

ALASKA LEGISLATURE SPECIAL COMMITTEE / SUBJECT FILES 86/2

974 SCOM44: HOUSE POWER ALTERNATIVES STUDY COMM. 1979-80 779

2. Use H. I. D. lamps first where ceiling heights, visual task requirements, and color rendition permit, then use fluorescent and/or mercury vapor 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 luminaires 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.

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 combustion 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 of 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 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 evaporative 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 for 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 conservation in heating, air conditioning, ventilating, illumination 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 appliances 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 new with efficiency increased over the average unit now in place as follows:

<u>Appliance</u>	<u>Increase in Efficiency</u>
-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:

	<u>Existing Buildings</u>		<u>New Buildings</u>	
	<u>At the Building Boundry</u>	<u>Raw¹ Source Energy</u>	<u>At the Building Boundry</u>	<u>Raw Source Energy</u>
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 effective 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° either side of due south, and at a tilt angle from the horizontal ranging from 30° to 60° 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 collector 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 available. 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 collectors and associated equipment can be amortized through fuel and/or electricity savings each month in the year.

Solar water heaters are commercially available 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 to 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 aerial 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. Equipping 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°F instead of 230°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 air 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 percentage, 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 Kw-hrs 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 unsensible 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 equipment 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 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 demands 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 accommodate 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 accommodate 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)

<u>1980</u>	<u>1985</u>	<u>1990</u>	<u>1995</u>
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-

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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, 1979 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 411×10^9 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 672×10^9 Btu input, or a difference of 261×10^9 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 the 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.

<u>Load Class</u>	<u>Average Load Per Customer (Kw)</u>	<u>Total Load for Customer Class (Mw)</u>
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 development enhances TE installations, offers other energy-saving opportunities and preserves open spaces as compared to sprawl development.¹ Some examples

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 Hauppauge
- 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 Association¹ has singled out two potential areas for concentrated growth in Suffolk: South Stony Brook/Smith Haven and Holtenvilla/Holbrook. The Brookhaven Master Plan² 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.

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 Pill, 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 firm 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 could 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 could 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 off-shore 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 tethnology, 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 sulphur 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 land-filling), 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, although 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 are in various stages of progress. These are reviewed below:

1. Hempstead, Long Island

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 turn-key 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. Babylon-Huntington-Islip

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. Other Current Activities

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 26.2×10^{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 industrial 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 million megawatt hours of energy saving 80,000,000 gallons of oil equivalent per year.

-
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

<u>Year</u>	<u>Population In Thousands¹</u>	<u>Annual Solid Waste Generation, Millions of Tons²</u>	<u>Annual Heat Potential³</u>	<u>Projected % of Energy Recovery</u>	<u>Projected Energy from Waste</u>	<u>Electric Energy Equivalent Millions MWH⁴</u>
1980	2868	2.6	27.6 x 10 ¹² Btu	10%	2.8 x 10 ¹² Btu	.25
1985	3075	2.8	29.5 x 10 ¹² Btu	20%	5.9 x 10 ¹² Btu	.52
1990	3249	3.0	31.5 x 10 ¹² Btu	30%	9.5 x 10 ¹² Btu	.84
1995	3431	3.1	33.0 x 10 ¹² Btu	40%	13.2 x 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.

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) 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 indicates that voluntary efforts to conserve are not enough without incentives, disincentives 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 standards 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

¹Refer 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 uses¹. 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.

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 credit, 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.

Oregon 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.

Washington 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.

California 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.

