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Statement of John P. Keith, President, Regional Plan Association,
before the Subcommittee on the City Committee on Banking, Finance and
Urban Affairs, U.S. House of Representatives: Washington, D.C.,
September 14, 1977

My name is John P. Keith. I am President of Regional Plan Association, the oldest regional planning body in North America. The Association studies existing and prospective development problems for the urban region centered on New York City, which stretches from Trenton, New Jersey to New Haven, Connecticut, and contains nearly a tenth of the nation's population.

Regional Plan began a study of energy consumption in the New York Region--well before the Arab boycott--with Resources for the Future which resulted in Regional Energy Consumption. Later, we were selected by the U.S. Department of Housing and Urban Development to prepare the government's official presentation at the UN Habitat Conference in Vancouver on "Human Settlements and Energy Conservation." In addition, the Urban Mass Transportation Administration financed in part a study we did recently on Public Transportation & Land Use Policy. Some of the following data were derived from these works.

The major conclusion reached in our energy studies is this: The "city" is a resource-conserving entity. This is especially true of energy as well as land. The higher the density of urban settlement the lower the energy consumption per person. This finding can be applied to the nation as well as to our Region, because our Region offers the full range of densities and urban patterns in the nation. Some levels of concentration as found in our older, highly desirable suburban counties are comparable to the pattern that will be required if we are to conserve energy.

In addition to concentration of development, the pattern of urbanization is important. There is a new urban pattern pervading the nation, which Regional Plan Association has labelled "spread city." It differs from traditional cities and suburbs, even though the average

density in some places may be similar. Most of the jobs and principal services no longer are located in the center of population. They scatter around the edges--the large installations on their own campuses lying off the main expressways, shopping centers at highway interchanges, the smaller services lining the roads. Then sub-divisions of one-family homes, generally on large lots, and an increasing number of small garden apartment complexes are scattered among the services wherever a builder can acquire developable land.

It is this new development pattern, with the rapid out-movement to spread city of almost everyone who can afford to live outside the traditional cities that is so profligate in energy use, particularly for transportation.

Higher density saves energy in buildings, through common walls and less roof area for the same enclosed space. True, sloppy heating practices in apartments sometimes dissipate this advantage, but the possible savings are large. In non-residential floorspace, we have found that energy consumption per square foot in fact declines significantly as density increases, despite elevators in high-rise structures. In addition, street lighting and other public uses of energy are saved in higher density non-residential arrangements.

But the substantial saving from more compact settlement comes from transportation. The higher the density, the fewer automobiles per person and the fewer miles each car travels. This is in part a result of more trips on public transportation, but it also results from fewer and shorter trips and more trips on foot. The travel of New York City residents is strikingly different from that of residents in outlying counties in our Region. For all forms of transportation, New York City residents use half as much energy per capita as residents of the Region outside the City, even though the area outside the City contains other old cities along with spread city and still-rural areas.

Since travel goes up with income, Regional Plan compared energy use for transportation per dollar of income. Residents of Manhattan--which still is the highest per-capita-income county in the Region and one of the nation's highest--used only 5,000 BTUs of energy per dollar of income (excluding air travel, which we did not allocate among counties).

In less dense areas of New York City such as Queens, comparable to Cambridge, Massachusetts, energy use almost doubles to 9,000 BTUs per

dollar of income. Close-in, older suburban counties, as Nassau on Long Island and Bergen in New Jersey, rise to 11,000 and 14,000 BTUs per dollar of income, respectively.

Middlesex County in New Jersey, largely developed in the post World War II period, has a density that is 40 percent that of Nassau but per dollar energy use is about half again greater, 17,500 BTUs per dollar of income.

The latest development trend in the New York Region, and the United States, is the out-movement of people and jobs from the older urbanized areas--not just the old cities--to the periphery. This is further compounding the problem of energy use for transportation, because almost all trips must be by auto. In our Region, examples are Orange County in the mid-Hudson area of New York State and Ocean County in New Jersey, where energy used for transportation per dollar of income doubles that of the older suburban county, Nassau, rising to 23,000 and 25,000 BTUs. The table from which I am making these comparisons is attached to my testimony. (Table C, page 9, Regional Energy Consumption.)

Lest you think this is purely a New York Region phenomenon, we can compare data for the nation as a whole. Per capita gasoline consumption in the nation in 1975 was 487 gallons, but only 372 gallons in the Mid-Atlantic States, a region still dominated by large cities and tight suburbs. The Mountain States used 578 gallons per capita and the West South Central 587.

