility will be privately owned and operated. LILCO has also agreed to a) purchase two steam turbine generators with a combined capacity of 32 megawatts that will be built under a turnkey arrangement by Black Clawson; b) purchase steam from boilers to be operated by Black Clawson. The facility will be located on a 15 acre parcel in the Roosevelt Field-Mitchell Field area. The boiler turbine generator facility is expected to operate 24 hours a day, seven days a week. LILCO has included the 32 megawatt capacity from these generators in its submission of planned future facilities in the 1975 Power Pool report. They are scheduled to be in line by 1978.

2. <u>Babylon-Huntington-Islip</u>

The three towns of Babylon, Huntington and Islip have agreed to jointly develop a 3,000 ton per day publicly-owned resource recovery-energy conversion facility. The technical design was developed by the State Environmental Facilities Corporation. The proposed plant is designed to a) serve as a district heating plant by supplying steam to Pilgrim State Hospital and the Brentwood Campus of Suffolk Community College, and b) sell steam to LILCO for use in a turbine generator to be built by LILCO (in the 32 megawatt range)..

3. <u>Other Current Activities</u>

North Hempstead is developing a solid waste demonstration project for possible financing under the Federal Community Development Act of 1974. This project would be aimed at perfecting a process that would convert the organic portion of waste into a fuel that could be sold to LILCO for use in existing oil-fired boilers. In addition, Sanitary District #1 in Hempstead is studying the feasibility of developing a salable gas from a pyrolysis process as a substitute for landfilling.

Potential for Energy Recovery in Nassau-Suffolk Area

According to a report by the N.Y.S.P.S.C.,[1] the heat content of N. Y. State's annual urban refuse is 149.8 trillion Btu. Using the New York State 1970 heat rate of 11,376 Btu/Kwh, the state's urban trash could have produced 13.2 million megawatt hours of electricity, or 20% of the electrical energy produced by the state's conventional steam generation equipment. The PSC report assumed an average level of waste generation of 5 pounds per capita per day, with a heat content of 5,260 Btu per pound.

Applying the same assumptions to the Bi-County area's 1975 population of 2.739 million, results in an annual heat content of 26.2 x $10^{12}$ Btu in the area's 1975 refuse. Converted to electricity, this would result in an annual electrical energy production of 2.3 million megawatt hours (at 11,376 Btu/Kwh).

Only a fraction of the Bi-County's energy potential in solid waste can be expected to be realized in the next twenty years. First, the most efficient use of the potential energy is for direct utilization for space heating or as process heat in manufacturing operations. This requires that users be located close to the steam producing operation, generally within a radius no greater than 1 to 2 miles. This factor will limit the future opportunities for using solid waste as the main fuel for indudstrial or commercial steam plants. Second, as an alternative use for the cellulose fibre, which makes up a major portion of the combustible part of urban trash, it can be salvaged and used in wallboard, and other types of paper derived products. While the market for scrap paper is, at present, at a low level, reclaimed fibre may well in the long run prove to be a more valuable commodity than its use as fuel. In addition, there are net energy savings in using scrap paper as opposed to making virgin pulp.

Table S1 shows an order of magnitude estimate of the potential energy contribution to Long Island from solid waste conversion for 1980-1995. As can be seen in this table, if it is assumed that by 1995, 40% of the area's solid waste were converted into electrical energy, it would produce an annual total of 1.16 millionmmegawatt hours of energy saving 80,000,000 gallons of oil equivalent per year.

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1. Kasper, William C., Solid Waste and Its Potential as a Utility Fuel, State of New York Public Service Commission, 1973.

## NASSAU-SUFFOLK SOLID WASTE ENERGY CONVERSION POTENTIAL

| Year | Population In Thousands[1] | Annual Solid Waste Generation Millions of Tons[2] | Annual Heat Potential[3] | Projected % of Energy Recovery | Projected Energy from Waste | Electric Energy Equivalent Millions MWH[4] |
|---|---|---|---|---|---|---|
| 1980 | 2868 | 2.6 | $27.6 \times 10^{12}$ Btu | 10% | $2.8 \times 10^{12}$ Btu | .25 |
| 1985 | 3075 | 2.8 | $29.5 \times 10^{12}$ Btu | 20% | $5.9 \times 10^{12}$ Btu | .52 |
| 1990 | 3249 | 3.0 | $31.5 \times 10^{12}$ Btu | 30% | $9.5 \times 10^{12}$ Btu | .84 |
| 1995 | 3431 | 3.1 | $33.0 \times 10^{12}$ Btu | 40% | $13.2 \times 10^{12}$ Btu | 1.16 |

1. From June 1974 projections by N.Y. State Office Planning Services

2. Based on 5 pounds per day per capita waste generation rate held constant to 1995. This constitutes a conservation projection of per capita waste generation since per capita rates have been historically rising.

3. Computed at 5,280 Btu per pound.

4. Computed at 11,376 Btu/Kwh.



TABLE S-1

## H. IMPLEMENTATION REQUIRES AFFIRMATIVE ACTION.

Although fuel shortages and higher prices provide powerful incentives to conserve energy and seek alternative sources, a more definitive energy policy with affirmative actions will be needed to implement a full energy management program program which includes all of the facets which I have been suggested herein:a)a) an intensive energy conservation and load management program, and b) widespread utilization of solar energy systems and total energy systems and c) further development of wind energy systems and solid waste conversion to fuel.

Even sudden unexpected external factors such as another oil embargo, or a middle east war, which might be expected to trigger greater conservation efforts, requires prior preparations (policy and measures) to avoid sudden drastic and undesirable changes in economic conditions and life style.

The rise in energy usage since the end of the embargo indi cates that voluntary efforts to conserve are not enough without incentives, dis-incentives legislative action and expanded educational programs. The Federal Government,financial institutions, New York State, the Bi-county and local municipal agencies, and of course, the consumer himself, all have important roles in promulgating and implementing energy policy.

### The Counties' Role

Suffolk and Nassau Counties face both opportunities and limitations in the ways they can respond to the challenge of implementing energy conservation measures and initiating alternative energy systems in the LILCO service area. Although virtually all the vacant land for future growth is located in Suffolk County, more than half of LILCO's present customers are located in Nassau County. The role of county government has been expanding greatly in recent years. Implementation measures such as building and zoning codes are enacted and administered by its constituent municipalities rather than the county itself. Other counties throughout the Nation have begun to establish building standards and adopt other regulations to control the use of energy.

By facing these challenges creatively, and utilizing their considerable resources, Suffolk and Nassau County can be prime movers. It would be inappropriate for me to prescribe the specific additions to administrative machinery to be developed, and through which, to spearhead an implementation effort. What does seem clear, however, is that if the counties wish to establish an "alternative energy future", then it will be necessary for them to mount an organized and sustained effort. Below are suggested directions in which to move, by whatever means each county chooses. These suggestions are intended to be illustrative rather than comprehensive:

1. Determine the powers that can be employed by county government in furthering energy conservation (codes and building standards, appliances and air conditioning energy use standards, regulations, tax relief incentives, etc.); recommend such state enabling legislation as may be required to facilitate the country's ability to play a direct role.

2. Create county-oriented energy research and evaluation capability. First priority should be placed on establishing inhouse, or through the use of consultants, the capability to make independent load forecasting and demand studies. A critical part of the operation could be an ongoing compilation and analysis of the large amount of data that LILCO is already required to publish periodically under various governmental regulations, such as the forecast material in the annual Power Pool reports. This operation could also seek to obtain unpublished LILCO data. Recommendations could also be made to PSC suggesting what types of additional information utilities should be required to assemble and publish that would assist the county in developing their own joint energy policy.

3. Identify and encourage changes in utility regulations and state and federal legislation that would further energy conservation efforts and facilitate the introduction of alternative energy systems.

4. Perform an educational role, stressing the seriousness of the energy problem,what can be done about alleviating the problems, and how home-owners and businessmen might gain direct benefits from conservation measures. The counties should also serve as a clearing house to collect and distribute information on solar heating and cooling, wind energy, total energy, heat pumps, and other technologies which are available to reduce energy consumption and peak power demand.

5. County-sponsored demonstration projects should be promoted. There are existing county building complexes which are suitable for total energy installations. As a first step, each county could initiate a TE retrofit feasibility study. As feasibility becomes more apparent, the County could carry out a TE project as a concrete example for others to follow. An alternative demonstration project would be to retrofit county buildings with solar heating and cooling, as is now being done in the New York Telephone Company switching building in Cutchogue. Similarly, retrofitting existing county buildings for energy conservation and monitoring the operation, will provide a valuable body of knowledge of the effectiveness and cost benefits as examples to the private sector.

6. Each county should conduct extensive surveys to establish a data base of existing energy usage by building type and sub-system within the buildings. This data base is essential in order to initiate future actions on a priority basis to reduce energy consumption.

7. Each new county owned building should be subjected to a rigid energy budget in accordance with the Federal G.S.A. Energy Conservation Guidelines,and construction contracts should be let on a life-cycle cost and energy use basis rather than on the lowest construction bid.

Long Island Lighting Company's Role

Five years ago, the statement that a utility was not merely responsible for supplying customer demands for energy, but also shaping and restraining this demand would have been met with serious argument. Today, this concept is more and more widely accepted. It is not an entirely new idea. In fact, the utilities historic practice of mounting a sales campaign to increase the number of electrically space-heated homes could be regarded as "shaping" demand for economic reasons. In that case, the intent was to drive up the winter load and bring it closer to the summer peak so that generating capacity, necessary in the summer, does not sit idle (and fail to bring in revenue) during winter months.

Restraining consumption at all times, and lowering or redistributing the demand at peak times is a more appropriate response for a long term policy. In the past, many electric water-heating customers were supplied with special meters for water heating during off-peak periods. The water was heated at night, stored, and used throughout the day. This practice relieved the utility of a significant load during peak hours and allowed the customer to obtain hot water more cheaply. In fact, the North East Utility Company in Connecticut maintains such a policy now. LILCO's plans to install time-of-day meters for a number of its customers reflects a resurgence of interest in the common sense practice of load levelling. As noted before, LILCO has applied for a rate change for time-of-day metering for 160 customers. LILCO should study in detail the costs and effects of a major time-of-day metering program involving thousands of customers on a voluntary and alternatively a mandatory basis. The costs for such systems should be evaluated against the total costs of new central generating plants.

Another example is LILCO's minimum insulation requirements for electrically heated homes and commercial buildings. It should be noted that a customer can ignore these standards if he is willing to pay the penalty of a higher rate and many space heating customers do not have storm sash or double glazing at present. These standars should be tightened and made mandatory.

LILCO should analyze heat pumps and storage systems in greater detail for their own information so that they can recommend them with confidence to customers in place of resistance heating.

LILCO is now moving in the direction of gathering and assembling a better data base for forecasting loads. LILCO has gained some knowledge about its residential load, through its appliance saturation studies. For a sample of major customers, LILCO also knows total hourly demand. Like other utilities, however, LILCO has yet to develop systematic survey data on how the energy it supplies to all its customers is actually used. LILCO should install test meters in a much larger number of residential and non-residential units to determine peak demand by end use and the time that it occurs.

Over and above its role in helping shape future demand for power, LILCO should play a much larger direct role in planning, promoting, building, owning, and operating or leasing some or all of the alternative energy sources or systems discussed earlier. LILCO has already begun in this direction including a 32 megawatt solid-waste fueled generating plant in its planned future capacity, and is planning five solar-assisted heat pump residences under a grant from EPRI.

As pointed out in a report by the National Academy of Sciences, privately developed new energy systems may have a hard time in competing with utilities in a situation where "the present rate structure of utility companies distribute the increased cost of new facilities among all customers. In one sense the old customers subsidized the new"[1]. If LILCO were to develop alternative energy systems as decentralized extensions of its total system, then the alternatives would have this same advantage of having their cost distribution among all LILCO's customers. Certainly this would be an innovation for LILCO, but there are existing instances of utilities that operate Total Energy Plants (Southern California Edison, for example).

Earlier some of the benefits that might be realized if LILCO were to develop a system of TE installations were summarized. This possibility should be tested by LILCO through a feasibility master plan for the large-scale introduction of TE in its service area using engines, turbines and fuel cells. The study would identify both specific existing buildings or complexes which could be retrofitted for TE and future potential TE service areas. Total development costs for the entire TE system would be estimated as well as future revenues (on the basis of a rate structure for electrical and thermal energy, low enough to attract potential customers). LILCO's investment and return in such an area-wide system should then be balanced against alternative system investments and measured against other approaches in terms of environmental impact.

1. National Academy of Sciences, Evaluating Integrated Utility Systems, 1974, Page 57.

Similarly, many more decentralized systems of delivering on-site energy through LILCO-owned and operated solar collectors should be analyzed for feasibility. Just as for TE, the solar system could be considered as a new method in an expanded LILCO system of delivering energy to customers. Both solar energy and TE may well flourish on their own due to a number of factors including skyrocketing electric rates. The future of wind, however, as a source of power tied in to the central grid depends strictly upon LILCO; there is no other entity except State and Federal government with the appropriate equipment and the fiscal resources at present. LILCO should conduct a research program directed towards the development of hardware and systems using wind generators. Professor William Heronemus has presented the case for this system on Long Island; the components could be put in place within a time frame that compares favorable with the extended period that planning and building a nuclear plant require. To develop a windpower source of generating capacity would entail a major effort by LILCO and some risk of performance not meeting expectations, but huge nuclear power plants also entail these same problems.

LILCO should take the lead in implementing a change in the New York Power Pool Regulations (they are self imposed) to reduce the required capacity margin in order to reduce redundant generating plant capacity.

## Need to Move Beyond Voluntary Measures

It is clear that the impact of voluntary conservation measures and better management - turning off unneeded lights, raising or lowering thermostat settings, cutting back on the use of appliances - will be significant, but not sufficient for reduction of energy consumption, but of limited importance for the reduction of future demand. In this regard, the 1973-74 experience for LILCO and other utilities is instructive.[1]

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[1] Refer to the report, New York State Department of Public Service, The Effects of Energy Conservation on New York State Utilities' Energy Requirements and Peak Demands, March, 1975. This report notes that many customers appear to be most of curtailing most of their energy consumption at off-peak periods. On pages 43-44, it is noted that "such a trend could have a devastating effect on the financial condition of the utilities since the growth in demand would require new plants for peaking and not produce much income through energy sales....of prime importance is a study of the cost/benefits of peak load pricing and demand management as compared to the alternate approach of providing energy storage systems for the purpose of meeting system peak loads"

In addition to the effects of price and reduced economic activity, it can be assumed that nearly all of the 1973-74 peak and consumption reductions were due to voluntary restraint or improved management as opposed to replacement of inefficient equipment and other mechanical or building changes that require lead time. While the impact on total LILCO consumption was significant in every category, the growth of summer peak load was only slightly reduced. The mass of LILCO's customers did not choose to voluntarily turn off their air conditioners when they wanted to use them the most in the warmest weather. On the other hand, if the typical LILCO customer of the future has an improved air conditioning system--one that operates more efficiently, and in the case of larger installations is coupled with a chilled-water load-levelling storage device that reduces peak demand, and is located in a structure with improved insulation--then peak summer demand will be reduced substantially even if most of the units in the service area are working at the same time.

The role of mandatory measures in retrofitting existing buildings or forcing consumers or businesses to replace equipment before it has worn out, will probably be limited. Attempts to upgrade existing homes through such devices as housing codes have posed enormous enforcement problems and mandatory retrofitting would result in a host of additional legal and political problems. Therefore, the "incentive" approach (federal tax credits, low cost loans, property tax exemptions, and educational programs stressing the real economic benefits in reduced operating costs), seems to be the most appropriate.

With respect to improving energy efficiency in new construction and major additions to existing buildings and replacement of old equipment or purchasing more efficient new equipment, incentives can of course play an instrumental role. In addition, however, mandatory requirements can produce significant results. Congress has passed a mandatory minimum performance standard for U.S. cars in terms of mileage per gallon, and established energy performance standards and labeling for air conditioners, freezers, television sets, and other devices. State, local and county building codes should be passed which would set building air conditioning, appliance and equipment performance standards for future energy utilization. However, as in all measures which involve government regulations and processing, there is the danger of inflexibility, red tape, and a stifling of innovative solutions. Great care should be exercised in drafting such codes.

Illustrations of Measures and Action

The following illustrative examples summarize but a few of the possible measures and actions which should be taken by the agencies with legislative power to do so:

1. Property tax exemptions should be instituted for building improvements or modifications that conserve energy (Indiana and New Mexico already provide exemptions for solar heating installations).

2. Federal tax credits should be provided for owners who insulate or add solar equipment to buildings, or otherwise expend funds to retrofit their building to reduce energy consumption.

3. Tax credits, accelerated depreciation and other subsidies should be provided for load levelling equipment. By reducing peaks, the load factor for the utility electric system would be improved, thereby slowing down the need for additional plants through a more efficient utilization of existing capacity.

4. Zoning codes should be developed which will protect solar system owners from the encroachment of their "sun rights" by other buildings. Existing zoning and building codes should be modified to insure that they do not prohibit solar and wind power additions to buildings and property. Florida has already passed a law requiring that all new homes be designed to permit later introduction of a solar system. This requirement has implications for both building orientation and structural considerations.

5. Useful as energy efficiency labeling of appliances may be, federal or state laws are needed to stipulate energy performance for air conditioners, freezers and other electrical apparatus, as well as penalties to be placed on poor performance appliances. In addition, the provision of incentives for manufacturers to produce more efficient energy-using equipment should be enacted (this could take the form of an investment tax credit. Such credits exist now for expansion of facilities which are not necessarily energy conserving.

6. Environmental impact statements and assessments are becoming a standard procedure not only at the federal level, but in an increasing number of states as well. The proper assessment of energy impacts needs to be made an integral part of these statements. Such analysis should be required for all larger public and private developments, whether by state, county or local enactment. Recommendations have also been made to the PSC that all new projects with an electric demand of more than 200 Kw should be required to file an "energy impact statement" prior to getting service. Such energy audits should include building types, uses and other load-levelling measures.

7. A feasibility analysis of supplying all or most of a new development's energy from TE should be made a required procedure for all larger buildings and developments.

8. Town zoning ordinances should be amended where necessary to discourage sprawl and encourage energy conserving clustering or "planned unit development". Larger developments would be exempted from the usual rigid land use and bulk specifications if they achieved a more efficient use of resources through clustering and the integration of a variety of uses[1]. Local zoning codes could be amended to include incentives for developers who include solar or energy conserving features, just as many zoning codes provide bonuses for developers who provide extra open space.

9. Loan programs should be instituted for energy-conserving improvements such as insulation, light-switching modifications, and thermal storage systems. In Michigan, gas utilities have administered and financed an attic retrofit insulation program for 85,000 homes. Low cost loans and long term mortgages should be provided when it can be shown that the proposed measures which require financing for their installation will indeed be energy conservation effective. A proposed Bill in the Senate now includes a 40 year 2% loan for such modifications.

10. Electric rates should be set by the PSC for stand-by supplementary service to developments with on-site electric power systems set to promote the development of such systems.

11. PSC should set rates which will encourage time-of-day metering.

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1 A model PUD ordinance for towns in New York is available from the Rochester, N.Y. Center for Governmental Research.

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MEMORANDUM

TO: Representative Hugh Malone
Attn: Mr. Mark Wittow

FROM: Jack Kreinheder, Issues Analyst JK

RE: Comparative Analysis of Comprehensive Energy Conservation Programs
Research Request No. 52

You have requested that we compare energy conservation legislation passed recently by the states of California, Minnesota, Montana, Oregon and Washington with conservation provisions contained in HB 851. Municipal ordinances enacted or under consideration by the cities of Portland and Seattle were also to be included in the analysis. The specific provisions we were asked to address are the following: (1) tax incentives for conservation investments by businesses and individuals; (2) energy conservation loan programs; (3) building construction standards or codes for energy conservation; (4) energy audits and life cycle cost analysis; (5) tax incentives for gasohol production; (6) long-term energy planning; and (7) incentives for waste heat utilization.

The relevant state or municipal laws relating to each of the seven provisions are discussed below. The appropriate statutes and ordinances are attached, should you wish additional detail or background information. The highlighted sections indicate the most important information.

Tax Incentives for Energy Conservation Investments

HB 851 would provide to businesses a tax credit of 35 percent of the cost of purchasing, constructing, and installing energy conservation facilities, up to a maximum credit of $25,000 (Sec. 8). Energy conservation facilities are defined as facilities for the use of waste heat, cogeneration facilities, fuel cells and other approved facilities added to existing structures.

A residential tax credit of 35 percent up to $2,000 would also be provided by HB 851 (Sec. 9). The credit would apply to "fuel conservation capital improvements", which include insulation, thermal windows and doors, alternate power, heating, or cooling sources such as solar energy and windpower, and a number of other energy saving devices or measures (Sections 10-13).

California has the largest residential tax benefit for energy conservation measures of the five states considered, but it is limited in scope to solar energy systems (including wind) and related improvements. A 55 percent tax redit, up to $3,000 is allowed for the cost of acquiring solar systems, and for other conservation measures applied in conjunction with solar systems of certain types. For example, ceiling, wall and floor insulation costs are eligible for the tax credit if the solar system is for space heating purposes; if the system is for water heating, water heater insulation jackets and faucet flow restrictors qualify for the credit. In 1979 the tax credit was extended to cover part of the cost of leasing solar systems from municipal utilities.

Oregon provides a personal income tax credit of 25 percent of weatherization costs, up to a maximum credit of $125, for weatherstripping, insulation, thermal windows and other conservation measures for residences or rentals. The credit was extended by 1979 legislation to cover mobile homes, floating homes, and multiple unit residential structures.

A 25 percent tax credit, up to $1,000 per dwelling, is also allowed for the cost of "alternative energy devices" using solar, water, wind or geothermal resources. To be eligible for the credit, the alternative energy device must meet 10 percent of the dwelling's total energy requirements.

An even larger credit is available for businesses and industries. Legislation enacted in 1979 offers corporate income tax credits of up to 35 percent of the installation costs of equipment which uses renewable resources for energy. The credit is limited to a maximum of $10 million of certified renewable resource capital improvements per facility. Although the percentage of the credit is identical to the credit which would be enacted in Alaska by HB 851, the maximum amount of the Oregon credit is much greater: $3,500,000 compared to $25,000 under HB 851.

A property tax exemption for residential solar energy systems was enacted in 1975. In 1979 the exemption was amended to include geothermal, wind, water, and methane gas systems for the purpose of heating, cooling, or generating electrical energy.

Low income senior citizens were entitled to a property tax refund of up to $300 for weatherization expenditures by a 1977 act, providing certain income and property value requirements were met. However, the act expired July 1, 1979.

Washington has no personal or corporate income tax, and therefore has no conservation incentives related to income taxes. A property tax exemption is provided for solar energy systems, as defined by the U. S. Department of Housing and Urban Development. Although the definition of an eligible solar system appears to be rather narrowly construed, the Washington exemption applies to all real property, both residential and commercial.

Minnesota enacted a residential energy credit in 1979 which allows a tax reduction of 20 percent, up to $2,000, of solar, wind, and other renewable energy expenditures for residential buildings of six dwelling units or less. In 1978, a property tax exemption was passed which excludes from taxation the value of a solar, wind, or agriculturally derived methane gas system used for heating, cooling, or electric power on either residential or commercial property.

Montana provides a tax deduction, as opposed to a credit, for energy-conserving investments to residential, commercial, industrial, or agricultural buildings. For residences, 100 percent of the first $1,000 expended may be deducted from taxable income, 50 percent of the next $1,000 expended, 20% of the next $1,000 expended, and 10% of the next $1,000 expended. The deduction is similar for non-residential buildings, except that $2,000 increments are used. Energy-conserving investments include any investments which reduce the waste or dissipation of energy or which reduce the energy required. The deduction, although small in comparison to tax credits offered by other states, is notable in that it is the only tax credit or deduction besides Oregon's which applies to non-residential property, as would the credit in HB 851.

Montana also exempts from property taxation, for a period of 10 years following installation, solar, wind, water, and other alternative energy sources. The exemption covers up to $20,000 of an investment for a single family residential dwelling, and up to $100,000 for a multifamily dwelling or a non-residential structure.

Energy Conservation Loan Programs

HB 851 would establish a residential energy conservation loan program, which would provide loans up to $10,000 at an interest rate of three percent a year for loans made before 1983, and a rate of 9.5 percent on loans made in 1983 or later (Sec. 19). Loans would be available for caulking and weatherstripping, heating system improvements, and other approved conservation measures. Income of loan applicants would not be a criterion in selecting loan recipients. No requirement for conservation assistance by utilities is included in the bill.

Minnesota appears to have the only state loan program for private conservation investments of the five states covered here. An estimated $17,000,000 in energy conservation loans has been distributed by the Minnesota Housing Finance Agency. Interest rates for energy conservation loans range from one to eight percent, depending on the income of the applicant. The maximum loan amount is $15,000. Minnesota law also provides for state payment of all or part of the cost for energy audits by schools and municipalities. Grants for conservation improvements are available for individuals with incomes of $5,000 or less.

Minnesota has no legislation authorizing or requiring utilities to provide conservation assistance to consumers, but three bills which would enact such requirements are currently before the legislature there.

<u>Oregon</u> law requires investor-owned gas and electric utilities to arrange for low-interest financing and installation of weatherization measures for their space heating customers. The maximum interest rate for conservation loans is 6.5 percent. Publicly-owned utilities and large fuel oil dealers are also required to provide their space heating customers with information on registered contractors supplying weatherization services and commercial lenders offering 6.5 percent loans.

A tax credit is provided to commercial lending institutions for the difference between the interest obtained from the statutory 6.5 percent rate and the amount of interest which would have been charged at the average home improvement interest rate during the preceding year, or 12 percent, whichever is lower.

Two Oregon utilities offer conservation loans on an interest-free, deferred payment basis to their space heating customers. There is no statutory requirement for the interest-free loans, and they are provided only for conservation measures which are cost/ effective for the utility relative to the cost of installing additional power generation. One of the utilities, Pacific Power and Light, offers such loans in the states of Oregon, Washington, Montana and Idaho. The utility also serves customers in Wyoming and California, but the Public Utilities Commissions in those states would not authorize the interest-free loans.

<u>Washington</u> statutes do not require utilities to provide conservation loans, but Pacific Power and Light and other utilities are providing loans on a voluntary basis. The state constitution currently prohibits publicly-owned utilities from providing loans; however, a bill authorizing and encouraging such loans was passed in 1979. A proposed constitutional amendment will be submitted to the voters at the next general election to make the bill effective.

<u>California</u> does not require utility loan programs, and as mentioned above, its Public Utilities Commission denied the application of Pacific Power and Light to offer interest-free conservation loans. However, 1979 legislation specifically authorized the Commission to permit or require utilities to institute energy conservation programs, including loans, for their customers. Pacific Power & Light officials stated that the Commission has asked the utility to resubmit its loan application, so it appears that utilities may be allowed or required to offer conservation loans in the near future

California does offer a state loan program for conservation investments, but the loans are limited to schools, hospitals, public care institutions, and units of local governments. To be eligible for loan funds, a conservation measure must recover the loan cost, including interest, through savings in energy costs during the repayment period, which is limited to eleven years.

<u>Montana</u> statutes provide that a public utility may install or pay for the installation of energy conservation materials or alternative energy systems in a dwelling. The utility may agree with the dwelling occupant for repayment of the cost at an annual interest rate of not more than seven percent. A financial institution is authorized to offer conservation loans at an interest rate not less than two percentage points below the 90-day federal reserve rate, and to claim a tax credit for the reduction in interest charges from the market rate, up to $2,000 per tax year. Public utilities can also receive a tax credit for the difference in interest charges for their conservation loans up to $200,000 in any tax year.

The <u>City of Portland</u> has approved low-interest conservation loans, but the funding for the program will be provided by the federal Department of Housing and Urban Development (HUD). Loans at 3 percent interest will be made to low-income homeowners, while 6.5 percent loans will be available for other homeowners and multifamily dwelling owners.

Portland had planned to offer interest-free conservation loans, but HUD denied the request in its grant. Interest-free loans will still be offered, but only for the cost of commercial and industrial energy audits required by Portland ordinances.

Seattle provided, through the City Light municipal utility, free attic and floor insulation to low income elderly homeowners who heated with electricity, up to a maximum of $450 per home. The allocated funds ($207,000) were expended in 1978 after 339 homes had been insulated. A number of other conservation financing programs are being considered, but none has been implemented.

Energy Conservation Building Standards

HB 851 would require all new public facilities of the state to comply with the ASHRAE 90-75R thermal and energy lighting standards (Sec. 20). ASHRAE is the American Society of Heating, Refrigeration, and Air Conditioning Engineers. In addition, existing public facilities have to be modified, to the extent economically feasible, to comply with these standards. With some exceptions, state loans could not be granted for new residential or commercial buildings unless the energy standards were met. Municipalities with building codes would be required to incorporate the standards for new buildings into their codes.

The ASHRAE 90-75R thermal and energy lighting standards, or comparable standards, have been adopted for new construction by Oregon, Minnesota, and California. Oregon and Minnesota have implemented state building codes which were based on the ASHRAE standards, but which are significantly more stringent in terms of conservation efficiency. Minnesota has also established standards for existing dwellings. The City of Seattle has enacted an energy code which is based on the ASHRAE model code, but which is also more stringent, particularly with respect to lighting and switching requirements. A prescriptive retrofit program is under consideration as explained below. Portland has no conservation standards as such, but has adopted a retrofit policy for existing structures based on cost effective measures.

In 1974, the Oregon legislature created an Energy Conservation Board, whose responsibility was to add conservation requirements to the state's building code. The board adapted the ASHRAE 90-75R standards to Oregon conditions and increased the requirements substantially in several areas, most notably for insulation levels. The conservation codes apply to both new residential and new non-residential buildings, although the requirements differ.

Oregon passed legislation in 1977 requiring the Director of Commerce to establish energy conservation standards for existing public buildings. However, the standards appear to relate primarily to operational procedures, rather than structural changes, and are entirely voluntary. A program encouraging public compliance with these standards was to be adopted in 1978 by the Department of Energy, but again, compliance was on a voluntary basis with no assistance or incentives provided. The Energy Conservation Board was also required to establish by 1978 a voluntary energy efficiency rating system for single family residences. The system uses a single number to indicate the energy efficiency of a dwelling, based mainly on heat loss characteristics of the structure. The Department of Energy is to encourage the voluntary use of the system in real estate transactions.

