CALIFORNIA'S ELECTRICITY DEMAND AND SUPPLY CHARACTERISTICS

A Statement Before the Assembly Subcommittee on State Electrical Energy Policy, February 15, 1973

W. E. Mooz and R. G. Salter

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by

W. E. Mooz and R. G. Salter*

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CALIFORNIA'S ELECTRICITY DEMAND CHARACTERISTICS

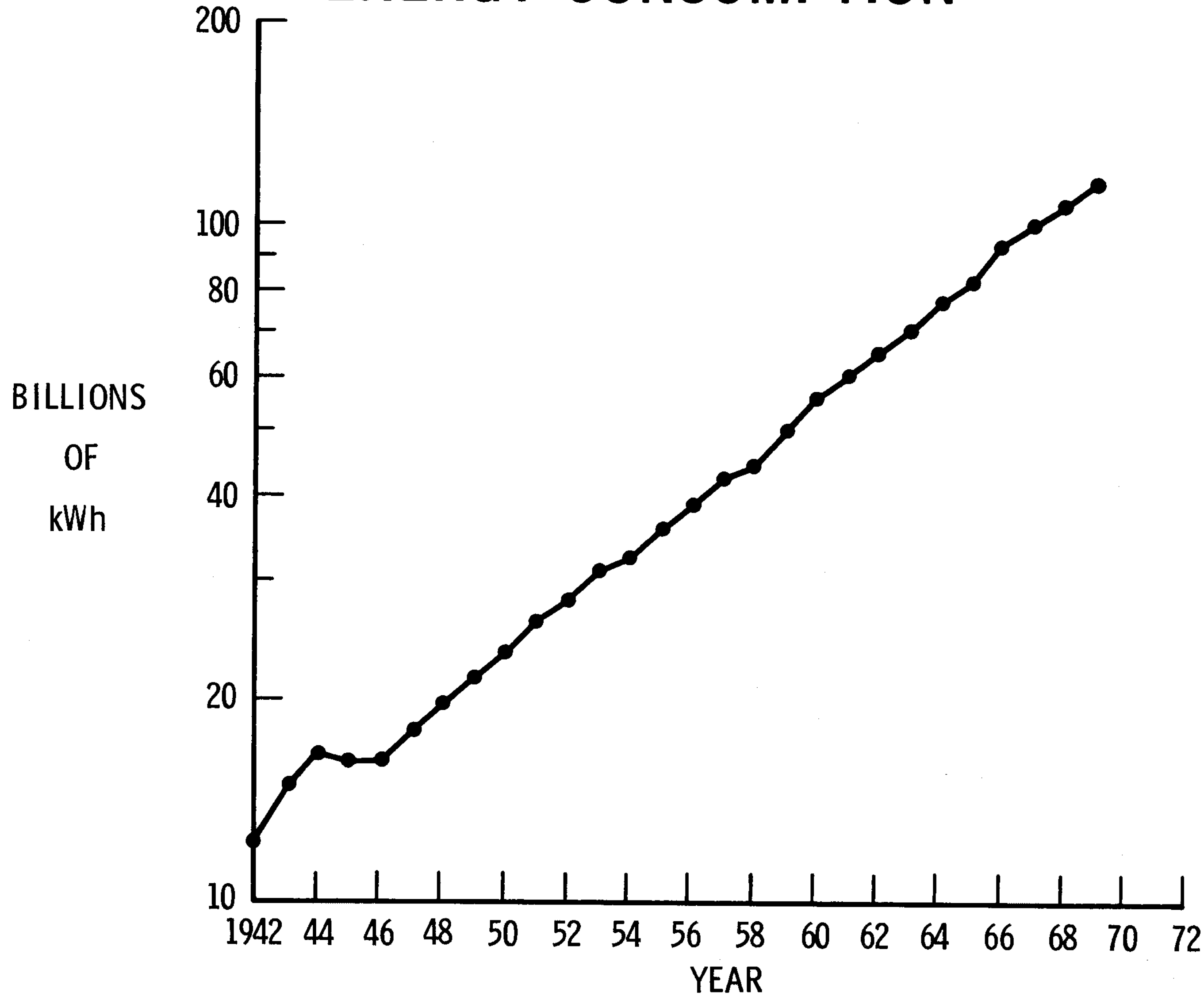
Any consideration of the use of electrical energy in California must begin with an examination of the rapid and steady increase in the demand for this energy in the recent past. Figure 1 shows this on semi-logarithmic coordinates, in which the reasonably constant rate of 8 to 9 percent is evident in the period examined.

Faced with this picture, it is easy -- and quite tempting -- to project this trend into the future. But there are reasonable arguments that suggest that the conditions under which this straight line trend has been established will not persist much longer. Particularly since during most of the period electricity prices have been decreasing on a constant dollar basis. In the last couple of years there has been a reversal in this trend, and almost all predictions for the future indicate substantial increases in electricity prices.

In order to get a better understanding of why electricity consumption is increasing, and where it's going, we studied the patterns of use in each sector of the California economy, and isolated the determinants of this use so that we could make some projections for the future. Three major sectors - the residential, industrial, and commercial sectors - account for about 90 percent of the total use of electricity in the state with the remaining 10 percent split up among a group of smaller consumers. Let me talk about the major sectors.

Fig. 1

HISTORICAL CALIFORNIA ELECTRICAL ENERGY CONSUMPTION



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The residential sector presently consumes about 28 percent of California's electricity, and in the ten year period from 1960 to 1970 was growing at an average rate of about 8 percent per year as shown in Figure 2. The driving forces behind this growth rate are the number of households and the average annual consumption of electricity per household. The number of households has increased at a slow but steady rate as a result of population growth and in migration (with the exception of the last couple of years). But the use of electricity in the average household is increasing dramatically, having doubled every 10 to 12 years for the last several decades. This is due primarily to the invention and introduction of major electrical appliances. The most important of these are central air conditioning, electric space heating, electric water heaters, electric clothes dryers, electric ranges, and refrigerators. The electricity used each year by these appliances in the average California home is shown in Figure 3, and the changes in saturation (or percent of homes owning the appliance) from 1960 to 1970 also shown for one marketing area. Note the large changes in the use of central airconditioning and electric heating. These increases are not unrelated to the change in numbers of all electric homes during the period, which is also shown. In comparison to the statewide average of about 5200 KWH per year, an all electric home uses from 25,000 to 30,000 KWH per year, depending upon the climate.

