

Water for Nevada

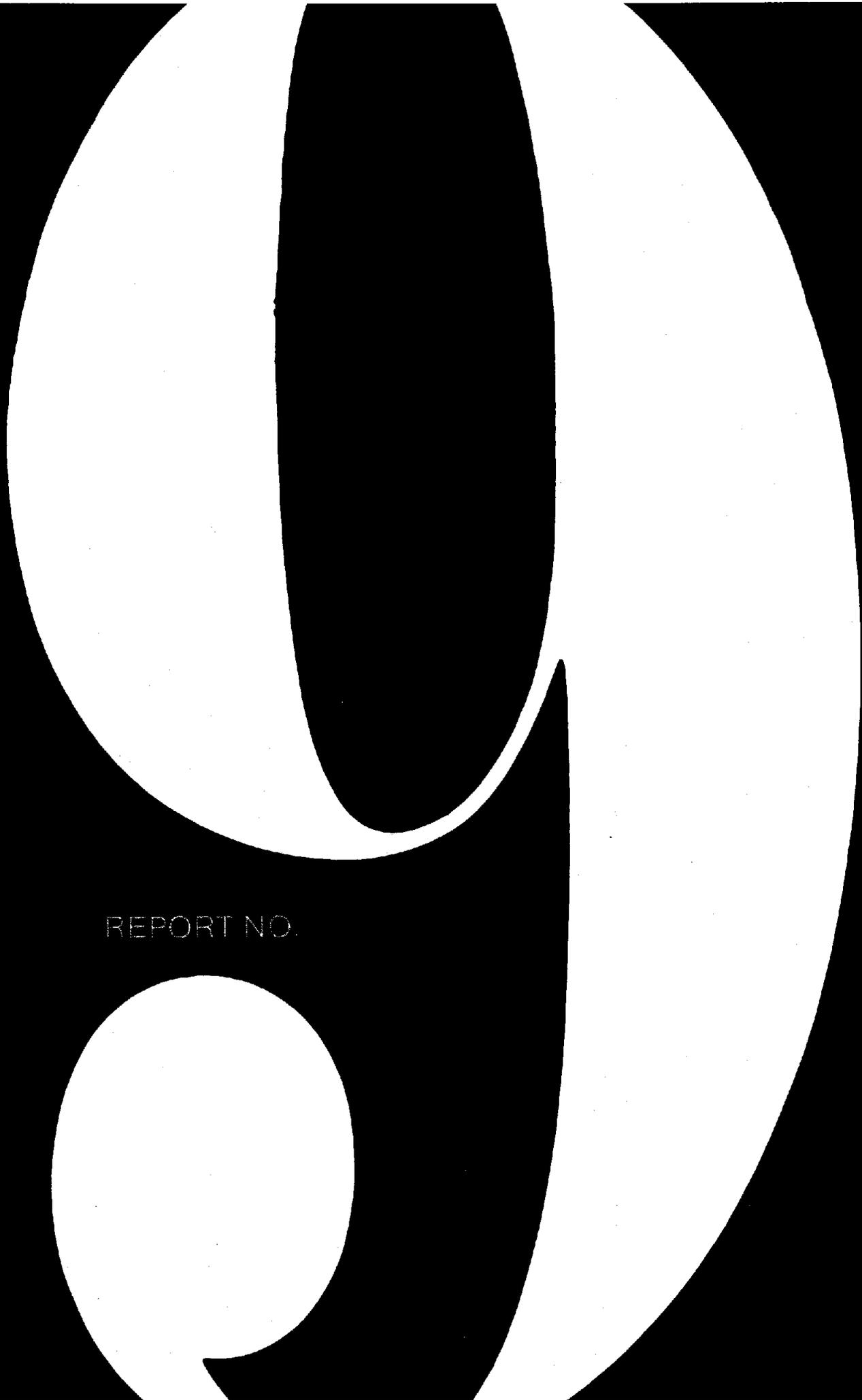


FORECASTS FOR THE FUTURE — ELECTRIC ENERGY

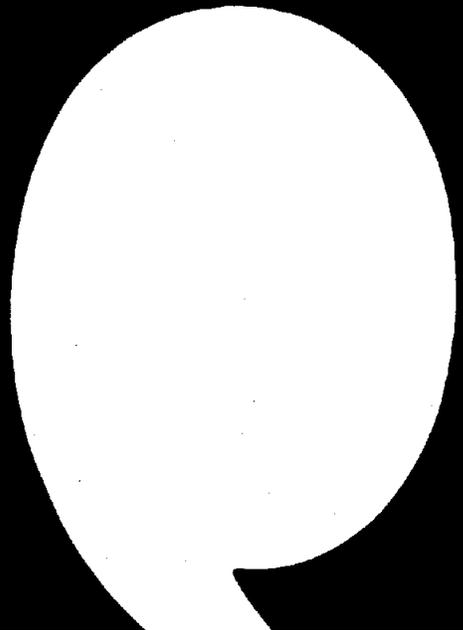
FORECASTS FOR THE FUTURE — ELECTRIC ENERGY

ABSTRACT

Electric energy generation and use as well as use of water and related land resources are considered from a Nevada viewpoint. Factors originating outside of Nevada are considered because Nevada is a part of the West and the Nation. Conservation measures, the subject of the detailed and separate addendum to the report, are summarized.



REPORT NO.



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TO THE CITIZENS OF THE STATE OF NEVADA

This report examines whether Nevada will import, export or be self sufficient with respect to electric energy, together with future water and related land resources questions. The report was edited and prepared by Victor R. Hill, of the Division's planning staff, along with Robert E. Walstrom, Natural Resources Consultant. Many other individuals and agencies provided extensive input for which there is space for only partial acknowledgment herein.

Nevada is currently a net importer of electric energy, and must also import the fuel required for generation within the State. Generation of electric energy in Nevada makes use of scarce water and related land resources. In this regard, generation requires considerable support. Accordingly, a preliminary listing of valleys which might efficiently support electric energy generation has been provided.

There are many things to consider related to Nevada's future electric energy course. Some of the more apparent include pressures building outside of Nevada affecting availability of sites and fuels. Transmission of electric energy is on a regional basis. Therefore, siting of generating facilities cannot escape regional import-export aspects. Inside of Nevada, this report examines methods of efficiently achieving reasonable economic and environmental balance, without a morass of regulations. However, recent and future federal actions may become controlling with respect to regulations.

It should be noted that there is great interest for future development of Nevada's geothermal resources. About 20% of the State is thought to have promise for future geothermal exploration. On a national scale, Nevada is estimated to be second only to California for potential geothermal development.

Additional emphasis in the report has been placed upon factors of efficiency in the use and generation of electric energy. In arid Nevada's future, conservation measures can help to prevent having to face in some areas the hard decision of whether to drink water or use it for coolant in electric energy generating stations.

Respectfully,

Roland D. Westergard
State Engineer

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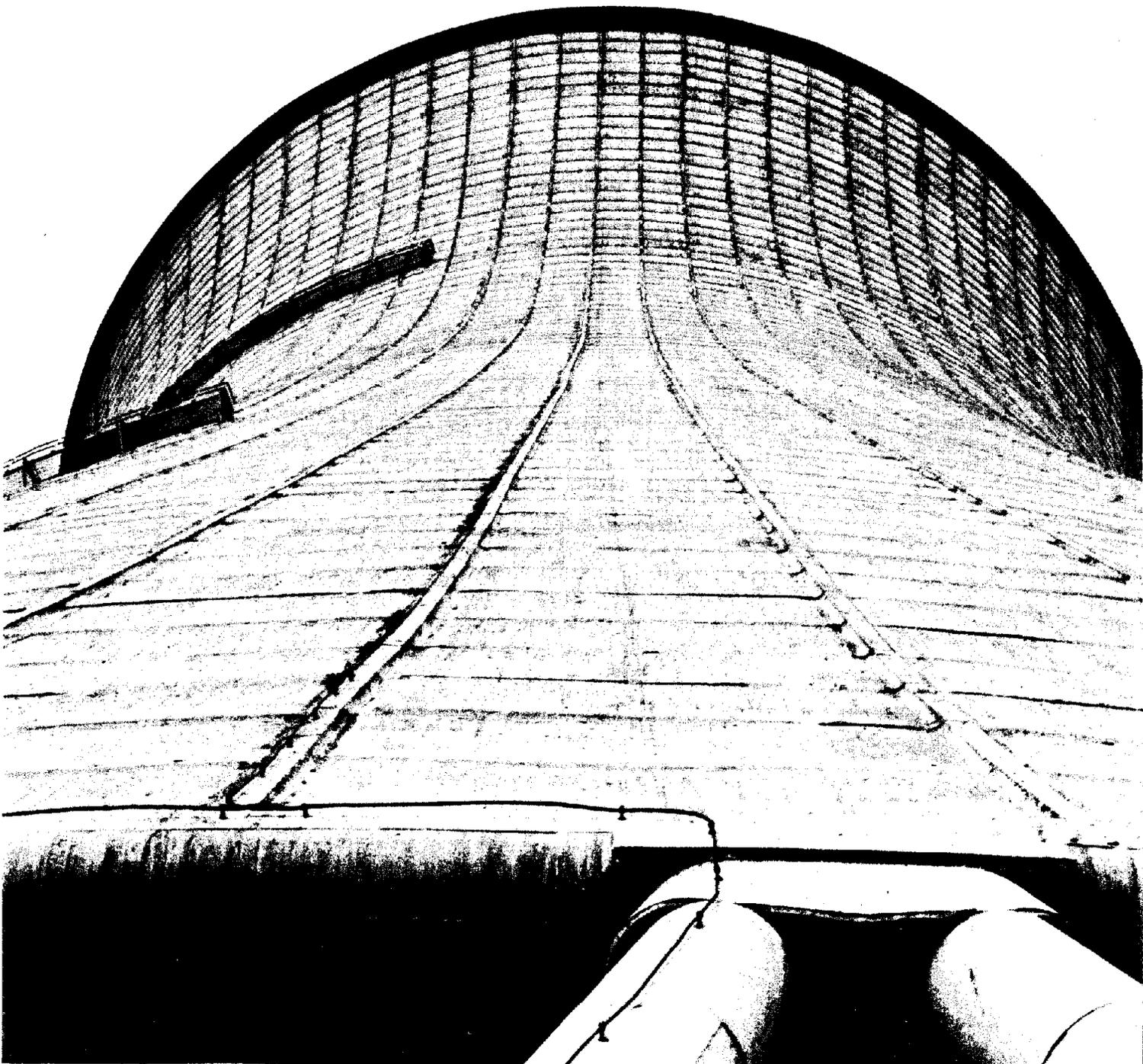
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Evaporative cooling tower at Rancho Seco.
Credit: R. E. Walstrom



FORECASTS FOR THE FUTURE — ELECTRIC ENERGY

CHAPTER 1 INTRODUCTION

This introduction identifies major issues necessary to compile a State Water Planning report about electric energy, for the period 1970-2020.

MAJOR ISSUES

Effects Upon Nevada

Electric energy use and generation should be considered in terms of their effects upon population, economic activity and resource use. The people of Nevada make use of electric energy in their everyday economic activities — residential, commercial and industrial. Generation of electric energy in Nevada makes use of the State's scarce water and related land resources. With these effects in mind, tremendously powerful and long term internal and outside forces will determine whether Nevada is nearly self sufficient with respect to electric energy or is a significant net importer or exporter.

Nevada's Present Internal Position

Nevada presently imports about 1/4 of its total electric energy use and imports essentially all of the fuel needed for the local generation of electric energy. Large portions of the State are sparsely populated, and are devoid of electrical service. In addition, the State's scarce water and related land resources suitable for use in electric

energy generation are under increasing competitive demand for other uses, particularly in urbanized areas.

External Factors

Over a long period of time, external factors due to the energy situation have been felt by individual citizens of Nevada. These pressures have appeared to individuals in terms of availability and costs of fuel for transportation and agriculture, as well as for electric energy. Effects upon the State's citizens will continue to be felt because forces which will impact Nevada are being applied from outside of Nevada, on an ascending scale of size. There is hardly any escape from external factors, given Nevada's present energy resource position.

The following significant external factors are expected to combine to produce energy related pressure upon the citizens of Nevada:

California: This state passed a "coastline initiative" in November 1972. Coupled with exclusions due to populated areas and environmental values, the coastline initiative has slowed the availability of new electric energy generating facilities. This may hurt Nevada's ability to purchase electric energy in California, and could possibly result in the need for additional generating capacity in Nevada.

11 Western States: In view of the uncertainty in the present energy situation, entities in the 11 Western States

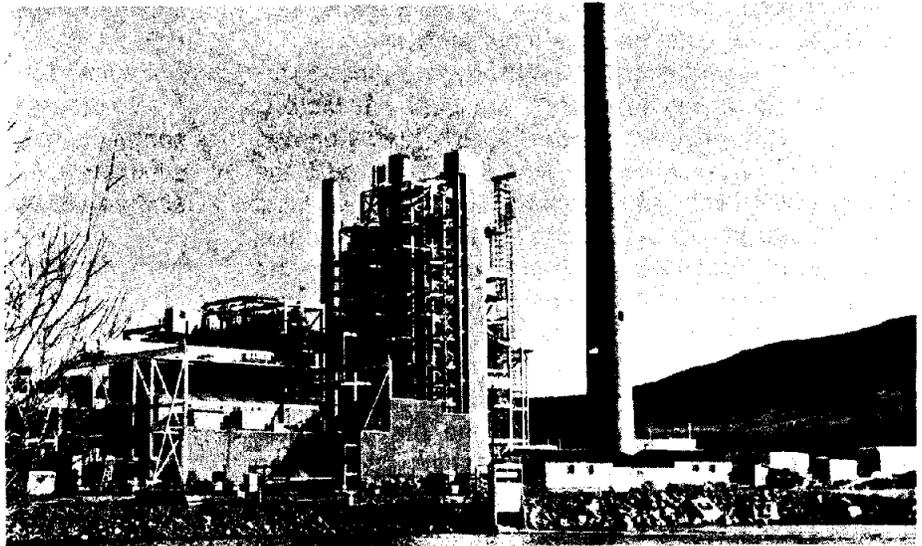
Hoover Dam Generating Station near Boulder City, Nevada. Hydropower.

Credit: U. S. Bureau of Reclamation



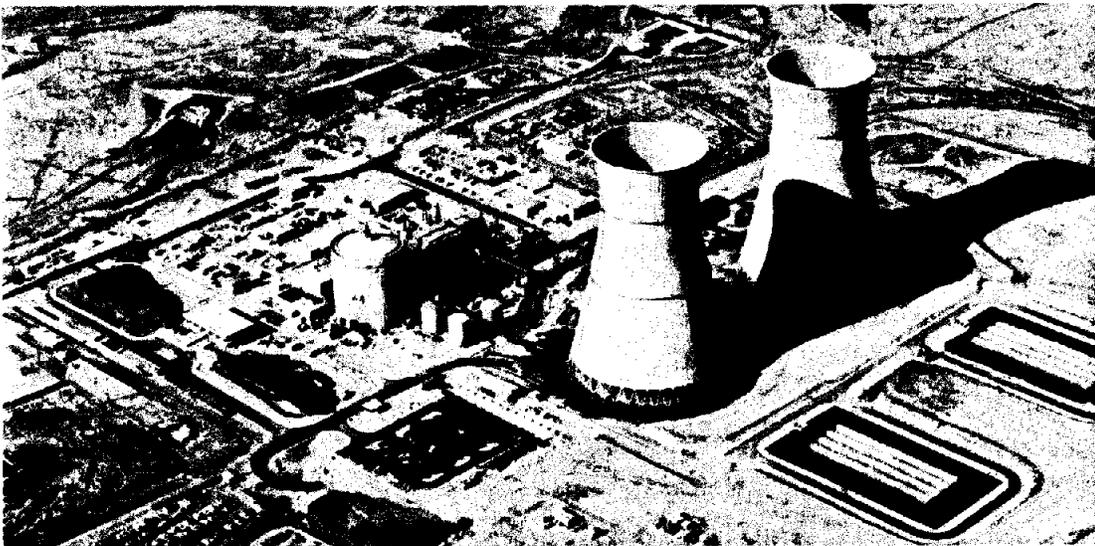
Tracy Generating Station near Reno, Nevada. Fossil Fueled.