Minnesota enacted an energy code in 1974 which incorporated all of the ASHRAE standards for new buildings and added additional insulation and other requirements. Minnesota is unique among the states considered here in that it has also enacted mandatory energy conservation standards for existing dwellings. These standards are mandatory only for rental property, and are part of an energy disclosure system established in 1977. Under the energy disclosure requirement, no home may be sold without the owner first providing to the buyer a copy of an energy disclosure report for the residence. The disclosure report is completed by building evaluators who determine the degree to which the residence complies with the energy conservation standards. The residence is not required to meet the standards; therefore, the disclosure system relies on the market value or "salability" of energy efficienty to induce homeowners to upgrade their homes to meet the conservation standards. Although the disclosure provision was to take effect October 1, 1979, implementation has been delayed and is scheduled for next fall.

The conservation standards were developed jointly by the Minnesota Energy Agency, the building code administrators, and an outside consultant. Energy Agency staff indicated that the standards are not as high as they would like, and that insulation levels and other provisions may be substantially increased for non-rental dwellings in the near future to correspond to the federal Residential Conservation Standards program.

The Minnesota energy conservation standards are mandatory for rental property. Effective January 1 of this year, all residences constructed before 1976 and occupied by renters were to be in compliance with the caulking and weatherstripping provisions embodied in the conservation standards. Enforcement of the requirements is to be through inspections on a random basis by the Energy Agency. Staff members said that compliance with the provisions is estimated to be about 50 percent, and the principal problem is in communicating the requirements to all rental owners in the state.

By July 1, 1983, all renter-occupied dwellings are required to be in compliance with all applicable energy conservation standards. Applicable in this context means that the conservation standards must be cost effective in relation to energy costs for an individual dwelling over a ten year payback period. It should be noted that because the state building code does not apply in some rural areas, the conservation standards cannot be enforced in the entire state. However, the standards are estimated to apply to 85 to 90 percent of all residences in the state.

Minnesota also requires that plans for new state buildings or for a renovation of 50 percent or more of an existing building or its energy system shall include designs which utilize active and passive solar energy systems, earth-sheltered construction, and other alternative energy sources where feasible.

California law specifies that the State Energy Commission must prescribe by regulation lighting, climate control, and other building design and construction standards for the purpose of energy conservation in new residential and non-residential buildings. The current standards are modeled closely after the ASHRAE 90-75R standards. A city, county, or state agency may not issue a building permit unless the building meets the energy standards in effect on the date an application for a building permit is filed.

The California standards differ from those of the other states with conservation standards in one important way. Both prescriptive and performance standards are required under California law. Precriptive standards, which are used in the other states, specify that certain design standards, for example, a given amount of insulation, be incorporated in new buildings. Performance standards in California's case refer to energy consumption per square foot of floor space, such as watts per square foot for lighting, or BTU's per square foot for heating and cooling. A structure meeting the performance standards need not comply with the prescriptive requirements, thus allowing greater flexibility and innovation in building design. The major disadvantage of performance standards appears to be that verification of compliance cannot always be made during the construction stage, as with prescriptive requirements, but must sometimes wait until the structure is built and in operation (particularly for energy consumption and heat loss standards). A computer program is used in California to predict building energy consumption levels.

Standards for lighting levels, light switching and control mechanisms, lighting energy budgets, and other factors have been developed by the Energy Commission for existing structures. These standards are strictly voluntary, however.

A final California conservation standard is one which requires that all new state-owned structures shall be equipped with a supplementary solar water heating system, unless exempted by the State Architect for reasons of economic or physical infeasibility.

The Washington legislature enacted thermal performance and design standards based on the ASHRAE standards in 1977, but the standards are still not in effect. Apparently, the Building Code Council, which was to implement the standards, objected to some of the standards as being too stringent for Washington conditions. A panel of five technical experts is currently studying the situation and is expected to recommend possible changes by May, when the standards would become effective.

One interesting aspect of the Washington standards as enacted is that although both performance and prescriptive standards were enacted, as in California, the application of the two conservation methods is the reverse of California's. While California law provides that a building meeting the performance standards need not comply with prescriptive standards, the Oregon statute says that compliance with the prescriptive standards shall be deemed to satisfy the performance requirements.

Montana has no building codes or standards specifically for the purpose of energy conservation.

The City of Seattle has adopted an energy code based closely on the model ASHRAE code which incorporates the ASHRAE 90-75R standards. The major changes to the code were with respect to lighting requirements. Seattle simplified the requirements to a watts per gross square foot measure and added detailed switching provisions for non-residential structures in order to reduce the unnecessary lighting of unused office or work spaces.

Seattle's Energy Office has made a major effort to develop a workable mandatory retrofit program for existing residences. A proposed Home Conservation Requirement for residential structures of four units or less was released for comment last fall. The City council has taken no action on the measure to date, and it now appears that the retrofit proposal will be considered by the council in late April. The proposal would require conformance to prescriptive weatherization standards developed by the Energy Office and would be voluntary for the first three years, after which a two-year mandatory inspection program would be conducted by the Seattle Building Department to ensure compliance.

Portland has adopted an energy conservation policy calling for a mandatory retrofit program, but it differs in several important ways from the Seattle proposal. The differences are explained in more detail in Attachment C, prepared by the City of Seattle, but the major distinctions between the two approaches are:

1. Portland's retrofit proposal applies to all structures, residential, commercial, and industrial, while Seattle's affects only smaller residential buildings (up to four units).

2. Portland's approach would tie conservation requirements to title transfer at the time of sale, after a five-year voluntary weatherization period. Certification of the necessary improvements would be made by the seller to the buyer. The Seattle program would require retrofit conservation measures within three years. All dwellings not inspected or certified during the three-year voluntary period would be inspected by the Seattle Building Department over the following two years.

3. The Seattle program would require conformance to specific prescriptive weatherization standards, while Portland would require those weatherization measures to be installed which a required energy audit indicated to be cost-effective in ten years (residential) or five years (commercial).

Energy Audits/Life Cycle Cost Analysis

HB 851 would require the Department of Transportation and Public Facilities (DOTPF) to conduct an energy audit on all State buildings as soon as practicable after the bill becomes effective, and again at least once every four years (Sec. 20). The audit results are to be submitted to the legislature each year. The Department of Commerce and Economic Development (DCED) would be required to adopt regulations mandating that an energy audit and life-cycle cost analysis be performed for all buildings to be purchased with State financial assistance. The DCED would also be required to establish criteria for the performance of energy audits, solicit bids, and enter into a contract for conducting energy audits. The fees to building owners for requested audits would be set at $25.00 until 1982, and $60.00 thereafter, for one- or two-family dwellings. Larger dwelling and nonresidential building fees would be set by regulation. DCED would reimburse energy auditors for the cost of audits in excess of fees received.

The DOTPF would also perform a life-cycle cost analysis for all state buildings under HB 851. Life-cycle cost is defined as the total cost of owning, operating, and maintaining a building over its useful life or term of lease, including its energy and fuel costs, based on an evaluation and comparison of alternative building systems.

Oregon has the most comprehensive residential energy audit legislation of the five states. Oregon law requires all utilities, both public and private, and large fuel oil dealers to provide a free home energy analysis to their space heating customers. The analysis must include, upon request, an inspection of the customer's dwelling to determine sources of heat loss, and an estimate of the cost of recommended weatherization measures. Over 33,000 households had requested an energy analysis in the first year of the program.

With regard to life-cycle cost analysis, Oregon statutes provide that a state agency planning to construct or renovate a building of more than 25,000 square feet must have such an analysis prepared for the facility. A state agency may accept the facility design if it determines that the analysis provides for an efficient energy system.

Minnesota does not require residential energy audits in the usual sense of the term, but does require audits for all state buildings and building energy reports for all county and municipal buildings. Based on the building energy reports, the Energy Agency is to indicate to each county and city those buildings upon which an energy audit must be performed. Two types of audits can be required, a "mini-audit" and a "maxi-audit"; the former is a brief inspection and analysis of easily effected conservation neasures, while the latter is a detailed engineering and economic analysis of structural conservation improvements. The audits on state buildings are to be completed by June 30, 1982, with local government audits required by December 31, 1982 (legislation was enacted in 1979).

As mentioned earlier, energy disclosure reports will soon be required for dwellings in Minnesota at the time of sale, but these reports are not energy audits. The reports will not suggest conservation improvements, but instead are only intended to determine compliance with specified standards.

California has no requirements for energy audits in either the public or private sector, but loan funds for this purpose are available to schools, hospitals, and local governments under the program discussed earlier.

California law does have a provision for life-cycle cost analysis, but it is not mandatory. The California Energy Commission was charged by statute with the preparation of a manual outlining methodology by which governmental agencies and the general public may, at their option, compare the life-cycle costs of various building design alternatives.

Washington's only legislative action regarding energy audits has been the passage of a bill authorizing utilities to perform such audits. A life-cycle cost requirement for new public buildings or major renovations has been in effect since 1975; however, the requirement was instituted by an executive order of the governor, rather than by the legislature.

Montana has no statutes relating to either energy audits or life-cycle cost analysis.

The City of Portland is currently using life-cycle cost analysis for the planning of new buildings and energy-related purchases. The use of life-cycle cost analysis by businesses will be encouraged (not required) under the Energy Conservation Policy. Energy audits are not required at present, but would be mandatory after September 15, 1984 under the weatherization retrofit proposal.

Tax Incentives for Gasohol Production

HB 851 would exempt gasohol from state fuel taxes (Sec. 14). The exemption would apply to fuel which is at least 10 percent ethyl alcohol by volume.

Of the five states considered here, none has exempted gasohol from taxation as a motor fuel. However, Oregon enacted legislation in 1979 which exempts real and personal property used in the production of substitute fuels from property taxation, and which exempts the portion of a firm's taxable net income attributable to the production of substitute fuels from the corporate income tax. To be eligible for the exemptions, a firm must commit 75 percent of its production of ethanol, methanol or other substitute fuel not derived from petroleum, natural gas or coal, for use in making gasohol. Gasohol is defined as a mixture of at least 10 percent ethanol, methanol or other substitute fuel.

LONG-TERM ENERGY PLANNING

HB 851 would amend AS 44.56.224 to require DCED to prepare an annual long-term energy development plan for meeting Alaska's projected energy demands at the lowest reasonable cost )Sec. 18). The plan is to include proposed short-term and long-term goals for energy conservation and energy production.

California, Minnesota, and Oregon have enacted legislation establishing annual or biennial reports which assess current and future energy supplies, demand, conservation and other factors. California requires its Energy Commission to submit to the governor and the legislature a biennial comprehensive energy report designed to: identify emerging trends related to energy supply, demand, conservation, and public health and safety factors; specify the level of statewide and service area electrical energy demand for each of the next 20 years; and to provide the basis for state policy and actions on these matters. A detailed list of 15 topics is required by statute to be included in the report. The Commission must recommend policie on the reduction of energy demand, the conservation of energy, and the development of potential sources of energy. The Commission was also required to prepare by January 1, 1980, a plan for the maximum feasible implementation of solar technology in California by 1990.

The Minnesota Energy Agency is required to prepare a biennial energy report nearly identical to California's, including the 20-year planning and forecast horizon, but the contents of the report are not specified in as much detail by the Minnesota statutes. One additional requirement of the Minnesota energy report is that the Energy Agency must submit recommendations for administrative and legislative actions to accomplish the purposes stated in the Agency's charter.

The only major differences in the Oregon approach to long-term energy planning from those of California and Minnesota appear to be that the analysis of energy pricing structures is stressed in Oregon's statutory energy report requirements, and that the report is required to be submitted on an annual basis.

Each of the three states require electric utilities to prepare 20-year forecasts of their expected energy demand. Minnesota and Oregon require similar forecasts from all major energy suppliers, including gas utilities and petroleum and coal suppliers. These forecasts provide the basis for forecasts and planning by the responsible agencies in each state.

Incentives for Waste Heat Utilization

HB 851 would enact an excise tax on excess waste heat production. Persons owning facilities which produce more than a specified level of waste heat would be required to sell the waste heat to any prospective buyer; failure to do so would result in a tax of $10 per million BTU's of waste heat produced in excess of the specified level.

Oregon is the only state of the five discussed here which has enacted legislation pertaining to the use of waste heat. Oregon does not require the sale of waste heat, but rather requires that all public and investor-owned utilities purchase on request excess energy, including electricity, waste heat, and other useful forms of energy, from persons operating cogeneration facilities. A cogeneration facility is one which produces energy as a by-product of its normal industrial process and the energy produced can be used for industrial, commercial, heating or cooling purposes.

Legislation relating to cogeneration or waste heat is pending in the states of Washington, California, and Minnesota. Washington is considering a tax exemption or credit for cogeneration, and a bill encouraging the use of waste heat for district heating systems is expected to pass in Minnesota.

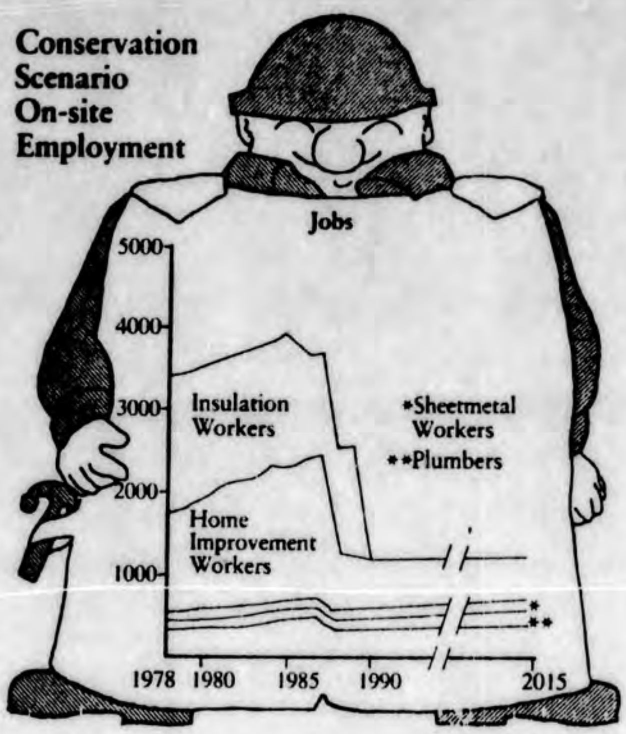
We hope that the information we have provided is useful to you. If we can be of further assistance, please let us know.

JK/bf

cc: Representative Brian Rogers

# Jobs and Energy on Long Island

## *Employment Potential of Energy Scenarios Compared*




*After the first 7-12 years of the Conservation/Solar Scenario, on-site employment drops sharply. Retrofits to existing housing stock have been completed, and the on-going labor demand level of new construction and maintenance is much lower.*

CONSERVATION is not only the least expensive "new energy source" presently available, it is also one of the most effective ways to create new jobs. Energy savings and lower rates of unemployment combine to make well-devised conservation programs attractive alternatives to energy from fossil fuels and nuclear power. These are the main conclusions of *Jobs and Energy*, a study of energy options for Nassau and Suffolk Counties on New York's Long Island, conducted by the Council on Economic Priorities (CEP), a non-profit public interest research group. CEP recommends that the Jamesport nuclear plants in Suffolk County (now canceled) not be built; they would cost more and provide fewer jobs per dollar invested than a combination of conservation and solar measures equally effective in meeting the area's energy needs.

CEP's research was designed to examine claims that nuclear power plants are economically beneficial and merit union support. "Employment has been among the most compelling arguments for nuclear power; the construction and operation of these plants creates many jobs, and the nuclear industry has not been slow to document them. Proposals to build nuclear facilities are often backed by organized labor, especially the construction and manufacturing trade unions whose workers stand to benefit most directly. Yet to place these employment benefits in perspective, it is necessary to compare them with the number and type of jobs which would be created if conservation and solar measures were installed in the buildings which would otherwise be supplied by the proposed plant."

CEP selected two eastern Long Island counties as the site for their comparison of the employment levels generated by various energy scenarios. The area's severe climate, high energy prices and serious unemployment problem typify conditions throughout New England, making it an interesting and sensitive site for a soft path study. In addition, high quality data on key research items were readily available. A previous study for the Suffolk County Legislature (by the architectural engineering firm of Dubin-Bloome Associates) assessing the regional potential for increasing residential energy efficiency was the starting point for CEP's analysis of employment effects. Parallel information on labor requirements for nuclear plant construction and operation came from permit applications by the Long Island Lighting Company (LILCO) to build two 1150 megawatt reactors at Jamesport, in Suffolk. To allow a comparison between these two energy options, the scenario was set within a 38-year period—1978 through 2015—corresponding to the construction period and service lifespan of the Jamesport nuclear plants. Unfortunately, the commercial and industrial sectors proved impossible to include, and one of the study's limitations is that it is a purely residential conservation scenario.

### The Conservation Package

CEP began with a list originally developed by Dubin-Bloome of more than 100 possible measures for residential conservation. Cost/benefit analysis trimmed this to a set of 34 highly cost-effective measures, which CEP incorporated into their Conservation/Solar Scenario. The most important group of conservation measures included seven *building envelope improvements* to increase the structure's thermal integrity. Seven *space heating measures* and four *cooling measures* were selected for their substantial contributions to household energy savings. Four *water heating measures* (including 50 square feet of solar collector panels) and twelve

## Conservation Scenario
## Gross Energy Savings by Fuel Type

TOTAL = $16.27 BILLION

| Fuel Type | Unit Cost | Total Energy Savings | $ Value |
|---|---|---|---|
| Electricity | $.0576/kWh | 110,968 × 10⁶ kWh | $6.39 billion |
| Natural Gas | $3.40/M ft.³ | 532 × 10⁶ M ft.³ | $1.81 billion |
| Oil | $.467/gallon | 17,274 × 10⁶ gallons | $8.07 billion |

***efficient appliances*** complete the conservation package. All of these measures are purely technical fixes. They employ only currently available technology, they have no significant impact on individual style of life or creature comforts, and they are generally sensible economic investments by today's energy prices.

CEP tried to make their projection of energy savings under the Conservation/Solar Scenario as realistic as possible by incorporating many other real-life assumptions. For example, they introduce conservation measures gradually, with full implementation in 10 to 15 years. Their calculation of yearly energy savings reflects the gradual nature of this process. Similarly, the total costs of the Conservation/Solar Scenario include re-investment in short-lived goods, such as energy-efficient refrigerators, which would be purchased a second time after the first ones wore out.

### Conservation/Solar Scenario Savings

The cost of the conservation package, though varying somewhat from household to household, would average $2,200 (1976 $) for the original installation, with an additional $1,000 needed for maintenance and replacement. The total investment in conservation and solar measures by the year 2015 would be about $4.04 billion. Based on present costs and consumption rates for Long Island, these measures would, over 38 years, displace energy valued at $16.27 billion, for a net savings of $12.23 billion.

### Estimating Effects on Employment

CEP calculated that the Conservation/Solar Scenario would generate an average of 10,400 to 12,700 *more jobs* than would traditional patterns of energy consumption. Almost all of the employment would be local to eastern Long Island, reducing the area's unemployment rate from its 1979 level of 6.3% to 5.5%. Considering only those measures which displace electricity, conservation is *over* 40% *more effective* at creating employment opportunities than the same amount spent on the Jamesport nuclear power plant.

Employment effects fall into four basic categories:

- *Direct Effects.* The Conservation/Solar Scenario provides direct, on-site employment for insulation installers, solar equipment specialists, heating and ventilation workers and plumbers, among others.
- *Indirect Effects.* The industries that supply on-site workers with materials and services experience indirect employment effects when they step up production to satisfy an increasing demand. Their greater activity, in turn, diffuses employment effects to other economic sectors, such as mining and transportation.
- *Induced Effects.* The workers and businesses directly and indirectly affected by increased economic activity receive wages or profits, some portion of which returns to the economy as further spending. This induces a second round of employment effects.
- *Respending Effects.* The Conservation/Solar Scenario would lower fuel costs, thereby increasing household discretionary income. Diverting this money to consumer goods rather than energy purchases would generate a large number of additional jobs. [cf. Schachter, 1979 for a review of these concepts.]

Two separate computer models assisted CEP in calculating employment effects of various energy scenarios. One model determined how investments in energy conservation and solar energy would affect the national economy, and the other focused exclusively on the economy of the Nassau/Suffolk region. Though clearly the best available, these models are not without problems. They are built around 1972 and 1967 economic data, respectively, and require conversions to present prices and costs. Inter-industry connections are also different today from those 8 to 13 years ago, so the models are to some extent functionally out of date. Using them to project employment nearly 40 years into the future implies a static economic structure, unresponsive to technological change. [See Boland, 1979 for further critique of these models.] Perhaps the most serious difficulty for the present study is that the regional and national models are not strictly comparable. The regional model includes induced effects from wage and contractor profit spending, while the national model does not. Consequently, as the authors note, "one cannot subtract the regional employment from the national to derive employment outside the Nassau/Suffolk region."

### Conservation/Solar Scenario vs. Continued Consumption

Using the national employment model, CEP determined that Long Island's present residential energy mix (49.6% fuel oil, 39.3% electricity and 11.1% natural gas) generates 17.7 labor years nationally per million dollars of expenditure. Over the 38 years of the scenario, assuming continued consumption at present rates and proportions, $16.27 billion would be spent on energy, supporting an average of 7,600 jobs. The Conservation/Solar Scenario is almost three times more effective (48.8 to 17.7), dollar for dollar, than traditional energy purchases in creating jobs, but there is still a net loss of jobs because the total investment in conservation measures is only one-quarter the value of the energy it displaces. On-site and 'multiplier' employment for conservation together produce only about 5,200 jobs, 2,400 fewer than with continued consumption patterns. This difference, though, is only a fraction of the employment generated by twelve and a quarter billion dollars in energy savings percolating through the national economy.

A large portion of this amount may be pre-empted by the

Long Island Lighting Company. As electricity is displaced by conservation and solar measures, utilities are likely to raise rates to meet their fixed costs. CEP estimates that 25% to 75% of the dollar savings from lower electricity consumption will be captured as rate increases. This estimate is much too high, according to other energy analysts, particularly if the utility finances solar or conservation measures (see Lovins, 1979). The rate increases assumed by CEP would fund between 1,000 and 3,000 jobs within the utilities. The remainder of the savings from conservation would move into consumer expenditures, which produce 50.3 labor years per million dollars spent. The net employment gain from conservation will thus average between 10,400 and 12,700 jobs over 38 years, and most of these employment effects will be local.

### The Jobs from Jamesport

*Jobs and Energy* goes on to consider the employment associated with construction and operation of the two 1150 megawatt nuclear power plants planned for Jamesport. The nuclear option on Long Island, CEP notes, would lead to 3,180 jobs nationally, at an estimated cost of $4 billion. Each million dollars invested would generate 30.2 labor years. To compare the employment effects of nuclear power and conservation, CEP devised a "Conservation Electric Scenario," consisting of a subset of their 34 original conservation measures. Only those items that saved electricity in cost-effective fashion were included. In this way, CEP avoided an asymmetrical comparison between the employment effects of producing one kind of energy and the jobs created by conserving another.

Of the $4.01 billion Conservation/Solar Scenario, only $620 million represented cost-effective displacement of electric power. This investment, though dwarfed by the $4 billion Jamesport plants, would still save one-quarter of the two reactors' total electrical output, and provide about that fraction of Jamesport's associated employment. Though smaller in scale than the nuclear project, the Conservation Electric Scenario creates jobs more efficiently, providing 40% more labor years per million dollars of investment.

CEP found that "improvements in the efficiency of residential electricity use can satisfy increases in regional end-use needs for electricity more cheaply than can nuclear power. This suggests that, at least up to a certain point, investing in electricity conservation measures would allow the economy to increase total productivity at a higher rate than would investing in nuclear power plants."

### Notes on Methodology

*Jobs and Energy* is an important addition to the growing body of soft path studies. It combines within a single analytical frame a realistic, detailed energy scenario and a state-of-the-art assessment of employment effects. Beginning as a search for reasonable alternatives to the Jamesport nuclear project, and building upon the results of related conservation studies, *Jobs and Energy* emerges as "what is perhaps the most comprehensive analysis of this kind" (Schachter, 1979).

However the results of their study are interpreted by labor economists, or acted upon by policy makers, CEP intended *Jobs and Energy* as a prototype, and included detailed methodological accounts in the report. At least one other

## National and Regional Employment Comparison
## Conservation Scenario and Continued Energy Consumption

| Energy Future | Dollars of expenditure (billions 1976$) | Labor years per million dollars expenditure: Regional | Labor years per million dollars expenditure: National | Average number of jobs: Regional | Average number of jobs: National |
|---|---|---|---|---|---|
| Continued Consumption | 16.27 | 8.0 | 17.7 | 3,400 | 7,600 |
| Conservation Scenario | | | | | |
| On-site Implementation plus multiplier | 4.04 | 45.4 | 48.8 | 4,800 | 5,200 |
| Increased Discretionary Spending | 7.43-10.63 | 34.9 | 50.3 | 6,800-9,800 | 9,800-14,100 |
| Utility Fixed Costs | 4.79-1.60 | 15.2 | 24.0 | 1,900-600 | 3,000-1,000 |
| **Total** | 16.27 | | | 13,500-15,200 | 18,000-20,300 |

study has been modeled directly after *Jobs and Energy*, running essentially the same computer programs with assumptions appropriate to all of New England (Rosen & Stutz, 1978). In support of further efforts such as these, CEP included a brief chapter on the methodological refinements they considered most worthwhile. They pointed to additional renewable energy sources and conservation measures as possible scenario components, and the tremendous potential for conservation in commercial and industrial sectors, which they were forced to exclude from their own analysis.

To this list of future research needs might be added a systematic examination of the "respending effect." It is standard for employment studies to assume that energy savings are funneled into discretionary consumer purchases, where they induce employment at a much higher rate. This is a critical assumption, since, at least in *Jobs and Energy*, much of the Conservation/Solar Scenario's employment advantage over Continued Consumption stems from the labor required to meet increased consumer demand.

CEP's authors note their reservations on this issue: "Ideally, the effects of increased discretionary income should be measured as marginal, rather than average, consumer purchases, but this was not possible. . ." The problem with this assumption, however, may go beyond the difference between the two types of purchase. Marginal phenomena are quite complex, and of the 7 to 11 billion dollars' worth of energy savings, major chunks may not go into consumer purchases at all, but move through the economy in ways that generate employment at a much lower rate.

Inflation is one of the primary economic forces reducing the value and the purchasing power of savings. *Jobs and Energy* tries to eliminate this factor by assuming constant 1976 dollars throughout the scenario. This method controls for inflationary increases in the *volume* of revenue flowing through a household, but not for the accompanying changes in relative *proportions* assigned to key items on the domestic budget. Inflation affects some costs more than it does others; leading the pack, for the past few years, are the costs for food, clothing, housing, interest charges and taxes (as cost-of-living increases propel wage earners into higher percentage brackets). Some of these items, notably housing and food, generate more jobs per dollar than the average; the others have a much lower job creation potential (Hannon, 1975).

Finance charges will reduce even further the sum available for discretionary consumer purchases. The Conservation/Solar Scenario requires an immediate investment of about $2.200 per residence, and obviously many times that amount for an apartment house with multiple units. Much, if not all, of this investment will have to be financed, and innovative programs such as the Oregon and TVA plans have demonstrated that this is possible at relatively low costs to the consumer. By comparison, the terms of the 1977 New York State Energy Conservation Act—9.83% on a seven-year loan with perhaps 20% of the interest charges returned as a tax credit—constitute a 'worst case.' Assuming these terms (as CEP does), total scenario costs will increase by 31%, from $4.01 to $5.26 billion. This should not affect employment, according to CEP, if finance charges have the same employment impacts as average consumer purchases, but Hannon (1975:99) presents data showing that they may be considerably lower.

Higher levels of consumer debt also serve to shift revenue away from average consumer purchases. For roughly the first third of the scenario, (10-12 years depending on financing) cumulative costs exceed total savings, using a worst-case assumption of high utility rate increases. During this period, households may enjoy less in the way of discretionary income than previously. Their debt burden will almost certainly increase: partly to finance the conservation measures, and partly to maintain their standard of living in the face of temporarily higher energy-related fixed costs. Consumers may emerge from this initial phase of the scenario with a higher ratio of debt to income than is comfortable for most middle-class families. Many may use their first personal savings from reduced energy bills not to acquire consumer goods but to service and retire some portion of their indebtedness. Older couples and others with lower debt burdens are likely to channel energy savings into consumer spending much as CEP predicts. But younger families at earlier phases of the domestic debt cycle may be more affected by the higher credit load. Local demographic conditions, then, play a role in determining marginal consumer spending patterns, which in turn control the number of jobs created by energy savings.

Because the respending effect accounts for so much of the employment advantage of conservation and solar measures over traditional energy use, further research along the lines suggested here appears to be of merit. However, even at this point, certain policy implications are clear. For energy savings from conservation to produce the maximum employment benefits, it is essential to institute financing arrangements that prolong the payback period and keep cumulative costs below total savings. Even though finance charges may rise as a result of this policy, consumer debt is unlikely to increase. The employment generated by respending of energy savings could ultimately be greater, and more evenly distributed over the life of the scenario.

*—Charles Drucker*

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# FUEL, CONSERVATION, & INDIVIDUAL CREDITS RELATIVE TO THE INDIVIDUAL INCOME TAX

ALASKA

DEPARTMENT OF REVENUE

JANUARY - 1980

# FUEL, CONSERVATION, & INDIVIDUAL CREDITS RELATIVE TO THE INDIVIDUAL INCOME TAX

STATE OF ALASKA

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TABLES

# FORWARD

This report is the first in a series based on the data contained in records collected by the Department of Revenue. The statistics in this report were compiled from individual income tax forms for the tax years 1977 and 1978.

The report concentrates on the Residential Fuel, Residential Fuel Conservation, and Individual Income Tax Credits in so far as amounts, distributions, and averages for adjusted gross income categories. The tables reveal some rather interesting information about these credits.

## INTRODUCTION

This report presents 1977 and 1978 data on Residential Fuel Credits (Fuel Credits), Residential Fuel Conservation Credits (Conservation Credits), and Individual Income Tax Credits (Income Credits). This data was compiled from DR 600 forms filed by full-year residents of Alaska and DR 600 PR forms filed by part-year and non-residents who derived income attributable to sources within Alaska.

In 1977 and 1978 Alaska residents were entitled to a Fuel Credit of 5 percent of all home fuel costs paid during the year. Home fuel costs were defined in the instructions for taxpayers as "the actual payments for wood, coal, heating oil, gas, propane, electricity, or other fuel consumed within Alaska for a residential housing unit." Whether or not any home fuel costs were actually paid, a minimum credit of $5.00 was allowed on resident returns with a filing status "married, filing separately" and a minimum of $10.00 was allowed on all other resident returns. Part-year and non-residents were instructed to prorate their Fuel Credit according to the number of months the taxpayer resided in Alaska.