Our work suggests that the rate of growth in the residential sector will taper off in the future for a variety of causes. A lower rate of population growth is one of these reasons, but it is not as important as a decrease in the growth rate in average household consumption. As mentioned,

Fig. 2

CONSUMPTION OF ELECTRICITY BY SECTOR IN CALIFORNIA

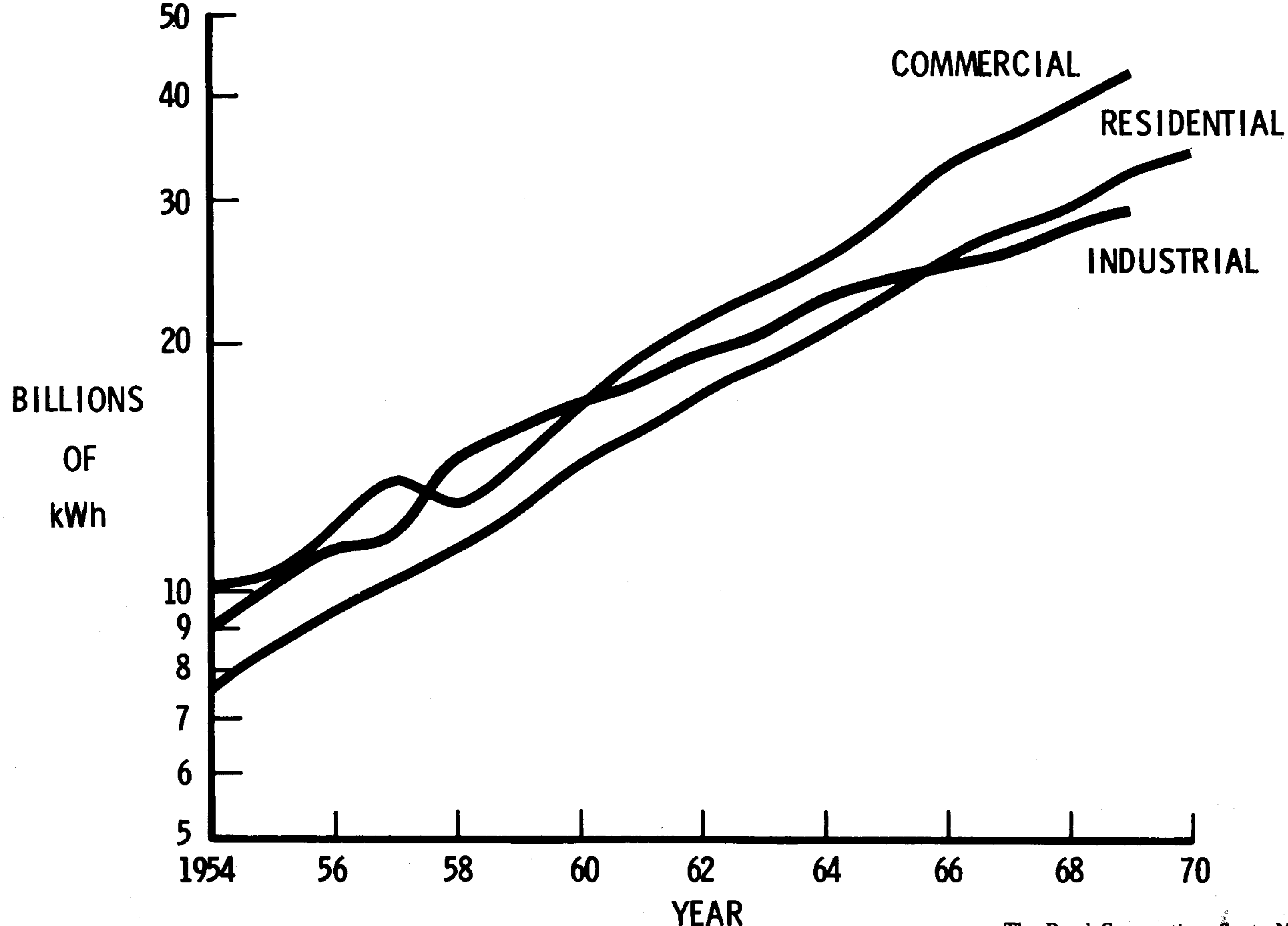

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Fig. 3

MAJOR HOUSEHOLD APPLIANCES

	Average Electricity per year (kWh/yr) (1969)	Saturation (%)* 1960	Saturation (%)* 1970
CENTRAL AIR CONDITIONING	1570 – 4360	3	8
ELECTRIC RANGES	1175	17	27
REFRIGERATORS	1140	90	100
ELECTRIC CLOTHES DRYERS	990	10	21
ELECTRIC WATER HEATERS	4220	5	9
ELECTRIC SPACE HEAT	4750 – 13,750	2	6

	Number 1960	Number 1970	Fraction (%) 1960	Fraction (%) 1970
ALL-ELECTRIC HOMES	143,000	566,000	2.9	8.6

* One major area – SCE

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the growth in average household consumption has been sustained by the invention and introduction of major electricity consuming appliances. We have not seen either the invention or introduction of any devices which fit this category in recent years, and it is expected that new appliances are liable to fit the category of "light" users, or occasional users of electricity. The electric tooth brush, carving knife, waste compacter, and other devices are typical of these, and they contribute very little to energy demands. Future average household electricity consumption is likely to be determined by changes in ownership (or saturation) of existing major electricity consuming devices. Our studies show that if this is the case, the present growth rate will slow to an average annual rate of about 4.5% for the 30 year period from 1970 to 2000. However, during this period, electricity prices will also probably rise enough to also affect the decisions of people to purchase appliances which are heavy users of electrical energy. The response of consumers to increased electricity prices depends upon how high prices go and what happens to the price of gas at the same time. These two factors are unknowns, but in one scenario which we postulated in our work, we found that residential electricity consumption in the year 2000 might be reduced by about five percent by price increases which might occur.

The industrial sector presently consumes about 25 percent of California's electricity, and the sector grew at the average rate of about 5 percent per year in the period from 1960 to 1970. This is shown in Figure 2. The 5 percent average growth rate is the smallest of the "big 3" sectors - residential, industrial, and commercial, and results in an ever shrinking share of the consumption in the state. While in 1970 industry used about 25 percent of the electricity in the state, in 1960 it consumed about 30 percent. There are a number of factors behind these numbers which are important to examine, and our study concentrated on these. Within industry itself, we found that the use of electrical energy could be projected by using the size of industry (that is, its output), the composition of industry (that is, the kinds of industrial activities), and the electrical energy intensiveness of each industry. The electrical energy intensiveness is simply a measure of how much electricity goes into each unit of industrial output. When we examined these factors, we found that while industrial output is growing, it is growing slower than other facets of the economy, this being one reason behind its slower growth in electricity consumption. We also found that the composition of the industrial base is changing, and moreover is liable to continue to change in the future. There are several reasons for this, ranging from the fact that industries such as aerospace and electronics are extremely important in the California economy, but are federally financed and consequently subject to different growth patterns, to the fact that the largest single industrial user of electricity - the petroleum industry - is based upon ever shrinking stocks of natural resources. Output of the petroleum industry in California has been declining in recent years and will continue to decline as petroleum is depleted. This will in turn, affect the use of electricity. In general, the composition of industry is slowly changing in such a way as to reduce the use of electricity per unit of industrial output.

At the same time that this is happening, one finds that within each industry itself there is a tendency to increase the use of electricity per unit of output. This results from technological changes and from the replacement of human labor by machines operated by electricity. These changes in the use of electricity are happening in almost all industries, but are expected to taper off and stabilize in the next couple of decades as, for example, it becomes less possible to replace the remaining human labor by machines.

