# MEASURES FOR SLOWING GROWTH IN ELECTRICITY CONSUMPTION

A STATEMENT BY DR. RONALD D. DOCTOR,
THE RAND CORPORATION, BEFORE THE ASSEMBLY SUBCOMMITTEE
ON STATE ELECTRICAL ENERGY POLICY
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## PREFACE

The following statement was presented on Friday, February 23, 1973, before the Subcommittee on State Electrical Energy Policy (Assemblyman Charles Warren, Chairman) of the California State Assembly Committee on Planning and Land Use (Paul Priolo, Chairman). The hearings of the subcommittee are based on two Rand studies performed at the request of the Planning and Land Use Committee of the California State Assembly (R-1115-RF/CSA and R-1116-NSF/CSA) with support of the National Science Foundation. The Rand statement presented at the hearings was intended to serve as a basis for subsequent testimony from other interested parties.

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Our discussion this morning will center on some of the measures that might reduce future demands for electricity. In order to gain some insight into the question of how reductions in the growth rate of electricity demand might come about and what reductions might be possible, one must first understand where the growth is occurring. Where are the greatest opportunities for slowing growth (Fig. 1)? We have concentrated our efforts on the residential and commercial sectors because that is where the greatest leverage for slowing growth seems to be. Although growth-slowing possibilities in the industrial sector have not been analyzed in detail, this sector is currently being examined under Rand's continuing NSF grant.

The residential sector currently accounts for about 30 percent of total electricity use in the state. This share is expected to decrease to 20-25 percent in the next 30 years. Even so, conventional projections indicate that use of electricity in the household sector will be almost six times higher at the end of the century than in 1970.

That growth is due only partly to an increase in the number of households. The number of households is expected to increase from about 6.7 million to about 12 million in the next 30 years. Most of the residential growth is due to a threefold increase in the electricity use of the *average* household.

Currently only 9 end uses account for 80 percent of household electricity consumption. Six of these--the ones underlined in Fig. 2--are particularly important as we'll see in a moment. And three of

# GROWTH OF CONSUMPTION

| SECTOR | ELECTRICITY CONSUMPTION | | | |
|---|---|---|---|---|
| | 1970 | | 2000 | |
| | Billions kWh | Percent of Total | Billions kWh | Percent of Total |
| RESIDENTIAL | 37 | 30 | 220 | 26 |
| COMMERCIAL | 43 | 35 | 470 | 55 |
| INDUSTRIAL | 29 | 24 | 110 | 13 |
| GOVERNMENTAL & OTHER | 14 | 11 | 50 | 6 |
| STATEWIDE TOTAL | 123 | 100 | 850 | 100 |

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Figure 1

# SOURCES OF RESIDENTIAL SECTOR GROWTH

- 9 END USES ACCOUNT FOR 80% OF CONSUMPTION

  Refrigerator, Lighting, Heating, TV,
  Air Conditioners, Cooking, Water Heating,
  Clothes Drying, Food Freezing

- 3 END USES ACCOUNT FOR 70% OF PROJECTED GROWTH

  Heating, Air Conditioning, Water Heating

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Figure 2

*these* six account for more than 70 percent of the projected growth in electricity needs for the average household.

The most dramatic increase in statewide electricity use, however, is expected to occur in the commercial sector, which by the year 2000 could account for 55-60 percent of statewide electricity consumption (Fig. 3). This elevenfold increase in electricity requirements is due primarily to a projected rapid expansion of commercial floor space; and second to increased use of electricity for heating, cooling, and lighting.