Credit: R. E. Walstrom



Rancho Seco Generating Station near Sacramento, California. Nuclear Fueled.

Credit: Sacramento Municipal Utility District



and Alaska are looking at methods for better matching use and generation of electric energy. A regional approach for all forms of energy is developing.

USA: On a national scale, government controls operate upon the production of natural gas and the importation of petroleum. It is uncertain how the combinations of sources and uses of energy will interact with government in the future.

World: Energy practically available for use is presently short in the world. Increased competition among the industrialized nations is increasing the price, particularly for petroleum and coal. As the availability of petroleum and coal diminish and the price increases, nuclear sources must become more attractive.

Timing: Present energy technology and time limitations upon its ability to change are pertinent factors. Individual and government decisions — their number, type, timing and sequence — limit technology and the efficiency with which it is applied. Timewise, we must phase-in and phase-out practical energy technologies according to limitations which are not shorter than the interval to train operators and probably not much longer than a human generation.

For instance, development of advanced nuclear reactor technology was directly undertaken about a generation ago and has recently become practical on a large scale. Taking nuclear electric energy generation as a limiting case, regulatory approvals and construction require about 10 years in addition to development of the technology.

Under these conditions, it is important to plan for electric energy within the foreseeable time limits of practical application of new technology. Therefore, we must look at least to the year 2000, and probably somewhat beyond, with major emphasis upon presently dependable large scale generating technology. Hydro, conventional fossil fuel and nuclear electric energy generating stations are the only practical producers which satisfy the need.

Alternative Postures

Nevada must consider its own best interest in energy matters, but still cannot be separated from its position in the Western States. Map 1A provides perspective upon Nevada and a portion of the West as a region, viewed from the Pacific Ocean. Map 1B shows the associated regional major transmission lines for electric energy.

The important point is that Nevada is near the electric

load center of the region and there are available valleys in Nevada with sites for generating electric energy. Economical generation requires increasingly large-scale facilities, which require huge amounts of capital, often resulting in regional participation. Interest in development of Nevada sites will fluctuate greatly with only small regional shifts in policy. Of course a number of sites would be needed under any condition by Nevada to meet its own future needs.

A big question is whether development of sites in Nevada valleys for regional benefit amounts to an opportunistic or a vulnerable economic-environmental posture for Nevada. The answer would depend upon the amount and method of use of Nevada's scarce water and related land resources.

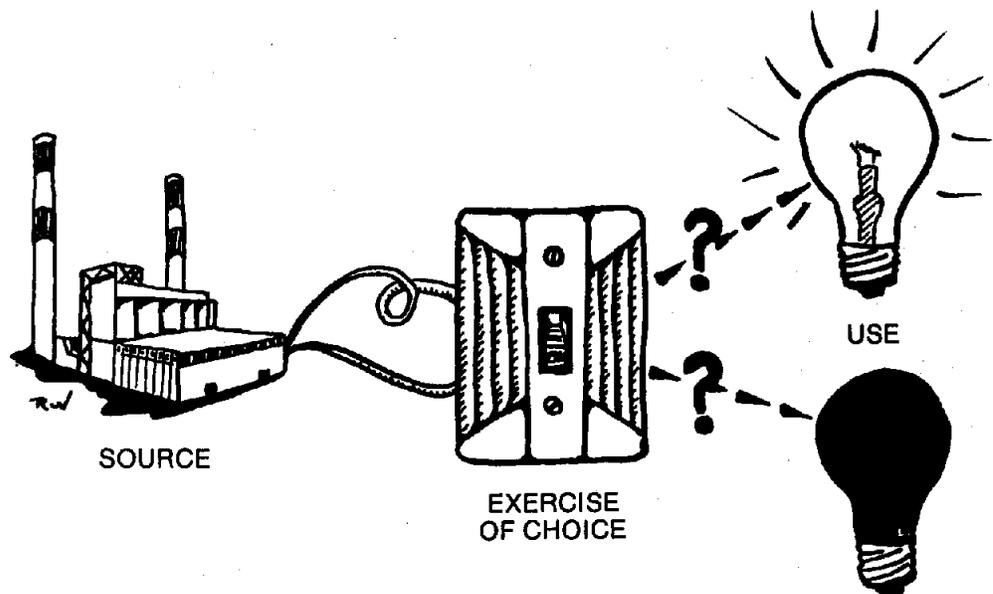
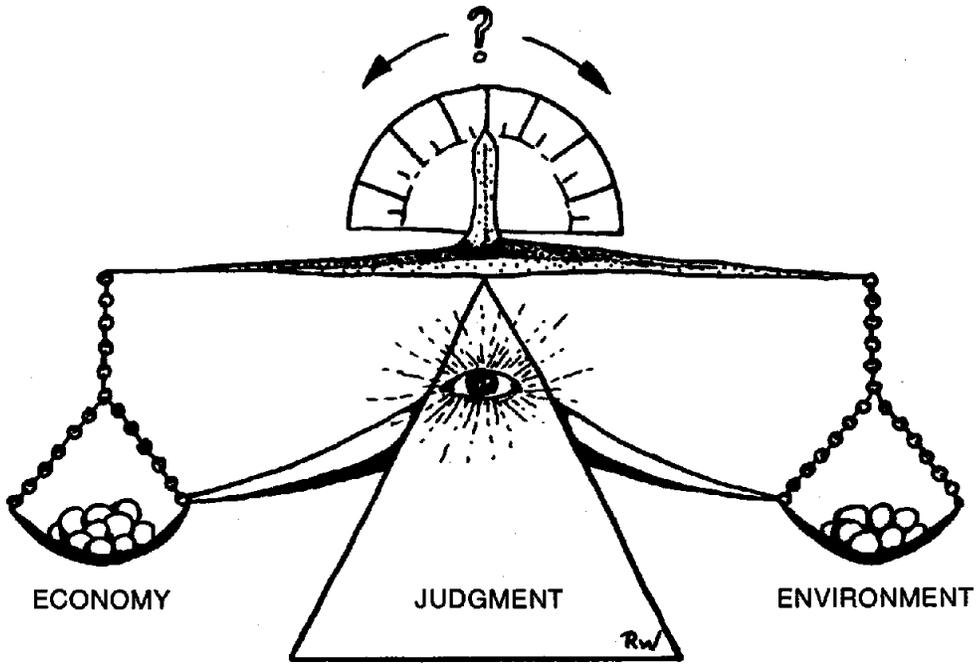
To prudently assure protection of the State's interest, serious consideration should be given to achieving self sufficiency. A significant import or export posture should also be considered.

Alternative Postures

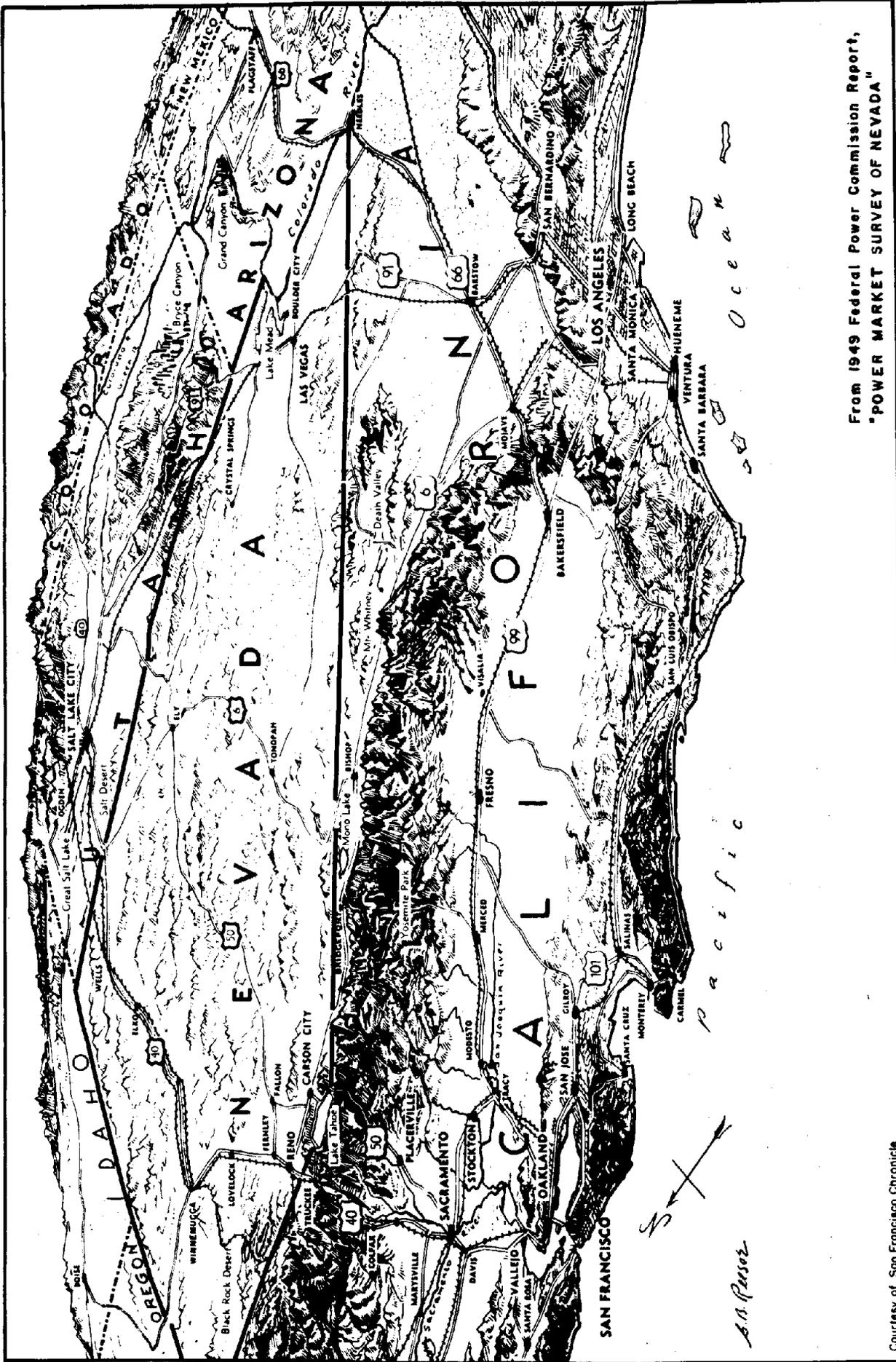
1. Continued significant import.
2. Nearly self sufficient.
3. Significant export.

For any posture, short term use of scarce water and related land resources should allow for the option of reasonable long term recovery of these same resources. With this option in mind, a preliminary siting-rating system utilizing the concept of reasonable economic-environmental balance has been developed. A number of valleys appearing to have the best potential for siting conventional and nuclear electric energy generating facilities were tentatively selected, using the siting-rating system.

Barring unforeseen upsets, this report has provided basic information for future water and related land resource options, as the normal course of events determines a future electric energy posture for Nevada.



QUALITY OF LIFE



From 1949 Federal Power Commission Report,
 "POWER MARKET SURVEY OF NEVADA"

MAP 1A
 NEVADA AND A PORTION OF THE WEST
 AS VIEWED FROM THE PACIFIC OCEAN

Courtesy of San Francisco Chronicle

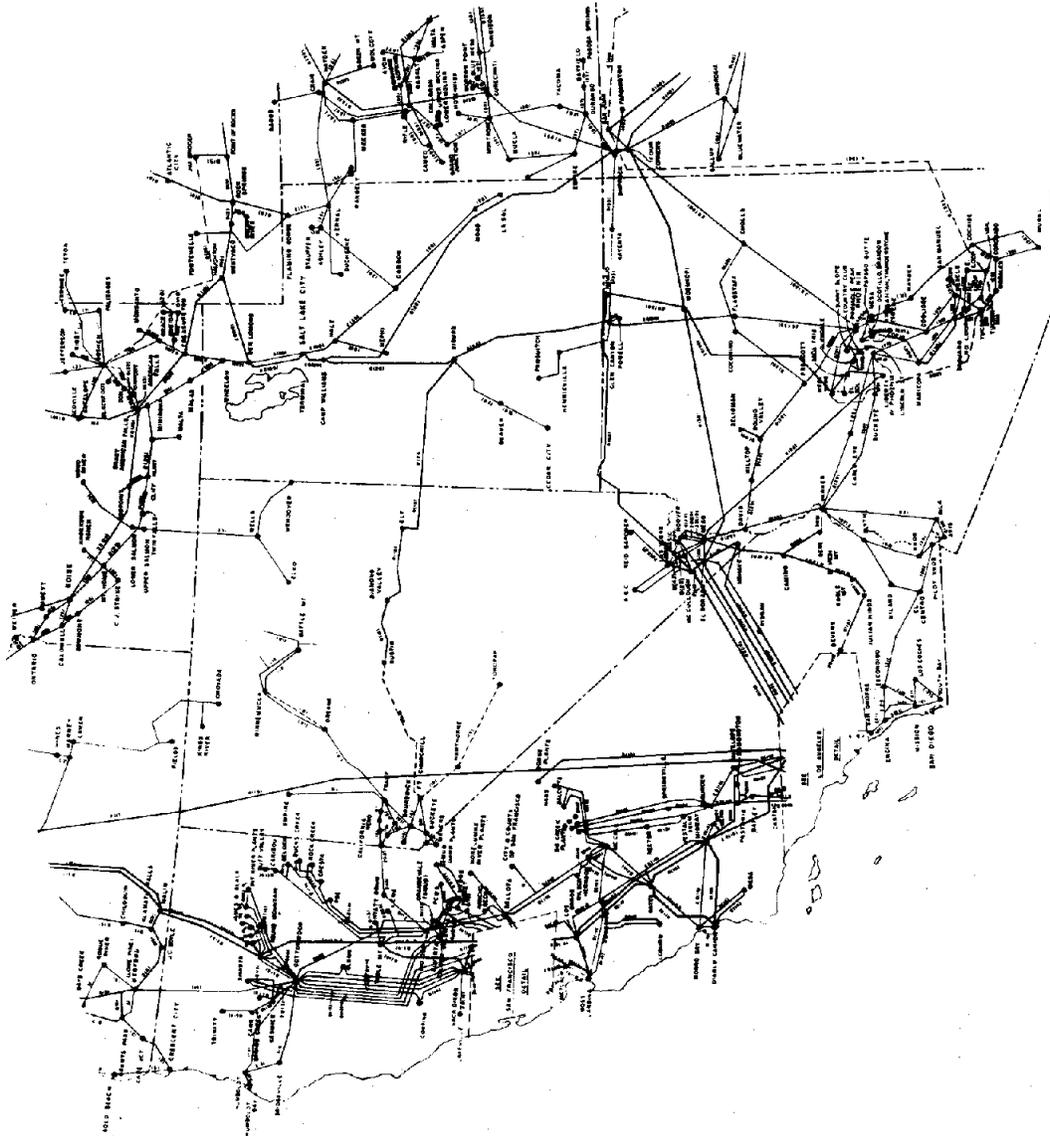
WESTERN SYSTEMS COORDINATING COUNCIL
 OPERATIONS COMMITTEE
 MAP OF PRINCIPAL TRANSMISSION LINES

JANUARY 1, 1974

MAIN LINES NUMBER ARE SCHEDULED
 FOR OPERATION ON 1974



1. BIRMINGHAM POWER ADMINISTRATION
2. BAYBERRY WATER, POWER COMPANY
3. BATTLE CREEK LIGHT
4. BATTLE CREEK LIGHT
5. PACIFIC POWER & LIGHT COMPANY
6. PORTLAND GENERAL ELECTRIC COMPANY
7. PUGET SOUND POWER & LIGHT COMPANY
8. CHELAN COUNTY PUBLIC UTILITIES DISTRICT
9. DOUGLAS COUNTY PUBLIC UTILITIES DISTRICT
10. GRANT COUNTY PUBLIC UTILITIES DISTRICT
11. NEWASMA PUBLIC POWER DISTRICT
12. TRI-STATE GENERATION & TRANSMISSION ASSOCIATION
13. U.S. BUREAU OF RECLAMATION-MID PACIFIC REGION
14. PACIFIC GAS & ELECTRIC COMPANY
15. STATE OF CALIFORNIA-DEPT. OF WATER RESOURCES
16. SIERRA PACIFIC POWER COMPANY
17. SACRAMENTO MUNICIPAL UTILITIES DISTRICT
18. DEPT. OF WATER & POWER-CITY OF LOS ANGELES
19. SOUTHERN CALIFORNIA Edison COMPANY
20. METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA
21. SAN DIEGO GAS AND ELECTRIC COMPANY
22. BRITISH COLUMBIA HYDRO & POWER AUTHORITY
23. WEST MONTANA POWER & LIGHT
24. THE MOUNTAIN POWER COMPANY
25. IOWA POWER COMPANY
26. U.S. BUREAU OF RECLAMATION-UPPER MISSOURI REGION
27. U.S. BUREAU OF RECLAMATION-LOWER MISSOURI REGION
28. U.S. BUREAU OF RECLAMATION-LOWER COLORADO REGION
29. ARIZONA PUBLIC SERVICE COMPANY
30. SALT RIVER PROJECT
31. SALT RIVER PROJECT
32. TUCSON GAS & ELECTRIC COMPANY
33. U.S. BUREAU OF RECLAMATION-UPPER COLORADO REGION
34. U.S. BUREAU OF RECLAMATION-UPPER COLORADO REGION
35. PUBLIC SERVICE COMPANY OF COLORADO
36. CITY OF COLORADO SPRINGS
37. COLORADO UTE ELECTRIC ASSOCIATION
38. PLAINS ELECTRIC GENERATION & TRANSMISSION
39. U.S. BUREAU OF RECLAMATION-SOUTHWEST REGION
40. PUBLIC SERVICE COMPANY OF NEW MEXICO
41. EL PASO ELECTRIC COMPANY
42. NEVADA POWER CO



MAP 1B
 PRINCIPAL ELECTRIC ENERGY TRANSMISSION LINES
 OF NEVADA AND A PORTION OF THE WEST

CHAPTER 2

PURPOSES OF THIS REPORT

OVERVIEW

As part of the State Water Planning effort, the Division of Water Resources is publishing a series of planning reports pertaining to future population, economic activity and resource use features for communities of interest within Nevada. Included are counties, cities, water and related land resource areas, economic regions, and rural areas.