Alaska residents were also entitled to a Conservation Credit of 10 percent of expenses paid or accrued during 1977 and 1978 for residential fuel conservation capital improvements to a personal residence located in the state. Expenses for residential fuel conservation improvements were defined in the instructions for taxpayers as the cost of additional installation or insulating materials installed in a residence that was already in existence on January 1 of that year, the cost of insulating windows, and the expenses of installation of alternate sources of power generation not dependent on fossil fuels for energy supply if that alternate source would become the primary source of power for the residence. A maximum credit of $100 was allowed on resident returns with filing status "married, filing separately," and a maximum of $200 was allowed on all other resident returns. Part-year and non-residents were instructed to prorate their Conservation Credit according to the number of months the taxpayer resided in Alaska.

On 1978 returns only, Alaska residents were entitled to an Income Credit of $200 on returns with filing status "married, filing jointly," and an Income Credit of $100 on all other returns. As in the case of Fuel Credits and Conservation Credits, part-year and non-residents were instructed to prorate their Income Credit according to the number of months the taxpayer resided in Alaska.

## BACKGROUND

Before describing the data collected on credits it is important to examine the distribution of 1977 and 1978 individual income tax returns by Adjusted Gross Income (AGI) to obtain some background information on the Alaskan taxpayer. A rough definition of AGI is the income received during the year by the person or couple filing the return, adjusted according to certain business and personal expenses as specified on the tax return. Full-year residents are instructed to use the same AGI that appears on their federal returns while part-year and non-residents must recalculate a different Alaska AGI based on only the income received while residing in Alaska. Whenever the term AGI is used in this report it will refer to the Alaska AGI.

Tables 1 and 2 are bar charts showing the distribution of 1977 and 1978 returns by AGI. For each AGI range indicated on the horizontal axis, the height of the bar above shows the percentage of returns filed during that year with an AGI falling within that range. The shaded part of each bar represents returns filed by full-year residents and the clear part represents returns filed by part-year and non-residents.

The type of information that can be drawn from, for example, the left-most bar on Table 1 would be:

- Almost 26% of the 1977 Alaska individual income tax returns showed an AGI between $0 and $5,000.
- Almost 16% of the 1977 returns were filed by full-year residents with an AGI less than $5,000.
- About 10% of the 1977 returns were filed by part-year and non-residents with an AGI less than $5,000.

It is evident from Tables 1 and 2 that the distribution of returns by AGI category did not change significantly from 1977 to 1978.

In the upper right corner of each bar chart there is a small inset showing some of the figures used in constructing the charts. On Tables 1 and 2 these insets show that the total number of returns filed decreased from 195,394 returns in 1977 to 183,725 returns in 1978. Also, the percentage of returns filed by part-year and non-residents decreased from 26.3% in 1977 to 22% in 1978.

Tables 13 and 14 show the data used in constructing Tables 1-12.

RESIDENTIAL FUEL CREDITS (FUEL CREDITS)

The distribution of Fuel Credits in 1977 and 1978 is shown on Tables 3 and 4. These bar charts indicate the percentage of Fuel Credit dollars allowed on returns falling within the AGI ranges indicated. If Fuel

Credit dollars had been distributed evenly among all returns, then Tables 3 and 4 which show the distribution of Fuel Credits would look similar to Tables 1 and 2 which show the distribution of returns. Instead, while most of the returns are grouped in the lower AGI ranges, the Fuel Credit dollars cluster in the middle AGI categories, indicating a higher ratio of Fuel Credit dollars per return for mid-level AGI returns than lower range returns.

Information on Fuel Credit dollars per return is also shown on Tables 8 and 9. This is illustrated by the following data taken from Tables 8A and 9A:

- The fifth line of Table 8A shows that the 39,983 1977 resident returns with AGI's between \$25,000 and \$50,000 received \$1,271,202 in Fuel Credits. This means that 20.5% of the 1977 returns received 45.4% of the Fuel Credit dollars taken that year.
- Similarly, Table 9A shows that in 1978 the 37,260 resident returns with AGI's between \$25,000 and \$50,000 received \$1,355,086 in Fuel Credits. This means that 20.3% of the 1978 returns received 44.5% of the Fuel Credit dollars taken that year.

Data on Fuel Credits is also displayed on Table 10. The upper part of the table shows the percentage of total returns in the different AGI categories receiving a Fuel Credit. Below this the average Fuel Credit received by these returns is shown. For example, the underlined numbers on the chart show:

- 20.5% of 1978 resident returns with AGI's between \$0 and \$5,000 received a Fuel Credit.
- 62.9% of all 1978 resident returns received a Fuel Credit.

- The average Fuel Credit received by 1978 resident returns with AGI's between $0 and $5,000 was $17.41.
- The average Fuel Credit received by all 1978 resident returns was $32.41.
- There were 90,125 1978 resident returns receiving $2,921,102 in Fuel Credits.

Table 10 shows that, in general, returns with high AGI's had a higher percentage of Fuel Credits than returns with low AGI's. Returns with high AGI's also received more Fuel Credit dollars than returns with low AGI's.

The bottom line of Table 10 shows that the amount of Fuel Credits paid increased from $2,798,038 in 1977 to $3,045,607 in 1978. This is due to the increase in the number of returns receiving a Fuel Credit from 96,070 in 1977 to 104,775 in 1978 rather than an increase in the size of the average Fuel Credit. In fact, there was a slight decrease in the average Fuel Credit from $29.12 in 1977 to $29.07 in 1978.

## RESIDENTIAL FUEL CONSERVATION CREDIT (CONSERVATION CREDITS)

The distribution of Conservation Credits in 1977 and 1978 is shown on Tables 5 and 6. As in the case of Fuel Credits, the distribution of Conservation Credits does not closely resemble the distribution of returns. Instead, Conservation Credits are concentrated in returns with mid-level AGI's, indicating a higher ratio of Conservation Credit dollars per return for mid-level AGI returns than lower range returns. Tables 8A and 9A show that the same 25% of the returns that received over 55% of the Fuel Credits, also received over 60% of the Conservation Credits. These returns were filed by residents with AGI's over $25,000.

Table 11 shows that, for the most part, the returns in the higher AGI categories have a higher percentage of Conservation Credits and received a higher average credit, than returns with lower AGI's. Also, there was a large increase from 1977 to 1978 in the number and amount of Conservation Credits taken on part-year and non-resident returns. In 1977 there were 360 part-year and non-residents receiving $16,094, while in 1978 there were 1,090 part-year and non-residents receiving $61,769. There was also an increase in the number of Conservation Credits taken by residents, from 10,655 credits in 1977 to 13,796 credits in 1978, but there was a slight decrease in the amount of these credits from $800,104 to $795,816.

INDIVIDUAL INCOME TAX CREDITS (INCOME CREDITS)

The distribution of Income Credits in 1978 is shown on Table 7. Additional information is shown on Table 9. Table 9C shows that $17,493,738 was allowed in Income Credits, more than four times the level of Fuel and Conservation Credits combined.

Table 12 shows that, for the most part, the returns in higher AGI categories have a higher percentage of Income Credits claimed and a higher average credit. This is due to two factors. First, returns with low AGI's may have had less than $100 in tax liability and therefore, since Credits cannot make total taxes negative, less than $100 was allowed as an Income Credit. If, due to other credits and adjustments, the return has no tax liability already, he gets no benefit from the credit. Secondly, there was a larger proportion of joint returns entitled to a $200 Income Credit in the higher AGI categories.

## SUMMARY

Overall, there was little change in the distributions of returns, Fuel Credits and Conservation Credits from 1977 to 1978. There was a decrease in total returns from 195,394 returns, of which 73.7% were filed by full-year residents, to 183,725 of which 78% were filed by full-year residents. The number of returns receiving a Fuel Credit increased from 96,070 in 1977 to 104,775 in 1978 with the average credit staying at a little over $29. The number of returns receiving a Conservation Credit also increased from 11,015 in 1977 to 14,886 in 1978, but the average Conservation Credit dropped from $74.10 to $57.61.

In 1977 and 1978 both Fuel and Conservation Credits were concentrated in returns with mid-level AGI's. Twenty-five percent of the returns, all those filed by residents with AGI's over $25,000, received over 50% of these credits. In general, returns in the high AGI categories showed both a higher percentage of returns receiving credits and a higher average credit.

Taxpayers were entitled to the Income Credit for the first time in 1978. $17,493,738 was taken in Income Credits on 1978 returns, more than four times the amount paid in Fuel and Conservation Credits combined. This amount is expected to increase in future years when each resident taxpayer will be allowed $100 in Income Credits for every tax year beginning after 31 December 1977 for which he files an income tax return, up to a limit of $300.

TABLE 1
1977 DISTRIBUTION OF RETURNS

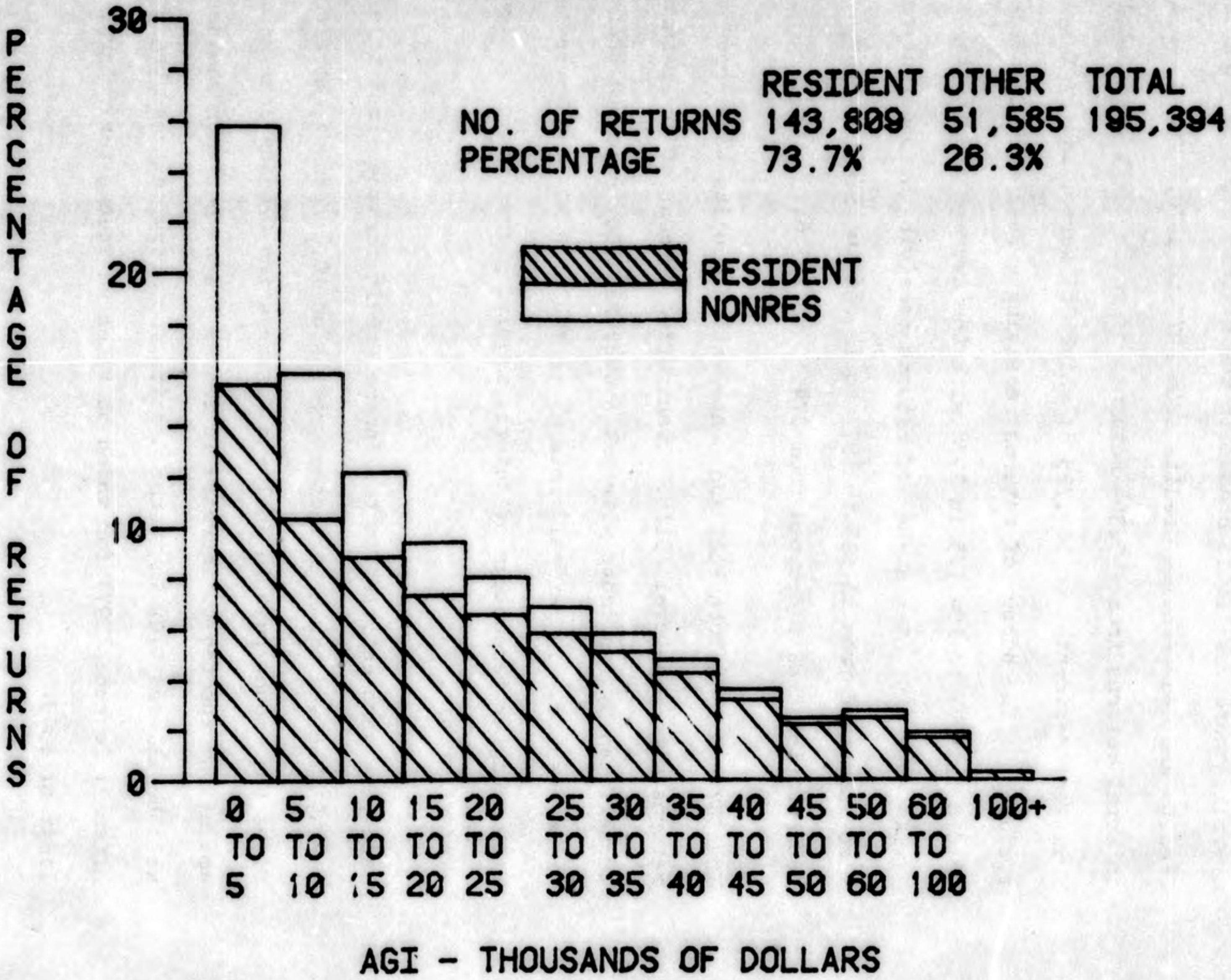
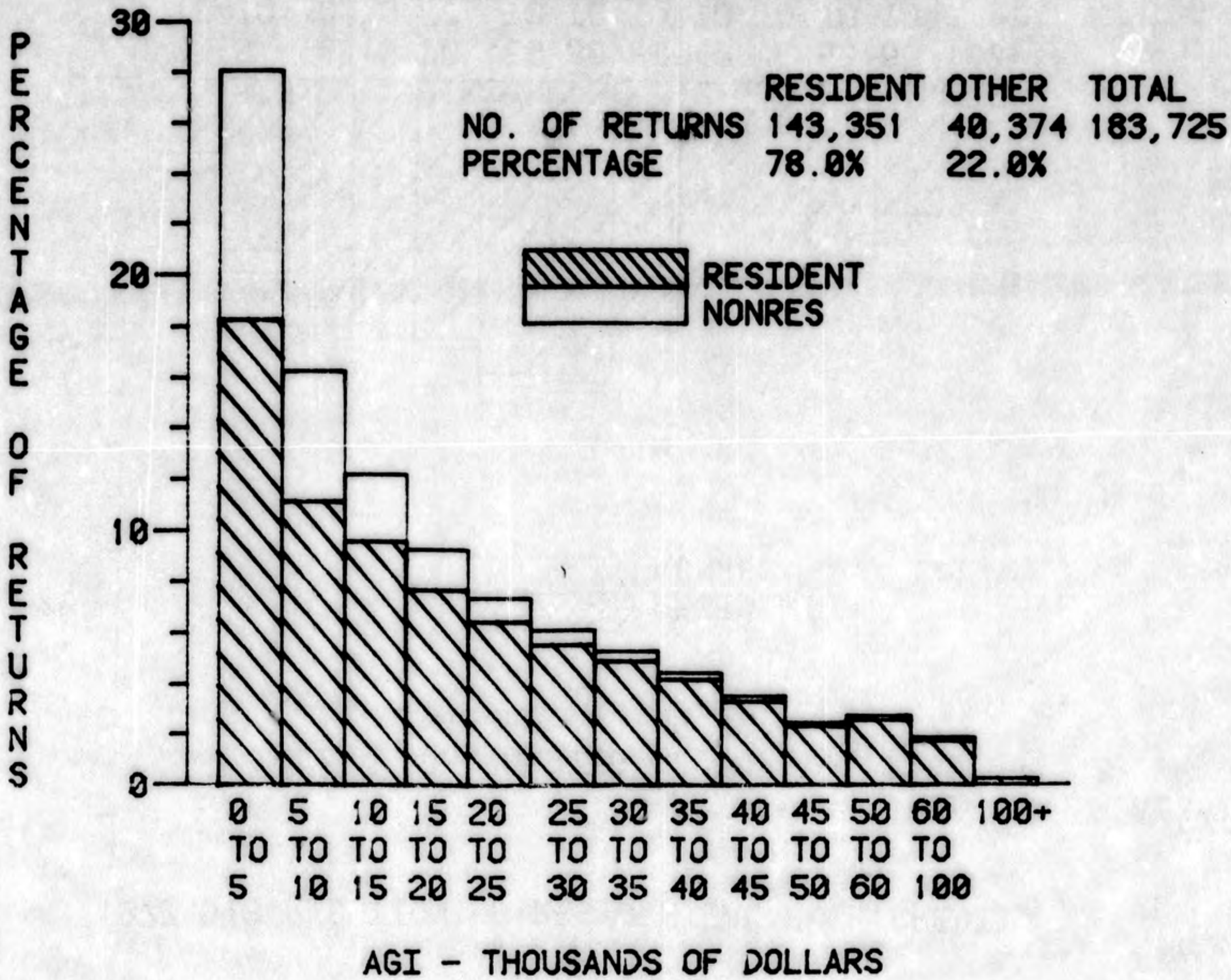
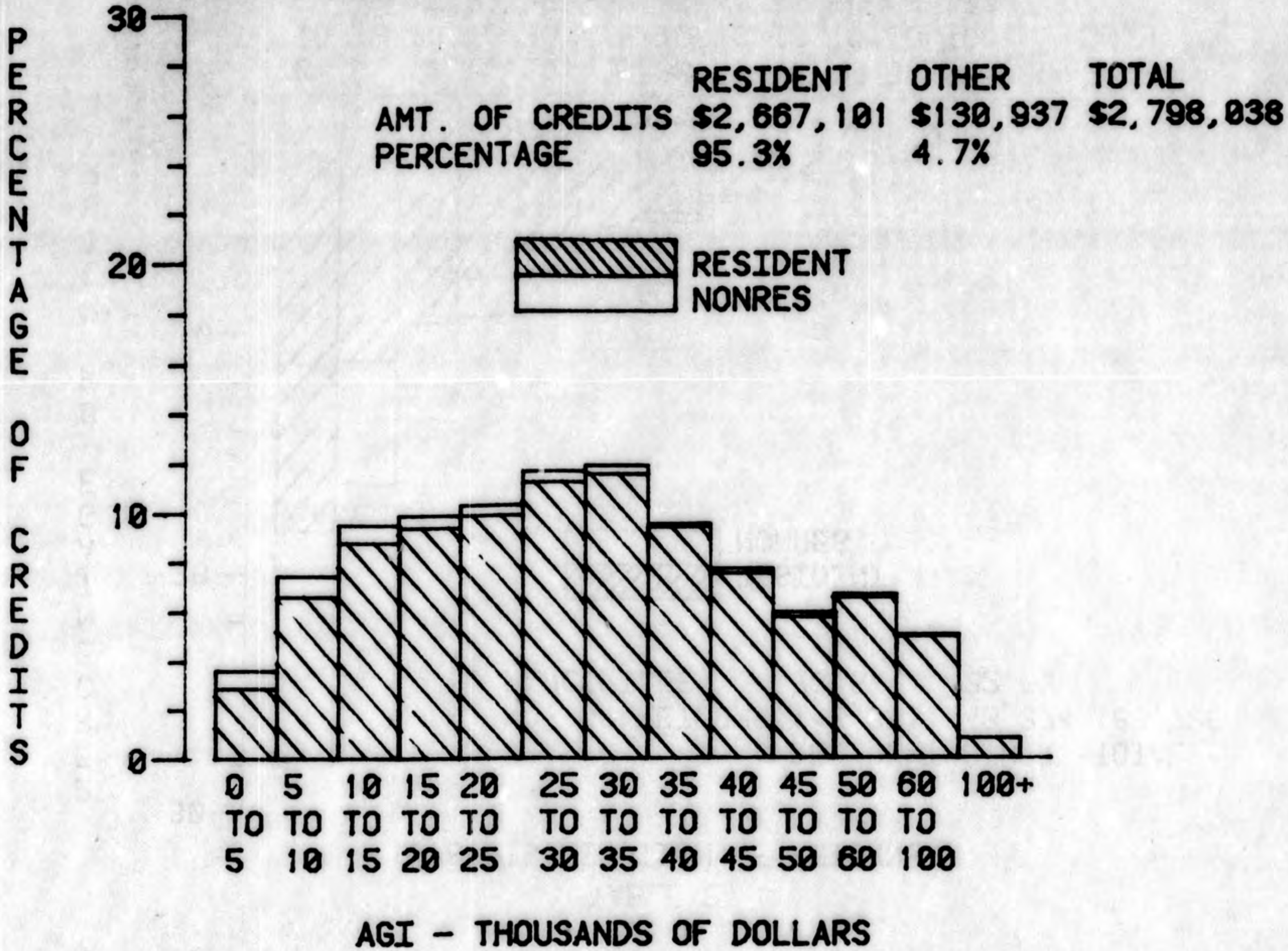


