Hr. 472

DOE/CS/8720-3

15
1-4-80

SOUTHWEST PROJECT

RESOURCE/INSTITUTIONAL REQUIREMENTS ANALYSIS

VOLUME III
SYSTEMS INTEGRATION STUDIES

DECEMBER 1979

Prepared for:
U.S. Department of Energy
Assistant Secretary for Conservation and Solar Energy
Office of Solar Applications

Printed in the United States of America
Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

NTIS price codes
Printed copy: ~~$7.25~~ 10, 00
Microfiche copy: A01

DOE/CS/8720-3
CATEGORY NO. UC-97

SOUTHWEST PROJECT

RESOURCE/INSTITUTIONAL REQUIREMENTS ANALYSIS

VOLUME III
SYSTEMS INTEGRATION STUDIES

DECEMBER 1979

Prepared by

951 0200
950 0732
950 9936
950 4289
599 1000

ARIZONA POWER AUTHORITY
ARIZONA PUBLIC SERVICE COMPANY
EL PASO ELECTRIC COMPANY
NEVADA POWER COMPANY
PORTLAND GENERAL ELECTRIC COMPANY
PUBLIC SERVICE COMPANY OF COLORADO
PUBLIC SERVICE COMPANY OF NEW MEXICO
SALT RIVER PROJECT
SAN DIEGO GAS & ELECTRIC COMPANY
SIERRA PACIFIC POWER COMPANY
SOUTHERN CALIFORNIA EDISON COMPANY
SOUTHWESTERN PUBLIC SERVICE COMPANY
UTAH POWER & LIGHT COMPANY
AND
STONE & WEBSTER ENGINEERING CORPORATION

Prepared for:
U.S. Department of Energy
Assistant Secretary for Conservation
and Solar Energy
Office of Solar Applications
Washington, D.C. 20585

Under
CONTRACT NO. EM-77-C-01-8720

SOUTHWEST

SUMMARY TABLE OF CONTENTS

VOLUME I
EXECUTIVE SUMMARY

VOLUME II
TECHNICAL STUDIES

VOLUME III
SYSTEMS INTEGRATION STUDIES

VOLUME IV
INSTITUTIONAL STUDIES

PREFACE

This document is Volume III of the four-volume Southwest Project Resource/Institutional Requirements Analysis Report. The complete report consists of the following volumes:

- I. Executive Summary
- II. Technical Studies
- III. Systems Integration Studies
- IV. Institutional Studies

Refer to the Summary Table of Contents on the following page for a delineation of the specific contents of Volumes I, II, and IV.

The work described herein was initiated in October 1976 and was conducted in accordance with Federal Energy Administration (FEA), now Department of Energy (DOE), contract number EM-77-C-01-8720.

The contract authorized Stone & Webster Engineering Corporation (S&W) to undertake, with the assistance of 13 electric utilities, a study whose purpose was to investigate ways to accelerate the commercialization of solar electric generating plants and their expected market penetration into the electric utility network of the southwestern United States through the year 2000.

In accordance with the contract, the study was conducted primarily from a utility perspective and included the utility view of the technical, legal, economic, and institutional considerations necessary to make central station generation of electricity from solar power commercially successful. No dispersed uses of solar electric generation were addressed.

This report provides a basis from which periodic updates can be made to analyze the effect of economic trends and technology developments on the utilization of solar and/or conventional electric generation as technology continues to progress in future years. The basis established in this report utilized current state-of-the-art technology for solar and conventional electric generating plants. Also, 1977 costs of conventional electric generating plants were utilized. The cost of first generation commercial solar electric generating plants was based on assumptions reflecting large scale manufacturing of components by a mature industry.

Certain cautions should be observed when using the data contained in this report for any purpose other than that intended by the Southwest Project. The costs of solar electric equipment, other forms of electric generating equipment, and fuel have been developed based on specific assumptions and are adjusted to reflect Southwest regional costs. The results of system integration modeling efforts were developed from specific utility system information and are not readily transferable to another region or utility system in all their aspects. Similarly, statements contained in this report may not be directly applicable to any single "typical" utility.

Lastly, institutional study data may be used as models, but are not readily transferable to other situations because they are either state or utility specific. While methodologies described in this study can be applied to other regions or situations, the specific data developed with these methodologies are directly applicable only to the region of interest. General conclusions can be drawn, however, which are applicable to the country as a whole.

The contract technical direction was under the supervision of Mr. Alex Haynes and Ms. Elaine Smith, DOE, Conservation and Solar Applications Division.

The Southwest Project Resource/Institutional Requirements Analysis Study and Report was primarily developed by the following personnel representing the organizations indicated:

Arizona Power Authority (APA)	L.S. Ormsby T.G. Sawyer
Arizona Public Service Company (APS)	Dr. M.L. Brown L.L. Daviet II E.R. Weber
El Paso Electric Company (ELP)	J.E. Brown
Nevada Power Company (NPC)	J.W. Arlidge H.R. Novak
Portland General Electric Company (PGE)	Norman Sanesi
Public Service Company of Colorado (PSC)	H.C. Klaiman D.T. Spangenberg, Jr.
Public Service Company of New Mexico (PSNM)	D.J. Groves J.D. Maddox

SOUTHWEST

Salt River Project (SRP)	R.M. Hayslip G. Ijams
San Diego Gas and Electric Company (SDGE)	R.G. Lacy J. Montgomery
Sierra Pacific Power Company (SPP)	J.A. Carito
Southern California Edison Company (SCE)	J.W. Ballance C.F. Bluemle D.N. Smith M.C. Wehrey
Southwestern Public Service Company (SPS)	K.L. Ladd
Utah Power & Light Company (UPL)	Dr. S.K. Evans
Stone & Webster Engineering Corporation	D.H. Guild, Project Manager B. Brodfeld J.A. Cleveland K.L. Hicks M.W. Noga A.M. Ross

S&W would also like to acknowledge the assistance and information provided by the State Energy Offices of Arizona, California, Colorado, Nevada, New Mexico, Oklahoma, Texas, and Utah, and by J.E. Bigger of the Electric Power Research Institute (EPRI).

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS (CONT)

SECTION 1

INTRODUCTION

The purpose of this project is to provide information to DOE which can be used to establish its plans for accelerated commercialization and market penetration of solar electric generating plants in the southwestern region of the United States. The area of interest includes Arizona, California, Colorado, Nevada, New Mexico, Utah, and sections of Oklahoma and Texas.

The project evaluated the potential integration of solar electric generating facilities into the existing electric grids of the region through the year 2000. The solar technologies considered in this study were selected on the basis of potential availability, applicability to the southwestern region, and viability during the time frame of 1985-2000. The technologies included wind energy conversion, solar thermal electric, solar photovoltaic conversion, and hybrid solar electric systems. Each of the technologies considered, except hybrid solar electric, was paired with a compatible dedicated energy storage system to ascertain the impact of such a system upon plant performance and its applicability to a utility grid system. The hybrid concept utilizes a conventionally fueled steam generator to augment a solar powered steam generator, so that a hybrid plant is not as dependent upon the availability of solar energy as are the other concepts. Operation of solar electric generating plants in conjunction with existing hydroelectric power facilities was also studied.

The participants in this project included twelve electric utility companies and a state power authority in the southwestern United States, as well as a major consulting engineering firm. Eleven of the electric utilities are private investor-owned and one is a public utility. The state power authority functions as a wholesaler of electric power only. The total installed capacity of the participating utilities, as of January 1, 1977, was approximately 30,000 MWe. This represented about 48 percent of the installed capacity in the region. The installed capacity of the individual utilities ranged from 562 MWe to 14,066 MWe. The diversity of the participating utilities ensured a balanced perspective for the evaluation of the technical aspects of solar electric generating plants throughout the Southwest. The efforts of S&W and the participating utilities, on this and continuing projects, are indicative of a strong interest on the part of the electric utility industry in the development of solar electric power on sound technical and economic bases. As potential future users of this technology, the efforts of all the project participants were directed toward accomplishing a comprehensive review of the entire range of technical, economic, regulatory, and institutional factors that can influence the commercialization of solar electric generating plants.

The project had two distinct and complementary objectives. One objective was to address the technical problems that must be resolved to facilitate the market penetration of solar electric generating plants. The other objective was to address institutional means of removing existing or potential barriers to accelerated commercialization of these systems.

This volume addresses the integration of solar electric generation into the long-range expansion plans of six representative utilities of the Southwest.

The purpose of the system integration study was to establish the investment that utilities could afford to make in solar thermal, photovoltaic, and wind energy systems, and to assess the sensitivity of the break-even cost to critical variables including fuel escalation rates, fixed charge rates, load growth rates, cloud cover, number of sites, load shape, and energy storage. This information will be used as input to Volume IV - Institutional Studies, one objective of which will be to determine the incentives required to close the gap between the break-even investment for the utilities of the Southwest and the estimated cost of solar generation.

The utilities that supplied base case expansion data and participated in the systems integration analysis are:

- Arizona Public Service Company (APS)
- El Paso Electric Company (ELP)
- Public Service Company of Colorado (PSC)
- Public Service Company of New Mexico (PSNM)
- Southern California Edison Company (SCE)
- Salt River Project (SRP)

These six utilities plan to install predominately nuclear, coal-fired, and combustion turbine capacity during the study period (1985–2000). Other planned capacity includes pumped storage, combined cycle, geothermal, and fuel cells.

Section 3 of this volume presents a description of the base case generation expansion plans used for comparison with plans including solar generation. Section 4 of this volume presents the philosophy behind the development and application of various computer models used in the analysis and discusses special problems of modeling solar generation. Several new models were developed specifically for this project; these were integrated into an overall procedure using existing as well as new models to analyze both capacity value and fuel cost replacement value of solar generation.

Section 5 of this volume presents a discussion of procedures used to perform the economic analyses and a derivation of economic factors used.

Section 6 of this volume presents overall study methodology as well as a detailed description of the development of expansion plans including solar generation. The characteristics of each utility and, specifically, variations between utilities of available insolation levels, the types and costs of utilized fuels, and load shapes are discussed.

SECTION 2

SUMMARY

2.1 INTRODUCTION

The six utilities represented in this study exhibit a wide range of characteristics that result in the break-even investment for a single concept varying by more than a factor of two between utilities. The most significant characteristic in the analysis is the cost of fuel replaced by solar generating capacity. The fuel replacement value is more important for solar generating units which have little capacity value, such as photovoltaic and wind, than for solar thermal units which exhibit higher capacity replacement value. Utility-by-utility break-even solar investment is shown in Table 2.1-1. Table 2.1-2 lists pertinent characteristics of the utilities that contributed to the variations shown in Table 2.1-1. Three distinct fuel replacement cost categories are evident in Table 2.1-2. ELP has a fuel replacement cost of 10 mills/kWh (1985) which is representative of utility systems that would displace nuclear capacity with solar capacity in their generation expansion plans. Fuel replacement costs of 17 and 21 mills/kWh (1985) for PSC and APS, respectively, represent a displacement of a high percentage of coal by solar generation. A high percentage of fuel replaced by solar generation for SCE and SRP was oil, resulting in fuel replacement costs of 41 and 49 mills/kWh (1985) for these utilities.

Those systems that have high fuel replacement costs (SCE and SRP) also have lower investment in capacity replaced because combustion turbines, which require a lower capital investment than other types of conventional units, constitute a high percentage of the conventional capacity replaced by solar generating plants.

Another factor which has a major effect on the break-even investment in solar generation is the fixed charge rate which is also shown in Table 2.1-2. SRP, because it is publicly financed, has a fixed charge rate of 11.88 percent which is 60 percent of the rate used by most of the utilities.

These two major effects do not account for all the differences shown in Table 2.1-1. For example, solar thermal is worth more to ELP than to APS even though APS has a higher fuel replacement cost. These differences will be accounted for in the sections that follow.

2.2 SOLAR THERMAL

Solar thermal plants are characterized by higher capacity factors and higher equivalent capacity when compared to other solar technologies. Both capacity and fuel replacement credit are important in all the analyses. For three of the systems studied, capacity credit is greater than fuel replacement credit, while for the other three systems, the reverse is true. The break-even investment in 1985 dollars per kilowatt for each utility for solar thermal plants is repeated here from Table 2.1-1.

	$/kW		
	600 MWh Storage	200 MWh Storage	No Storage
SRP	2,270	1,580	-
SCE	1,780	1,320	980
PSNM	-	1,110	-
PSC	1,260	930	-
ELP	1,140	880	-
APS	970	720	-

The solar thermal unit with 600 MWh storage has a 40 percent larger collector field than the same unit with 200 MWh storage which contributes both to the energy collected and the system reliability. As a result, this unit has the highest fuel replacement credit of all the concepts.

Figures 2.2-1 and 2.2-2 show graphically the relative value of solar thermal plants with 200 and 600 MWh storage for each of the six utilities, and indicate the relative importance of capacity credit, fuel replacement credit, and operation and maintenance (O&M) penalty.

The blank area represents capacity replacement credit which consists of the capital investment in conventional capacity that was displaced by solar capacity in the generation expansion plan. The crossed area represents the investment a utility could afford to make to save the fuel replaced by solar generation, or, in other words, the capitalized fuel cost.

Since solar O&M is more costly than conventional unit O&M, the total investment that may be made in solar generation is reduced by the capitalized amount of the difference in solar O&M and conventional unit O&M. This O&M penalty is shown as the shaded area which has a negative value in the figures. Since the process of capitalization consists of dividing an annual expense by a fixed charge rate, the relatively low fixed charge rate used by SRP will result in higher fuel credits and O&M penalties for SRP than for other utilities with identical annual expenses.

ELP's large capacity credit is due to its higher insolation levels and load characteristics. The APS load has some expected load management factored into the base case which accounts for its low capacity credit relative to ELP.

The overall system characteristics of SRP and SCE result in similar solar credits and penalties. The main difference is caused by the difference in fixed charge rates.

Figures 2.2-3 and 2.2-4 show the effect of different fuel escalation rates on break-even investments for the privately financed utilities for solar thermal with 200 and 600 MWh storage, respectively. In these figures, the break-even investment for the five privately financed utilities is recomputed for 6, 8, and 10 percent fuel escalation rates and plotted according to each utility's fuel replacement value. The curves show close correlation of break-even investment versus fuel replacement value for PSC, APS, and SCE. PSNM is consistently above the curve because its lower fixed charge rate of 14.61 percent gives a relatively higher value when compared to the other four utilities that used fixed charge rates of 19.62 percent.

In general, using a fuel escalation rate of 10 percent instead of 6 percent results in a doubling of the value of solar thermal generation to utilities that displace coal- and oil-fired capacity with solar generation. Figure 2.2-5 shows the effect of fuel escalation rate on SRP. As a result of the low SRP fixed charge rate and high fuel replacement credit, the value of solar thermal to SRP is more sensitive to fuel escalation than is the value of solar thermal to the other utilities. As shown in Figure 2.2-5, the value of solar thermal at 10 percent fuel escalation rate is approximately 2 1/2 times the value at a 6 percent escalation rate.

2.3 HYBRID SOLAR THERMAL

The hybrid solar thermal plant considered for the system integration studies consisted of an existing oil-fired, steam generating unit retrofitted with a solar thermal steam supply capable of supplying steam to the turbine generator in parallel with the existing oil-fired boiler. The useful life of the oil-fired unit was extended by conversion to a hybrid unit, and, for this reason, was assigned full capacity replacement credit.

The break-even investment in 1985 dollars per kilowatt is repeated from Table 2.1-1 for the two utilities studied.

	Retrofit Hybrid Break-Even Investment ($/kW 1985)
PSNM	1,160
SRP	770

The effect of fuel escalation rate on the value of hybrid to SRP is shown on Figure 2.2-5. As this figure shows, the value of hybrid is less sensitive to fuel escalation than solar thermal or photovoltaic units. This results from the fact that a larger part of the value of hybrid is attributable to capacity credit which does not change with changes in fuel cost.

2.4 PHOTOVOLTAIC SYSTEMS

The photovoltaic plant with no storage facilities analyzed in this study is comparable in value to a solar thermal plant with no storage. The solar thermal plant exhibited a higher capacity replacement and fuel value due to its two axis tracking, but these advantages were more than offset by the lower O&M cost of the nontracking photovoltaic plant.

The break-even investment for photovoltaic systems in the utilities studied is:

	$/kW (1985)
SRP	1,380
SCE	1,020
APS	490

Figure 2.4-1 shows graphically the relative value of photovoltaic plants to the three utilities studied and the relative importance of capacity credit, fuel replacement credit, and O&M penalty. There is little O&M penalty associated with photovoltaic units and also little capacity credit for SCE and SRP. Figure 2.4-2 shows the effect of different fuel escalation rates on the value of photovoltaic systems. The break-even investment for photovoltaic generation is more sensitive to fuel escalation than is the break-even investment for solar thermal plants.

Photovoltaic units with no storage have less capacity credit than solar thermal units with 200 or 600 MWh storage, and, as a result, replace less coal fired capacity in the generation expansion plans. For this reason, oil constitutes a higher percentage of the fuel replaced by photovoltaic units.

The average cost of fuel replaced by photovoltaic systems is about 125 mills/kWh for both SRP and SCE. This is about 20 percent higher than the cost of fuel replaced by solar thermal units. This feature partly compensates for the low equivalent capacity value of photovoltaic systems.

The fuel replacement for APS has an average cost of only 44 mills/kWh which accounts for its relatively low fuel credit and low overall break-even investment.

2.5 WIND ENERGY SYSTEMS

The wind energy systems show the least value of the technologies tested, but the dollar per kilowatt break-even investment for wind machines is based on the maximum rating of the unit, while the break-even investment for the other technologies is based on the rated value of the units, which is only about 80 percent of their maximum output. As a result, the break-even investment value of wind machines is understated when compared to solar thermal and photovoltaic units. Also, these results would be different for specific site data or wind machine designs that produced a higher capacity factor. As shown in Table 6.6-1 and Figure 2.5-1, the capacity replacement value is very low and the fuel savings are offset, to a considerable extent, by O&M penalties. The small size of these units contributes to a high O&M cost which ranges from \$53-\$82/kW/year. The effect of fuel escalation on break-even investment for wind energy systems for privately financed utilities is shown in Figure 2.5-2. A high fuel replacement cost, such as that exhibited by SCE and SRP combined with sites that produce high capacity factors (40 percent or higher), will be required to raise the value of wind energy systems to as high as \$1,000/kW.

2.6 RELATIVE VALUE TO EACH UTILITY

The relative value of the solar technologies to each utility studied is shown in Figures 2.6-1 through 2.6-6. In general, solar thermal has more value than wind or photovoltaic. For SCE (Figure 2.6-4) it can be seen that solar thermal with no storage is about breaking even with photovoltaic with no storage.

2.7 HYDROELECTRIC STORAGE

There is no difference in the capacity value of solar generation when installed on utility systems with or without run-of-the-river hydroelectric generation with limited pondage. The systems of the Southwest have daily winter load shapes that might benefit from the right combination of solar and limited pondage hydroelectric, but these advantages are offset by summer load shapes in which the daily peak loads correspond more closely with peak solar output. In effect, solar and hydroelectric compete for peaking service.

2.8 UTILITY SYSTEM LOAD GROWTH

The system load growth rates projected for this study varied from a 2.9 to 7.2 percent average compound annual rate from 1985-2000. Rates different from those projected will not affect the results to any great degree but certain trends are worth noting.

Load growth rates lower than those projected will tend to increase the fuel replacement value by reducing the rate at which new, more efficient capacity is added. This trend would increase the relative value of photovoltaic units to solar thermal plants, and increase the break-even investment of all solar capacity.

2.9 EFFECT OF USER INSTALLED SOLAR HEATING AND COOLING AND LOAD MANAGEMENT

The degree to which daily load shapes differ from those used in this study will have an effect on the break-even investment. When the load was adjusted to lower the peak but maintain the energy, the capacity value of solar thermal units was reduced. The daily peak load was lowered 10 percent, causing a 14 percent reduction in both the capacity value and the break-even investment.

Those solar technologies that are useful primarily as fuel savers, such as photovoltaic and wind, are relatively immune to the effects of changing load shapes.

TABLE 2.1-1

SOLAR BREAK-EVEN INVESTMENT, $/kW
(1985 DOLLARS)

	PSNM	SRP	ELP	SCE	PSC	APS
Solar Thermal						
600 MWh storage		2,270	1,140	1,780	1,260	970
200 MWh storage	1,110	1,580	880	1,320	930	720
No storage				980		
Photovoltaic						
No storage		1,380		1,020		490
Wind						
No storage			30	510	410	
10 MWh storage				590		
Retrofit Hybrid						
No storage	1,160	770				

SOUTHWEST

TABLE 2.1-2

SYSTEM CHARACTERISTICS

Utility	Replacement Fuel Value, mills/kWh 1985	2000	Escalation, %	Conventional Capacity Investment 1985 $/kW	Fixed Charge Rate, %
PSNM	18	68	7.0	800	14.61
SRP	49	106	5.3	607	11.88
ELP	10	27	7.2	1,086	19.62
SCE	41	108	6.7	672	19.62
PSC	17	53	8.0	936	19.62
APS	21	43	4.9	866	19.62