These considerations suggest several changes in energy use patterns that might be effective in moderating the growth of electricity use in both the residential and commercial sectors over the next several decades. Six such measures for the residential and two for the commercial sector are shown in Fig. 4. Before discussing these, however, there are two points I want to make: First, the measures shown all reflect a basic conservation theme. None would deprive people of the beneficial services provided by energy. These measures would promote more efficient and less wasteful use of energy and in the process would help to reduce the consumer's fuel and electricity bills. Second, we have applied these growth-slowing measures to *new* construction and *new* appliance purchases only. Existing stocks of appliances and existing homes and other buildings would not be affected by the measures we're suggesting. That is, we have simply estimated the savings in electricity use that might be possible in the year 2000 by applying these measures between now and then. We have not defined the implementation path by which one would get to the year 2000. Although that still needs to be done, let me point out that the relative desirability of alternative implementation paths depends on the effectiveness and degree of restraint imposed by the various policy actions that government and industry are able to bring to bear on the problem. I'll indicate some of these policy instruments in a few moments, but I'll leave detailed discussion of them for Dr. Kent Anderson's statement, following mine.

# SOURCES OF GROWTH — COMMERCIAL

- FLOOR AREA INCREASES 7-FOLD BETWEEN 1970 & 2000
- INTENSITY OF ELECTRICITY USE ($kWh/ft^2$) INCREASES BY ALMOST 50%
- ELECTRIC HEATING & COOLING ACCOUNT FOR 50% OF $kWh/ft^2$
- LIGHTING ACCOUNTS FOR 24% OF $kWh/ft^2$

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Figure 3

# MEASURES FOR CONSERVING ELECTRICITY

RESIDENTIAL

- IMPROVED INSULATION
- SOLAR ENERGY — HEATING, COOLING, WATER HEATING
- GAS SUBSTITUTION
- INCREASE ROOM AIR CONDITIONING EFFICIENCY
- DECREASE ELECTRICITY FOR LIGHTING
- LOW ENERGY BUILDINGS

COMMERCIAL

- DECREASE ELECTRICITY FOR LIGHTING
- GAS SUBSTITUTION — HEATING AND COOLING

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Figure 4

Four of the growth-slowing measures shown in Fig. 4 are of major importance because they bear directly on the sources of greatest growth (heating, cooling, and lighting).

- Installing improved insulation in new buildings;
- Substitution of gas for electricity in selected end uses;
- Extensive use of solar energy for heating, water heating and cooling requirements in new construction; and
- Reducing electricity requirements for lighting in the commercial sector.

Now let me divert a moment to discuss the gas substitution measure. Although our contract called for us to examine possibilities of reducing the growth in *electricity* demand only, we believe it is important to take account of the interrelationships between different forms of energy. The gas substitution measure can serve as a reasonable example.

It is logical to expect that this substitution of gas would greatly increase gas demands and aggravate an already serious gas supply problem. But this is not necessarily true. In fact, the substitution of gas for electricity in certain uses, namely heating, water heating, cooking and clothes drying and possibly in central air conditioning and refrigeration--all of which are major components of the growth of electricity use over the next three decades--*can* result in a reduction of statewide gas demand. This is because using gas directly is more efficient than the process of burning gas at a powerplant to produce electricity which then must be transmitted to homes or businesses for use. Thus, increased residential and commercial use of gas *could* be more than offset by decreased use of gas at the electric utility. Whether overall gas demand would increase or decrease depends on how much gas the electric utilities would normally consume. Even if gas demand were to increase, the increase could be at least partially counterbalanced by gas savings resulting from improved insulation, the use of solar energy, the construction of low energy buildings, and by gas conservation measures. If all measures were successfully carried out, gas consumption would be only slightly greater than that implied by conventional projections.

Still, there is the question of whether or not the conventionally projected gas demands can be met. There is no doubt that the gas supply problem can be very serious, but it is important to separate it into its components. The short term or immediate problem appears to revolve around insufficient incentives for gas producers to explore and develop new but expected gas fields. There are indications that the FPC is beginning to take steps to alleviate this problem by allowing well head prices of gas to rise. The longer term problem, as we observed in the previous committee session,* involves the ultimate depletion of domestic supplies of natural gas. In between there are many things we can do to minimize the effects of the problem. Among the more important actions available are: to increase our imports of gas (in the form of liquified natural gas) and to accelerate the development of facilities for producing synthetic gas--methane--from coal, or from the oil shales. Both imported LNG and synthetic gas from coal are expected to begin arriving in California by 1975-76. The "shortage" of gas projected for the 1980 time period could almost be made up from these two sources. (8-250 million cf/day plants or shipments would make up most of the projected deficit for 1980.)