Electric energy¹, statewide and regionally, requires substantial support from water and related land resources. A comparable situation was last assessed on a statewide basis in 1949, when the Federal Power Commission published *Power¹ Market Survey, State of Nevada*. The 1949 report was done largely at the instigation of then State Engineer Alfred Merritt Smith, also Secretary of the Colorado River Commission of Nevada.

Use of electric energy is a nearly all pervading economic activity. From a planning standpoint, it is prudent to have a good idea of the amount and distribution of electric energy use and generation with the passage of time, so as to better focus upon internal and outside opportunities and problems.

PURPOSES

The major purpose underlying this report has been to attempt to provide appropriate answers for these

major questions:

For Electric Energy Use And Generation

1. *How many* mega watt-hours (energy), *where* and *when*? (See Tables 2 and 6 and associated narrative.)
2. How might energy be practically *conserved*? (See Chapter 4.)

For Electric Energy Generation Only

3. *How many* acre-feet of plant water use, *where* and *when*? (See Tables 4 and 5 and associated narrative.)
4. Where might facilities best be *located*, considering both economy and environment? (See Chapter 4 narrative under "Siting." See also Appendix A in separate addendum to this report.)

Despite the obvious necessity for internal Nevada focus on these questions, it is important to emphasize that the State cannot escape moving in a Western regional context and sometimes a national context for sources of electric energy. Therefore, the previous major questions for Nevada are highly applicable to the Western States, and are justifiably addressed on both State and regional bases.

Regional balance between generation and use of electric energy has been predicted to occur about 2000, based upon analysis of past amounts and distributions

Transmission lines and towers near Hoover Dam.
Credit: U. S. Bureau of Reclamation



of generation.² This regional balance is important assurance of future well being for all States involved.

Unfortunately, predicted regional balance cannot be extended to Nevada's individual situation. Outside focus is presently assured by Nevada's electric energy import posture, potential generating sites in mostly closed, trough shaped valleys, and sparsely distributed population, as well as nearness to the regional electric load center. These conditions will not allow prediction of Nevada's future generating capacity, although electric energy use for Nevada has been reasonably projected.

Hence, being self sufficient with respect to electric energy may be prudent for Nevada, but it is not the most important of questions. The important major questions are whether Nevada can continue to import significant amounts of electric energy, or whether Nevada will export significant amounts of electric energy to contribute to the regional balance.

Variations in population, economic activity and resource use have a way of periodically interchanging energy import-export roles. Consequences for Nevada of being in one role or the other can be better understood in terms of picturesque phrases, "— importing water over a power line", and "— exporting water over a power line." These opposing roles are matched for a price where local water resources suitable for supporting electric energy generation are scarce and foreseeably under strong competitive demand, while outside sources of electric energy want to keep it for their own uses, rather than sell it.

The bulk of this report has been dedicated to being prepared for the normal course of development of these major import-export alternatives, while maintaining the long term integrity of the State's water and related land resources.

Problems associated with the quantitative aspects of *how much* electric energy, *where* and *when* at first glance might tend to eclipse the necessity for conservation of electric energy. Conservation on a large scale will lessen overall problems, because electric energy has become an all pervading favorite, for which there presently is no practical, large scale replacement.

Conservation of electric energy involves proper use of factors of efficiency which are discussed in Chapter 4, "Conservation for Electric Energy Generation and Use". Siting is probably the most important efficiency factor from economic and environmental viewpoints.

Efficiency for both generation and use of electric energy (source-use combinations) are important ele-

ments in this large scale conservation effort. Efficient substitution of other energy forms for electric energy is also important. Efficient matching of source-use combinations can be idealized, but it is more efficient to think in terms of really successful existing combinations. Care should be exercised that attempts at substitution of other energy forms for electricity does not in the overall picture require a larger total amount of available energy.

Source-use combinations for electric energy have developed in many places through a long period of time. These combinations are the product of extensive experience, and are probably the most efficient for the present situation. Any attempts at immediate change must be subject to very careful scrutiny for total effects upon the factors of efficiency.

¹Because this report has been written in sections, by persons from diverse backgrounds and interests, electric generating plants and other facilities are referred to differently. In some sections the discussion will contain reference to "electric energy generating . . ." In other sections, the reference will be to "electric power generating . . .". For the Division of Water Resources, the focus is mostly upon energy, because annual water use depends upon energy more than power. For utilities, the focus is mostly upon power, because installed electric generating capacity depends upon demand for power more than energy.

Energy and power are related because power is energy expended per unit of time. For a service area, on an annual basis, the total energy generated divided by the time in one year will give the *average* electric power generated for that year. Of course, power demand varies quite a bit above and below the average on a daily, weekly and seasonal basis — both predictably and unpredictably.

In this report, we are attempting to focus mostly upon the long term electric energy use and generation, and associated interactions with water and related natural resources.

²See Table 6 and Figures 6, 7 and 8 with associated narrative.

Overton Wildlife Management Area on Lake Mead.
Credit: U. S. Bureau of Reclamation



CHAPTER 3

AMOUNTS OF ELECTRIC ENERGY GENERATION AND USE

FUTURE MEANING

This chapter provides numbers and narrative to show some of the most probable future meaning for Nevada and the West, in terms of per capita electric energy.

Powerful Forces Interacting

Every day we use water and electric energy on such a free basis that few of us ever need to think beyond whether something happens when the faucet is turned, or the switch is pushed.

Nevertheless, these small, repeated exercises of choice constitute the powerful forces behind total use of electric energy and evolution of its technology. This situation is why predictions of amounts and distributions and times of occurrence of population, electric energy use, and associated water uses are important for purposes of maintaining reasonable options for Nevada.

LISTING OF PROJECTIONS¹

Most Probable Basis

Projections presented in the following portions of this report relate to providing a most probable numerical basis for accomplishing this report's purposes, and have not advocated policy of encouraging or discouraging growth. Major projections include items listed in Table 1.

GROWTH PATTERNS INSIDE NEVADA

Study Boundaries

As part of the Nevada State Water Plan and the WESTWIDE Study², the Federal Power Commission's San Francisco office and the Division of Water Resources cooperated in making a set of electric energy projections for the State of Nevada.

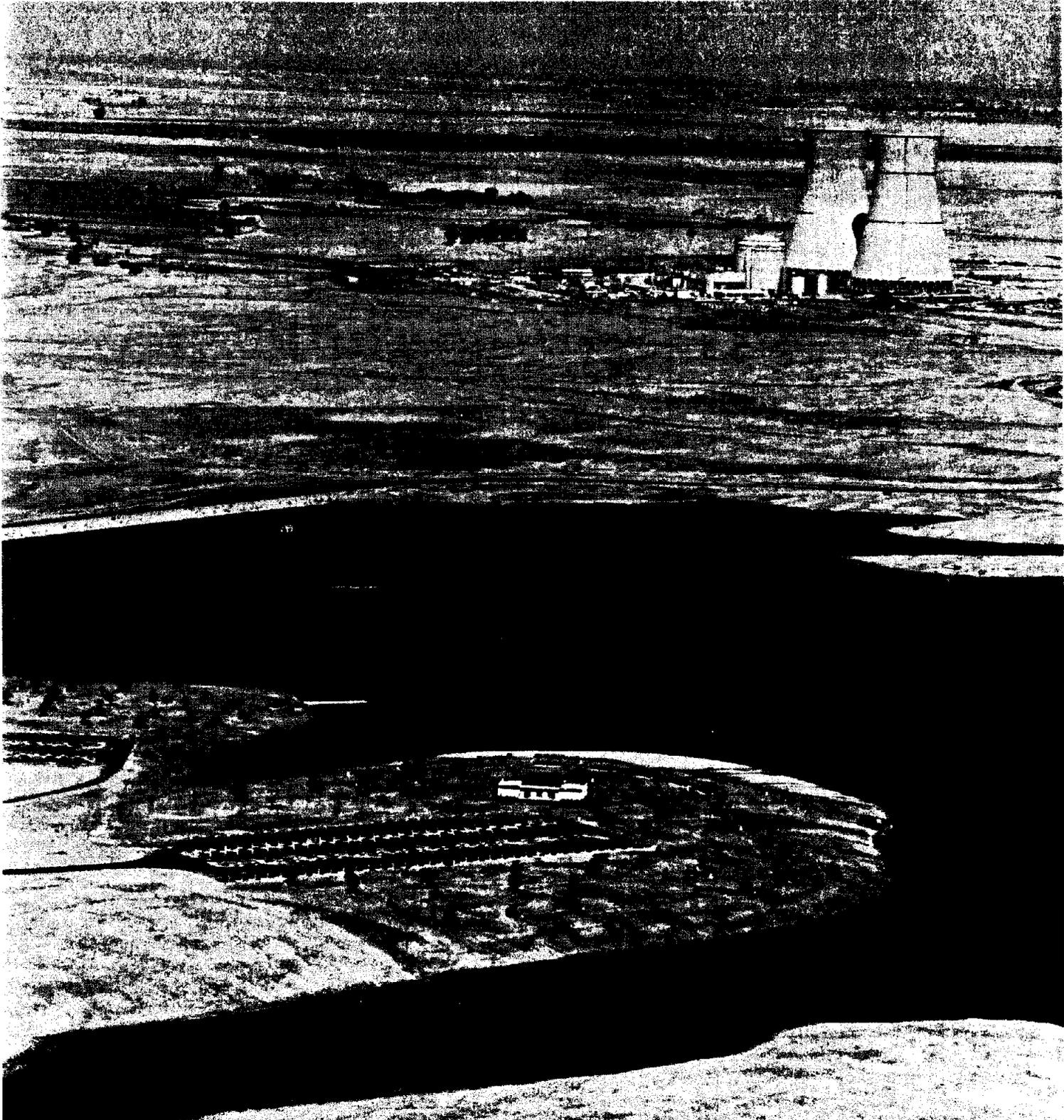
Usually, the Federal Power Commission is concerned with electric energy use in Power Supply Areas (PSA's), which cross State boundaries, but follow county lines in most cases. However, an agreement was made to cut the PSA's at the Nevada State boundaries, so that the base data and projections would cover only Nevada.

A study published in 1949 provided base data for older Nevada areas designated Power Market Areas I, II, III and IV, in the period 1930 through 1945. This report provides base data for Nevada portions of the newer PSA's designated 41, 46B, 47 and 48, in the period 1950 through 1970. Map 2 shows the older Power Market Areas, and Map 3 shows the present Power Supply Areas (PSA's). Correspondence between older and newer areas is only approximate and is as follows:

Correspondence

PSA 41 is Area III less Eureka and White Pine Counties, plus McDermitt Township in Humboldt County.

Recreation associated with generation at Rancho Seco.
Credit: Sacramento Municipal Utility District



PSA 46B is Area I less McDermitt Township in Humboldt County.

PSA 47 is Area II plus Eureka and White Pine Counties.

PSA 48 is Area IV, which includes Clark and Lincoln Counties.

Nevada Projection Approach

Population projections were made at the Division of Water Resources by an approach which uses only federal 10 year census data. The approach has been based upon the fact that there is a highly stable relationship between numbers of people and how they are distributed. As such, the projections are policy free. They provide an unbiased baseline from which to view various material and economic needs of the population, in terms of per capita use rates — electric energy, water, income, etc.

Principal sources of historical energy data used to assist in making estimates of future loads are the power system statements submitted to the FPC by electric utilities. Electric energy projections provided by the FPC were based upon the approach of applying projected per capita use rates to the population projections. The reasonableness of the numbers so obtained by the FPC was verified independently.

Coolant water projections are based upon the present average technology in steam electric generating stations, which use about .7 gallons of water for every kilowatt hour produced. It has been assumed only for purposes of water calculation that there is no net export or import of electric energy across Nevada's borders, and that conventional generating facilities will use evaporative cooling systems. These conditions of water-electric energy equivalency are not now completely true, and are expected to be only approximately true in the future, but are very convenient for discussion and for accounting. Conditions have been noted on Table 4 and Figure 4.

Past and Expected Patterns

Table 2 provides historic electric energy usage data, 1930-1970, and projections, 1970-2020. Data prior to 1950 are listed by PSA's for convenience rather than the older Power Market Areas. Energy requirements are shown for each class of use for those portions of FPC Power Supply Areas 41, 46B, 47 and 48 within the boundaries of Nevada. The sum of requirements for the four areas gives Nevada's total requirements, which are depicted for area and class of sales by Figures 1 and 2.

Table 3 provides historic data and projections for population and per capita electric energy use and Figure 3 shows per capita electric energy use. Coolant water needs for the four areas and the State are listed in Table 4 and shown by Figure 4.

Energy requirements in all four areas increased at rapid rates over the 1950-1971 period. Average annual growth rates in the two major load areas, PSA 46 (northwestern Nevada) and PSA 48 (southern Nevada) areas, were equal for the period, both 10.4 percent. The average annual increase in PSA 41 (northeastern Nevada) was 10.5 percent while that in PSA 47 around Tonopah and Hawthorne was 7.65 percent. Even this lowest rate of 7.65 percent means a doubling of requirements about every 9.4 years. The combined requirements of the Reno-Lake Tahoe and Las Vegas areas comprise almost 96 percent of the States' 1971 total requirements.

For the State as a whole, commercial energy use, with a 13.3 percent 21-year average annual rate of growth, is the fastest growing class. Residential use is next with a 12.3 percent growth rate. In 1971, the two classes of use made up 67 percent of the total Nevada requirements. When combined with industrial use, the three classes of use in 1971 account for 89 percent of total requirements.

Electric energy requirements for the distant future are subject to many predictable and some major surprise factors which influence growth. However, for planning or any other purposes, major surprises cannot be reasonably taken into account. With these qualifications, future per capita requirements have been reasonably defined through use of available statistical data. The intent has been to avoid too low or too high estimates of requirements. If resulting estimates are too low, the installed power supply may be inadequate for the developing area economy. If the resulting estimates are too high the worst that can happen is that there may be excess capacity for a brief period or construction of some facilities may need to be postponed.

