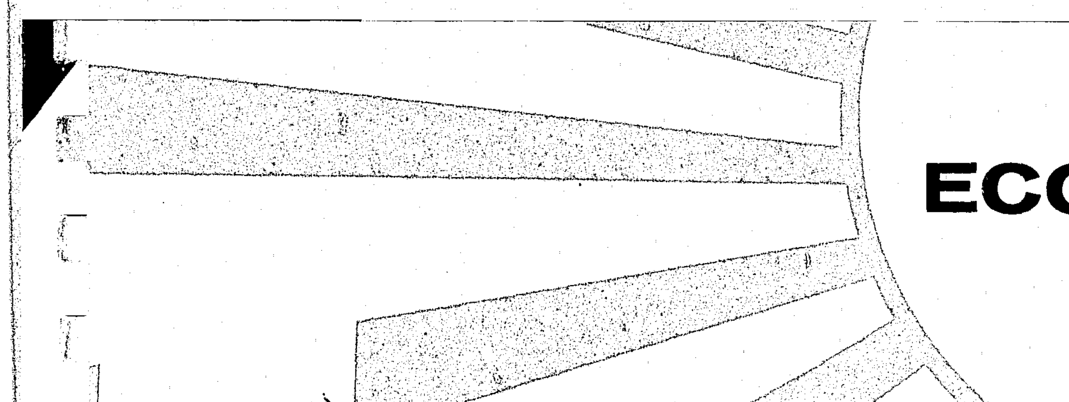


THE ECONOMICS OF ENERGY

...native strategies for conserving a dwindling regional resource

...ate Regional Planning Commission
...NECTICUT • NEW JERSEY • NEW YORK

FEBRUARY 1974

TRI-STATE REGIONAL PLANNING COMMISSION
100 Church Street, New York, N.Y. 10007 (212) 433-4200

TSRPC 2068–4702–3M 2/74

The preparation of this report was financed in part through federal funds made available by the U.S. Department of Transportation, Federal Highway Administration, and Urban Mass Transportation Administration under the Urban Mass Transportation Act of 1964, as amended; a comprehensive planning grant from the U.S. Department of Housing and Urban Development; and in cooperation with the states of Connecticut, New Jersey and New York.

1/13/75

THE ECONOMICS OF ENERGY ...

alternative strategies for conserving a dwindling regional resource

We have long taken for granted a seemingly limitless supply of energy; and indeed, our whole economy and way of life have seemed to be tied to an ever more lavish use of that energy.

Given this background, the recent spate of headlines concerning existing and threatened shortages is, to say the least, unsettling. Natural gas is in short supply. We may be faced with rationing of gasoline. Nuclear generation of electricity is lagging badly behind the sanguine forecasts of even two years ago, amid worries over its environmental hazards and the disposal of its deadly byproducts.

These elements have been with us for some time, and the recently imposed embargo on oil imports from the Middle East only exacerbates what appears to be the end of cheap energy in this Region.

Are we really running out of energy supplies; or, as some have claimed, is this a contrived scenario by some sinister economic cabal aimed at securing higher prices? It would be somehow comforting to be able to point the finger at a villain with a black hat, but unfortunately it is not that simple. What are the facts?

PRESENT CONDITIONS

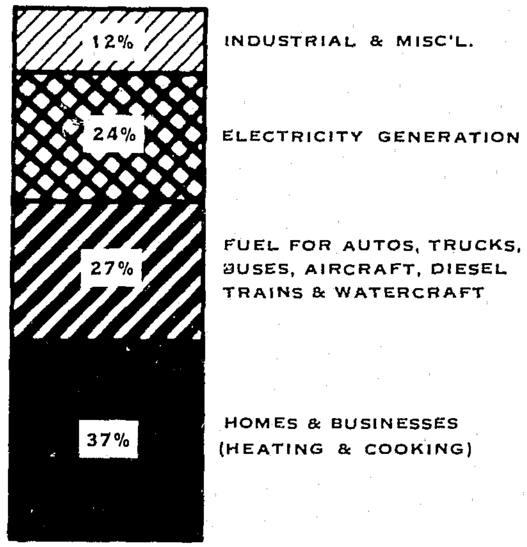
In 1970 the Tri-State Region's homes, businesses and transportation equipment consumed about 4320 trillion British thermal units of source energy—oil, natural gas and coal. A British thermal unit (BTU) is the quantity of energy required to raise the temperature of one pound of water one degree Fahrenheit at or near 39.2°F. A gallon of home heating oil, for example, has a heat value of about 138,000 BTU's.

A part of this source energy was used to generate electricity, and some of the electricity was brought in by long-distance transmission lines from outside the Region.

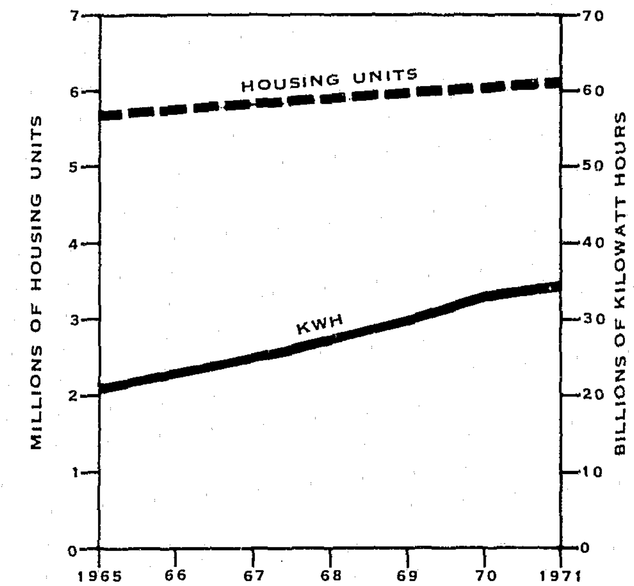
Numbers like 4320 trillion are hard to grasp. One way to visualize the huge quantities involved is to pretend that the fuels involved are all oils, and that the island of Manhattan is a huge open-air storage tank. Then the sticky stuff would be 6½ feet deep from the Battery to the Harlem River.