Our projections in the industrial sector reflect all of these facts - the shrinking importance of the industrial sector, its changing composition, and its changing use of electricity. We find, as we did in the residential sector, that the expected growth rate is lower than what has been experienced in the past, and for the 30-year period from 1970 to 2000 might average about three percent per year. This is, of course, without taking into account anticipated energy price increases, which might reduce electricity use by about ten percent.

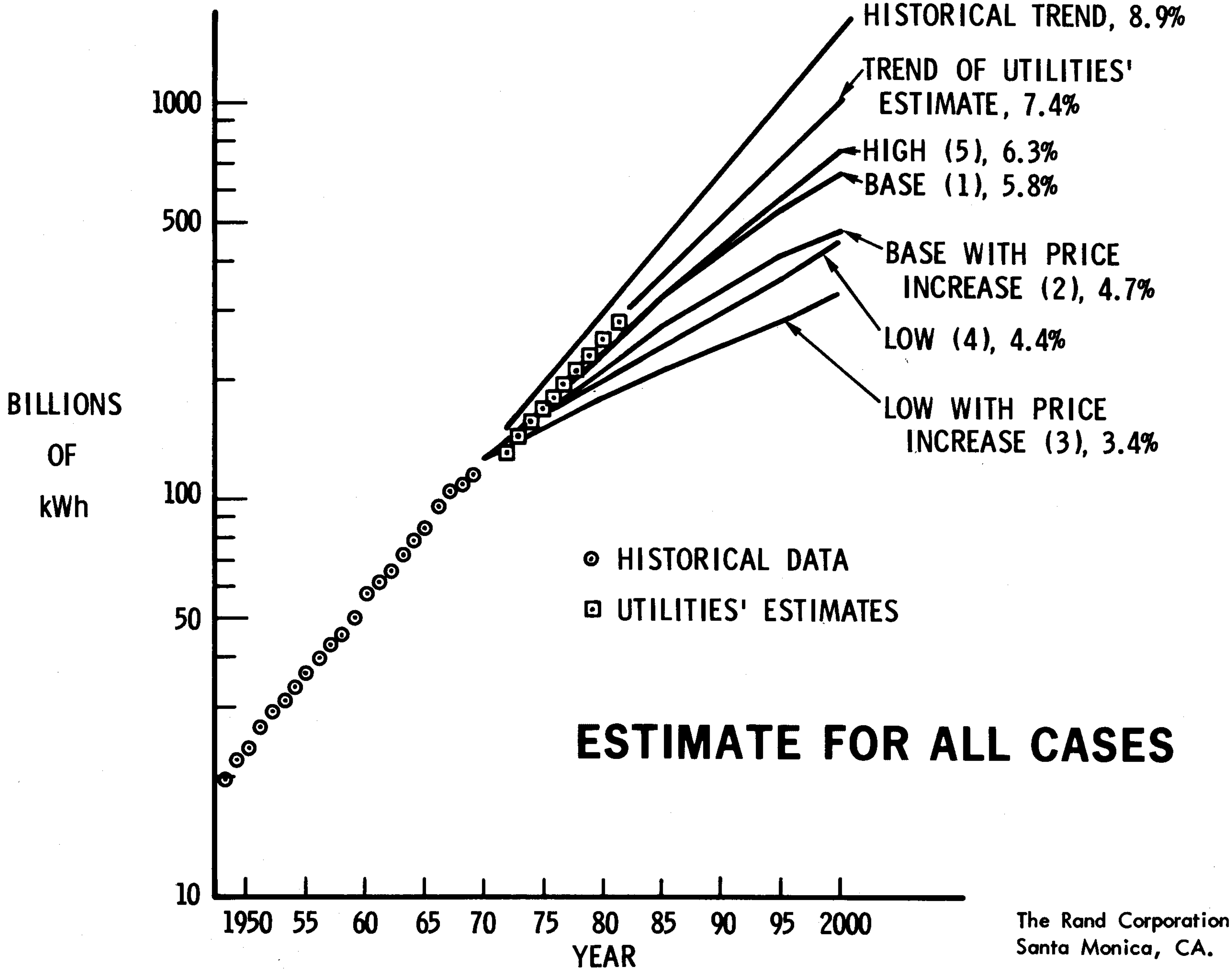
The commercial sector is the largest sectoral consumer in California, and it is also the fastest growing, but unfortunately it is also that sector which is most difficult to analyze. From 1960 to 1970 the use of electrical energy by the commercial sector grew at a rate of about ten percent, as shown in Figure 2, causing the sector to increase from consuming 30 percent of California electricity to 37 percent. One major reason for this is that the service sector is growing very rapidly, and this growth accounts for almost half of the growth rate in the use of electricity. But compounding the growth in commercial output are two extremely important factors.

The first of these is that the floor area per unit of output is increasing, and the second is that the amount of electricity per unit of floor area is also increasing. So we have a situation in which the commercial sector is using bigger buildings and more floor space per dollar of output, and these buildings are of the type which are electrically heated and cooled. The commercial sector also has been influenced by airconditioned shopping centers or malls, which are becoming increasingly popular.

Our examination of the commercial sector took account of these trends, yet we found results similar to those of the other major sectors - a lower growth rate in the demand for electrical energy in the 30 years from 1970 to 2000 might be expected, and increases in energy prices will further lower this growth rate.

In aggregate, when our work is compared with ten-year projections prepared by the California Public Utilities Commission and published in July 25, of 1972, the differences are not great if energy price increases are not considered. This is shown in Fig. 4. As an example, our projection for 1980 was 258 billion KWH of generation compared to the CPUC projection of 264 billion KWH. However, when price increases are taken into account, this changes in accordance with the magnitude and timing of these increases. In one example which we chose, price increases in electricity and gas reduced the 1980 projection to 231 billion KWH, or by about ten percent. It is not possible to make comparisons beyond 1980, because the last projection of energy by the CPUC was for 1981. Our projections were made to the year 2000 , for a variety

Fig. 4


HISTORICAL TREND, 8.9%
TREND OF UTILITIES' ESTIMATE, 7.4%
HIGH (5), 6.3%
BASE (1), 5.8%
BASE WITH PRICE INCREASE (2), 4.7%
LOW (4), 4.4%
LOW WITH PRICE INCREASE (3), 3.4%
BILLIONS OF kWh
1000
500
100
50
10
HISTORICAL DATA
UTILITIES' ESTIMATES
ESTIMATE FOR ALL CASES
1950 55 60 65 70 75 80 85 90 95 2000
YEAR
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of reasons. One of these reasons was that we wished to make comparisons with other projections to the year 2000, and to relate both to the electricity conservation work to be discussed later. In general, however, our work shows a more pronounced slowing of the electrical energy demand growth rate in the years from 1980 to 2000 as the combined effects of residential and commercial appliance saturation, industrial composition and intensiveness changes, and price increases all combine to reduce the rates. Under one postulated set of conditions we found that the average rate of growth between 1970 and 2000 would be slightly less than five percent.

I've talked a bit about projection techniques in explaining the results which I've presented. I would now like to focus on the differences in the techniques which we developed and used in our study and the techniques which have traditionally been used by the state. I don't intend to go into detail, but rather intend to highlight just the major points.