In addition, actions could be taken that would encourage the conservation of gas at the point of use. For example, these might include:

1. Use of electric ignition systems instead of continuously burning pilot lights. (Pilot lights currently consume about 8 percent of the residential gas consumption in the nation.)
2. More efficient design of gas consuming applicances (e.g., ranges).

Thus it is important to recognize that if new institutional arrangements are initiated at the state level to deal with electricity conservation, these institutions also should have authority to consider gas and other forms of energy.

Now let's return to our menu of growth-slowing measures. Large savings in both electricity and gas requirements can be obtained simply

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*Doctor, R. D., *Consequences of the Present Policy of Demand Accommodation,* The Rand Corporation, P-5016, April 1973.

by increasing insulation levels in new construction. On the basis of recent studies, we estimate that 40-50 percent savings in the heating and cooling requirements of just the residential sector are feasible by improving insulation in new construction. A study of improved thermal insulation in residences carried out by John Moyers at the Oak Ridge National Laboratory indicated that the higher initial cost of improved insulation would be paid back in 4 to 7 years by reduced fuel and electricity bills. Improved insulation would help to reduce both electricity and gas consumption.

Solar energy devices for heating, water heating and possibly cooling can be made available using existing technology. We estimate that direct use of solar energy could result in a 70 percent decrease in energy requirements for heating and cooling, thus saving both electricity and gas bills. Because of the need to resolve the economic problems of solar energy utilization, significant implementation of this measure might be delayed 10 to 15 years.

Electricity used for household lighting could be reduced by 50 percent, mainly through a combination of selective conversion to fluorescent lighting, together with application of basic conservation practices. At least a 10 percent saving in residential electricity use could be obtained by designing new buildings specifically with energy conservation in mind.

Room air conditioner efficiencies vary by more than a factor of two between units providing the same degree of cooling. We estimate that average efficiencies of units purchased can be increased by at least 50 percent.

In the commercial sector, we estimate that electricity requirements for lighting can be reduced by up to one-third. In this sector, gas substitution for heating and cooling is even more effective and feasible at slowing electricity demand growth than in the residential sector.

Application of these and other measures could reduce electricity demand in the year 2000 by as much as 65 percent from conventional projections or by almost 40 percent from the Rand Base Case Projection (with price increases) that was discussed by Mr. William Mooz yesterday. Such a reduction would produce a 3 percent per year average annual rate of growth between now and the end of the century.

Before I go on, let me say a few words about the subject of identifying an acceptable growth rate as called for in the Hearing Notice. First, it is difficult to define what an "acceptable" growth rate would be. Many economists hold that there is no such thing as a single acceptable growth rate. One *can* define what *range* of growth rates might be possible for different levels of growth slowing efforts. But before attempts are made to implement growth slowing policies, detailed evaluations should be made of the costs and benefits of instituting growth rate reduction policies.

In our work for this committee, we have taken the first step. We have identified a range of possibilities and have shown that *conservation* measures have the potential for producing significant reductions in demand growth rates. If, for example, an average growth rate in electricity consumption of 3 percent per year could be achieved, then many of the problems connected with the conventionally projected growth could be relieved or postponed sufficiently to allow time for the development of rational, long-term solutions to our energy problems. Thus an average 3 percent rate of growth would mean that instead of almost 130 new fossil fuel and nuclear units, fewer than 25 would be needed between now and the year 2000. The saving of over 100 power generating units would be significant in terms of reducing resource scarcity and land and water use problems.

In this respect, let me raise one other point. So far we have dealt separately with potential supply adjustments and with demand adjustments, but we must recognize that *both* supply and demand adjustments will come into play in future years. In combination, they offer the hope of favorable resolution of California's prospective electricity problems.