Montana 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 City of Portland 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 efficiency 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. Prescriptive 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 measures, 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 policies 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

Representative Hugh Malone
Page No. 17

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

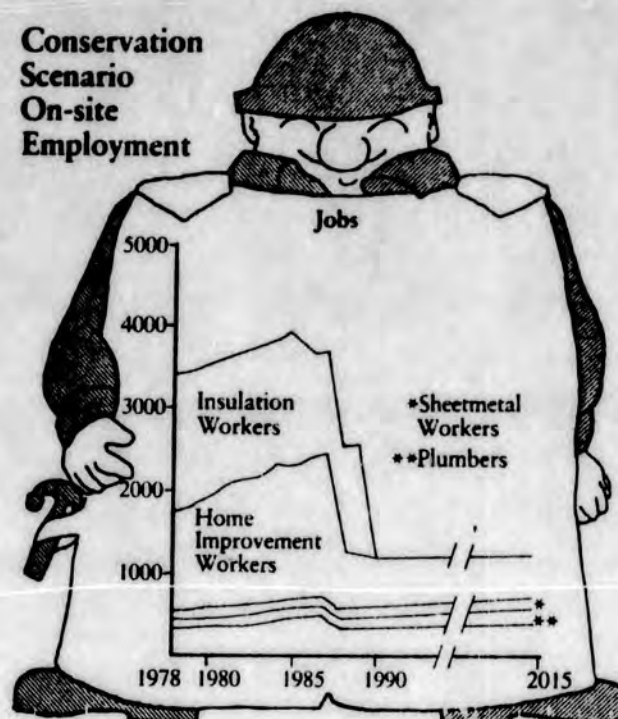
Employment Potential of Energy Scenarios Compared

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

Conservation Scenario On-site Employment



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.

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 × 10 ⁶ kWh	\$6.39 billion
Natural Gas	\$3.40/M ft. ³	532 × 10 ⁶ M ft. ³	\$1.81 billion
Oil	\$.467/gallon	17,274 × 10 ⁶ 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.

- **Responding 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		Average number of jobs	
		Regional	National	Regional	National
Continued Consumption	16.27	8.0	17.7	3,400	7,600
Conservation Scenario					
On-site Imple- mentation 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 "responding 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 responding 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 responding of energy savings could ultimately be greater, and more evenly distributed over the life of the scenario.

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

ALASKA
DEPARTMENT OF REVENUE

JANUARY - 1980

FUEL, CONSERVATION, & INDIVIDUAL
CREDITS
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2

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TABLE OF CONTENTS

FORWARD.	.ii
INTRODUCTION	1
BACKGROUND	2
RESIDENTIAL FUEL CREDITS (FUEL CREDITS).	3
RESIDENTIAL FUEL CONSERVATION CREDITS (CONSERVATION CREDITS)	5
INDIVIDUAL INCOME TAX CREDIT (INCOME CREDITS).	6
SUMMARY.	7

TABLES

TABLE 1	1977 DISTRIBUTION OF RETURNS.	8
TABLE 2	1978 DISTRIBUTION OF RETURNS.	9
TABLE 3	1977 DISTRIBUTION OF RESIDENTIAL FUEL CREDITS	10
TABLE 4	1978 DISTRIBUTION OF RESIDENTIAL FUEL CREDITS	11
TABLE 5	1977 DISTRIBUTION OF RESIDENTIAL FUEL CONSERVATION CREDITS	12
TABLE 6	1978 DISTRIBUTION OF RESIDENTIAL FUEL CONSERVATION CREDITS	13
TABLE 7	1978 DISTRIBUTION OF INDIVIDUAL INCOME TAX CREDITS.	14
TABLE 8A	RESIDENT RETURNS - 1977	15
TABLE 8B	PART-YEAR AND NON-RESIDENT RETURNS - 1977	15
TABLE 8C	ALL RETURNS - 1977.	15
TABLE 9A	RESIDENT RETURNS - 1978	16
TABLE 9B	PART-YEAR AND NON-RESIDENT RETURNS - 1978	16
TABLE 9C	ALL RETURNS - 1978.	16
TABLE 10	RESIDENTIAL FUEL CREDITS.	17
TABLE 11	RESIDENTIAL FUEL CONSERVATION CREDITS	18
TABLE 12	INDIVIDUAL INCOME TAX CREDIT.	19
TABLE 13	DISTRIBUTION OF CREDITS - 1977.	20
TABLE 14	DISTRIBUTION OF CREDITS - 1978.	21

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:

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

- o 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.
- o 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:

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

- o The average Fuel Credit received by 1978 resident returns with AGI's between \$0 and \$5,000 was \$17.41.
- c The average Fuel Credit received by all 1978 resident returns was \$32.41.
- o 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

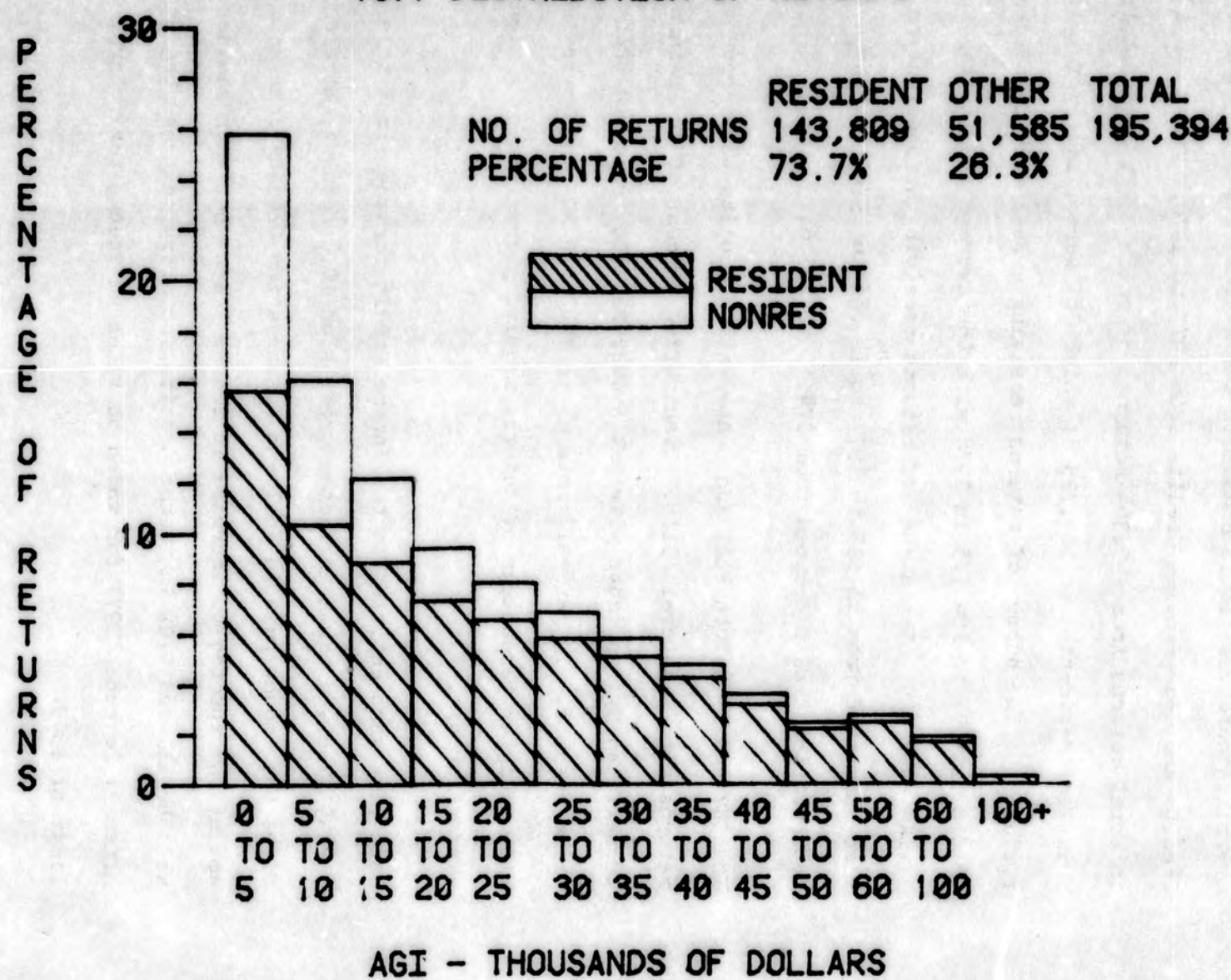