Comparing individual states, New York used the least gasoline per capita--330 gallons--mainly because of New York City's relatively sparse use. Massachusetts was next with 397 gallons per capita. Ohio, with a mix of compact cities and rural areas, used 474 gallons, but Texas used 610 and Arizona, 536. In both states, it should be noted, the urban population is now 80 percent of the total. In short, states of predominantly spread-out urban areas used upwards of 20 percent more gasoline per capita than the old urban states of the Northeast, and it is this spread-out growth pattern that is predominating currently across the country.

Finally, there are indications that life style apart from travel habits reduces energy use at higher densities. At the fringes of the New York Region, per capita electricity use in the home per dollar of income was found to be substantially higher than in the cities. For

example, in high-income outer suburban counties in New Jersey, electricity use was over 50 percent greater per dollar of income than in Queens, where per capita income was identical but density was $2\frac{1}{2}$ times greater. Suburban counties of the same income fell in between, according to density.

Why home electricity use is strongly affected by density we cannot say for sure. Regional Plan's current research into how households in the several parts of our Region spend their incomes will give us clues. We can guess, however, that it relates in part to having more space in the home and yard to heat, cool and tend, and the extra space also provides more room to use and store power equipment.

There is confirmation for the data from a study done by the School of Architecture and Engineering of the University of Texas, where energy use in homes on different lot sizes were compared. Since these homes were different in style and age and were near each other in Houston and since transportation was excluded from the study, the findings that energy use per dollar of income did indeed go up with larger lots is important substantiation.

HUD's experiments in total energy use show how building at moderate city densities can further conserve energy. Nashville's use of that City's refuse to heat and cool the downtown is another way in which compact urban areas can save even more energy. Generally, co-generation--the use of heat now wasted in generating electricity--and recycling of wastes are economical mainly at city densities. The potential is indicated by our finding that if the New York Region could use the heat wasted in electricity generation, it would save the equivalent of all the oil burned for home heating in the entire Region with its population of nearly 20 million.

What these findings suggest is a way of substantially cutting U.S. energy consumption in the long run by making our settlements more compact. In 1970, the average density in urban America was five dwelling units to the acre. In the 1940's and '50's, most of the suburbs were being built at higher density than this, yet this 1970 average is a mixture of cities, suburbs and spread city--indicating how dispersed the settlement of the 1960's became.

Behavior suggests that if the typical suburban community of five units to the acre were to become 15 units to the acre instead,

i.e., the density of typical garden apartments or one-family homes on 30 by 100 foot lots, auto travel would be cut by 30 percent and public transportation travel would be doubled. Note that this is only a thirteenth the density of Manhattan, less than a third the density of Queens and very little denser than one of the highest-income suburban counties in America, Nassau County on Long Island. Outside our Region, the equivalents are Cambridge, Massachusetts; Berkeley and San Francisco, California; and Washington, D.C. But this is a marked change from current land use practices. It will require strong public policy intervention to bring about such a change.

This recommendation does not anticipate that people will give up owning cars. Concentration makes unnecessary--if it relates to a compact downtown where jobs and services are clustered--the second, third and fourth cars that households are increasingly buying. In the New York Region, for example, the number of households with two or more cars doubled between 1960 and 1970 while the number with only one car actually dropped. In that decade, the slippage in lower bracket family income actually raised slightly the number of households without any cars! In most parts of the country, more than one car is necessary because everything is located so as to require auto trips. With increasing percentages of two workers or more in households and with jobs scattering so people living together are likely to go to work in different directions, the one-car family is becoming obsolete.

Energy use could be cut voluntarily another way, too--by raising prices. Experience in our Region over the past four years, when energy prices far outstripped the cost-of-living and per capita real income was dropping, suggests that rising prices will indeed cut energy use. No one knows how high prices would have to rise above inflation to achieve cuts, but indications are that it will take a very steep rise in energy prices to cut consumption voluntarily.

Alternatively one might look to involuntary ways to cut energy consumption, for example, rationing. But when gasoline was rationed during World War II, even in a wartime atmosphere, driving was cut less than would occur by increasing average densities from five units to the acre to 15.

Our data have established that large-scale voluntary energy conservation would result from raising average urban densities. But

would people voluntarily live at the higher densities? No one would deny that families and businesses are choosing lower densities under present circumstances. But Regional Plan Association feels that federal policies, particularly if supplemented by state policies, could change the circumstances and so the choices.

The most important need is to redirect the nation's principal activities back into city downtowns and to discourage their scatter on the urban fringes. The federal government can do a great deal toward this recentralization by itself, by placing its own installations in downtowns and by announcing that its investments in infrastructure will aim at encouraging downtowns as places to assemble and at discouraging the scatter of facilities. We have in mind shifting transportation investment from peripheral highways to public transportation and to some of the short links in urban highways needed to assure easy traffic flow into and out of downtowns; also, ending the rapid extension of federally-assisted sewer and water lines into the countryside. If both the federal government and the states followed these policies, the beginnings of a return to a higher-density and energy-saving lifestyle could occur.