For estimates of residential and commercial requirements, trends of persons per customer were prepared from the numbers of customers reported in power system statements and from population estimates. The past energy use per customer for each class was obtained from historical data and then projected, with modifications as needed to conform to economic data, to produce reasonable estimates of future use. Total residential and commercial requirements were obtained by multiplying the number of customers by the use per customer.

Future estimates of the remaining classes of use were made by extrapolating past trends with adjustments made as economic projections dictated. The estimates were checked by the FPC to be certain that they reflect a reasonable estimate of growth in per capita use, based upon available data and judgment born of past experience. As stated earlier, the reasonableness of the FPC numbers was verified independently.

Nevada's prospects for continued electric load growth appear strong and the estimates shown on Table 2 show such a continuation. Energy requirements are expected to nearly double between 1971 and 1980 from 6,260 GWh³ to 12,311 GWh, and then to experience a gradually decreasing rate of increase over the remaining period of forecast. Energy requirements are estimated at 53,500 GWh in 2020. The estimates reflect gradual saturation of high energy using appliances, a slowing population growth rate, and concurrent slowing in industrial and other growth.

In 2020 energy requirements in PSA 48 area are expected to constitute almost three-fourths of total Nevada requirements. The combined requirements of PSA 46 and PSA 48 are estimated to be almost 98 percent of the total electric energy required in the State.

Population-Water-Energy Situation

People need both water and electric energy. Where and when there is significant economic competition for water to satisfy both of these needs, the population-water-energy situation should be viewed as an integrated whole. Such is the case in Nevada.

Statewide, electric energy use is growing a lot faster than municipal and industrial water use, which in turn is growing a little faster than population. Generation of electric energy requires large amounts of coolant water, which are often obtained in economic competition with even larger demands for municipal and industrial uses. In the urbanized areas of Nevada, particularly the Las Vegas Valley, competition for use of the scarce water resource is expected to intensify in the future. Additionally, environmental concerns involve both energy and water use.

Table 5 provides projections for Nevada's population, municipal and industrial water use and electric energy use for the period 1970 through 2020. Figure 5 shows that use of electric energy is becoming economically more important with respect to municipal and industrial water use. Under these conditions, water required for generation of electric energy also increases

in relative value with respect to municipal and industrial use.

The future of electric energy use (E) relative to municipal and industrial water use (W) is characterized by the ratio, E/W, and is a result of what people are doing to make use of water and energy at future times.

By the end of the study period, 2020, Table 5 and Figure 5 indicate that:

1. Per capita electric energy use, E/P, will be about 190% above the 1970 value.
2. Per capita municipal and industrial water use, W/P, will be about 15% above the 1970 value.
3. Electric energy use relative to municipal and industrial water use, E/W, will be about 150% above the 1970 value.

Number of Nevada Generating Stations

Electric energy use projections provided in Tables 2 and 5 can be converted to the number of generating stations statewide, assuming Nevada is nearly self-sufficient with respect to electric energy. If the average size generating station in Nevada is assumed in the future to produce 500 megawatts, 5 stations would be required at 1980, 9 stations at 1990, 13 stations at 2000, 17 stations at 2010 and 20 stations at 2020. Chapter 4 preliminarily lists 26 valleys which might efficiently support electric energy generation.

GROWTH PATTERNS OUTSIDE NEVADA

Interpretation of Outside Pressures

For Nevada, with its own internal pressures, the outside pressures will mostly determine the State's future electric energy posture.

Chief concern for Nevadans is how California and the West will fare with respect to the rest of the nation. If the West becomes self sufficient, or exports electric energy, then probably Nevada will not see scarcity. If the West and particularly California, is short, then Nevada may have to tighten its belt at some time with respect to electric energy use. It is of comfort to Nevada and the other States in the West that regional balance between generation and use of electric energy has been predicted to occur between 1995 and 2000.

Further analysis of the future electric energy situation for Nevada, California and the West, is based upon past amounts and distributions of electric energy generation in a national context.

Study Boundaries

For purposes of this report, the national context has been viewed from the four regions defined by the U.S. Bureau of the Census. These are:

Four Census Regions

1. West
2. South
3. Northeast
4. North Central

Alaska, Hawaii and Puerto Rico have not been specifically examined in this study. This is because their electric energy transmission systems are not connected with the main body of the States.

In addition to the previous four regions, another group of States has been selected to further show the total applicability of the results to be discussed. Five States, at least one from each region, were selected:

Selected States

1. California (West)
- 2, 3. Texas, Florida (South)
4. New York (Northeast)
5. Michigan (North Central)

All five States have exhibited a relatively high population growth rate coupled with a large base population. All have seaports and conduct varying amounts of foreign trade. All exhibit varying characteristics for water and related land resources, climate, economy and population. As a group, these selected States could be expected to show a consistent sampling of what each part of the nation is doing. Therefore, these States should also mirror what the nation is doing with respect to population and electric energy — just as well as any of the four regions could mirror these national activities.

Map 4 shows the four census regions of the nation, with all 11 of the contiguous Western States being outlined. Outlines are also provided for the entire three remaining regions. In addition, the five selected States are cross-hatched.

Regional Projection Approach

Regional and national population and electric energy generation projections have been made by the same technique used to make Nevada's population projections. The technique is independent in principle of the purposes and policy inclinations of the investigator. As such, the projections resulting are as free as personally

possible of what are usually called "policy aspects". This unbiased base line approach for viewing per capita needs of the population is covered by Part 3 of Appendix E in greater detail. There it is re-emphasized that the amount and distribution of per capita electric energy generation has tremendous momentum through the long term, is difficult to distort and consequently is highly predictable.

Past and Expected Patterns

Table 6 provides historic and projected data for the period 1920-2020. Figures 6, 7 and 8 illustrate the data.

Table	Figure	Categories of Data
6	6	1. Population
6	7	2. Electric energy generation
6	8	3. Per capita electric energy generation
6	none	4. Ratios of per capita electric energy generation for parts of the nation to the nation. (Part/Total).
Figure	Groupings Covered by Data	
6, 7, 8	1. The four census regions and the nation	
6, 7, 8	2. The five selected States as a classification	
6, 7, 8	3. California	

Population and electric energy annual growth must slow down in the nation. What this means is that both will continue to grow, but at decreasing annual amounts, and at some future time could achieve "net zero growth". Barring huge upsets, this zero growth will not occur for population or electric energy prior to 2020, the end of the period of concern for this study.

Prior to 1960, the nation's long term population growth was occurring at an increasing annual amount. At about 1960, this increasing annual growth reached a maximum and "inflected" or "turned around". Since inflection, long term population growth has continued, but at a decreasing annual amount.

The nation's long term annual amount of electric energy growth is expected to inflect about 1975 while the comparable per capita annual growth is also expected to inflect about 1975. Important annual growth inflections have occurred or are expected to occur as shown by Table 7.

TABLE 7: IMPORTANT INFLECTION TIMES FOR LONG TERM GROWTH

Area	Population	Energy Generation	Per Capita Energy Generation
Nation	1960 apx.	1975 apx.	1975 apx.
Selected	"	"	"
South	"	"	"
Northeast	"	"	"
North Central	"	"	"
West	"	"	"
California	1960 apx.	1975 apx.	1975 apx.
Nevada*	1982 apx.*	1986 apx.*	1975*

Notes: Apx. means approximately. Long term dates are given approximately.

*Electric energy use rather than generation for Nevada. Division of Water Resources projections were used instead of FPC projections for determining inflections for Nevada. These projections are maintained open file.

From Table 7, the West and California are listed as having inflections in annual growth for total generation and per capita generation at 1975. Nevada also has an inflection in annual growth at 1975 — for per capita use.

If total use and generation in the West and California do not get out of reasonable balance, then perhaps Nevada's total electric energy use, which appears headed for inflection in annual growth at 1986, will not be locally burdensome. However, if electric energy should become short in areas surrounding Nevada, higher costs will be incurred by Nevada's individual citizens. These costs will show up in utility investments for new generating capacity inside Nevada and in higher prices for imported electric energy, where and when available. Costs must be ultimately passed on to the consumer.

Effects of the Arab oil embargo felt in 1973 and 1974 have alerted people to the short term facts of life for conservation of electricity. To what extent effects of the short term oil embargo are coupled with and have masked the inflections shown in Table 7 is difficult to say. One difficulty is that the projections are long term and are not tabulated for exact annual comparisons. Certainly, electric energy use and generation annual growth rates for Nevada and California have slowed. This slowing should be attributed to being right at the generation inflection point, as well as effects of the short term Arab oil embargo.

With the coupling of these two apparent causes for slowing of annual growth in electric energy use and

generation, a short term but false impression of security could be created. It must be emphasized that plans for new facilities should be based upon long term considerations, and not a short term false impression of security. Any holiday in long term preparations could have uncomfortable results for Nevada.

A further emphasis on the meaning of the inflections presented in Table 7 for Nevada's growth is this. Electric energy policies and related assumptions conceived for larger and slower growing areas may not be applicable to Nevada. Nevada's rural areas use about one-half as much electricity per capita as does the nation and the urbanized areas use considerably more than the nation. Cuts in funding for rural electrification will hurt expectations of the rural areas. Curtailments in new generating capacity inside Nevada coupled with lack of importable electric energy due to shortage elsewhere will hurt expectations of the urbanized areas. For Nevada, the impact of shortage upon individual citizens is greater than in surrounding areas with more temperate weather, lesser per capita needs and greater resources to call upon.

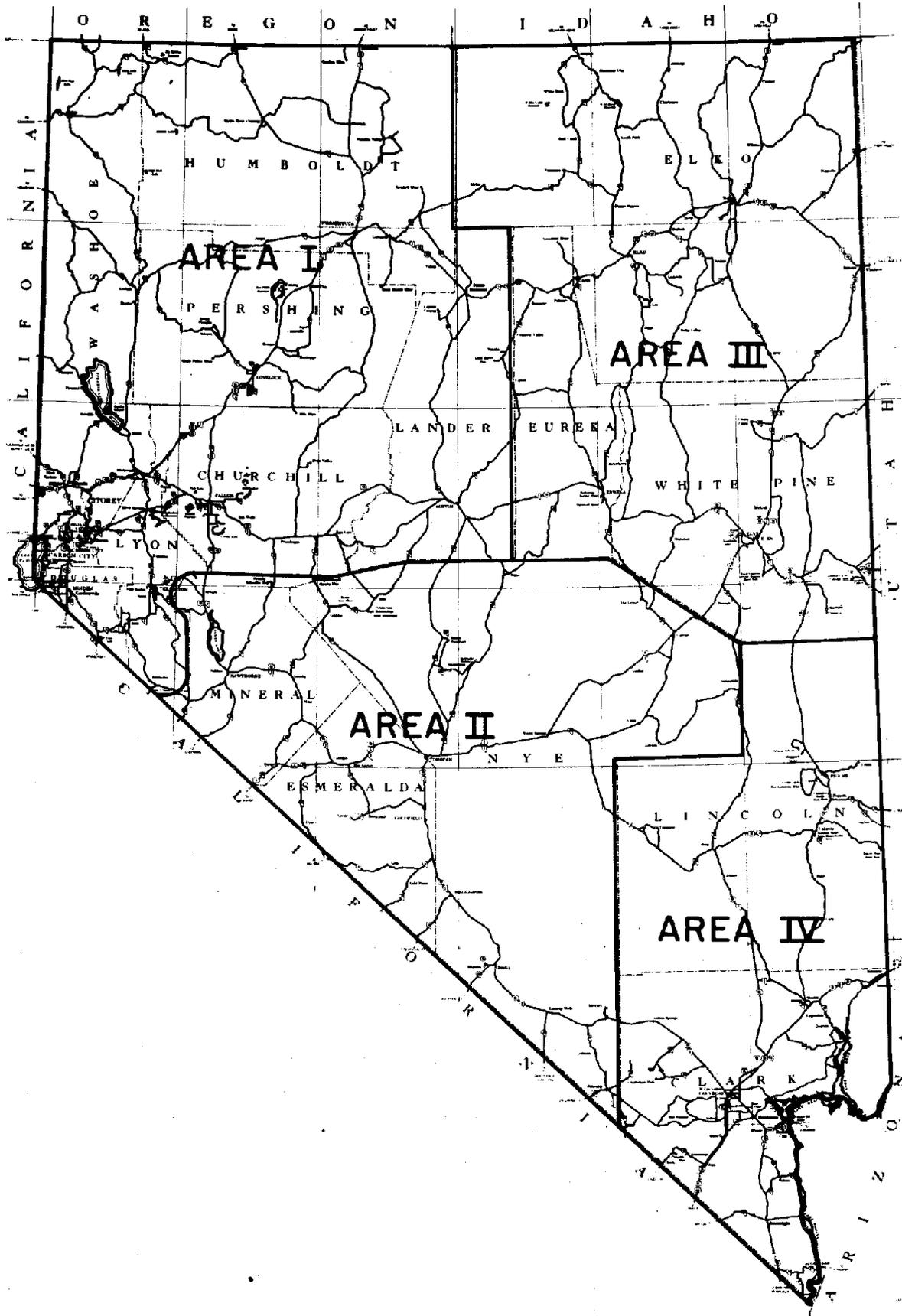
PRUDENCE OF SELF SUFFICIENCY

All of the previous discussion points to the prudence of Nevada's attempting to become nearly self sufficient with respect to electric energy. There are more than enough sites to achieve this. However, the economic and environmental considerations must be carefully and reasonably weighed.

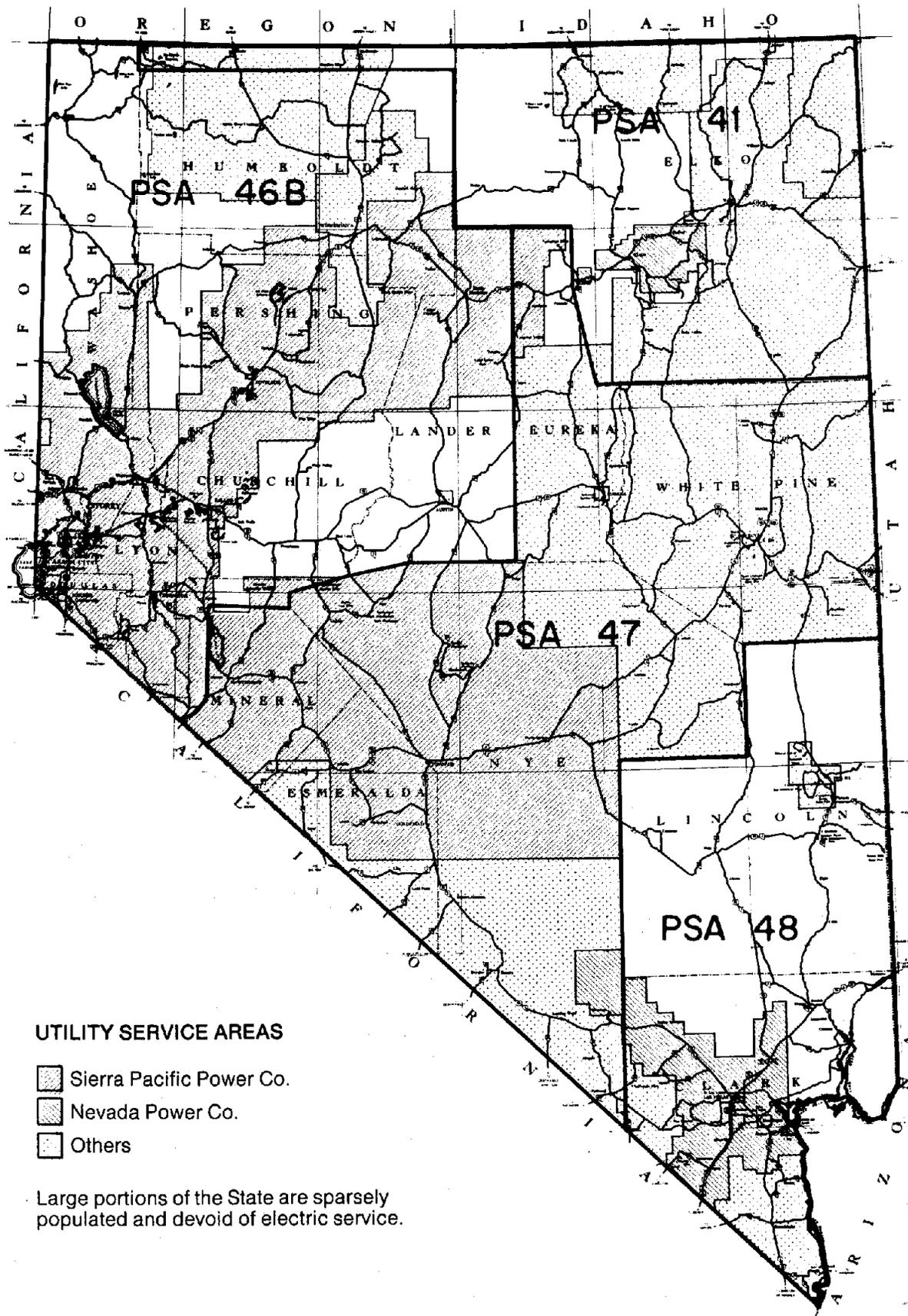
¹To avoid confusion over the meanings of the words "predict," "forecast" and "project" it is necessary to say that they may be used interchangeably for all Division of Water Resources generated population and electric energy numbers presented herein. This convention is used to emphasize that these numbers are the product of a theory of growth and prediction method which are independent in principle of the policy inclinations of the investigator. As such, predictions, forecasts and projections are our best estimates of future conditions, barring huge upsets, and can be used with a high degree of confidence — in contrast to future conditions contrived from mere assumptions.