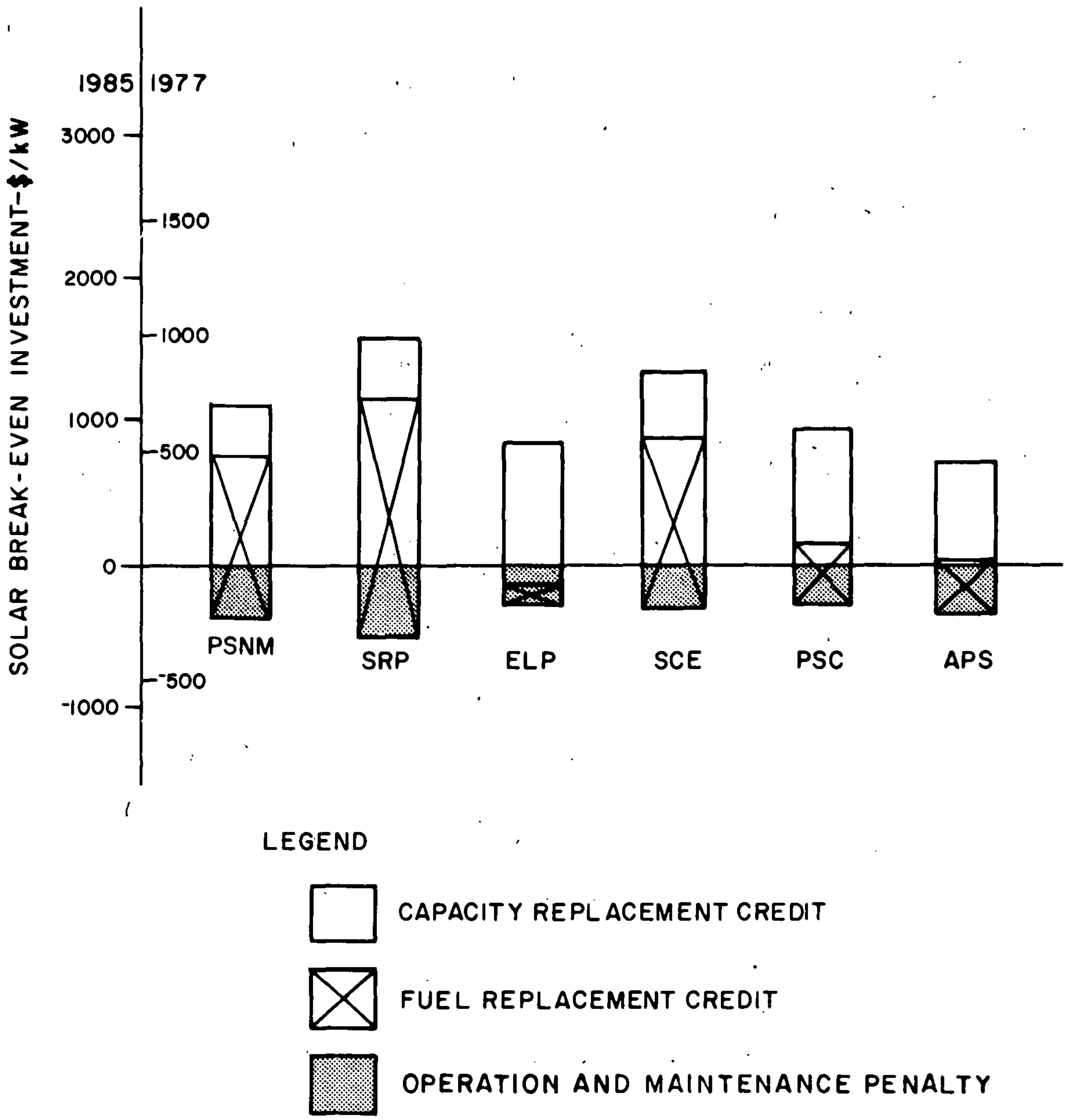


FIGURE 2.2-1
SOLAR BREAK-EVEN INVESTMENT
SOLAR THERMAL 200 MWh STORAGE

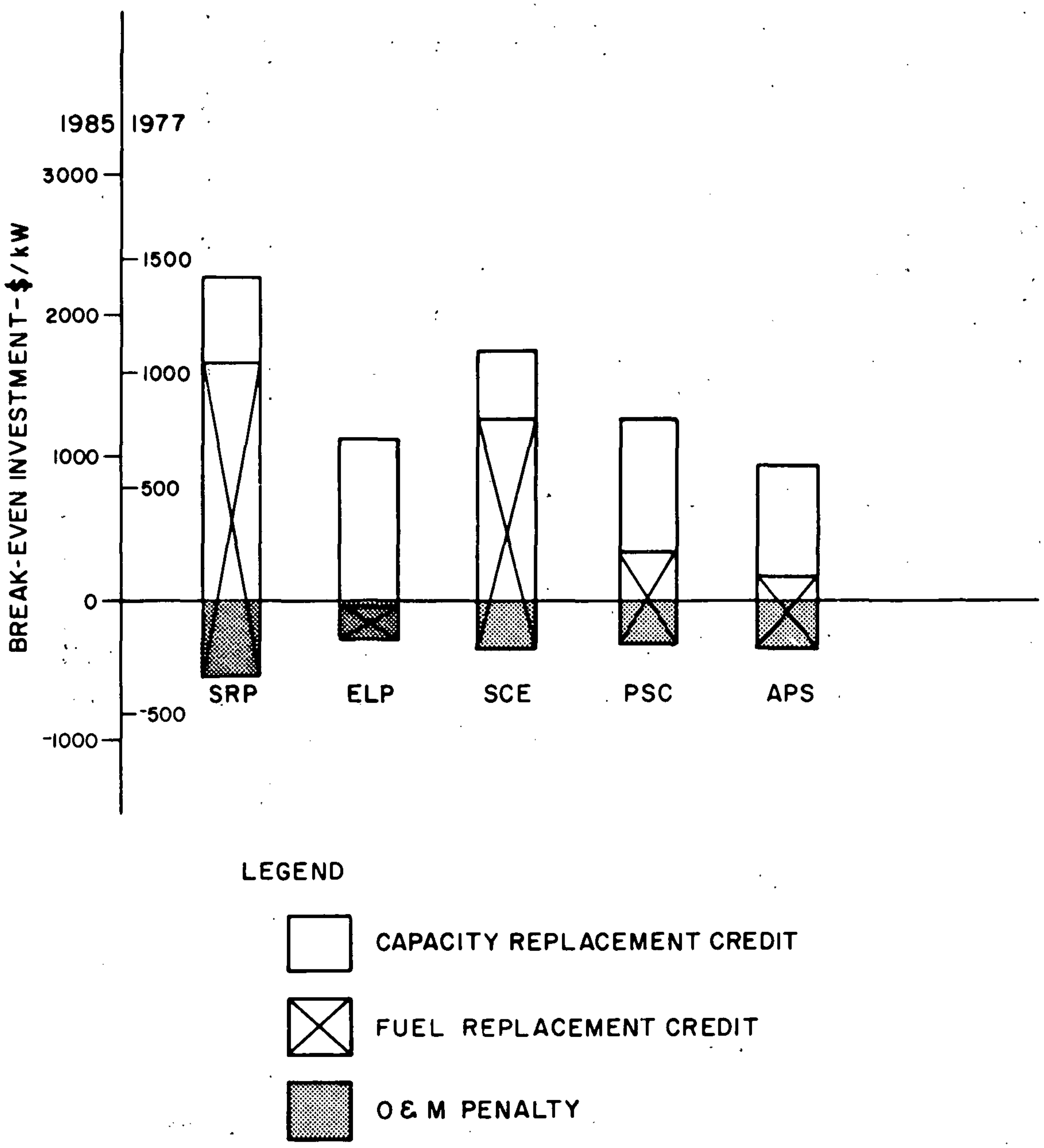


FIGURE 2.2-2
SOLAR BREAK-EVEN INVESTMENT
SOLAR THERMAL 600 MWh STORAGE

SOUTHWEST PROJECT

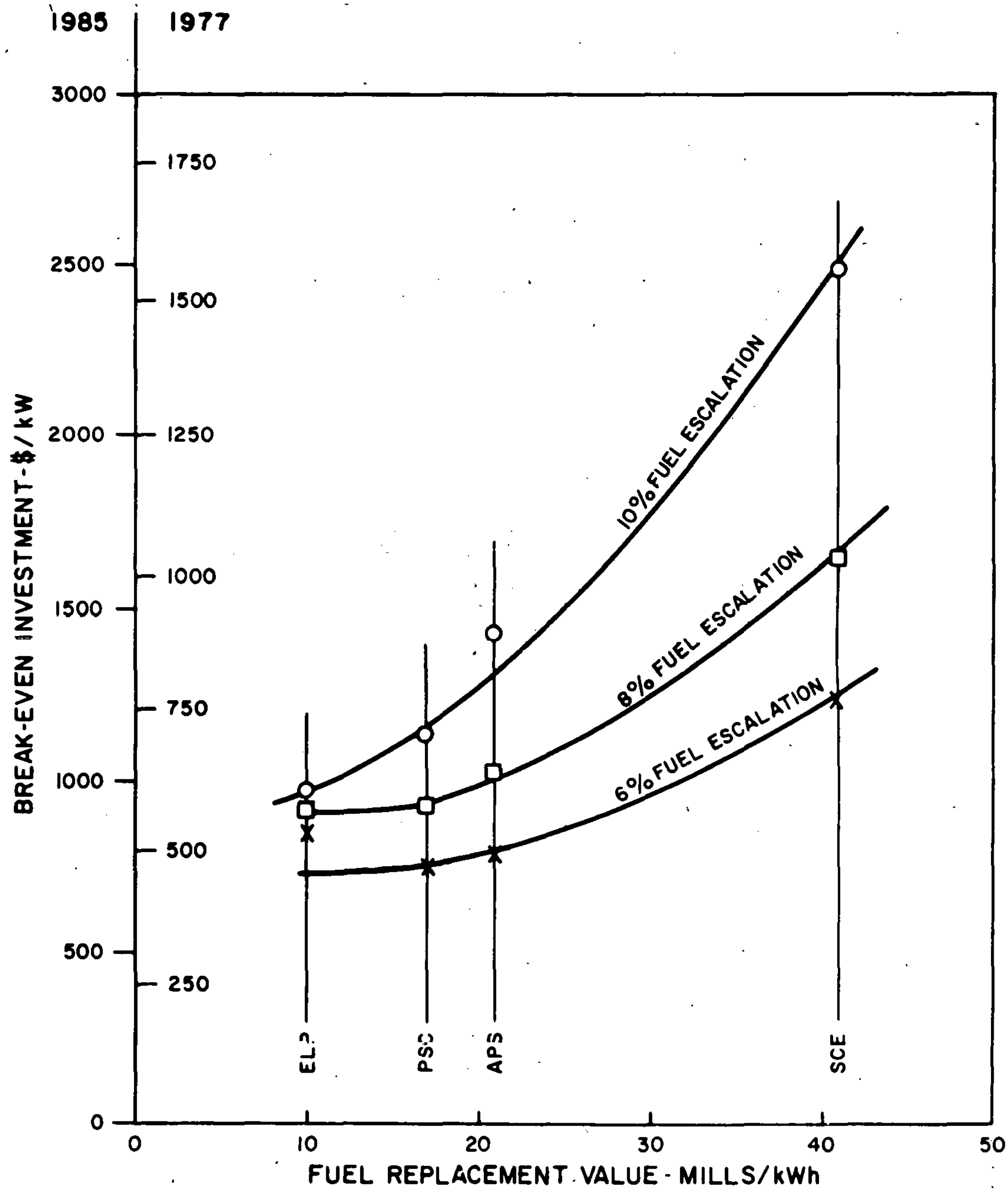


FIGURE 2.2-3
EFFECTS OF FUEL ESCALATION ON SOLAR BREAK-EVEN INVESTMENT
SOLAR THERMAL-200 MWh STORAGE
PRIVATELY FINANCED UTILITIES

SOUTHWEST PROJECT

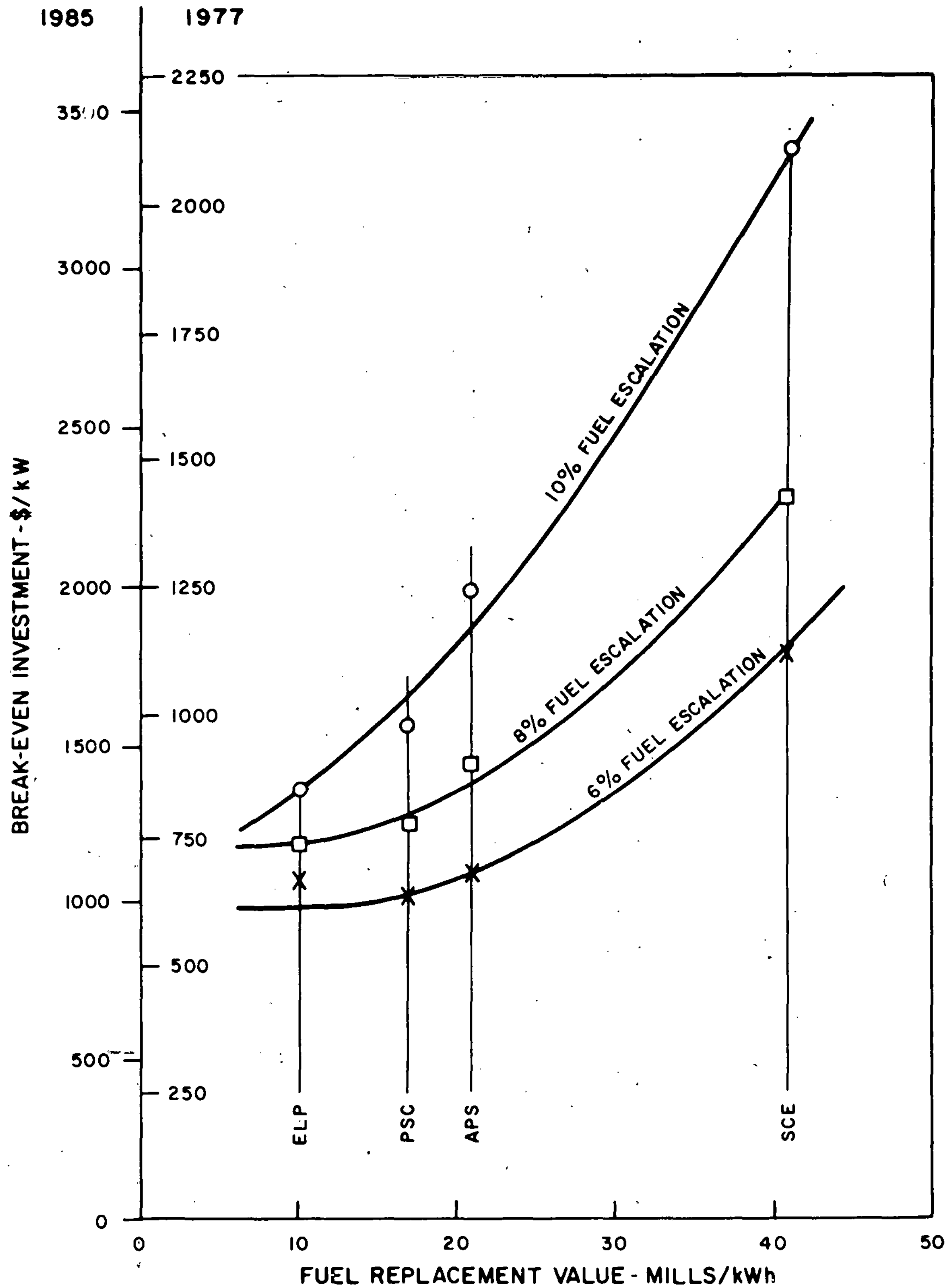


FIGURE 2.2-4
EFFECTS OF FUEL ESCALATION ON SOLAR BREAK-EVEN INVESTMENT
SOLAR THERMAL-600 MWh STORAGE
PRIVATELY FINANCED UTILITIES