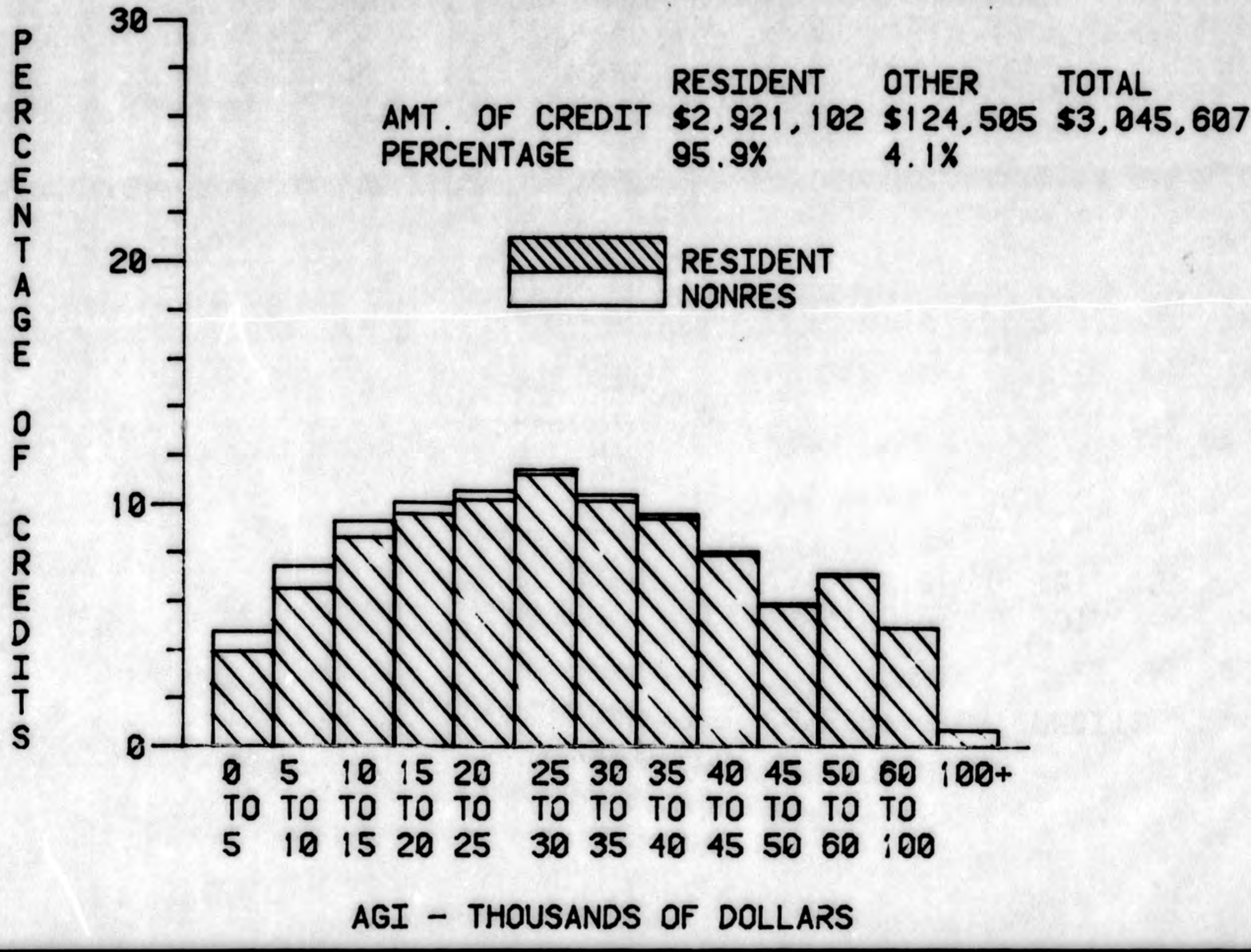
TABLE 2
1978 DISTRIBUTION OF RETURNS



## TABLE 3
## 1977 DISTRIBUTION OF RESIDENTIAL FUEL CREDITS

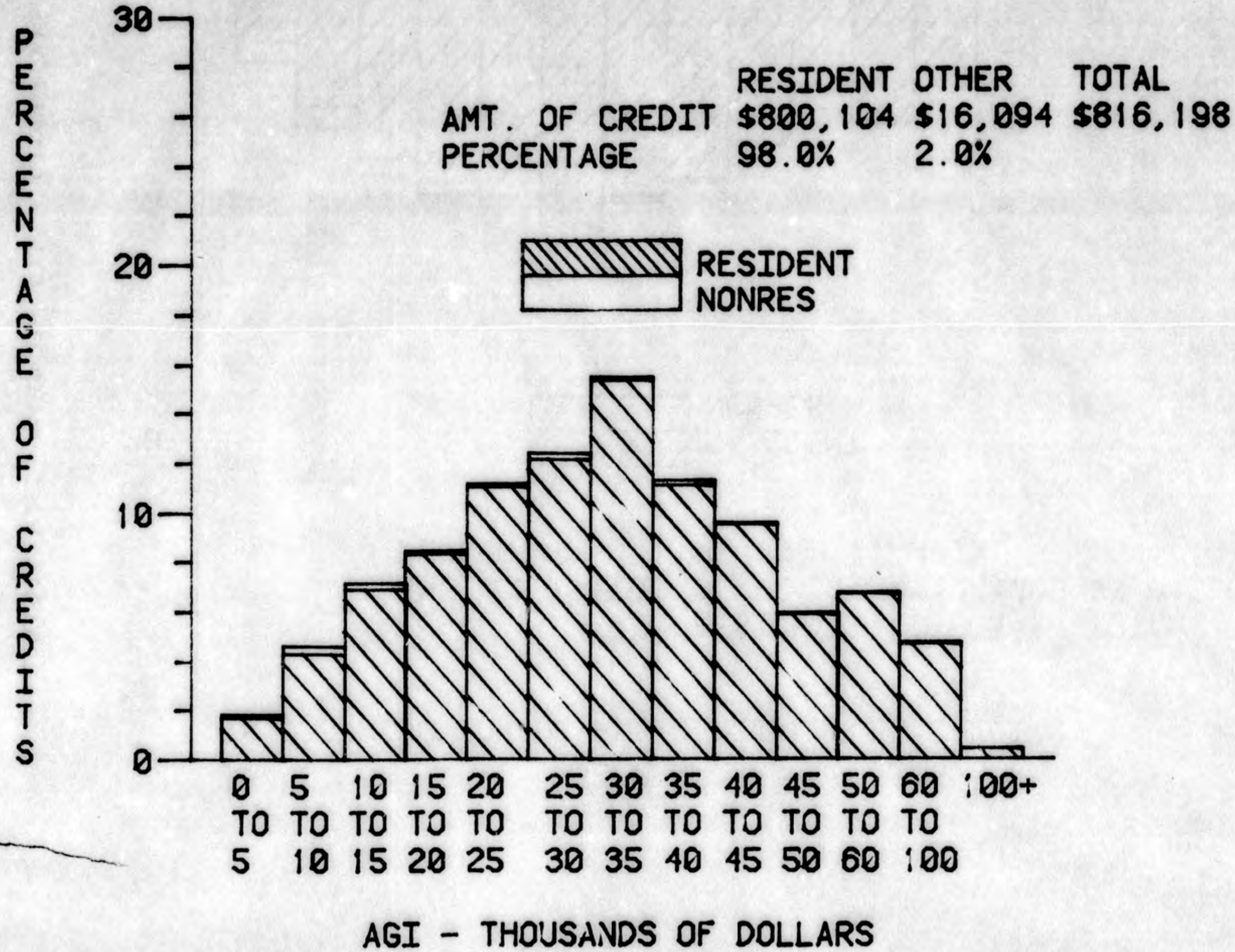


## TABLE 4
## 1978 DISTRIBUTION OF RESIDENTIAL FUEL CREDITS



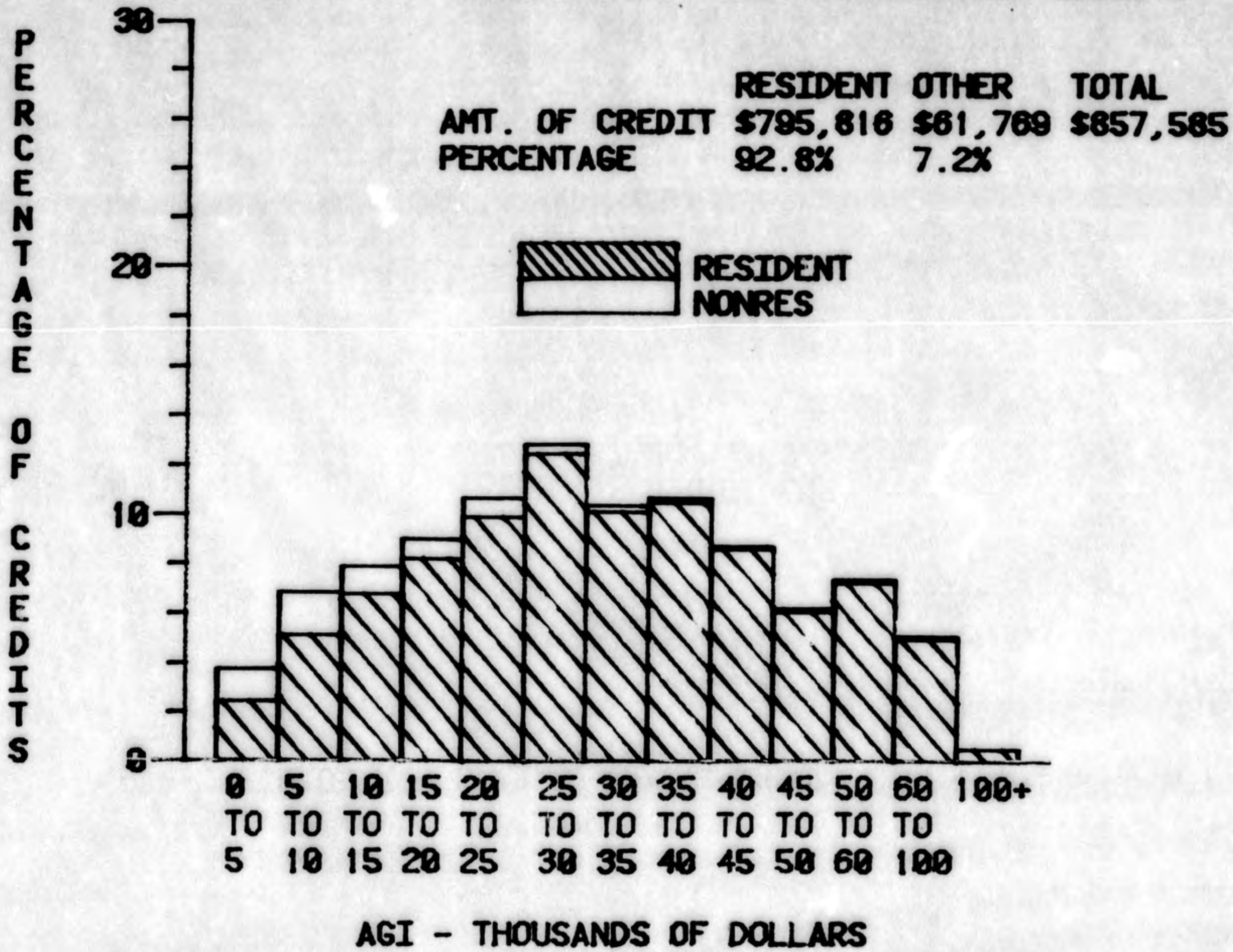
## TABLE 5

## 1977 DISTRIBUTION OF RESIDENTIAL FUEL CONSERVATION CREDITS



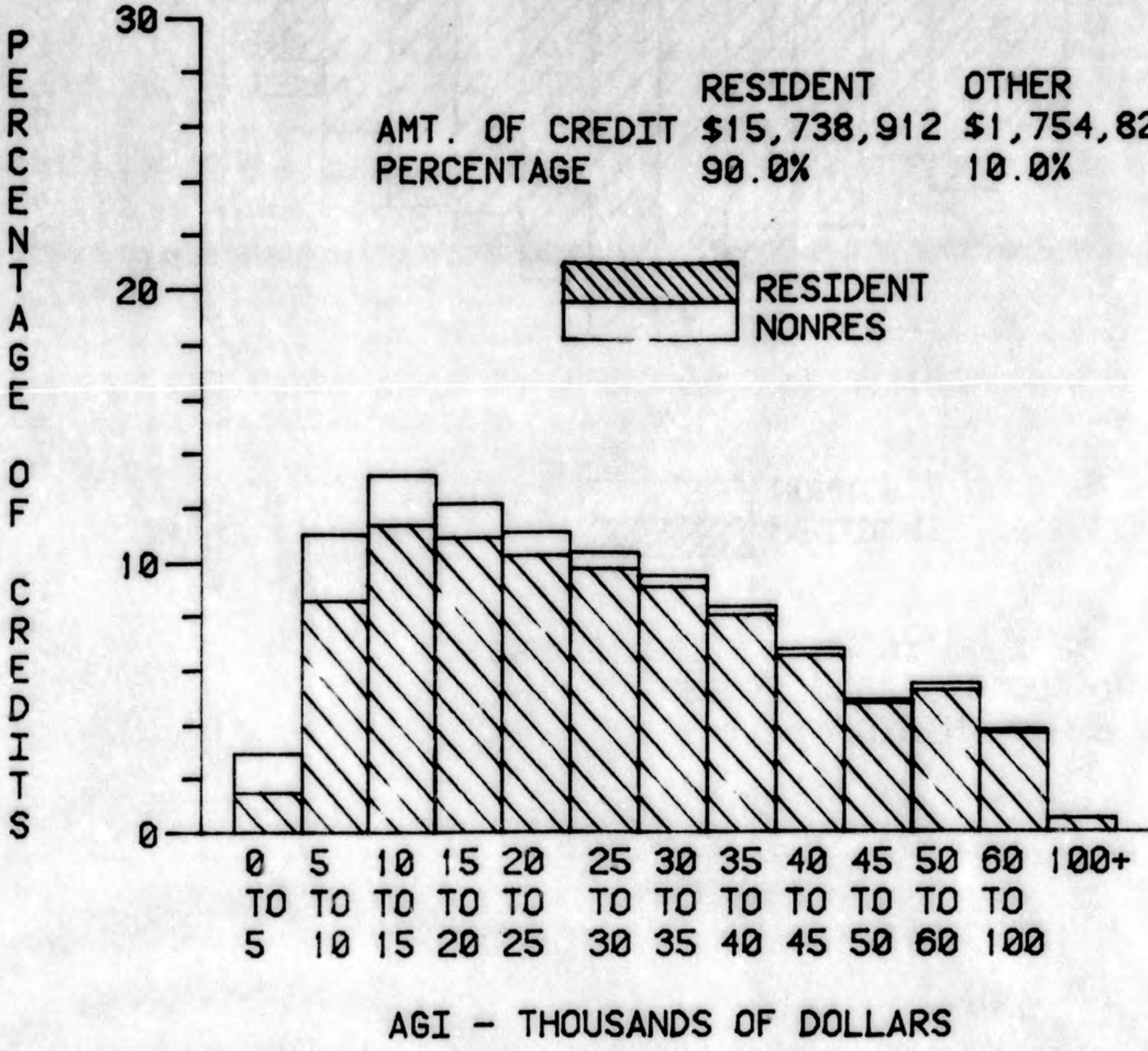
## TABLE 6

## 1978 DISTRIBUTION OF RESIDENTIAL FUEL CONSERVATION CREDITS



## TABLE 7
## 1978 DISTRIBUTION OF INDIVIDUAL INCOME TAX CREDITS

| | RESIDENT | OTHER | TOTAL |
|---|---|---|---|
| AMT. OF CREDIT | $15,738,912 | $1,754,826 | $17,493,738 |
| PERCENTAGE | 90.0% | 10.0% | |



## TABLE 8A

## RESIDENT RETURNS - 1977

| AGI Thousands of Dollars | Resident Returns | | Residential Fuel Credits | | Residential Fuel Conservation Credits | |
|---|---|---|---|---|---|---|
| | Number | % | Dollars | % | Dollars | % |
| 0-5 | 30,590 | 15.7% | $ 80,369 | 2.9% | $ 13,840 | 1.7% |
| 5-10 | 20,249 | 10.4% | $ 185,026 | 6.6% | $ 35,284 | 4.3% |
| 10-15 | 17,335 | 8.9% | $ 246,625 | 8.8% | $ 56,396 | 6.9% |
| 15-25 | 26,976 | 13.8% | $ 539,056 | 19.3% | $157,813 | 19.3% |
| 25-50 | 39,983 | 20.5% | $1,271,202 | 45.4% | $439,838 | 53.9% |
| 50+ | 8,676 | 4.4% | $ 344,823 | 12.3% | $ 96,933 | 11.9% |
| Total | 143,809 | 73.7% | $2,667,101 | 95.3% | $800,104 | 98.0% |

## TABLE 8B

## PART-YEAR AND NON-RESIDENT RETURNS 1977

| AGI Thousands of Dollars | Part-Year and Non-Resident Returns | | Residential Fuel Credits | | Residential Fuel Conservation Credits | |
|---|---|---|---|---|---|---|
| | Number | % | Dollars | % | Dollars | % |
| 0-5 | 19,853 | 10.2% | $ 19,213 | 0.7% | $ 1,072 | 0.1% |
| 5-10 | 11,177 | 5.7% | $ 23,670 | 0.8% | $ 2,703 | 0.3% |
| 10-15 | 6,543 | 3.3% | $ 19,666 | 0.7% | $ 2,225 | 0.3% |
| 15-25 | 7,082 | 3.6% | $ 28,116 | 1.0% | $ 2,833 | 0.4% |
| 25-50 | 5,857 | 3.0% | $ 34,028 | 1.2% | $ 6,248 | 0.8% |
| 50+ | 1,073 | 0.5% | $ 6,244 | 0.2% | $ 1,013 | 0.1% |
| Total | 51,585 | 26.3% | $130,937 | 4.7% | $16,094 | 2.0% |

## TABLE 8C

## ALL RETURNS - 1977

| | All Returns | | Residential Fuel Credits | | Residential Fuel Conservation Credits | |
|---|---|---|---|---|---|---|
| | Number | % | Dollars | % | Dollars | % |
| Resident | 143,809 | 73.7% | $2,667,101 | 95.3% | $800,104 | 98.0% |
| Other | 51,585 | 26.3% | $ 130,937 | 4.7% | $ 16,094 | 2.0% |
| Total | 195,394 | | $2,798,038 | | $816,198 | |

TABLE 9A

RESIDENT RETURNS - 1978

| AGI Thousands of Dollars | Resident Returns | | Residential Fuel Credits | | Residential Fuel Conservation Credits | | Individual Income Tax Credits | |
|---|---|---|---|---|---|---|---|---|
| | Number | % | Dollars | % | Dollars | % | Dollars | % |
| 0-5 | 33,582 | 18.3% | $ 120,117 | 3.9% | $ 20,664 | 2.4% | $ 261,316 | 1.5% |
| 5-10 | 20,515 | 11.2% | $ 198,191 | 6.5% | $ 43,424 | 5.1% | $ 1,497,153 | 8.6% |
| 10-15 | 17,564 | 9.5% | $ 261,918 | 8.6% | $ 57,979 | 6.8% | $ 1,982,114 | 11.3% |
| 15-25 | 25,947 | 14.1% | $ 601,140 | 19.8% | $155,634 | 18.1% | $ 3,687,541 | 21.1% |
| 25-50 | 37,260 | 20.3% | $1,355,086 | 44.5% | $409,109 | 47.7% | $ 6,664,510 | 38.1% |
| 50+ | 8,483 | 4.6% | $ 384,650 | 12.6% | $109,006 | 12.7% | $ 1,646,278 | 9.4% |
| Total | 143,351 | 78.0% | $2,921,102 | 95.9% | $795,816 | 92.8% | $15,738,912 | 90.0% |

TABLE 9B

PART-YEAR AND NON-RESIDENT RETURNS
1978

| AGI Thousands of Dollars | Part-Year and Non-Resident Returns | | Residential Fuel Credits | | Residential Fuel Conservation Credits | | Individual Income Tax Credits | |
|---|---|---|---|---|---|---|---|---|
| | Number | % | Dollars | % | Dollars | % | Dollars | % |
| 0-5 | 18,088 | 9.8% | $ 24,388 | 0.8% | $11,235 | 1.3% | $ 254,075 | 1.4% |
| 5-10 | 9,311 | 5.1% | $ 27,485 | 0.9% | $15,441 | 1.8% | $ 428,898 | 2.4% |
| 10-15 | 4,884 | 2.7% | $ 20,325 | 0.7% | $ 9,460 | 1.1% | $ 324,901 | 1.9% |
| 15-25 | 4,560 | 2.5% | $ 25,318 | 0.8% | $13,542 | 1.6% | $ 378,608 | 2.2% |
| 25-50 | 2,954 | 1.6% | $ 22,503 | 0.7% | $ 9,872 | 1.1% | $ 305,062 | 1.7% |
| 50+ | 577 | 0.3% | $ 4,486 | 0.2% | $ 2,219 | 0.3% | $ 63,282 | 0.4% |
| Total | 40,374 | 22.0% | $124,505 | 4.1% | $61,769 | 7.2% | $1,754,826 | 10.0% |

TABLE 9C

ALL RETURNS - 1978

| Type of Return | All Returns | | Residential Fuel Credits | | Residential Fuel Conservation Credits | | Individual Income Tax Credits | |
|---|---|---|---|---|---|---|---|---|
| | Number | % | Dollars | % | Dollars | % | Dollars | % |
| Resident | 143,351 | 78.0% | $2,921,102 | 95.9% | $795,816 | 92.8% | $15,738,912 | 90.0% |
| Other | 40,374 | 22.0% | $ 124,505 | 4.1% | $ 61,769 | 7.2% | $ 1,754,826 | 10.0% |
| Total | 183,725 | | $3,045,607 | | $857,585 | | $17,493,738 | |

TABLE 10

RESIDENTIAL FUEL CREDITS

| AGI | 1977 | | | 1978 | | |
|---|---|---|---|---|---|---|
| Thousands of Dollars | Resident | Part-Year and Non-Resident | All Returns | Resident | Part-Year and Non-Resident | All Returns |
| **Percentage of Returns Receiving a Residential Fuel Credit** | | | | | | |
| 0-5 | 15.5% | 18.3% | 16.6% | 20.5% | 25.2% | 22.2% |
| 5-10 | 41.4% | 27.7% | 36.5% | 50.3% | 41.0% | 47.4% |
| 10-15 | 54.3% | 31.3% | 48.0% | 64.5% | 46.3% | 60.6% |
| 15-25 | 68.6% | 34.6% | 61.5% | 77.8% | 49.7% | 73.6% |
| 25-50 | 84.5% | 34.8% | 78.1% | 89.9% | 50.9% | 87.0% |
| 50+ | 88.3% | 29.5% | 81.9% | 93.1% | 43.0% | 89.9% |
| All AGI Categories | 57.4% | 26.3% | 49.2% | 62.9% | 36.3% | 57.0% |
| **Average Residential Fuel Credit Received By Returns Claiming a Credit** | | | | | | |
| 0-5 | $16.93 | $ 5.27 | $11.87 | $17.41 | $ 5.36 | $12.62 |
| 5-10 | $22.05 | $ 7.66 | $18.18 | $19.21 | $ 7.20 | $15.96 |
| 10-15 | $26.20 | $ 9.59 | $23.23 | $23.10 | $ 8.99 | $20.76 |
| 15-25 | $29.14 | $11.48 | $27.08 | $29.79 | $11.18 | $27.91 |
| 25-50 | $37.65 | $16.68 | $36.45 | $40.46 | $14.96 | $39.36 |
| 50+ | $45.00 | $19.70 | $43.99 | $48.72 | $18.09 | $47.79 |
| All AGI Categories | $32.34 | $ 9.63 | $29.12 | $32.41 | $ 8.50 | $29.07 |
| Number of Returns Receiving a Residential Fuel Credit | 82,478 | 13,592 | 96,070 | 90,125 | 14,650 | 104,775 |
| Total Amount of Residential Fuel Credits Received | $2,667,101 | $130,937 | $2,798,038 | $2,921,102 | $124,505 | $3,045,607 |

TABLE 11

RESIDENTIAL FUEL CONSERVATION CREDITS

| | AGI Thousands of Dollars | 1977 Resident | 1977 Part-Year and Non-Resident | 1977 All Returns | 1978 Resident | 1978 Part-Year and Non-Resident | 1978 All Returns |
|---|---|---|---|---|---|---|---|
| Percentage of Returns Receiving a Residential Fuel Conservation Credits | 0-5 | 0.8% | 0.2% | 0.6% | 1.9% | 1.7% | 1.8% |
| | 5-10 | 2.9% | 0.8% | 2.2% | 5.5% | 2.9% | 4.7% |
| | 10-15 | 5.0% | 0.8% | 3.8% | 7.9% | 3.3% | 6.9% |
| | 15-25 | 8.3% | 1.0% | 6.8% | 11.1% | 4.1% | 10.1% |
| | 25-50 | 13.9% | 1.5% | 12.3% | 16.9% | 4.6% | 16.0% |
| | 50+ | 13.1% | 1.0% | 11.8% | 16.9% | 5.0% | 16.2% |
| | All AGI Categories | 7.4% | 0.7% | 5.6% | 9.6% | 2.7% | 8.1% |
| Average Residential Fuel Conservation Credit Received By Returns Claiming a Credit | 0-5 | $56.95 | $21.88 | $51.07 | $32.39 | $36.60 | $33.76 |
| | 5-10 | $59.70 | $30.37 | $55.86 | $38.16 | $56.35 | $41.69 |
| | 10-15 | $65.12 | $44.50 | $64.00 | $41.59 | $59.50 | $43.42 |
| | 15-25 | $70.20 | $38.28 | $69.18 | $53.82 | $73.20 | $54.98 |
| | 25-50 | $79.01 | $71.82 | $78.90 | $64.97 | $72.59 | $65.13 |
| | 50+ | $85.03 | $92.09 | $85.10 | $75.86 | $76.52 | $75.87 |
| | All AGI Categories | $75.09 | $44.71 | $74.10 | $57.68 | $56.67 | $57.61 |
| Number of Returns Receiving a Residential Fuel Conservation Credit | | 10,655 | 360 | 11,015 | 13,796 | 1,090 | 14,886 |
| Total Amount of Residential Fuel Conservation Credits Received | | $800,104 | $16,094 | $816,198 | $795,816 | $61,769 | $857,585 |

TABLE 12

INDIVIDUAL INCOME TAX CREDIT

| | AGI Thousands of Dollars | 1978 Residents | 1978 Part-Year and Non-Residents | 1978 All Returns |
|---|---|---|---|---|
| Percentage of Returns Receiving an Individual Income Tax Credit | 0-5 | 25.12% | 50.96% | 34.17% |
| | 5-10 | 87.28% | 79.31% | 84.79% |
| | 10-15 | 96.27% | 84.23% | 93.65% |
| | 15-25 | 98.40% | 85.48% | 96.47% |
| | 25-50 | 99.64% | 83.72% | 98.47% |
| | 50+ | 99.67% | 77.12% | 98.23% |
| | All AGI Categories | 79.78% | 68.19% | 77.23% |
| Average Individual Income By Returns Claiming a Credit | 0-5 | $ 30.97 | $ 27.56 | $ 29.19 |
| | 5-10 | $ 83.62 | $ 58.08 | $ 76.16 |
| | 10-15 | $117.22 | $ 78.97 | $109.74 |
| | 15-25 | $144.43 | $ 97.13 | $138.16 |
| | 25-50 | $179.51 | $123.36 | $176.00 |
| | 50+ | $194.71 | $142.21 | $192.09 |
| | All AGI Categories | $137.62 | $ 63.74 | $123.28 |
| Number of Returns Receiving an Individual Income Tax Credit | | 114,365 | 27,533 | 141,898 |
| Total Amount of Individual Income Tax Credits Received | | $15,738,912 | $1,754,826 | $17,493,738 |

## TABLE 13

## DISTRIBUTION OF CREDITS - 1977

| Type of Returns | AGI Thousands of Dollars | Number of Returns | Number of Returns with Fuel Credits | Amount of Fuel Credits | Number of Returns with Conservation Credits | Amount of Conservation Credits |
|---|---|---|---|---|---|---|
| Resident Returns | 0-5 | 30,590 | 4,748 | $ 80,369 | 243 | $ 13,840 |
| | 5-10 | 20,249 | 8,391 | $ 185,026 | 591 | $ 35,284 |
| | 10-15 | 17,335 | 9,414 | $ 246,625 | 866 | $ 56,396 |
| | 15-25 | 26,976 | 18,496 | $ 539,056 | 2,248 | $157,813 |
| | 25-50 | 39,983 | 33,766 | $1,271,202 | 5,567 | $439,838 |
| | 50+ | 8,676 | 7,663 | $ 344,823 | 1,140 | $ 96,933 |
| | Total | 143,809 | 82,478 | $2,667,101 | 10,655 | $800,104 |
| Part-Year and Non-Resident Returns | 0-5 | 19,853 | 3,643 | $ 19,213 | 49 | $ 1,072 |
| | 5-10 | 11,177 | 3,091 | $ 23,670 | 89 | $ 2,703 |
| | 10-15 | 6,543 | 2,051 | $ 19,666 | 50 | $ 2,225 |
| | 15-25 | 7,082 | 2,450 | $ 28,116 | 74 | $ 2,833 |
| | 25-50 | 5,857 | 2,040 | $ 34,028 | 87 | $ 6,248 |
| | 50+ | 1,073 | 317 | $ 6,244 | 11 | $ 1,013 |
| | Total | 51,585 | 13,592 | $ 130,937 | 360 | $ 16,094 |
| All Returns | 0-5 | 50,443 | 8,391 | $ 99,582 | 292 | $ 14,912 |
| | 5-10 | 31,426 | 11,482 | $ 208,696 | 680 | $ 37,987 |
| | 10-15 | 23,878 | 11,465 | $ 266,291 | 916 | $ 58,621 |
| | 15-25 | 34,058 | 20,946 | $ 567,172 | 2,322 | $160,646 |
| | 25-50 | 45,840 | 35,806 | $1,305,230 | 5,654 | $446,086 |
| | 50+ | 9,749 | 7,980 | $ 351,067 | 1,151 | $ 97,946 |
| | Total | 195,394 | 96,070 | $2,798,038 | 11,015 | $816,198 |

TABLE 14

DISTRIBUTION OF CREDITS - 1978

| Type of Returns | AGI Thousands of Dollars | Number of Returns | Number of Returns with Fuel Credits | Amount of Fuel Credits | Number of Returns with Conservation Credits | Amount of Conservation Credits | Number of Returns with Income Credits | Amount of Income Credit |
|---|---|---|---|---|---|---|---|---|
| Resident Returns | 0-5 | 33,582 | 6,900 | $ 120,117 | 638 | $ 20,664 | 8,437 | $ 261,316 |
| | 5-10 | 20,515 | 10,317 | $ 198,191 | 1,138 | $ 43,424 | 17,905 | $ 1,497,153 |
| | 10-15 | 17,564 | 11,336 | $ 261,918 | 1,394 | $ 57,979 | 16,909 | $ 1,982,114 |
| | 15-25 | 25,947 | 20,182 | $ 601,140 | 2,892 | $155,634 | 25,532 | $ 3,687,541 |
| | 25-50 | 37,260 | 33,495 | $1,355,086 | 6,297 | $409,109 | 37,127 | $ 6,664,510 |
| | 50+ | 8,483 | 7,895 | $ 384,650 | 1,437 | $109,006 | 8,455 | $ 1,646,278 |
| | Total | 143,351 | 90,125 | $2,921,102 | 13,796 | $795,816 | 114,365 | $15,738,912 |
| Part-Year and Non-Resident Returns | 0-5 | 18,088 | 4,551 | $ 24,388 | 307 | $ 11,235 | 9,218 | $ 254,075 |
| | 5-10 | 9,311 | 3,820 | $ 27,485 | 274 | $ 15,441 | 7,385 | $ 428,898 |
| | 10-15 | 4,884 | 2,262 | $ 20,325 | 159 | $ 9,460 | 4,114 | $ 324,901 |
| | 15-25 | 4,560 | 2,265 | $ 25,318 | 185 | $ 13,542 | 3,898 | $ 378,608 |
| | 25-50 | 2,954 | 1,504 | $ 22,503 | 136 | $ 9,872 | 2,473 | $ 305,062 |
| | 50+ | 577 | 248 | $ 4,486 | 29 | $ 2,219 | 445 | $ 63,282 |
| | Total | 40,374 | 14,650 | $ 124,505 | 1,090 | $ 61,769 | 27,533 | $ 1,754,826 |
| All Returns | 0-5 | 51,670 | 11,451 | $ 144,505 | 945 | $ 31,899 | 17,655 | $ 515,391 |
| | 5-10 | 29,826 | 14,137 | $ 225,676 | 1,412 | $ 58,865 | 25,290 | $ 1,926,051 |
| | 10-15 | 22,448 | 13,598 | $ 282,243 | 1,553 | $ 67,439 | 21,023 | $ 2,307,015 |
| | 15-25 | 30,507 | 22,447 | $ 626,458 | 3,077 | $169,176 | 29,430 | $ 4,066,149 |
| | 25-50 | 40,214 | 34,999 | $1,377,589 | 6,433 | $418,981 | 39,600 | $ 6,969,572 |
| | 50+ | 9,060 | 8,143 | $ 389,136 | 1,466 | $111,225 | 8,900 | $ 1,709,560 |
| | Total | 183,725 | 104,775 | $3,045,607 | 14,886 | $857,585 | 141,898 | $17,493,738 |

# innovations

## Rhode Island's Energy Conservation Corporation

**Introduction**: In 1977, a Rhode Island program was implemented that anticipated the effects of the then-pending National Energy Conservation Policy Act. The Rhode Island Citizens Energy Conservation Corporation (RICECC) was established as a nonprofit organization by the cooperative efforts of the state and major private corporations to help all Rhode Island property owners (not just low-income families) reduce the amounts of energy their homes consume.

To produce a more palatable acronym, the corporation later was referred to as "Rhode Islanders Saving Energy" (RISE).

RISE achieves its objective by providing: (1) free home energy audits with detailed costs of the improvements necessary to reduce energy use; (2) selection of approved contractors to perform the work authorized by the homeowner; (3) supervision and inspection of contractors' work, and (4) reduced financing rates on loans from local lending institutions. Other services, such as advice on oil burner maintenance, wood stove heating and solar energy availability and suitability may soon be included in RISE activities. Similar services for commercial buildings eventually may be provided, pending the promulgation of federal standards regarding energy efficiency in such structures.

Several provisions of the 1978 National Energy Conservation Policy Act should make this Rhode Island program of particular interest to governors, state energy offices, public utility commissions and utility companies.

**Federal Legislation:** Under the National Energy Conservation Policy Act, each governor must submit a plan to the Department of Energy that will describe how the regulated utility companies in his state will provide information to their customers regarding energy conservation and solar energy measures the customers could adopt, along with the costs of such measures and an estimate of how much energy each measure will save. The utility companies must have procedures for delivering this information to their customers by January 1, 1980.

The utilities must also have available by that same date procedures which will provide for inspection of individual residential structures, at the owner's request, to ascertain the appropriate energy conservation steps that could be employed, their costs and anticipated energy savings. The utility must also offer to arrange to have the conservation devices installed and assist the homeowner in obtaining a loan to finance the selected work. Nonregulated utilities and home heating supplies must comply with these standards in order to have an approved energy conservation program.

Of relevance to homeowners is another part of the administration's energy legislation package–the Energy Tax Act. Under this law, a nonrefundable credit is allowed for a maximum of 15 percent of the first $2,000 invested in certain conservation equipment and materials, including storm doors and win-

The Council of State Governments

*This report was prepared by Tom Hauger, a former special assistant with the Council of State Governments working in the area of energy information. Mr. Hauger prepared this report under contract to the Innovations Transfer Program of the Council of State Governments.*

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dows, automatic furnace ignition systems, insulation, caulking and weather-stripping. A similar credit is provided for 30 percent of the first $2,000 and 20 percent of the next $8,000 (to a maximum credit of $2,200) for residential investments in solar, wind, or other renewable energy sources for home heating or cooking or for domestic hot water.

**Background**

Since 1975 there has been such movement among states toward the adoption of energy conservation. Part of this activity was spurred by federal legislation, such as the 1975 Energy Policy and Conservation Act which encouraged the states to adopt thermal efficiency and insulation standards. In further recognition of the value of the value of home insulation for reducing fuel usage, at least two federal programs were established to help low-income persons weatherize their homes. The promotion of carpools, solar tax incentives and right-turn-on-red measures offered less promise and smaller returns than the potential of proper building insulation, especially in the colder climates of the northeast.

In the spring of 1977 Governor J. Joseph Garrahy convened the first meeting of a group of Rhode Island corporate leaders to advise him on energy matters, particularly conservation. The governor's energy office supplied staff services for the committee.

From the options available for its consideration, the committee chose to concentrate first on the problem of residential insulation. This decision was based partly on the knowledge that the housing stock in Rhode Island consists predominately of older single-family structures. Over 90 percent are more than 40 years old and are apparently inadequately insulated or weather-sealed.

The committee suggested a private corporation provide home energy audits and insulation services. Financial support to establish the corporation was soon forthcoming as four of the state's major banks, a department store, and other Rhode Island companies pledged to underwrite a $110,000 loan from one of the banks as the basic capital for RICECC. (To date only about $75,000 of that amount has been drawn for RICECC's use.) At the outset, a consulting firm was retained to design the operation and structure of the corporation and the corporation began to screen insulation contractors for participation in the program.

In January 1978, the first audits were performed and by April several homeowners had opted for improvements recommended by the auditors. But the corporation was in trouble. In its haste to show results, it tried to make unmanageable leaps in too many directions at once. Staffing was inappropriate and relations with the banking and contracting communities were strained. In April, the consulting firm hired a new manager.

The manager's first step was to personally review the work done up to that time by the contractors and then to rectify the errors that had been committed in many of these jobs. And the task of building RICECC credibility was begun. The new RICECC manager offered training sessions for each contractor who wanted to participate in the program as a way to ensure standard and proper work among the contractors. Insulation and other materials manufacturers helped provide training on the proper use of their products.

Meanwhile, audits continued and work was performed where requested with RICECC supervision and inspection of completed jobs. More homeowner interest in the program was elicited through public appearances by the manager of RICECC and employees of the governor's energy office before local civic groups and with public service announcements on television and radio and messages included with utility bills. In time, a record of performance had been established that could be used to show lending institutions the viability and effectiveness of the program. Several lenders were by then offering reduced interest loans for homeowners employing the RICECC service and contractors.

## RICECC—Its Structure and Operations

In the summer of 1978, RICECC was advised that its acronym was awkward and unpronounceable. So, it adopted the new acronym RISE (for Rhode Islanders Saving Energy) as the title for its operating program, although the corporation is officially chartered as RICECC. The telephone is answered "RISE," and most promotional material refers to RISE, not RICECC.

RISE currently operates with a nine-member staff—a manager, a contract supervisor, a contract inspector, an administrative assistant, a clerk-typist and four residential energy auditors. The office operations cost about $17,000 a month. Funds are obtained from the contributions of utility companies and from a profit margin on all jobs performed.

Depending on the viewpoint of the observer, RISE is a consumer protection organization, a guarantor of work for insulation contractors, or a significant deliverer of energy conservation information and services in the state. In working toward its goal of saving energy, RISE fits all these descriptions.

## Customer Service

The RISE services are activated when a homeowner requests an energy audit. At that point, one of the corporation's four auditors examines the house for various types of heat loss. (Audits are often done in evenings or on weekends for the convenience of the homeowner.) Using a standard eight-page form, the auditor takes about an hour to compile a complete description of the house along with specific areas of potential heat loss due to infiltration or conduction through floors, ceilings, walls and windows. Back in the office, the auditor calculates the heating Btu's that could be saved through application of appropriate materials and prepares a list of recommendations for the homeowner.



The recommendations are rank-ordered with the most cost-beneficial appearing first. When the recommendations are presented to the homeowner, actual cost for the suggested measures are included along with approximate payback periods (time over which energy cost savings equal cash outlay for improvements). The homeowner is also given information on the federal tax credit the installation of certain materials may offer. In addition, the auditor can provide some instructions for the homeowner interested in do-it-yourself improvements for heat retention.

If the homeowner is interested in having the recommended work done by professionals, the rest of the RISE package is activated. The auditor can provide a list of banks in the state who have agreed to offer lower interest loans for participants in the RISE program. A 24-hour processing of loan applications for RISE customers enables the homeowner to make the decision to proceed with the work by contacting the RISE office. RISE, in turn, assigns the job to the next contractor on its rotational list, who has a franchise to deal in the materials selected by the homeowners. The contractor can refuse the job, but then must wait until the others on the list have been given offers before he will get another chance.