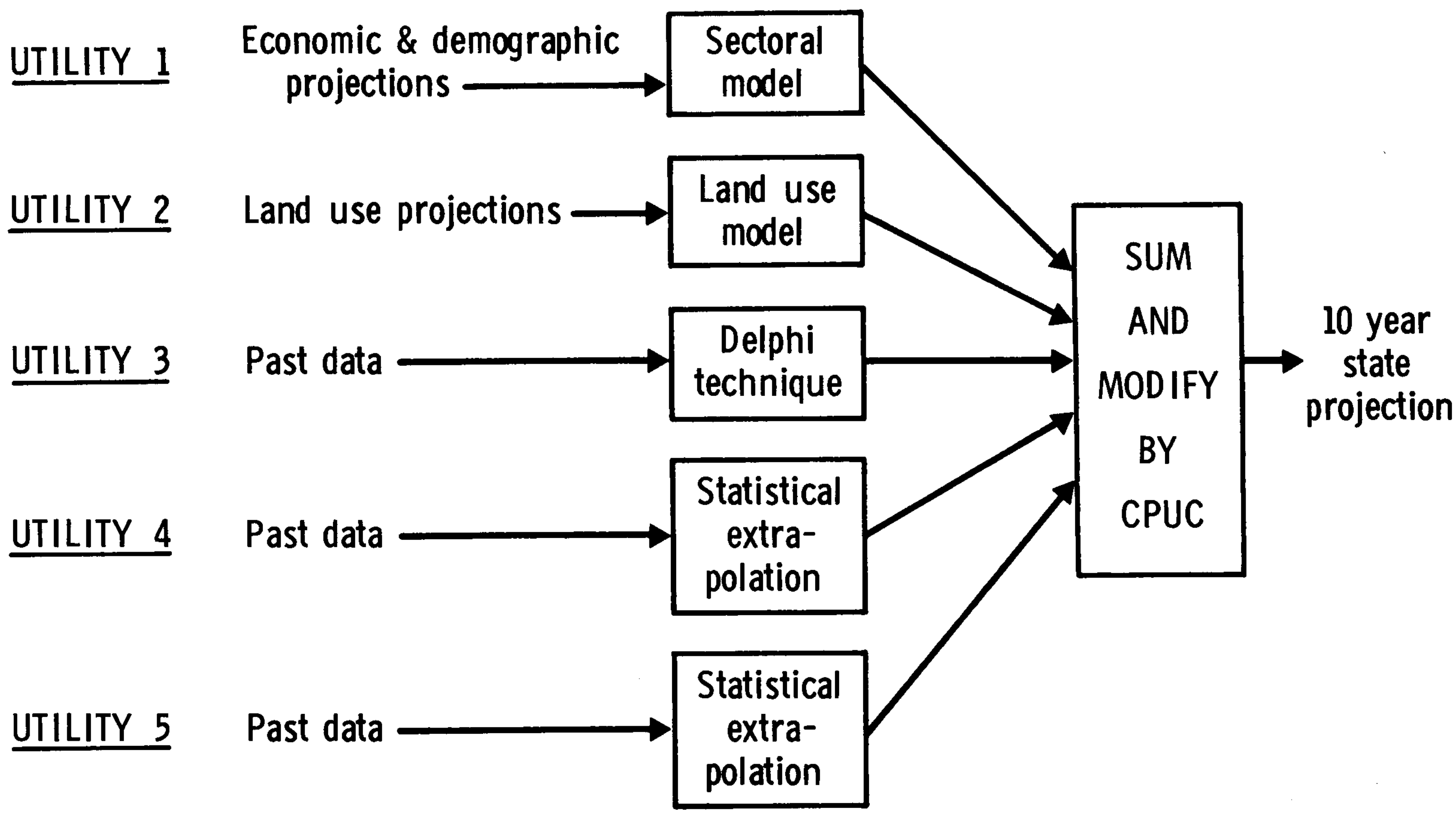
The existing procedure is shown in Figure 5. It is a procedure which has obviously worked well in the past, but which now falls short of providing the answers to new types of questions. Several observations may be made.

The first point is that the utilities originate the projections, and although there is every evidence that they have been dispassionately prepared, questions might be raised about the adequacy for all state planning purposes of complete reliance on estimates prepared by those whose prime interests are the marketing of their product. This was one reason for the state commissioning the creation of an independent methodology.

Secondly, each utility makes its projection based upon their own methodological approach, and these vary widely. As shown in Fig. 1, there

Fig. 5

PRESENT METHODS OF PROJECTING STATE ELECTRICITY DEMAND



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are two formal models in use which are rather well developed. One of these is based upon economic and demographic inputs and generates outputs of the energy requirements of each of several socio-economic sectors. The data base for this model is carefully prepared, and there is constant work involved in updating and improving both the model and the data base. The other formal model has been in continuous use in the same conceptual form for over 40 years. It is based upon land use and uses a grid which is coincident with the Bureau of the Census grid. Consequently, census data may be used as it is applicable in projecting changes in the use of the land. A third utility carefully monitors their marketing data and observes the trends of demand. Then by using a Delphi technique, these trends are modified and projected. The remaining two utilities simply use statistical extrapolation of past data on electricity consumption.

However well these methods have worked in the past, it is clear that the use of several quite different methodologies is questionable unless there are obvious reasons why this should be done. Simply the maintenance of the several different data bases argues against it, as does the very difficult task of assuring that the data bases are consistent. Also, as we shall later observe, the use of a mixture of methodologies effectively precludes meaningful analysis of the factors influencing demand.

The third point that is important is that there are no formal provisions for assuring that the inputs to the five methodologies are consistent. We have seen examples where one utility projects a three-fold increase in electricity use by the average household for lighting, while a neighboring utility projects only a 15 percent increase in the same period. Similarly we have seen examples where one utility projected an average household consumption increase, 50 percent of which was due to increases in consumption by miscellaneous appliances. For the same period, a neighboring utility projected a similar consumption increase, yet less than 20 percent of the increase was ascribed to miscellaneous appliances. Each may in fact be correct in their analysis and their conclusions for their individual marketing areas. On the other hand, the differences just quoted may result from lack of coordination in the preparation of consistent inputs, since in the information which we saw, adequate supporting data were not provided.

The fourth objection to the existing system is probably the most important one. This is that the system cannot be used for any meaningful analysis of alternative future development patterns. Our procedure is designed to make such analyses. Our model uses projections of population, economy, types and sizes of industry, appliance ownership, and energy prices, among other factors, to address the questions of the future demand for electricity under various conditions which might exist. Some utility methodologies use some of these factors, but none of them use all of the factors, and some use virtually none of them. Thus addressing the problems of the future becomes difficult simply because the electricity projections of the utilities are unable to respond to variations in these inputs in any systematic fashion. One might well ask why the analytical function is important, and if so, why the problem has not emerged until now. It is easy to see that the state and the utilities have functioned in a satisfactory manner in the past without this capability, and have fulfilled their mandate to provide service to meet the load. A variety of reasons were responsible for this, mostly resulting from steady population and economic growth and slowly declining energy prices. As long as this situation remained constant, extrapolations of the past adequately predicted the future.