TABLE 2
1978 DISTRIBUTION OF RETURNS

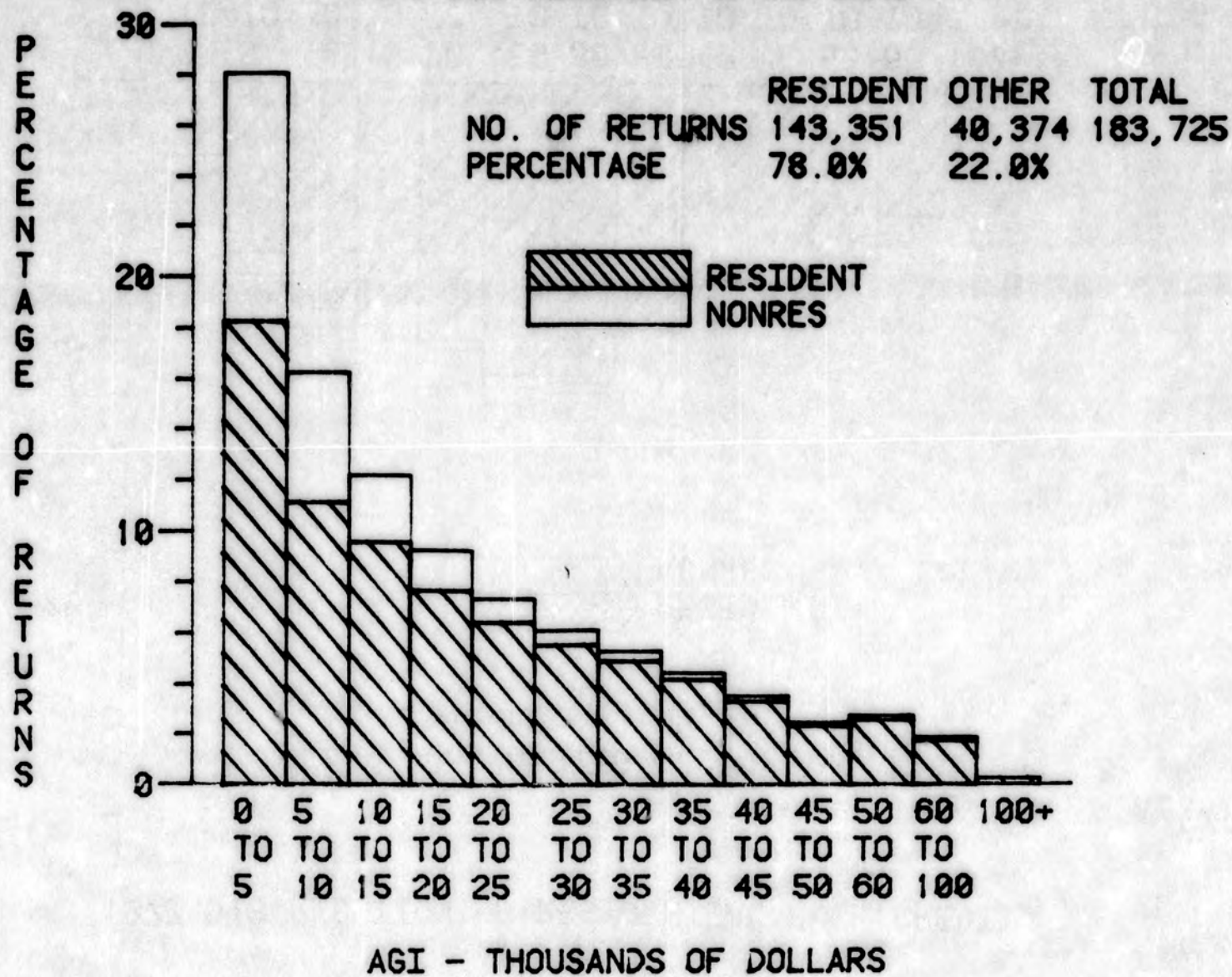


TABLE 3
1977 DISTRIBUTION OF RESIDENTIAL FUEL CREDITS