If the contractor accepts the offer, he does so at the price offered by RISE with materials specified by RISE contract supervisors. Upon completion of the work, RISE sends out an inspector (not an auditor) who uses a thermal scanner to ensure the proper installation of the right materials. If an error has been made or some procedure omitted, the contractor is called back to satisfactorily complete the work. The contractor is not paid until the inspection indicates a correct performance. RISE, in turn, collects from the homeowner the total contract cost which includes the amount paid to the contractor plus a 25 percent margin that helps allay RISE's overhead. The average contract costs the homeowner about $1,300. The price is still very competitive with prices for comparable work done without RISE supervision because RISE pays the contractors at a wholesale rate. RISE also guarantees the work of its contractors and its customers are eligible for the lower bank rates.

## Contractor Relations

There also have been occasions where homeowners have been dissatisfied with work done by contractors that was not completed through RISE, but the homeowners sought advice and help from RISE. It is a yardstick of RISE's current credibility that in many such cases contractors, even those not participating in the program, are willing to remedy work that has been judged faulty.

None of this is to say that RISE has browbeaten contractors into compliance. Rather, a working relationship has been established out of mutual respect and mutual benefit. Nine of the 14 contractors presently on the contractor rotation list rely exclusively on RISE for their jobs. The contractors and their crews have received special training from RISE that has enabled them to do their work better. Indeed, some contractors use only certain of their workers on RISE jobs, knowing the rigorous supervision and inspection to which that work is subject.

RISE also has helped improve the image of insulation contractors who previously may have been characterized as fast-talking salesmen with limited knowledge and minimal skills. Now, their work is guaranteed by a publicly sponsored corporation. There are even instances where a contractor will call in RISE as an arbiter when a non-RISE customer has refused to pay the contractor for work that is unacceptable to the homeowner for some reason.

The contractors also benefit from RISE's promotion of the corporation's activities. RISE's steady growth and heightened public image are expected to keep the demand for weatherization work fairly constant, even through traditionally slack warm weather months, thus possibly preventing seasonal layoffs of insulation workers. It is interesting to note, too, that prior to RISE, the average weatherization job for contractors cost only about one fourth of RISE's current per-job average.

## Energy Savings

At the end of calendar year 1978, more than 2,500 free home energy audits had been performed by RISE. In approximately 25 percent of these homes, RISE contracted to perform at least some of the recommended improvements. Based on responses to limited telephone follow-up, another 35 percent of the homeowners performed the work themselves or made their own contract arrangements.

Most of the home heating in Rhode Island is done by oil furnaces. Through RISE, oil users can obtain the advice of an oil burner expert regarding the size, condition and operation of oil burners. Originally, $20 was charged for this service, but as part of a state demonstration project, the service is now free for the homeowner. So far, RISE does not provide repair contractors for oil burners, but it is attempting to establish a program for these contract services similar to the program for weatherization.

Other coming additions to RISE include solar and wood stove components. Under the solar program, auditors will explore the attitudes of homeowners toward the use of solar energy and give advice as to the feasibility and technology available for solar use in domestic hot water production. A delivery mechanism employing local solar product suppliers and installers has just been launched. The wood stove program involves advising homeowners on the safe and efficient installation and use of wood stoves as home heating devices.

## The State Role

The RISE manager contends continued state participation in the program is critical to its success. Although it was the governor who called together the group that proposed the formation of the corporation, and that group was partially staffed by members of the governor's energy office (GEO), the state has continued to remain removed from the daily operations of RISE, but the state's relatively low-keyed assistance is considered extremely important to the viability of the corporation.

The two most vital contributions the state provides are public acceptance and liaison with other government agencies. Despite RISE's connection with the business community and its own now-respected status, state approval gave it a higher credibility among its potential customers in the development stages. Even today, promotional brochures contain a letter of official endorsement from the state's energy conservation director. (At this writing, plans were being made for the governor to give additional public acclaim to the program as a result of the favorable impression he drew of RISE when his house was recently audited and insulated.)

Signing letters of praise is not the only way in which the director of energy conservation assists the program. He and his office have written a proposal to the federal Department of Energy that is expected to bring funds to the state for financing the solar component of RISE. The GEO also serves as a liaison between RISE and state agencies, such as the building code commissioner who sets insulation standards for new buildings, or the community affairs agency which administers a weatherization program for low-income households. Some office support, such as use of copying machines, is provided by the GEO as well.

The GEO has another role with respect to RISE–a role that is harder to define, but that might be termed "watchdog." Because of the public trust that has accrued to the program and the reliance state government has placed on RISE as educator and unbiased provider of energy construction services, the state feels a responsibility to guard against the misuse of this trust.

## The Private Sector Role

Even though the original idea of RISE came from influential members of the Rhode Island business community, similar support was not as easily come by from other segments of the private sector. Insulation contractors, for instance, were at first skeptical of the concept and wary of the competition or control the new corporation posed. However, these contractors not only accept RISE's presence now, but rely on its advice and contracts.

*Insulation contracting is an important element of the Rhode Island energy conservation program.*

In the case of the banking community, a different pattern of doubt/acceptance developed. Four major banks were among the initial backers of the loan to start RISE. Bank financing of RISE weatherization contracts is now available at 10-11½ percent (instead of the usual 15-18 percent) from banks that are satisfied of a reduced risk because of the guaranteed standards of contract performance. The RISE auditors give the homeowners they visit a list of the participating banks and these banks have procedures for expediting applications from these customers.

The state's private utility companies also support the program. A spokesman for the state's largest electric utility said that despite the company's mild skepticism at the outset of the program, the utility, for the first time ever, stuffed its billing envelopes with brochures for an otuside organization–RISE. This same utility previously had its own home energy audit program and offered advice from its experience to the fledgling corporation. The state's 10 energy utilities now voluntarily contribute a total of $5,000 per month to the operational funds of RISE. While voluntary, this contribution should not be seen as entirely altruistic since the utilities recognize that RISE is delivering a consumer-oriented energy conservation program that would be required of the utilities in the near future under the National Energy Act.

## Transferring the Innovation

Rhode Island's city-state size affords it a certain advantage in the implementation of a program such as RISE. A person can drive from Providence to any other location in the state in less than an hour. In the case of RISE, this means that all the auditors can work in the same capital city office and save the costs of administering satellite offices. It also means that insulation contractors are equally capable of serving the whole state and the cooperating banks have branches throughout the state.

In a larger state, the logistics of screening contractors and obtaining banking community support might require more patience than was necessary in Rhode Island. But the people involved in running RISE are convinced that the program could work equally well in a larger state with the same government and private sector cooperation as a basis. The program does not have to be implemented through a private corporation to be successful, but that arrangement seems to reduce personnel and other governmental administration problems.

More important factors are the need for the program management to have a thorough understanding of the technical and market aspects of weatherization and a well-trained staff of auditors. In a large state it might be more practical to begin the program in a single market area and then expand to other areas as funding and expertise permit. Utility companies should be considered as sources of seed money for a home energy conservation program in light of requirements in the National Energy Act. In Rhode Island, the utilities seem certain that their financial burden for RISE is much less than they would incur if they constructed and funded their own programs.

## Conclusion

In the delivery of state government services, Rhode Island's Citizens Energy Conservation Corporation shows such functions need not result in new in-statehouse bureaus or regulations. Through cooperation with the private business sector, Rhode Island's program indicates state government adaptability and effectiveness. There is little research indicating what other state services might be similarly resolved through such cooperative ventures, but it does indicate possibilities exist, particularly where the desirable product or service is readily available from private enterprise, but is necessary to state service delivery. The state government's role as a broker provides a realistic, reliable and efficient means of both serving individual citizens and meeting overall public service goals—in this case energy conservation.

## INNOVATIONS REPORTS

*Railroad Rehabilitation: A Program to Upgrade Selected Branch Lines in Iowa, January 1976, 23 pp. (BPF, $3)*

* *Health Cost Containment: The Connecticut, Maryland, and New Jersey Responses, March 1976, 44 pp. (BPX, $3)*

* *State Energy Management: The California Energy Resources Conservation and Development Commission, May 1976, 32 pp. (RM 580, $3)*

*Periodic Reappraisal of Real Property: The Utah Approach, July 1976, 35 pp. (RM 581, $3)*

*Investing State Funds: The Wisconsin Investment Board, August 1976, 31 pp. RM 583, $3)*

* *Retirement System Consolidation: The South Dakota Experience, December 1976, 46 pp. (RM 588, $3)*

*Centralizing State Information Services: Kentucky's Approach, November 1976, 6 pp. (BYL, $2)*

* *The Bond Bank Innovation: Maine's Experience, February 1977, 60 pp. (RM 604, $3)*

* *Random Moment Sampling: Georgia's Indirect Cost Allocation Experiment, February 1977, 8 pp. (BAA, $2)*

*A State-Supported Local Corrections System: The Minnesota Experience, February 1977, 29 pp. (RM 603, $3)*

*Managing Natural Resource Data: Minnesota Land Management Information System, May 1977, 48 pp. (RM 616, $3)*

*The Management Audit: A New Experiment in State Regulation of Utilities, July 1977, 6 pp. (BCP 77, $2)*

*Developing Primary Health Care for Rural Areas in North Carolina, June 1977, 40 pp. (RM 620, $3)*

*Merging Producer and Consumer Interests: Domestic Agricultural Marketing in New York and Pennsylvania, September 1977, 29 pp. (RM 623, $3)*

*Health Cost Containment Revisited, July 1977, 8 pp. (BDC 77, $2)*

*Systematic Use of Volunteers: A Florida Case Study, November 1977, 8 pp. (BEP 77, $2)*

*Incentives and Performance: Minnesota's Management Plan, April 1978, 12 pp. (BHO 78, $2)*

*Health Manpower Licensing: California's Demonstration Projects, April 1978, 24 pp. (RM 631, $3)*

*Assessing Management Potential in State Government, April 1978 (RM 634, $2)*

*Georgia's Residential Restitution Centers, May 1978 (RM 636, $3)*

*Untangling the Permit Web: Washington's Environmental Coordination Procedures Act, June 1978, 45 pp. (RM 627, $3)*

*Restoring Municipal Credit: The New Jersey Qualified Bond Program, June 1978, 10 pp. (RM 643, $2)*

*Bail Bond Reform in Kentucky and Oregon, August 1978, 31 pp. (RM 645, $3)*

*Permanent Part-Time Employment: A Staffing Option for State Government, August 1978, 10 pp. (RM 648, $2)*

*New Mexico's Centralized Risk Management, May 1979 (BOV:79, $3)*

*Vermont's New Signs of the Times, June 1979 (RM 666, $2)*

*Financing Family Farms in Minnesota, May 1979, 6 pp. (RM 662, $2)*

*Published version is out of print, but photocopied versions are available.

*RM:665* *Price $2.00*

ENERGY CONSERVATION

# Technological breakthrough

**THE recent start-up of the world's first MHD (magneto-hydrodynamic) power plant, in the vicinity of Moscow, promises to rank as a landmark in the history of energy conservation. The wasteful use of fuels which is inherent in electricity generation is perhaps the most important single factor making for an exaggerated overall growth of energy demand, the more so because electricity consumption tends to rise even faster than the direct consumption of fuels. The concept of MHD technology is designed to reduce this waste.**

So far, power stations have all been based on steam turbines. They utilise their fuel input, in most cases, to the extent of barely 30 per cent, while even the most advanced types of turbine generators will never be able to achieve efficiencies significantly in excess of 40 per cent. A typical MHD power plant, however, dispenses with the generator equipment and utilises the fuel more thoroughly by converting it into very-high-temperature gases which are then passed through a magnetic field to generate electricity.

The Moscow plant, consisting of an MHD generator as a topping unit coupled with a steam plant bottoming unit, actually operates at an efficiency rate as high as about 50 per cent. Beyond that, it is hoped that further technical progress, with the use of greater heat, will eventually make it possible to reach efficiencies up to around 60 per cent—equal to twice what is now the normal standard.

## US-Soviet collaboration

Remarkably, the new technological breakthrough is the outcome of close international collaboration, chiefly between the Americans and the Russians. The Moscow plant has been built with the direct co-operation of experts from leading US firms such as General Electric, Westinghouse, Avco and others, under an agreement with the US Energy Research and Development Agency. Work on this and other relevant facilities in the USSR has been paralleled by similar work in the USA itself, and there has also been a great deal of work on MHD projects elsewhere, notably in Japan where highly efficient superconducting magnets have been developed. A paper describing the varied efforts in this field has recently been submitted by an international team to the World Energy Conference*, and a fuller report will shortly be published in Paris.

The Moscow plant still serves primarily for experimentation, though its power output is fed into the general grid. The plant can operate either on natural gas or on fuel oil and is said to achieve a remarkably high degree of cleanliness in its exhaust gases provided that attention is given to the removal of nitrogen oxide concentrations. Furthermore, plans for the construction in the USSR of a 500 MW commercial plant are now at an advanced stage and it is hoped that this will start operating in the mid-1980s. The point has been stressed that the MHD principle will be especially well suited for electricity generation on a very large scale.

## Low-grade fuel acceptable

Research and development in the USA is largely concentrated on coal-fired MHD facilities, some of which have already been put to extensive tests, and the projected Russian 500 MW plant is also expected to run on solid fuels. MHD power systems will probably offer the important advantage of being suitable for fuelling with low-grade, high-sulphur coals; and it may thus become possible to by-pass the coal gasification or liquefaction process with a concomittant improvement in net plant efficiency and economy. Among other important current US projects is the construction at Montana of a large specialised component development and integration facility, for completion by 1979.

The economic as distinct from the technical efficiencies of the prospective commercial MHD plants have until recently been subject to wildly differing estimates. The situation has now, however, been largely clarified thanks to independent research by teams from the General Electric and Westinghouse groups, working on the basis of identical specifications laid down by the US National Aeronautics and Space Administration.

The two teams arrived at ranges of cost estimates per unit of power output from first-generation commercial MHD plants which—in the case of Westinghouse—are, on average, 23 per cent higher and—in the case of General Electric—31 per cent higher than comparable cost range data from advanced steam turbine plants. Capital costs for MHD power plants were estimated by the two teams to be 50 per cent and 61½ per cent respectively above those of advanced conventional plants, but their running costs are far more favourable in view of the substantially lower fuel requirements.

* *Magneto-hydrodynamic power generation, an international status report.* By A E Sheindlin, Institute of High Temperatures, Moscow; W D Jackson, US Energy Research and Development Administration; W S Brzozowski, Institute for Nuclear Research, Warsaw; L H Th Rietjens, Eindhoven University of Technology.

**Subscription rates**

In spite of the continued rise in production costs, we have managed to keep our subscription rates unaltered over the past two years, Regretfully, however, an increase in these rates is now unavoidable. The following new rates, including postage, will apply with effect from 1st January 1978; they take into account alterations both in postal and currency exchange rates.

| | |
|---|---|
| £25 | Surface mail within the UK. |
| US$ 50 | Surface mail to all other destinations. |
| US$ 55 | Airmail to Europe. |
| US$ 60 | Airmail to all other destinations. |

We also publish a special Press edition, printed on one side of the paper only, which some subcribers find useful for cutting and filing items from the journal for reference purposes. Also with effect from 1st January 1978, this edition will cost £37.50 within the UK and US$ 80 for delivery to all other destinations.

The two estimates are sufficiently close to serve as an adequate provisional guide. Initial extra costs of 23-31 per cent may not be regarded as excessive, considering that there is scope for further reductions both in capital costs and fuel requirements as a result of technological improvements. Moreover, the savings of fuel are bound to become economically even more attractive with the expected continued rise in average fuel prices. The consensus of informed opinion seems to be that the MHD plants of the 1980s will be at least competitive with conventional plants.

The paper submitted to the World Energy Conference by experts from different countries stresses that MHD electrical power generation "has now joined the ranks of technologies for which engineering feasibility has been established", and that planning emphasis should therefore be shifted "from exploratory work and scientific approaches to an engineering oriented programme directed towards specific component and development problems". The paper makes it clear, at the same time, that considerable further progress may well be achieved as a result of fundamental studies devoted to the development of even more advanced types of MHD technology. —*B.A.R.*

# SWEDEN

# The case for reduced consumption

**AS might be expected for the most prosperous country in Europe, Sweden's energy consumption *per capita* is also one of the highest – in 1973 at 6 110 kg of coal equivalent it was exceeded in Europe only by Belgium with 6 253 kg, according to UN figures. But hydro-electricity, Sweden's only appreciable indigenous energy resource, meets about 15 per cent of overall energy demand. Most of the balance – including up to an estimated 15 million metric tons of crude oil this year – must be imported, and the 8.2 million Swedes are increasingly concerned at the long-term effect of energy imports on their national wealth.**

This year imports of crude oil and products are budgeted to amount to about Kr 13 745 million, or nearly 18 per cent of total estimated value of imports. While Swedish industry and trade continue to flourish high energy imports may be acceptable, but lower overall economic growth and a shift in the pattern of energy consumption are being discussed as means to a more moderate rate of energy use.

Nuclear electricity was seen by the government as the best alternative to imported oil, and there were plans to build 19 nuclear plants by 1985 and up to 24 by 1990, giving a combined capacity of nearly 24 000 MW. However, planners had not taken into account strong public feeling on nuclear energy and energy consumption. Many people are opposed to nuclear power stations on safety grounds and a survey showed that three-quarters of respondents would prefer lower living standards to increased energy use.

### Lower energy use

The nuclear energy debate still goes on, but the government has recognised the importance of curbing total energy consumption. This is planned to rise at no more than 2 per cent annually to 1985, compared with an estimated 3.4 per cent annual rise if no special measures are taken. After 1990 it is hoped that energy use can be held constant. It has recently been suggested that Sweden could maintain its standard of living on two-thirds of current energy consumption, but some of the measures necessary to achieve this – less-advanced technology, longer-lasting products, more emphasis on public transport, etc – may not yet be acceptable.

Sweden now has five completed nuclear power plants, although the first (a small unit at Agesta) has now become uneconomic. There are two boiling water reactors of 440 MW and 580 MW capacity at Oskarshamn and a third of 760 MW at Ringhals, and the most recent is a pressurised water reactor of 820 MW, also at Ringhals. A further six plants are either under construction or have been granted construction permits; there will be two additional pressurised water reactors of 910 MW capacity each at Ringhals, two 580 MW reactors at Barsebeck and two of 900 MW at Forsmark.

The government's commitment to nuclear power was underlined when it was decided to develop Swedish nuclear technology, rather than to rely entirely on foreign expertise. A group of Swedish companies and Westinghouse won orders for the Ringhals 2, 3 and 4 plants, while the half state-owned Asea-Atom will build seven reactors.

However, beyond the eleven power stations either existing, under construction or sanctioned at present and an additional two reactors planned for existing stations, Sweden's nuclear programme remains to be decided. If no further plants are to be built, nuclear capacity in 1985 will total nearly 8 000 MW (on a par with effective hydro-electricity capacity at present) and will meet 12 per cent of primary energy demand. Oil's share could then reduce to 60 per cent of energy demand from about 70 per cent at present – a worthwhile saving, but not the complete answer to the high cost of energy imports.

Sweden's two 50 per cent state-owned exploration companies – Oljeprospektering AB (responsible for domestic operations) and Petroswede AB (responsible for exploration overseas) – have for several years invested considerably in drilling work in the hope of securing direct access to oil reserves, but have met with little success. Minor fields have been discovered around the island of Gotland by Oljeprospektering and four wells on the island have been in production at very low rates for over a year, while Petroswede has been involved in exploration, particularly in Egypt, Tunisia and Spain.

It is natural that the Swedes should look to hydro-electricity – along with forestry and iron ore, one of the country's most important indigenous resources – as an alternative to dependence on imported oil. A high rainfall, with most of the rain as well as snow falling at high altitudes, together with numerous lakes have allowed hydro-electricity generation to be developed at relatively low cost. The result is that at present some 76 per cent of internal electricity production is hydro-generated.

With most major rivers suitable for hydro-electricity generation already utilised and with environmental reasons for not building dams and generators on many of those that are not, it appears that Sweden's scope for increasing its reliance on hydro-electricity is limited. In 1974 206 220 terajoules* of hydro-electric energy were generated from the 1 000 or so existing plants, compared with the 219 600 TJ which, according to the government, should be available in a year of normal rainfall when new facilities now sanctioned become operational. With a theoretical overall potential for the generation of 720 000 TJ of hydro-electricity annually, it is officially estimated that about 342 000 TJ (including current and sanctioned capacity) could be utilised if new plants were installed at all sites where it would be economic to do so. Hydro-electric energy availability could then increase by 56 per cent or some 122 400 TJ, but this estimate assumes that rivers such as the Vindel, Pite, Kalix and Torne-Muonio (which in the past have been excluded from hydro-electric plans on environmental grounds) would be harnessed.

The government has accordingly decided to limit the expansion of hydro-electricity generation to 18 000 TJ bringing the planned total up to 237 600 TJ. However, as an experiment six small hydro-electric generators will be installed this summer and tested for a year. If successful, it has been suggested that 300 of these remotely-controlled units could be installed.

With no indigenous natural gas or coal, Sweden's consumption of oil *per capita* is the highest in the world. In addition to importing 10 049 000 metric tons of crude oil in 1974 the major part of the country's refined product needs was also imported, the total of main refined products imports amounting to 17 272 000 tons compared with an aggregate consumption of 23 384 000 tons. The 8.3 million tons/year Scanraff refinery, brought on stream a year ago and increasing Sweden's refining capacity to 20.6 million tons/year, will boost crude oil imports by up to 30 per cent this year. According to official estimates, the corresponding fall in refined product imports will be about 12 per cent from 1975-76 but total refinery production is likely to rise by 17 per cent.

Although the country's substantial imports of refined products have in the past been a cause for concern, they could be less so in the future. With refineries in western Europe generally operating at low throughputs – a situation which was recently predicted to last for several years – there could well be advantages in still having to import a certain proportion of the refined products requirement. Production from the four large-scale refineries (Scanraff with 8.3 million tons/year, BP 5.5 million tons/year, Shell 5 million tons/year and Nynäs with some 1.8 million tons/year), together with imports of certain products, may prove to be the most effective way of meeting the country's refined product needs.

This consideration, together with the recent growth in Norway's refining capacity, may lead to the postponement or cancellation of the proposed 7 million tons/year Statsraff refinery at Lysekil, for which investment decisions were due to be taken this year. It has been suggested that Norway's Mongstad refinery, of which the current capacity is 4 million tons/year, should be expanded and that Sweden should be given long-term contracts for the delivery of refined products, as an alternative to the planned Lysekil refinery.

Norway's influence is also being considered in the petrochemicals sector now that investment plans for the coming decade are discussed. Sweden's projected second ethylene cracker – a 500 000 tons/year unit to be built at Stenungsund on the west coast by Stenungsunds Kemiska – is also in doubt because of Norway's now-building petrochemical complex at Bamble, Telemark, which includes a cracker. The fears that Scandinavian countries could develop excess capacity for petrochemicals production, while being disadvantaged as petrochemicals exporters, are justified. Accordingly, the Swedish and Norwegian industry ministers have agreed to co-ordinate their respective plans, and a joint committee on immediate matters is due to report later this year. —*M.Q.*

* 1 terajoule = 277.778 megawatt hours

## FORTHCOMING CONFERENCES AND EXHIBITIONS

**Health and Safety in the Oil Industry (C).** The Grand Hotel, Eastbourne, England, *28th September-1st October*. Enquiries: Lynda Boothby, Institute of Petroleum, 61 New Cavendish Street, London W1M 8AR, England. Telephone: 01-636 1004. Telex: 264380.

**World Offshore Exhibition and Conference.** Olympia, London, England, *4th to 7th October*. Enquiries: Dermot B Graham, Fairs and Exhibitions Ltd, 21 Park Square East, Regents Park, London NW1 4LH, England. Telephone: 01-935 8200. Telex: 21879.

**Gastech 76 International Conference and Exhibition.** Hilton Hotel, New York, *5th-8th October*. Enquiries: The Gastech Organisation, 2 Station Road, Rickmansworth, Herts WD3 1QP, England.

**Preisbildung in der Energiewirthschaft (C).** University of Cologne, West Germany, *13th-14th October*. Enquiries: Professor Dr Hans K Schneider, Energiewirtschaftliches Institut, University of Cologne, West Germany.

**Design and Construction of Offshore Structures (C).** Institution of Civil Engineers, London, England, *27th-28th October*. Enquiries: Institution of Civil Engineers, 1-7 Great George Street, London SW1P 3AA, England.

**Longer Term Energy Modelling (C).** University of Guildford, Surrey, England, *5th November*. Enquiries: Mrs C Steels, Department of Economics, University of Guildford GU2 5XH, England. Telephone: 0483 71281. Telex: 85331.

**Offshore International Exhibition and Conference.** National Exhibition Centre, Birmingham, England, *7th-10th December*. Enquiries: Industrial and Trade Fairs Ltd, Radcliffe House, Blenheim Court, Solihull, West Midlands, B91 2BG, England. Telephone: 021-705 6707. Telex: 337073.

 by B.A.Rahmer

# The scope for economy

**A highly original new research study, concentrating on conditions in the United Kingdom but broadly applicable to other countries as well, confirms once again that there is great scope for fuel saving even on the assumption that governments are content with moderate energy conservation policies which would not drastically affect the lifestyles of their people.**

The authors' general conclusion from their own detailed statistical analysis is that a relatively rapid growth in the country's gross national product, by an average of 3-4 per cent annually, would be compatible with annual increases in energy consumption of only about 1½ per cent, which would raise total consumption from 342 million tonnes coal equivalent in 1976 to not more than about 500 million tonnes in the year 2000. Alternatively, if the general economic growth during the period should remain below 2 per cent, the authors think that fuel demand would probably rise at a minimal rate, possibly remaining well below 400 million tonnes coal equivalent in the last year of the century.

The new study*, made under the auspices of Sussex University, is based on a consideration of the probable course of fuel and electricity requirements in the various sectors of the national economy. It thus differs from those numerous statistical exercises which assume, initially, a fairly constant relationship between energy growth and general economic growth though they may make minor adjustments to take account of special circumstances in individual economic sectors. The present authors emphasise that energy demand in a dynamic society is bound to be affected by changes in the composition just as much as in the size of the national product.

The main statistical findings of the study are summarised in Table I which shows the "maximum" and "minimum" amounts of energy (calculated in billion therms) that may be required in the year 2000, on any reasonable set of assumptions, by the main sectors of the national economy. The probable contribution of the various types of fuels is even more difficult to asses beforehand but Table II indicates a hypothetical split-up of energy resources, on the further assumption that the energy demand will be covered as far as possible by indigenous resources such as North Sea oil and gas, local coal, and nuclear power.

The authors themselves describe their general outlook as "fairly conventional". They consider a reasonably rapid growth to be in the national interest;

**TABLE I**
**UK ENERGY CONSUMPTION BY ECONOMIC SECTORS**
Billion therms

| | 1976 Actual | 2000 Minimum | 2000 Maximum |
|---|---|---|---|
| Domestic | 14.5 | 14.2 | 16.2 |
| Manufacturing | 17.5 | 19.6 | 28.2 |
| Iron and steel | 5.3 | 3.7 | 8.4 |
| Transport | 12.7 | 17.2 | 19.9 |
| Public/commercial | 6.5 | 5.3 | 7.7 |
| Agriculture | 0.7 | 0.7 | 1.0 |
| Total Net a) | 57.3 | 60.8 | 81.4 |
| Total Gross b) | 85.0c) | 83.8 | 143.1 |

a) Sum total of the sectoral figures which indicate their requirements of fuels and electricity.
b) Also including uses by fuel and electricity industries, distribution losses and non-energy uses of oil.
c) Approximate figure.

they favour energy conservation policies but recognise that governments are inevitably hampered by political and social as well as purely economic constraints; and they take no account, in their statistical calculations, of the potentialities of district heating, industrial combined heat and power stations, or the use of solar, tidal, wave and other types of energy. They also assume, somewhat pessimistically, that there will be no progress in the overall efficiency of the electricity supply industry during the remainder of this century. By and large they would presumably agree that less "conventional" attitudes could lead to sharper reductions in energy demand than they anticipate.

Domestic heating, lighting, cooking, *etc*, accounts at present for as much as one-quarter of Britain's energy demand+ though this sector of the economy is obviously not directly affected by the growth of the gross national product. The number of households by the year 2000 will probably be about 10 per cent higher than in 1976; and the study maintains that energy consumption in the domestic sector might,

+ In terms of net energy supplies, *ie* excluding certain losses, notably in the generation of electricity. For details, see footnotes to Table I:

**TABLE II**
**UK ENERGY CONSUMPTION BY FUELS a)**
Million tonnes coal equivalent

| | 1976 Actual | 2000 Minimum | 2000 Maximum |
|---|---|---|---|
| Coal | 120.1 | 83.2 | 162.3 |
| Oil | 149.4 | 124.2 | 224.1 |
| Natural Gas | 57.9 | 88.2 | 88.2 |
| Nuclear and Hydro | 14.6 | 39.7 | 102.2 |
| | 342.0 | 335.3 | 576.8b) |

a) Gross consumption (see Table I, footnote b). The fuel distribution in 2000 is hypothetical, as explained in the text.
b) It is assumed that, by fairly rigorous policies, the maximum could be kept down to 500 or less.

**Estimating UK Energy Demand for the Year 2000: A Sectoral Approach.* By J H Cheshire and A J Surrey. SPRU Occasional Paper series No 5. Sciences Policy Research Unit University of Sussex. Mantell Building, Falmer, Brighton, Sussex BN1 9RF, United Kingdom.

over these years, also rise by up to about one-tenth but that there is the chance of an actual standstill or even a slight reduction. There is certainly no reason to think that people in future will want to be much warmer, to use much more hot water, or to cook much more food; ownership levels of high-load electrical appliances, with the possible exception of freezers and dishwashers, are already approaching saturation point; and there is, at the same time, considerable scope for the wider use of more efficient heating installations and, above all, for improved insulation.

A recent survey shows that only 36 per cent of dwellings in the UK have some sort of loft insulation, that only 0.2 per cent have cavity wall insulation, and that the amount of useful energy required for space heating could be roughly halved if all dwellings were insulated to really high standards. There will, indeed, be some automatic improvement in insulation standards over the next two decades as obsolescent houses are replaced by modern dwellings; but there would also be a good case for improving the insulation standards of existing houses, if necessary with government assistance in the form of tax relief or low-interest loans. Persistent high unemployment could perhaps persuade governments of the advantage of a joint job-creation scheme linked to improved domestic insulation.