²The WESTWIDE Study was inaugurated subsequent to the passage of the Colorado River Basin Project Act (P. L. 90-537) in September 1968. The Bureau of Reclamation, in the Department of Interior, was assigned to work with States wholly or partly West of the Continental Divide in furthering their water planning efforts. Nevada has made extensive use of the state and federal study team formed under WESTWIDE, and subsequently, continued under Nevada auspices.

³Gigawatt hours. See Table 1 for further explanation.



MAP 2
NEVADA PORTIONS OF FPC
POWER MARKET AREAS I, II, III & IV
 (Prior to 1950 for purposes of this report)

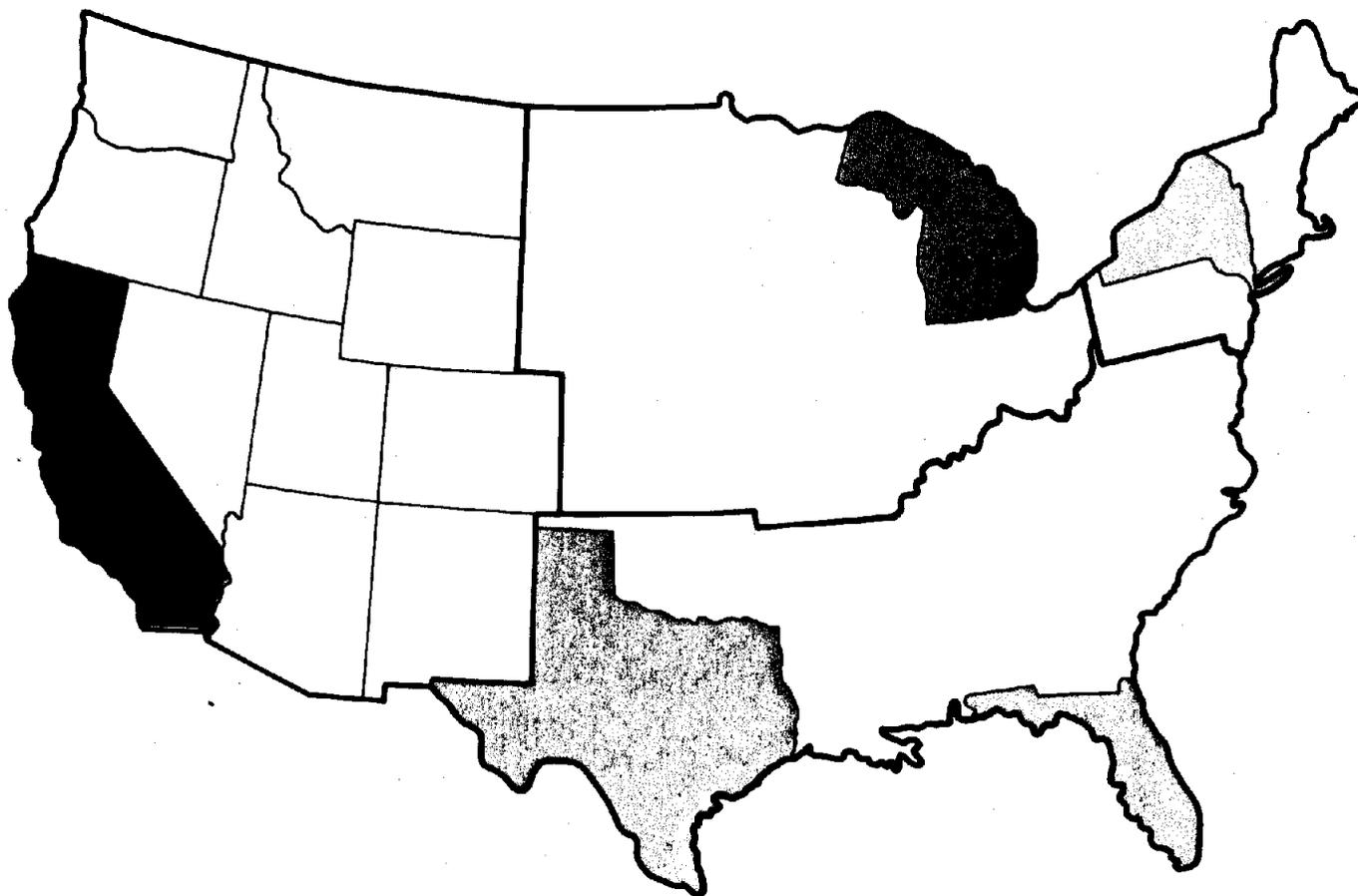


MAP 3
NEVADA PORTIONS OF FPC
POWER SUPPLY AREAS 41, 46B, 47 & 48
 (1950 to circa 1970 for purposes of this report)

The 48 Contiguous States in 4 Regions *: WEST,
SOUTH,
NORTHEAST,
NORTH CENTRAL

* Alaska, Hawaii and Puerto Rico not shown.

Selected States: CALIFORNIA (West), TEXAS, FLORIDA (South), NEW YORK (Northeast),
and MICHIGAN (North Central)



WEST

The 11 Contiguous Western States, wholly or partly West of the Continental Divide:
WASHINGTON, OREGON, CALIFORNIA, IDAHO, NEVADA, MONTANA, WYOMING,
UTAH, ARIZONA, COLORADO, and NEW MEXICO.

MAP 4
UNITED STATES OF AMERICA
THE 48 CONTIGUOUS STATES IN 4 REGIONS

TABLE 1
PROJECTIONS IN THIS REPORT

Type of Projection and Time Period	Description of Coverage	Pages	Tables	Base Data Period
1. Population from 1970 to 2020 at 10 year intervals	a. Nevada ¹ and its four Power Supply Areas (PSA's)	23, 24	3, 5	1920-1970
	b. California	25	6	1920-1970
	c. West	25	6	1920-1970
	d. Nation	25	6	1920-1970
2. Electric energy generation from 1970 to 2020 at 10 year intervals ³	a. Nevada and its four Power Supply Areas (PSA's) ²	21, 23	2	1930-1970
	b. California	25	6	1920-1970
	c. West	25	6	1920-1970
	d. Nation	25	6	1920-1970
3. Per Capita Electric energy generation from 1970 to 2020 at 10 year intervals	a. Nevada and its four Power Supply Areas (PSA's) ²	23, 24	3, 5	1950-1970
	b. California	25	6	1920-1970
	c. West	25	6	1920-1970
	d. Nation	25	6	1920-1970
4. Coolant water equivalent to generation from 1970 to 2020 at 10 year intervals ⁴	a. Nevada and its four Power Supply Areas (PSA's)	24	4	Based upon .7 gallons of water per KWH of electric energy generated.

Notes: ¹ Nevada population projections were previously published in State Water Plan report No. 5, entitled, "Forecasts for the Future — Population."

² Use rather than generation for Nevada only. Nevada's historical use data is not complete until the late 1940's. Per capita electric energy use estimates were made by the FPC, and multiplied by Division of Water Resources population numbers to arrive at total electric energy use.

³ TWh means terawatt hours, and is also written TWH. A TWH is 1,000 gigawatt hours (GWH). A GWH is 1,000 megawatt hours (MWH). A MWH is 1,000 kilowatt hours (KWH). A KWH is 1,000 watt hours (WH). A kilowatt (KW) is about 3/4 of a horsepower (HP), omitting the factor of time.

So, a KWH of electricity is equivalent to about 3/4 of the output of a one horsepower engine operating for one hour. A GWH is one million KWH, and is equivalent to the output of a 3/4 million horsepower engine operating for one hour.

⁴ Amounts of water are given in acre-feet per year (AF/Y). An acre-foot of water is the amount required to cover an acre one foot deep, and is approximately 1/3 million gallons.

**TABLE 2
NEVADA ELECTRIC ENERGY USE GROWTH PATTERNS, HISTORIC AND PROJECTED
IN THE PERIOD 1930-2020**

	Historic										Projected				
	1930	1935	1940	1945	1950	1955	1960	1965	1970	1980	1990	2000	2010	2020	
NEVADA*	N.A.	N.A.	N.A.	536	793	1,618	2,218	3,838	5,838	12,311	22,402	33,912	45,146	53,550	
Residential	8	13	34	92	194	404	617	1,259	1,919	3,986	7,171	10,548	13,799	16,851	
Commercial	15	17	40	74	145	322	590	1,126	1,875	4,529	8,985	14,256	19,300	22,203	
Industrial	33	37	87	200	337	720	818	1,025	1,432	2,478	3,945	5,682	7,536	9,417	
All Others	5	7	12	29	44	53	49	82	180	301	463	650	831	993	
Total Classified Sales	61	74	173	396	720	1,499	2,075	3,492	5,406	11,295	20,564	31,137	41,466	49,194	
Losses	18	19	27	42	73	118	143	346	431	1,016	1,838	2,775	3,680	4,356	
Self Supplied Ind.	N.A.	N.A.	N.A.	98											
PSA 41	69	46	119	105	14	22	30	57	81	186	325	461	573	652	
Residential	2	2	3	3	4	8	11	18	26	60	108	154	192	220	
Commercial	2	2	3	3	6	9	13	23	34	87	155	219	266	292	
Industrial	4	2	19	5	—	—	—	9	10	17	27	40	56	74	
All Others	1	1	1	3	3	3	3	4	5	5	7	8	9	10	
Total Classified Sales	9	7	25	14	13	20	28	53	74	170	297	421	523	596	
Losses	1	1	2	1	1	1	2	4	7	16	28	40	50	57	
Self Supplied Ind.	59	38	92	90											
PSA 46B	N.A.	N.A.	97	129	219	395	606	1,042	1,605	3,341	5,756	8,522	10,879	12,657	
Residential	5	9	19	30	72	127	206	315	451	885	1,493	2,172	2,721	3,145	
Commercial	11	12	24	42	68	119	220	380	585	1,207	2,068	3,088	3,911	4,480	
Industrial	6	17	30	20	35	92	90	193	368	844	1,500	2,230	2,930	3,500	
All Others	5	6	5	9	4	5	11	17	30	60	103	153	195	227	
Total Classified Sales	27	44	78	101	179	343	527	905	1,434	2,996	5,162	7,643	9,757	11,352	
Losses	10	10	17	24	40	51	79	137	171	345	594	879	1,122	1,305	
Self Supplied Ind.	N.A.	N.A.	2	3											
PSA 47	30	26	24	18	23	52	48	72	108	184	282	384	483	561	
Residential	—	1	1	1	7	9	12	18	26	45	69	95	118	136	
Commercial	1	—	1	2	4	7	11	19	37	70	113	154	192	220	
Industrial	23	18	17	10	10	18	20	26	31	47	68	92	120	143	
All Others	—	1	1	—	2	15*	2	3	3	4	4	5	5	6	
Total Classified Sales	24	20	20	13	22	48	44	66	97	166	254	346	435	505	
Losses	6	6	5	4	1	3	3	6	11	18	28	38	48	56	
Self Supplied Ind.	—	—	—	—											
PSA 48	N.A.	N.A.	N.A.	285	537	1,149	1,534	2,666	4,044	8,600	16,039	24,545	33,211	39,680	
Residential	1	2	12	57	111	260	388	908	1,416	2,996	5,501	8,127	10,768	13,080	
Commercial	1	3	11	27	68	187	347	704	1,218	3,165	6,651	10,795	14,931	17,211	
Industrial	—	—	21	166	293	610	708	798	1,024	1,570	2,350	3,320	4,430	5,700	
All Others	—	—	5	17	36	30	33	58	143	232	349	485	622	750	
Total Classified Sales	2	5	50	267	506	1,087	1,476	2,468	3,801	7,963	14,851	22,727	30,751	36,741	
Losses	—	1	5	12	31	62	59	199	242	637	1,188	1,818	2,460	2,939	
Self Supplied Ind.	N.A.	N.A.	N.A.	6											

(continued)

TABLE 2 (continued)

PSA's 41 and 47	99	72	143	123	37	74	78	129	189	370	607	845	1,056	1,213
Residential	2	3	4	4	11	17	23	36	52	105	177	249	310	356
Commercial	3	2	4	5	10	16	24	42	71	157	268	373	458	512
Industrial	27	20	36	15	10	18	20	35	41	64	95	132	176	217
All Others	1	2	2	3	5	18	5	7	8	9	11	13	14	16
Total Classified Sales	33	27	45	27	35	68	72	119	171	336	551	767	958	1,101
Losses	7	7	7	5	2	4	5	10	18	34	56	78	98	113
Self Supplied Ind.	59	38	92	90										

Notes: Energy use is in terms of gigawatt hours (GWH) annually. For 1950 and subsequent, the Self-Supplied Industrial category has been included with Industrial. See text on "Past and Expected Patterns" for description of Power Market Areas prior to 1950 and Power Supply Areas for 1950 and subsequent. *Electric energy generation and use growth patterns would have the same statewide total if Nevada were self sufficient.

All Other category for 1950 and subsequent normally includes: street lighting, public authority, company's own use, irrigation and drainage pumping, and electric transportation; for Sierra Pacific Power Co. in PSA 46B, includes street lighting and public authority, under Commercial. Residential category includes farm energy but excludes irrigation and drainage pumping.

Data tabulated for the period subsequent to 1970 are the product of numerical and graphical interpolation techniques. Accuracy to the number of significant figures provided is not intended; likewise for the period 1930-1970.

**TABLE 3
NEVADA GROWTH PATTERNS FOR POPULATION, PER CAPITA
USE AND TOTAL USE OF ELECTRIC ENERGY**

	1970	1980	1990	2000	2010	2020
POPULATION (In terms of resident persons)						
Nevada	488,738	770,000	1,082,000	1,319,000	1,477,000	1,564,000
PSA 41	15,044	23,300	29,475	33,600	35,685	36,725
PSA 47	23,827	26,700	29,100	31,225	32,700	34,100
PSA 41 and 47	38,871	50,000	58,575	64,825	68,385	70,825
PSA 46B	174,022	239,800	305,625	357,275	389,665	403,165
PSA 48	275,845	485,700	717,800	896,900	1,018,950	1,090,000
ELECTRIC ENERGY USE (In terms of giga watt hours annually)						
Nevada	5,838	12,311	22,402	33,912	45,146	53,550
PSA 41	81	186	325	461	573	652
PSA 47	108	184	282	384	483	561
PSA 41 and 47	189	370	607	845	1,056	1,213
PSA 46B	1,605	3,341	5,756	8,522	10,879	12,657
PSA 48	4,044	8,600	16,039	24,545	33,211	39,680
PER CAPITA USE (In terms of kilowatt hours per person annually)						
Nevada	11,945	15,875	20,704	25,710	30,566	34,239
Equivalent in Men*	23	30	39	49	58	65
PSA 41	5,384	7,982	11,026	13,720	16,057	17,753
PSA 47	4,533	6,891	9,691	12,298	14,470	16,452
PSA 41 and 47	4,862	7,400	10,363	13,035	15,442	17,127
PSA 46B	9,223	13,932	18,834	23,853	27,919	31,394
PSA 48	14,660	17,706	22,345	27,366	32,593	36,404

Notes: *Refer Table 22 for additional information. Estimates based upon a person's work output for one hour being 0.06 kilowatt hours.