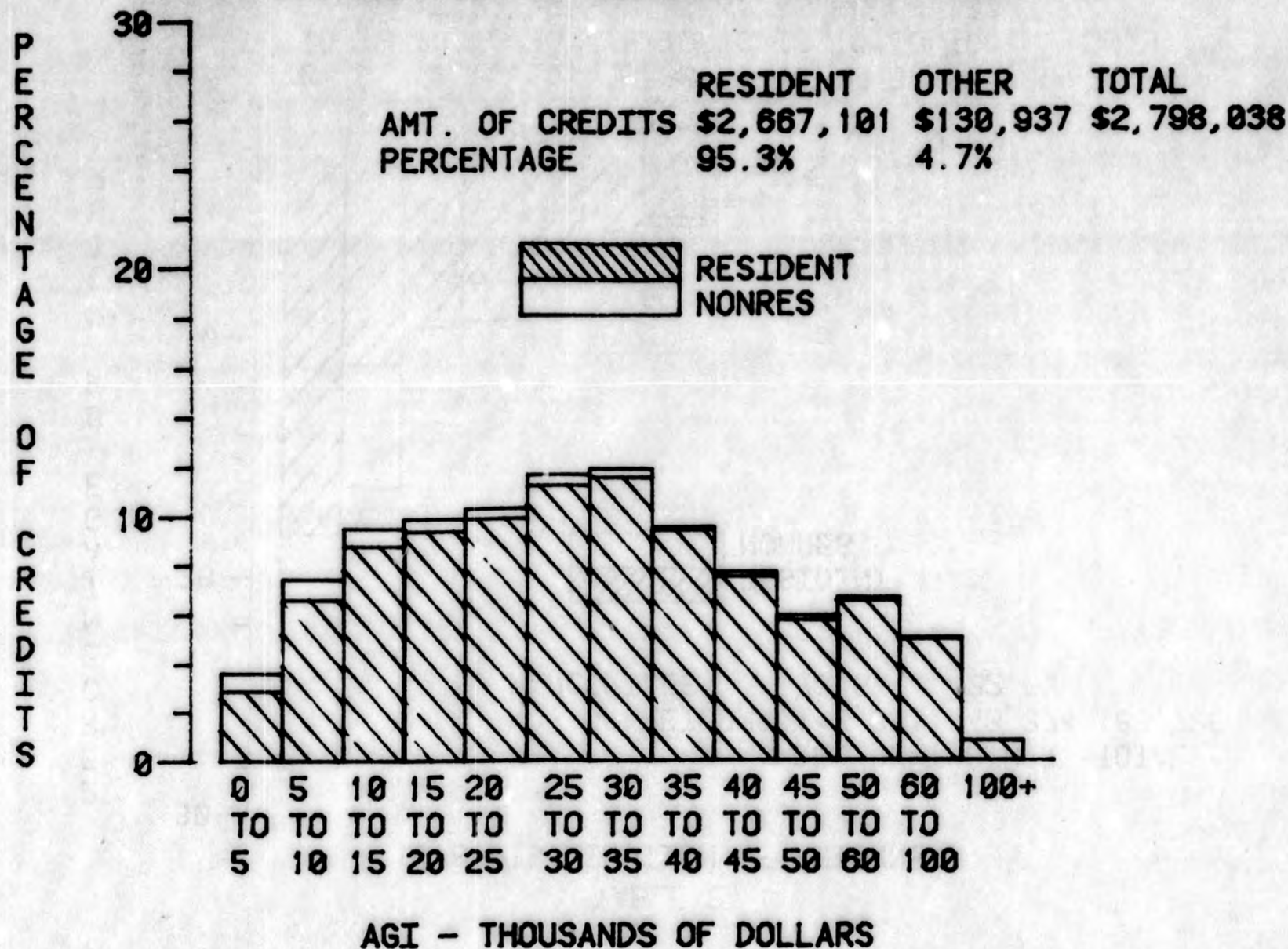


TABLE 4

1978 DISTRIBUTION OF RESIDENTIAL FUEL CREDITS

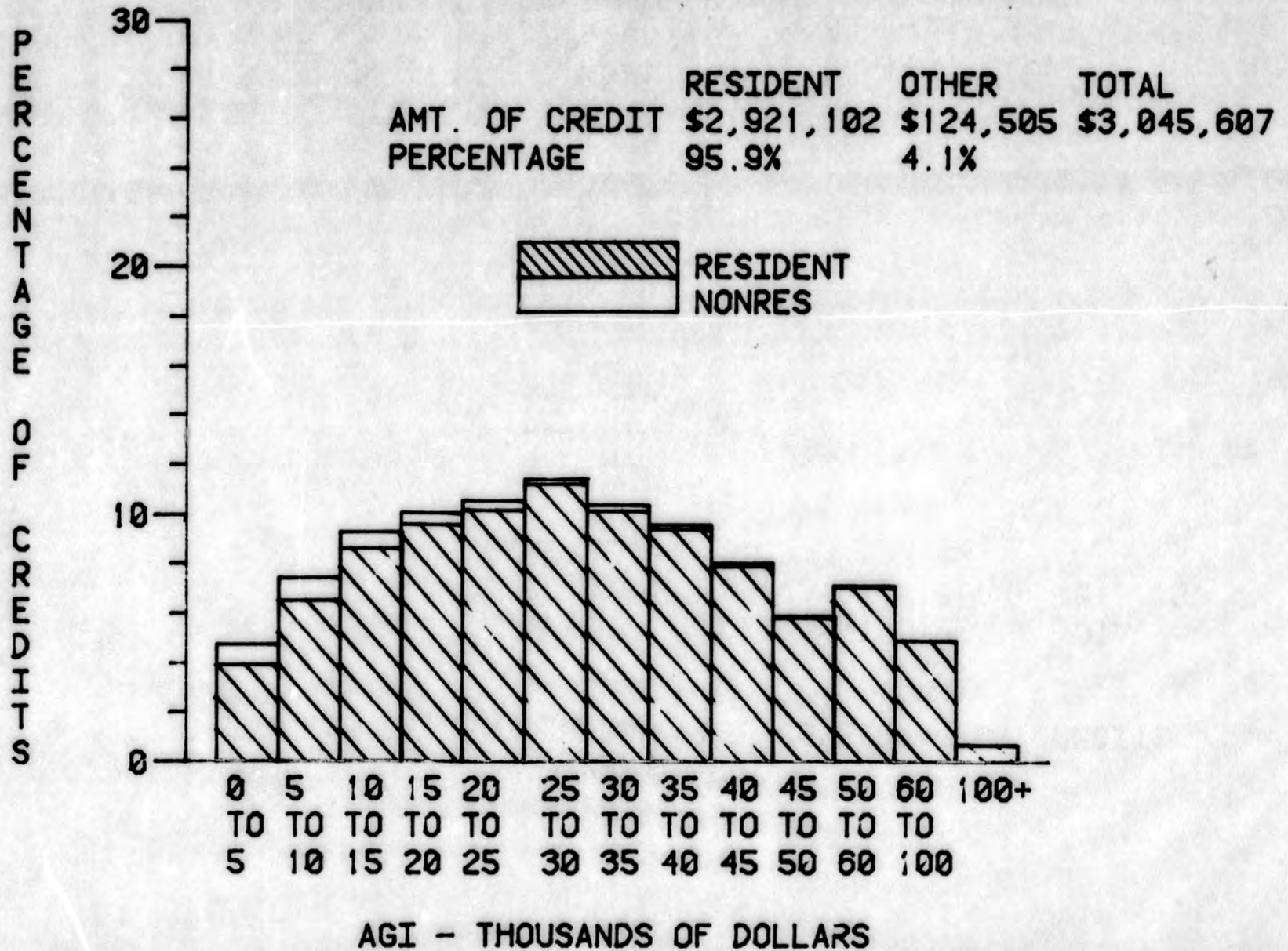


TABLE 5

1977 DISTRIBUTION OF RESIDENTIAL