Many people ARE attracted to city living--if they get benefits of compactness--for example, being within walking distance or an easy public transportation trip of their job and of the special attractions that only large numbers of diverse people can support and of interesting neighborhoods. In addition, the increasing number of single and small households provide another basis for attracting people to cities. Seriously combatting such negative conditions as crime, poor municipal services, particularly education, would greatly increase the candidates for living in present cities and for moving closer to them in tighter suburbs.

There are many social reasons for dealing with city problems, but for energy reasons alone, it is sensible to make cities attractive enough to justify a choice of higher-density living.

Some increase in energy costs so they somewhat reflect the real value of energy could be combined with these positive inducements to recentralization by using the proceeds of an increased gasoline tax to subsidize and improve public transportation. Just a one cent a gallon gasoline tax nationwide would pay for all subsidies from all sources to all public transportation systems in the country. A few

cents more could begin to provide public transportation that competes with the automobile in comfort and attractiveness.

Congress, rightfully, has been concerned about the impact of higher energy costs on people of moderate and low income and appears critical of additional gasoline taxes. However, it is not the cost of gasoline alone, but the other costs of automobile ownership -- initial outlay, insurance, maintenance, repairs -- that are rapidly escalating. The steps to counteract spread development that we recommend Congress take would have a more ameliorative effect over the long run, though we still recommend raising revenue from gasoline taxes as an immediately beneficial measure.

Further, as these jobs have left the cities and older urbanized areas, they have left behind those who cannot afford the new housing in the new locations or the cost of a car to reach them. These are primarily the blacks, Hispanics and other minorities. The result has been an exacerbation of our social problems.

Inhibiting "spread city" is important, also, to the federal budget. In our Region, as in other parts of the United States, the federal government is investing large sums in capital improvements for public transportation and committing itself to subsidies for operating costs. Continued spread development, where almost all trips, of necessity, must be by automobile, will assure diminishing use of in-place public transportation. In turn, this will minimize the effect of the public investment and maximize the deficits. The same is true of many other federal programs that assist in paying for urban infrastructure.

In conclusion, I should say that conserving energy by re-centralizing urban development is not in the same class as more immediate measures, such as raising gasoline prices and cutting the use of automobiles. The result will not be immediate, but long range. Yet, there is another way to turn the question: our present pattern of development commits us to a high level of energy and physical resource consumption in perpetuity. Its life-cycle costs in energy and environmental terms are extremely high, and we have no assurance that we will be able to support these costs in the future. The best thing we can do now for the long future is deliberately to encourage those higher density patterns that are frugal in physical resource consumption and that give us social benefits as well.

Table C.
Selected Indicators of Energy Consumption Related to Density, 1970.

	Gross population density pers./sq. mi.	Total net energy use million Btu per capita (average) (actual)	Residential use thousand Btu per \$ All energy Electricity (average) (actual)	Transportation use thousand Btu per \$ (actual)	Residential use thousand Btu per sq. ft. of residential floorspace (actual)	Comm., Publ. & Industrial thousand Btu per sq. ft. of nonresidential floorspace (actual)		
1 Manhattan	69,965	173	178	13.4	0.73	5.1 + 3.7 (unallocated)	138	190
2 Brooklyn	37,531	126	124	13.5	1.08	5.6 + 3.7	176	359
3 Bronx	35,066	127	103	13.5	1.06	5.8 + 3.7	134	327
4 Queens	18,293	147	151	13.6	1.02	9.1 + 3.7	191	408
5 Hudson	13,479	157	121	13.6	1.05	8.9 + 3.7	115	254
6 Essex	7,291	174	167	13.7	1.14	8.6 + 3.7	135	291
7 Union	5,273	180	191	13.7	1.32	11.3 + 3.7	144	248
8 Richmond	5,120	181	161	13.8	1.38	9.0 + 3.7	200	435
9 Nassau	4,790	182	190	13.8	1.25	11.3 + 3.7	229	346
10 Bergen	3,845	185	200	13.8	1.25	13.8 + 3.7	158	275
11 Passaic	2,467	190	176	13.9	1.45	11.3 + 3.7	148	243
12 Westchester	2,058	191	202	13.9	1.07	10.5 + 3.7	206	365
13 Middlesex	1,866	192	253	13.9	1.68	17.5 + 3.7	150	428
14 Mercer	1,336	194	180	14.0	1.43	15.0 + 3.7	146	313
15 Rockland	1,288	194	213	14.0	1.46	18.3 + 3.7	191	391
16 Suffolk	1,256	194	208	14.0	1.76	19.3 + 3.7	192	430
17 Fairfield	1,253	194	177	14.0	1.56	13.3 + 3.7	182	203
18 New Haven	1,224	194	198	14.0	1.95	19.9 + 3.7	179	220
19 Monmouth	969	195	166	14.1	1.71	14.4 + 3.7	146	272
20 Morris	820	196	197	14.1	1.69	17.3 + 3.7	153	311
21 Somerset	646	196	205	14.2	1.53	17.0 + 3.7	148	350
22 Ocean	326	197	201	14.4	2.40	22.9 + 3.7	122	663
23 Dutchess	272	198	209	14.4	1.98	22.0 + 3.7	148	446
24 Orange	267	198	232	14.5	2.11	25.0 + 3.7	153	556
25 Putnam	241	198	172	14.6	2.22	24.2 + 3.7	118	357
26 Warren	205	198	186	14.6	2.52	22.8 + 3.7	112	323
27 Hunterdon	160	198	183	14.7	2.19	20.8 + 3.7	119	405
28 Litchfield	153	198	181	14.7	2.34	22.3 + 3.7	165	280
29 Sussex	147	198	153	14.7	2.00	21.9 + 3.7	107	336
30 Ulster	124	198	214	14.8	2.37	24.7 + 3.7	167	450
31 Sullivan	53	198	221	15.3	3.11	29.7 + 3.7	83	167