Data tabulated for the period subsequent to 1970 are the product of numerical and graphical interpolation techniques. Accuracy to the number of significant figures provided is not intended; likewise for 1970.

TABLE 4
COOLANT WATER NEEDS FOR NEVADA'S FUTURE ELECTRIC ENERGY GENERATION

	1970	1980	1990	2000	2010	2020
COOLANT WATER NEEDS (In terms of acre-feet per year)						
Nevada	12,552	26,446	48,124	72,850	96,983	115,036
PSA 41	174	398	698	990	1,230	1,401
PSA 47	232	396	606	824	1,038	1,204
PSA 41/47	406	794	1,304	1,814	2,268	2,605
PSA 46B	3,451	7,177	12,364	18,307	23,370	27,190
PSA 48	8,695	18,475	34,455	52,728	71,344	85,241

Notes: Assuming no net import or export of electric energy. Water use based upon .7 gallons per kilowatt hour.

Data tabulated for the period subsequent to 1970 are the product of numerical and graphical interpolation techniques. Accuracy to the number of significant figures provided is not intended; likewise for 1970.

TABLE 5
PROJECTIONS FOR NEVADA'S POPULATION, MUNICIPAL AND INDUSTRIAL WATER USE AND ELECTRIC ENERGY USE, 1970-2020

Projected Quantities for Study Period, 1970 to 2020 *(See Table 2 for Historical Data)							
Subject of Projection	Symbol	1970	1980	1990	2000	2010	2020
Population	(P)	489	770	1,082	1,319	1,477	1,564
Water Use (M & I)	(W)	224	368	530	662	756	815
Elec. Energy Use*	(E)	58.4	123	224	339	452	536
Ratios Comparing the Above Projected Quantities							
Per Capita Elec. Energy Use	(E/P)	.119	.160	.207	.257	.306	.343
Per Capita (M & I) Water Use	(W/P)	.458	.478	.490	.502	.512	.521
Elec. Energy Use Relative to Water Use	(E/W)	.261	.334	.423	.512	.598	.658
Percent Increase in Importance Above 1970 Conditions, as Calculated from Ratios Above							
Per Capita Elec. Energy Use	(E/P)	none	34%	74%	116%	157%	188%
Per Capita (M & I) Water Use	(W/P)	none	4%	7%	10%	12%	14%
Elec. Energy Use Relative to Water Use	(E/W)	none	28%	62%	96%	129%	152%

Notes: Population is in terms of thousands of resident persons.

Water use in terms of thousands of acre-feet per year, and does not include coolant water use for future stream electric energy generating plants. M & I means municipal and industrial.

Electric energy use is in terms of megawatt hours per year divided by the constant one hundred thousand (10^5). The constant divisor was selected merely to make the numbers easier to tabulate. So, to arrive at the actual projected energy use, the tabulated number would have to be multiplied by 100,000.

TABLE 6
POPULATION AND ELECTRIC ENERGY GROWTH PATTERNS FOR GROUPINGS
OF STATES BY AREA AND CLASS, 1920-2020

Population data were taken from Table 14 of the 1973 Statistical Abstract of the USA. Electric Energy generation data for 1960 and 1970 were taken from Table 834 of the same source. Comparable tables from prior Abstracts were consulted to obtain data for 1920, 1930, 1940 and 1950.

	Historic										Projected		
	1920	1930	1940	1950	1960	1970	1980	1990	2000	2010	2020		
POPULATION													
USA (Thousands)	106,022	123,203	132,165	151,326	179,323	203,212	223,000	239,000	252,000	260,000	263,000		
Northeast	29,662	34,427	35,977	39,478	44,678	49,041	52,900	55,800	58,000	59,400	60,000		
North Central	34,020	38,594	40,143	44,461	51,619	56,572	61,100	64,900	67,800	69,400	70,200		
South	33,126	37,858	41,666	47,197	54,973	62,795	68,300	73,100	77,000	79,500	80,500		
West*	8,902	11,897	13,882	19,562	27,194	33,734	38,900	43,100	46,800	48,700	49,500		
Selected	23,111	30,400	33,954	42,270	54,854	65,051	73,500	80,500	86,500	89,800	90,800		
California	3,427	5,677	6,907	10,586	15,717	19,953	23,500	26,400	28,900	30,100	30,800		
ELECTRIC ENERGY GEN.													
USA (TWH)	43.6	95.9	145	329	842	1,640	2,654	3,492	4,158	4,680	5,023		
Northeast	15.8	31.5	454	79.6	155	287	455	590	695	780	840		
North Central	13.1	28.1	421	94.6	232	416	645	835	980	1,100	1,180		
South	6.7	19.8	33.5	90.7	301	627	1,040	1,380	1,658	1,870	2,010		
West*	8.0	16.4	24.0	64.2	153	304	492	644	771	860	920		
Selected	13.6	31.2	41.0	86.7	225	467	790	1,055	1,260	1,430	1,540		
California	3.7	8.9	9.8	24.8	64.9	124	200	264	315	355	380		
PER CAPITA GEN.													
USA (KWH Per Cap)	411	778	1,097	2,174	4,695	8,070	11,900	14,613	16,500	18,000	19,100		
Northeast	531	916	1,261	2,016	3,465	5,854	8,600	10,573	11,980	13,130	14,000		
North Central	386	729	1,049	2,127	4,496	7,353	10,550	12,866	14,454	15,850	16,809		
South	201	524	805	1,922	5,482	9,977	15,200	18,878	21,532	23,520	24,969		
West*	897	1,380	1,730	3,284	5,640	9,018	12,650	14,950	16,467	17,660	18,586		
Selected	588	1,026	1,208	2,051	4,102	7,179	10,748	13,106	14,566	15,924	16,960		
California	1,080	1,568	1,419	2,343	4,129	6,215	8,511	10,000	10,938	11,794	12,338		
PER CAPITA RATIOS													
FOR: (GROUPINGS/USA)													
Northeast	1.292	1.177	1.149	.927	.738	.725	.723	.724	.726	.729	.733		
North Central	.939	.937	.956	.978	.958	.911	.887	.881	.876	.881	.880		
South	.489	.674	.734	.884	1.168	1.234	1.277	1.293	1.305	1.307	1.307		
West*	2.182	1.774	1.577	1.511	1.201	1.117	1.063	1.023	.998	.981	.973		
Selected	1.431	1.319	1.101	.943	.874	.890	.903	.897	.883	.885	.888		
California	2.628	2.015	1.294	1.078	.879	.770	.715	.684	.663	.655	.646		

Notes: *West does not include Alaska and Hawaii in this table. States included are: Washington, Oregon, California, Idaho, Nevada, Montana, Wyoming, Utah, Arizona, Colorado and New Mexico.

One terawatt hour (TWH) is one billion kilowatt hours (KWH). See Table 1 for further information.

Per capita ratios are obtained by dividing per capita generation for groupings, such as area or class, by per capita generation for the nation.

See Map 4 for selected states, which include: California, Texas, Florida, New York and Michigan.

Data tabulated for the period subsequent to 1970 are the product of numerical and graphical interpolation techniques. Accuracy to the number of significant figures provided is not intended; likewise for the period 1920-1970.

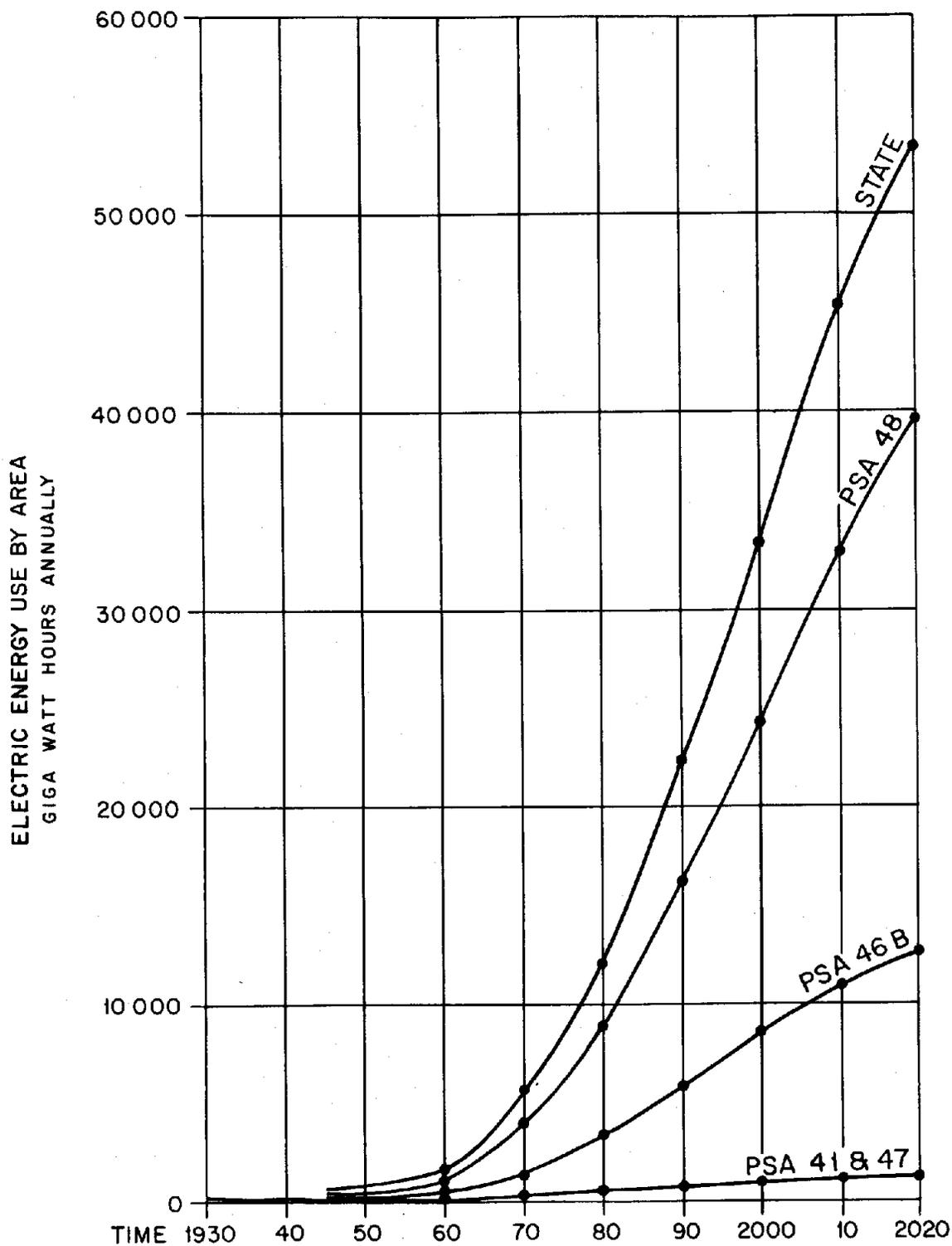


FIGURE 1
 NEVADA ELECTRIC ENERGY GROWTH PATTERNS BY AREA
 (Data taken from Table 2)

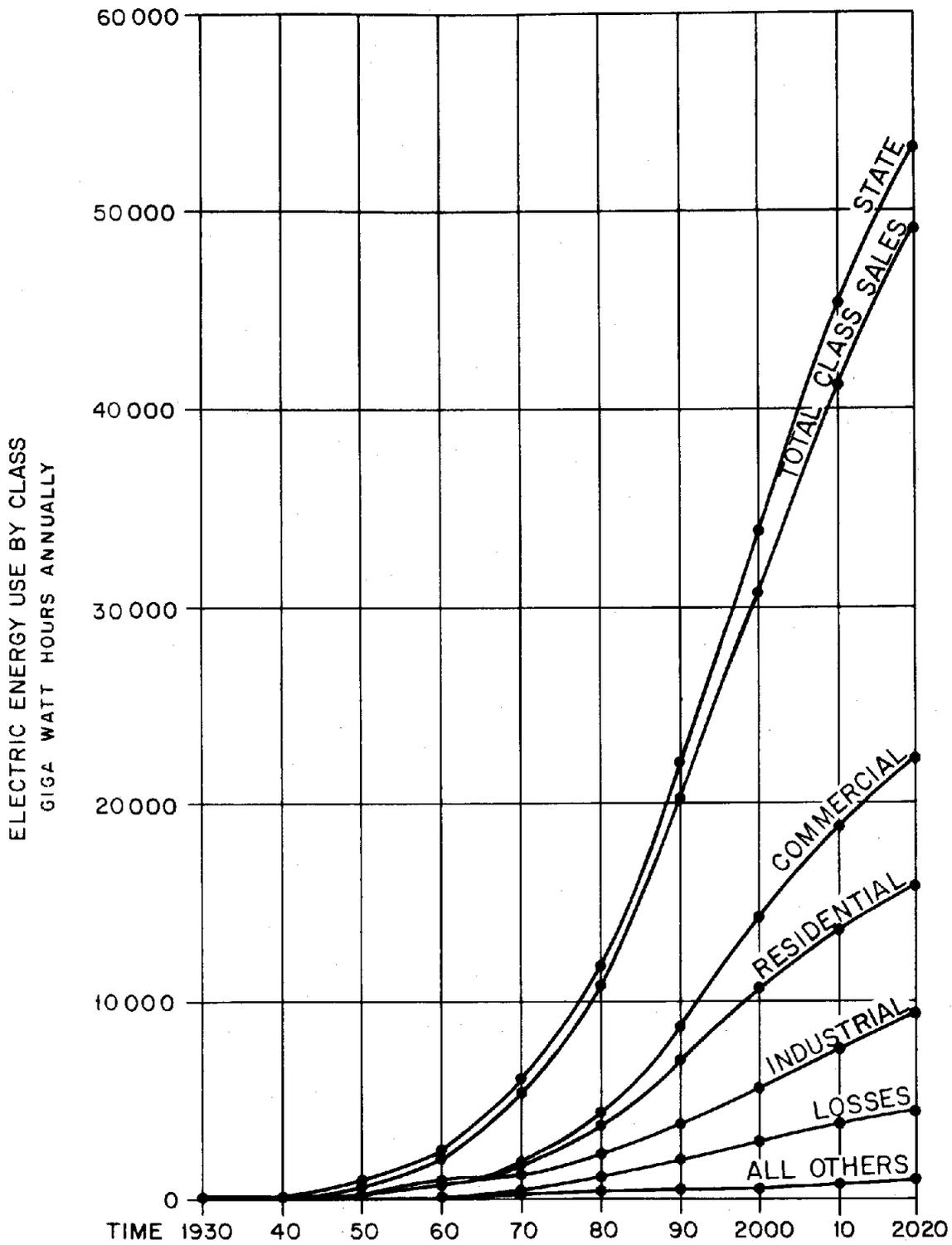


FIGURE 2
 NEVADA ELECTRIC ENERGY GROWTH PATTERNS BY CLASS OF USAGE
 (Data taken from Table 2)