SOUTHWEST PROJECT

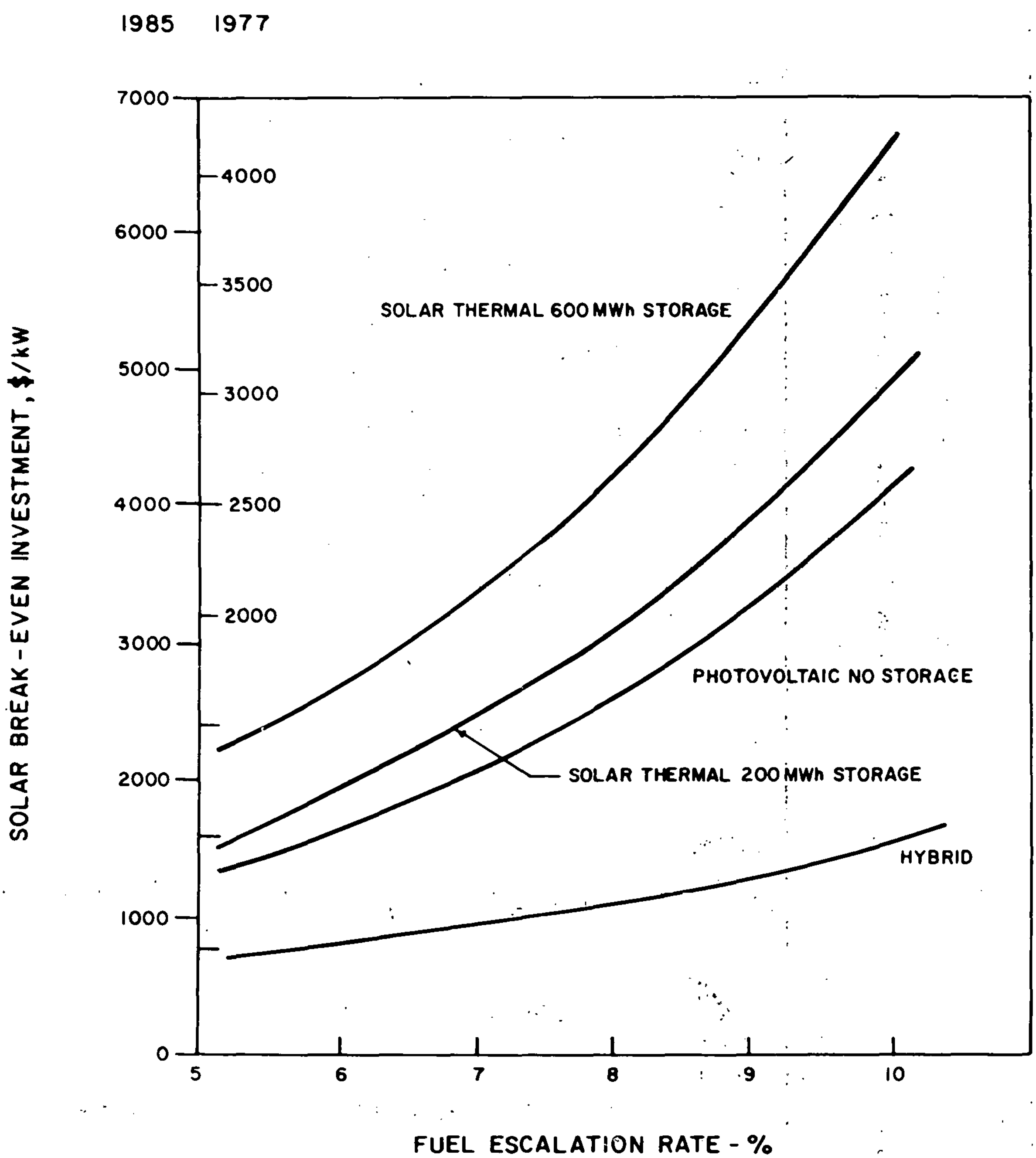


FIGURE 2.2-5
EFFECTS OF FUEL ESCALATION ON
SOLAR BREAK-EVEN INVESTMENT
SALT RIVER PROJECT -
PUBLICLY FINANCED UTILITY

SOUTHWEST PROJECT

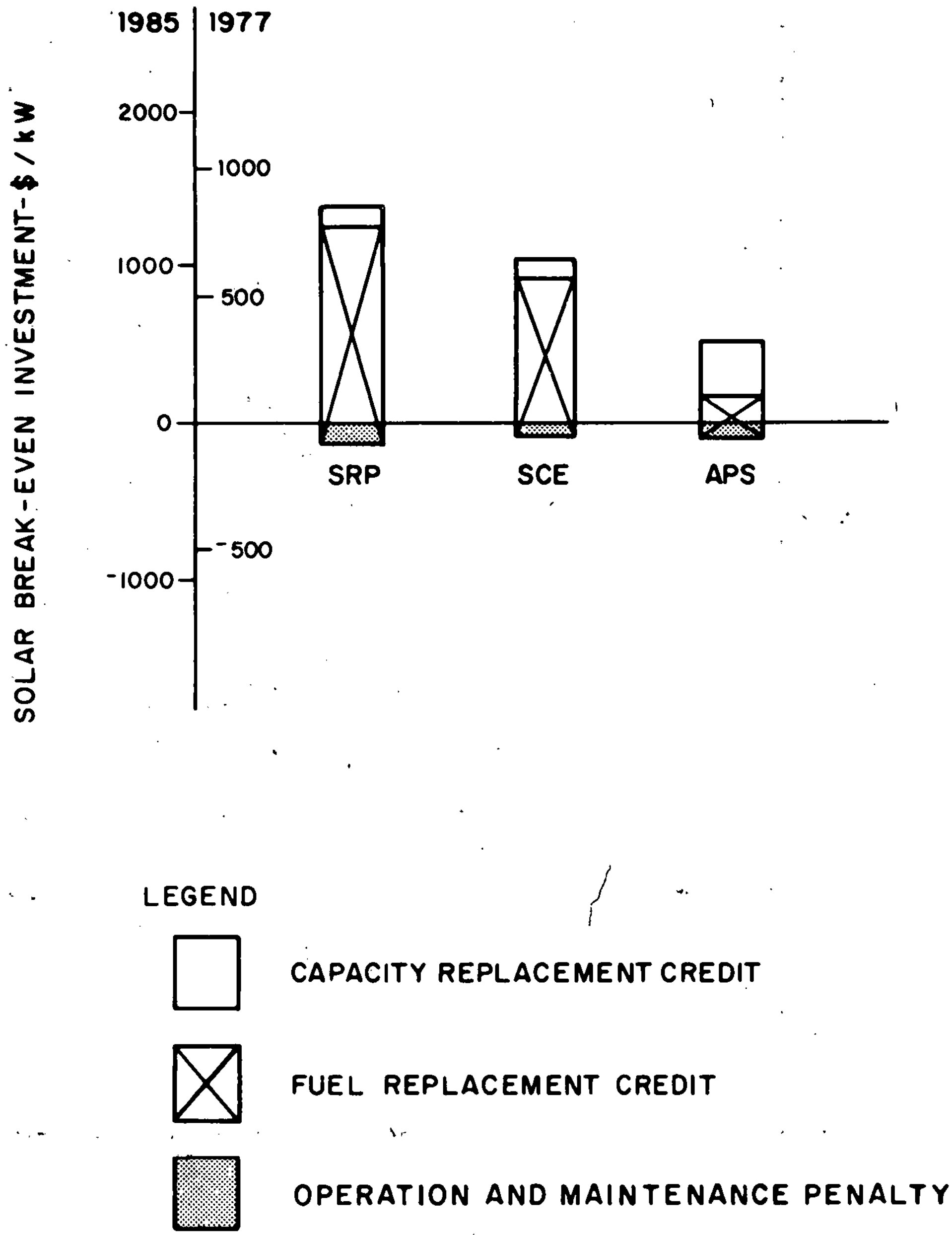


FIGURE 2.4-1
SOLAR BREAK-EVEN INVESTMENT
PHOTOVOLTAIC-NO STORAGE

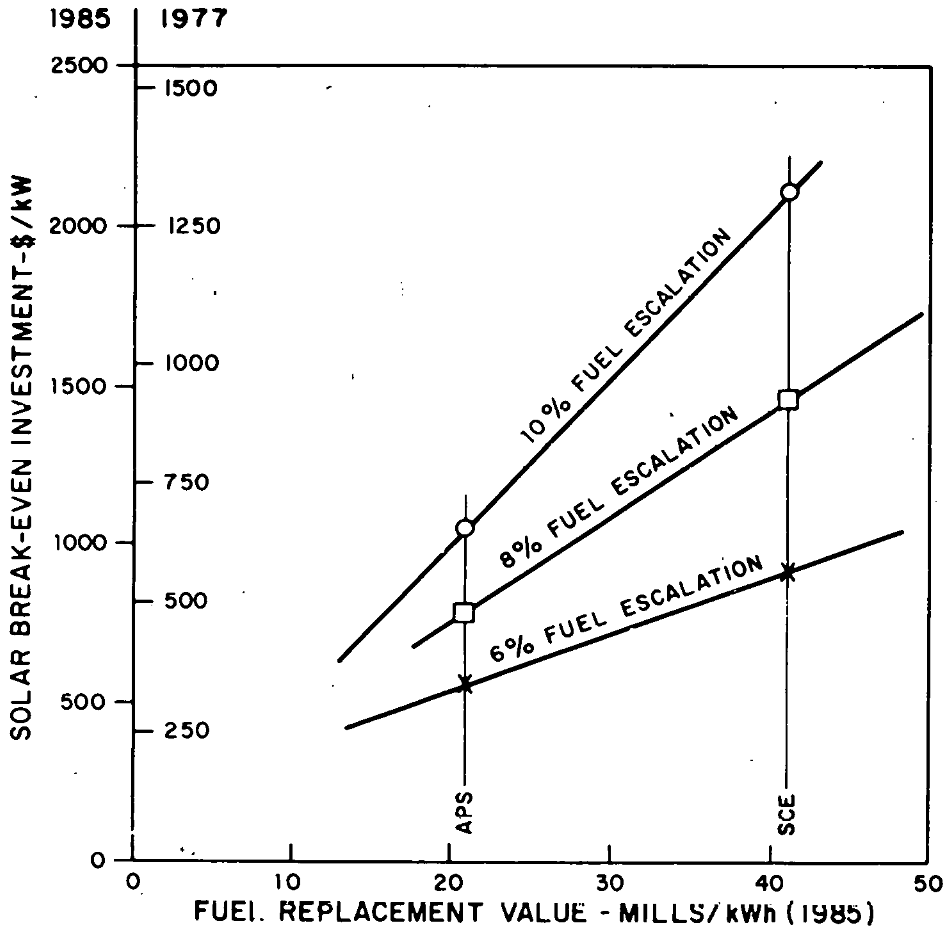


FIGURE 2.4-2

EFFECTS OF FUEL ESCALATION ON SOLAR BREAK-EVEN INVESTMENT

PHOTOVOLTAIC - NO STORAGE

PRIVATELY FINANCED UTILITIES

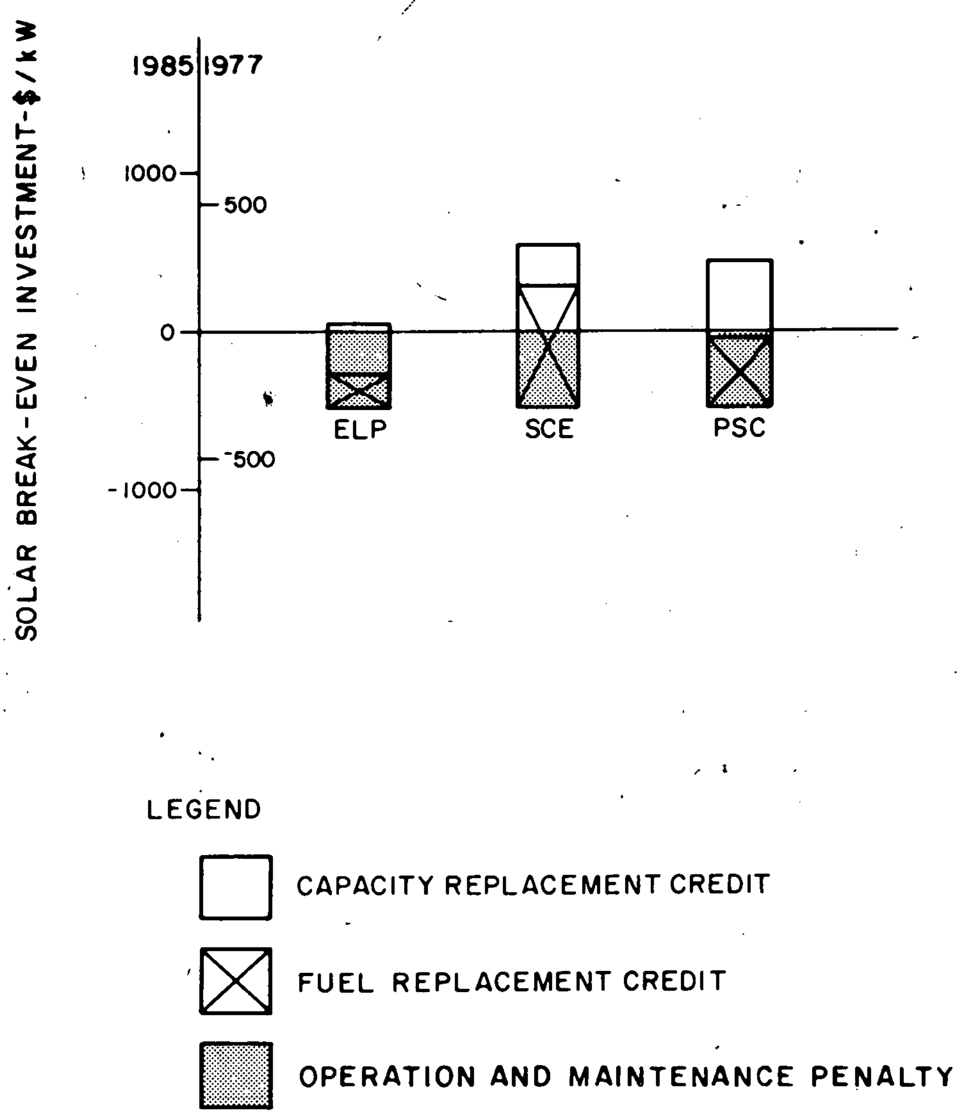


FIGURE 2.5-1
SOLAR BREAK-EVEN INVESTMENT
WIND-NO STORAGE

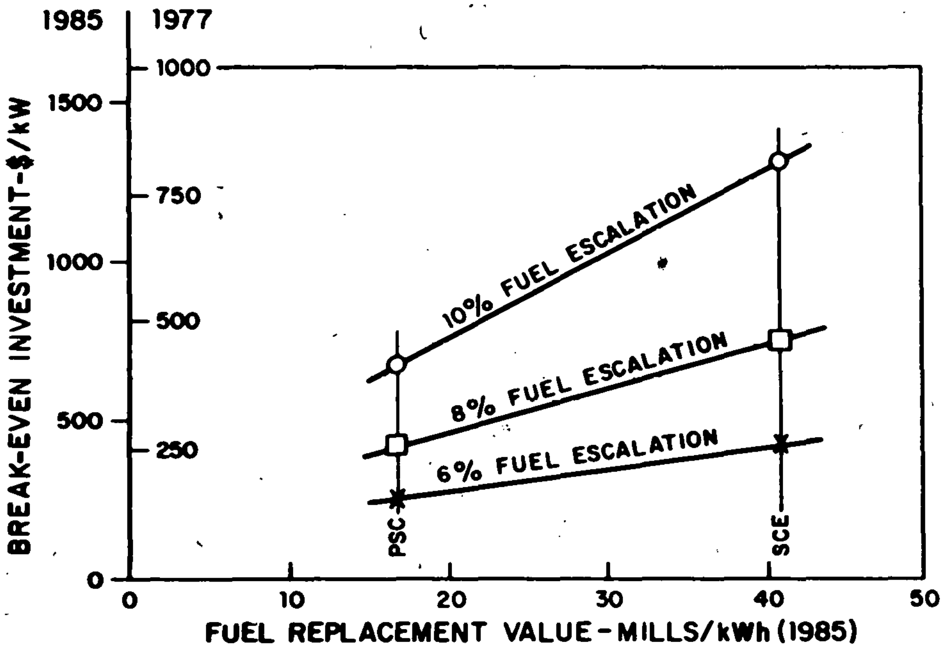


FIGURE 2.5-2

EFFECTS OF FUEL ESCALATION ON SOLAR BREAK-EVEN INVESTMENT

WIND ENERGY SYSTEMS

PRIVATELY FINANCED UTILITIES

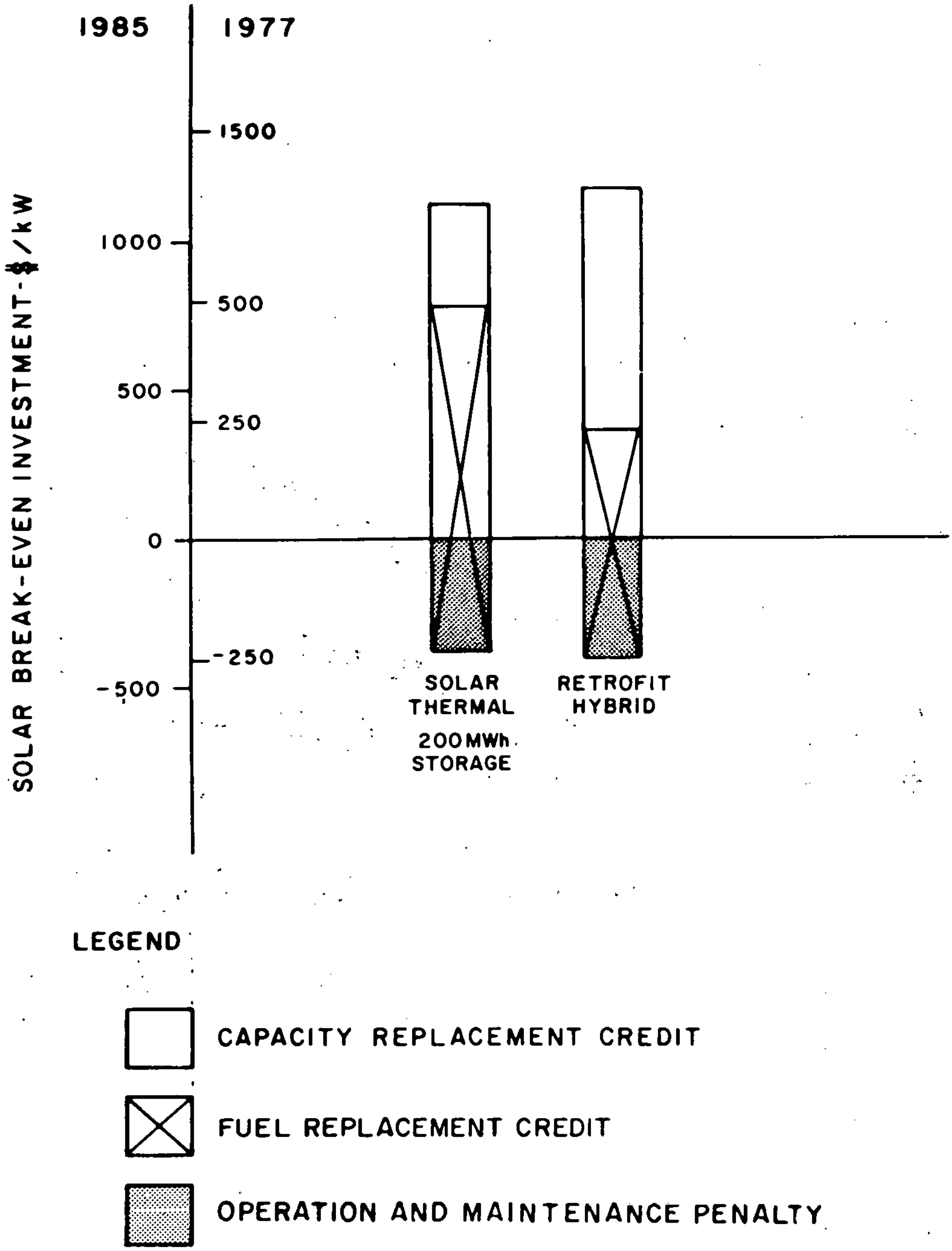


FIGURE 2.6-1
PUBLIC SERVICE COMPANY OF NEW MEXICO
RELATIVE VALUE OF SOLAR TECHNOLOGIES

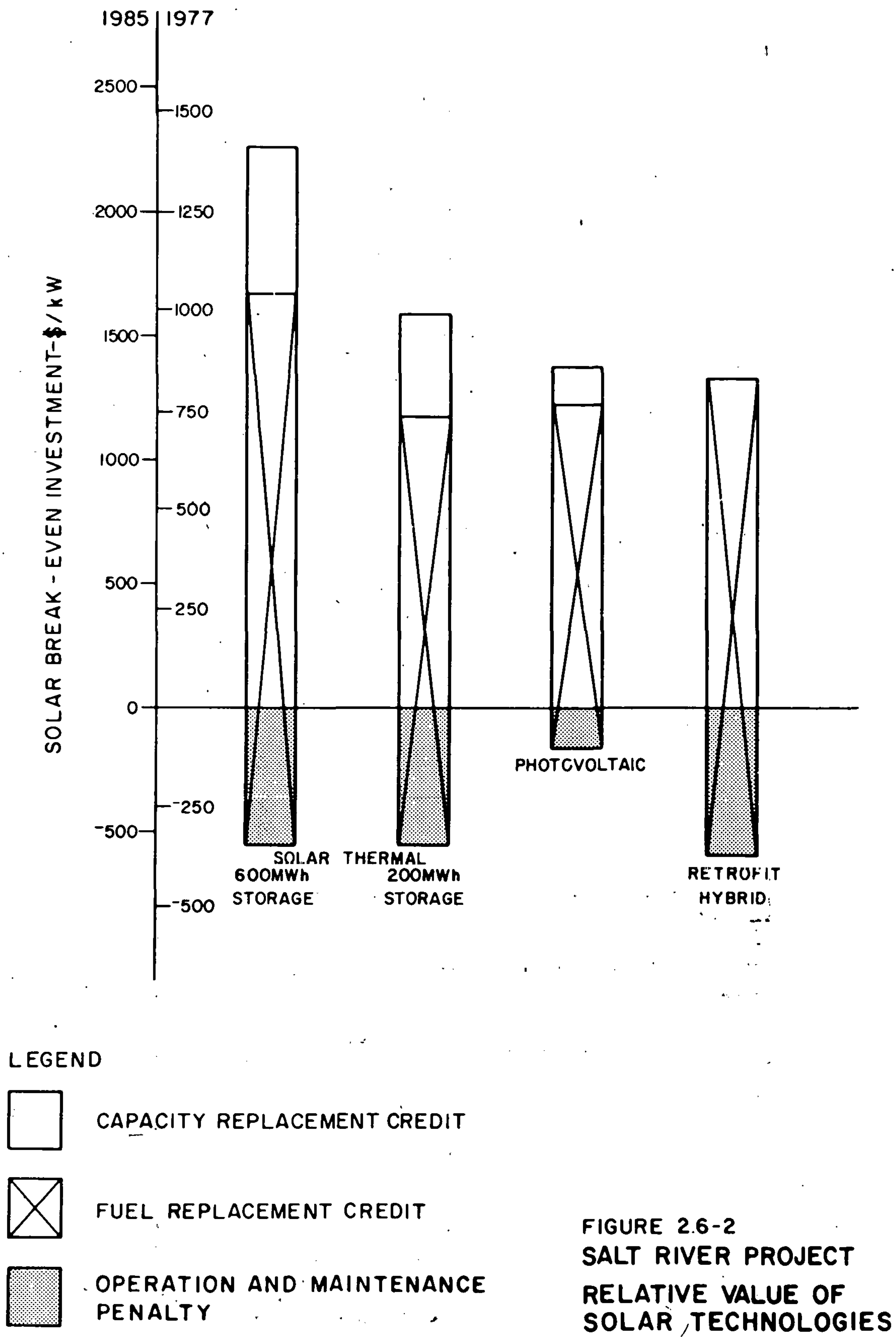


FIGURE 2.6-2
SALT RIVER PROJECT
RELATIVE VALUE OF SOLAR TECHNOLOGIES

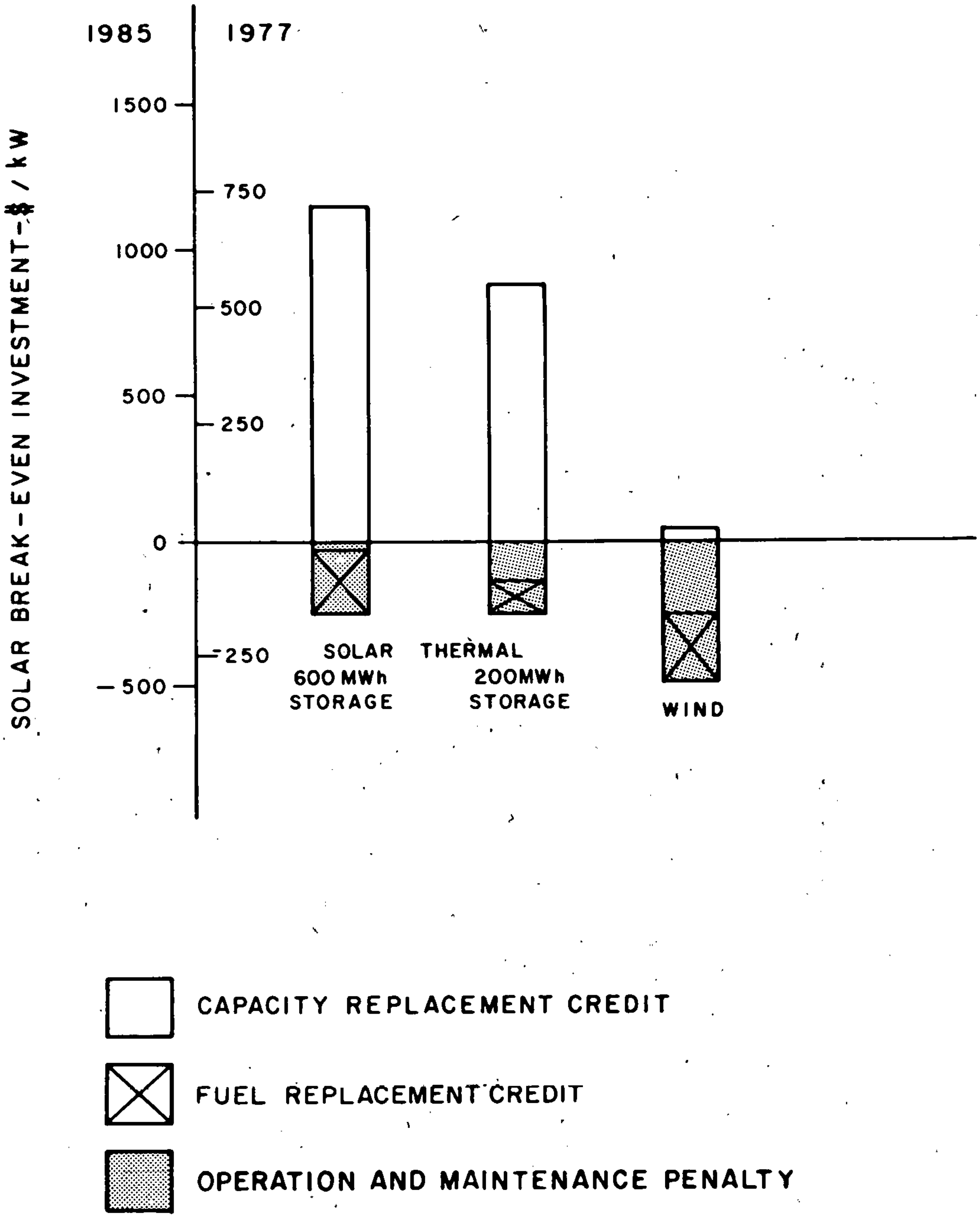


FIGURE 2.6-3
EL PASO ELECTRIC COMPANY
RELATIVE VALUE OF SOLAR TECHNOLOGIES

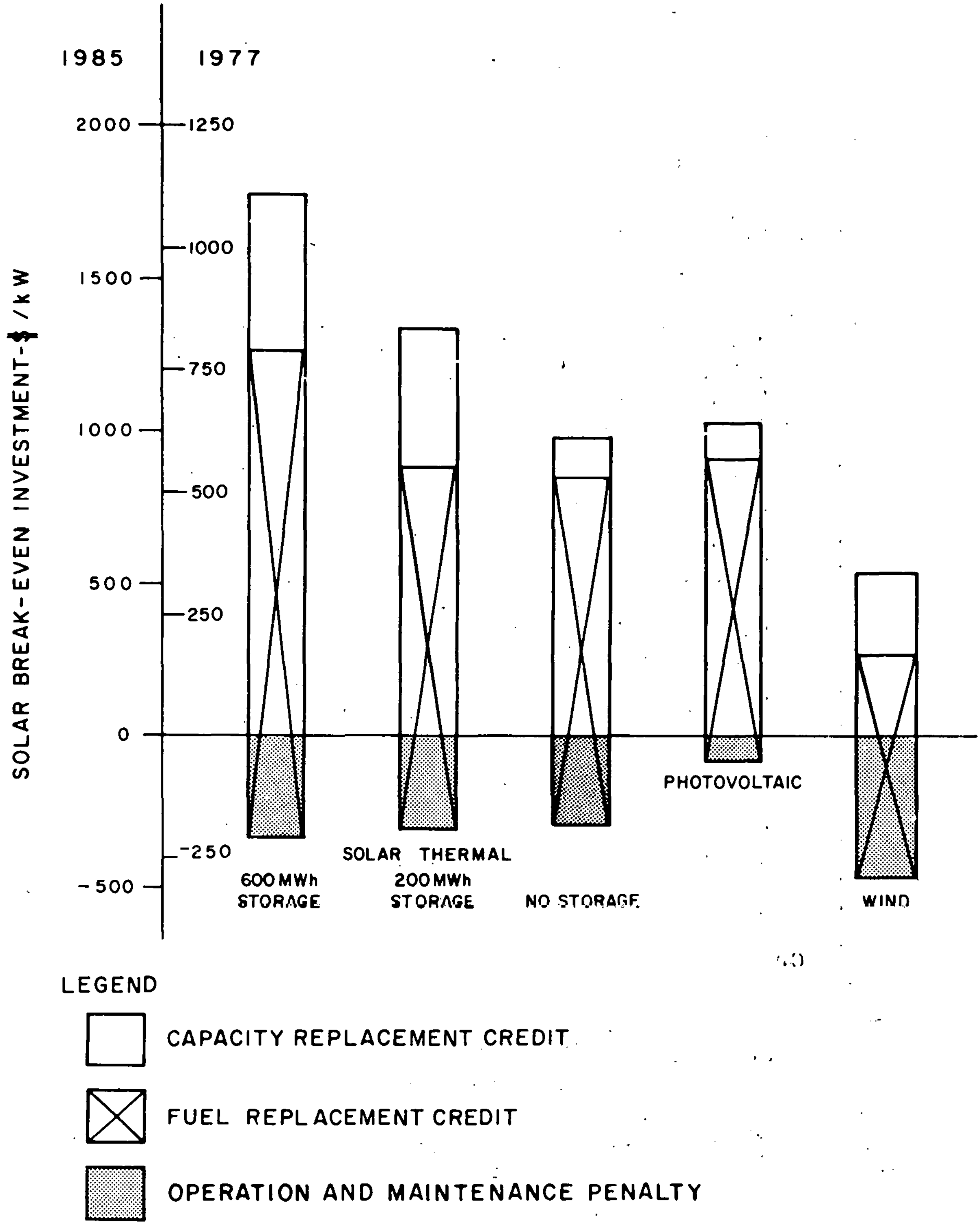
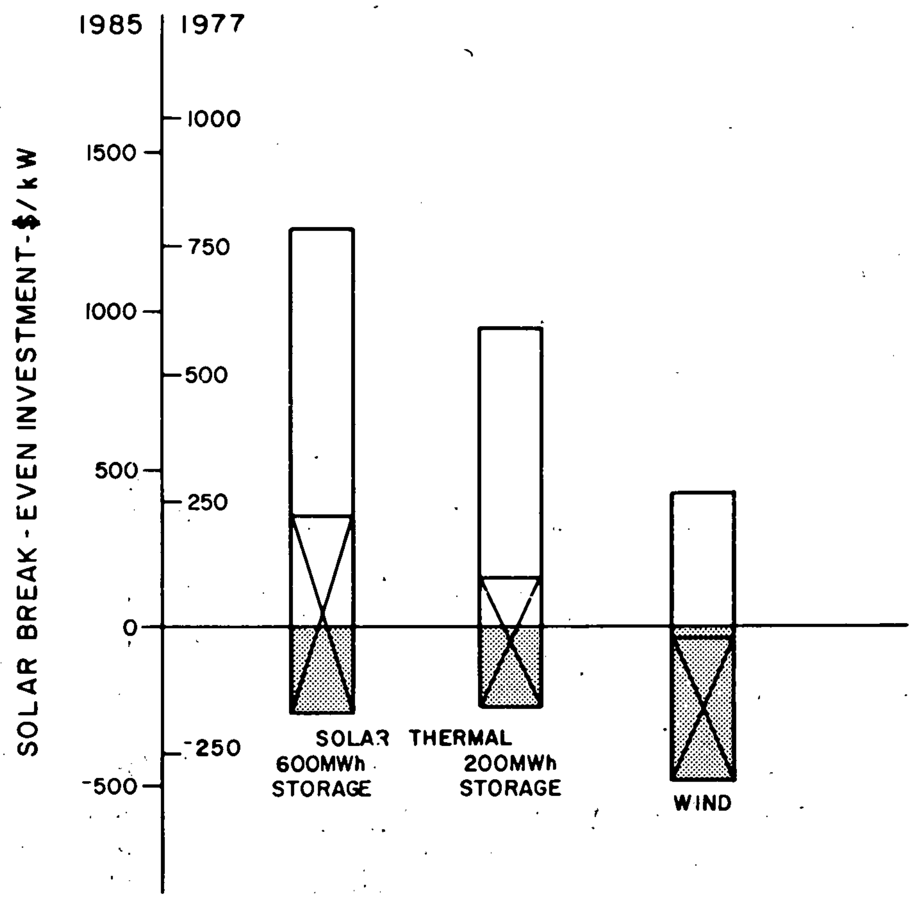


FIGURE 2.6-4
SOUTHERN CALIFORNIA EDISON COMPANY
RELATIVE VALUE OF SOLAR TECHNOLOGIES



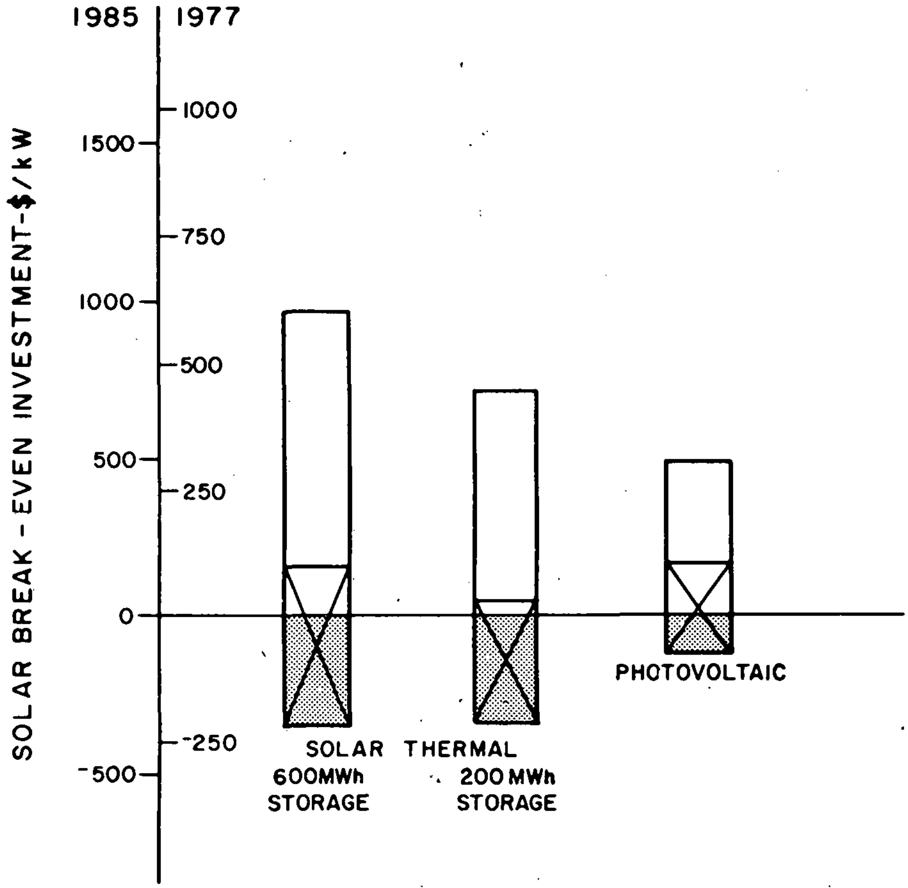
LEGEND

CAPACITY REPLACEMENT CREDIT

FUEL REPLACEMENT CREDIT

OPERATION AND MAINTENANCE PENALTY

FIGURE 2.6-5
PUBLIC SERVICE COMPANY OF COLORADO
RELATIVE VALUE OF SOLAR TECHNOLOGIES



LEGEND

CAPACITY REPLACEMENT CREDIT

FUEL REPLACEMENT CREDIT

OPERATION AND MAINTENANCE PENALTY

FIGURE 2.6-6
ARIZONA PUBLIC SERVICE COMPANY
RELATIVE VALUE OF
SOLAR TECHNOLOGIES

SOUTHWEST PROJECT

SECTION 3

GENERATION EXPANSION PLANS

3.1 INTRODUCTION

This section provides information on the utility expansion plans for the 1985–2000 period as they existed at the time of submittal. These plans do not include solar generation and form the bases for comparison with the plans developed in Section 6 that will include various amounts and types of solar generation. Although these base case plans were the actual plans when the utilities supplied the data for this project, it must be pointed out that "actual" system expansion plans are constantly changing as new information becomes available and the plans reported here reflect the conditions in existence only at a single specific point in time.

By including specific systems in the analyses, certain practical aspects of the problems of integrating solar generation into utility expansion plans are identified that would otherwise be missed in a hypothetical study. For instance, most of the utility expansion plans are not strictly optimum in terms of pure economics. One major trend for most utilities throughout the United States is a policy of installing both nuclear and coal-fired capacity to limit risks involved in dependence upon a single, primary fuel. In addition, shortages of capital, and regulatory restrictions which delay or prevent the installation of nuclear and coal-fired units tend to encourage the utilities to install more combustion turbine capacity than would otherwise be economical.

Care must be exercised when adjusting these plans to include solar generation and when interpreting the results, since any change may improve or degrade the plan economically regardless of the effect that solar generation may have on the system costs associated with the expansion plans.

3.2 ECONOMIC ANALYSIS OF EXPANSION PLANS

Utilities continually develop and update long range generation expansion plans. Each utility studied supplied current, base case generation expansion plans through the year 2000 for use in this study.

Once the base case expansion plans were established, it was necessary to determine the elements of expense over the study period on a consistent basis for all six utilities. These elements included fixed charges on investment, fuel costs, and O&M expenses. Thus, comparisons could be made between the base case plans and plans including solar generation and likewise among the various utilities.

The most complex part of this analysis is the fuel dispatch simulation used to determine the fuel cost component of annual expense. For this purpose, a proprietary computer program PROMOD III, developed and owned by Energy Management Associates (EMA) of Atlanta, Georgia, was used. EMA was retained to work with each of the six utilities to develop a 15-year fuel cost simulation. Each utility supplied detailed data on load shape and load forecast, unit heat rates, fuel costs, O&M costs, forced outage rates, maintenance schedule, etc, in PROMOD III format.

S&W-prepared plant investment estimates (Volume II - Section 6) were used to determine the investment required to construct the new capacity identified in each utility's expansion plans.

The annual O&M costs for conventional capacity were estimated to be 1 percent of the capital investment. Table 3.2-1 is a summary of the fuels consumed by each utility in the year 2000. Table 3.2-2 indicates the types of generation which will exist on each utility system in the year 2000, according to their expansion plans. Capacity added during the study period is shown separately.

Tables 3.2-3 through 3.2-8 are summaries of the present worth of revenue requirements (PWRR) calculated for each of the six utilities. The annual fuel costs were taken directly from the PROMOD III fuel cost simulations, as were system peak load, capacity, and generation in gigawatt - hours (GWh). A levelized fixed charge rate of 19.62 percent was used for SCE, APS, ELP, and PSC as being representative of utility fixed charge rates. PSNM chose to supply actual fixed charge rate data for its system since PSNM has considerably lower property taxes than that used for the representative fixed charge rate. The PSNM fixed charge rate also reflects a 10 percent investment tax credit rather than the 4 percent used in the representative rate. These changes, plus other minor modifications, resulted in a fixed charge rate of 14.61 percent for PSNM. SRP, the only publicly financed utility of the group, utilizes a fixed charge rate of 11.88 percent.

In the PROMOD III simulations, each fuel type was escalated separately and, in general, differently by each utility. The fuel escalation rates used by each utility are summarized in Table 3.2-1.

An analysis that ends at the year 2000 would neglect fuel cost escalation beyond the year 2000 and would not properly credit prior installed solar generation for future savings in fuel. An "end effects" procedure commonly used in PWRR analyses was used to take account of effects after the year 2000. That is, the system load and generation were considered to be fixed at the year 2000 level for the period 2000-2020, and the PWRR for these additional years was added to the 1985-2000 PWRRs. During the "end effects period" fuel and O&M costs were escalated at the appropriate rates.