Times change. Everyone recognizes that a constant growth rate cannot be maintained forever, but few can agree when it will begin to slow down, as they know it must. Now, as planners look ahead, they see interruptions in the smooth growth patterns. Population growth in California has changed, due both to changes in birth rates and to a marked change in inmigration. Energy prices are beginning to rise, and are projected to continue to rise. Patterns of the state's future industrial makeup are no longer clear.

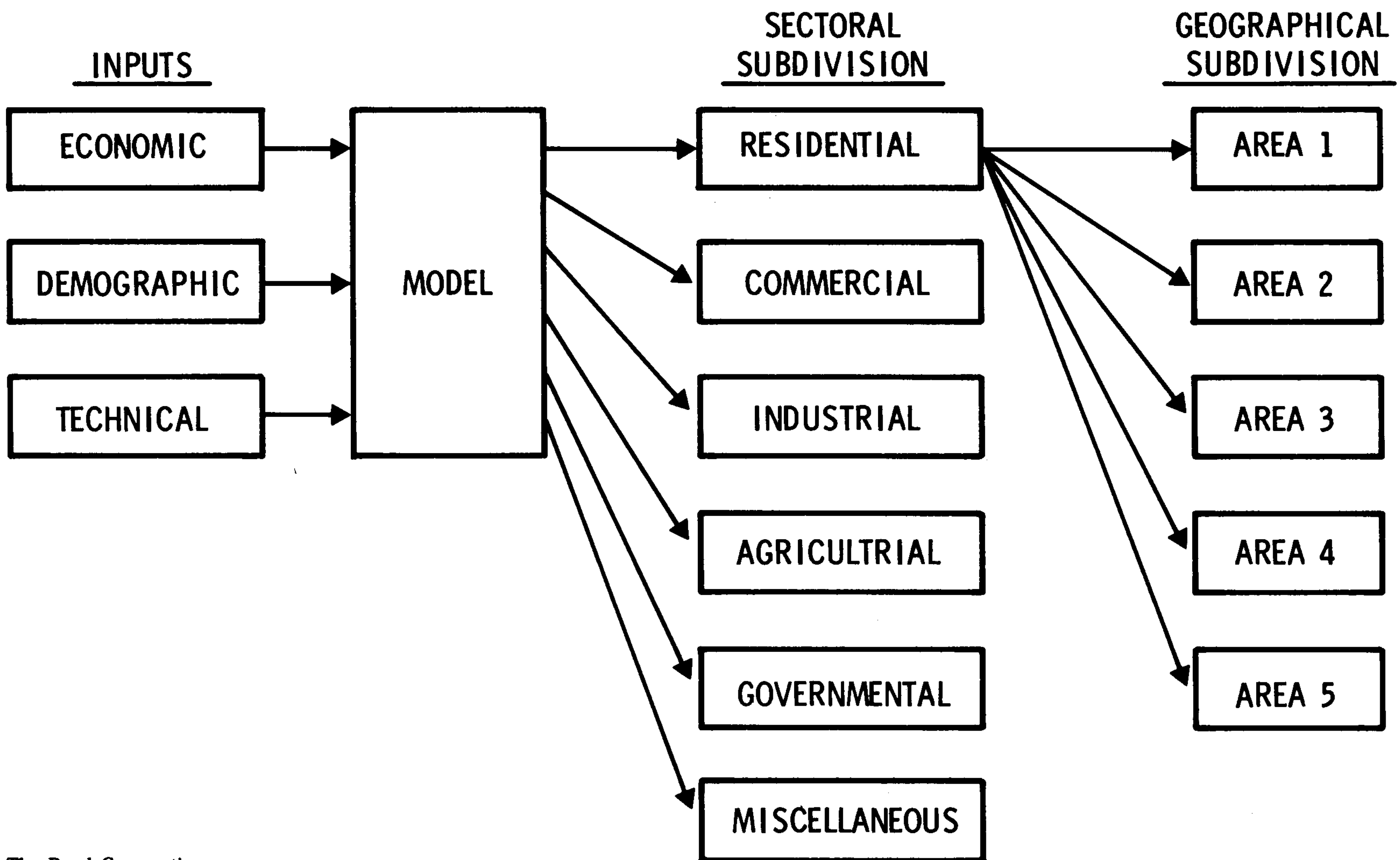
To interpret these signs into projected electricity demands requires techniques that deal consistently and explicitly with the effects of population, electricity prices, and the other variables which are likely to change in the future, and the existing methods largely failed in this regard.

With this background on the present system and its drawbacks, we can now look at the methodology which we developed at Rand for the state. It should be apparent that the first three objections to the existing system were immediately corrected by our methodology, in that it was designed for use by the state on a statewide basis, using consistent inputs. Consequently, most of the discussion to follow will dwell upon the details built into the model to enhance its use for analytical purposes.

Figure 6 illustrates the general structure of the model. The inputs are demographic, economic, and technical in nature. The model itself was