The largest share of this massive supply of energy, 37 percent, went into homes and businesses, primarily for heating and cooking. Fuel for autos, trucks, buses, aircraft, diesel trains and watercraft took another 27 percent, followed by electricity generation, 24 percent, and industrial and miscellaneous uses, 12 percent.

HOW ENERGY IS USED



HOME USE OF ELECTRICITY IS INCREASING FASTER THAN HOMES



Trends in Regional Electricity Use

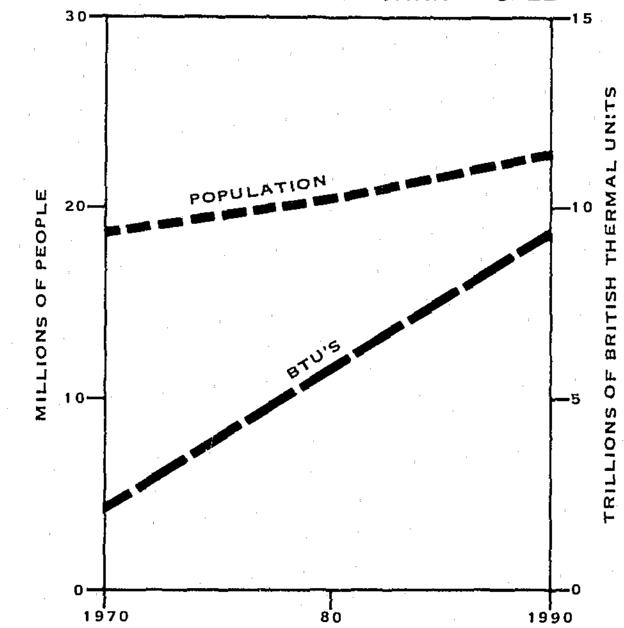
Regionally, the use of electricity has been steadily accelerating over the last few years. From 1965 to 1971 total electric sales for the ten companies serving the Region grew by nearly 50 percent, from 67.7 billion kilowatt hours (KWH) to 101.3 billion.

Residential sales during the period increased from 28.1 percent to 31.6 percent of the total. The number of residential customers increased only 7.9 percent, but average residential customer use increased from 3249 KWH to 5057 KWH, a growth of 55.6 percent. Among the individual utility companies there is a wide range in average residential use – in 1971 this ran from a low of 3355 KWH for Consolidated Edison to a high of 7553 KWH for New Jersey Power and Light. In general, the higher absolute rates of usage and the higher rates of increase during the late 60's seemed to occur with the companies serving the less urban areas.

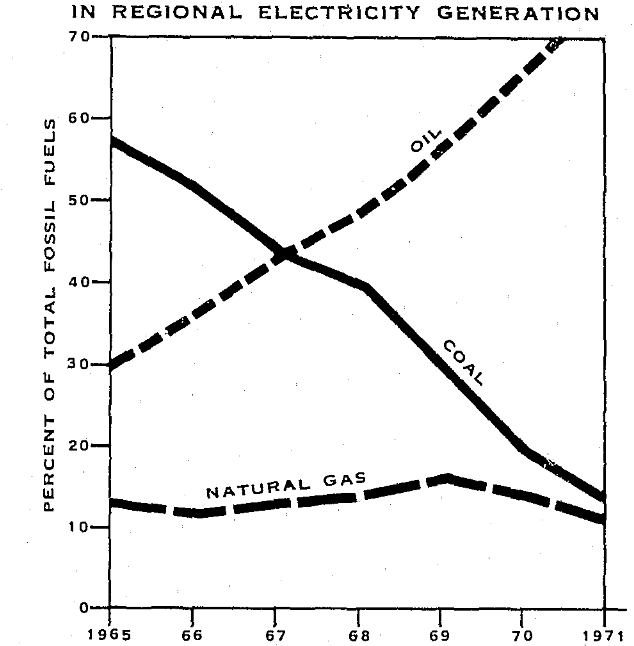
Total peak load for the ten companies grew at an annual average rate of 8.5 percent. The growth of generating capacity during the same period was at a slightly lower rate, 7.3 percent. There is an extremely wide range of variation among the companies; for example, Consolidated Edison experienced a growth in peak load of 35.2 percent over the period studied, yet capacity was increased by only 14.0 percent. The corresponding figures for Orange and Rockland Utilities were 105.1 percent and 202.9 percent.

The fuel mix used by the Region's electric utilities in their generator boilers has undergone a dramatic change. In 1965, 57 percent of fossil-fueled generation was by coal vs. 30 percent by oil. By 1971 coal was down to 14 percent and oil had vaulted to 75 percent. The natural gas trend has been quite flat, showing minor fluctuations and ending up just two percentage points lower than in 1965.

PEOPLES' USE OF ENERGY IS INCREASING FASTER THAN PEOPLE



OIL HAS REPLACED COAL AS THE FUEL IN REGIONAL ELECTRICITY GENERATION



FUTURE DEMAND

By 1990 the Region's total energy requirements are expected to reach 8800 trillion BTU's—double the 1970 consumption. There will probably be some shifts in usage, with electricity generation requiring 32 percent of the total, and the share to homes and business dropping to 30 percent.