Turning to the important field of the manufacturing industries other an iron and steel, the study assumes a "maximum" annual production growth of 4 per cent and a "minimum" of 1 per cent over the 24-year period, roughly in line with the anticipated growth ranges for the national economy as a whole. Energy trends in the various manufacturing industries differ, but previous experiences, both during the "low-cost" period up to 1973 and during the "high-cost" period afterwards, show that there are in most industries continuous sharp reductions in energy requirements per unit of output, thanks to technical improvements, economies in scale, "waste" recovery, *etc.* Interestingly, the outstanding exception appears to have been in the engineering industries where higher labour productivity has been achieved by greater mechanisation, requiring more capital and more energy per employee.

Taking these previous experiences into account, and assuming that rising real energy prices will discourage an accelerated growth of the most energy-intensive industries, the authors postulate that, as a rule, a 1.0 per cent increase in industrial output will be accompanied by an increase in net energy requirement of only about 0.5 per cent. It would appear, on this basis, that net energy consumption in manufacturing industries during 1976-2000 will rise by a minimum of 12 per cent and a maximum of about 60 per cent, though *gross* requirements will rise somewhat faster because a higher proportion of the energy will probably be required in the shape of electricity. The study also makes the point that energy requirements would probably rise at a more rapid rate if energy prices in the UK were held below world price levels, if the availability of North Sea oil and gas led to a big expansion of the production of basic chemicals, or if there were a further shift in the composition of imports from raw materials to semi-finished goods, owing to the gradual industrialisation of Third World countries.

The iron and steel industries are treated separately, partly because of their great significance for one particular type of fuel — coking coal — and partly because of uncertainties raised by the possible replacement of iron and steel by other materials (aluminium, cement, plastics) and the possible establishment of iron and steel industries in other countries at the expense of the UK industry. There has been a long history of gradual improvements in the energy efficiency of iron and steel industries which will no doubt continue, but output projections for UK steelmaking capacity by the turn of the century vary from a minimum of 20 million tonnes/year (significantly less than at present) to as much as 40 million. The industry's net energy requirements could, therefore, either rise by up to 60 per cent or decline by up to 30 per cent over the period under consideration

### Still more motor cars

The study is perhaps unduly pessimistic about the prospects for energy conservation in the transport sector, where it foresees an increase in fuel requirements — almost exclusively liqud fuels — by somewhere between 35 and 57 per cent. The dominant factor in the recent past has, of course, been the expansion of road transport, notably private road vehicles, with the average number of cars for every 100 inhabitants going from 11 in 1960 to 25 in 1976. The present ratio is very similar to elsewhere in Western Europe, but the study assumes that it will rise by the year 2000 to at least 34 and possibly as much as 42.5 per 100. It also assumes significant further growth in freight traffic and, still more, in air traffic.

Car ownership in the British Isles is certainly not yet approaching saturation point but — given the different geographical, sociological and economic conditions — it may well be doubted whether it will ever reach the high present car density of the USA (45 per 100 people). The suggested "maximum" ratio for 2000 therefore appears unrealistic. The study recognises that "anti-motor" policies are inevitably unpopular though it recommends fiscal measures to foster greater fuel economy.

Be that as it may, the figures so far quoted indicate that the anticipated increase in fuel consumption as a whole is substantially lower than the assumed increase in the vehicle population. Experience shows that, as families acquire a second or third car, the *average* mileage for each single car tends to decline; and — unless the real price of motor fuel is allowed to fall — there is reason to anticipate significant fuel economies, perhaps by 40 or even 50 per cent, as a result of incremental technical improvements over the next two decades or so. A further reduction in motor transport could also result from government policies fostering public transport, and from developments in electronics and telecommunications, *etc.*

The study is curiously vague in its comments on commercial consumers and public services whose energy requirements in the year 2000 "will be in the range between 20 per cent above and 20 per cent below the 1976 level". The authors themselves seem to consider it improbable that the share of the "service" sector will continue to grow in relation to the economy as a whole, and they point out that many commercial buildings are "over-lit", while improved heating control systems in public buildings (according to one case study) could reduce energy requirements by as much as 30-50 per cent. ■

# Widespread profit gains in third quarter

Mixed financial results from the five major internationals and a positive improvement in performance by most leading independents were features of US oil company operations in the third quarter of 1978. For 18 companies tabulated, the average advance since July-September 1977 was only some 4 per cent, but for the 13 leading independents profits were 15% higher. For the nine months January-September the changes were less marked, amounting to 3% overall and 7% for the independents.

Third-quarter changes reported by the five majors ranged from a gain of 12% by SoCal to declines of 14% and 15% by Texaco and Exxon; but both the latter attributed the setback to foreign currency translation losses. Exxon, while conceding that the strengthening of most major foreign currencies temporarily boosted its foreign operating earnings in terms of dollars, indicated a net loss of $178 million due to the effect on its foreign currency financial obligations of the general weakening of the dollar. Current accounting requirements oblige it to report such foreign exchange effects, though these "balance sheet" items are highly volatile and could distort the true income position. Exxon stated that earnings from operations as such were 9.5% up in the third quarter, at $807m. Texaco similarly reported foreign currency translation losses ($52m) which were greater than its overall decline in earnings ($35m); but for Gulf, Mobil and SoCal they were a relatively insignificant item, amounting to a combined figure of some $30m.

Operating results in the third quarter were mostly good for the "big five", though both Exxon and Gulf reported declines at home, while SoCal and Texaco noted reduced profits abroad. There were clear signs of a strong recovery downstream, marked by higher prices for gasoline in the USA and natural gas in Europe. Taking the first nine months as a whole, three groups — Exxon, SoCal and Mobil — increased their profits in most sectors, to show gains of 4, 2 and 13% respectively. But Texaco's profits slumped by 23% due largely to increased costs in the context of gross crude production down by 9% in the USA and 15% in foreign areas. And Gulf, despite a good third quarter, reported nine-month earnings 7% down on a continued decline in worldwide refining and marketing profits, a further deterioration in chemicals, and a widening loss on nuclear involvement through its 50% stake in General Atomic.

**US OIL COMPANIES: NET EARNINGS**
Million dollars

| | July-September | | % | January-September | | % |
|---|---|---|---|---|---|---|
| | **1977** | **1978** | *change* | **1099** | **1978** | *change* |
| Exxon | 635.0 | 540.0 | *−15* | 1 855.0 | 1 920.0 | *+4* |
| Gulf | 195.0 | 208.0 | +7 | 577.0 | 538.0 | −7 |
| Mobil | 239.0 | 259.0 | *+8* | 702.0 | 795.0 | *+13* |
| SoCal | 236.0r) | 264.0 | *+12* | 734.0r) | 748.0 | +2 |
| Texaco | 247.9 | 212.8 | *−14* | 728.4 | 558.6 | *−23* |
| Total, majors | 1 552.9 | 1 483.8 | *−4* | 4 596.4 | 4 559.6 | *−1* |
| Amerada Hess | 33.9 | 30.6 | *−10* | 156.7 | 97.7 | *−38* |
| Atlantic Richfield | 193.9 | 220.5 | *+14* | 530.4 | 581.8 | *+10* |
| Cities Service | 40.2 | 52.6 | *+31* | 155.9 | 148.3 | −5 |
| Continental Oil | 81.0r) | 105.8 | *+31* | 298.7r) | 296.1 | *−1* |
| Getty Oil | 66.4 | 95.8 | *+44* | 223.9 | 225.7 | *+1* |
| Marathon Oil | 49.6 | 50.5 | *+2* | 139.9 | 151.3 | *+8* |
| Occidental Petroleum | 39.2 | 19.3 | *−51* | 92.5 | (−16.6) | − |
| Phillips Petroleum | 123.2 | 107.8 | *−12* | 369.8 | 411.1 | *+11* |
| Shell Oil | 209.0 | 249.0 | *+19* | 563.0 | 621.0 | *+10* |
| Standard (Indiana) | 273.3 | 286.5 | *+5* | 794.9 | 921.7 | *+16* |
| Standard (Ohio) | 36.5 | 125.7 | *+244* | 110.9 | 285.7 | *+158* |
| Sun Oil | 94.9 | 97.1 | *+2* | 269.1 | 270.9 | *+1* |
| Union Oil | 95.5 | 92.6 | *−3* | 253.2 | 258.5 | +2 |
| Total, others | 1 336.6 | 1 533.8 | *+15* | 3 958.9 | 4 253.2 | +7 |
| Grand total | 2 889.5 | 3 017.6 | *+4* | 8 555.3 | 8 812.8 | *+3* |

*r) Restated*

Among the 13 other companies listed, all but four showed solid gains in both periods. Apart from their virtual immunity from foreign currency factors, most of these domestically oriented companies had higher profits upstream on increased output and improved prices for crude oil and natural gas, as well as better earnings downstream due largely to strong demand for gasoline — which reached an all-time peak of 8 million b/d in August. Shell Oil and Standard of Indiana both underlined this as a potent factor in their higher profits. The latter's worldwide earnings were once again greater than those of any company listed bar Exxon.

The most spectacular gains were scored by Sohio, whose profits multiplied on the rising flow of North Slope crude, despite some oil refining and marketing problems and poor results for chemicals and coal. Arco's big stake in the Alaska pipeline was likewise a major factor in profits up by 14% in the third quarter and 10% for the nine months. Getty's third quarter boost of 44% reflected increased foreign crude production (primarily from the UK North Sea) as well as higher prices for domestic oil and gas. Conoco's 31% increase was attributed to improvements in all business areas, including coal and chemicals.

Special factors accounted for the significantly lower third-quarter profits of three companies. Amerada Hess, down 10%, was plagued by lower realisations on residual fuel sales. Occidental announced a 51% decline due largely to financial arrangements for a proposed legal settlement costing $11m; for the nine months, it showed a net loss of $16.6m compared with a year-earlier net profit of $92.5m, owing largely to write-downs of its European refining operations (see *Petroleum Economist* September 1978, page 374). Phillips Petroleum, with extensive foreign operations, was one of the few citing foreign currency translation effects as a major factor, amounting to a loss of $17.4m in the third quarter — sufficient to account for its 12% decline in earnings.

In general, however, this group of companies had a good third quarter with average gains of 15%, following a first half when profits were less than 4% up. According to the *Wall Street Journal*, analysts believe that many will report improved results for the fourth quarter and the full year as well. ■

strategies or goals of a program in progress. The engineering societies also have an advantage over permanent organizations in that they are not responsible for maintaining the employment level or "sales" of such a permanent organization; hence they can recommend program termination when a program is no longer useful.

Engineering societies have responded to requests for help in assembling forums for planning and review; the American Society of Mechanical Engineers, for example, is producing excellent results in developing a plan for R & D in tribology, and the Society of Automotive Engineers is proceeding effectively to plan R & D for road vehicle aerodynamics and tire and suspension rolling losses. Further, effective applied research in any of the technical disciplines requires a community with "critical mass." Planning and review by the engineering societies, as well as interagency coordination, help to assemble such a community, although the effort to make it most effective in furthering applied research should probably be supported by providing support in larger blocks, in one place, over relatively long periods of time.

## Conclusions

The critically important role of applied research has been identified in a number of specific past, present, and future activities related to fuel conservation. The importance of applied research generally tends to go unrecognized as compared with basic research and product development processes, not only in fuel conservation activities but in virtually every area of technology implementation. There are well-defined roles for both government and industry in the effective utilization of applied research, and the engineering societies offer a potentially effective existing framework for government and industry to implement these roles.

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# U.S. Energy Demand: Some Low Energy Futures


Demand and Conservation Panel of the Committee on Nuclear and Alternative Energy Systems


This article presents several plausible energy demand scenarios for the United States through the year 2010, each one derived from analytic efforts conducted by the Demand and Conservation Panel (*1*) of the National Research Council's Committee on Nuclear and Alternative Energy Systems (CONAES). While the CONAES study (*2*) covers a range of plausible energy futures—from continued rapid growth in demand to actual reductions in demand—we focus here on futures in which demands are lower, in order to provide insight into how energy demand growth can be reduced, and on the consequences of low energy growth. As a further effort to explore low energy growth, we assume future economic growth to be smaller than it has been in the past or than many think it likely to be in the future. This analysis is not intended to show that low demand futures are the most likely or the most desirable; instead, it is meant to illustrate the opportunities for lower energy demand growth and the public policies required to realize these opportunities.

Low energy futures could result from constraints on supplies that appear as higher prices, import restraints, rationing, taxes, or other public policies (for instance, in response to limitations on oil and gas imports, $SO_x$ and $CO_2$ production, and nuclear power). They could also result from a national decision to use energy resources more efficiently or from shifts in social priorities (such as less pollution of air and water). Adjustments to these changed conditions, whether in developing new energy supplies, expanding old ones, devising a more efficient utilization system, or changing the mix of goods and services demanded, will require decades of effort. To devise and implement a reasonable


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plan of action we must gain a better understanding of future supplies of energy (and their cost) and at the same time project plausible levels of demand for energy, identifying factors that can influence the future course of demand (energy price, population and income growth, status of technology, and so forth).

*Summary*. The basic features of the U.S. energy supply and utilization system change so slowly that an understanding of the dynamics of major change requires projections that extend several decades. Over such a time most energy-consuming capital stock is replaced, life-styles change, and technology evolves. This study of plausible low energy futures leans heavily on detailed engineering analysis of demand by sector, combined with econometric techniques where appropriate. The results indicate that, given time for the system to respond to prices, regulations, and incentives, U.S. energy demand is very elastic. Consequently, a major slowdown in demand growth can be achieved simultaneously with significant economic growth by substituting technological sophistication for energy consumption.

The scenarios presented here suggest that there is much more flexibility toward reducing energy demand than has been assumed in the past. Indeed, it appears that very similar conditions of habitat, transportation, and other amenities could be provided in the year 2010 with primary energy consumption ranging from 60 to 135 $\times 10^{15}$ Btu's (quads). This wide range of plausible future energy demands results from the technically possible responses to various price and policy possibilities.

## Background

For many decades before the 1970's, the price of a unit of energy was a small and steadily decreasing part of almost everyone's budget. Major discoveries of oil and gas, combined with rapidly advancing technology, led to falling energy prices and promoted enormous growth in consumption. Not only did we find ever-increasing uses for energy, but because the relative price was falling there was correspondingly less incentive to be concerned about efficiency of utilization; instead, expansion of production (especially of electricity) was attractive because each new generating unit was more efficient and helped lower the average cost of production. Despite falling energy prices and the consequent lack of concern for conservation, efficiency of energy utilization improved steadily. For example, industry's energy consumption per unit of output fell at a rate of 1 to 1.5 percent per year from 1950 to 1970 (*3*). Indeed, in the past half-century, U.S. energy consumption per capita rose by 50 percent while the productivity of that energy—the ratio of gross national product (GNP) to energy consumed—rose by 70 percent. Part of this improvement came about through conversion from coal to oil and gas (conversion of railroads from coal-fired steam to diesel) but much is attributable to other factors such as new processes and advances in materials (solid state electronics, improved insulation) that made possible more efficient energy conversion and utilization.

Between 1946 and 1973 amenities such as large automobiles, air conditioning, frost-free refrigerators, and home freezers changed from luxuries to necessities and found ready markets. The future, according to many observers, was filled with prospects of ever-cheaper energy that would provide for our many wants, enable resource production from low-grade ores, and turn deserts green with desalted water. Electricity so cheap that it would hardly pay to meter it was even conjectured. Such times of technological Nirvana now seem far more than 15 years in the past.

Several separate events occurred over the past decade that have profoundly influenced both our energy systems and our perception about the future.

- As low-cost domestic oil resources were consumed, the nation began, in the late 1960's, to depend on imported oil, which was then cheap. The hidden costs (vulnerability to cutoffs and discontinuities in price) of that dependence appeared with the oil embargo of 1973.
- Low-cost nuclear power emerged more slowly and turned out to be more costly than anticipated. Costs of other new energy forms (such as synthetic fuels from coal) also escalated rapidly.
- There was increased awareness in the 1960's of external costs of energy production, such as pollution and health and safety costs. External costs contributed to energy price increases in the 1970's as some of them were internalized. Some coal users switched to oil and natural gas, pushing up demand for those rapidly depleting energy forms.

The long-term trend of declining real energy price (that is, corrected for inflation) was reversed in the early 1970's, when major price increases were traumatically introduced by the Organization of the Petroleum Exporting Countries (OPEC) (fall 1973) and other fuel prices subsequently moved upward (Fig. 1). The trend toward higher prices is not likely to be reversed soon. At issue, therefore, is the extent to which society can respond to these higher prices not by sacrifice but through conservation—substitution of activities and increased efficiency of use.

## What Is Energy Conservation?

Few concepts are subject to as many different interpretations as energy conservation (*4*, *5*). In recent years, most people have associated conservation almost exclusively with curtailment, as unanticipated interruptions in supplies of oil and natural gas have forced Americans to cut back on energy use. In this article we do not view conservation as curtailment. Instead, conservation includes technological and procedural changes that allow us to reduce demand for energy (or specific scarce fuels) without corresponding reductions in the goods and services we enjoy. That is, conservation is a means of enhancing the energy user's perceived welfare; it leaves society materially better off than it would be otherwise and therefore is an act of enlightened self-interest; it implies that benefits of conservation actions exceed costs. These changes can be accomplished by substituting capital (insulation) or ingenuity (new microprocessor controls on heating systems) for the brute force use of energy to accomplish a particular task. Our definition allows for changes in the market basket of goods and services making up the GNP, as consumers shift to less energy-intensive goods and services to meet their needs (shifting to less energy-intensive modes of travel, buying more durable or repairable goods).

In the United States today the need for economic efficiency alone demands that energy be conserved. Energy is being wasted in buildings and industrial processes because they were designed in an era when today's energy scarcities and price levels were not foreseen; the energy component of operating costs was then too small to warrant much attention. Today we find it cost-effective to upgrade much energy-consuming equipment and to build more energy-efficient vehicles, industrial equipment, and buildings for the future. In the past, government policies led to energy prices far below replacement cost—the price level that would occur under perfect market conditions. As these policies are changed, higher levels of energy conservation will become economic.

Many advocates argue for more energy conservation than even "perfect" market signals would call for. The most commonly cited reason is that we should reduce oil imports to minimize our vulnerability to embargoes and our balance-of-payments deficits. Some of the other reasons have to do with timing; President Carter maintains that energy conservation can give us time to reevaluate our commitment to the plutonium breeder reactor and possibly achieve a significant reduction in the risks of nuclear proliferation. Holdren (*6*) and Lovins (*7*) suggest that too much energy too soon may create greater hazards than too little too late and recommend energy conservation policies. Conservation would provide the nation with the flexibility to pick and choose among long-term energy options as the uncertainties surrounding nuclear waste management, the technology of solar cells, and the climatic effects of fossil fuel combustion are clarified. Kissinger (*8*) points to the possibility that oil exporting nations may accumulate balance-of-payments surpluses large enough to precipitate financial crises and economic chaos in the industrial democracies of the world. Other reasons for conserving energy are based on ethical considerations such as the fact that the United States has only 5 percent of the world's population, yet consumes more than one-third of the world's energy, and the belief held by environmentalists that major external costs remain in the energy system and that much of our finite energy resources should be saved for future generations.

**The Demand Study**

In this study the Demand and Conservation Panel examined some plausible paths that energy demand might take in the future (through 2010) in response to price and other factors. It was undertaken in support of a more comprehensive CONAES study of the future of energy supply and demand (*2, 9*). Panel members were chosen to provide a diversity of points of view and disciplinary skills. Additional resources and expertise were brought into the study by several resource groups, which were formed by the Panel to examine specific issues (*1*).

At the outset, the Panel encountered considerable conventional wisdom about energy use that has found extensive, if tacit, acceptance in various segments of American society. The following are some examples of what are now known to be misconceptions about energy use.

- Energy and the production of goods and services are intimately and inextricably linked: energy is a relatively fixed factor in GNP.
- Energy consumption and jobs are inextricably tied together; more energy consumption means more jobs, and vice versa.
- Higher illumination levels generally help productivity; low illumination is injurious to the eyes.
- Reducing the growth of energy consumption implies replacement of machines (bulldozers) with manual labor (men and women wielding picks and shovels).
- Turning down the thermostat at night is counterproductive; the energy used in heating up the house in the morning more than offsets any savings.

This kind of folklore indicated a need to develop a more quantitative technical and economic understanding of the dynamics of energy consumption. The Panel decided to map out a broad range of plausible future levels of consumption (*10*). Since consumption is influenced by many factors, certain things were assumed, such as population growth rate at Census Bureau series II, and others were allowed to vary, notably the price of energy, the economic growth rate, and public policies.

Economic growth was assumed to vary linearly in time, with total (real) GNP doubling by 2010. In a variant analysis GNP was allowed to triple by 2010. The latter case corresponds to an average real GNP growth of 3 percent per year between 1975 and 2010 with higher than average growth in the near term (for example, 4 percent) and lower growth in the long term, reflecting lower population growth. In this article we report results based on the assumption of a 2 percent average growth rate, again with higher than average growth in the near term. It should be emphasized that even in these low-demand futures we assume a doubling of real income over the next 35 years.

For most scenarios, price was used as the primary driving force behind the different outcomes. There were three pricing assumptions, corresponding approximately to prices four times, double, and equivalent to 1975 prices (see Table 1). A very low growth variant, assuming significant changes in life-style, was also studied.

Prices serve many functions in a market economy. They reflect the relative scarcity of resources and serve as signals to producers and consumers in allocating the supply of and demand for energy resources. Prices assumed for the scenarios were allowed to reflect external costs as they affect occupational and public health as well as environmental quality, and the degree to which these costs become internalized in the costs of energy products.

Public policies can serve these functions as well. First, they can and do affect price. Environmental regulations internalize costs, tax policy affects pricing patterns, and regulatory agencies (such as state utility commissions) sometimes set prices. For example, in response to external costs, regulation has set minimum standards on car safety, air pollution, pesticides, strip-mining, and mine safety. Second, conservation education can shift the mix of goods and services demanded as well as their energy efficiency. Third, tax subsidies can and have promoted production. Therefore

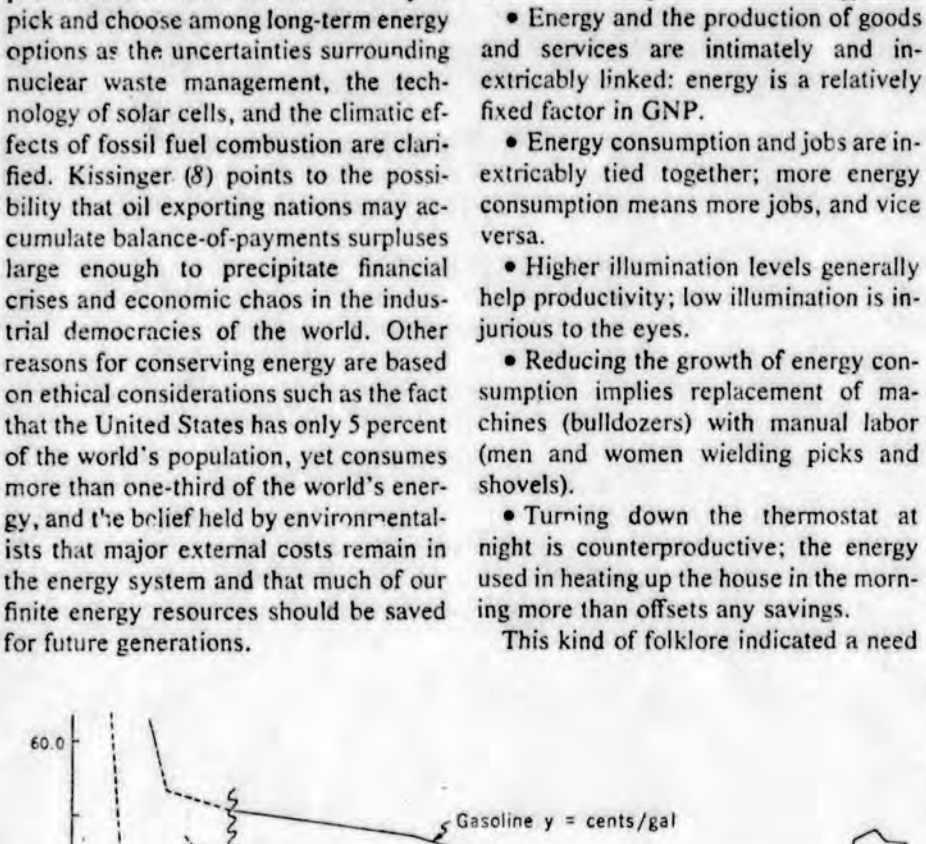


Fig. 1. History of residential energy prices (1976 dollars).

public policies can be alternatives or surrogates for price changes, seeking to reflect social value and cost and guide producers and consumers in decisions concerning production and consumption.

In analyzing the dynamics of demand over such an extended period of time it was decided to invoke several different techniques.

1) *Near future (the next decade).* Since energy consumption patterns in this period will strongly reflect the characteristics of existing capital stock, the most appropriate approach was felt to be econometric analysis. In applying this technique, recent trends in energy consumption were analyzed and used to project demand as influenced by both price and nonprice factors. Statistical techniques were used to determine the past quantitative relationships of energy use to energy prices, conservation efforts, incomes, GNP, population, and other demographic and economic factors. Energy demand in the future was defined by the interaction of these observed historical relationships tempered by the assumptions of future economic and demographic variables. Although this technique can be used to examine historical variations in energy use in relation to geographic variations in energy prices and income to obtain near-term insights, it has limited validity for application to the distant future. It cannot logically be applied to periods with major differences in economic structure or energy prices. The contribution of econometrics to the work of the Panel was that it indicated whether the short-term response to assumed prices and incomes in each scenario leads energy demand to follow a path in the near future that is consistent with the Panel's energy projections into the next century.

2) *Longer-term future (to 2010).* Energy consumption characteristics of various amenities (such as transportation and habitat) can change markedly over periods comparable to the average lifetime of energy-consuming capital equipment (cars, air conditioners, and houses). Social conditions and attitudes can also change greatly over a 35-year span. Therefore, even though our analysis will undoubtedly turn out to be somewhat off the mark, it is important because actions taken today will significantly affect the conditions that exist in 2010. A detailed engineering approach was taken to analyze plausible energy trends in each consuming sector over the long term. Energy consumption was partitioned into three sectors—residential and commercial buildings and appliances, industry, and transportation—

Table 1. Detailed price schedules for key fuel types were determined for each scenario. Average consumer prices for distillate oil, natural gas, utility coal, and electricity in 2010 are given in 1975 dollars per million Btu's. Prices are assumed to change slowly and continuously between 1975 and 2010.

| Scenario | Consumer price ($/MBtu) | | | |
|---|---|---|---|---|
| | Distillate oil | Natural gas | Utility coal | Electricity |
| | | *1975* | | |
| Actual | 2.81 | 1.29 | 0.81 | 7.91 |
| | | *2010* | | |
| I and II | 13.49 | 14.84 | 3.24 | 26.37 |
| III | 6.74 | 7.42 | 1.62 | 15.82 |
| IV | 2.81 | 3.09 | 0.81 | 7.91 |

which were examined independently. The results of the independent sectoral demand analyses were integrated, using energy input-output analysis to make them consistent with a specified market basket of goods and services making up the GNP in each scenario.

For the scenarios presented here, the real GNP growth rate was assumed to slowly decline from 3 percent in the late 1970's to about 1 percent in 2010, corresponding to a linear increase and a doubling of real GNP over the 35-year period. The reduced GNP growth rates in the latter years stem from expected reductions in the rate of growth of population and the labor force. The assumption that GNP will rise while the labor force is leveling off implies a positive rate of growth in productivity, but does not specify the sectors in which it occurs. The scenarios may be taken to reflect various assumptions about relative price changes in energy and nonenergy sectors, or price may be considered simply a surrogate for a variety of government policy options.

All scenarios implicitly account for the development and market penetration of new technologies and products. This is accomplished by specifying the market basket of consumer goods and services consistent with a fixed GNP. Any new product within this limit would have to displace another; only the differential energy requirement would be relevant.

*Caveats.* Neils Bohr pointed out that "it is very difficult to make an accurate prediction, especially about the future." We feel that for such subjects as energy demand it is even very difficult to make an accurate projection. Thus, we present our major disclaimers about the study.

- It is assumed that the future unfolds smoothly. Energy prices are a primary driving force behind the analyses, and it is assumed that they are known to energy users or that appropriate regulations compensate for the lack of perfect information. If there is extreme uncertainty about energy prices, and reason to believe that they may drop significantly, many persons will choose not to make major capital investments in conserving technologies.
- For most of the outcomes studied it is assumed that personal tastes will not change very much from those of today. Roughly the same (albeit twice as large) market basket of goods is to be provided to consumers in 2010 as today. Changes

Table 2. Energy demand scenarios.

| Scenario | Energy price ratio, 2010/1975* | Energy conservation policy | Energy in 2010 (quads) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Buildings | Industry | Transport | Total | Losses† | Primary consumption‡ |
| I | 4 | Very aggressive, deliberately arrived at reduced demand requiring some life-style changes | 6 | 26 | 10 | 42 | 16 | 58 |
| II | 4 | Aggressive; aimed at maximum efficiency plus minor life-style changes | 10 | 28 | 14 | 52 | 22 | 74 |
| III | 2 | Slowly incorporates more measures to increase efficiency | 13 | 33 | 20 | 66 | 28 | 94 |
| IV | 1 | Unchanged from present policies | 20 | 39 | 26 | 85 | 51 | 136 |
| 1975 | | | 16 | 21 | 17 | 54 | 17 | 71 |

*Overall average; assumptions by specific fuel type were made reflecting parity and supply; price increases were assumed to occur linearly over time. The price was assumed to be either that actually charged at the final point of demand or the shadow price reflecting a policy. †Losses include those due to extraction, refining, conversion, transmission, and distribution. Electricity is converted at 10,500 Btu/kWh, coal is converted to synthetic liquids and gases at 68 percent efficiency. ‡These totals include only marketed energy. Active solar systems provide additional energy to the buildings and industrial sectors in each scenario. Total energy consumption values are 63, 77, 96, and 137 quads in scenarios I, II, III, and IV, respectively.