TABLE 3.2-1

BASE CASE FUEL DISPATCH - YEAR 2000

Utility	Coal	Oil	Nuclear	Total
Generation (percent)				
PSNM	32.0	-	68.0	100
SRP	58.6	19.6	21.8	100
ELP	53.3	11.1	35.6	100
SCE	20.0	41.0	39.0	100
PSC	62.0	1.0	37.0	100
APS	59.0	4.0	37.0	100
Fuel Cost, mills/kWh				
PSNM	46.0	-	20.0	28.3
SRP	36.3	184.5	13.0	58.7
ELP	45.9	85.9	12.5	38.5
SCE	33.7	127.9	25.5	69.1
PSC	52.1	167.7	10.4	37.8
APS	26.4	83.2	15.9	24.8
Fuel Escalation Rate (percent)				
PSNM	7.0	-	6.0	
SRP	4.0	6.0	4.1	
ELP	7.0	5.0	6.5	
SCE	5.0	7.0	6.5	
PSC	8.0	8.0	8.0	
APS	5.0	5.0	4.0	

SOUTHWEST

TABLE 3.2-2

BASE CASE GENERATING CAPACITY
(MWe)

		PSNM	SRP	ELP	SCE	PSC	APS	Total
Nuclear								
Existing	1985	260	572	400	2,450	330	720	4,732
Added		2,710	286	300	5,007	2,200	1,360	11,863
Total	2000	2,970	858	700	7,457	2,530	2,080	16,595
Coal								
Existing	1985	1,205	1,784	176	1,630	3,263	2,414	10,472
Added		236	420	1,013	3,400	2,600	1,800	9,469
Total	2000	1,440	2,204	1,189	5,030	5,863	4,214	19,941
Oil								
Existing	1985	301	1,285	922	11,619	278	1,564	15,969
Added		0	540	0	4,032	800	600	5,972
Total	2000	0	1,825	886	15,651	1,078	2,164	21,941
Pumped Storage								
Existing	1985	0	0	0	0	268	0	268
Added		850	500	200	0	400	0	1,950
Total	2000	850	500	200	0	668	0	2,218
Hydroelectric								
Existing	1985	0	232	0	1,501	39	5	1,777
Added		0	0	0	140	0	0	140
Total	2000	0	232	0	1,641	39	5	1,917
Geothermal								
Existing	1985	0	0	0	0	0	0	0
Added		0	0	0	1,100	0	0	1,100
Total	2000	0	0	0	1,100	0	0	1,100
Total Capacity								
	1985	1,766	3,873	1,498	17,200	4,178	4,703	33,218
Added		3,796	1,746	1,513	13,679	6,000	3,760	30,494
Retired		-301	-0	-26	-1,545	-0	-0	-1,872
	2000	5,261	5,619	2,985	29,334	10,178	8,463	61,840

ECONOMIC ANALYSIS
PUBLIC SERVICE OF NEW MEXICO
PHC ST2 - $980 PER KW - SOUTHWEST PROJECT

TABLE 3.2-3
PUBLIC SERVICE OF NEW MEXICO
15 YEAR EXPANSION PLAN
BASE CASE

STUDY NO 40
STUDY PERIOD 1985 TO 2000
END EFFECTS PERIOD 20 YEARS

INFLATION RATES -
INVESTMENT = 0.0600
OPERATION & MAINT = 0.0600
FUEL (SEE TABLE 3.2-1)

DISCOUNT RATE = 0.1100

LEVELIZED FIXED CHARGES

CONVENTIONAL	NUCLEAR	PEAKING	TRANSMISSION
0.1461	0.1461	0.1461	0.0

ALL COSTS IN THOUSANDS OF DOLLARS

						-------NEW	CAPACITY---------		
YEAR	MW PEAK LD	MW CAPACITY	MW RES	PC RES	TOTAL GWH	MW	INVEST	OPER EXP	TRANS INVEST
1985	1545.	2096.	551.	35.66	9565.	300.	182910.	3119.	0.
1986	1635.	2226.	591.	36.15	10157.	130.	157676.	2207.	0.
1987	1720.	2216.	496.	28.84	10694.	0.	47729.	506.	0.
1988	1831.	2452.	621.	33.92	11393.	236.	163840.	1737.	0.
1989	1946.	2416.	470.	24.15	12085.	0.	125762.	1333.	0.
1990	2080.	2706.	626.	30.10	12881.	290.	252549.	2677.	0.
1991	2245.	2706.	461.	20.53	13939.	0.	193854.	2055.	0.
1992	2422.	2996.	574.	23.70	15051.	290.	198533.	2104.	0.
1993	2614.	3236.	622.	23.79	16293.	300.	374253.	3967.	0.
1994	2818.	3636.	818.	29.03	17530.	400.	477983.	5066.	0.
1995	3041.	3636.	595.	19.57	18958.	0.	236175.	2504.	0.
1996	3280.	4036.	756.	23.05	20480.	400.	494130.	5238.	0.
1997	3538.	4186.	648.	18.32	22046.	250.	612699.	6495.	0.
1998	3822.	4566.	744.	19.47	23841.	400.	567608.	6016.	0.
1999	4129.	4891.	762.	18.45	25769.	400.	709915.	7525.	0.
2000	4459.	5291.	832.	18.66	27856.	400.	1391614.	14752.	0.

COST SUMMARY

YEAR	FUEL COST	OPERATING EXPENSE	PROPERTY TAX	FIXED CHARGES	CUMULATIVE INVESTMENT	ANNUAL COST	ANNUAL COST PRES. WORTH	CUMULATIVE ANNUAL COST	CUM ANN COST PRES. WORTH
1985	168519.	3119.	0.	26723.	182910.	198361.	178703.	198361.	178703.
1986	180626.	5592.	0.	49760.	340586.	235978.	191525.	434338.	370228.
1987	201466.	6434.	0.	56733.	388315.	264633.	193498.	698971.	563726.
1988	232705.	8557.	0.	80670.	552155.	321931.	212066.	1020902.	775792.
1989	263942.	10403.	0.	99044.	677917.	373389.	221588.	1394291.	997380.
1990	289041.	13704.	0.	135941.	930466.	438686.	234540.	1832977.	1231919.
1991	345314.	16582.	0.	164263.	1124319.	526159.	253429.	2359136.	1485348.
1992	382712.	19681.	0.	193269.	1322852.	595661.	258474.	2954797.	1743822.
1993	436040.	24828.	0.	247947.	1697106.	708815.	277094.	3663612.	2020916.
1994	477478.	31384.	0.	317780.	2175089.	826642.	291131.	4490252.	2312047.
1995	550015.	35771.	0.	352285.	2411263.	938071.	297635.	5428322.	2609682.
1996	609608.	43155.	0.	424478.	2905393.	1077240.	307920.	6505562.	2917602.
1997	740292.	52239.	0.	513993.	3518092.	1306523.	336449.	7812083.	3254051.
1998	803030.	61389.	0.	596920.	4085700.	1461338.	339024.	9273421.	3593074.
1999	892953.	72598.	0.	700638.	4795613.	1666108.	340242.	10939609.	3941316.
2000	946832.	91705.	0.	903953.	6187225.	1942490.	365757.	12882096.	4307070.
TERM	13171150.	1170779.		7198466.		21540384.	4055899.	34422480.	8362967.

END EFFECT FINAL YEAR FUEL ESCALATION
1.0000 PU. ESCALATED AT 0.0700 PU.

ECONOMIC ANALYSIS
SALT RIVER PROJECT
PWC BASE CASE - SOUTHWEST PROJECT
STUDY NO 50
STUDY PERIOD 1985 TO 2000
END EFFECTS PERIOD 20 YEARS

TABLE 3.2-4
SALT RIVER PROJECT
15 YEAR EXPANSION PLAN
BASE CASE

INFLATION RATES -
INVESTMENT = 0.0600
OPERATION & MAINT = 0.0600
FUEL (SEE TABLE 3.2-1)

DISCOUNT RATE = 0.0835

LEVELIZED FIXED CHARGES

CONVENTIONAL	NUCLEAR	PEAKING	TRANSMISSION
0.1188	0.1188	0.1188	0.0

ALL COSTS IN THOUSANDS OF DOLLARS

YEAR	MW PEAK LD	MW CAPACITY	MW RES	PC RES	TOTAL GWH	NEW CAPACITY MW	NEW CAPACITY INVEST	NEW CAPACITY OPER EXP	TRANS INVEST
1985	2836.	3876.	1040.	36.67	15845.	0.	0.	0.	0.
1986	2963.	4229.	1266.	42.73	16678.	286.	195432.	2072.	0.
1987	3080.	4229.	1149.	37.31	17641.	0.	150011.	1590.	0.
1988	3185.	4229.	1044.	32.78	18454.	0.	0.	0.	0.
1989	3280.	4229.	949.	28.93	19223.	0.	0.	0.	0.
1990	3386.	4349.	963.	28.44	20076.	120.	29421.	312.	0.
1991	3474.	4599.	1125.	32.38	20837.	0.	22583.	239.	0.
1992	3572.	4599.	1027.	28.75	21666.	0.	0.	0.	0.
1993	3667.	4719.	1052.	28.69	22440.	120.	35040.	372.	0.
1994	3769.	4839.	1070.	28.39	23018.	120.	64039.	679.	0.
1995	3870.	5089.	1219.	31.50	23634.	0.	28510.	302.	0.
1996	3963.	5089.	1126.	28.41	24217.	0.	0.	0.	0.
1997	4061.	5439.	1378.	33.93	24824.	350.	524324.	5558.	0.
1998	4158.	5439.	1281.	30.81	25411.	0.	273745.	2901.	0.
1999	4254.	5499.	1245.	29.27	25988.	60.	24922.	264.	0.
2000	4350.	5619.	1269.	29.17	26535.	120.	109969.	1166.	0.

COST SUMMARY

YEAR	FUEL COST	OPERATING EXPENSE	PROPERTY TAX	FIXED CHARGES	CUMULATIVE INVESTMENT	ANNUAL COST	ANNUAL COST PRES. WORTH	CUMULATIVE ANNUAL COST	CUM ANN COST PRES. WORTH
1985	208155.	0.	0.	0.	0.	208155.	192114.	208155.	192114.
1986	214287.	2072.	0.	23217.	195432.	239576.	204073.	447731.	396187.
1987	245491.	3786.	0.	41039.	345443.	290316.	228236.	738047.	624422.
1988	291497.	4013.	0.	41039.	345443.	336549.	244193.	1074595.	868615.
1989	354762.	4254.	0.	41039.	345443.	400055.	267901.	1474650.	1136516.
1990	415420.	4822.	0.	44534.	374864.	464775.	287256.	1939425.	1423772.
1991	469604.	5350.	0.	47217.	397446.	522170.	297858.	2461595.	1721630.
1992	558656.	5671.	0.	47217.	397446.	611543.	321956.	3073138.	2043586.
1993	643124.	6383.	0.	51379.	432487.	700886.	340555.	3774024.	2384141.
1994	778161.	7444.	0.	58987.	496526.	844593.	378755.	4618616.	2762895.
1995	867024.	8193.	0.	62374.	525036.	937591.	388057.	5556207.	3150952.
1996	946648.	8685.	0.	62374.	525036.	1017706.	388755.	6573912.	3539707.
1997	964251.	14764.	0.	124664.	1049359.	1103678.	389105.	7677587.	3928812.
1998	1063706.	18550.	0.	157185.	1323105.	1239442.	403294.	8917028.	4332105.
1999	1149472.	19927.	0.	160146.	1348026.	1329545.	399272.	10246574.	4731375.
2000	1337254.	22289.	0.	173210.	1457995.	1532753.	424825.	11779325.	5156196.
TERM	18860640.	356934.		1657203.		20874784.	5785747.	32654096.	10941943.

END EFFECT FINAL YEAR FUEL ESCALATION
0.3400 PU. ESCALATED AT 0.0600 PU.
0.1500 PU. ESCALATED AT 0.0300 PU.
0.5100 PU. ESCALATED AT 0.0400 PU.

END OF DATA

TABLE 3.2-5
EL PASO ELECTRIC COMPANY
15 YEAR EXPANSION PLAN
BASE CASE

ECONOMIC ANALYSIS
EL PASO ELECTRIC COMPANY
PWC BASE CASE - SOUTHWEST PROJECT
STUDY NO 30
STUDY PERIOD 1985 TO 2000
END EFFECTS PERIOD 20 YEARS

INFLATION RATES -
INVESTMENT = 0.0600
OPERATION & MAINT = 0.0600
FUEL (SEE TABLE 3.2-1)

DISCOUNT RATE = 0.1200

LEVELIZED FIXED CHARGES

CONVENTIONAL	NUCLEAR	PEAKING	TRANSMISSION
0.1962	0.1962	0.1962	0.0

ALL COSTS IN THOUSANDS OF DOLLARS

YEAR	MW PEAK LD	MW CAPACITY	MW RES	PC RES	TOTAL GWH	NEW CAPACITY MW	NEW CAPACITY INVEST	NEW CAPACITY OPER EXP	TRANS INVEST
1985	1135.	1498.	363.	31.98	6118.	0.	0.	0.	0.
1986	1195.	1672.	477.	39.92	6452.	200.	95663.	1013.	0.
1987	1258.	1672.	414.	32.91	6810.	0.	73429.	779.	0.
1988	1325.	1793.	468.	35.32	7178.	121.	88522.	938.	0.
1989	1400.	1793.	393.	28.07	7568.	0.	67949.	720.	0.
1990	1475.	1914.	439.	29.76	7983.	121.	85631.	908.	0.
1991	1555.	1914.	359.	23.09	8416.	0.	65730.	696.	0.
1992	1638.	1985.	347.	21.18	8868.	71.	62290.	660.	0.
1993	1725.	2085.	360.	20.87	9392.	100.	90337.	958.	0.
1994	1816.	2285.	469.	25.83	9916.	200.	309361.	3279.	0.
1995	1910.	2285.	375.	19.63	10424.	0.	212407.	2251.	0.
1996	2008.	2485.	477.	23.75	10958.	200.	248826.	2636.	0.
1997	2110.	2585.	475.	22.51	11559.	100.	244680.	2594.	0.
1998	2216.	2785.	569.	25.68	12169.	200.	320788.	3400.	0.
1999	2326.	2785.	459.	19.73	12766.	0.	214602.	2274.	0.
2000	2440.	2985.	545.	22.34	13389.	200.	541615.	5741.	0.

COST SUMMARY

YEAR	FUEL COST	OPERATING EXPENSE	PROPERTY TAX	FIXED CHARGES	CUMULATIVE INVESTMENT	ANNUAL COST	ANNUAL COST PRES. WORTH	CUMULATIVE ANNUAL COST	CUM ANN COST PRES. WORTH
1985	138163.	0.	0.	0.	0.	138163.	123360.	138163.	123360.
1986	133564.	1013.	0.	18769.	95663.	153346.	122247.	291509.	245607.
1987	144324.	1853.	0.	33176.	169092.	179353.	127660.	470862.	373266.
1988	147537.	2902.	0.	50544.	257614.	200983.	127728.	671845.	500995.
1989	170714.	3797.	0.	63875.	325563.	238386.	135267.	910231.	636261.
1990	191886.	4932.	0.	80676.	411194.	277494.	140587.	1187725.	776848.
1991	224572.	5924.	0.	93572.	476923.	324068.	146592.	1511793.	923440.
1992	251579.	6940.	0.	105794.	539214.	364312.	147140.	1876105.	1070579.
1993	283254.	8314.	0.	123518.	629550.	415085.	149684.	2291190.	1220263.
1994	310339.	12092.	0.	184214.	938911.	506645.	163126.	2797835.	1383389.
1995	349904.	15069.	0.	225889.	1151318.	590861.	169858.	3388696.	1553247.
1996	385223.	18609.	0.	274708.	1400144.	678540.	174164.	4067236.	1727411.
1997	430819.	22319.	0.	322714.	1644824.	775852.	177805.	4843085.	1905216.
1998	469901.	27058.	0.	385653.	1965613.	882612.	180600.	5725696.	2085816.
1999	541175.	30956.	0.	427758.	2180215.	999888.	182676.	6725582.	2268492.
2000	598220.	38554.	0.	534023.	2721830.	1170796.	190982.	7896379.	2459474.
TERM	7263973.	454669.		3988848.		11707490.	1909744.	19603856.	4369215.

END EFFECT FINAL YEAR FUEL ESCALATION
0.5500 PU. ESCALATED AT 0.0700 PU.
0.2800 PU. ESCALATED AT 0.0500 PU.
0.0900 PU. ESCALATED AT 0.0650 PU.
0.0800 PU. ESCALATED AT 0.0600 PU.

TABLE 3.2-6

SOUTHERN CALIFORNIA EDISON COMPANY
15 YEAR EXPANSION PLAN
BASE CASE

ECONOMIC ANALYSIS
SOUTHERN CALIFORNIA EDISON COMPANY
PWC BASE CASE - SOUTHWEST PROJECT

STUDY NO 10
STUDY PERIOD 1985 TO 2000
END EFFECTS PERIOD 20 YEARS

INFLATION RATES -
INVESTMENT = 0.0600
OPERATION & MAINT = 0.0600
FUEL (SEE TABLE 3.2-1)

DISCOUNT RATE = 0.1200

LEVELIZED FIXED CHARGES

CONVENTIONAL	NUCLEAR	PEAKING	TRANSMISSION
0.1962	0.1962	0.1962	0.0

ALL COSTS IN THOUSANDS OF DOLLARS

						-------NEW CAPACITY---------			
YEAR	MW PEAK LD	MW CAPACITY	MW RES	PC RES	TOTAL GWH	MW	INVEST	OPER EXP	TRANS INVEST
1985	14880.	17200.	2320.	15.59	83688.	1082.	300147.	3181.	0.
1986	15420.	18401.	2981.	19.33	87056.	1201.	847059.	8979.	0.
1987	15990.	19090.	3100.	19.39	89836.	1289.	865816.	9178.	0.
1988	16550.	19104.	2554.	15.43	93130.	345.	886428.	9396.	0.
1989	17150.	19709.	2559.	14.92	96284.	605.	419409.	4446.	0.
1990	17760.	20768.	3008.	16.94	99748.	1059.	657404.	6968.	0.
1991	18380.	21268.	2888.	15.71	103324.	500.	1210122.	12827.	0.
1992	19050.	22378.	3328.	17.47	107221.	1110.	1400818.	14849.	0.
1993	19730.	23528.	3798.	19.25	111188.	1150.	2202967.	23352.	0.
1994	20440.	24418.	3978.	19.46	115454.	890.	1229103.	13028.	0.
1995	21118.	24466.	3348.	15.85	119666.	260.	939274.	9956.	0.
1996	21930.	25336.	3406.	15.53	124166.	870.	1107841.	11743.	0.
1997	22719.	26446.	3727.	16.40	128855.	1110.	1891928.	20054.	0.
1998	23537.	27368.	3831.	16.28	133727.	1070.	2357915.	24994.	0.
1999	24385.	28374.	3989.	16.36	138789.	1150.	2487948.	26371.	0.
2000	25263.	29334.	4071.	16.11	144048.	1070.	3647912.	38669.	0.

COST SUMMARY

YEAR	FUEL COST	OPERATING EXPENSE	PROPERTY TAX	FIXED CHARGES	CUMULATIVE INVESTMENT	ANNUAL COST	ANNUAL COST PRES. WORTH	CUMULATIVE ANNUAL COST	CUM ANN COST PRES. WORTH
1985	2375255.	3181.	0.	58889.	300147.	2437325.	2176183.	2437325.	2176183.
1986	2655926.	12351.	0.	225082.	1147206.	2893359.	2306568.	5330681.	4482752.
1987	2972539.	22270.	0.	394955.	2013021.	3389764.	2412767.	8720445.	6895517.
1988	3288069.	33002.	0.	568872.	2899449.	3889943.	2472129.	12610387.	9367646.
1989	3590210.	39428.	0.	651160.	3318858.	4280798.	2429040.	16891168.	11796684.
1990	3980704.	48762.	0.	780142.	3976262.	4809605.	2436695.	21700784.	14233378.
1991	4405968.	64515.	0.	1017568.	5186383.	5488050.	2482515.	27188832.	16715890.
1992	4675039.	83235.	0.	1292408.	6587199.	6050680.	2443768.	33239504.	19159648.
1993	4973346.	111580.	0.	1724630.	8790163.	6809554.	2455593.	40049072.	21615248.
1994	5412311.	131303.	0.	1965780.	10019266.	7509393.	2417823.	47558464.	24033072.
1995	6069477.	149138.	0.	2150066.	10958536.	8368680.	2405795.	55927136.	26438864.
1996	6756065.	169829.	0.	2367424.	12066377.	9293316.	2385362.	65220464.	28824224.
1997	7354626.	200073.	0.	2738620.	13958303.	10293317.	2358962.	75513712.	31183184.
1998	8081432.	237071.	0.	3201243.	16316215.	11519746.	2357167.	87033440.	33540352.
1999	8879890.	277667.	0.	3639379.	18804160.	12846936.	2347086.	99880336.	35887424.
2000	9757089.	332995.	0.	4405096.	22452064.	14495178.	2364476.	114375456.	38251904.
TERM	122397184.	3926985.		32903600.		159227760.	25973472.	273603072.	64225392.

END EFFECT FINAL YEAR FUEL ESCALATION
0.7000 PU. ESCALATED AT 0.0700 PU.
0.2200 PU. ESCALATED AT 0.0650 PU.
0.0800 PU. ESCALATED AT 0.0500 PU.

TABLE 3.2-7
PUBLIC SERVICE COMPANY OF COLORADO
15 YEAR EXPANSION PLAN
BASE CASE

ECONOMIC ANALYSIS
PUBLIC SERVICE COMPANY OF COLORADO
PWC BASE CASE - SOUTHWEST PROJECT

STUDY NO 30
STUDY PERIOD 1985 TO 2000
END EFFECTS PERIOD 20 YEARS

INFLATION RATES -
INVESTMENT = 0.0600
OPERATION & MAINT = 0.0600
FUEL (SEE TABLE 3.2-1)

DISCOUNT RATE = 0.1200

LEVELIZED FIXED CHARGES

CONVENTIONAL	NUCLEAR	PEAKING	TRANSMISSION
0.1962	0.1962	0.1962	0.0

ALL COSTS IN THOUSANDS OF DOLLARS

YEAR	MW PEAK LD	MW CAPACITY	MW RES	PC RES	TOTAL GWH	NEW CAPACITY MW	NEW CAPACITY INVEST	NEW CAPACITY OPER EXP	TRANS INVEST
1985	3716.	4178.	462.	12.43	21139.	0.	0.	0.	0.
1986	3932.	4578.	646.	16.43	22249.	400.	399709.	4237.	0.
1987	4152.	4978.	826.	19.89	23431.	400.	480416.	5092.	0.
1988	4381.	4978.	597.	13.63	24728.	0.	119846.	1270.	0.
1989	4645.	5578.	933.	20.09	26065.	600.	687188.	7284.	0.
1990	4910.	5978.	1068.	21.75	27538.	400.	369691.	3919.	0.
1991	5195.	5978.	783.	15.07	29087.	0.	44831.	475.	0.
1992	5481.	6578.	1097.	20.01	30653.	600.	572915.	6073.	0.
1993	5811.	6578.	767.	13.20	32426.	0.	202430.	2146.	0.
1994	6152.	7378.	1226.	19.93	34459.	800.	626479.	6641.	0.
1995	6513.	7378.	865.	13.28	36446.	0.	221356.	2346.	0.
1996	6881.	8178.	1297.	18.85	38477.	800.	1313904.	13927.	0.
1997	7301.	8178.	877.	12.01	40677.	0.	464247.	4921.	0.
1998	7731.	9178.	1447.	18.72	42758.	1000.	1934969.	20511.	0.
1999	8174.	9178.	1004.	12.28	45308.	0.	683689.	7247.	0.
2000	8634.	10178.	1544.	17.88	47634.	1000.	2640528.	27989.	0.

COST SUMMARY

YEAR	FUEL COST	OPERATING EXPENSE	PROPERTY TAX	FIXED CHARGES	CUMULATIVE INVESTMENT	ANNUAL COST	ANNUAL COST PRES. WORTH	CUMULATIVE ANNUAL COST	CUM ANN COST PRES. WORTH
1985	323145.	0.	0.	0.	0.	323145.	288522.	323145.	288522.
1986	365926.	4237.	0.	78423.	399709.	448586.	357610.	771731.	646132.
1987	416372.	9584.	0.	172681.	880126.	598636.	426097.	1370366.	1072229.
1988	476923.	11429.	0.	196194.	999971.	684546.	435041.	2054912.	1507270.
1989	502918.	19399.	0.	331021.	1687159.	853337.	484206.	2908250.	1991476.
1990	570898.	24482.	0.	403554.	2056850.	998933.	506090.	3907183.	2497567.
1991	650432.	26426.	0.	412349.	2101680.	1089207.	492702.	4996386.	2990269.
1992	672909.	34084.	0.	524755.	2674595.	1231747.	497482.	6228131.	3487751.
1993	777261.	38275.	0.	564472.	2877025.	1380007.	497645.	7608135.	3985395.
1994	896857.	47212.	0.	687387.	3503504.	1631455.	525285.	9239588.	4510679.
1995	1041718.	52391.	0.	730817.	3724859.	1824925.	524622.	11064512.	5035298.
1996	1196164.	69462.	0.	988605.	5038764.	2254231.	578605.	13318742.	5613899.
1997	1390785.	78551.	0.	1079689.	5503008.	2549026.	584171.	15867764.	6198067.
1998	1381726.	103774.	0.	1459330.	7437975.	2944831.	602571.	18812592.	6800637.
1999	1623380.	117248.	0.	1593470.	8121663.	3334098.	609127.	22146688.	7409762.
2000	1816326.	152272.	0.	2111541.	10762190.	4080140.	665559.	26226832.	8075317.
TERM	25344976.	1795729.		15772037.		42912736.	6999994.	69139552.	15075311.

END EFFECT FINAL YEAR FUEL ESCALATION
1.0000 PU. ESCALATED AT 0.0800 PU.