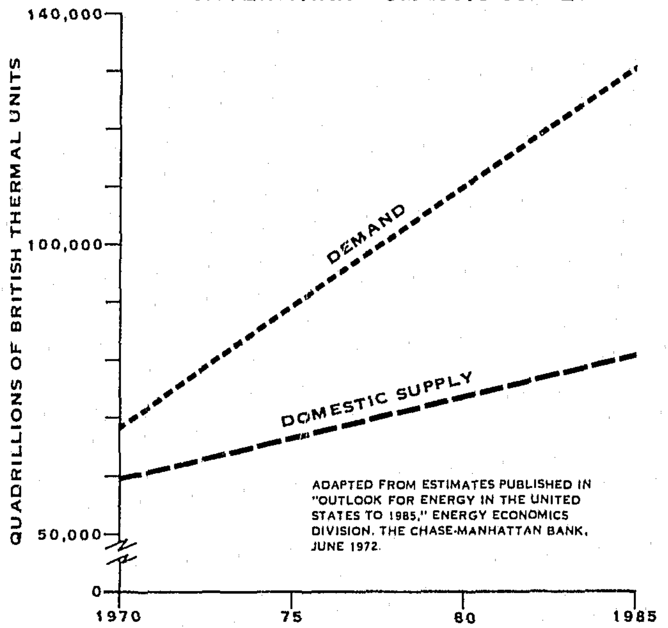
During this period the Region's population is expected to grow from 19 million to about 23 million—a 21 percent increase. Thus, the biggest part of the leap in energy consumption will be due to a continuation of the strong upsurge in per capita usage.

Average Residential Customer Use of Electric Energy

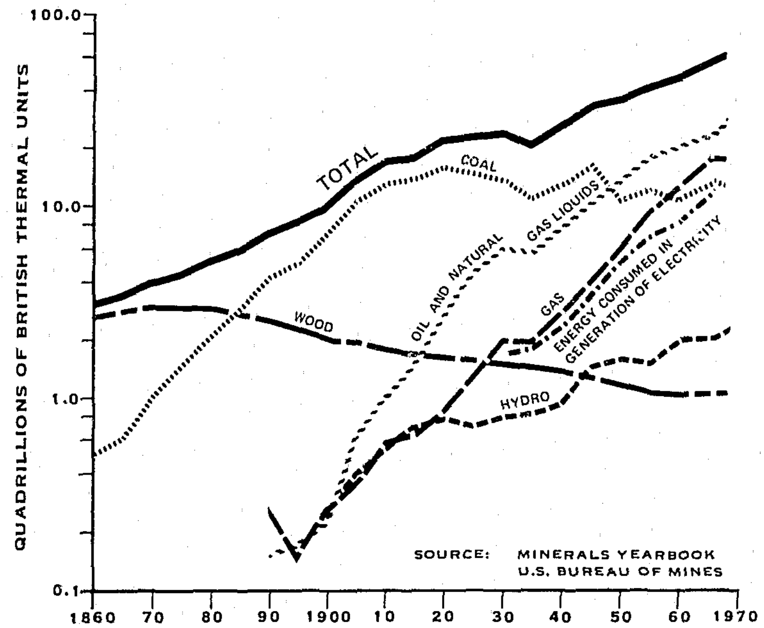
kilowatt-hours

COMPANY	1965	1966	1967	1968	1969	1970	1971	Six-Year Increase
Consolidated Edison	2,277	2,439	2,522	2,736	2,950	3,290	3,355	47.3%
Long Island Lighting	4,345	4,647	4,980	5,412	5,882	6,354	6,720	54.7
Orange & Rockland Utilities	3,526	3,791	4,110	4,645	4,894	5,957	5,744	62.9
Central Hudson Gas & Electric	4,124	4,425	4,805	5,167	5,635	6,136	6,468	56.8
Public Service Electric & Gas	3,318	3,614	3,836	4,199	4,562	4,967	5,184	56.2
Jersey Central Power & Light	4,395	4,714	5,044	5,451	5,914	6,432	6,742	53.4
New Jersey Power & Light	4,846	5,211	5,683	6,081	6,610	7,164	7,553	55.9
Connecticut Light & Power	4,554	4,913	5,423	5,905	6,436	7,070	7,445	63.5
Hartford Electric Lighting	4,411	4,660	5,033	5,393	5,763	6,256	6,525	47.9
United Illuminating	4,480	4,741	5,144	5,531	5,898	6,325	6,616	47.7
WEIGHTED AVERAGE	3,249	3,502	3,735	4,067	4,423	4,869	5,057	55.6%
YEAR-TO-YEAR GROWTH		7.8%	6.7%	8.9%	8.8%	10.1%	3.9%	
AVERAGE ANNUAL GROWTH								9.3%

U.S. ENERGY DEMAND IS INCREASING FASTER THAN DOMESTIC SUPPLY



SOURCES AND CONSUMPTION OF PRIMARY ENERGY IN THE UNITED STATES



FUTURE SUPPLY

On the supply side the outlook is not encouraging. The Region's supply is largely dependent on national characteristics of the industry. The three basic sources are oil, gas and coal.

Oil

In 1970, the U.S. was consuming about 15 million barrels of oil per day. By 1980, it is expected to demand between 20 and 25 million barrels. But U.S. production, now around 10 million, will rise to only 11 million from presently known reserves. When the pipeline from Alaska's north slope is built, this could add around 2 million barrels, and off-shore deposits could provide another plus if environmental objections can be met. Even so, there will almost certainly be a gap that will have to be met by increased imports or reduced consumption. It is estimated that this country will be dependent on foreign sources for at least 40 percent of its oil by 1980. The Tri-State Region, with its superlative seaport facilities and its relative isolation from domestic oil fields, was already importing about 40 percent of its requirements from foreign sources prior to the present curtailment.