For example, in our previous presentations to this committee, we have mentioned geothermal energy. Professor Robert Rex of U.C. Riverside has estimated that California's Imperial Valley overlies a vast geothermal reservoir that has a potential capacity of 30,000 MW. That represents less than 20 percent of the conventionally projected capacity requirement for the year 2000. *If*, however, growth in electricity demand is slowed to 3 percent per year, and *if* exploration and development leads to on-line geothermal capacity beginning in 1985, then between 1985 and 2000 no new fossil fueled or nuclear power plants would be required in California and installed nuclear capacity could be limited to less than 5000 MW. Thus the combination of a new supply technology and slowed growth in demand can be very effective in relieving our electricity problems.

There is considerable uncertainty, however, as to whether or not 30,000 MW of geothermal capacity really exists in the Imperial Valley, and until detailed implementation cost studies are carried out, there will be uncertainty as to whether or not a 3 percent growth rate is really achievable or desirable. But argument on these matters obscures the main point. Even if geothermal capacity ultimately were only 10,000-15,000 MW instead of 30,000 and if the growth rate were 4 percent instead of 3 percent, the point is that the benefits of *combining* new supply adjustments with demand reduction are sufficiently large to make more detailed economic and implementation analyses appear to be warranted.

Let me now turn very briefly to consideration of what the state government can do to encourage adoption of these various conservation measures. Across the top row of Fig. 5 are the six electricity conservation measures used in our study. An "X" indicates that a particular policy action (shown on the left-hand column) can help to promote a particular conservation measure. Since these policy actions are the subject of Dr. Kent Anderson's presentation, immediately following mine, I will just point out that the policies fall into 3 groups: (1) policies designed to elicit voluntary responses from consumers and developers, including especially a program of consumer education and efficiency labels on appliances; (2) policies based on financial incentives, and disincentives (the latter through taxes on electricity or electricity using appliances); and (3) restrictive policies, the most extreme of which is rationing or outright prohibition, but including more moderate policies such as placing limits on utility promotional activities or setting minimum insulation or appliance efficiency standards.

# POLICY ACTIONS AND ELECTRICITY CONSERVATION MEASURES

| Policy Action | Gas Substitution | Solar | Insulation | Air Conditioning | Lighting | Low-Energy Building |
|---|---|---|---|---|---|---|
| Media Advertising | X | X | X | X | X | X |
| Appliance Labeling | | | | X | X | |
| Literature | | X | X | | X | X |
| Solar Demonstration | | X | | | | |
| Solar Industry Tax Relief | | X | | | | |
| Electricity Tax | X | X | | X | X | X |
| Appliance Tax | X | X | | X | | |
| Limit Sales Promotion | X | X | | | | |
| Building Code | | X | X | | | X |
| Appliance Efficiency Standards | | | | X | X | |
| Utility Pricing Regulations | X | X | | X | | |

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Figure 5

This list is *not* all-inclusive. There *are* others. However, this list includes actions that, in our judgment, offer the greatest promise of being beneficial.

Next Dr. Kent Anderson will discuss these policy actions in greater detail. For now, I will just note that our approach to slowing growth in electricity demands is to suggest a gradual approach, starting first with voluntary policy instruments and moving toward more restrictive actions only as further analysis suggests they are desirable. In addition, we believe the state government has a significant role to play in energy conservation matters.

That role, I will note, does *not* necessarily include across-the-board support for research and development, an area perhaps best left to the Federal Government and the private sector. It may, however, include R&D support for subjects of particular concern to California. The *major* state role is to clarify state objectives with respect to energy production and use. Such clarification would provide a basis for reviewing state policies and formulating new ones where needed. In developing this role, major attention should be devoted to coordinaating energy policies with other state policies (notably land use, transportation and welfare policies) and to monitoring and evaluating the effectiveness and effects of energy conservation actions.

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