FUEL CONSERVATION CREDITS

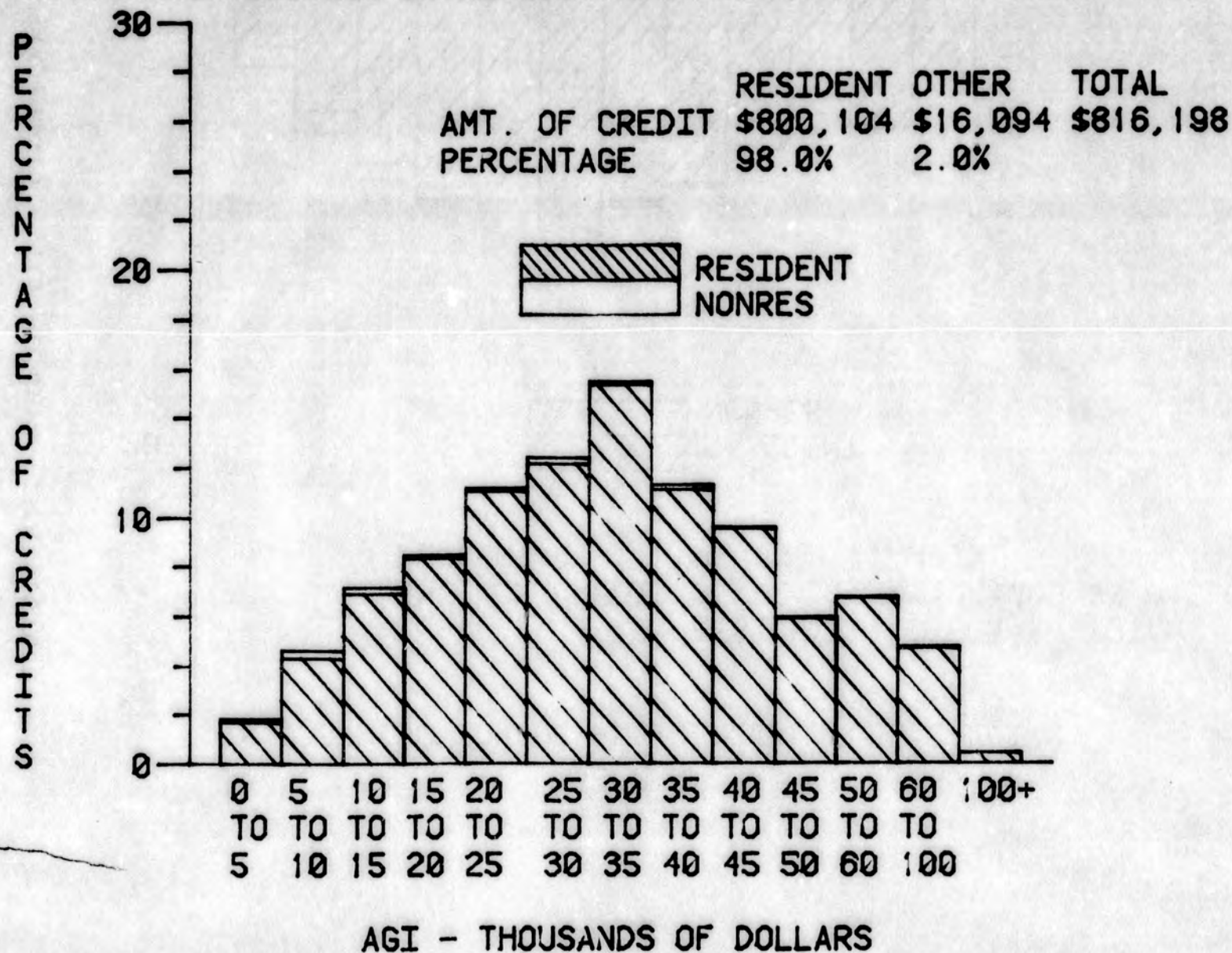


TABLE 6

1978 DISTRIBUTION OF RESIDENTIAL FUEL CONSERVATION CREDITS

	RESIDENT	OTHER	TOTAL