END OF DATA

TABLE 3.2-8
ARIZONA PUBLIC SERVICE COMPANY
15 YEAR EXPANSION PLAN
BASE CASE

ECONOMIC ANALYSIS
ARIZONA PUBLIC SERVICE COMPANY
PWC BASE CASE SOUTHWEST PROJECT
STUDY NO 20
STUDY PERIOD 1985 TO 2000
END EFFECTS PERIOD 20 YEARS

INFLATION RATES -
INVESTMENT = 0.0600
OPERATION & MAINT = 0.0600
FUEL (SEE TABLE 3.2-1)

DISCOUNT RATE = 0.1200

LEVELIZED FIXED CHARGES

CONVENTIONAL	NUCLEAR	PEAKING	TRANSMISSION
0.1962	0.1962	0.1962	0.0

ALL COSTS IN THOUSANDS OF DOLLARS

						-------NEW	CAPACITY---------		
YEAR	MW PEAK LD	MW CAPACITY	MW RES	PC RES	TOTAL GWH	MW	INVEST	OPER EXP	TRANS INVEST
1985	4345.	4703.	358.	8.24	21773.	100.	15800.	0.	0.
1986	4544.	5063.	519.	11.42	23046.	360.	228726.	0.	0.
1987	4808.	5363.	555.	11.54	24303.	300.	420877.	0.	0.
1988	5046.	5663.	617.	12.23	25665.	300.	359090.	0.	0.
1989	5284.	5963.	679.	12.85	26941.	300.	336701.	0.	0.
1990	5522.	6213.	691.	12.51	28251.	250.	301768.	0.	0.
1991	5759.	6513.	754.	13.09	29564.	300.	319874.	0.	0.
1992	5997.	6663.	666.	11.11	31029.	150.	245842.	0.	0.
1993	6235.	6913.	678.	10.87	32281.	250.	224412.	0.	0.
1994	6472.	7263.	791.	12.22	33678.	350.	447370.	0.	0.
1995	6710.	7463.	753.	11.22	35034.	200.	386103.	0.	0.
1996	6948.	7663.	715.	10.29	36498.	200.	273922.	0.	0.
1997	7186.	7963.	777.	10.81	37835.	300.	505056.	0.	0.
1998	7423.	8163.	740.	9.97	39320.	200.	605317.	0.	0.
1999	7661.	8463.	802.	10.47	40671.	300.	562958.	0.	0.
2000	7899.	8463.	564.	7.14	42073.	0.	335034.	0.	0.

COST SUMMARY

YEAR	FUEL COST	OPERATING EXPENSE	PROPERTY TAX	FIXED CHARGES	CUMULATIVE INVESTMENT	ANNUAL COST	ANNUAL COST PRES. WORTH	CUMULATIVE ANNUAL COST	CUM ANN COST PRES. WORTH
1985	328525.	0.	0.	3100.	15800.	331625.	296093.	331625.	296093.
1986	333165.	0.	0.	47976.	244526.	381141.	303843.	712765.	599937.
1987	355134.	0.	0.	130552.	665403.	485686.	345702.	1198451.	945638.
1988	372601.	0.	0.	201006.	1024493.	573606.	364537.	1772057.	1310175.
1989	413820.	0.	0.	267066.	1361193.	680886.	386353.	2452943.	1696528.
1990	454341.	0.	0.	326273.	1662961.	780614.	395483.	3233557.	2092011.
1991	493478.	0.	0.	389032.	1982835.	882510.	399203.	4116067.	2491214.
1992	553330.	0.	0.	437266.	2228677.	990596.	400085.	5106663.	2891299.
1993	615524.	0.	0.	481296.	2453089.	1096819.	395524.	6203482.	3286823.
1994	673407.	0.	0.	569070.	2900459.	1242476.	400044.	7445958.	3686867.
1995	751419.	0.	0.	644823.	3286562.	1396241.	401386.	8842199.	4088253.
1996	833346.	0.	0.	698566.	3560484.	1531911.	393203.	10374107.	4481454.
1997	895026.	0.	0.	797658.	4065539.	1692683.	387919.	12066787.	4869369.
1998	987256.	0.	0.	916421.	4670857.	1903676.	389530.	13970460.	5258899.
1999	1073369.	0.	0.	1026873.	5233811.	2100243.	383706.	16070701.	5642604.
2000	1157163.	0.	0.	1092606.	5568843.	2249770.	366986.	18320464.	6009589.
TERM	12516081.		0.	8161161.		20677232.	3372904.	38997712.	9382494.

END EFFECT FINAL YEAR FUEL ESCALATION
0.9300 PU. ESCALATED AT 0.0500 PU.
0.0700 PU. ESCALATED AT 0.0400 PU.

END OF DATA

SECTION 4

COMPUTER MODELS

4.1 INTRODUCTION

This section addresses the modeling effort required to evaluate the inclusion of solar generation in the generation plans of the six utilities studied, and provides a description of four computer models that were employed in this effort. Five of the six utilities were familiar with or were using some version of PROMOD III which is a proprietary program owned by EMA. For this reason, PROMOD III was used to compute fuel cost for each unit and for each system. In addition, EMA and S&W developed three new programs to supplement PROMOD III in solar generation modeling.

The evaluation of solar generating units is complicated by the hourly and seasonal variations in solar generating capacity due to predictable variations in solar radiation and less predictable changes in weather conditions. However, this disadvantage can be partially offset by the reasonable assumption that solar generation can be dispatched without consideration of the heat rate and fuel cost characteristics of the other units on the system since solar units should always be in service when environmental conditions permit except for periods when the unit is down for maintenance. This assumption allows the problem to be segregated into two independent phases. Phase 1 is concerned with the problem of determining the hour-by-hour solar generation capability and adjusting the load to be supplied by the remaining units, and Phase 2 is the application of standard dispatch procedures to allocate the remaining load to conventional generation facilities. Three computer programs were developed to perform the analysis required in Phase 1 and PROMOD III was used for Phase 2.

4.2 PROMOD III

PROMOD III performs the conventional unit dispatch using a probabilistic dispatch technique.

Basically, the units are loaded according to weekly load duration curves, taking into account the probability that individual units will be forced out of service. This forced outage probability has the effect of increasing loading on the remaining units with higher fuel costs. Planned maintenance is also taken into account. In addition to computing the probable generation and fuel costs for each unit, this model also computes the probability that the load will not be served due to simultaneous forced outages of generating units. This feature is used to measure the reliability of the base case expansion plans as compared to the reliability of other expansion plans with solar generation.

4.3 WTP AND ROSPAM

The Weather Tape Processor (WTP) and Run-Of-The-Sun-Power-Availability-Model (ROSPAM) convert hourly weather data, insolation levels, and solar plant characteristics into the amount of energy available, on an hour-by-hour basis, for supplying electric power to the utility transmission grid or for storage. This calculation is performed for a day typical for each month.

WTP edits Aerospace Corporation weather tapes for a given location to extract hourly data on temperature, wind speed, direct and total insolation, etc, and converts this information to ROSPAM input.

ROSPAM models the three solar generator types - solar thermal, photovoltaic, and wind energy systems. The solar thermal plant has a maximum capability of 120 MW when generating directly from the solar boiler and 100 MW when generating from storage. It was assumed to have two axis tracking and efficiency characteristics as described in Volume II, Section 3. Storage levels of 0, 200, and 600 MWh were modeled. Storage can be charged at a maximum rate of 100 MWh per hour and can be charged while the generating unit is also delivering power to the grid. The total steam available, however, is limited by the size of the collector field. The turbine generator is capable of generating from steam supplied simultaneously from storage and from the solar boiler, but the total output is limited to 120 MW by the turbine generator rating.

The photovoltaic system (Volume II, subsection 3.3.4) is modeled as a nontracking system with a maximum output from direct generation of 130 MW, or 100 MW from battery storage. Battery storage is located on the alternating current side of the main inverters so that it is effectively independent of the photovoltaic plant and could be dispatched without regard to the photovoltaic generation. However, for this study, the storage was dispatched as though it were part of the photovoltaic plant.

The wind generating plant (described in Volume II - subsection 3.3.1.1) consists of seven 1.5 MW units. The total plant rating is 10.5 MW with an average wind velocity of 30 mph and a cut-in velocity of 11 mph. This system was modeled with and without 10 MWh of storage. Generation from storage is possible at a lower rate of 5 MWh per hour.

Storage capability associated with the solar thermal and photovoltaic systems requires larger collector fields than systems without storage. The simulated dispatch of the storage system (i.e., when and when not to store energy and when to generate from storage), is accomplished by the Load Adjustment Model (LAM) but the size of the collector fields is reflected in the output of ROSPAM as increased power available.

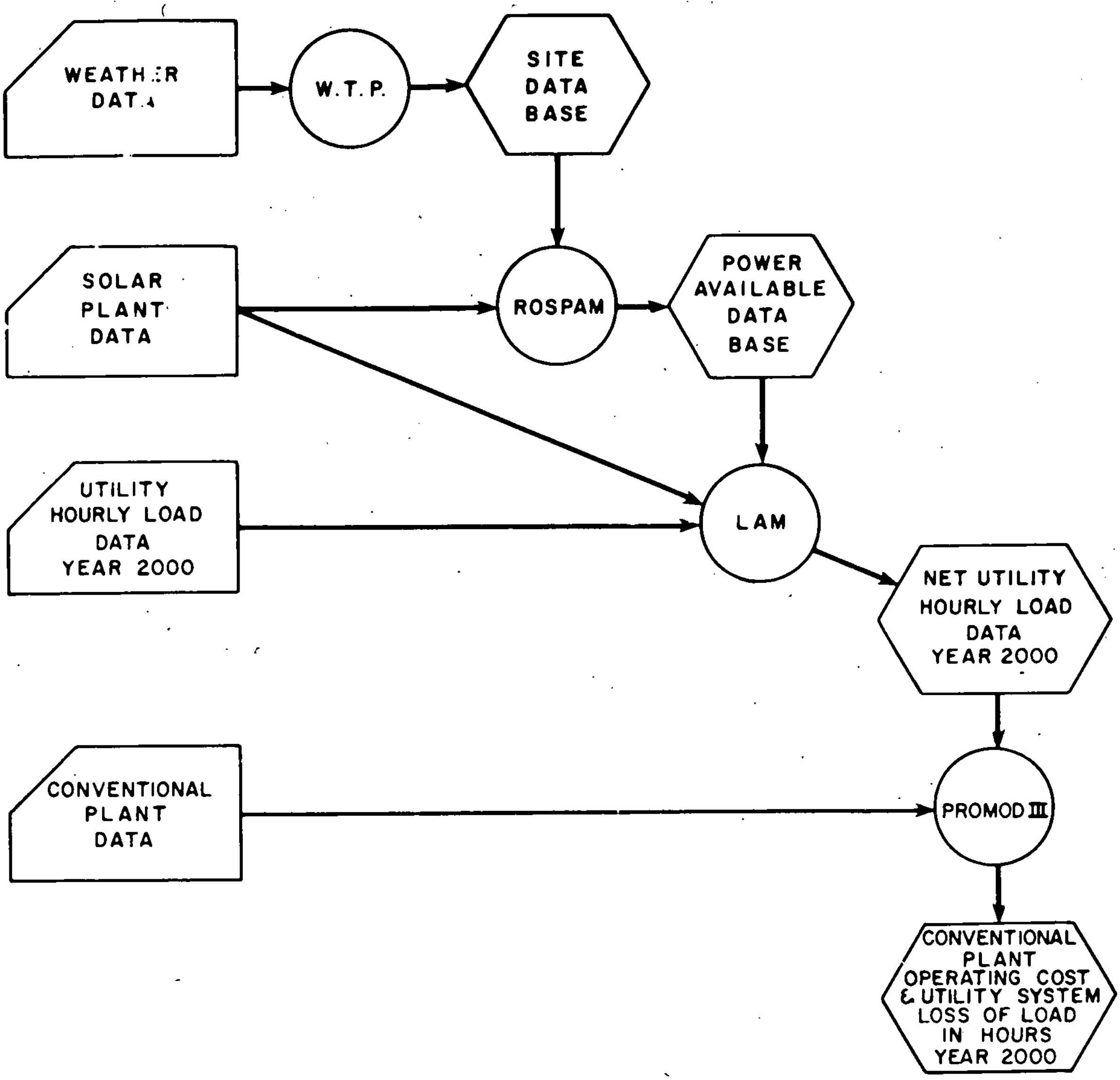
A full month's data is analyzed by ROSPAM, and a rough probability distribution of generation available each hour of a typical day is developed by dividing the 30 sets of weather data for each hour (same hour of the day for 30 days) into three groups, which result in a low, medium, and high generation level. The outputs are three 24 hour curves of solar generation available and a probability that each curve will exist.

4.4 LOAD ADJUSTMENT MODEL

LAM was developed by EMA as part of the project and it performs two basic functions. It uses the three hourly power availability curves supplied by ROSPAM and the system hourly load data for a typical week to dispatch the storage associated with solar generation, and it develops a new hourly load curve by computing the expected solar generation and subtracting this from the original hourly load curve.

4.5 PROCEDURE FOR USING MODELS

The flow of information from one program to the next is demonstrated in Figure 4.5-1. To summarize the preceding discussion, WTP and ROSPAM use raw weather data, insolation data, and a plant algorithm to predict the hourly output of the solar plant for a typical day of each of the twelve months. Three hourly curves are developed representing low, medium, and high solar plant generation and the probability associated with each level of output. The output of ROSPAM is used by LAM along with hourly loads for a typical week in each month to dispatch the solar storage and to generate a new weekly load curve modified to reflect expected solar generation. This weekly curve is provided to PROMOD III where a probabilistic fuel cost simulation determines the loading of conventional units and the reliability of the system for a particular utility.



SOURCE:
SOUTHEAST REPORT

FIGURE 4.5-1
FLOW DIAGRAM
COMPUTER MODELS

SOUTHWEST PROJECT

SECTION 5

ECONOMIC FACTORS

5.1 INTRODUCTION

This section of the report reviews the economic analyses used in the system integration studies and includes a derivation of the fixed charge rates and discussions of escalation rates and the evaluation methodology.

In general, the methodology is either consistent with or extracted directly from the publication, The Cost of Energy from Utility-Owned Solar Electric Systems - A Required Revenue Methodology for ERDA/EPRI Evaluations, prepared by Jet Propulsion Laboratories.

Two types of approaches are used to compare solar technologies with conventional generation. One is based on a 15-year expansion plan with end effects for another 20 years. The other is based on a one year analysis of the year 2000 with fuel and O&M costs levelized over 20 years.

5.2 FIXED CHARGE RATES

Levelized fixed charge rates, used to compute the annual cost of an investment, are calculated by multiplying the investment by the fixed charge rate. Fixed charges on the investment are directly comparable to other annual expenses such as fuel cost. Annual costs can be "capitalized" by dividing the annual cost by the levelized fixed charge rate to produce an equivalent investment that would generate annual fixed charges equal to the annual expense. Both concepts; i.e., annual costs and capitalized costs, are used in this study.

For four of the investor owned utilities, namely SCE, PSC, APS, and ELP, a fixed charge rate of 19.62 percent was used. Use of this value was based on typical utility financial data and was agreed to by these utilities. PSNM used higher investment tax credits, lower ad valorem added value taxes, and made other minor adjustments to the "typical" values used for the other utilities to derive a fixed charge rate of 14.61 percent. SRP, as a publicly financed utility, used a fixed charge rate of 11.88 percent based on a cost of money to SRP of 8.35 percent resulting in a capital recovery factor of 9.18 percent plus 2.7 percent for taxes and insurance.

5.3 ESCALATION

Fuel escalation is one of the variables to which the value of solar generation is most sensitive. Each utility specified an expected 1985 fuel cost and the escalation rate for each fuel type in the base case expansion plans. Fuel escalation rates varied from 4 to 8 percent as shown previously on Table 2.1-1. In the sensitivity studies, the effect of varying fuel escalation rates over a range of 6 to 10 percent was investigated for each utility in order to demonstrate the effect of fuel escalation rate on the break-even investment in solar generation, and to allow comparisons to be made between utilities on a common basis.

The fuel escalation rates were considered to be a constant, compound rate for the period 1985-2020.

Escalation of capital investment and O&M cost was considered to be 6 percent per year throughout the study.

5.4 15-YEAR EXPANSION PLANS

5.4.1 Present Worth of Revenue Requirements (PWRR)

A standard method used by utilities for evaluating alternative generation expansion plans is based on comparisons of revenue requirements. All annual expenses associated with a given expansion plan including fuel cost, fixed charges on investment, and O&M are computed for each year of the study. The present worth of the annual costs for each year is found and reduced to a single amount which is the sum of the PWRR.

In this study, the fuel costs were computed by the dispatch program, PROMOD III, which included the appropriate fuel escalation rates. The investment in each year of the study was multiplied by the fixed charge rate to produce the fixed charges on investment.

Annual fixed O&M costs for conventional units were assumed to be 1 percent of the total initial capital investment. Annual O&M costs for solar generating units were taken directly from Volume II, Section 6.

The cost of money used in the derivation of fixed charge rate was used as the discount rate in the present worth calculations. The fuel costs included in the PWRR analysis included the fuel costs of all the units installed in the system while fixed charges and O&M costs were included only for new capacity added after 1985.

SECTION 6

ANALYSIS OF SOLAR PLANS

6.1 INTRODUCTION

This section reports the results of an evaluation of solar generation in the southwestern utility environment. The results presented herein are the break-even investment costs between solar thermal, photovoltaic, and wind energy systems on the one hand and conventional generating capacity on the other, and the sensitivity of these values to fuel escalation, accelerated depreciation, investment tax credit, and cost of debt.

The estimated investment required for solar generation and conventional generation is developed in Volume II. The incentives required to reduce the gap between estimated cost and break-even cost are covered in Volume IV using data developed in this section.

EMA supplied the computer model, PROMOD III, which was used for all the fuel cost simulations. In addition, EMA developed a solar load adjustment model (LAM) used in the solar generation analysis, and worked with the six utilities participating in this phase of the project to compute fuel costs for the base case, generation expansion plans for the period 1985–2000.

Both single-year and 15-year analyses were used in this study. The single-year analyses were based on the year 2000 as determined from the base case 15-year runs, and, in general, produce results similar to those obtained from the 15-year analyses.

Solar generation has varying degrees of both capacity and fuel replacement value, and both contribute to the break-even investment cost calculation. Operation and maintenance (O&M) charges are generally greater than those required for conventional capacity and also impact on the break-even value.

6.2 CAPACITY REPLACEMENT VALUE

The system reliability determined in the six base case plans is measured by PROMOD III in terms of loss of load hours (LOLH) which represents the expected number of hours in a year that simultaneous outages of generating capacity will exceed the system installed reserve. The forced outage rate of a particular unit is the probability that it will not be available for service at any particular point in time. Both the load shape (load duration curve) and individual unit forced outage rates contribute to LOLH.

Unlike conventional capacity that is available around the clock and is not affected by weather, solar generation may vary minute-to-minute and season-by-season even with optimal environmental conditions. Variations in cloud cover and other environmental changes may further affect the availability of the unit.

The two computer programs discussed in Section 4, WTP and ROSPAM, were used to predict the variable output of the solar generator, and LAM was used to dispatch the solar generated energy and adjust the base case load duration curve accordingly. When this adjusted load curve, with solar generation removed from the original curve, was used in PROMOD III, the resulting LOLH was reduced, indicating a more reliable system. The amount of conventional generating capacity in the base case plan was then reduced until the LOLH matched to base case value. To accomplish the reduction in conventional generation, only capacity to be installed after 1985 was considered for replacement. Of this capacity, conventional hydroelectric and geothermal were exempted, leaving pumped storage, nuclear, coal- and oil-fired capacity to be replaced by new solar generation. For four utilities, only coal- and oil-fired capacity was replaced by solar. The conventional units were derated proportionately to achieve the target level of reliability. The investment in conventional capacity removed in this manner was defined as the capacity replacement value of the added solar capacity.

6.3 FUEL REPLACEMENT VALUE

Once the conventional generation was derated, PROMOD III was used to dispatch the conventional generation to supply the adjusted load curve. The resulting system megawatt-hours and fuel expense were then subtracted from the megawatt-hours and fuel cost of the base case to produce solar generator megawatt-hours and fuel saving.

The percentage of fuel cost saving due to replacing each type of fuel (coal, oil, and nuclear) was determined by comparing the individual unit dispatches in the two cases of PROMOD III year 2000 simulations to establish a weighted average fuel escalation rate for fuel displaced by solar generation. This fuel escalation rate was then used to compute a levelized fuel saving for the end effects period 2000-2020, inclusive. This levelized fuel saving was divided by the fixed charge rate to produce a capitalized value of fuel saving for the year 2000 which was then reduced to a 1985 investment value by dividing by a compound 6 percent per year investment escalation rate. For example, the installation of 13 solar thermal units with 200 MWh storage on the PSC system resulted in a fuel saving of $153 million in the year 2000. The fuel cost saving was multiplied by 1.765 to represent the effects of escalating the fuel at 8 percent per year from 2000 through 2020. The present worth of (1.7656) x ($153 million) for 21 years is the same as the present worth of fuel escalated year by year for the same period. Therefore, fuel cost levelized (2000)

= 1.7656 ($153 million)
= $270 million

The investment that will produce annual fixed charges equal to the levelized fuel saving is then:

$$\frac{270}{0.1962} = \$1,377 \text{ million}$$

where 0.1962 is the fixed charge rate. Or, in other words, $1,377 million invested in the 13 solar units in the year 2000 would generate annual fixed charges exactly equal to fuel cost savings. In order to express this "capitalized" fuel saving in terms of investment in 1985 dollars it is necessary to perform the following operation:

$$\text{Investment (1985)} = \frac{\$1,377}{(1.06)^{15}} \text{ million} = \$574 \text{ million}$$

6.4 OPERATION AND MAINTENANCE PENALTY

Annual O&M costs for each solar type were determined in Volume II. These values are shown below in 1985 dollars:

	Storage (MWh)	Annual O&M, 1985
Solar thermal	None	$4,100,000
Solar thermal	200	$4,300,000
Solar thermal	600	$4,600,000
Hybrid	None	$4,400,000
Photovoltaic	None	$1,400,000
Photovoltaic	200	$1,700,000
Wind	None	$700,000
Wind	10	$700,000

The annual O&M costs for conventional units was taken to be 1 percent of the conventional unit investments.

The O&M cost of conventional capacity replaced by solar generation was subtracted from solar O&M to produce an annual O&M penalty, in 1985 dollars. Dividing this annual penalty by the levelized fixed charge rate produces the capitalized O&M penalty.

6.5 SOLAR DATA

Weather tapes were acquired from Aerospace Corporation for Inyokern, California; Phoenix, Arizona; El Paso, Texas; Albuquerque, New Mexico; and Grand Junction, Colorado. Hourly data of direct and total insolation, wind speed, temperature, humidity, barometic pressure, cloud cover, etc, were extracted from these tapes as input to the computer program ROSPAM which converted the data into hourly megawatt output from the solar generators.

Data for wind energy systems were also obtained from SCE for a specific site at which SCE has been gathering data. Direct insolation data were used for solar thermal plants and total insolation data were used for photovoltaic plants. Cloud cover was recorded on a scale of 0 to 10, with the lower numbers reflecting clear skies. The solar plants were considered to be completely shut down when the recorded cloud cover for more than half the daylight hours was seven or higher. Typical solar generation during a clear summer or winter day for a solar thermal plant with 600 MWh storage is shown in Figures 6.5-1 through 6.5-12. The percentage of time that solar thermal and photovoltaic units were entirely out of service due to excessive cloud cover is shown in Table 6.5-1.

The locations represented by the Aerospace Corporation weather tapes were not particularly selected for their suitability for wind energy systems. As a result, the wind data extracted from the tapes for SCE and PSC indicated that very little power would be generated at those sites. Data supplied by SCE were substituted for the Aerospace data for SCE and both SCE and ELP data were used for the analysis of wind machines for PSC.

6.6 RESULTS

A number of alternative generation plans for the year 2000, including varying amounts of solar generation, was evaluated. Nine of these plans were also analyzed for the period 1985-2000.

A more limited analysis of the PSNM system was performed. As a result, the two 16 year expansion plans studied include the addition of solar generation in only the first year. For the other utilities, increasing amounts of solar generation were installed throughout the study period.

The following table lists the types of solar generation additions studied for each utility.

	Storage	PSNM	SRP	ELP	SCE	PSC	APS
Solar Thermal	600 MWh		X	X	X	X	X
Solar Thermal	200 MWh	X	X	X	X	X	X
Solar Thermal	None				X		
Hybrid	None	X	X				
Wind	10 MWh				X		
Wind	None			X	X	X	
Photo-voltaic	None		X		X		X

Figures 6.6-1 through 6.6-6 show the equivalent amount of conventional capacity replaced by each type of solar generation presented for each utility as a function of solar penetration. Equivalent capacity is defined as the megawatt reduction in conventional capacity divided by the amount of solar capacity installed. A nominal rating of 100 MW was used for solar thermal and photovoltaic solar units in the calculations.

It is important to remember that these units have maximum generation ratings of 120 and 130 MW, respectively, and operate at these levels rather consistently during the summer months. Equivalent capacity based on these maximum ratings would be considerably reduced. The break-even solar investment is shown in Figures 6.6-7 through 6.6-12 and Table 6.6-1.

6.6.1 Public Service Company of New Mexico

Two solar technologies were examined for PSNM - solar thermal with 200 MWh storage (ST-2) and hybrid. The hybrid unit was a combined oil-fired and solar thermal plant with no storage.

6.6.1.1 One Year Analyses

The results for the PSNM solar simulations are shown in Figures 6.6-1 and 6.6-7 and Table 6.6-1 and are summarized on Table 6.6-2.

PSNM plans to install only nuclear and pumped storage capacity during most of the study period. A coal-fired unit is planned for 1988 and accounts for only 6 percent of the capacity added during the study period, while nuclear accounts for 72 percent and pumped storage accounts for 22 percent of the added capacity. In the two 1 year cases studied, a 50 MW solar plant was used to replace pumped storage capacity. A 50 MW hybrid plant was considered to have reliability comparable to a 50 MW pumped storage plant, while a 50 MW solar thermal plant with 200 MWh storage was found to be equivalent in reliability to 20 MW of pumped storage capacity.

The hybrid plant consists of an existing oil fired plant plus a solar steam supply to provide steam to the turbine generator in parallel with the oil fired boiler. The oil fired portion of the plant would run only when the system required capacity due to forced outages and maintenance of other equipment and when the solar part of the plant was not available for this required service. No attempt was made in this analysis to account for oil consumed for startup, banking, or buffering.