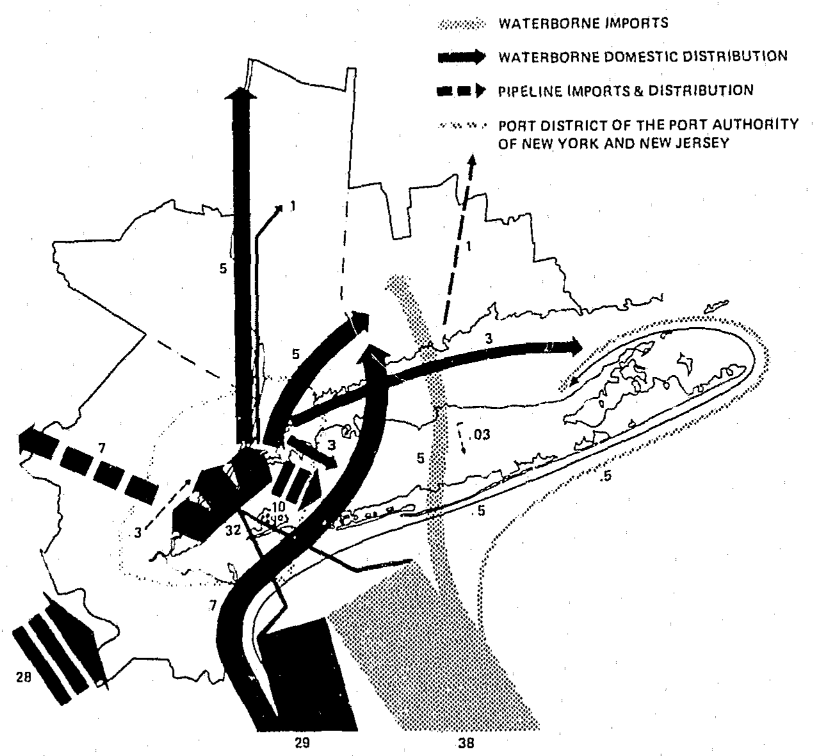
Electricity-Generating CAPACITY Compared to Summer *PEAK LOAD*
thousands of kilowatts

COMPANY	1965		1966		1967	
Consolidated Edison	7,809	*5,710*	7,774	*6,154*	7,532	*6,147*
Long Island Lighting	1,500	*1,466*	1,606	*1,568*	2,045	*1,676*
Orange & Rockland Utilities	171	*255*	369	*293*	360	*313*
Central Hudson Gas & Electric	351	*362*	351	*393*	596	*407*
Public Service Electric & Gas	4,615	*3,757*	4,610	*4,100*	5,132	*4,308*
Jersey Central Power & Light		*744*		*864*		*906*
New Jersey Power & Light		*299*		*321*		*348*
Connecticut Light & Power	1,209	*1,091*	1,279	*1,215*	1,461	*1,233*
Hartford Electric Lighting	733	*602*	777	*659*	787	*688*
United Illuminating	527	*559*	527	*605*	548	*617*
TOTAL*	16,915	*14,845*	17,293	*16,172*	17,913	*16,643*
YEAR-TO-YEAR GROWTH	–	–	2.2%	*8.9%*	3.6%	*2.9%*
AVERAGE ANNUAL GROWTH	–	–	–	–	–	–

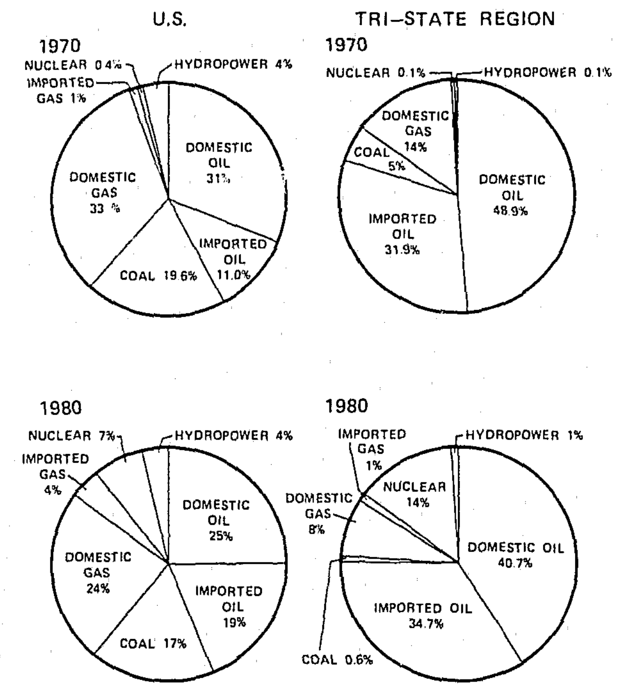
COMPANY	1968		1969		1970		1971		Percent Increase	
Consolidated Edison	7,943	*6,960*	8,296	*7,266*	9,420	*7,041*	8,904	*7,719*	14.0%	*35.2%*
Long Island Lighting	2,428	*1,876*	2,381	*2,005*	2,569	*2,176*	2,788	*2,405*	85.9	*64.1*
Orange & Rockland Utilities	360	*381*	517	*434*	518	*476*	518	*524*	202.9	*105.5*
Central Hudson Gas & Electric	596	*454*	599	*491*	611	*521*	580	*549*	65.2	*51.7*
Public Service Electric & Gas	6,025	*4,828*	6,154	*5,195*	6,597	*5,398*	7,483	*5,925*	62.1	*57.7*
Jersey Central Power & Light		*1,124*		*1,240*		*1,316*		*1,452*		*95.2*
New Jersey Power & Light		*390*		*424*		*456*		*488*		*63.2*
Connecticut Light & Power	1,528	*1,405*	1,658	*1,520*	2,111	*1,628*	3,036	*1,672*	68.4	*53.3*
Hartford Electric Lighting	880	*775*	975	*819*	1,143	*870*	1,096	*885*	49.5	*47.0*
United Illuminating	919	*678*	919	*718*	919	*754*	920	*804*	74.6	*43.8*
TOTAL*	20,679	*18,871*	21,499	*20,112*	23,888	*20,636*	24,325	*22,423*	43.8	*51.0*
YEAR-TO-YEAR GROWTH	15.4%	*13.4%*	4.0%	*6.6%*	11.1%	*2.6%*	1.8%	*8.7%*	–	–
AVERAGE ANNUAL GROWTH	–	–	–	–	–	–	–	–	7.3%	*8.5%*