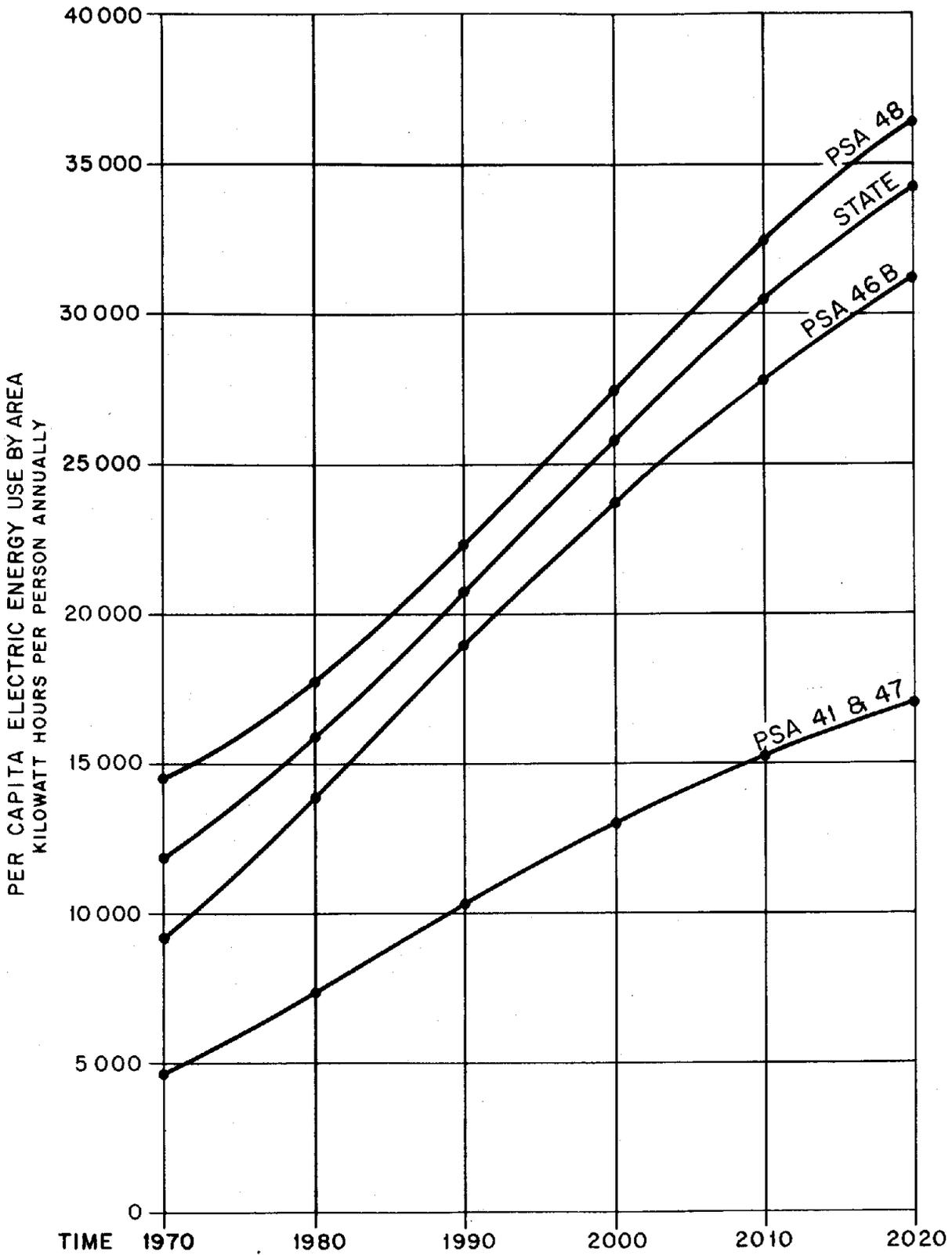


FIGURE 3
NEVADA PER CAPITA ELECTRIC ENERGY GROWTH PATTERNS
 (Data taken from Table 3)

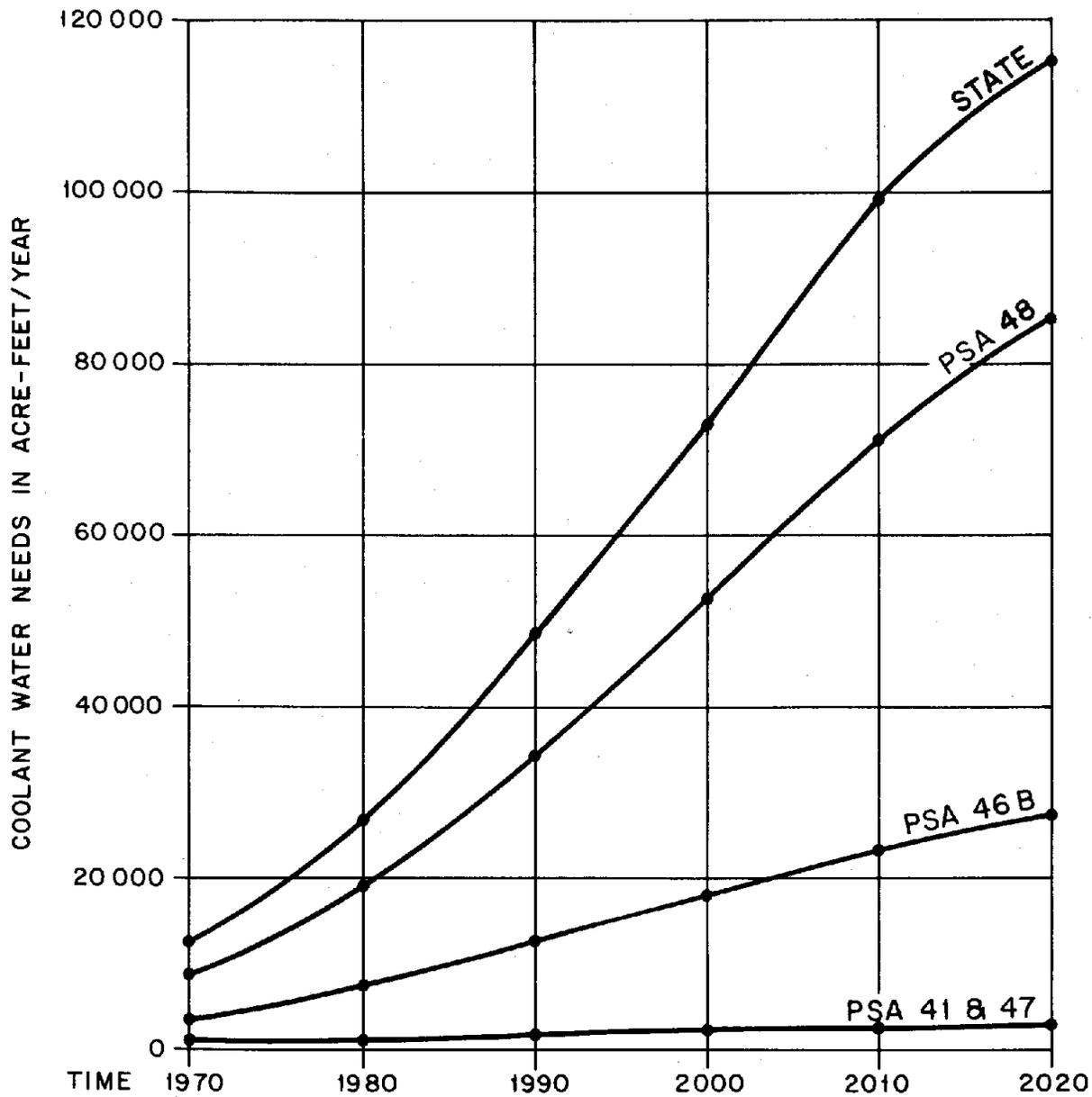


FIGURE 4
COOLANT WATER NEEDS FOR NEVADA'S FUTURE ELECTRIC ENERGY GENERATION,
ASSUMING NO NET IMPORT OR EXPORT OF ELECTRIC ENERGY
(Data taken from Table 4)

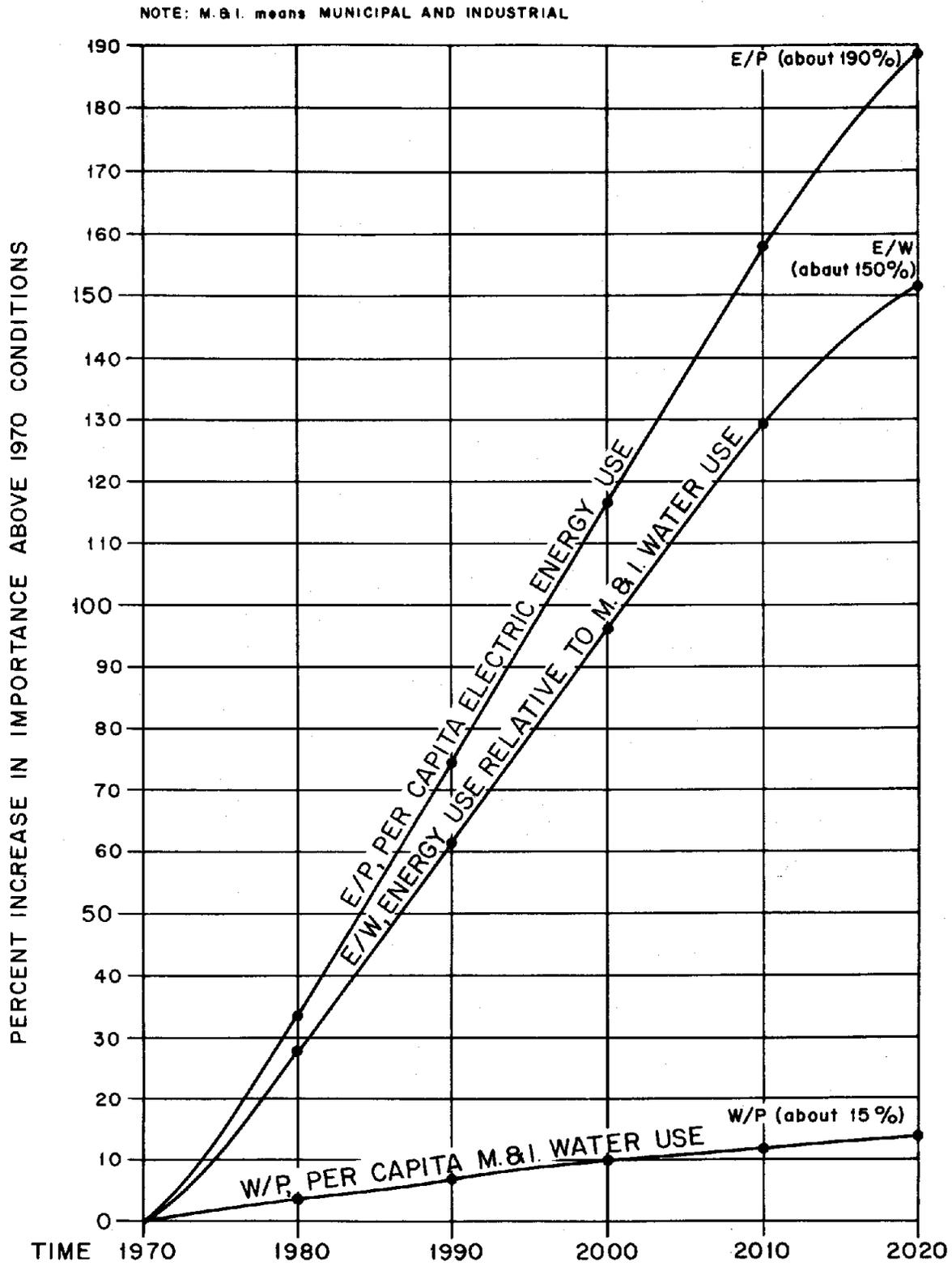


FIGURE 5
 PERCENT INCREASE IN IMPORTANCE ABOVE 1970 CONDITIONS WITH TIME
 (Data taken from Table 5)

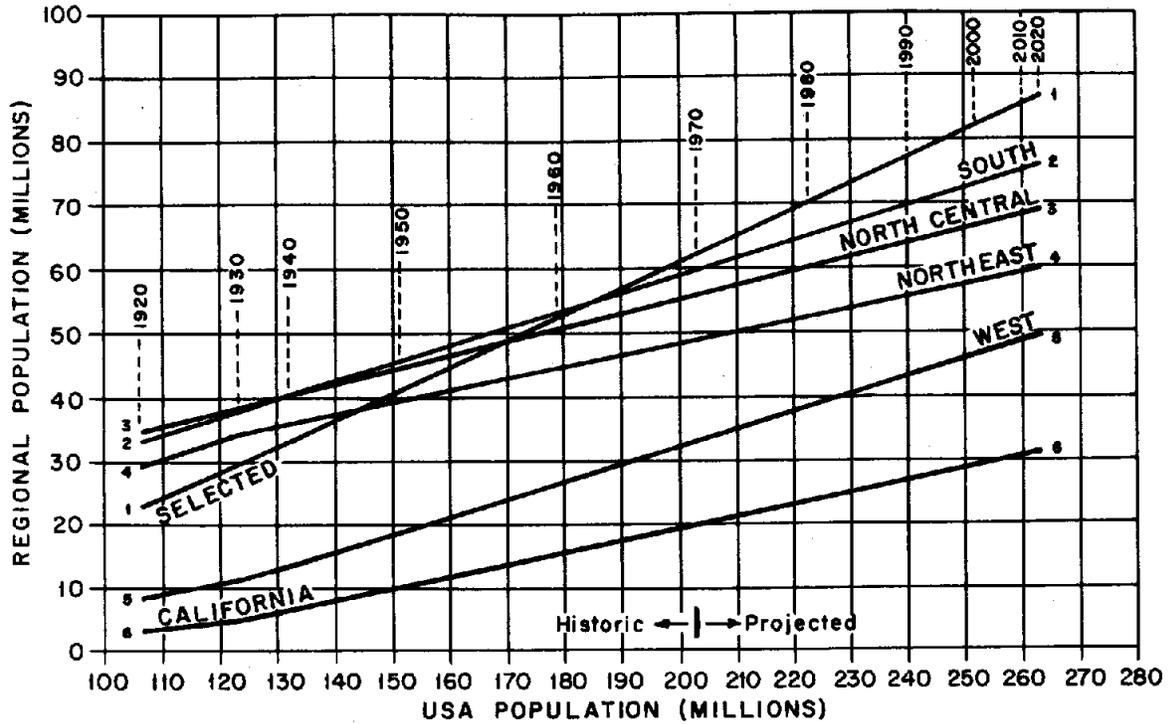


FIGURE 6
POPULATION GROWTH PATTERNS FOR THE NATION
AND GROUPINGS OF STATES BY AREA AND CLASS, 1920-2020
 (Data taken from Table 6)

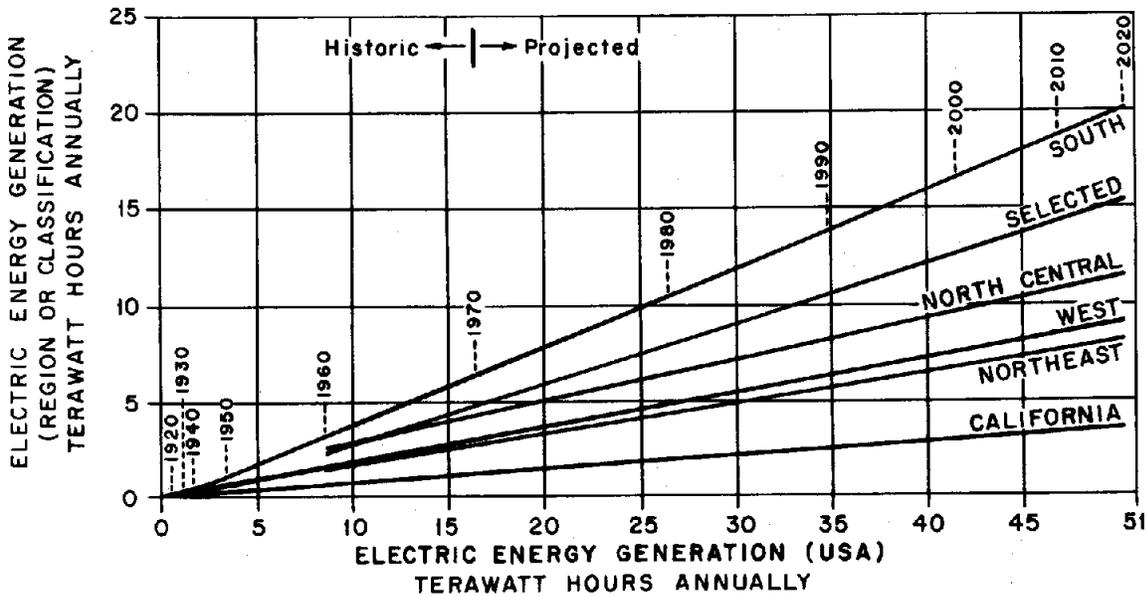


FIGURE 7
ELECTRIC ENERGY GENERATION GROWTH PATTERNS FOR THE NATION
AND GROUPINGS OF STATES BY AREA AND CLASS, 1920-2020
 (Data taken from Table 6)