The hybrid plant was represented in the study as two separate plants. One was a 50 MW solar thermal plant with no storage and the other a 50 MW conventional oil fired plant. This model configuration involves an approximation in that it allows both "units" to run simultaneously at times of system emergency to supply the load when other units are out of service. The major error in this approximation is that the reliability of the system as calculated by PROMOD will appear better than it actually would be if only one or the other unit was allowed to run. The error does not affect results appreciably since the reliability criteria were not used to determine the replacement capacity value of the hybrid plant. The fuel consumed by the oil fired portion of the plant will be slightly in error on the high side, but this effect would be offset by a reduction of other, expensive generation. The solar thermal portion of the 50 MW hybrid plant operated at 26 percent capacity factor in the year 2000 while the oil fired portion ran at a 35 percent capacity factor. However, 40 percent of the oil fired generation was used to displace very expensive emergency purchases. The unit would be required to run at only a 20 percent capacity factor to produce the same reliability (LOLH) as the base case. The net fuel replacement value of the hybrid plant in the year 2000 was approximately 68 mills/kWh.

The solar thermal plant with 200 MWh storage operated at a 36 capacity factor in the year 2000 with a net fuel replacement value of 76 mills/kWh.

6.6.1.2 Sensitivity Tests

The sensitivity of solar break-even investment to fuel escalation rate is shown in Figure 6.6-13. This curve provides a multiplier by which the break-even investment shown in Figure 6.6-7 and Table 6.6-1 for PSNM may be adjusted for different assumed fuel escalation rates. The fuel cost is escalated uniformily from 1985-2020 at the rate indicated. The base escalation rate was 7 percent, at which the break-even investment for solar thermal with 200 MWh storage was $1,110/kW. At an 8 percent fuel escalation rate, the break-even investment would be increased to approximately $1,400/kW or to $2,220/kW for a 10 percent fuel escalation. The value of solar thermal with 200 MWh storage is slightly more sensitive to the fuel escalation rate than solar thermal hybrid with no storage because a greater portion of its total value results from fuel savings.

The curve in Figure 6.6-14 shows the Investment Tax Credit (ITC) multiplier for PSNM. The ITC effectively changes the fixed charge rate. If, for instance, ITC were lowered from the value used for PSNM of 10 to 4 percent, the fixed charge rate would be increased from 14.61 to 15.74 percent, and the break-even investment would be reduced by a factor of 14.61/15.74 = 0.93 to $1,030/kW for solar thermal with 200 MWh storage instead of $1,110/kW as indicated on Table 6.6-1. A 20 percent ITC would increase the value of solar thermal with 200 MWh storage to $1,270/kW.

The sensitivity of break-even investment to cost of debt is shown in Figure 6.6-15. The ratio of debt to total capitalization was fixed at 50 percent. With a reduction in cost of debt, due to special considerations being applied to solar, similar to pollution control bonds, the discount rate used in present worth calculations is decreased as is the fixed charge rate. The overall effect on break-even investment of lowering the cost of debt from the base value of 9.32 to 5 percent was to increase the break-even investment by 16 percent, or to increase the value of solar thermal unit with 200 MWh storage from $1,160 to $1,290/kW. If the cost debt were reduced to zero, the break-even investment would be increased to approximately $1,550/kW.

The sensitivity of break-even investment to accelerated depreciation is shown in Figure 6.6-16. This curve provides a multiplier to convert break-even investment as shown in Figure 6.6-7 and Table 6.6-1 for different Asset Guideline Periods (AGP). An AGP of 20 percent was applied to the tax life of 28 years to derive an AGP of 22.5 years in the base case. Higher values of the AGP will produce shorter effective tax lives and lower the federal income tax portion of the fixed charge rate. For instance, an AGP of 50 percent would produce an AGP life of 14 years which would increase the break-even investment of solar generation by 7 percent. A reduction in the AGP to 5 years would increase the value of solar by 21 percent.

6.6.1.3 Present Worth of Revenue Requirements (1985-2000)

The base case expansion plan without solar generation was evaluated for the period 1985 - 2000 as shown in Table 6.6-3. This base case was modified to produce two expansion plans including the installation of solar generation in 1985 with the remainder of the plan unchanged. In the first case, a 50 MW hybrid unit was used to replace 50 MW of the 300 MW pumped storage unit scheduled to be installed in 1985. In the other case, a 50 MW solar thermal unit with 200 MWh storage was installed in 1985. This unit was used to replace only 20 MW of the pumped storage unit. As shown in Table 6.6-4, the investment in solar thermal hybrid generation to make the PWRR a break-even was $1,150/kW as compared to a value of $1,160/kW in the one year analysis. Similarly, the break-even investment in solar thermal generation with 600 MWh storage as shown in Table 6.6-5 was $1,027/kW as compared to a value of $1,110/kW in the one year analysis. In the year 2000 analysis, all the solar generation was assumed to be installed in the year 2000.

6.6.2 Salt River Project

6.6.2.1 One Year Analyses

Solar thermal, hybrid, and photovoltaic solar technologies were evaluated for SRP. The results of this analysis can be found in Figures 6.6-2 and 6.6-8 and are summarized on Table 6.6-6.

SRP was the only publicly financed utility studied and had a fixed charge rate of 11.88 percent. The projected load growth was only 2.9 percent/yr, the lowest of the utilities studied. The generation expansion plan consisted of 47 percent combustion turbines, 30 percent coal, and 23 percent nuclear. In order for the amount of solar generation installed to equal 5 percent of the total system generating capacity, it would be necessary to replace one-third of the planned combustion turbine and coal-fired capacity with solar facilities. For this reason, only one level of penetration was assumed in the analysis. The weighted average cost of fuel replaced by solar generation was 106 mills/kWh. Both the capitalized fuel replacement value and the O&M penalty were higher for SRP than for the other five utilities studied due to the low fixed charge rate and the high replacement fuel cost.

6.6.2.2 Sensitivity Tests

Sensitivity of break-even investment to fuel escalation rates for SRP can be found in Figure 6.6-17. As can be seen from this curve, the value of solar generation is quite sensitive to fuel escalation and the values shown in Table 6.6-1 will nearly double if an escalation rate of 8 percent were used instead of the 5.3 percent value projected in the base case.

The sensitivity of break-even investment to changes in cost of debt for SRP is shown in Figure 6.6-18. A reduction in cost of debt to 2 percent would double the value of solar to SRP.

6.6.2.3 Present Worth of Revenue Requirements (1985-2000)

The PWRR for SRP is shown on Table 6.6-7. No 15-year generation expansion plans were developed for SRP because the low load growth rate did not allow opportunities for conventional capacity replacement until 1995 or later. Plans based on this assumption would not significantly vary from the one year analysis of 2000.

6.6.3 El Paso Electric Company

6.6.3.1 One Year Analyses

Two solar technologies were examined for ELP - solar thermal with 600 and 200 mWh storage (ST-6 and ST-2) and wind with no storage (W-0). The results for these cases are shown in Figures 6.6-3 and 6.6-9 and Table 6.6-1, and can be summarized as follows:

SOLAR BREAK-EVEN INVESTMENT

Type	Break-Even $/kW	Penetration (%)	Ratio of Conventional to Solar Capacity	CF (%)
ST-6	1,140	10	1.06	46
ST-2	880	10	0.94	35
Wind	30	5	0.27	16

The amount of conventional capacity replaced by solar thermal with 600 MWh storage was slightly greater than the nominal capacity of the solar generation installed. As shown in Figure 6.5-3, the solar thermal unit with 600 MWh storage generates at least 100 MW, 18 hours per day (6 a.m. to midnight) in the summertime. During the period from 6 a.m. to 6 p.m., it generates 120 MW.

ELP plans to install 72 percent coal, 21 percent nuclear, and 7 percent pumped storage during the study period. Both nuclear and coal-fired capacity are replaced by solar generation.

ELP has the highest capacity value and the lowest fuel replacement value of the six utilities studied and ranks fourth in value of solar thermal generation.

The location for the wind data extracted from the Aerospace Corporation weather tapes for El Paso was not particularly suited to a wind energy system. As a result, wind generation has practically no value to ELP partly due to the low wind machine capacity factor (16 percent) and partly to the low fuel cost replacement value. Even if specific sites were found that would produce higher capacity factors, wind would not have a high value to ELP since the fuel replacement value is low.

6.6.3.2 Sensitivity Tests

The sensitivity of solar break-even investment to changes in fuel escalation rates is shown in Figure 6.6-19. This figure provides a multiplier by which the break-even investment for ELP shown in Figure 6.6-9 and Table 6.6-1 may be adjusted for different assumed fuel escalation rates. The fuel cost is escalated uniformly from 1985-2020. The base escalation rate was 7.2 percent which resulted in a break-even investment for solar thermal with 200 MWh storage of $880/kW. For a 10 percent fuel escalation rate this value would be increased by 11 percent to $980/kW. The break-even investment for ELP is not very sensitive to changes of the fuel escalation rate since most of the value of solar generation to ELP is capacity replacement credit.

The sensitivity of the ELP solar break-even investment to ITC is shown in Figure 6.6-14. This figure provides multipliers to adjust the solar break-even investment shown in Figure 6.6-9 and Table 6.6-1 for values of ITC differing from the 4 percent assumed in the base case. The ITC effectively changes the fixed charge rate. If, for instance, the ITC were increased from the base value of 4 to 10 percent the fixed charge rate would be decreased from 19.62 to 18.62 percent and the break-even investment would be increased by 5.5 percent. For the solar thermal plant whose break-even investment was $880/kW in the base case, a 10 percent ITC would increase the value to approximately $930/kW. A 20 percent ITC would increase the value of the solar thermal plant with 200 MWh storage to approximately $1,020/kW.

The sensitivity of break-even investment to cost of debt is shown in Figure 6.6-20. The ratio of debt to total capitalization was fixed at 50 percent. With the reduction in cost of debt, the discount rate used in present worth calculations was decreased as was the fixed charge rate. The overall effect on break-even investment of lowering the cost of debt from the base value of 9 to 5 percent was to increase the break-even investment by 10 percent or to increase the value of solar thermal with 200 MWh storage from $880 to $970/kW. If the cost of debt were reduced to zero, the break-even investment would be increased to $1,100/kW.

The sensitivity of break-even investment to accelerated depreciation is shown in Figure 6.6-16. This curve provides a multiplier to convert break-even investment as shown in Figure 6.6-9 and Table 6.6-1 for different AGPs. An effective tax life, or AGP, of 23 years was used in the base case. Shorter effective tax lives lower the federal income tax portion of the fixed charge rate. For instance, an AGP of 14 years would increase the break-even investment in solar generation by 7 percent, and a reduction in the AGP to 5 years would increase the solar value by 21 percent.

To check the effect of daily load shape on the value of solar generation, the hourly loads for ELP for the year 2000 were adjusted to lower the peak load by 10 percent while maintaining the energy consumed constant over the week. This type of change in load shape could result from load management and user installed solar heating and cooling. The purpose was to show the sensitivity of the results to changes in load shape that might take place by the year 2000 rather than to predict what these changes might be.

The equivalent capacity of solar thermal generation with 200 MWh storage was 94 percent for a 10 percent penetration (Figure 6.6-3). When the load shape was changed to represent a moderate amount of load management (Figure 6.6-21), the equivalent capacity was reduced to approximately 83 percent, resulting in a reduction in capacity value of 14 percent. Thus, overall value to ELP was reduced from $880 (1985) to $760/kW.

6.6.3.3 Present Worth of Revenue Requirements (1985-2000)

Two expansion plans were developed for solar thermal generation with 200 MWh storage. Each plan included the installation of three 100 MW units. An early installation plan installed the first unit in 1986, replacing nuclear capacity, followed by two more units in the 1990's which replaced coal-fired capacity. The delayed expansion plan installed one half of a solar unit in 1988 followed by the second half in 1992. Full size solar units were added in 1996 and 1998. These plans are shown in Table 6.6-8.

The PWRR for the base plan plus the two solar plans are shown in Tables 6.6-9, 6.6-10, and 6.6-11. The break-even investment for solar generation in the "Early Plan" was $702/kW as compared to a value of $880/kW from the one year analysis. This large difference is due to the 8-year period from 1986-1993 when a fuel penalty resulted from the replacement of nuclear capacity in 1986. By waiting to install solar generation until coal-fired capacity was available for replacement, the break-even investment was considerably increased to $1,435/kW.

6.6.4 Southern California Edison Company

6.6.4.1 One Year Analyses

Solar thermal with no storage (ST-0) and with 200 and 600 MWh storage (ST-2 and ST-6), photovoltaic with zero and 200 MWh storage (PV-0 and PV-2), and wind energy systems (W-0 and W-2) were modeled for SCE. One case was run for a wind energy system with 10 MWh storage and, although the storage increased the capacity replacement value, it increased the value of the wind energy system by less than $100/kW. The capacity value of photovoltaic solar generation was increased very little with 200 MWh storage and was not evaluated in terms of break-even investment, since it is obviously not yet economical to install present day state-of-the-art battery storage. The results can be seen in Figures 6.6-4 and 6.6-10 and Table 6.6-1, and are summarized in Table 6.6-12.

SCE's expansion plans call for the following capacity mix to be added between 1986 and 2000:

	Percent
Nuclear	38
Coal	26
Combined Cycle	2
Combustion Turbine	22
Fuel Cells, Geothermal, and Hydroelectric	22
	100

Only oil- and coal-fired capacity was replaced by solar generators. Eighty-five percent of the fuel cost savings resulted from replacing oil, and the average cost of fuel replaced was 108 mills/kWh, the highest of the six utilities studied.

SCE ranks second to SRP in value of ST-6, ST-2, and PV-0 and first in the value of wind energy systems of the utilities tested. (SRP was not tested for wind energy systems.)

6.6.4.2 Sensitivity Tests

The sensitivity of solar break-even investment to fuel escalation rate is shown on Figure 6.6-22. This curve provides a multiplier by which the break-even investment for SCE shown on Figure 6.6-10 and Table 6.6-1 may be adjusted for different assumed fuel escalation rates. The fuel cost is escalated uniformly at the rate indicated from 1985 to 2020. The base escalation rate was 6.7 percent at which the break-even investment for solar thermal with 200 MWh storage was $1,320/kW. At an 8 percent fuel escalation rate, the break-even investment would be increased by 30 percent to approximately $1,720/kW, and for a fuel escalation rate of 10 percent the value would be doubled to approximately $2,640/kW. As indicated on Figure 6.6-22, wind is more sensitive to the fuel escalation rate than photovoltaic or solar thermal. This is due to the fact that most of the value of wind generation to SCE is fuel replacement credit.

The curve in Figure 6.6-14 shows the ITC multiplier for SCE. The ITC effectively changes the fixed charge rate, and the effect for SCE is exactly the same as that described in subsection 6.6.3.2 for ELP for which the base case fixed charge rate was also 19.62 percent.

The sensitivity of break-even investment to cost of debt is shown in Figure 6.6-23. The ratio of debt to total capitalization was fixed at 50 percent. With a reduction in cost of debt, the discount rate used in present worth calculations was decreased as was the fixed charge rate. The overall effect on break-even investment of lowering the cost of debt from the base value of 9 to 5 percent was to increase the break-even investment by 11.4 percent, or to increase the value of solar thermal generation with 200 MWh storage from $1,320 to $1,470/kW. If the cost of debt were reduced to zero, the break-even investment would be increased to $1,770/kW for the same unit.

The sensitivity of break-even investment to accelerated depreciation is shown on Figure 6.6-16. This curve provides a multiplier to adjust break-even investment as shown in Figure 6.6-10 and Table 6.6-1 for different AGPs. The effect of reductions in the AGP for SCE is the same as that reported in subsection 6.6.3.2 for ELP for which an identical fixed charged rate structure was assumed.

Since weather affects all solar units at one site simultaneously, the overall effect of plant shutdown due to cloud cover is far more critical than outages of individual solar plants due to mechanical failure.

At Inyokern, California, cloud cover exceeded the shutdown level as shown in Table 6.5-1, on the average, about 18 percent of the time. The typical monthly outages varied from 6 percent in July to 25 percent in February. A sensitivity analysis was made in which these outages were reduced by half and the equivalent capacity and fuel savings recalculated. This change resulted in an increase in equivalent capacity from approximately 86 to 106 percent of the conventional capacity replaced and an increase in capacity factor from 36 to 40 percent. As a result, the break-even investment in solar thermal generation with 200 MWh storage was increased from $1,320 to $1,550/kW.

6.6.4.3 Present Worth of Revenue Requirements (1985-2000)

Two 15-year solar expansion plans were developed, one for solar thermal units with 600 MWh storage and one for wind generators. These two plans are shown on Table 6.6-13.

Tables 6.6-14, 6.6-15, and 6.6-16 summarize the PWRR calculations for the base case generation expansion plan and the solar thermal and wind energy expansion plans, respectively. An investment in solar thermal generation of $1,800/kW is required to make the PWRR a break-even with the base case expansion plan. The wind system break-even investment is $550/kW.

	Solar Break-Even Investment, $/kW (1985 Dollars)	
	ST-6	W-0
Year 2000 Analysis	1,780	510
1986-2000 Expansion	1,800	550

In general, one would expect the break-even investment to be less for the 1985 through 2000 analyses than for the one year analysis of the year 2000, since solar capacity should become more valuable in the later years due to fuel escalation. In the case for SCE, however, another element is at work which almost exactly counteracts the expected trend. A large part of the SCE generation will be oil-fired at the beginning of the study period. The addition of coal-fired and nuclear capacity through time will reduce the percentage of energy supplied by oil, and the mix of replaced fuel will change toward more coal and less oil as the plan progresses year-by-year from 1986 toward 2000. As a result, relatively higher fuel replacement costs will exist in the earlier years, so that, in effect, the value of solar capacity is fairly constant over the study period (in 1985 dollars).

It is worth noting that the first solar thermal unit installed in 1986 replaces 94 MW of conventional generation but the last nine units installed in 2000 each replace only 35 MW due to the reduction in equivalent capacity with increased solar penetration.

6.6.5 Public Service Company of Colorado

6.6.5.1 One Year Analyses

Solar thermal with 200 and 600 MWh storage (ST-2 and ST-6) and wind energy systems with no storage (W-0) were modeled for PSC. The results of these studies can be found in Figures 6.6-5, 6.6-11, and Table 6.6-1. Briefly, the results are summarized as follows.

SOLAR BREAK-EVEN INVESTMENT

Type	$/kW	Penetration (%)	Ratio of Conventional to Solar Capacity	CF (%)
ST-6	1,260	10	1.04	35
ST-2	930	10	0.84	25
Wind-0(1)	420	5	0.47	26
Wind-0(2)	100	5	0.32	16

(1) based on SCE wind data
(2) based on ELP wind data

Solar thermal with 600 MWh storage replaces slightly more conventional capacity than the solar capacity installed. On a clear day the solar units generate at least 100 MW for 16 hours per day from 7 a.m. until midnight. They generate 120 MW during the summer peak.

PSC plans to install 6,000 MW of new generation between 1986 and 2000, 43 percent of which will be coal and 37 percent nuclear. The remainder will be combustion turbines and pumped storage. The solar thermal units for PSC have the second highest capacity replacement value of the six utilities studied, even though the solar capacity factors are considerably lower than those for utilities that are located farther south. Since a large part of the new generation installed is coal-fired capacity, practically all the fuel replaced by solar generation is coal and the average fuel replacement value is 52.1 mills/kWh (in 2000).

Of the six utilities, PSC ranks third in break-even investment of solar thermal systems. As can be seen from Table 6.6-1, PSC has the second highest capacity value of the six utilities and the capacity value accounts for more than half the value of solar generation.

The wind data available on the Aerospace Corporation weather tape for Grand Junction, Colorado were not adequate to determine the suitability of a wind energy system because this location was not selected for its suitability for wind energy systems, but two analyses were made, one using data from ELP and one supplied by SCE. The major difference between these two sets of data is the 0.16 capacity factor produced by the ELP data as compared to 0.26 capacity factor produced by SCE data. The wind energy system has a higher capacity value and lower fuel replacement value for PSC than for SCE resulting in a slightly lower value to PSC. The value of wind generation to PSC based on the ELP data, however, is higher than the value of wind generation to ELP.

6.6.5.2 Sensitivity Tests

The sensitivity of solar break-even investment to fuel escalation rate is shown in Figure 6.6–24. This curve provides a multiplier by which the break-even investment shown in Figure 6.6–11 and Table 6.6–1 for PSC may be adjusted for different assumed fuel escalation rates. The cost of fuel is escalated uniformly at the rate indicated from 1985 through 2020. The base escalation rate was 8 percent, at which point the break-even investment for solar thermal with 200 MWh storage was $930/kW. At a 10 percent fuel escalation rate the break-even investment would be increased by 25 percent to approximately $1,160/kW. The value of wind energy systems to PSC is more sensitive to fuel escalation rate changes than the solar thermal units because of its lower capacity credit.

The curve in Figure 6.6–14 shows the ITC multiplier. The ITC effectively changes the fixed charge rate and the effect of changes in ITC on PSC is the same as that reported in subsection 6.6.3.2 for ELP which was assumed to have the same fixed charge rate structure as PSC.

The sensitivity of break-even investment to cost of debt is shown in Figure 6.6–25. The ratio of debt to total capitalization was fixed at 50 percent. With the reduction in cost of debt, the discount rate used in present worth calculations was decreased as well as the fixed charge rate. The overall effect on break-even investment of lowering the cost of debt from the base value of 9 to 5 percent was to increase the break-even investment by 11.2 percent or to increase the value of solar thermal generation with 200 MWh storage from $930 to $1,030/kW. If the cost of debt were reduced to zero, the break-even investment would be increased to $1,210/kW for the same unit.

The sensitivity of break-even investment to accelerated depreciation is shown in Figure 6.6–16. This curve provides a multiplier to convert break-even investment as shown in Figure 6.6–11 and Table 6.6–1 for different AGPs. The effect of assuming a shorter AGP is the same for PSC as that reported in subsection 6.6.3.2 for ELP.

6.6.5.3 Present Worth of Revenue Requirements (1985-2000)

Two 15-year expansion plans were developed for PSC, one for solar thermal with 200 MWh storage and the other with 600 MWh storage. The base case expansion plan plus these two plans are shown on Tables 6.6–17 through 6.6–20.

The only difference between these two plans is the larger amount of conventional capacity replaced by solar thermal with 600 MWh storage. As can be seen, solar generation was installed in some years when no suitable replacement could be made for base plan capacity so that the replacement was delayed until the next coal-fired unit or combustion turbine was scheduled to be installed. The break-even investment in the 15-year plan was a little less than that developed for the one year plan analysis for the year 2000. This is partly due to the fact that solar becomes more economical with time for PSC based on the 8 percent fuel escalation rate used.

	Solar Break-Even Investment, $/kW (1985 Dollars) ST-2	ST-6
Year 2000 Analysis	900	1,240
1985-2000 Expansion	810	1,150

6.6.6 Arizona Public Service Company

6.6.6.1 One Year Analyses

Solar thermal plants with 600 and 200 MWh storage (ST–6 and ST–2) and photovoltaic systems with no storage (PV–0) were modeled for APS. The results are shown in Figures 6.6–6, 6.6–12 and Table 6.6–1, and can be summarized as follows.

	Break-Even ¢	Penetration	Ratio of Conventional to Solar	CF
ST-6	970	10	0.94	45
ST-2	720	10	0.78	34
PV-0	490	10	0.37	24

Thirty-six percent of the generation to be installed by APS during the study period will be nuclear and 48 percent coal. The fuel replaced by solar generation is almost entirely coal, at 43¢/million Btu (2000). APS ranks third of the six utilities in terms of capacity value for solar generation, fourth for fuel replacement value, and fifth in total value of solar thermal generation. It ranks third of the three utilities studied for photovoltaic generation.

6.6.6.2 Sensitivity Tests

The sensitivity of solar break-even investment to fuel escalation rate is shown on Figure 6.6-26. This curve provides a multiplier by which the break-even investment shown in Figure 6.6-12 and Table 6.6-1 for APS may be adjusted for different assumed fuel escalation rates. The fuel was escalated uniformly at the rate indicated from 1985 to 2020. The base escalation rate was 4.9 percent at which the break-even investment for solar thermal with 200 MWh storage was $720/kW. At 8 percent fuel escalation rate, the break-even investment would be increased by 45 percent to approximately $1,040/kW and to $1,480/kW if the fuel escalation rate were 10 percent. The value of photovoltaic is slightly more sensitive to fuel escalation rate than solar thermal because a larger part of the value of photovoltaic to APS is fuel replacement cost.

The curve on Figure 6.6-14 shows the ITC multiplier for APS. The ITC effectively changes the fixed charge rate and the effect of changes in ITC are the same for APS as that reported in subsection 6.6.3.2 for ELP which has an identical assumed fixed charge rate structure.

The sensitivity of break-even investment to cost of debt is shown in Figure 6.6-27. The ratio of debt to total capitalization was fixed at 50 percent. With a reduction in cost of debt, the discount rate used in present worth calculations was decreased as was the fixed charge rate. The overall effect on break-even investment of lowering the cost of debt from the base value of 9 to 5 percent was to increase the break-even investment by 9 percent or to increase the value of solar thermal generation with 200 MWh storage from $720 to $780/kW. If the cost of debt were reduced to zero, the break-even investment would be increased to $890/kW.

The sensitivity of break-even investment to accelerated depreciation is shown in Figure 6.6-16. This curve provides a multiplier to adjust break-even investment as shown in Figure 6.6-12 and Table 6.6-1 for different AGPs. The changes in AGP have the same effect on APS as that reported in subsection 6.6.3.2 for ELP which has an identical assumed fixed charge rate structure.

6.6.6.3 Present Worth of Revenue Requirements (1985-2000)

Two 15-year expansion plans were developed for APS, one for solar thermal with 200 MWh storage and the other for photovoltaic with no storage. The base case expansion plan plus these two plans are shown in Tables 6.6-21, 6.6-22, 6.6-23, and 6.6-24.

The break-even investment in solar for these 15-year expansion plans compares as follows to the one year analysis break-even investment.