*Excluding nonreporting companies.
Blank space indicates no report.

REGIONAL PETROLEUM TRAFFIC
MILLIONS OF TONS



PRESENT AND FUTURE SOURCES OF ENERGY



Petroleum traffic in the Tri-State Region is complex, because the Port of New York serves in part as a redistribution point for the rest of the Region. The accompanying sketch indicates stylistically the approximate patterns of movement.

Each year, 80 million tons of petroleum products enter the Region by water, and 28 million by pipeline. Entry is mostly through the heart of the Port of New York. However, about 1 million tons of refined products are received at a deepwater port at Northville, Long Island, and an estimated 12 million tons of long-haul traffic go directly to New Haven and Bridgeport by water.

The Region's 53 million tons of waterborne petroleum shipments are nearly all destined for points within the Region. About 9 million tons cross the border–4 million to New England and 5 million to various points on the Hudson River.

Pipelines carry 7 million tons out of the port district to points north and west of the Region, and 1 million tons flow from New Haven north to Springfield, Mass.

Regional sales of refined petroleum products showed a wide degree of variability during the period 1965-1971. The heavier residual oil was up about 74 percent; the lighter distillate oils registered a very moderate overall increase of 13 percent, but this group includes diesel fuel, which went up 62 percent, and gasoline, whose sales were up 27 percent. Distillate oils should show extremely sharp increases in the next couple of years, due to heavy utility use, both as turbine fuel and for blending with residual oil to reduce sulphur content.

Gas

The U.S. consumed 22.1 trillion cubic feet of natural gas last year. Proven domestic reserves are down to 247 trillion cubic feet, from 289 trillion in 1967. U.S. gas companies say they cannot even fill current requirements at officially regulated rates. Wellhead prices are said to be too low to encourage the all-out exploration effort that seems called for, although the Federal Power Commission recently released its hold on gas prices to the extent of inviting pipelines and producers to negotiate prices for new supplies above the agency's ceiling, subject to agency approval case by case. The President's recent energy message proposed that gas from new wells, gas newly destined for interstate markets and the continuing production of natural gas from expired contracts should no longer be subject to price regulations at the wellhead.

Liquified natural gas (LNG) from outside the U.S. is expected to help fill the gap, though it will be expensive. Three major companies have negotiated to buy $10 billion worth from Algeria between now and 1997. Another agreement is reported to be nearing completion under which $10 billion worth of LNG, at the rate of 2 billion cubic feet per day, for 25 years, will be imported to the U.S. east coast from the Soviet Union. These projects may run into difficulty, however, due to a groundswell of resistance to the siting of LNG storage tanks on safety and environmental grounds.

Four pipelines now bring natural gas into the Region from Texas and Louisiana, and a fifth from Lambertville, N.J. Volume in 1970 was about 617 billion cubic feet.

Coal

Known coal reserves amount to about 2 trillion tons against 530 million tons consumed in 1970, so supply is hardly an imminent problem. But coal is the dirtiest fuel, most of the low-sulphur varieties are located in the West, and air pollution regulations have all but eliminated coal as a fuel in this Region. The production of substitute natural gas (SNG) from coal appears to be a promising future resource, in view of the huge reserves of coal available. To date, however, only small-scale pilot projects are in existence, and

Sales of Selected Refined Petroleum Products*

New York, New Jersey and Connecticut
thousands of barrels

	1965	1966	1967	1968	1969	1970	1971	Six-Year Increase
Distillate Oils	180,228	180,353	186,848	188,647	193,396	198,686	203,602	13.0%
Residual Oils	162,195	186,647	217,299	228,923	242,948	269,384	281,399	73.5
Diesel Oil**	9,352	11,283	***	12,196	13,756	***	15,139	62.0
Gasoline	202,342	209,370	217,141	227,380	242,120	245,943	256,756	26.9

*Bureau of Mines, *Fuel Oil Sales,* Annual.
**Included in distillate oils total.
***Not reported.

it is probably unrealistic to expect SNG to be a major fuel over the next few years.

As of now, the Region's use of coal has almost vanished—1970 volume was under 8 million tons, and 1973's volume is probably not much over 2 million.

There is one element that appears likely at some point to reverse the direction of the coal-to-oil switch. This would be the development of a technology for the economic desulfurization of stack gases from industrial boilers and furnaces. Stack gas desulfurization is already available in a variety of processes. They are not yet quite economic.