Note: "Unallocated" category, consisting mostly of fuel for air travel, rail freight and waterborne freight is evenly distributed among the counties according to population.

Sources: Energy Table 17, Population and Income Table 19, floorspace from TSRPC and Tables 20 and 21

The charts on the opposite page and the "average" columns in Table C are based on lines of best fit defined by the correlation equations below. R² indicates what proportion of the dependent variable in each case is explained by the independent variable, such as density (D).

- | | | |
|--|---|---|
| (1) million Btu per capita in transportation | = + 0.0315D ² - 2.7521D + 65.2139 | R ² = 0.7574 (excluding unallocated) |
| (2) million Btu per capita in industry | = + 0.0024D ² - 0.3305D + 20.3046 | R ² = 0.0680 (excluding unallocated) |
| (3) million Btu per capita in comm. & publ. facil. | = + 0.0146D ² - 0.6801D + 43.9159 | R ² = 0.1005 |
| (4) million Btu per capita in residences | = - 0.0006D ² + 0.0439D + 51.1004 | R ² = 0.0008 |
| (5) million Btu per capita total | = + 0.0479D ² - 3.7188D + 180.5341 | R ² = 0.4684 (excluding unallocated) |
| (6) thousand Btu per \$ income in res. electricity | = $\frac{5.763}{\log D} - 0.285$ | R ² = 0.8937 |
| (7) thousand Btu per \$ income in res. energy | = $\frac{4.940}{\log D} + 12.415$ | R ² = 0.0289 |

Not shown on these pages are the following relationships, used in developing projections described on p. 17:

Residential kWh per \$ of Household income

- | | | |
|-------------|-----------------------------------|-------------------------|
| (8) (1970) | = $\frac{1746.5}{\log D} - 102.1$ | R ² = 0.9026 |
| (9) (1960) | = $\frac{1317.1}{\log D} - 117.7$ | R ² = 0.8275 |
| (10) (1950) | = $\frac{948.0}{\log D} - 109.4$ | R ² = 0.7375 |

Commercial and public facilities
mWh per nonmanufacturing employee

- | | | |
|-------------|--------------------------------|-------------------------|
| (11) (1970) | = $\frac{0.4431}{FAR} + 4.038$ | R ² = 0.4715 |
| (12) (1960) | = $\frac{0.2924}{FAR} + 2.206$ | R ² = 0.4694 |
| (13) (1950) | = $\frac{0.1416}{FAR} + 1.309$ | R ² = 0.3023 |

FAR is the county-wide floorspace to lot area ratio of nonresidential buildings, varying from 0.1 in the outer suburbs to 0.3 in the inner suburbs to 3.5 in Manhattan (TSRPC ITR 4291-3204)

Industrial mWh (in thousands):

- | | | |
|-------------|-----------------------------|-------------------------|
| (14) (1970) | = 15.18 (J) ^{0.33} | R ² = 0.9470 |
| (15) (1960) | = 6.60 (J) ^{0.99} | R ² = 0.96 |
| (16) (1950) | = 2.81 (J) ^{1.05} | R ² = 0.9 |

J is plant-site manufacturing employment in thousands (Table 20).