Fig. 6

STRUCTURE OF RAND MODEL



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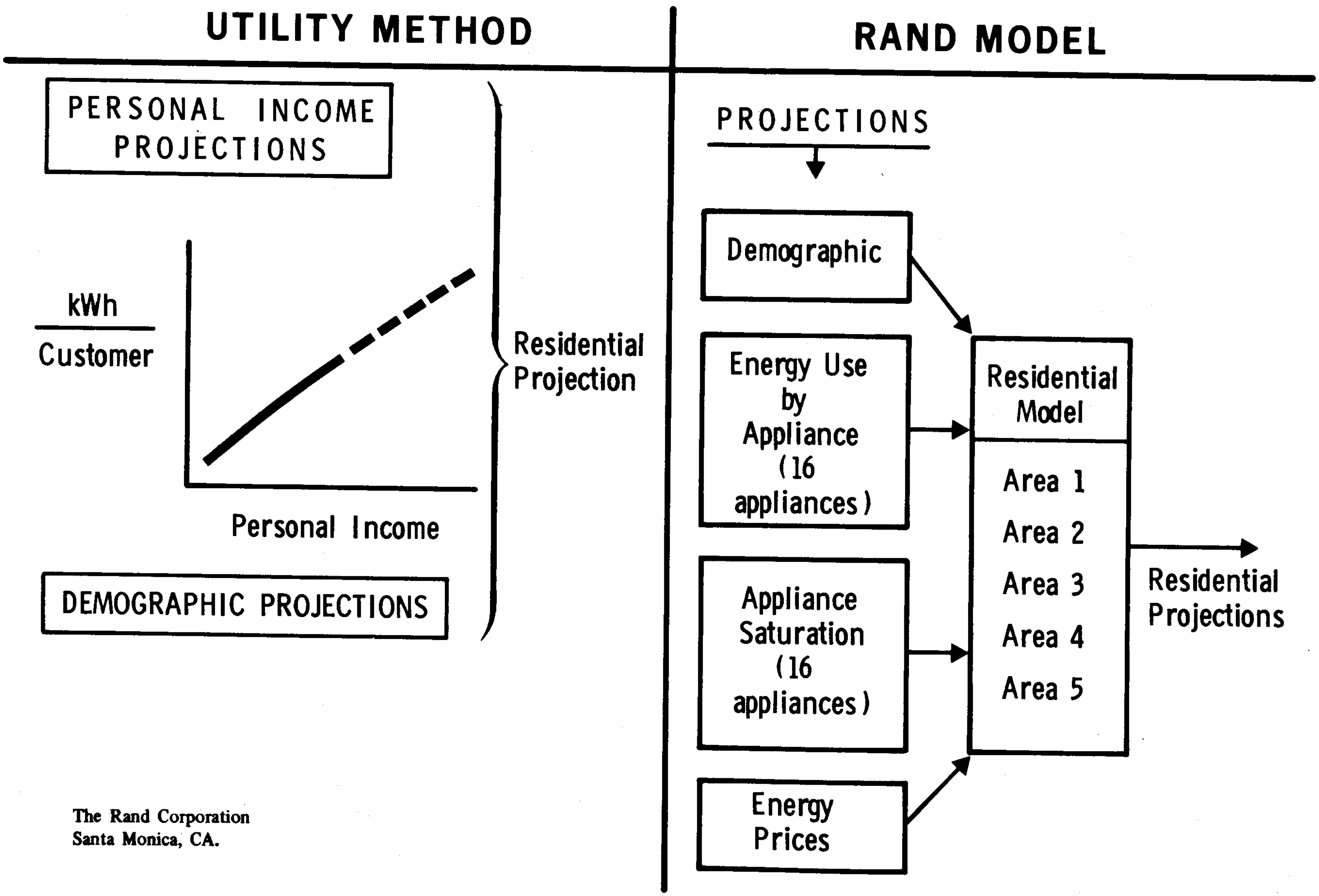
constructed on the basis of socio-economic sectors, and in the case of the residential sector was further subdivided into five geographical regions. As might be suspected, these regions conform closely to the five utility marketing areas, thereby simplifying the collection of data, and preserving the separation of California's widely varying climatological areas. Fig. 7 shows the comparison between the methodology which we developed. Note that demographic inputs are used in both models, and that in both models these are used to determine the number of customers in the residential sector (which is equal to the number of households). The utility model then depends upon projections of the average annual electrical energy consumption per household to complete the estimate. This information is developed from projections of per capita personal income and a statistically derived relationship between personal income and average electricity use.

Our model went into considerably more detail, yet is similar to that used by many utilities. We also use the number of households and the average annual consumption per household, but we base the consumption on a much more detailed examination of its determinants. These determinants are the average annual consumption of the various household electrical appliances, and the saturation (or percent ownership) of these appliances. Together with the area breakdown, there are 28 appliances considered. The average annual consumption of each of these 28 inputs is obtained from projections of past data. For each of the 28 appliance consumption inputs is a matching appliance saturation input. The saturations are also obtained from projections of past data, and are projected by using standard saturation curves. Implicit in the model

Fig. 7

RESIDENTIAL SECTOR



is the assumption that personal income, urban vs. rural locations, and other important variables are embodied in the saturation curve. Price data on electricity and gas, the two competitive forms of energy for residential use in California, are also input to the model, and act to modify the saturation curves of those appliances where either form of energy may be used.

In Fig. 8, comparisons of one utility method of treating the Industrial Sector with the Rand model are shown. The utility method uses carefully prepared data, yet the method relies upon a relationship between the use of electricity in the industrial sector in one part of the state and the Gross National Product. While there may be some historical basis for this, the relationship is philosophically unappealing and may actually be spurious.

The Rand model achieved a greater level of detail by breaking the industrial sector into 25 manufacturing and mining industries, and relating electricity use in each industry to its output, in terms of dollars of value added, to the prices of electricity and gas, and to the electrical energy intensiveness, in terms of kWh per dollar of value added, of the industry. The resulting model allows us to use the expected size of the industrial sector, its composition, its energy intensiveness, and energy prices as determinants of the demand for electricity.

Fig. 9 illustrates the comparison between one present projection method used by a utility for the commercial sector, and the Rand method. The utility method estimates the number of commercial customers as a function of the population, then uses this together with time series estimates of the electricity consumption per customer. Generally, the consumption per customer has been increasing. Our system is not substantially different, due largely to