THE GAP BETWEEN DEMAND AND SUPPLY

Given the state of imbalance between energy supply and demand, there are basically three responses the nation can make:

- *We can accept as inevitable a heavy and increasing dependence on foreign oil.*
- *We can institute a crash program to develop our domestic reserves of fossil fuels.*
- *We can adopt a serious program of energy conservation.*

The truth of the matter is that we are probably going to have to rely to some degree on all of these options. Like it or not, we cannot escape, for the short term at any rate, from increasing our imports of oil. Import quotas have been abolished, and presumably there will be an immediate sharp increase in imports, depending on Near East oil policies. But it is essential that we work out an accommodation between energy needs and environmental concerns that will enable us to move rapidly in expanding domestic production.

Natural Gas Sales
thousands of cubic feet

COMPANY	1965	1966	1967	1968	1969	1970	1971	Six-Year Increase
Connecticut Light & Power..........	12,948,000	14,233,758	15,533,900	16,085,190	17,909,957	18,558,104	18,895,895	45.9%
Greenwich Gas	1,994,277	2,250,604	2,472,269	2,479,240	2,600,072	2,706,146	2,900,000	45.4
Southern Connecticut Gas	12,475,118	13,407,006	14,607,353	14,201,975	15,341,948	16,367,626	16,779,718	34.5
New Jersey Natural Gas	19,079,000	22,019,000	25,156,000	27,201,000	29,978,000	33,093,000	35,971,000	88.5
Public Service Electric & Gas.......	127,131,297	136,676,672	150,824,094	157,067,966	170,958,052	185,848,161	195,625,277	53.9
Brooklyn Union Gas	78,762,772	79,237,652	85,179,716	89,897,801	96,318,946	99,779,505	98,982,243	25.8
Central Hudson Gas & Electric.....	5,243,316	5,618,048	6,094,694	6,155,708	6,930,276	8,442,275	9,470,474	80.6
Consolidated Edison	51,894,458	53,300,573	56,742,468	57,742,868	61,588,317	68,891,652	71,008,080	36.8
Long Island Lighting	29,305,384	31,544,323	36,273,862	38,364,824	42,191,602	45,191,602	47,507,443	62.1
Orange & Rockland Utilities	14,228,000	14,975,000	16,555,000	17,940,000	18,846,000	23,224,000	23,320,000	63.9
TOTAL	353,161,622	373,262,636	409,439,356	427,136,572	462,663,170	501,992,016	520,460,940	47.4
YEAR-TO-YEAR GROWTH..........		5.7%	9.7%	4.3%	8.3%	8.5%	3.7%	
AVERAGE ANNUAL GROWTH..								7.9%

We are not here addressing the question of possible exotic new sources of energy, like fusion power, giant windmills, magnetohydrodynamics, fuel cells and geothermal energy. One or more of these may eventually furnish a substantial share of our energy requirements, but that day is probably decades away.

The major problem with petroleum supply is that almost every aspect of its handling involves some sort of adverse environmental effects, demonstrable or potential. There are believed to be extensive deposits of crude oil and natural gas on the Atlantic outer continental shelf that could go a long way toward alleviating our fuel shortages, but there is considerable apprehension over possible oil spills resulting from drilling operations off our shores. We need a deepwater port to accommodate the new generation of giant tankers, but some environmentalists fear that the risk of a catastrophic spill would be significantly increased by the presence of these supertankers in our waters. And we need to increase refining capacity, but a refinery is by its nature an undesirable neighbor from pollution and esthetic standpoints. All these drawbacks mean that we have some difficult choices to make.

We need, too, to implement every possible method of cutting down on wasteful and inefficient uses of energy. Substantial savings can be made using existing technology and without materially affecting the quality of life.

In considering these strategies, we will primarily limit our discussion to those which could reasonably be deemed within the scope of governments in the Tri-State Region. Other measures, such as improvements in automobile efficiency and development of new energy sources, are more appropriate to a national framework.

WAYS TO CONSERVE FUEL AND ENERGY

Changes in Building Design

There are several aspects of building design that offer some potential savings, although they are necessarily of a long-term nature:

1. Energy requirements for heating and cooling in new housing construction can be reduced 40 to 50 percent from present standards by improved levels of insulation. The Federal Housing Authority recently issued a revision to minimum property standards, significantly tightening insulation requirements on homes subject to FHA mortgages. There are no mandatory requirements on others.

2. Lighting industry critics claim that most modern-day buildings, including schools, factories and office buildings, have far more electric light than they need -in some cases 10 to 20 times too much—and they blame lighting equipment makers and power companies. New York City schools, for example, have raised the light in classrooms 200 percent in 19 years.

A not inconsiderable fringe benefit of lower lighting levels would be a reduction in air conditioning requirements. Lighting experts estimate that except on the very hottest days, the main function of office air cooling is to remove the heat from intense lighting; and cooling may even be required when it's snowing outside.

3. The building with the smallest ratio of exposed surface to heated usable volume will lose the least **heat** during the cold season and require the least artificial **cooling** during hot weather. According to sample computations by the Rand Corporation, a two-story house with 1200 to 1800 square feet of floor area would have about 20 to 25 percent less surface area than a one-story house with the same floor area, and would require 20 to 25 percent less energy for heating and cooling, assuming equal levels of insulation.

4. The consensus of a series of studies on **electric resistance heating** carried out by New York State's Public Service Commission is that, while electric resistance heating is highly efficient, the production and transmission of electricity is not. As a consequence, in almost all cases more energy is used to heat a building with electric resistance than with fossil fuel heat.