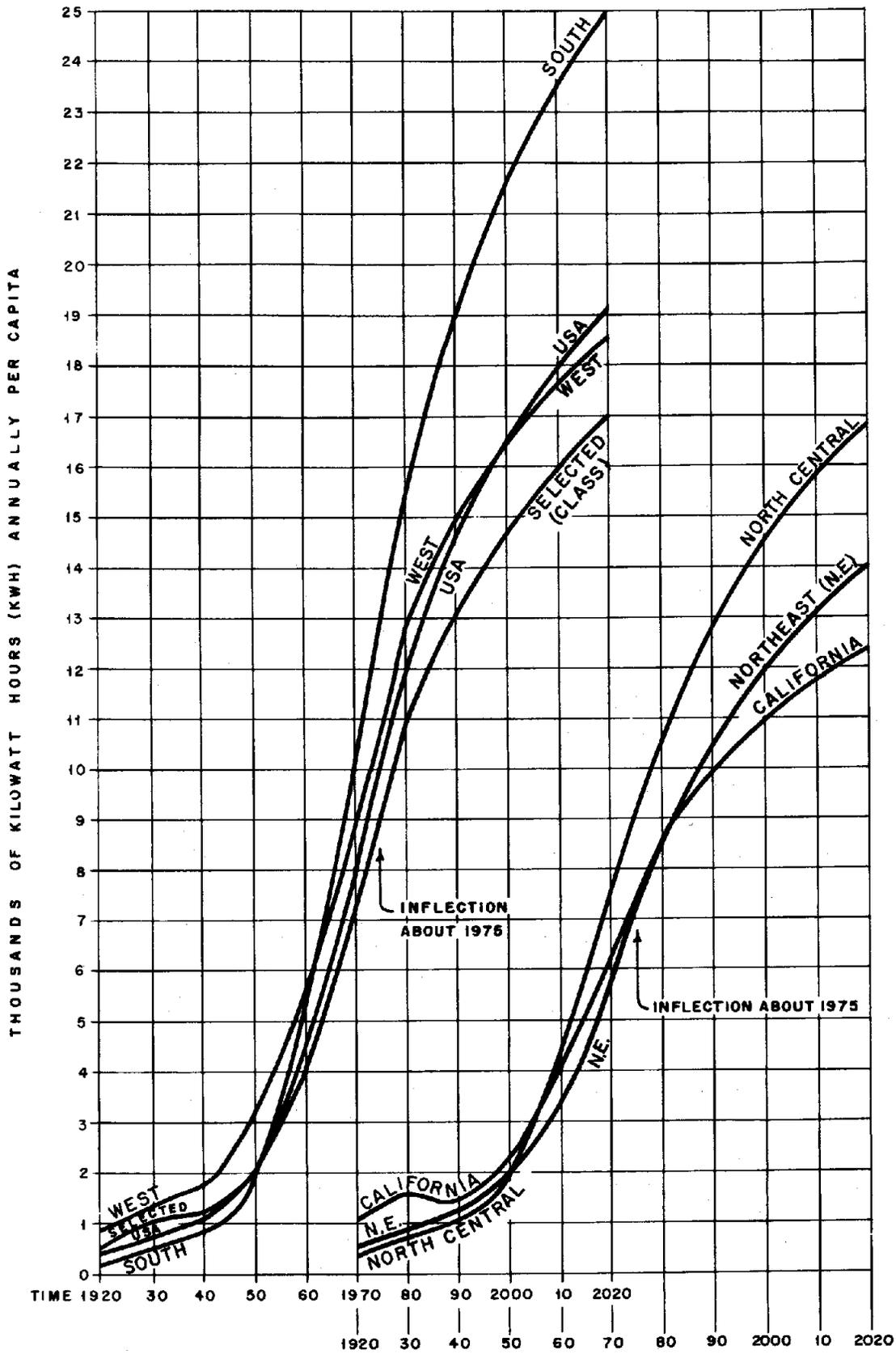


FIGURE 8
PER CAPITA ELECTRIC ENERGY GENERATION GROWTH PATTERNS FOR THE NATION
AND GROUPINGS OF STATES BY AREA AND CLASS, 1920-2020
 (Data taken from Table 6)

CHAPTER 4

CONSERVATION FOR ELECTRIC ENERGY GENERATION AND USE

LIMITATIONS

Efficiency

To mitigate the effects of expected shortages, conservation measures should be applied to both the sources and uses of electric energy taken together with water and related land resources, where economically, environmentally and technically justified. The combinations of sources and uses are primarily determined in the market place and by evolution of technology, which provide practical limits to conservation. However, there are also social (regulatory, planning) limits and less obvious natural limits. All of these limitations may be described in terms of degrees of efficiency.

As previously stressed, source-use combinations are the product of extensive experience, and are probably the most efficient for the present total situation. To avoid paying a long term penalty in total energy efficiency, any attempts at immediate change of source-use combinations must not be exempted from the competition of the market place, for mere short term electric energy benefit.

Finally, efficiency for electric energy generation and use should be considered in the total context of effects upon population, economic activity and resource use in both the short and long term.

Factors of Efficiency

The separate addendum to this report is composed of appendices organized around the individual factors

of efficiency and the technology of water use in energy processes. There is no question that these factors are wrapped up in the total environment in which we carry on our affairs. Nobody has yet learned how to understand or control complexity of this magnitude — it just operates on the basis of many small, individual decisions, which seem to be “invisible”. However, occasionally some important facts stand out partially from the total complexity. This is the status of the factors of efficiency and the justification for taking an expanded look at them in the individual appendices, which are summarized following:

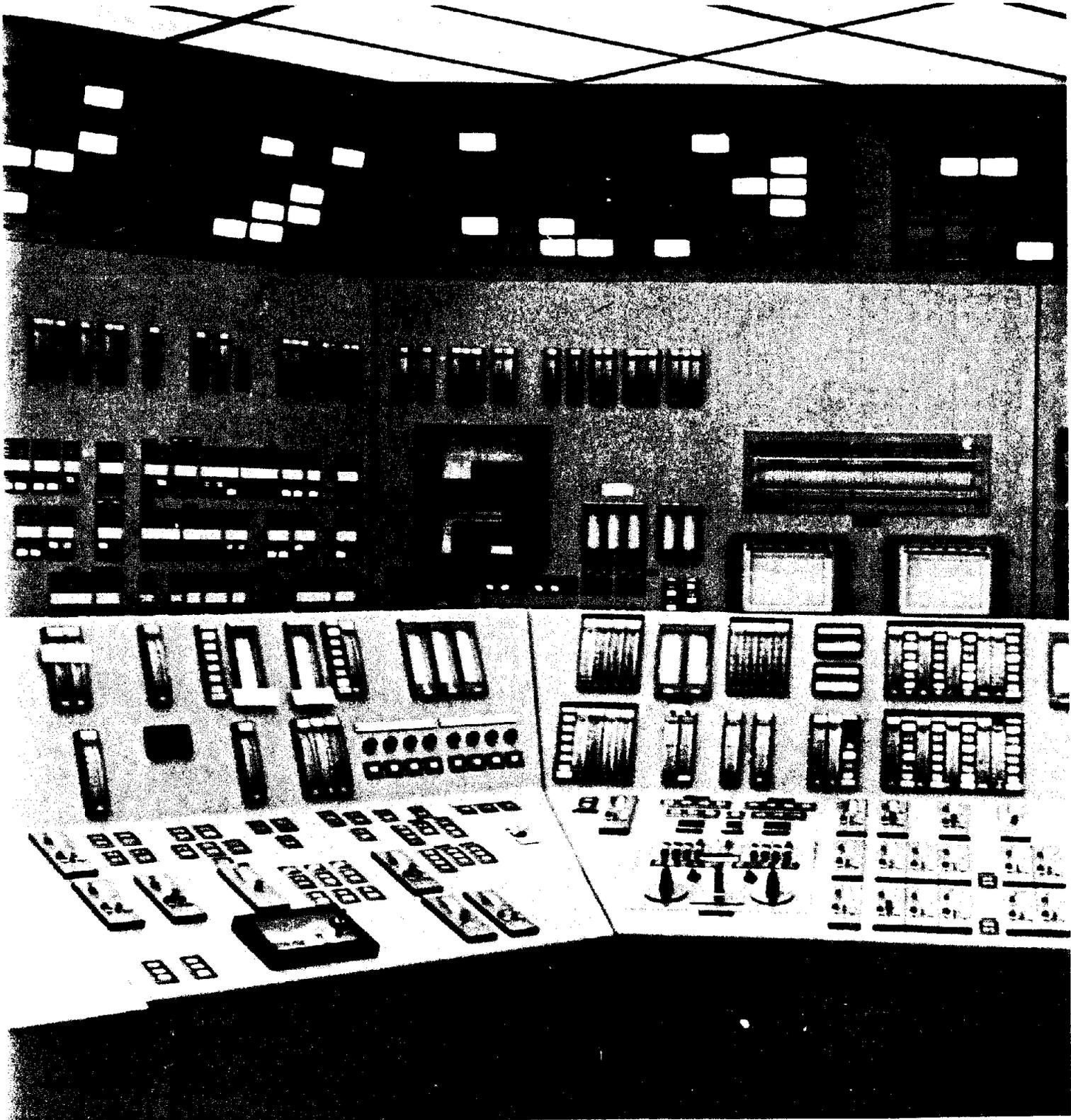
For Electric Energy Generation:

Appendix A, Siting

A preliminary siting-rating system was developed, which attempts to take into account reasonable economic and environmental balance, at a high level of efficiency, without a morass of regulations. However, recent and future federal actions may become controlling with respect to regulations.

A tentative selection was made of 26 valleys or hydrographic areas, which might efficiently support electric energy generation facilities. Tentative selection was partly based upon adequate ground water to support 1,000 megawatts of electric generating capacity. In the neighborhood of 15,000 acre-feet of perennial yield would be required¹. Valleys in developed urban and

Control room at Rancho Seco during construction phase.
Credit: R. E. Walstrom



rural areas have been temporarily set aside from consideration, pending study beyond this report. Included in the set aside classifications are the Las Vegas Valley, as well as other valleys in the Carson, Truckee, Humboldt and Walker River systems.

Electrical generating capacity close to larger electric load centers is economically efficient. Planners often say, "Keep the people and the facilities to serve them close together" — so as to cut down on the total facilities required. However, there are limits to closeness where quality of life has been built and will continue to depend upon use of scarce water and related land resources.

If there is intense competition for existing water resources in an urbanized valley or area, it would probably be necessary to site generating facilities which would use additional water in a nearby but not water short location. The same would be true for agricultural areas, if generating facilities would infringe upon existing rights. Each situation should be judged on its own merits.

Valleys tentatively selected are listed by name and State Water Plan identification number, in the order of increasing perennial yield² of the ground water basin:

Dixie Valley 128; Smoke Creek Desert 21; Kober Valley 139; Frenchman Flat 160; King's River Valley 30; Newark Valley 154; Coyote Spring Valley 210; Fish Lake Valley 117; Lower Reese River and Whirlwind Valleys 59, 60; Clayton Valley 143; Clover Valley 177; Pahroc Valley 208; Pahrnagat 209; Snake 195; Black Rock Desert 28; Diamond Valley 153; Amargosa 230; White River Valley 207; Muddy River Springs Area 219; Railroad Valley 173; Ruby Valley 176; Quinn River Valley 33; Big Smoky Valley (North) 137b; Steptoe Valley 179; Spring Valley 184.

Appendix B, Alternative Processes

Practical replacement processes for proven existing electric energy sources, such as hydro (base load), conventional fossil fuels and nuclear, are not expected to be available on a large scale much before the year 2000.

There is extreme interest in Nevada for an early technical breakthrough leading to utilization of geothermal resources. Presently, 13 areas in Nevada are identified by the U. S. Geological Survey as Known Geothermal Resource Areas (KGRA), and about 20% of the State is thought to have potential for future geothermal exploration. On a national scale, Nevada is estimated to be second only to California for potential geothermal energy development. The most promising developments are for generation of electricity and for heating and cooling of structures.

For supplying peak power needs, pumped storage generation is expected to become more attractive as the size of Nevada's electric energy load increases and transmission systems in the 11 Western States become more highly interconnected. As part of a recent reconnaissance study, the Federal Power Commission and Nevada have tentatively identified a sampling of potential pumped storage sites in Nevada.

Direct conversion of solar radiation into electricity is expected to be the most ideal, large scale, long term solution to electric energy problems. However, direct conversion of solar radiation into electricity is presently too expensive and experimental for large scale use. A related aspect is that solar operated non-electrical heating and cooling systems for structures are expected to come into limited use, thus relieving some of the need for scarce electricity.

Appendix C, Rate of Use

Reduced time on line for appliances and equipment as well as scheduled avoidance of use during periods of peak demand could ease potential shortages. This amounts to slowing the rate of energy use, and therefore generation, as well as an attempt to achieve greater efficiency at some lesser total amount of generation.

On the average, Nevadans use sufficient electric energy to employ quite a few people at hard manual labor in producing that energy. In 1970, each of us made use of electric energy equivalent to 23 people working full time. Projections indicate that this "people equivalent to energy use" will become about 30 in 1980, about 39 in 1990 and about 49 in 2000.

Certainly, if each of us had to get on the treadmill to produce electric energy, the use would drop. We don't have to do this, but the previous comparison serves a useful purpose to gain attention for the problem.

Appendix D, Design

More efficient design for heating, cooling and lighting by residential, commercial and industrial appliances and equipment would use less energy. Better insulation of structures would also be a more efficient design factor. Costs of more efficient design would be balanced against long term savings in operation.

For Electric Energy Generation and Use:

Appendix E, Natural Limits

a. *Available Energy.* In energy terms, what is theoretically contained in a *fuel*, what we take in *process* and

what is needed for the *job* are greatly different in amount. Reduction of the wasted energy portion of these differences in energy required between job and process and between process and fuel would increase the available energy for doing work. This could be achieved by more efficient job-process-fuel combinations.

It is the concept of reducing waste of available energy which can lead to significant improvement in the previous combinations, subject to judgment in the market place, available technology and the natural limitations of thermodynamics.

- b. *Process Operating Temperature.* Efficiency in any energy process improves as the source temperature rises within design limits above some lower base temperature required to operate the process. Electric energy is capable of producing high temperatures, and consequently, is potentially highly efficient. However, not all processes require high temperatures, and design might reasonably be shifted away from scarce electricity for these processes, again subject to judgment in the market place, available technology and the natural limitations of thermodynamics.
- c. *Amount and Its Distribution.* For purposes under consideration, amount (or number) and its distribution applies to population and related activities, in which electric energy generation and use and general resource uses and economic activities are included.

Amount and its distribution for population and electric energy generation and use has the quality of natural limit, because there is a tremendously stable, long term, straight-line relationship between total amount and its distribution by area or class. In this regard, refer to Figures 6 and 7, where the lines are essentially straight, except close to the origin, which is during the period of early and somewhat undeveloped growth. Barring huge upsets, the behavior shown by the figures will continue to be essentially straight and smooth. This is the manifestation of a natural limit.

Character of this limit cannot be greatly changed without huge upsets, which means that population and electric energy generation and use cannot be efficiently redistributed³ on a large scale.

Appendix F, Regulatory Situation

Regulations usually operate to slow the rate of technological growth and efficient applications of source-use or job-process-fuel combinations previously described.

Regulations can also serve to directly or indirectly retard or accelerate some aspects of population growth.

Appendix G, Technology of Water Use for Energy Processes

The preceding title has been chosen by the U. S. Geological Survey, for their Circular 703, published in 1974. The entire text of the circular has been reproduced for the addendum to this report, because of the need to present the most recent water requirements for energy processes of concern to Nevada and the West. Circular 703 is maintained open file at the Division of Water Resources and at the U. S. G. S. Office in Carson City.

¹Refer to Appendix G for discussion of water consumption by electric energy generation and other energy processes.

²Perennial yield may be defined as the maximum amount of natural discharge that economically and legally can be salvaged over the long term by pumping.

³Numbers of people are distributed by place and other important classifications which might include age, sex, race, religion, wealth, health, education, skill, housing, employment status, etc. Electric energy generation and use are distributed by place and classification having to do with the previously mentioned source-use combinations or job-process-fuel combinations.