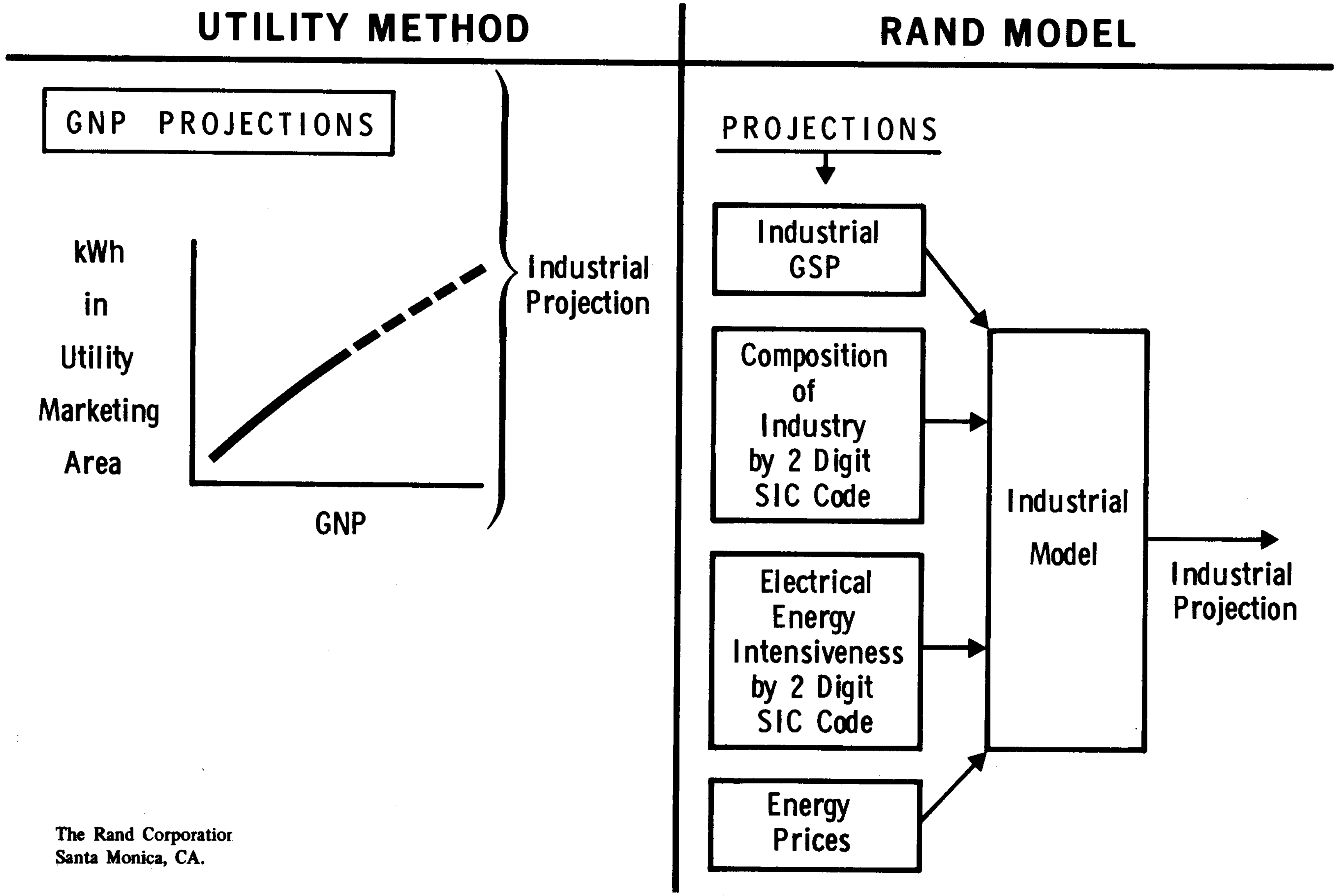


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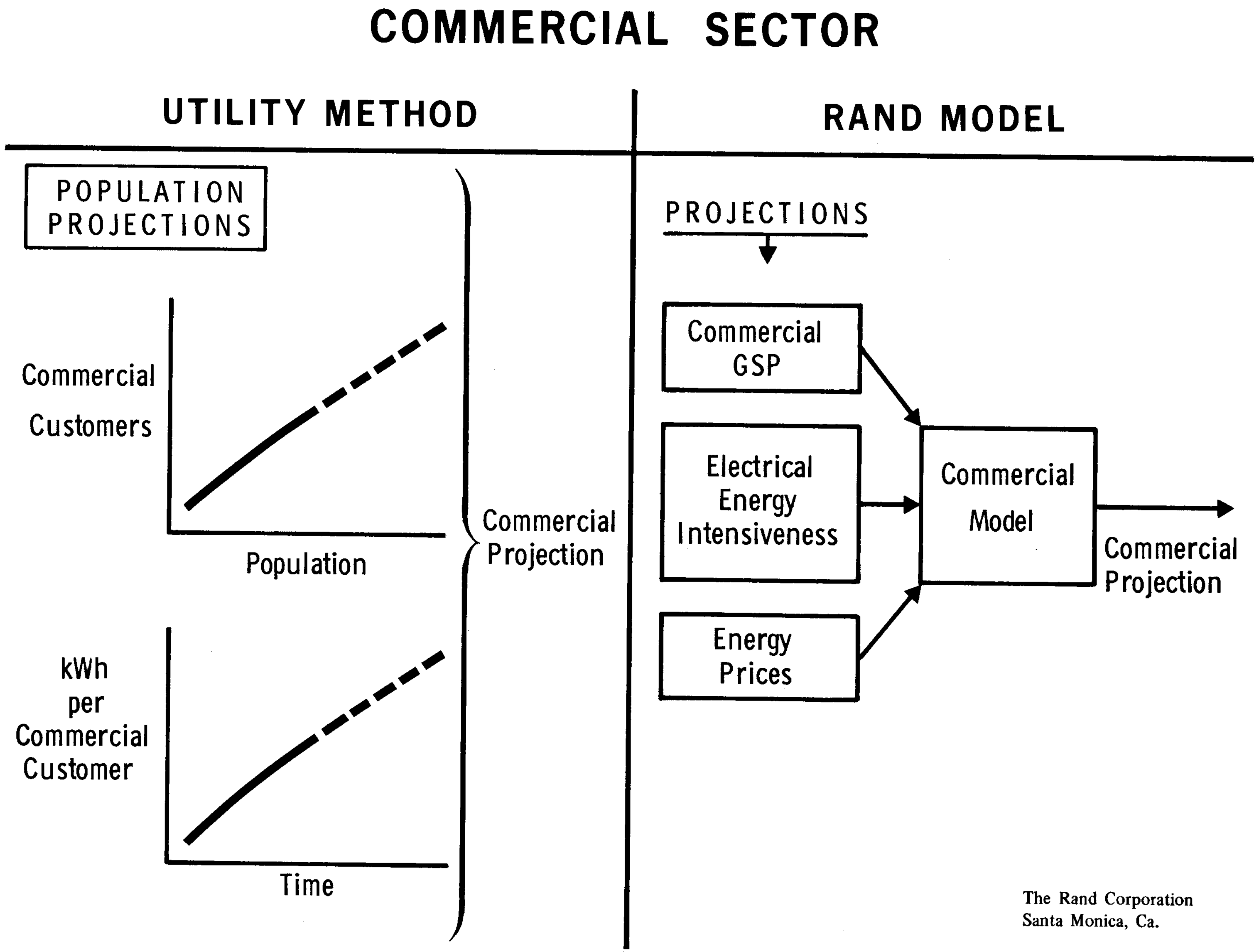
Fig. 9



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inadequate data and the very diffuse nature of the commercial sector. In keeping with other portions of the model, the commercial sector is driven by projections of the commercial share of GSP, the electrical energy intensiveness of the commercial sector, and the energy prices. Of course we find that the energy intensiveness, in terms of kWh per dollar of GSP, is rising, just as the utilities observe that the per customer consumption is rising. At the moment we have been content to use projections of the observed trend, but ongoing work is attempting to isolate the determinants of the increase, as has been previously described.

This concludes a very broad description of the differences between the present system of projecting the state's electrical energy needs with the method developed at Rand. There are obviously other methods which could be used besides these, including aggregate relationships based upon projections of GSP, per capita income, and other economic indicators. Each of these may have its own merits, but no presently existing methods, to our knowlege, provide the state with the capability of the Rand methodology. The analysis of projections conducted provides a basis for Dr. Doctor's work which will be discussed tomorrow.

CALIFORNIA'S ELECTRICITY SUPPLY

My discussion of California's electricity supply characteristics will be fairly brief. It is an area which we have studied only as it impinged upon our work with the demand for energy, and then solely as an extension of our work with energy.

It should be understood that electricity supply, or generating capacity, is intimately related to the demand for electrical energy, and that by making reasonable assumptions concerning the ratio of generating capacity to electrical energy demands, one may talk in either set of terms. This is what we did in those areas of our studies where it was necessary to talk about capacity. The actual study of capacity itself has many facets and nuances which are exceedingly complex, and where these are important we suggest that they be discussed with those skilled in the art.

I am going to describe the existing supply system, the rate of growth experienced, and the anticipated increase in this capacity in the future. Virtually all of what I say has been taken from published information - notably the July 25, 1972 CPUC report on ten- and twenty-year forecasts. These take us out to 1991. I am also going to use some of our work which extends the CPUC information by use of FPC data to the year 2000, and also talk about some of our own independent estimates to the year 2000.

Fig. 10 shows the generating capacities as of the end of 1971. Approximately 65 percent of this capacity is fossil fueled, with hydroelectric sources accounting for about 27 percent. At the end of 1971, nuclear capacity was very small in comparison, accounting for only 1.4 percent of the total.