5. **Electric water heating**, too, is an inefficient use of energy. According to a report prepared by the Office of Economic Research for the New York State Public Service Commission, it requires 121,000 BTU's of natural gas to warm 50 gallons of water from 32°F to 212°F in a gas-fired water heater. Almost twice as many BTU's of fossil fuel, 234,000, must be burned in an electric power plant to perform the same operation in an electric water heater. Or, from another standpoint, an average residential customer, says the Commission, would almost double his electrical requirements if he installed an electric hot water heater, based on an average use per New York State residential customer of 4662 KWH in 1970 and Edison Electric Institute's estimate that a standard electric water heater uses 4220 KWH annually.

Aside from questions of building design, the U.S. Office of Emergency Preparedness has estimated that the setting of all residential thermostats two degrees higher during the summer and two degrees lower during the winter would produce in 1980 energy savings equivalent to approximately 600,000 barrels of oil a day, or somewhat higher than one percent of the total U.S. fuel consumption in 1980.

Changes in Electricity Generation

Obviously, any measures to reduce consumption of electric energy will reduce basic fuel usage for electricity generation. Within the utility industry itself, the replacement of old generating units by new, more efficient ones can result in savings of primary energy fuels. From this standpoint, environmentalist tactics that delay unreasonably the construction of new facilities can be counterproductive, since they postpone the retirement of the less efficient units that tend to put more pollutants in the atmosphere.

Additionally, for an electric utility that also supplies street steam for space heating, there are definite fuel savings available through the use of gas turbines that generate in series with waste-

heat boilers to provide steam for distribution to heating customers. These savings can range from about 30 gallons of fuel oil per megawatt hour of electricity generated at night to 60 gallons during peak hours.

However, even with the measures previously described, and even if the necessary fuels were obtainable, electricity might still be in short supply. Electric energy production is likely to fall short of demand during the 1970's because of the severe problems being encountered by the electric utilities in securing approval for generating plant sites. Aside from the environmental objectives, there are safety questions relating to nuclear and breeder reactors that have not been answered.

Changes in Transportation

The private automobile and the rest of the transportation industry used 55 percent of U.S. petroleum output in 1965; it will use about 60 percent in 1980; and by the year 2000 the proportion will be around 70 percent. At the present, that usage is split up among the modes as follows:

Mode	Percent of Energy Use
Intercity and rural automobiles	26.4%
Urban automobiles	30.7
Aircraft	11.4
Intercity railroads	3.5
Urban railroads	0.1
Waterways and pipelines	1.4
Intercity buses	0.2
Local buses (including school buses)	0.6
Intercity trucks	7.0
Local trucks	14.9
Other	3.8
	100.0%

Thus, we see the passenger auto, generally conceded to be an inefficient means of transport, both from an energy consumption and an air pollution standpoint, accounting for 57 percent of transportation energy use. Relative energy efficiencies of the various passenger modes are indicated in the following table, expressed in terms of passenger miles per gallon of fuel.

Transportation System	Passenger Miles Per Gallon
Compact automobile	42
Full size automobile	15
Bus	110
Commuter train	100
Turbo train	33
Metroliner	38
Hovertrain	20
Gravity vacuum tube train	30
Short takeoff and landing aircraft (STOL)	23
Small jet	24
Jumbo jet	28
U.S. Supersonic Transport (SST)	15

These are national average estimates, and they are subject to regional variations because of differences in such things as average loading. For example, if buses carry an average of 30 passengers, they are getting twice as many passenger miles per gallon as in a situation where the average loading is only 15, which is about the average in this Region. A study is under way to develop a similar table of energy efficiencies for the Tri-State Region. It is considered unlikely, however, that the new data will alter the principal meaning of the table, which is that the full-size automobile, at current average loadings, is the least efficient of all the modes now in use.

Numerous energy conservation strategies have been proposed for the transportation sector. The foregoing table makes it rather evident where priorities should lie. These conservation measures could include:

1. Promotion of increased loading on all modes of transportation.

2. Promotion of increased use of mass transit–bus, subway and commuter train–with concomitant reduction in the use of private automobiles, which with their usual loading of only one or two persons are quite inefficient.

3. Encouragement of carpooling through such incentives as reduced tolls for cars carrying four or more persons.

4. Encouragement of a trend to smaller, more economical automobiles through a progressive tax on horsepower.

5. Elimination of lightly loaded airflights by putting limitations on the number of flights.

6. Truck freight consolidation: that is, some plan under which presently uncoordinated pick-up and delivery service would be reorganized. This might mean, for example, a system of depots for all local freight now handled in many near-empty trucks with each depot serving a specific, limited geographical segment of the urban area, combined with single-agency pick-up and delivery. Such a plan, if it could be worked out, would result in major savings, not only through the elimination of inefficient truck trips, but more important, through the use of larger vehicles.

7. Development of methods to store deceleration energy–the energy that is expended, for example, in braking subway trains to a stop. Some scientists believe that it may be possible to harness this energy instead of wasting it, thereby reducing the consumption of electricity from conventional sources.

It is difficult to determine the potential for energy savings from these measures. It is possible, however, to make a rough calculation of the effect of diverting some proportion of travel from the passenger automobile to, say, the bus. Annual auto travel in 1985 is expected to amount to about 101 billion passenger miles in the Tri-State Region. If some means could be found to divert 15 percent of this travel to buses, energy savings would amount to about 114 trillion BTU's, which would be about 1.4 percent of total energy requirements in that year.

In the area of truck freight consolidation, it has been estimated that a consolidation scheme like the one described above has the potential for annual savings in the Region of about 9 trillion

BTU's, not to mention the social gains in reduction of air pollution and downtown congestion.