Table 3. Total primary energy consumption in 2010 by fuel type. Each set of numbers represents only one of a wide variety of energy resources that could be used to meet energy demands. Because energy resources are largely interchangeable over the long run, the actual mix in 2010 can be influenced by changes in price, technology, and policy.

| Fuel type | Total primary energy consumption (quads) | | | | |
|---|---|---|---|---|---|
| | Scenario | | | | 1975 |
| | I | II | III | IV | |
| Liquid fuels* | 24 | 29 | 38 | 50 | 30 |
| Gaseous fuels† | 8 | 9 | 11 | 26 | 17 |
| Coal (direct use)‡ | 10 | 11 | 13 | 10 | 4 |
| Electric inputs§ | 17 | 26 | 32 | 50 | 26 |
| Total purchased fuels‖ | 58 | 74 | 94 | 136 | 71 |
| Active solar¶ | 5 | 3 | 2 | 1 | Negligible |
| Totals | 63 | 77 | 96 | 137 | 71 |

*Liquid fuels include petroleum, shale oil, and synthetic liquids derived from coal. †Gaseous fuels include natural gas and gasified coal. ‡Figures do not include coal used for liquid and gaseous fuels (necessary in most of the scenarios) or for electricity production. §Includes coal, nuclear, hydro, geothermal, and oil (for peak demand only). ‖Because of rounding off, totals may not equal the sums for fuel sectors. ¶Estimated use of active solar units in buildings and industry.

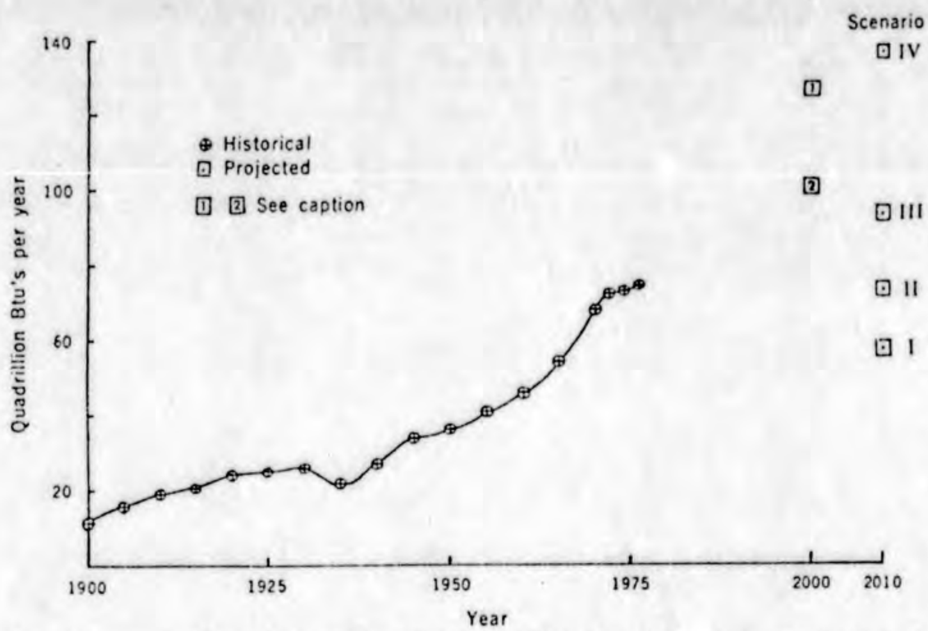


Fig. 2. Summary of total U.S. energy demand scenarios. Some information was obtained on values for 1990, but the detailed evaluations were focused on 2010. Other results shown for comparison are [1] the Energy Policy Project (EPP) (*16*) "tech fix" case and the Institute for Energy Analysis (IEA) (*18*) "high" case, and [2] the EPP "zero energy growth" case and the IEA "low" case.

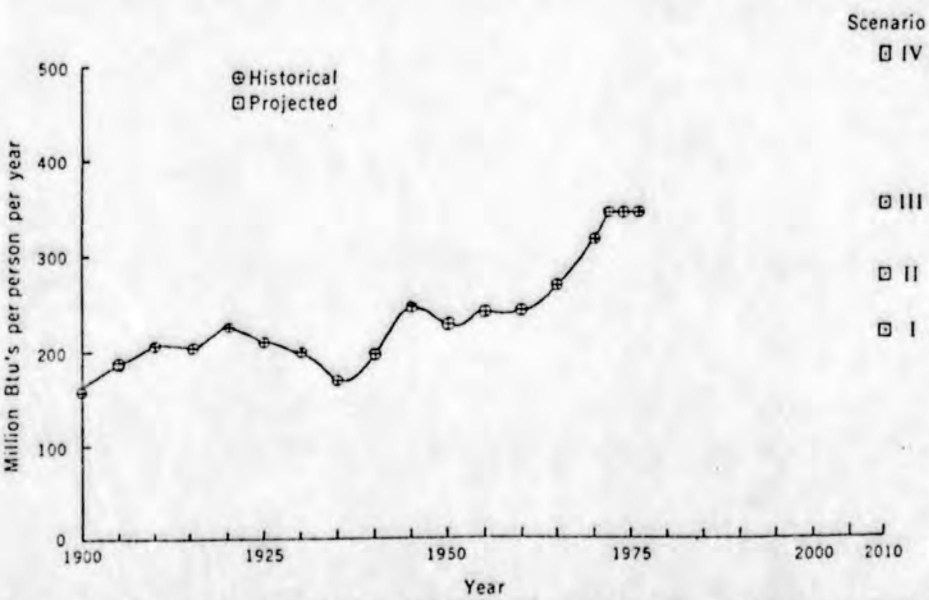


Fig. 3. Per capita energy demand history and projections. Population growth rate was assumed to be that given by Census Bureau series II.

in values could modify this assumption drastically.

• Because the use of energy in the United States is so inefficient, energy consumed in providing an amenity can be reduced by changes in efficiency over a relatively wide range (*11*, *12*). That is, an increase in the real price of energy can make it economically very attractive to use less energy to provide a particular amenity. Recent history shows that the effect of price can just as easily be produced by regulation, standards, incentives, and disincentives; it can also be produced by supply uncertainty, especially in the industrial sector.

• Long-term economic growth is exceedingly difficult to predict because it depends on vagaries of population growth, politics, social attitudes, labor productivity, technological innovation, and resource availability. Therefore any long-term GNP or, for that matter, population assumption is subject to challenge.

• Almost all of our past experience with energy (the basis for econometrically derived price elasticities) has been in an era of falling real energy prices. The lag times associated with price elasticities may not be applicable under conditions of rising real prices.

• Energy consumption models that are primarily based on engineering can only be approximate; this is partly because assumptions must be made about economically rational market behavior. For example, people may choose to buy a slightly cheaper, low-efficiency refrigerator and pay higher operating costs.

• New kinds of unusually energy-intensive consumer goods are not assumed explicitly but neither are new kinds of energy-saving technologies. Either or both could change demand patterns significantly in a decade.

• Energy prices are assumed to reach parity—that is, price is assumed to reflect the quality of energy—by the middle 1980's. (This means that coal will continue to be priced lower than oil or gas on a Btu basis.)

## Results of the Analyses

Results are presented here for four demand growth scenarios. Each is believed to represent an internally consistent picture of the U.S. economic system in the year 2010. No scenario is presumed to be more probable than the others. They represent a broad range of plausible alternative futures, within the focus of this article on lower-demand futures.

The characteristics of the scenarios are summarized in Table 2. The scenarios highlight the strikingly wide range of energy efficiencies that appear to be technically and economically feasible for a particular level of economic activity. The energy demand paths are illustrated in Fig. 2. The demand levels in 2010 were obtained by using input-output synthesis of the separate sectoral analyses. Trends and projections in terms of per capita energy demand are shown in Fig. 3 and the energy GNP ratio in Fig. 4.

Plausible energy supply mixes corresponding to the scenarios are summarized in Table 3. However, it must be remembered that over a period of decades the mix of fuels (as well as aggregate demand) can change considerably. A discussion of the amount of electricity that could be used is given later in this article. The energy supply mixes shown in Table 3 are quite conventional: resource conservation significantly reduces the imperative for crash programs to develop new technologies and provides the flexibility to eliminate one or more technologies for environmental or safety reasons.

In scenario I we examine a set of fairly extreme changes by considering the combined implications of substantially higher energy prices, significant life-style accommodations, and reduction of energy consumption by equipment to approximately 60 percent of the per capita level today. Some shift of the population to warmer climates and colocation of industry and residences is assumed. For the intermediate scenarios (II and III), we assume substantially higher energy prices and corresponding major market accommodations to obtain amenities less expensively. The results for scenario II indicate the extent to which a society that chooses a high efficiency of utilization, through technical sophistication and innovation of its social institutions, can avoid substantially modifying the nominal market basket of goods and services. The results obtained for scenarios III and IV reflect a future much like today, where efficiency improvements in familiar energy-consuming devices permit production of goods and services with corresponding changes in life-styles. It should be noted, however, that even though the assumed efficiency improvements are cost-effective in terms of assumed energy prices, they are not likely to be achieved in the absence of supportive policies.[7]

*Econometric results.* Long-run price elasticities were found to be comparable to those reported in other recent studies (13). The greatest response observed was the long-run price elasticity of −1.7 (industrial use of natural gas), while the smallest was the elasticity of −0.4 for gasoline use with respect to gasoline price. Historic price responses provide a basis for examining how near-future growth in energy demand may vary with energy price.

Differentiation of conservation, price, and income influences in reducing energy demand in 1974 showed that after the increase in energy prices and the decline in personal incomes throughout the country were taken into account, energy use fell below what would be expected from this price- and recession-induced decline. This nonprice-induced conservation effect accounted for further reductions in use of 6 percent (residential-commercial electricity) to 13 percent (industrial use of coal). It probably reflected lower speed limits, increased energy awareness, and simple improvements in energy management. It is impossible to know whether this nonprice effect will continue in the future; however, it apparently existed in a weaker form in 1975, and essentially disappeared in 1976. One such projection (for scenario III) is reproduced in Fig. 5. It shows the near-future econometric forecast associated with twofold growth in real energy prices from 1975 to 2010.

*Opportunities for improved efficiency*

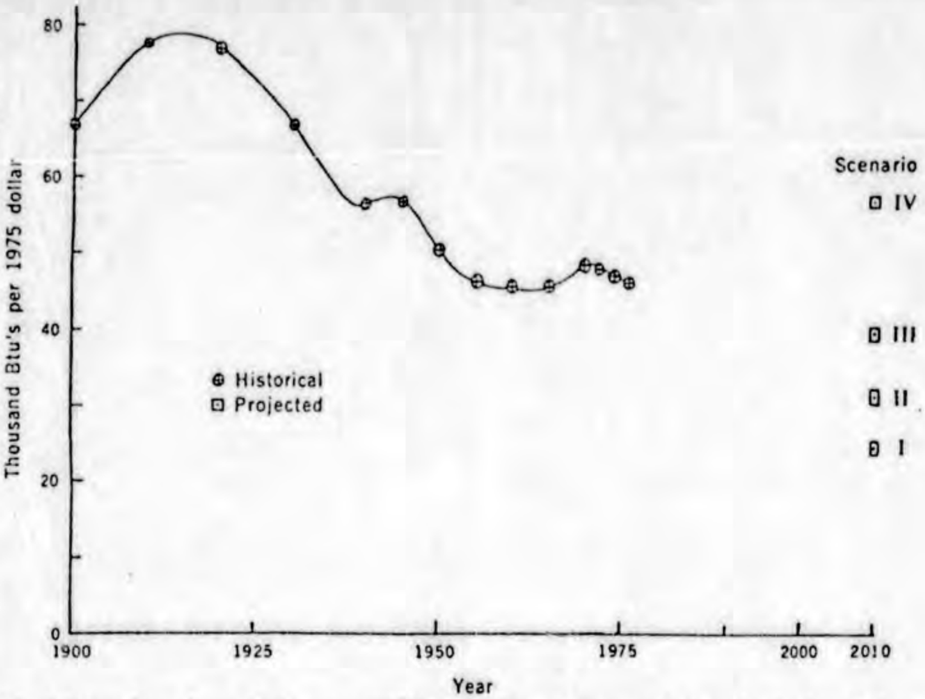


Fig. 4. Time dependence of the energy/GNP ratio. Many factors such as market basket choices and the price of energy can affect this ratio. Long-term trends in the ratio reflect changes in technology as they affect the energy intensity of new capital stock.

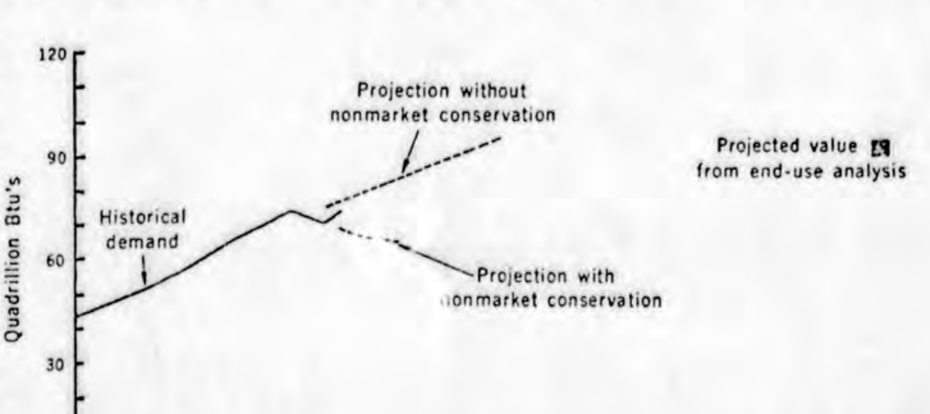


Fig. 5. Energy demand projection for the next 10 years. This example, corresponding to scenario III, indicates the range of total U.S. energy demand that could occur. The upper dashed line corresponds to demand driven by price factors, the lower one to demand influenced by price factors as well as nonmarket factors, including heightened awareness and regulations similar to those existing in 1974 and 1975. The demand value in 2010 obtained through detailed end-use analysis is consistent with extension of the range of econometrically derived demand.

*of use*. Analyses of the engineering potential for higher efficiency show that major opportunities exist in all sectors of demand and that the economic incentive to shift to higher efficiency is a strong function of the price of energy. Figures 6, 7, and 8 illustrate this point (*10, 14, 15*). Although the most impressive opportunities for higher efficiency of use occur with *new* capital goods, there are also many good ways to improve the efficiency of the existing system (operation of buildings, industrial processes).

### Highlights of the Scenarios

*Scenario IV*. With the exception of the price of natural gas (which more than doubles by 2010), energy prices remain constant in this scenario over the entire period, possibly because of breakthroughs in the supply sector or public policies that provide subsidies to energy price. Higher gas prices might result from either deregulation of wellhead prices, regulation at increased price levels, or the introduction of synthetic gas produced from coal.

Despite the lack of higher energy prices, the incentive to increase efficiency of use is greater than it was before 1972, because in those years real energy prices were falling. Furthermore, energy prices are higher today than they were when most existing capital investments were made. Therefore there are additional incentives to increase efficiency even without further improvements in the technology of energy utilization. As a consequence, the efficiency of energy use improves modestly over the period. Representative changes are given in Table 4.

In the buildings sector, the lagged effect of postembargo energy prices and public policy actions already under way result in efficiency improvements in new stocks through 1980. Because of continued increases in gas prices, small improvements in most gas appliances occur beyond 1980. The better performance in new products and buildings is felt throughout the period to 2010 as older stocks are replaced. However, improvements occur very slowly; for example, electric space heating continues to be dominated by resistance heaters. In the industrial sector the historic trend to lower energy consumption per unit output continues but at a slower pace, resulting in an overall drop of 18 percent by 2010.

In transportation, per capita energy consumption grows modestly, but technological advances result in small improvements in efficiency. Current policies [such as miles per gallon (MPG) standards for automobiles] continue. No significant shifts occur in freight modes, but the percent of consumer transportation expenditures in air travel increases as automobile travel begins to be saturated (ownership, minutes traveled per day, and so on). Transportation energy intensiveness drops in all sectors. Mass transit travel (per capita) nearly doubles.

*Scenario III*. In this scenario real energy prices steadily climb, ending in 2010 at twice the 1975 levels. These increases are mostly due to higher production costs as cheap supplies of fossil fuels are exhausted. There are substantial efficiency increases in the buildings, including improvements in thermal integrity of structures and increased efficiency of appliances (see Table 5). Overall building energy use *decreases* at an average annual rate of 0.6 percent, compared to growth of 3 percent per year from 1950 to 1975. The major reason for the decrease in growth rate is the reduction in space heating requirements. Because of differences in assumed energy prices, the relative market share of electricity increases from 21 to 51 percent, while the natural gas share declines from 53 to 21 percent. Electric heat pumps become more efficient and find widespread use. Solar energy becomes increasingly important toward the end of the period for air conditioning, space heating, and water heating. The energy efficiency ratio of new air conditioners in 2010 is close to 10 Btu's per watt-hour (compared with 6 Btu/W-hour in 1975). Because of the increase in energy prices, there are increased expenditures for energy in buildings. However, the percentage of personal income spent for household fuel increases only moderately, from 3.1 in 1975 to 4.3 in 2010. There is a corresponding increase of 3 percent in capital expenditures for buildings and appliances during the period. The technologies to produce the higher efficiencies in this scenario are either currently on the market or are achievable by well-known means. Figures 6 and 7 indicate the kinds of improvements that

Table 4. Energy efficiencies in 2010, according to scenario IV.

| Buildings and appliances | | Industry | | Transportation | |
|---|---|---|---|---|---|
| Type | Intensity* | Type | Intensity† | Type | Intensity‡ |
| Thermal integrity (heating) | | Agriculture | 0.95 | Automobile | 20 mpg |
| Residential | 0.76 | Aluminum | 0.79 | Light trucks and vans | 16 mpg |
| Commercial | 0.7 | Cement | 0.75 | Air passenger | 0.5 |
| Government and education | 0.5 | Chemicals | 0.84§ | Truck freight | 0.9 |
| Space conditioning | | Construction | 0.73 | Air freight | 0.6 |
| Air conditioning | 0.94 | Food | 0.86 | Rail freight | 1.0 |
| Electric heating | 0.9 | Glass | 0.82 | | |
| Gas and oil heating | 0.8 | Iron and steel | 0.83 | | |
| Refrigeration and freezing | 0.92 | Paper | 0.76 | | |
| Lighting | 0.70 | Other industry | 0.85 | | |

*Energy intensity of new construction and products in 2010 compared with 1975. †Average energy per unit production in 2010 compared with 1975. ‡When figures are not given in designated units they refer to energy intensity in 2010 compared with 1975 (including changes in load factor). §Excluding feedstock.

Table 5. Energy efficiencies in 2010, according to scenario III.

| Buildings and appliances | | Industry | | Transportation | |
|---|---|---|---|---|---|
| Type | Intensity* | Type | Intensity† | Type | Intensity‡ |
| Thermal integrity (heating) | | Agriculture | 0.85 | Automobile | 27 mpg |
| Residential | 0.63 | Aluminum | 0.63 | Light trucks and vans | 21 mpg |
| Commerical | 0.6 | Cement | 0.63 | Air passenger | 0.45 |
| Government and education | 0.45 | Chemicals | 0.78§ | Truck freight | 0.8 |
| Space conditioning | | Construction | 0.65 | Air freight | 0.6 |
| Air conditioning | 0.75 | Food | 0.76 | Rail freight | 0.97 |
| Electric heating | 0.63 | Glass | 0.76 | | |
| Gas and oil heating | 0.75 | Iron and steel | 0.76 | | |
| Refrigeration and freezing | 0.68 | Paper | 0.71 | | |
| Lighting | 0.70 | Other industry | 0.75 | | |

*Energy intensity of new construction and products in 2010 compared with 1975. †Average energy per unit production in 2010 compared with 1975. ‡When figures are not given in designated units they refer to energy intensity in 2010 compared with 1975 (including changes in load factor). §Excluding feedstock.

might be expected in the energy efficiencies of structures and appliances. Similar improvements are likely for other kinds of appliances and buildings.

In the industrial sector the steadily increasing price of energy results in slower production growth in the energy-intensive aluminum and chemicals industries than in industries producing less energy-intensive substitutes. The overall weighted average energy consumed per unit output in 2010 is 26 percent lower than in 1975. Some shifts have occurred between producing sectors (less steel, more aluminum and fiber glass), reflecting changed demands by manufacturers and the construction industry. Industrial cogeneration becomes widely practiced.

In the transportation sector, per capita energy consumption in 2010 remains about the same as in 1975 despite slightly expanded passenger and freight movement. The average energy intensity of automobiles (Btu's per vehicle mile) drops to half of the 1975 value, reflecting large gains in automobile performance (Fig. 8). Airline travel grows at an average 2 percent per year. Mass transit use in 2010 (passenger miles per capita) is 3.5 times that in 1975. Although water freight stays relatively constant, rail freight expands (in ton-miles per capita) by about 30 percent and truck freight by

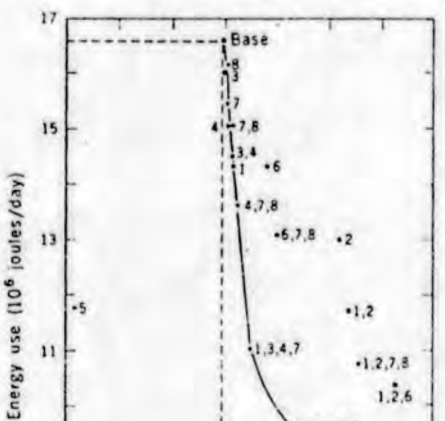


Fig. 6. Energy intensiveness of a typical household refrigerator-freezer combination, plotted against purchase price. The energy intensiveness falls rapidly for relatively small increments in first cost (*14*). Modifications corresponding to the numbered points were: 1, increase insulation thickness; 2, improve insulation thermal conductivity; 3, remove fan from cooled area; 4, add antisweat heater switch; 5, eliminate frost-free and forced air systems; 6, improve compressor efficiency; 7, increase condenser surface area; and 8, increase evaporator surface area.

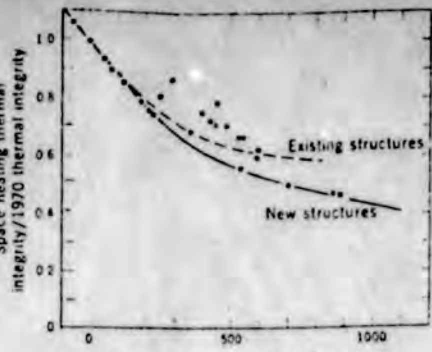


Fig. 7. Energy intensiveness of new and existing residential dwellings as a function of investment in construction (or retrofit). Energy intensiveness falls rapidly for small increases. There are more cost-effective opportunities for new structures because insulation investments cut the required size (and therefore cost) of heating and cooling systems (*15*).

40 percent, and air freight expands threefold.

*Scenario II*. In this case consumption in 2010 is about the same as today, after going through a peak around 1990. Energy prices increase substantially for all energy forms over the 35-year period from 1975 to 2010. Real energy prices are assumed to essentially quadruple by 2010. Public policies provide incentives, taxes, standards and regulations, vigorous research and development (R & D), and public education to help accelerate the United States toward high efficiency of energy utilization.

Because of the higher prices, there are substantial improvements in new appliances, and buildings are carefully designed and constructed for efficient energy use (Table 6) More energy improvements are made in existing buildings than in scenarios III and IV. As a result, overall energy use in buildings declines from 16 quads in 1975 to 11 quads in 2010. Although energy consumption is reduced somewhat, the very high energy prices result in substantial increases in expenditures for fuel. However, increases in income over the period reduce the relative impacts so that residential fuel expenditures increase only from 3.1 to 4.9 percent of personal income. Thermostats are set back and room temperatures are kept lower in winter (68°F) and higher in summer (75°F). Some new appliance technologies are introduced in this scenario. For example, high-efficiency electric and gas heat pumps may be developed and widely adopted with thermal storage (the annual cycle energy system, where heat is stored in water). Decentralized uses of solar energy for space heating, air conditioning, and water heating make a substantial contribution near the end of the period (25 percent of new air conditioners, 50 percent of new space heaters, and 70 percent of new water heaters in 2010). Improved retrofit measures and construction practices are an important aspect of the scenario. Retrofit measures include extensive insulation of previously uninsulated exterior walls. Passive solar house construction, consisting of heavily insulated structures with a large area of windows facing south, become popular after 1990. Typical house construction would include double 2 by 4 inch exterior walls with a full 8 inches of insulation and 12 inches of insulation in ceilings. Some underground or earth-covered construction would further reduce the energy consumption.

Industry responds to the price trends and tight government regulations and makes large investments in both retrofit and new process development, resulting in an overall decrease in energy consumed per unit output that reaches a value 34 percent lower in 2010 than in 1975. However, the cost of conversion to new, more efficient processes still does not warrant a significantly accelerated write-off of existing plants purely for energy reasons. To achieve this improved efficiency current air pollution standards are not tightened. Throwaway packaging de-

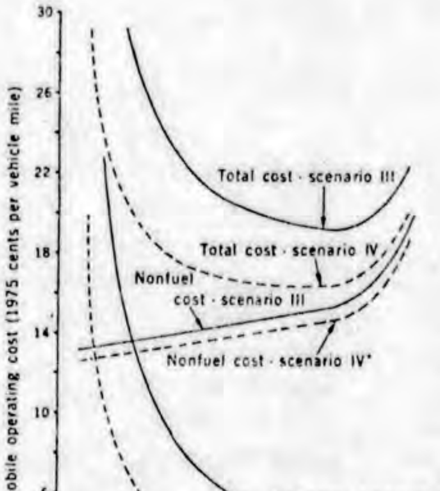


Fig. 8. Total cost of private automobiles plotted against mileage performance achievable by 1985. To provide approximately the same interior space, safety features, and so on, a more energy-efficient car is more expensive, but the added cost is not great for mileages less than 35 to 40 miles per gallon. Balanced against operating costs, the total cost of ownership and operation is remarkably insensitive to mileage. Note that nonfuel cost includes such items as depreciation, maintenance, garaging, parking and tolls, insurance, taxes and fees, and interest lost.

proved efficiency, saving 1 qu[illegible]

No changes are made in the air transport sector beyond those in effect for scenario II. Energy use for freight transportation is reduced by one-third (2.0 quads) by shifts toward a more service-oriented economy and by strong policies promoting shifts from truck to rail transport.

The mix of goods and services constituting the GNP in all other scenarios showed only income effects, such as saturation of food purchases and increases in purchases of durable goods. If present trends continue toward higher prices for all resources (including energy) relative to labor, it may be expected that goods will be made more durable and will be maintained longer. Under such conditions the consumer market basket would shift away from goods toward services (including repair and maintenance).

Table 6. Energy efficiencies in [illegible]

| Buildings and appliances | | Industry | | Transportation | |
|---|---|---|---|---|---|
| Type | Intensity* | Type | Intensity† | Type | Intensity‡ |
| Thermal integrity (heating) | | Agriculture | 0.85 | Automobile | 37 mpg |
| Residential | 0.63 | Aluminum | 0.55 | Light trucks and vans | 30 mpg |
| Commercial | 0.42 | Cement | 0.60 | Air passenger | 0.42 |
| Government and education | 0.35 | Chemicals | 0.74§ | Truck freight | 0.6 |
| Space conditioning | | Construction | 0.58 | Air freight | 0.6 |
| Air conditioning | 0.66 | Food | 0.66 | Rail freight | 0.91 |
| Electric heating | 0.52 | Glass | 0.69 | | |
| Gas and oil heating | 0.72 | Iron and steel | 0.72 | | |
| Refrigeration and freezing | 0.58 | Paper | 0.64 | | |
| Lighting | 0.60 | Other industry | 0.57 | | |

*Energy intensity of new construction and products in 2010 compared with 1975. †Average energy per unit production in 2010 compared with 1975. ‡When figures are not given in designated units they refer to energy-intensity in 2010 compared with 1976 (including changes in load factor). §Excluding feedstock.

clines. Production of chemical foams and fiber glass for expanded thermal insulation increases; production of materials for strong but lightweight automobiles is expanded. Industrial cogeneration and power plant waste heat utilization become commonplace.

The most efficient automobiles, using new technologies such as the Brayton and Stirling engines, are introduced beginning in the late 1980's. Federal MPG standards set under the Energy Policy and Conservation Act of 1975 (Public Law 94-163) are reached and new standards are set, taking full advantage of the technological potential to increase mileage. People spend about 30 percent more time in cars, on the average, than in 1975. Air passenger miles per capita increase to a level about 60 percent greater than today's, while telecommunications technology improves substantially. Increased demand results in two generations of aircraft by 2010, which provide one-third more seat-miles per gallon. Airplane load factors increase from 55 to 75 percent as a result of government policy. Some modal switching from truck to rail occurs, and improvements in truck fuel efficiency and load factors yield substantial energy savings. Despite expanded per capita use (miles traveled, tons carried) the energy consumed in this sector in 2010 falls by 18 percent. Per capita use of mass transit expands nearly fivefold.

*Scenario I.* This scenario received less detailed attention than the others; it was derived by making incremental changes in the assumptions for scenario II concerning additional energy-conserving policy actions. As is the case for any level of energy use, many possible configurations of technology and life-style are compatible with an energy use of 59 quads at twice today's GNP. Here we describe only one set of changes relative to scenario II. We emphasize that such a scenario could not occur without aggressive, coordinated long-term policy actions in the areas of land use, transportation, and electric utility regulation. A more restricted set of policies limited to energy use (efficiency standards, energy taxes) probably could not achieve such a large reduction in energy use by 2010.

Energy use in buildings is reduced through improved building materials and construction techniques, including expanded use of passive solar design, and extensive use of such techniques as annual cycle energy systems, as well as active solar units. Continued migration to "sun belt" states occurs, along with acceleration of trends toward multifamily units. These measures combine to reduce end use for space conditioning and water heating to a level about one-third less than obtained in scenario II. Additional savings (about 1 quad) accrue from using steam from cogeneration in commercial and apartment buildings. An additional 0.3 quad of electricity is saved through further increases in the efficiency of appliances.

Substantial shifts occur in industrial production, favoring less energy-intensive goods. Major investments are made in new process technology and in new, highly efficient plants with cascaded use of heat. Since maximum practicable cogeneration (of electricity and industrial heat) was assumed in scenario II, no major additional improvements are assumed here.

The average time spent in automobiles (currently about 53 minutes per person per day) is reduced by 2010 to the 1963 average (43 minutes), in part because of better organized living patterns. This results in a savings of 1 quad of gasoline. In scenario II no improvement in the efficiency of military fuel use was assumed. In scenario I we assumed a 50 percent

Scenario I calls for significant changes in energy-consuming technology, and almost all activities become quite energy-efficient. The net result of these changes, in terms of primary fuel use, is a primary energy demand of 59 quads per year, corresponding to 60 percent of today's per capita energy. Scenario I may signal an approach to the level where energy and GNP become tightly coupled even in the longer term because presently anticipated technological improvements are fully utilized in scenario I.