Fig. 10

EXISTING GENERATING CAPACITIES DECEMBER 31, 1971

TYPE	CAPACITY	FRACTION
HYDRO	9,417 MW	26.8%
FOSSIL		
STEAM - IN STATE	20,105 MW	57.2%
- IMPORT	1,688 MW	4.8%
GAS TURBINE	864 MW	2.5%
NUCLEAR	493 MW	1.4%
GEOTHERMAL	184 MW	.5%
FIRM TRANSFERS	2,385 MW	6.8%
TOTAL	35,136 MW	100%

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SOURCE: CPUC, "REPORT ON 10 & 20 YEAR FORECASTS OF ELECTRIC UTILITIES LOADS AND RESOURCES," JULY 1972

Fig. 11 illustrates the growth of capacity in the state. This has been growing at roughly the same rate as the demand for energy, and the effects of the growth rate are clearly evident, in that in each ten-year period from 1940 to 1970, the generating capacity which was constructed and put on line was at least equal to the entire state total at the beginning of the decade. This resulted in the capacity increasing to ten times its initial amount in just 30 years.

As capacity has increased, the proportion of it which was supplied from hydroelectric sources had decreased, as potential sites became increasingly less available. This, of course, is a trend which will continue. Note that while in the 40's the majority of California's supply was from hydroelectric sites, these are now in the minority.

To give an idea of what the supply picture looks like in terms of physical terms, in 1970 there were about 325 hydroelectric units at 166 separate sites in the state, and about 145 thermal units on 40 separate sites.

Figure 12 shows estimates of the future capacity requirements. As mentioned, those projections through 1991 are from the CPUC, including the breakdown of the type of generation. The increasingly important role of nuclear energy is clear, and in consonance with this, the percentage of supply from fossil fueled and hydroelectric sources is falling off. It is important to note that while the percentage of these is decreasing, the absolute capacity is increasing.

Fig. 11

HISTORICAL GROWTH OF GENERATING CAPACITY 1940 — 1970

	1940	1950	1960	1970
GENERATING CAPACITY, MW	3000	6000	13000	30000
HYDRO, %	60	58	35	26

GROWTH RATE	40's	50's	60's
	7.2	8.0	8.9
OVERALL	8.0		

1970 GENERATING MIX

	MW	%	SITES	UNITS	UNITS/SITES
HYDRO	7619	26	166	325	~ 2
THERMAL	20,389	68	40	145	~ 3.2
IMPORTS	1,792	6			

SOURCE: THE RESOURCES AGENCY, "SITING THERMAL POWER PLANTS IN CALIFORNIA" FEBRUARY 1970

Fig. 12

ESTIMATED FUTURE GENERATING NEEDS

	GROWTH RATE %	TOTAL MW
1971	—	35,136
1981	6.1	63,473
1991	6.1	115,210
2000	6.7	195,000*
	5.8	156,000*
	3.0	69,400*

PERCENT OF TOTAL

GENERATING MIX	1971	1981	1991
HYDRO	27	21	15
FOSSIL			
STEAM	57	39	23
IMPORT	5	11	8
GAS TURB.	3	4	7
NUCLEAR	1	19	36
GEOTHERMAL	<1	2	1
FIRM TRANSFERS	7	4	2
UNDEFINED	—	<1	10

SOURCE: Ibid CPUC, *R-1116

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The figures shown for the year 2000 are from the Rand study, and are shown with the growth rates associated with them. The 6.7 percent growth rate is that associated with an extension of the CPUC's 1991 figure by using FPC published estimates. The 5.8 percent growth rate was arrived at as a base case estimate of future growth, and the 3 percent growth rate was used as an objective in the study of growth rates. These figures for capacity were derived from the appropriate energy information, as previously stated. They are presented as examples of what the generating capacity requirements might be in the year 2000 under differing assumptions about the growth rate in the demand for energy.

Fig.13 addresses the question of the adequacy of the projected generating capacity. What is shown is the projected margin of generating capacity over projected needs, again using CPUC figures. Generally speaking, we understand that a margin of about 20 percent is desired, this being needed for normal maintenance of equipment and other contingencies. Note that in all cases except one the 20 percent is exceeded. However, the CPUC has identified various delay contingencies which could reduce the margins shown to those in the right hand column. Note that those shown for Southern California for 1981 could produce a deficit in the projected need. The delay contingencies examined have no probabilities associated with them, and consequently there is no "feel" for what the chances of reduced margins are. We made an analysis of the combined uncertainties of both supply and demand in Southern California from now until 1980, and our work indicates that there is only a 20 percent probability of being below the 20 percent margin, and virtually no probability of being below a 15 percent margin.

Fig. 13

GENERATING MARGINS
(MINIMUM OF 20% DESIRED)

NORTHERN CALIFORNIA	SCHEDULED	SPECIFIC DELAY CONTINGENCIES
1976	21.3%	6-14%
1981	25.2%	1-19%
SOUTHERN CALIFORNIA		
1976	19.6%	7%
1981	26.7%	<12>-<3>%
1980	<20% WITH 20% PROBABILITY* <15% WITH ZERO PROBABILITY*	

SOURCE: Ibid CPUC, *R-993-DUE TO UNCERTAINTIES IN BOTH SUPPLY AND DEMAND.

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The question of the precise state role in electricity supply R&D is far from obvious. It seems clear, however, that the state should be particularly interested in encouraging (and possibly sponsoring) R&D in those areas which tend to be of special interest to California. We list here a set of these concerns which we think are of particular importance.

- A considerable effort is currently under way in the development of design concepts for all kinds of structures, including power plants, so that they can survive seismic ground motions. A problem of importance, however, is the estimation of the probable character and magnitude of such ground motions at particular locations. The latter problem deserves a continued emphasis in California because of the prevalence of seismic events in our history and the likelihood of future such events. The criteria needed include the definition of the size, character, and frequency of the seismic event(s) which are a proper basis for design at a specific location.

- There are several ongoing efforts to examine the costs and benefits of placing electric generating and transmission facilities underground. A continued effort with emphasis on the California situation is desired, possibly with demonstrations for several actual installations.

- The California coast is generally of a different character than the East and Gulf coasts of this country--having a more precipitous continental shelf. As a result, the offshore siting systems being developed for these other coasts are generally not appropriate for California. The possibility of offshore siting in California should not be completely discounted, however, and a systematic search for and the ultimate development of satisfactory concepts is highly desirable, due to the potential advantages that may accrue.

- The siting of power plants in the interior of California, as an alternative to coastal locations, gives rise to the question of cooling systems and their needs for water. Central and Southern California interior locations must be considered inherently water short areas and cooling approaches are needed which would permit the least possible impact on these limited water supplies, without excessive increases in overall generating costs, if inland power plant siting is to be a viable alternative to the coastal locations.

- Geothermal energy resources are potentially very important to the satisfaction of electric generating needs in California. The magnitude of these resources is currently quite uncertain and this uncertainty is inhibiting the rate of exploration and development. It seems desirable for the state to participate in a research program to reduce these uncertainties so that if sufficient resources are verified, private development will be stimulated and an earlier benefit will accrue to the state's population.

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