	Solar Break-Even Investment, $/kW (1985 Dollars)	
	ST-2	PV-0
Year 2000 Analysis	695	470
1985-2000 Expansion	630	485

6.7 LOAD GROWTH RATE

Analysis of the expansion plan for each utility and the integration of solar generation into this plan is useful in determining the effects of load growth rate on choice of solar generation, break-even investment in solar generation, and penetration.

The system load growth rates projected by the six utilities varies from a low of 2.9 percent for SRP to a high of 7.3 percent for PSNM. The load growth rate is expressed as the average compound annual percentage increase from 1985 to 2000.

The choice of type of solar generation as a function of load growth rate is a function of the degree to which capacity value contributes to the total value of the particular technology. For example, zero load growth would eliminate the capacity credit portion of the break-even investment.

Low load growth also reduces the rate at which new, efficient nuclear and coal fired capacity will be added to the system and, as a result, increases the fuel replacement value over the life of the solar unit. This also tends to make fuel savers relatively more valuable than units with high capacity value. For example, the analysis of SCE (with a load growth rate of 3.6 percent) has shown a tendency toward a more efficient fuel mix with time which results in slightly higher break-even investment for solar installed early in the study period. If the load growth rate was higher, the fuel replacement costs in later years would be relatively less and would result in lower break-even investment.

The effect on potential solar penetration is demonstrated by the SRP results in which a 10 percent penetration of solar thermal with storage would have replaced more conventional capacity (oil and coal fired) than is planned for addition between 1985-2000. On the other hand, it would be possible to install 10 percent photovoltaic generation because of its low capacity value.

6.8 HYDROELECTRIC STORAGE

The effect of hydroelectric storage on the capacity replacement value of solar thermal with no storage was tested for the PSC system for the year 2000.

Two base cases without solar generation were developed that exhibited the same reliability in terms of LOLH. Case A capacity consisted entirely of conventional thermal units and Case B capacity included three 100 MW hydroelectric units with 20 percent annual capacity factor operated in the peak shaving mode.

Three solar thermal units, each with a capability of generating 120 MW and with no storage, were added to each of these base case systems and thermal capacity was reduced to produce the target LOLH.

In both cases, 157 MW of thermal capacity was replaced by the solar generation. The analysis was repeated with twice the hydroelectric capacity and four times the hydroelectric energy; i.e., 600 MW of hydroelectric with a 40 percent capacity factor, with no discernible change in the capacity replaced by the solar thermal units.

Figures 6.5-5 and 6.5-11 show the summer and winter load shapes for PSC. It can be seen that there may be some advantage to hydroelectric storage during the winter months since solar generation does not coincide with the daily peak, but this advantage is offset by competition between solar and hydroelectric for peak shaving credit in the summer months.

This analysis was limited to a small amount of hydroelectric in a utility system, and the results are not necessarily applicable to systems which may be energy limited and largely dependent upon hydroelectric capacity.

SOUTHWEST

TABLE 6.5-1

SOLAR THERMAL AND PHOTOVOLTAIC

	Percent of Time Plant Is Shutdown Due to Cloud Cover				
	Albuquerque	Phoenix	El Paso	Grand Junction	Inyokern
Month					
January	39	29	16	29	16
February	36	32	22	57	25
March	32	29	42	32	23
April	23	3	20	20	23
May	13	3	6	48	19
June	10	3	17	20	20
July	23	10	36	10	6
August	6	6	6	19	13
September	43	20	23	23	17
October	23	3	13	16	23
November	27	13	27	20	23
December	19	23	23	26	6
Average	25	15	21	27	18

SOUTHWEST

TABLE 6.6-1

SOLAR BREAK-EVEN INVESTMENT, $/kW
FOR SIX SOUTHWEST UTILITIES
(1985 DOLLARS)

	PSNM[1]	SRP[2]	ELP[3]	SCE[3]	PSC[3]	APS[3]
Solar Thermal						
600 MWh Storage						
Capacity		590	1,150	522	927	815
Fuel		2,220	250	1,588	620	509
O&M		-540	-260	-330	-287	-354
Total		2,270	1,140	1,780	1,260	970
200 MWh Storage						
Capacity	320	390	1,020	433	758	680
Fuel	1,180	1,710	110	1,197	455	383
O&M	-390	-520	-250	-310	-283	-343
Total	1,110	1,580	880	1,320	930	720
No Storage						
Capacity				140		
Fuel				1,140		
O&M				-300		
Total				980		
Photovoltaic						
No Storage						
Capacity		170		125		318
Fuel		1,370		992		284
O&M		-160		-97		-112
Total		1,380		1,020		490
Wind						
No Storage						
Capacity			390	260	430	
Fuel			230	740	470	
O&M			-490	-490	-490	
Total			30	510	410	
Hybrid						
Capacity	800	600				
Fuel	760	680				
O&M	-400	-510				
Total	1,160	770				

NOTES:

1. 1 percent market penetration
2. 5 percent market penetration
3. 10 percent market penetration

TABLE 6.6-2

SOLAR BREAK-EVEN INVESTMENT
PUBLIC SERVICE COMPANY OF NEW MEXICO
(1985 DOLLARS)

Type	Break-Even ($/kW)	Penetration (Percent)	Ratio of Conventional to Solar Capacity	Capacity Factor (Percent)
ST-2	1,110	1.0	0.4	36
Hybrid	1,160	1.0	1.0	26(1)

NOTE:

1. Solar portion only

ECONOMIC ANALYSIS
PUBLIC SERVICE OF NEW MEXICO
PWC ST2 - $980 PER KW - SOUTHWEST PROJECT

TABLE 6.6-3
PUBLIC SERVICE OF NEW MEXICO
15 YEAR EXPANSION PLAN
BASE CASE

STUDY NO 40
STUDY PERIOD 1985 TO 2000
END EFFECTS PERIOD 20 YEARS

INFLATION RATES -
INVESTMENT = 0.0600
OPERATION & MAINT = 0.0600
FUEL (SEE TABLE 3.2-1)

DISCOUNT RATE = 0.1100

LEVELIZED FIXED CHARGES

CONVENTIONAL	NUCLEAR	PEAKING	TRANSMISSION
0.1461	0.1461	0.1461	0.0

ALL COSTS IN THOUSANDS OF DOLLARS

						-------NEW CAPACITY---------			
YEAR	MW PEAK LD	MW CAPACITY	MW RES	PC RES	TOTAL GWH	MW	INVEST	OPER EXP	TRANS INVEST
1985	1545.	2096.	551.	35.66	9565.	300.	182910.	3119.	0.
1986	1635.	2226.	591.	36.15	10157.	130.	157676.	2287.	0.
1987	1720.	2216.	496.	28.84	10694.	0.	47729.	506.	0.
1988	1831.	2452.	621.	33.92	11393.	236.	163840.	1737.	0.
1989	1946.	2416.	470.	24.15	12085.	0.	125762.	1333.	0.
1990	2080.	2706.	626.	30.10	12891.	290.	252549.	2677.	0.
1991	2245.	2706.	461.	20.53	13939.	0.	193854.	2055.	0.
1992	2422.	2996.	574.	23.70	15051.	290.	198533.	2104.	0.
1993	2614.	3236.	622.	23.79	16293.	300.	374253.	3967.	0.
1994	2818.	3636.	818.	29.03	17530.	400.	477983.	5066.	0.
1995	3041.	3636.	595.	19.57	18958.	0.	236175.	2504.	0.
1996	3280.	4036.	756.	23.05	20480.	400.	494130.	5238.	0.
1997	3538.	4186.	648.	18.32	22046.	250.	612699.	6495.	0.
1998	3822.	4566.	744.	19.47	23841.	400.	567608.	6016.	0.
1999	4129.	4891.	762.	18.45	25769.	400.	709915.	7525.	0.
2000	4459.	5291.	832.	18.66	27856.	400.	1391614.	14752.	0.

COST SUMMARY

YEAR	FUEL COST	OPERATING EXPENSE	PROPERTY TAX	FIXED CHARGES	CUMULATIVE INVESTMENT	ANNUAL COST	ANNUAL COST PRES. WORTH	CUMULATIVE ANNUAL COST	CUM ANN COST PRES. WORTH
1985	168519.	3119.	0.	26723.	182910.	198361.	178703.	198361.	178703.
1986	180626.	5592.	0.	49760.	340586.	235978.	191525.	434338.	370228.
1987	201466.	6434.	0.	56733	388315.	264633.	193498.	698971.	563726.
1988	232705.	8557.	0.	80670	552155.	321931.	212066.	1020902.	775792.
1989	263942.	10403.	0.	99044	677917.	373389.	221588.	1394291.	997380.
1990	289041.	13704.	0.	135941	930466.	438686.	234540.	1832977.	1231919.
1991	345314.	16582.	0.	164263.	1124319.	526159.	253429.	2359136.	1485348.
1992	382712.	19681.	0.	193269.	1322852.	595661.	258474.	2954797.	1743822.
1993	436040.	24828.	0.	247947.	1697106.	708815.	277094.	3663612.	2020916.
1994	477478.	31384.	0.	317780.	2175089.	826642.	291131.	4490252.	2312047.
1995	550015.	35771.	0.	352285.	2411263.	938071.	297635.	5428322.	2609682.
1996	609608.	43155.	0.	424478.	2905393.	1077240.	307920.	6505562.	2917602.
1997	740292.	52239.	0.	513993.	3518092.	1306523.	336449.	7812083.	3254051.
1998	803030.	61389.	0.	596920.	4085700.	1461338.	339024.	9273421.	3593074.
1999	892953.	72598.	0.	700638.	4795613.	1666188.	348242.	10939609.	3941316.
2000	946832.	91705.	0.	903953.	6187225.	1942490.	365757.	12882096.	4307070.
TERM	13171150.	1170779.		7198466.		21540384.	4055899.	34422480.	8362967.

END EFFECT FINAL YEAR FUEL ESCALATION
1.0000 PU. ESCALATED AT 0.0700 PU.

TABLE 6.6-4
PUBLIC SERVICE OF NEW MEXICO
15 YEAR EXPANSION PLAN
HYBRID

ECONOMIC ANALYSIS
PUBLIC SERVICE OF NEW MEXICO
PHC HYBRID - $1150/KW - SOUTHWEST PROJECT

STUDY NO 40
STUDY PERIOD 1985 TO 2000
END EFFECTS PERIOD 20 YEARS

INFLATION RATES -
INVESTMENT = 0.0600
OPERATION & MAINT = 0.0600
FUEL (SEE TABLE 3.2-1)

DISCOUNT RATE = 0.1100

LEVELIZED FIXED CHARGES

CONVENTIONAL	NUCLEAR	PEAKING	TRANSMISSION
0.1461	0.1461	0.1461	0.0

ALL COSTS IN THOUSANDS OF DOLLARS

						-------NEW CAPACITY---------			
YEAR	MW PEAK LD	MW CAPACITY	MW RES	PC RES	TOTAL GWH	MW	INVEST	OPER EXP	TRANS INVEST
1985	1545.	2066.	521.	33.72	9565.	300.	172525.	2877.	0.
1986	1635.	2196.	561.	34.31	10157.	130.	152254.	2161.	0.
1987	1720.	2186.	466.	27.09	10694.	0.	47729.	506.	0.
1988	1831.	2422.	591.	32.28	11393.	236.	163840.	1737.	0.
1989	1946.	2336.	440.	22.61	12085.	0.	125762.	1333.	0.
1990	2080.	2676.	596.	28.65	12881.	290.	252549.	2677.	0.
1991	2245.	2676.	431.	19.20	13939.	0.	193854.	2055.	0.
1992	2422.	2966.	544.	22.46	15051.	290.	198533.	2104.	0.
1993	2614.	3206.	592.	22.65	16293.	300.	374253.	3967.	0.
1994	2818.	3606.	789.	27.96	17530.	400.	477983.	5066.	0.
1995	3041.	3606.	565.	18.58	18958.	0.	236175.	2504.	0.
1996	3280.	4006.	726.	22.13	20480.	400.	494130.	5238.	0.
1997	3538.	4156.	618.	17.47	22046.	250.	612699.	6495.	0.
1998	3822.	4536.	714.	18.68	23641.	400.	567608.	6016.	0.
1999	4129.	4861.	732.	17.73	25769.	400.	709915.	7525.	0.
2000	4459.	5261.	802.	17.99	27856.	400.	1391614.	14752.	0.

COST SUMMARY

YEAR	FUEL COST	OPERATING EXPENSE	PROPERTY TAX	FIXED CHARGES	CUMULATIVE INVESTMENT	ANNUAL COST	ANNUAL COST PRES. WORTH	CUMULATIVE ANNUAL COST	CUM ANN COST PRES. WORTH
1985	169656.	2077.	0.	25206.	172525.	197739.	178143.	197739.	178143.
1986	182377.	5210.	0.	47450.	324779.	235037.	190761.	432776.	368904.
1987	203546.	6029.	0.	54423.	372508.	263998.	193034.	696774.	561938.
1988	234423.	8128.	0.	78360.	536348.	320911.	211394.	1017686.	773332.
1989	266547.	9948.	0.	96734.	662110.	373229.	221494.	1390915.	994826.
1990	291735.	13222.	0.	133632.	914659.	438589.	234483.	1829503.	1229313.
1991	347475.	16071.	0.	161954.	1108512.	525499.	253111.	2355002.	1482424.
1992	384965.	19139.	0.	190959.	1307045.	595064.	258214.	2950046.	1740638.
1993	438477.	24254.	0.	245638.	1681299.	708369.	276919.	3658435.	2017558.
1994	478808.	30775.	0.	315471.	2159282.	825054.	290572.	4483489.	2308129.
1995	553036.	35126.	0.	349976.	2395456.	930138.	297656.	5421625.	2605785.
1996	612961.	42471.	0.	422168.	2839586.	1077600.	308023.	6499221.	2913803.
1997	738092.	51514.	0.	511683.	3502285.	1301288.	335101.	7800508.	3243909.
1998	803186.	60621.	0.	594611.	4069893.	1458416.	338346.	9258921.	3587255.
1999	897464.	71783.	0.	698329.	4779806.	1667575.	348531.	10926497.	3935787.
2000	951181.	90842.	0.	901644.	6171418.	1943666.	365978.	12870160.	4301762.
TERM	13231652.	1159752.		7180075.		21571472.	4061752.	34441632.	8363511.

END EFFECT FINAL YEAR FUEL ESCALATION
1.0000 FU. ESCALATED AT 0.0700 PU.

ECONOMIC ANALYSIS
PUBLIC SERVICE OF NEW MEXICO
PWC BASE CASE - SOUTHWEST PROJECT

TABLE 6.6-5
PUBLIC SERVICE OF NEW MEXICO
15 YEAR EXPANSION PLAN
SOLAR THERMAL-200 MWh STORAGE

STUDY NO 40
STUDY PERIOD 1985 TO 2000
END EFFECTS PERIOD 20 YEARS

INFLATION RATES -
INVESTMENT = 0.0600
OPERATION & MAINT = 0.0600
FUEL (SEE TABLE 3.2-1)

DISCOUNT RATE = 0.1100

LEVELIZED FIXED CHARGES

CONVENTIONAL	NUCLEAR	PEAKING	TRANSMISSION
0.1461	0.1461	0.1461	0.0

ALL COSTS IN THOUSANDS OF DOLLARS

YEAR	MW PEAK LD	MW CAPACITY	MW RES	PC RES	TOTAL GWH	NEW CAPACITY MW	NEW CAPACITY INVEST	NEW CAPACITY OPER EXP	TRANS INVEST
1985	1545.	2066.	521.	33.72	9565.	300.	160800.	1704.	0.
1986	1635.	2196.	561.	34.31	10157.	130.	146132.	1549.	0.
1987	1720.	2186.	466.	27.09	10694.	0.	47729.	506.	0.
1988	1831.	2422.	591.	32.28	11393.	236.	163840.	1737.	0.
1989	1946.	2386.	440.	22.61	12085.	0.	125762.	1333.	0.
1990	2080.	2676.	596.	28.65	12881.	290.	252549.	2677.	0.
1991	2245.	2676.	431.	19.20	13939.	0.	193854.	2055.	0.
1992	2422.	2966.	544.	22.46	15051.	290.	198533.	2104.	0.
1993	2614.	3206.	592.	22.65	16293.	300.	374253.	3967.	0.
1994	2818.	3606.	788.	27.96	17530.	400.	477983.	5066.	0.
1995	3041.	3606.	565.	18.58	18958.	0.	236175.	2504.	0.
1996	3280.	4006.	726.	22.13	20480.	400.	494130.	5238.	0.
1997	3538.	4156.	618.	17.47	22046.	250.	612699.	6495.	0.
1998	3822.	4536.	714.	18.68	23841.	400.	567608.	6016.	0.
1999	4129.	4861.	732.	17.73	25769.	400.	709915.	7525.	0.
2000	4459.	5261.	802.	17.99	27856.	400.	1391614.	14752.	0.

COST SUMMARY

YEAR	FUEL COST	OPERATING EXPENSE	PROPERTY TAX	FIXED CHARGES	CUMULATIVE INVESTMENT	ANNUAL COST	ANNUAL COST PRES. WORTH	CUMULATIVE ANNUAL COST	CUM ANN COST PRES. WORTH
1985	171482.	1704.	0.	23493.	160800.	196680.	177189.	196680.	177189.
1986	184474.	3356.	0.	44843.	306932.	232673.	188843.	429353.	366032.
1987	205710.	4064.	0.	51816.	354661.	261590.	191272.	690943.	557304.
1988	237444.	6045.	0.	75753.	518502.	319242.	210295.	1010184.	767599.
1989	268703.	7740.	0.	94127.	644264.	370570.	219915.	1380754.	987514.
1990	293656.	10881.	0.	131024.	896813.	435561.	232869.	1816315.	1220382.
1991	350383.	13590.	0.	159346.	1090665.	523319.	252061.	2339634.	1472444.
1992	388843.	16509.	0.	188352.	1289199.	593704.	257624.	2933338.	1730068.
1993	443637.	21466.	0.	243030.	1663452.	708134.	276827.	3641472.	2006895.
1994	484211.	27821.	0.	312863.	2141435.	824895.	290516.	4466364.	2297411.
1995	559050.	31994.	0.	347368.	2377610.	938412.	297743.	5404774.	2595154.
1996	617691.	39151.	0.	419561.	2871739.	1076402.	307681.	6481174.	2902835.
1997	752700.	47995.	0.	509076.	3484438.	1309770.	337285.	7790944.	3240120.
1998	810288.	56890.	0.	592003.	4052046.	1459180.	338523.	9250123.	3578643.
1999	905505.	67829.	0.	695721.	4761960.	1669054.	348840.	10919178.	3927484.
2000	959222.	86650.	0.	899036.	6153572.	1944907.	366212.	12864081.	4293696.
TERM	13343494.	1106240.		7159308.		21609040.	4068825.	34473120.	8362520.

END EFFECT FINAL YEAR FUEL ESCALATION
1.0000 PU. ESCALATED AT 0.0700 PU.

TABLE 6.6-6

SOLAR BREAK-EVEN INVESTMENT
SALT RIVER PROJECT
(1985 DOLLARS)

Type	Break-Even ($/kW)	Penetration (Percent)	Ratio of Conventional to Solar Capacity	Capacity Factor (Percent)
ST-6	2,270	5	0.98	45
ST-2	1,580	5	0.65	35
PV-0	1,380	5	0.33	24
Hybrid	1,330	5	0	28
Hybrid	770	5	1.0	28

ECONOMIC ANALYSIS
SALT RIVER PROJECT
PWC BASE CASE - SOUTHWEST PROJECT
STUDY NO 50
STUDY PERIOD 1985 TO 2000
END EFFECTS PERIOD 20 YEARS

TABLE 6.6-7
SALT RIVER PROJECT
15 YEAR EXPANSION PLAN
BASE CASE

INFLATION RATES -
INVESTMENT = 0.0600
OPERATION & MAINT = 0.0600
FUEL (SEE TABLE 3.2-1)

DISCOUNT RATE = 0.0835

LEVELIZED FIXED CHARGES

CONVENTIONAL	NUCLEAR	PEAKING	TRANSMISSION
0.1188	0.1188	0.1188	0.0

ALL COSTS IN THOUSANDS OF DOLLARS

						-------NEW	CAPACITY---------		
YEAR	MW PEAK LD	MW CAPACITY	MW RES	PC RES	TOTAL GWH	MW	INVEST	OPER EXP	TRANS INVEST
1985	2836.	3876.	1040.	36.67	15845.	0.	0.	0.	0.
1986	2963.	4229.	1266.	42.73	16678.	286.	195432.	2072.	0.
1987	3080.	4229.	1149.	37.31	17641.	0.	150011.	1590.	0.
1988	3185.	4229.	1044.	32.78	18454.	0.	0.	0.	0.
1989	3280.	4229.	949.	28.93	19223.	0.	0.	0.	0.
1990	3386.	4349.	963.	28.44	20076.	120.	29421.	312.	0.
1991	3474.	4599.	1125.	32.38	20837.	0.	22583.	239.	0.
1992	3572.	4599.	1027.	28.75	21666.	0.	0.	0.	0.
1993	3667.	4719.	1052.	28.69	22440.	120.	35040.	372.	0.
1994	3769.	4839.	1070.	28.39	23018.	120.	64039.	679.	0.
1995	3870.	5089.	1219.	31.50	23634.	0.	28510.	302.	0.
1996	3963.	5089.	1126.	28.41	24217.	0.	0.	0.	0.
1997	4061.	5439.	1376.	33.93	24824.	350.	524324.	5558.	0.
1998	4158.	5439.	1281.	30.81	25411.	0.	273745.	2901.	0.
1999	4254.	5499.	1245.	29.27	25988.	60.	24922.	264.	0.
2000	4350.	5619.	1269.	29.17	26535.	120.	109969.	1166.	0.

COST SUMMARY

YEAR	FUEL COST	OPERATING EXPENSE	PROPERTY TAX	FIXED CHARGES	CUMULATIVE INVESTMENT	ANNUAL COST	ANNUAL COST PRES. WORTH	CUMULATIVE ANNUAL COST	CUM ANN COST PRES. WORTH
1985	208155.	0.	0.	0.	0.	208155.	192114.	208155.	192114.
1986	214287.	2072.	0.	23217.	195432.	239576.	204073.	447731.	396187.
1987	245491.	3786.	0.	41039.	345443.	290316.	228236.	738047.	624422.
1988	291497.	4013.	0.	41039.	345443.	336549.	244193.	1074595.	868615.
1989	354762.	4254.	0.	41039.	345443.	400055.	267901.	1474650.	1136516.
1990	415420.	4822.	0.	44534.	374864.	464775.	287256.	1939425.	1423772.
1991	469604.	5350.	0.	47217.	397446.	522170.	297858.	2461595.	1721630.
1992	558656.	5671.	0.	47217.	397446.	611543.	321956.	3073138.	2043586.
1993	643124.	6383.	0.	51379.	432487.	700886.	340555.	3774024.	2384141.
1994	778161.	7444.	0.	58987.	496526.	844593.	378755.	4618616.	2762895.
1995	867024.	8193.	0.	62374.	525036.	937591.	388057.	5556207.	3150952.
1996	946648.	8685.	0.	62374.	525036.	1017706.	388755.	6573912.	3539707.
1997	964251.	14764.	0.	124664.	1049359.	1103678.	389105.	7677587.	3928812.
1998	1063706.	18550.	0.	157185.	1323105.	1239442.	403294.	8917028.	4332105.
1999	1149472.	19927.	0.	160146.	1348026.	1329545.	399272.	10246574.	4731375.
2000	1337254.	22289.	0.	173210.	1457995.	1532753.	424825.	11779325.	5156196.
TERM	18860640.	356934.		1657203.		20874784.	5785747.	32654096.	10941943.

END EFFECT FINAL YEAR FUEL ESCALATION
0.3400 PU. ESCALATED AT 0.0600 PU.
0.1500 PU. ESCALATED AT 0.0300 PU.
0.5100 PU. ESCALATED AT 0.0400 PU.

END OF DATA

TABLE 6.6-8

EL PASO ELECTRIC COMPANY
SOLAR EXPANSION PLANS

	Early Plan			Delayed Plan		
	Solar Capacity Installed	Conventional Capacity Removed		Solar Capacity Installed	Conventional Capacity Removed	
	MWe	Type	MWe	MWe	Type	MWe
1986	100	Nuclear	100			
1987				50	Coal	56
1988						
1989						
1990						
1991						
1992				50	Coal	55
1993						
1994	100	Coal	100			
1995						
1996				100	Coal	100
1997						
1998	100	Coal	92	100	Coal	90
1999						
2000						

ECONOMIC ANALYSIS
EL PASO ELECTRIC COMPANY
PWC BASE CASE - SOUTHWEST PROJECT
STUDY NO 30
STUDY PERIOD 1985 TO 2000
END EFFECTS PERIOD 20 YEARS

TABLE 6.6-9
EL PASO ELECTRIC COMPANY
15 YEAR EXPANSION PLAN
BASE CASE

INFLATION RATES -
INVESTMENT = 0.0600
OPERATION & MAINT = 0.0600
FUEL (SEE TABLE 3.2-1)

DISCOUNT RATE = 0.1200

LEVELIZED FIXED CHARGES

CONVENTIONAL	NUCLEAR	PEAKING	TRANSMISSION
0.1962	0.1962	0.1962	0.0

ALL COSTS IN THOUSANDS OF DOLLARS

						-------NEW	CAPACITY---------		
YEAR	MW PEAK LD	MW CAPACITY	MW RES	PC RES	TOTAL GWH	MW	INVEST	OPER EXP	TRANS INVEST
1985	1135.	1498.	363.	31.98	6118.	0.	0.	0.	0.
1986	1195.	1672.	477.	39.92	6452.	200.	95663.	1013.	0.
1987	1258.	1672.	414.	32.91	6810.	0.	73429.	779.	0.
1988	1325.	1793.	468.	35.32	7178.	121.	88522.	938.	0.
1989	1400.	1793.	393.	28.07	7568.	0.	67949.	720.	0.
1990	1475.	1914.	439.	29.76	7983.	121.	85631.	908.	0.
1991	1555.	1914.	359.	23.09	8416.	0.	65730.	696.	0.
1992	1638.	1985.	347.	21.18	8868.	71.	62290.	660.	0.
1993	1725.	2085.	360.	20.87	9392.	100.	90337.	958.	0.
1994	1816.	2285.	469.	25.83	9916.	200.	309361.	3279.	0.
1995	1910.	2285.	375.	19.63	10424.	0.	212407.	2251.	0.
1996	2008.	2485.	477.	23.75	10958.	200.	248826.	2636.	0.
1997	2110.	2585.	475.	22.51	11559.	100.	244680.	2594.	0.
1998	2216.	2785.	569.	25.68	12169.	200.	320788.	3400.	0.
1999	2326.	2785.	459.	19.73	12766.	0.	214602.	2274.	0.
2000	2440.	2985.	545.	22.34	13389.	200.	541615.	5741.	0.