AMT. OF CREDIT	\$795,816	\$81,769	\$857,585
PERCENTAGE	92.8%	7.2%	

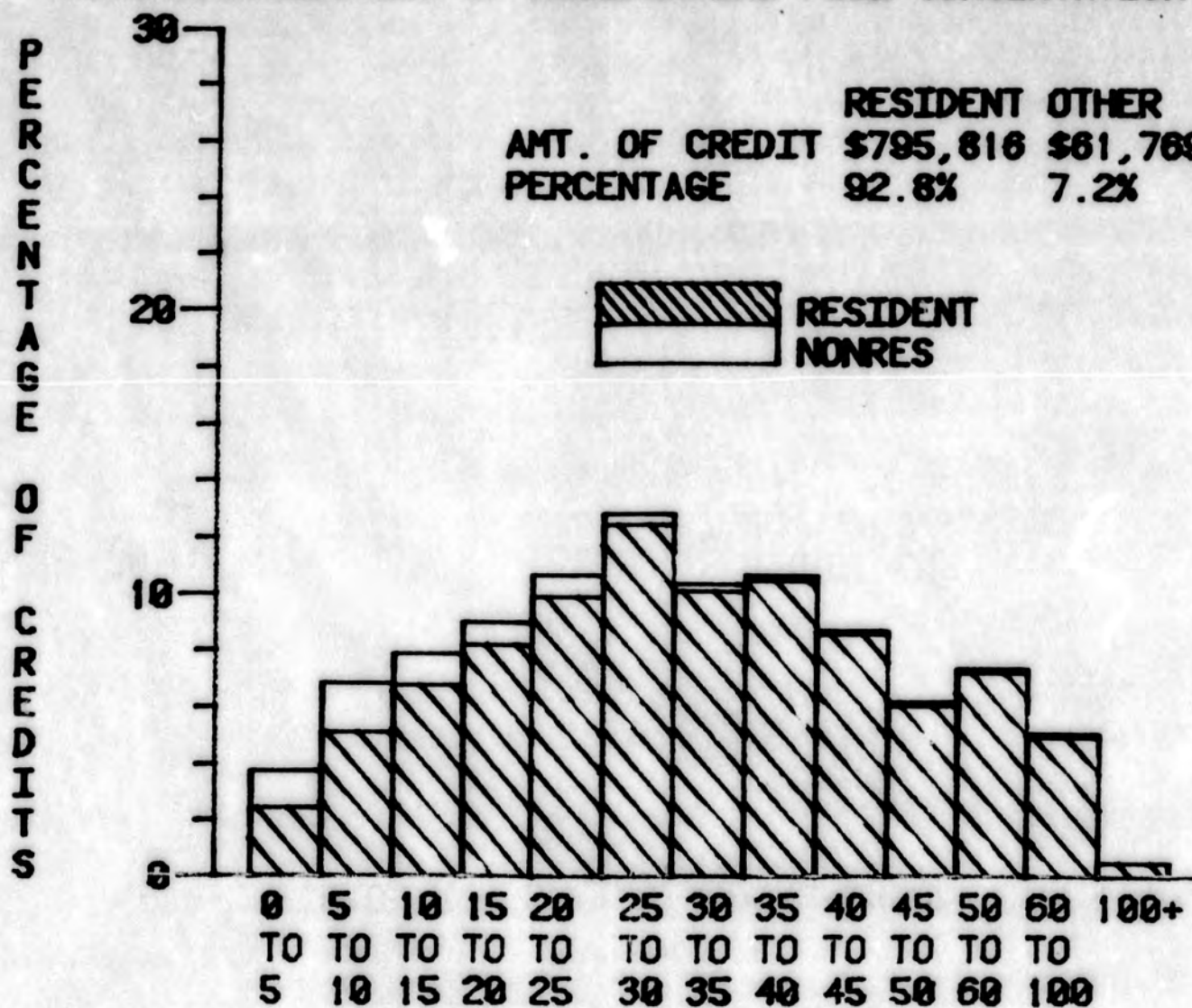


TABLE 7

1978 DISTRIBUTION OF INDIVIDUAL INCOME TAX CREDITS