## Discussion of Results

*Demand for electricity.* The demand for energy as electricity has grown substantially faster than the demand for total energy (7.1 percent per year in the decade 1960 to 1970, compared to 4.2 percent per year for all energy). Analyses based on a broad range of assumptions suggest that the demand for electricity will grow substantially more slowly in the future. Ranges of average electricity demand growth are given in Table 7. These ranges are rather broad because of the ease with which electricity can be interchanged with other energy forms in new construction. Thus, an electric heat pump and a gas heating system are almost directly interchangeable. Similarly, for many industrial heat applications and ground-based transportation either electricity or gaseous or liquid fuels can be used. Only in a few applications does electricity appear to serve uniquely (lighting, specialized industrial applications, computers).

For the maximum electricity use analyses virtually all electric heating of buildings was assumed. In the industrial sector, the maximum (purchased) electricity scenario describes a situation where there is almost no self-generation of electricity, and where many processes are electrified. At the same time, the transportation sector was still assumed to operate primarily on liquid fuels. Major advances in electric energy storage (such as high-efficiency batteries) could change this situation significantly, however, and lead to even greater demands for electric energy than those included in the analyses given here. In the minimum electricity analyses, gas and oil provide virtually all heating needs, and electricity use is restricted to electric drive and other critical processes. Since the figures pertain only to electricity purchased from utilities, they understate the actual extent to which the industrial sector relies on internally generated electricity.

*Economic effects*. The scenarios imply a large potential for long-term change in the ratio of energy use to GNP. As long as the transition to energy-efficient capital stocks occurs smoothly and over a significantly long period of time, there is no reason to expect major adverse effects on the GNP. There appear to be no major differences in labor requirements between scenarios I and IV. Since only 16 percent of the labor force is employed in the sectors responsible for 70 percent of industrial energy consumption, the potential for appreciable impacts in that area is small. Labor in construction and maintenance of buildings, appliances, and automobiles could increase, offsetting reduced employment in energy-producing sectors.

Essentially all capital goods require energy (power plants, industrial equipment, buildings). Today about 25 percent of new capital available in the private sector goes for energy supply and conversion facilities (*16*). This is expected to increase in the future as more capital-intensive energy supply technologies are introduced (solar electric systems, synthetic fuel, nuclear plants). We assume for the purpose of analysis that this would increase to 30 percent in 2010 for scenario IV (energy prices about the same as today's). We will now consider the differences between this "nominal" case and scenario II.

In scenario II energy consumption is about 40 percent lower than in scenario IV, so we assume that the capital needed for energy supply facilities is likewise reduced by 40 percent to only 18 percent of total capital. This leaves 82 percent of new private capital available for energy-consuming stocks, representing about a 12 percent increase over the nominal 70 percent level. Each of the sectoral analyses indicated that the incremental capital cost of achieving scenario II efficiency levels is less than 10 percent of total non-energy capital investment. Therefore, the capital not used for energy production could match or exceed the additional capital needed to improve energy efficiency of energy-consuming equipment.

Table 7. Role of purchased (utility) electricity (2010) in terms of [illegible]

| Sector | Scenario II* | | Scenario III | | Scenario IV | | 1975 (actual) |
|---|---|---|---|---|---|---|---|
| | Minimum | Maximum | Minimum | Maximum | Minimum | Maximum | |
| Buildings, quads | 10 | 22 | 13 | 25 | 17 | 43 | 12 |
| Industry, quads | 8 | 17 | 9 | 20 | 11 | 23 | 8 |
| Transportation, quads† | 1 | 4 | | 4 | | 4 | |
| Total, quads | 18 | 43 | 22 | 49 | 28 | 70 | 20 |
| Primary energy, quads | 74 | | 94 | | 136 | | 71 |
| Electricity, percent of primary energy‡ | 25 | 56 | 24 | 49 | 23 | 52 | 28 |
| Average annual electricity growth, percent§ | 0.2 | 2.6 | 0.7 | 3.2 | 2.2 | 4.0 | |

*Electricity demand growth for scenario I was not estimated here. †A major shift to electricity for ground transportation is not assumed here. However, if about half of transportation were shifted to electricity by 2010 the additional electrical demand, beginning in 1990, would be ~5 GW/year. ‡These numbers represent upper and lower bounds, based on corresponding policies. The likely consumption in each scenario, barring such policies, is given in Table 2. §Over the period 1975 to 2010.

To check sensitivity to assumptions about GNP growth, the Panel considered another scenario in which conditions were assumed identical to those in scenario III except that the GNP is 40 percent higher in 2010 (nearly tripling instead of doubling the 1975 levels). Energy use increases by only 35 percent. This might be interpreted as implying an income elasticity of about 0.90, which is not inconsistent with the results of Herendeen and Tanaka (*17*) for the U.S. economic system in the early 1960's. This less than proportional increase in energy use is due entirely to shifts in the market basket of goods and services.

## Conclusions

The purpose of this article has been to report on plausible energy futures corresponding to the low range of possible energy supplies. The Panel concluded that whatever driving forces might be involved, it will be technically feasible in 2010 to use roughly a total amount of energy as low as that used today and still provide a higher level of amenities, even with total population increasing 35 percent. It should be noted, however, that even under such low-energy scenarios there would still be enormous requirements for developing new energy supplies to replace depleted resources. The results of the analysis can be discussed in terms of responses to some frequently raised questions about the U.S. energy system.

*Is a lower-energy future a bleak one for the United States?* Probably the most important single finding of the study is that our national well-being can improve while energy growth is constrained to varying degrees. For this to occur requires higher energy prices, more regulation, or both. However, in every sector of the economy major increases in energy efficiency can be made by using presently available technology, and even greater improvements can be made with technology now under development. The large discrepancies between present energy efficiencies and those that are thermodynamically obtainable, together with economic analysis, show that improvements in efficiency of 1 percent per year or more are sustainable over a number of decades in the United States. If slower population growth trends continue, present amenity levels could be maintained and might be slowly expanded (at about half of past economic growth rates) without major increases in energy use

*Is a low-energy future a low-technology future?* Probably just the reverse is true. A low-energy future offers strong incentives for technological innovation. In many recent inventions information has been substituted for energy. Modern computers and communication equipment perform better than past units but use only a small fraction of the energy. The techniques used to bring about energy reductions reported in this study in almost every case rely on the use of advanced technology.

*If energy demand growth was so rapid in the past, how can it be so slow in the future without major effects?* The most significant reasons for rapid energy growth since World War II have been the following.

- Steadily declining energy prices relative to the prices of other goods and services.
- Expanding consumer population.

- Introduction and rapid market penetration of energy-intensive consumer products that provide basic amenities (such as individualized transportation, comfortable habitat, and household conveniences).
- Increasing cost of labor, which increased the substitution of capital and energy for labor.
- Major increases in disposable income, enabling rapid expansion of consumer buying power.

None of these factors is likely to continue at its historic pace. Many past projections of energy futures simply did not take into account inevitable changes in these trends. Where they are taken into account, future demand growth is projected to be slower even without active conservation policies. In all the scenarios discussed in this article we assumed virtually complete saturation of the use of air conditioning and other major appliances by 2010, but did not explicitly account for new "phantom" appliances as energy-intensive as air conditioning. But neither did we count such new technologies as increasing energy efficiency. Considering that real energy prices will probably increase in the future, the latter type of technological development is more likely than the former.

The long-term substitutability of labor and capital for energy indicates that goods and services can continue to be provided in the future with less energy input. However, to do this requires other human and material resources. Therefore, unemployment in power plant construction is compensated by greater employment in constructing more energy-efficient commercial buildings and residences; lower requirements for steel in automobile construction are offset by an increased demand for aluminum and fiber glass; and control system designing for nuclear power plants is replaced by control system designing for space conditioning in commercial buildings. As long as these changes occur slowly, their impacts are minimized. It is essential to have time for adjustment.

*What constrains our progress toward more efficient energy utilization?* We have pointed out that existing products and technological know-how, if fully utilized, will permit major improvements in energy efficiency with little change in life-style. We can also be confident that improved technologies can be developed through R & D investments in this relatively unexplored field. Because there are already many technical opportunities for improved energy efficiency, we must conclude that the most important near-term constraints or impediments are not technological ones. They may be categorized as follows.

1) Price signals: energy consumers tend to weigh their conservation investment decisions against current average energy prices, whereas energy producers (such as utilities) weigh investment decisions against long-run incremental prices. Since energy prices at the margin are now usually considerably higher than average prices, producer and consumer investment decisions are not made on equivalent bases. Thus investments are biased toward increasing supply rather than moderating demand. This situation would be largely eliminated if prices were adjusted (as through an energy surcharge tax) to approximate long-run incremental costs.

2) Time: given time, changes that would be highly traumatic if made quickly can be relatively easy. Unfortunately, Americans have a tendency to want to do things instantly. (As Adlai Stevenson said, "We Americans seem never to see the handwriting on the wall . . . until our back is up against it.") Retrofitting is important and economical, but since the greatest technical opportunities to save energy can be achieved in new capital stock, it is clear that attendant efficiencies can be achieved only as that stock is replaced. The time needed for such stock turnover ranges from about a decade (air conditioners, automobiles) to a half-century (industrial processes). Time is also required to introduce new ways of designing and building energy-consuming items.

3) Standards and regulations: public policies that were developed when energy was cheap and plentiful frequently have the effect of constraining energy-conserving actions. These policies include natural gas price controls, freight transportation regulations, building codes, procurement procedures, and tax policy. Most of these are federal policies but there are also many state and local ones. Progress in energy efficiency that is rapid enough to meet national needs will require policies that directly influence energy-consuming activities.

*If relative energy prices stay at about their present level, what is the likely future of demand?* If we utilize available technology and make wise economic decisions (minimum total cost), future energy demand growth will be considerably slower than most past projections have indicated. Even a small increase in real energy prices provides a significant opportunity for cost saving through higher efficiency of energy use. Depending on the details of future events, U.S. energy consumption could actually peak within the next 20 years even though well-being continues to improve. But it seems more likely that demand growth will simply slow down. Much depends on public policies (especially those that affect investment), population growth, labor cost, consumer choices, and economic growth. Of this, however, we are certain: many of the principal factors that drove the high energy demand growth in the past are no longer with us.

**References and Notes**


1. The members of the CONAES Demand and Conservation Panel are listed in the author note. Its chairman is J. Gibbons. The Panel's Resource Groups and their chairmen are: Buildings, R. Carlsmith; Industry, M. Whiting; Transportation, E. Goodson; Integration, E. Bullard; and Economics, D. Chapman. Extensive technical assistance was provided by R. Barnes, E. Berndt, L. Colquitt, K. Friedman, E. Hirst, K. Johnson, T. Mount, D. Pilati, and T. Tyrrell. In addition in each Resource Group a number of experts from universities, business, and government contributed to the study. Although the Panel reached a consensus about the main points brought out in this study, there were individual differences of opinion about some details. These were small enough that no dissenting or minority opinions were recorded.
2. Report of the National Research Council Committee on Nuclear and Alternative Energy Systems, in press. This article summarizes some of the information supplied to CONAES for their consideration but does not necessarily represent their opinions or conclusions.
3. R. Barnes, "The evaluation of new energy sources for process heat," prepared for the National Science Foundation by Dow Chemical Company, September 1975.
4. See, for example, J. Gibbons and R. Sant, *The Changing Economics of Energy*, B. Abrahamson, Ed. (Westview, Boulder, Colo., 1975), pp. 105–140; W. Tavoulareas and C. Kaysen, *A Debate on "A Time to Choose"* (Ballinger, Cambridge, Mass., 1977).
5. L. Schipper and J. Darmstadter, *Technol. Rev.* 80, 40 (January 1978).
6. J. Holdren, testimony before the Subcommittee on Energy and Power, Committee on Interstate and Foreign Commerce, U.S. House of Representatives, 22 March 1977.
7. A. Lovins, *Soft Energy Paths: Toward a Durable Peace* (Ballantine, New York, 1977).
8. H. Kissinger, address before the Alliance to Conserve Energy, Chicago, 11 June 1977.
9. Interim Report of the National Research Council Committee on Nuclear and Alternative Energy Systems, National Academy of Sciences, January, 1977. See also P. M. Boffey, *Science* 195, 380 (1977).
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11. K. W. Ford, G. I. Rochlin, M. H. Ross, R. H. Socolow *et al.*, Eds., *Efficient Use of Energy: A Physics Perspective* (American Institute of Physics, New York, 1975).
12. E. P. Gyftopolous, L. J. Lazaridas, T. F. Widmer, *Potential Fuel Effectiveness in Industry* (Ballinger, Cambridge, Mass. 1975).
13. See, for example, T. Mount and T. Tyrrell, in (*10*), appendix.
14. R. Hoskins and E. Hirst, *Energy and Cost Analysis of Residential Refrigerators* (Report ORNL/CON-6, Oak Ridge National Laboratory, Oak Ridge, Tenn., 1977).
15. E. Hirst and J. Jackson, *Energy* 2, 131 (1977).
16. See, for example, Ford Foundation Energy Policy Project staff, *A Time To Choose: America's Energy Future* (Ballinger, Cambridge, Mass., 1974).
17. R. Herendeen and J. Tanaka, *Energy* 1, 165 (1976).
18. C. Whittle *et al.*, *Economic and Environmental Implications of a U.S. Nuclear Moratorium, 1985–2000* (Institute for Energy Analysis Report ORAU/IEA 76-4, Oak Ridge Associated Universities, Oak Ridge, Tenn., 1976).
19. The CONAES study has been conducted under the auspices of the National Research Council and supported in part by the Department of Energy.

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# FACT SHEET

# ENERGY LOAN PROGRAM

AUTHORITY:

PUBLIC LAW 95-315 APPROVED ON JULY 4, 1978, AUTHORIZED THE ESTABLISHMENT OF A SMALL BUSINESS ENERGY LOAN PROGRAM BY AMENDING THE SMALL BUSINESS ACT TO ADD A SECTION 7(1).

ELIGIBILITY:

LOANS UNDER THIS PROGRAM ARE INTENDED TO PROVIDE A MEANS FOR SMALL BUSINESS CONCERNS TO ENTER(STARTUP), CONTINUE, OR EXPAND IN DEVELOPING, MANUFACTURING, SELLING, INSTALLING OR SERVICING OF SPECIFIC ENERGY MEASURES. ENTERPRISES INSTALLING OR UNDERTAKING ENERGY CONSERVATION MEASURES FOR THEIR OWN ACCOUNT ARE NOT ELIGIBLE UNDER THIS PROGRAM. ONLY THE FOLLOWING ENERGY MEASURES ARE ELIGIBLE FOR FINANCIAL ASSISTANCE UNDER THESE PROGRAMS:

(1.) SOLAR THERMAL ENERGY EQUIPMENT WHICH IS EITHER OF THE ACTIVE TYPE BASED UPON MECHANICALLY FORCED ENERGY TRANSFER, OR OF THE PASSIVE TYPE BASED ON CONVECTIVE, CONDUCTIVE, OR RADIANT ENERGY TRANSFER OR SOME COMBINATION OF THESE TYPES.

(2.) PHOTOVOLTAIC CELLS AND RELATED EQUIPMENT.

(3.) A PRODUCT OR SERVICE THE PRIMARY PURPOSE OF WHICH IS CONSERVATION OF ENERGY THROUGH DEVICES OR TECHNIQUES WHICH CAN BE DEMONSTRATED TO INCREASE THE ENERGY EFFICIENCY OF EXISTING EQUIPMENT, METHODS OF OPERATION, OR SYSTEMS WHICH USE FOSSIL FUELS, AND WHICH IS ON THE ENERGY CONSERVATION MEASURES LIST OF THE SECRETARY OF ENERGY.

(4.) EQUIPMENT THE PRIMARY PURPOSE OF WHICH IS PRODUCTION OF ENERGY FROM WOOD, BIOLOGICAL WASTE, GRAIN, OR OTHER BIOMASS SOURCE OF ENERGY. THIS REFERS TO ENERGY DEVELOPED BY THE BURNING OF COMBUSTIBLE BIOLOGICAL MATERIALS AND/OR THE CONVERSION TO SOLID, LIQUID OR GASEOUS FUELS. THE BURNING OF WOOD AND OTHER FORMS OF BIOMASS IS THE OLDEST FORM OF BIOMASS USE.

## Use of Proceeds

Proceeds of small business energy loans may be used to purchase vacant land immediately necessary for the construction of a plant or to acquire buildings, machinery, equipment, furniture, fixtures, facilities, supplies, or materials for an eligible loan measure.

## Amount, Terms and Interest Rates

The statutory ceiling on small energy direct loans is $350,000. Loans made under the Loan Guaranty Program may exceed $500,000 if the amount of participation or the amount guaranteed by SBA does not exceed the lesser of $500,000 or 90% of the total loan. Terms may be up to 15 years. Interest rates will be the same as SBA's Business Loan Program.

## How to Apply

Interested applicants must first seek financing from qualified lenders on a direct basis or under the SBA Guaranty Program. Should the bank decline the request, only then can applicants apply for direct SBA financing

**lion last** year, according to Energy Dept. data. The value of petroleum exports including condensates rose 9.7% to £ 2.17-billion on an f.o.b. basis. Oil import costs fell 12% to £4.49-billion: £3.53-billion, down 13.8%, for crude oil, and £958-million, down 4.3%, for products.

Crude oil production climbed 40% in 1978 to 53.4-million tons, with exports taking roughly 44%. Refined product output rose 3.3% to 89.2-million tons. The largest increases were for lighter products, notably jet fuel.

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**UNITED KINGDOM–Testing of two processes for converting coal to oil products and petrochemical feedstocks will advance to the pilot-plant stage.** Design and feasibility studies have been started for the pilot plants, each to process 25 tons of coal daily. The National Coal Board has already successfully tested both processes at the laboratory level. One dissolves coal in coal-derived solvent to make gasoline, diesel fuel and kerosine. The other employs high-pressure hot coal gas to make benzene, toluene, xylene and chemical feedstocks. The plants are part of an eight-year oil and gas from coal pilot project expected to cost £43-million.

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**UNITED STATES—Dependence on imported sources of energy fell last year and the overall growth in energy needs slowed down further to only 1.8% from 2.5% in 1977 and 5.3% in 1976**, the Energy Dept. reports. Total energy demand reached the equivalent of 36.7-million b/d of crude oil. Energy imports, at the equivalent of 8.74-million b/d, covered 23.8%, down from 26.1% in 1977 but up from 22.6% in 1976. Crude oil imports fell 7.4% as new Alaskan supplies became available, and products imports fell 8.6% on stock drawdowns.

## PIW Index

January and February issues of "Petroleum/Energy Business News Index" are now available, providing an index to PETROLEUM INTELLIGENCE WEEKLY issues of Jan. 1 through Feb.26. For copies of this monthly publication and annual subscription details, contact: The American Petroleum Institute, Central Abstracting & Indexing Service, 275 Madison Av., New York, N.Y. 10016. Telephone: (212) 685-6254.

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**UNITED STATES–The cost of modifying existing tankers to meet new U.S. safety standards for entering U.S. ports will add $50- to $85-million a year through 1985 to the oil import bill**, the government estimates. It's expected the added cost will be reflected in higher freight rates.

Depending on a ship's size and whether an owner opts for segregated ballast tanks, crude oil washing or dedicated ballast tanks, it will cost up to $2-million to outfit a product carrier and $500,000 to $2-million for a crude oil carrier. It's assumed some 589-655 foreign-flag crude carriers, 138-156 foreign-flag product carriers and 90 U.S.-flag ships will be affected by the new U.S. standards, which are slightly stricter than recently adopted international guidelines (PIW Oct.9, p.8). The effect of these standards on newbuilding costs is not estimated.

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**UNITED STATES—President Carter is expected to announce in a major energy address this week his delayed decision on the crude oil price control issue, as well as measures to cut oil demand** under the 20-nation International Energy Agency commitment (PIW March 12,p.3 & 4).

Mandatory controls on domestic crude prices expire May 31. The President then will have the authority to decide whether to continue them, phase them out or lift them entirely before Sept.30,1981, when all oil price controls are due to end. Surging world oil prices and tight supply, together with the Carter commitment to an anti-inflation program, have complicated an already difficult political dilemma over the decision. Any proposal to loosen the controls would likely be tied to some form of tax to prevent producing companies from reaping "windfall profits." A new tax would require Congressional action. There's no current plan in the Administration for a "plowback" provision to return part of such tax to the oil industry to spur more energy investment, but it could be a political tradeoff.

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**VENEZUELA—Crude oil production this year has continued to average a high 2.3-million b/d through early March, up some 36% from year earlier and 100,000 b/d over the annual average target** that the new government says it intends to retain. Crude production jumped to a 2.3-million average in fourth-quarter 1978 at the onset of the Iranian export shutdown, but the 1978 average of 2.17-million was still below the annual target.

The high current level represents 95% of maximum 2.43-million b/d installed capacity and is stirring political debate. The Oil Ministry says capacity should be raised to 2.8-million for a better cushion and greater flexibility in meeting unusual demand.

## New Publications

Jan. 1979 edition of **"International Crude Oil & Product Prices, a Biannual Review & Analysis of Price Trends in World Markets,"** by Energy Economics Research in cooperation with Middle East Economic Survey, 127 pp. From Middle East Petroleum & Economic Publications, P.O. Box 4940, Nicosia, Cyprus. Annual airmail subscription (two reports) $280.

**"Energy Options & Conservation, Proceedings of the Fourth International Conference"** (in Oct. 1977). Published by the International Research Center for Energy & Economic Development, 216 Economics Bldg., University of Colorado, Boulder, Colorado 80309, 300 pp, $14.50.

Susan Thorsteinson

## In New Posts

Ralph E. Bailey becomes chairman and chief executive of **Continental Oil Co.** April 1, succeeding retiring Howard W. Blauvelt who remains a director and executive committee member.

Len Dickinson, formerly with **Easco,** has joined **Stevinson Hardy International**, London.

**South Korea** has named former Foreign Minister Kim Dong-Jo president of its new **Korea Oil Development Corp.**

## Clarification

Mobil's worldwide third-party crude oil sales volume was roughly 230,000 b/d last year. It's less this year including 9% allocation cuts.

The 330,000 b/d reported for Mobil in PIW March 19,p.1 includes 100,000 b/d that isn't strictly third-party, since it involves tie-in deals and/or joint ventures where Mobil supplies crude and offtakes products. For example, Mobil explains, it supplies a joint Spanish lube venture in the Canary Islands, offtaking products. And in Japan it supplies crude to Fuji Kosan, taking the white products for Mobil Sekiyu.

# All-Electric Homes May Be Cheaper

By AL CAMPBELL
For The Times

PALMER — More in self defense than for business promotion, the Matanuska Electric Association has prepared a study indicating that all-electric homes, once relatively expensive, now may be cheaper to heat than dwellings with oil-fired furnaces.

Even with a recently-granted 29 percent rate increase for electric consumers in the Matanuska-Susitna area, utility officials believe heating oil prices have outstripped power bills to the point where electrically heated homes could be making a comeback.

At least one major bulk oil dealer in the Valley agrees with the the utility's conclusions. But Benjamin Cottle of Cottle Fuels said oil men feel their prices may level out, while electric rates will continue to rise past the point where electric heat is cheaper than oil.

"Yes, quite honestly MEA (heating) is cheaper," said Cottle. "For a long time oil was cheaper, but now we are stuck with these higher prices."

Cottle, who is also an elected director of Matanusta Electric, predicted that new electrical hookups will force the utility to extend itself to the point where power prices will have to be raised to pay for the construction work.

A utilify spokesman said the electrical cooperative does not see that situation "in the foreseeable future."

The study compares a typical, 1,300 square-foot home in the Mat-Su area. It is based on the present killowatt-hour rate but compares oil-heat costs at the rate of 71.9 cents per gallon, and most dealers in the area are now charging more than 80 cents per gallon for No. 2 furnace oil.

Thus the savings would be even greater for all-electric homes, given the higher oil prices — and they are predicted to top $1 a gallon in Alaska this winter.

Matanuska Electric figures show annual costs to the owner of the 1,300-foot home to be $2,136.56 for an oil-fired home and only $1,716.62 for all-electric. The study includes cost of purchase and installation of the heating system in a new home, as well as the monthly energy bill for heat.

Most of the savings would be in a new home, where the cost of an oil furnace is considerably higher than electric systems.

But Valley homebuilders say higher oil prices are making it more attractive for some home owners to scrap their oil system and pay for new installation of electrical heating.

Noel Woods, president of the Matanuska Homebuilders' Association, said several people have indicated to him they are planning to switch, and there is "certainly no big demand for oil" in new homes under construction.

Builders have always preferred to install electric heat if they could get a similar price for the homes without oil heat. Oil furnaces require valuable floor space and costly duct work, as well as outdoor excavation for storage tanks, all of which comes off the contractor's profit.

Still, Matanuska Electric is not promoting new or converted use of all-electric homes. In response to requests by the Energy Department, Rural Electrification Agency and other federal authorities, electric utilities nationwide are playing down consumption in favor of conservation of all energy systems.

The days of "live better electrically" and other media campaigns are over, as the nation rejects any sales pitch designed to promote energy consumption.

Matanuska Electric officials here say they prepared the study only to answer complaints from householders whose electric bills have jumped drastically with recent rate increases. Says a utility official "we can show them we can still be cheaper than oil. And many of them are surprised that they have to agree with us."





8-9-79

# A Hard-Headed Look at the Energy Debate

By William Tucker

e of the gravest problems in the en- debate in the United States has been videning gap between the people who iings in American society and the peo- who come up with new ideas.

For all its disdain for practicalities and nouveau-elite snobbery, the environ- ntal movement, it must be admitted, been very good at latching onto origi- l approaches to the problems of society. was the environmental movement, after l, which was seriously considering the

## The Bookshelf

*"Energy Future"*
*Edited by Robert Stobaugh and Daniel Yergin. Random House. 353 pages. $12.95.*

limits of fossil fuels and other resources as early as the 1960s (even though, by the time the crunch hit, a good portion of the movement had jumped on the "consumer" bandwagon and was ready to blame it all on the oil companies). Conservation and solar energy, two of the most recent contributions of environmentalism, are also ideas which, at bottom, have an enormous amount of merit.

The trouble has been that, because environmentalists come up with these ideas first, they are able to tangle them up in their own personal quirks and fantasies so that they become rather unappealing to the broad range of people in society. In order to listen to Barry Commoner talk about the possibilities of photovoltaic electricity, for example, we must also put up with his lectures on "sunshine socialism," and hear about how solar energy will usher in the overthrow of capitalism which Commoner has undoubtedly dreamed about since his boyhood days in Brooklyn. Amory Lovins, another environmental genius, gives us not only a fairly brilliant analysis on the possibilities of energy conservation, but also a pastoral fantasy of a world divided up into isolated, independent neighborhoods, all watering their own organic gardens and tending to the neighborhood windmill. This is, of course, the inevitable result of Commoner's desire to play a permanent adversary role in American culture, or the mincing disdain for the world of practicality which oozes out of every page of Lovins's writings.

"Energy Future" is a book that does a heroic job in bridging this gap between the thinkers and the doers, between environmental elitists and the hard-pressed world of responsible people who must deal every day with the demands of consumers, special-interest groups and unrelenting market forces. The result of the Harvard Business School's six-year-long energy project, "Energy Future" is a truly magnificent book which may be the most important contribution yet to the debate.

The authors, headed by Roger Stobaugh, president of the Academy of International Business and a Cabinet-level consultant, are, surprisingly, all hard-headed professors and graduate students at the Harvard Business School. The exception is Daniel Yergin, a political science lecturer at the Kennedy School of Government at Harvard, who has written a book about the origins of the Cold War. Lest anyone think that the issues have been weighted in favor of the counterculture, however, it must be noted that the section on nuclear energy is written by I.C. Bupp, a Harvard Business School lecturer who has been an ardent supporter of nuclear power, yet is still willing to admit some of its obvious limitations.

The premise of this book is simple—we have indeed reached the era of limits. Although there is ample evidence that getting rid of price controls will stimulate some new production of fossil fuels (and the authors are absolutely in favor of the "gradual" elimination of all market restrictions on energy products), they recognize that we have nonetheless reached an era of *natural* limits on energy production, and that expanding the conventional sources of oil and gas will not be able to meet projected demands of our society at anything resembling current prices. So too, the coal and nuclear options have their inherent limits.

The two areas that show the greatest promise for a return on investment in increasing national energy "production" at the margin are, the authors assert, conservation and solar energy. "Conservation," they insist, does not mean austerity, but improved efficiency—clamping down on all the ways that we waste energy right now. Solar energy includes a wide variety of "renewable" sources, with the most promising areas of development in small hydroelectric plants, solar heating devices and photovoltaic electricity generated in decentralized patterns.

What is most delightful about this book is its thorough, hard-headed understanding of the economic and marketing problems involved in developing these two new energy "sources." Stripping the ideas of romantic pastoralism and utopian rhetoric, the authors squarely face their largest impediment—that these two energy strategies will involve millions of small, isolated decisions made by individual homeowners, minor public officials, and low-level factory workers—precisely the people who are the most poorly informed and least motivated to do something about the energy problem.

Dispelling myths about any widespread impulses toward "self-sufficiency," the authors explain why industry has led the way in improving energy efficiency (Dow Chemical has reduced energy consumption an unbelievable 40% since 1973) while homeowners and consumers have lagged far behind, and why it will be absolutely necessary that the full efforts of American industry be enlisted in any attempt to make these two techniques work. They cite the section of the 1978 National Energy Act in which Congress actually *prohibited* the utility companies from helping to retrofit buildings for greater heating conservation as a "major blunder" which they say will "cost the nation many hundreds of millions of barrels of oil equivalent a year."

There is so much more excellent material in this book that I hesitate to drop any more tidbits for fear of giving the impression that its essence can be conveyed in a short review. It should be read by anyone seriously concerned with the energy debate, which must now include almost everyone with a sense of responsibility in American society. What is most attractive is the book's readability—a trim 240 pages of well-directed argument with a mass of footnotes in the back for further references. The promise that "Energy Future" offers is that neither side—the environmental fanatics or the full-speed-ahead, supply-oriented enthusiasts—will see only their own reflection, but will recognize the reasonable points the other side is making. It could mark a watershed in the decade-old energy debate.

*Mr. Tucker is a contributing editor of Harper's magazine.*


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