Changes In Industrial Processes

The industrial use of electricity, principally in factories, differs widely among the various industries. On a national basis, in 1968 the use by manufacturing broke down as follows:

Application	Electricity Use Billion KWH	Percent
Mechanical drive	574	80%
Electrolytic processes	84	12
Direct heat	38	5
Other (such as lighting & air conditioning)	23	3
	719	100%

Clearly, the use of electricity in factories is dominated by the technical requirements of production, particularly those relating to mechanical functions or electro-chemical reactions. Since these processes so dominate electricity use in industry, it is not possible to estimate savings in the same way as for homes and businesses.

Given the importance of mechanical drive as a source of electricity use in manufacturing, modifications would probably consist primarily of: (1) shifting to nonelectric motors; or (2) designing more efficient mechanical systems and machines so that less horsepower will be required.

The outlook for energy conservation in this sector without cutting production is relatively slight.

Changes In Energy Prices

Natural gas moving interstate is subject to price regulation by the Federal Power Commission, and the price has been held at an artificially low level, causing industry and the utilities to use "America's premium fuel" instead of coal or oil, and inhibiting to some degree exploration for additional reserves.

Congress has been asked to end federal regulation of wellhead prices. If this is done, the price should move sharply higher, and the result should be a step-up in exploration and an eventual increase in supplies. There is, however, a substantial lead time between discovery of a new field and flow of the new gas in a pipeline.

Petroleum prices are moving up, and this trend is likely to be accompanied by increased dependence on Middle East crude oil, as the exporting countries flex their muscles. Since 1970 the price they receive for their crude has risen 72 percent, and the major multinational oil companies are committed to additional 10 percent price hikes in each of the next two years. Also, exporting countries are demanding still another price boost to reflect the latest dollar devaluation.

These higher prices, plus big investments for pollution-control equipment on generation plants, will almost surely bring about higher prices for electricity. The long-range effect of higher prices will be to decrease the demand for both electricity and the basic fuels, or rather to slow its growth. Short-term effects are less clear. People are not apt to scrap their big automobiles or their inefficient air conditioners because of higher operating costs. As these stocks require replacement, however, there will be a tendency to shift to more energy-efficient equipment.

Changes In Electric Energy Rate Schedules

The price paid for electricity by Tri-State residential consumers displayed a rather remarkable stability from 1965 to 1971. Among the nine regional electric utility companies reporting, the average rate per kilowatt hour in 1971 compared to 1965 was unchanged for three, higher for three and lower for three. The maximum increase was 10.7 percent, while one company's average rate was down 8.3 percent.

This is the more remarkable considering that during the same period fuel costs soared. Five of the eight companies reporting experienced increases of over 60 percent, with one reporting 96.7 percent. The smallest increase reported was 18.8 percent.

The present electric utility price structure encourages usage by providing for reduction in the unit price as consumption increases. Some rates, like those for electrical heating, also encourage use in off-peak periods. The residential tariffs of one of the Region's major utilities point up these features.

A residential customer using 350 KWH in a month, which is typical in New York State, is paying an average cost of 4.27¢ per kilowatt-hour. At 450 KWH this average drops to 3.77¢.

If he heats his home electrically and uses 3200 KWH during a winter month, his average cost is 1.98¢. But during the summer months, if air conditioning loads bring his consumption to the same 3200 KWH, his average cost is 2.54¢ per kilowatt-hour.

This arrangement has the effect of manipulating demand in order to reduce the gap between summer and winter peaks. A strong incentive is offered to electric heating through the low winter rate, and a penalty is in effect levied on excessive use of air conditioners through the inverted summer rate.

The New York State Public Service Commission has been approving summer-rate differentials, similar to the arrangement noted above, with several utilities in the Region. A spokesman explains that this differential "represents a necessary but conservative step toward requiring air-conditioning customers to bear a higher proportion of the costs their uneven demands place on other customers."

New Jersey's Board of Public Utility Commissioners, however, is reported to be unfavorably disposed toward this concept. Peak loads of Connecticut utilities are more evenly balanced between summer and winter, so there is little incentive for a seasonal differential of any kind there.

CONCLUSION

Thus, there are many avenues to us for reducing the carefree profligacy with which we have been using up our energy resources.

Nearly all of these that we have discussed could be implemented by governmental action at some level—either legislative or regulatory—and involve no new technology. The choices that we make among these options deserve very careful consideration, for they will affect both the economy and the environment for a long time to come. But the situation is urgent; we cannot afford to procrastinate in initiating conservation strategies if we hope to escape from having drastic and unwelcome modifications imposed on our life-style.

This report, prepared by Robert Leighton, is based upon analyses that are more fully described in a series of staff reports that may be examined at the Commission's library:

Historical Trends in Electric Energy and Fossil Fuels in the Tri-State Region, July 1973, 4393-1215.

Meeting the Region's Growing Demand for Electric Power, November 1971, 4263-2303.

The following were also sources of information for this report:

J.E. Moyers, *The Value of Thermal Insulation in Residential Construction: Economics and the Conservation of Energy,* Oak Ridge National Laboratory, Oak Ridge, Tenn., ORWL-NSF-EP-9, December 1972.

The Rand Corporation, *California's Electrical Quandary: III Slowing the Growth Rate,* Santa Monica, Calif., September 1972.

Thomas E. Browne, *The Impact of Energy Conservation on Energy Demands,* Office of Economic Research, New York State Public Service Commission, Albany, N.Y., May 1972 (OER Rept. 11).

W.P. Goss and J.G. McGowan, "Transportation and Energy—A Future Confrontation," *Transportation,* Vol. 1, No. 3, November 1972, pp. 265-289.

R.E. MacDonald, *The Pattern of Energy Consumption in the United States,* Stanford Research Institute, unpublished paper, Menlo Park, Calif., November 1971.

END