COST SUMMARY

YEAR	FUEL COST	OPERATING EXPENSE	PROPERTY TAX	FIXED CHARGES	CUMULATIVE INVESTMENT	ANNUAL COST	ANNUAL COST PRES. WORTH	CUMULATIVE ANNUAL COST	CUM ANN COST PRES. WORTH
1985	138163.	0.	0.	0.	0.	138163.	123360.	138163.	123360.
1986	133564.	1013.	0.	18769.	95663.	153346.	122247.	291509.	245607.
1987	144324.	1853.	0.	33176.	169092.	179353.	127660.	470862.	373266.
1988	147537.	2902.	0.	50544.	257614.	200983.	127728.	671845.	500995.
1989	170714.	3797.	0.	63875.	325563.	238386.	135267.	910231.	636261.
1990	191886.	4932.	0.	80676.	411194.	277494.	140587.	1187725.	776848.
1991	224572.	5924.	0.	93572.	476923.	324068.	146592.	1511793.	923440.
1992	251579.	6940.	0.	105794.	539214.	364312.	147140.	1876105.	1070579.
1993	283254.	8314.	0.	123518.	629550.	415085.	149684.	2291190.	1220263.
1994	310339.	12092.	0.	184214.	938911.	506645.	163126.	2797835.	1383389.
1995	349904.	15069.	0.	225889.	1151318.	590861.	169858.	3388696.	1553247.
1996	385223.	18609.	0.	274708.	1400144.	678540.	174164.	4067236.	1727411.
1997	430819.	22319.	0.	322714.	1644824.	775852.	177305.	4843085.	1905216.
1998	469901.	27058.	0.	385653.	1965613.	882612.	180600.	5725696.	2085816.
1999	541175.	30956.	0.	427758.	2180215.	999888.	182676.	6725582.	2268492.
2000	598220.	38554.	0.	534023.	2721830.	1170796.	190982.	7896379.	2459474.
TERM	7263973.	454669.		3988848.		11707490.	1909744.	19603856.	4269215.

END EFFECT FINAL YEAR FUEL ESCALATION
0.5500 PU. ESCALATED AT 0.0700 PU.
0.2800 PU. ESCALATED AT 0.0500 PU.
0.0900 PU. ESCALATED AT 0.0650 PU.
0.0800 PU. ESCALATED AT 0.0600 PU.

TABLE 6.6-10
EL PASO ELECTRIC COMPANY
15 YEAR EXPANSION PLAN
SOLAR THERMAL-200 MWh STORAGE
(REPLACING NUCLEAR CAPACITY)

ECONOMIC ANALYSIS
EL PASO ELECTRIC COMPANY
PWC ST2 - $702 PER KW INVEST - SOUTHWEST PROJECT
STUDY NO 30
STUDY PERIOD 1985 TO 2000
END EFFECTS PERIOD 20 YEARS

INFLATION RATES -
INVESTMENT = 0.0600
OPERATION & MAINT = 0.0600
FUEL (SEE TABLE 3.2-1)

DISCOUNT RATE = 0.1200

LEVELIZED FIXED CHARGES

CONVENTIONAL	NUCLEAR	PEAKING	TRANSMISSION
0.1962	0.1962	0.1962	0.0

ALL COSTS IN THOUSANDS OF DOLLARS

YEAR	MW PEAK LD	MW CAPACITY	MW RES	PC RES	TOTAL GWH	NEW CAPACITY MW	NEW CAPACITY INVEST	NEW CAPACITY OPER EXP	TRANS INVEST
1985	1135.	1498.	363.	31.98	6118.	0.	0.	0.	0.
1986	1195.	1672.	477.	39.92	6452.	200.	90990.	3309.	0.
1987	1258.	1672.	414.	32.91	6810.	0.	69843.	2540.	0.
1988	1325.	1793.	468.	35.32	7178.	121.	88522.	938.	0.
1989	1400.	1793.	393.	28.07	7568.	0.	67949.	720.	0.
1990	1475.	1914.	439.	29.76	7983.	121.	85631.	908.	0.
1991	1555.	1914.	359.	23.09	8416.	0.	65730.	696.	0.
1992	1638.	1985.	347.	21.18	8868.	71.	62290.	660.	0.
1993	1725.	2085.	360.	20.87	9392.	100.	90337.	958.	0.
1994	1816.	2285.	469.	25.83	9916.	200.	239789.	6279.	0.
1995	1910.	2285.	375.	19.63	10424.	0.	159004.	4554.	0.
1996	2008.	2485.	477.	23.75	10958.	200.	248826.	2636.	0.
1997	2110.	2585.	475.	22.51	11559.	100.	244680.	2594.	0.
1998	2216.	2793.	577.	26.04	12169.	208.	281820.	7705.	0.
1999	2326.	2793.	467.	20.08	12766.	0.	184691.	5579.	0.
2000	2440.	2993.	553.	22.66	13389.	200.	541615.	5741.	0.

COST SUMMARY

YEAR	FUEL COST	OPERATING EXPENSE	PROPERTY TAX	FIXED CHARGES	CUMULATIVE INVESTMENT	ANNUAL COST	ANNUAL COST PRES. WORTH	CUMULATIVE ANNUAL COST	CUM ANN COST PRES. WORTH
1985	138163.	0.	0.	0.	0.	138163.	123360.	138163.	123360.
1986	135970.	3309.	0.	17852.	90990.	157131.	125264.	295294.	248624.
1987	149428.	6048.	0.	31555.	160833.	187031.	133125.	482326.	381749.
1988	155453.	7349.	0.	48923.	249355.	211725.	134555.	694051.	516304.
1989	179874.	8510.	0.	62255.	317304.	250639.	142219.	944689.	658523.
1990	201676.	9928.	0.	79056.	402935.	290660.	147257.	1235348.	805780.
1991	234228.	11220.	0.	91952.	468664.	337400.	152623.	1572748.	958403.
1992	263444.	12553.	0.	104173.	530954.	380170.	153544.	1952919.	1111946.
1993	296345.	14264.	0.	121897.	621291.	432506.	155966.	2385425.	1267912.
1994	313827.	21399.	0.	168944.	861080.	504169.	162329.	2889594.	1430241.
1995	346606.	27236.	0.	200141.	1020084.	573983.	165006.	3463577.	1595248.
1996	380274.	31507.	0.	248960.	1268910.	660741.	169596.	4124318.	1764843.
1997	428530.	35991.	0.	296967.	1513591.	761487.	174513.	4885803.	1939356.
1998	461438.	45855.	0.	352260.	1795411.	859553.	175881.	5745352.	2115237.
1999	531851.	54185.	0.	388496.	1980102.	974532.	178043.	6719881.	2293281.
2000	587981.	63178.	0.	494761.	2521716.	1145918.	186924.	7865798.	2480205.
TERM	7139647.	745048.		3695586.		11580276.	1888993.	19446064.	4369195.

END EFFECT FINAL YEAR FUEL ESCALATION
0.5500 PU. ESCALATED AT 0.0700 PU.
0.2800 PU. ESCALATED AT 0.0500 PU.
0.0900 PU. ESCALATED AT 0.0650 PU.
0.0800 PU. ESCALATED AT 0.0600 PU.

TABLE 6.6-11
EL PASO ELECTRIC COMPANY
15 YEAR EXPANSION PLAN
SOLAR THERMAL-200 MWh STORAGE
(REPLACING COAL-FIRED CAPACITY)

ECONOMIC ANALYSIS
EL PASO ELECTRIC COMPANY
PWC ST2 - $1435 PER KW INVEST - SOUTHWEST PROJECT
STUDY NO 30
STUDY PERIOD 1985 TO 2000
END EFFECTS PERIOD 20 YEARS

INFLATION RATES -
INVESTMENT = 0.0600
OPERATION & MAINT = 0.0600
FUEL (SEE TABLE 3.2-1)

DISCOUNT RATE = 0.1200

LEVELIZED FIXED CHARGES

CONVENTIONAL	NUCLEAR	PEAKING	TRANSMISSION
0.1962	0.1962	0.1962	0.0

ALL COSTS IN THOUSANDS OF DOLLARS

YEAR	MW PEAK LD	MW CAPACITY	MW RES	PC RES	TOTAL GWH	NEW CAPACITY MW	NEW CAPACITY INVEST	NEW CAPACITY OPER EXP	TRANS INVEST
1985	1135.	1498.	363.	31.98	6118.	0.	0.	0.	0.
1986	1195.	1672.	477.	39.92	6452.	200.	95663.	1013.	0.
1987	1258.	1672.	414.	32.91	6810.	0.	73429.	779.	0.
1988	1325.	1787.	462.	34.87	7178.	115.	89460.	1997.	0.
1989	1400.	1787.	387.	27.64	7568.	0.	68668.	1534.	0.
1990	1475.	1908.	433.	29.36	7983.	121.	85631.	908.	0.
1991	1555.	1908.	353.	22.70	8416.	0.	65730.	696.	0.
1992	1638.	1974.	336.	20.51	8868.	66.	76611.	2136.	0.
1993	1725.	2074.	349.	20.23	9392.	100.	101328.	2107.	0.
1994	1816.	2274.	458.	25.22	9916.	200.	309361.	3279.	0.
1995	1910.	2274.	364.	19.06	10424.	0.	212407.	2251.	0.
1996	2008.	2474.	466.	23.21	10958.	200.	282407.	6336.	0.
1997	2110.	2574.	464.	21.99	11559.	100.	270456.	5433.	0.
1998	2216.	2784.	568.	25.63	12169.	210.	372499.	7705.	0.
1999	2326.	2784.	458.	19.69	12766.	0.	254294.	5579.	0.
2000	2440.	2984.	544.	22.30	13389.	200.	541615.	5741.	0.

COST SUMMARY

YEAR	FUEL COST	OPERATING EXPENSE	PROPERTY TAX	FIXED CHARGES	CUMULATIVE INVESTMENT	ANNUAL COST	ANNUAL COST PRES. WORTH	CUMULATIVE ANNUAL COST	CUM ANN COST PRES. WORTH
1985	138163.	0.	0.	0.	0.	138163.	123360.	138163.	123360.
1986	133564.	1013.	0.	18769.	95663.	153346.	122247.	291509.	245607.
1987	144324.	1853.	0.	33176.	169092.	179353.	127660.	470862.	373266.
1988	145427.	3962.	0.	50728.	258552.	200117.	127178.	670979.	500444.
1989	167347.	5733.	0.	64201.	327221.	237281.	134639.	908259.	635083.
1990	188322.	6985.	0.	81002.	412852.	276308.	139986.	1184567.	775069.
1991	220616.	8100.	0.	93898.	478581.	322614.	145934.	1507180.	921003.
1992	244275.	10722.	0.	108929.	555192.	363925.	146983.	1871106.	1067986.
1993	273469.	13472.	0.	128809.	656520.	415750.	149924.	2286855.	1217910.
1994	299467.	17559.	0.	189506.	965881.	506532.	163090.	2793387.	1380999.
1995	337824.	20864.	0.	231180.	1178287.	589868.	169573.	3383255.	1550572.
1996	364097.	28452.	0.	286588.	1460694.	679137.	174318.	4062392.	1724889.
1997	404001.	35592.	0.	339652.	1731151.	779244.	178583.	4841635.	1903472.
1998	432227.	45432.	0.	412736.	2103649.	890395.	182192.	5732028.	2085664.
1999	496509.	53737.	0.	462628.	2357943.	1012874.	185048.	6744899.	2270712.
2000	551108.	62702.	0.	568893.	2899558.	1182703.	192924.	7927599.	2463636.
TERM	6691905.	739446.		4249311.		11680657.	1905367.	19608256.	4369002.

END EFFECT FINAL YEAR FUEL ESCALATION
0.5500 PU. ESCALATED AT 0.0700 PU.
0.2800 PU. ESCALATED AT 0.0500 PU.
0.0900 PU. ESCALATED AT 0.0650 PU.
0.0800 PU. ESCALATED AT 0.0600 PU.

TABLE 6.6-12

SOLAR BREAK-EVEN INVESTMENT
SOUTHERN CALIFORNIA EDISON COMPANY
(1985 DOLLARS)

Type	Break-Even ($/kW)	Penetration (Percent)	Ratio of Conventional to Solar Capacity	Capacity Factor (Percent)
ST-6	1,780	10	0.85	47
ST-2	1,320	10	0.72	36
ST-0	1,050	10	0.62	30
PV-0	1,020	10	0.20	26
Wind-0	510	7	0.40	26
Wind-2	590	7	0.55	26

TABLE 6.6-13

SOLAR EXPANSION PLANS
SOUTHERN CALIFORNIA EDISON COMPANY

Year	Solar Capacity Installed (MWe)	Solar Thermal 6-Hr Storage: Conventional Capacity Removed — Type	MWe	Penetration (Percent)
1985				
1986	100	CC	94	0.5
1987	100	FC	94	1.0
1988				
1989	100	CT	94	1.5
1990				
1991	200	Coal	188	1.9
1992				
1993	400	Coal	376	3.0
1994	100	CT	94	3.7
1995	100	CT	94	4.5
1996	300	Coal	282	5.5
1997	400	CT	267	6.8
1998	600	CT, Coal	577	8.8
1999	300	CT	202	9.5
2000	900	CT, Coal	314	12.3
Total	3,600		2,676	12.3
		Wind - No Storage		
1985				
1986	210.0	CC	130	1.1
1987	42.0	FC	26	1.3
1988	42.0	FC	23	1.5
1989	52.5	CT	28	1.8
1990	52.5	CT	28	1.9
1991	126.0	Coal	64	2.5
1992				
1993	94.5	Coal	72	2.8
1994	126.0	CT	63	3.2
1995	136.5	CT	47	3.8
1996	157.5	Coal	61	4.3
1997	199.5	CT	74	4.8
1998	231.0	Coal	80	5.5
1999	273.0	CT	72	6.3
2000	315.0	Coal	48	7.2
Total	2,058.0		816	7.2

NOTES:

CC = Combined Cycle

FC = Fuel Cell

CT = Combustion Turbine

TABLE 6.6-14
SOUTHERN CALIFORNIA EDISON COMPANY
15 YEAR EXPANSION PLAN
BASE CASE

ECONOMIC ANALYSIS
SOUTHERN CALIFORNIA EDISON COMPANY
PWC BASE CASE - SOUTHWEST PROJECT
STUDY NO 10
STUDY PERIOD 1985 TO 2000
END EFFECTS PERIOD 20 YEARS

INFLATION RATES -
INVESTMENT = 0.0600
OPERATION & MAINT = 0.0600
FUEL (SEE TABLE 3.2-1)

DISCOUNT RATE = 0.1200

LEVELIZED FIXED CHARGES

CONVENTIONAL	NUCLEAR	PEAKING	TRANSMISSION
0.1962	0.1962	0.1962	0.0

ALL COSTS IN THOUSANDS OF DOLLARS

YEAR	MW PEAK LD	MW CAPACITY	MW RES	PC RES	TOTAL GWH	NEW CAPACITY MW	NEW CAPACITY INVEST	NEW CAPACITY OPER EXP	TRANS INVEST
1985	14880.	17200.	2320.	15.59	83688.	1082.	300147.	3181.	0.
1986	15420.	18401.	2981.	19.33	87056.	1201.	847059.	8979.	0.
1987	15990.	19090.	3100.	19.39	89836.	1289.	865816.	9178.	0.
1988	16550.	19104.	2554.	15.43	93130.	345.	886428.	9396.	0.
1989	17150.	19709.	2559.	14.92	96284.	605.	419409.	4446.	0.
1990	17760.	20768.	3008.	16.94	99748.	1059.	657404.	6968.	0.
1991	18380.	21268.	2888.	15.71	103324.	500.	1210122.	12827.	0.
1992	19050.	22378.	3328.	17.47	107221.	1110.	1400818.	14849.	0.
1993	19730.	23528.	3798.	19.25	111188.	1150.	2202967.	23352.	0.
1994	20440.	24418.	3978.	19.46	115454.	890.	1229103.	13028.	0.
1995	21118.	24466.	3348.	15.85	119666.	260.	939274.	9956.	0.
1996	21930.	25336.	3406.	15.53	124166.	870.	1107841.	11743.	0.
1997	22719.	26446.	3727.	16.40	128855.	1110.	1891928.	20054.	0.
1998	23537.	27368.	3831.	16.28	133727.	1070.	2357915.	24994.	0.
1999	24385.	28374.	3989.	16.36	138789.	1150.	2487948.	26371.	0.
2000	25263.	29334.	4071.	16.11	144048.	1070.	3647912.	38669.	0.

COST SUMMARY

YEAR	FUEL COST	OPERATING EXPENSE	PROPERTY TAX	FIXED CHARGES	CUMULATIVE INVESTMENT	ANNUAL COST	ANNUAL COST PRES. WORTH	CUMULATIVE ANNUAL COST	CUM ANN COST PRES. WORTH
1985	2375255.	3181.	0.	58889.	300147.	2437325.	2176183.	2437325.	2176183.
1986	2655926.	12351.	0.	225082.	1147206.	2893359.	2306568.	5330681.	4482752.
1987	2972539.	22270.	0.	394955.	2013021.	3389764.	2412767.	8720445.	6895517.
1988	3288069.	33002.	0.	568872.	2899449.	3889943.	2472129.	12610387.	9367646.
1989	3590210.	39428.	0.	651160.	3318858.	4280798.	2429040.	16891168.	11796684.
1990	3980704.	48762.	0.	780142.	3976262.	4809605.	2436695.	21700784.	14233378.
1991	4405968.	64515.	0.	1017568.	5186383.	5488050.	2482515.	27188832.	16715890.
1992	4675039.	83235.	0.	1292408.	6587199.	6050680.	2443768.	33239504.	19159648.
1993	4973346.	111580.	0.	1724630.	8790163.	6809554.	2455593.	40049072.	21615248.
1994	5412311.	131303.	0.	1965780.	10019266.	7509393.	2417823.	47558464.	24033072.
1995	6069477.	149138.	0.	2150066.	10958536.	8368680.	2405795.	55927136.	26438864.
1996	6756065.	169829.	0.	2367424.	12066377.	9293316.	2385362.	65220464.	28824224.
1997	7354626.	200073.	0.	2738620.	13958303.	10293317.	2358962.	75513712.	31183184.
1998	8081432.	237071.	0.	3201243.	16316215.	11519746.	2357167.	87033440.	33540352.
1999	8879890.	277667.	0.	3689379.	18804160.	12846936.	2347086.	99880336.	35887424.
2000	9757089.	332995.	0.	4405096.	22452064.	14495178.	2364476.	114375456.	38251904.
TERM	122397184.	3926985.		32903600.		159227760.	25973472.	273603072.	64225392.

END EFFECT FINAL YEAR FUEL ESCALATION
0.7000 PU. ESCALATED AT 0.0700 PU.
0.2200 PU. ESCALATED AT 0.0650 PU.
0.0800 PU. ESCALATED AT 0.0500 PU.

ECONOMIC ANALYSIS
SOUTHERN CALIFORNIA EDISON COMPANY
PWC ST6 - $1800 PER KW INVEST - SOUTHWEST PROJECT
STUDY NO 10
STUDY PERIOD 1985 TO 2000
END EFFECTS PERIOD 20 YEARS

TABLE 6.6-15
SOUTHERN CALIFORNIA EDISON COMPANY
15 YEAR EXPANSION PLAN
SOLAR THERMAL-600 MWh STORAGE

INFLATION RATES -
INVESTMENT = 0.0600
OPERATION & MAINT = 0.0600
FUEL (SEE TABLE 3.2-1)

DISCOUNT RATE = 0.1200

LEVELIZED FIXED CHARGES

CONVENTIONAL	NUCLEAR	PEAKING	TRANSMISSION
0.1962	0.1962	0.1962	0.0

ALL COSTS IN THOUSANDS OF DOLLARS

YEAR	MW PEAK LD	MW CAPACITY	MW RES	PC RES	TOTAL GWH	NEW CAPACITY MW	NEW CAPACITY INVEST	NEW CAPACITY OPER EXP	TRANS INVEST
1985	14880.	17200.	2320.	15.59	83688.	1082.	300147.	3182.	0.
1986	15420.	18407.	2987.	19.37	87056.	1207.	915991.	11293.	0.
1987	15990.	19102.	3112.	19.46	89836.	1295.	1011499.	15724.	0.
1988	16550.	19135.	2585.	15.62	93130.	364.	886428.	9397.	0.
1989	17150.	19746.	2596.	15.14	96284.	611.	514281.	7325.	0.
1990	17760.	20805.	3045.	17.15	99748.	1059.	757968.	10020.	0.
1991	18380.	21317.	2937.	15.98	103324.	512.	1318513.	18186.	0.
1992	19050.	22427.	3377.	17.73	107221.	1110.	1515713.	20529.	0.
1993	19730.	23601.	3871.	19.62	111188.	1174.	2512464.	36092.	0.
1994	20440.	24497.	4057.	19.85	115454.	896.	1684130.	30387.	0.
1995	21118.	24551.	3433.	16.26	119666.	266.	1208428.	18125.	0.
1996	21930.	25439.	3509.	16.00	124166.	888.	1526954.	27454.	0.
1997	22719.	26573.	3854.	16.96	128855.	1134.	2824474.	50842.	0.
1998	23537.	27518.	3981.	16.91	133727.	1093.	3693852.	70806.	0.
1999	24385.	28622.	4237.	17.38	138789.	1248.	3723781.	69669.	0.
2000	25263.	30168.	4905.	19.42	144048.	1656.	7735562.	156682.	0.

COST SUMMARY

YEAR	FUEL COST	OPERATING EXPENSE	PROPERTY TAX	FIXED CHARGES	CUMULATIVE INVESTMENT	ANNUAL COST	ANNUAL COST PRES. WORTH	CUMULATIVE ANNUAL COST	CUM ANN COST PRES. WORTH
1985	2375255.	3182.	0.	58889.	300147.	2437326.	2176184.	2437326.	2176184.
1986	2642945.	14666.	0.	2[illegible]8606.	1216137.	2896218.	2308847.	5333540.	4485029.
1987	2919208.	31270.	0.	4[illegible]7062.	2227636.	3387540.	2411184.	8721080.	6896214.
1988	3233238.	42543.	0.	6[illegible]0979.	3114064.	3886760.	2470106.	12607840.	9366319.
1989	3519699.	52421.	0.	7[illegible]1881.	3628345.	4284001.	2430857.	16891824.	11797176.
1990	3893713.	65586.	0.	860594.	4386312.	4819894.	2441908.	21711728.	14239084.
1991	4286657.	87708.	0.	11[illegible]9286.	5704822.	5493649.	2485048.	27205376.	16724131.
1992	4521738.	113499.	0.	1416669.	7220535.	6051905.	2444263.	33257280.	19168384.
1993	4752613.	156400.	0.	1909614.	9732997.	6818627.	2458865.	40075904.	21627248.
1994	5104447.	196171.	0.	2240041.	11417124.	7540658.	2427890.	47616560.	24055136.
1995	5719592.	226066.	0.	2477134.	12625551.	8422793.	2421351.	56039360.	26476496.
1996	6313541.	267084.	0.	2776723.	14152503.	9357344.	2401796.	65396704.	28878288.
1997	6753583.	333950.	0.	3330885.	16976976.	10418417.	2387631.	75815120.	31265920.
1998	7243649.	424793.	0.	4055618.	20670816.	11724058.	2398973.	87539120.	33664896.
1999	7798927.	519950.	0.	4786221.	24394608.	13105094.	2394251.	100644144.	36059136.
2000	8136687.	707828.	0.	6303936.	32130160.	15148449.	2471038.	115792608.	38530176.
TERM	102070144.	8347361.		47086880.		157504304.	25692336.	273296896.	64222528.

END EFFECT FINAL YEAR FUEL ESCALATION
0.7000 PU. ESCALATED AT 0.0700 PU.
0.2200 PU. ESCALATED AT 0.0650 PU.
0.0800 PU. ESCALATED AT 0.0500 PU.

TABLE 6.6-16
SOUTHERN CALIFORNIA EDISON COMPANY
15 YEAR EXPANSION PLAN
WIND - NO STORAGE

ECONOMIC ANALYSIS
SOUTHERN CALIFORNIA EDISON COMPANY
PWC WDO - $546 PER KW INVEST - SOUTHWEST PROJECT
STUDY NO 10
STUDY PERIOD 1985 TO 2000
END EFFECTS PERIOD 20 YEARS

INFLATION RATES -
INVESTMENT = 0.0600
OPERATION & MAINT = 0.0600
FUEL (SEE TABLE 3.2-1)

DISCOUNT RATE = 0.1200

LEVELIZED FIXED CHARGES

CONVENTIONAL	NUCLEAR	PEAKING	TRANSMISSION
0.1962	0.1962	0.1962	0.0

ALL COSTS IN THOUSANDS OF DOLLARS

YEAR	MW PEAK LD	MW CAPACITY	MW RES	PC RES	TOTAL GWH	NEW CAPACITY MW	NEW CAPACITY INVEST	NEW CAPACITY OPER EXP	TRANS INVEST
1985	14880.	17200.	2320.	15.59	83688.	1082.	300147.	3181.	0.
1986	15420.	18481.	3061.	19.85	87056.	1281.	872690.	16472.	0.
1987	15990.	19186.	3196.	19.99	89836.	1305.	882584.	20071.	0.
1988	16550.	19219.	2669.	16.13	93130.	364.	881478.	11778.	0.
1989	17150.	19849.	2699.	15.74	96284.	630.	430170.	7570.	0.
1990	17760.	20933.	3173.	17.87	99748.	1084.	683923.	11808.	0.
1991	18380.	21495.	3115.	16.95	103324.	562.	1222949.	21177.	0.
1992	19050.	22604.	3554.	18.66	107221.	1110.	1399516.	20981.	0.
1993	19730.	23777.	4047.	20.51	111188.	1173.	2211754.	30502.	0.
1994	20440.	24730.	4290.	20.99	115454.	953.	1279715.	27951.	0.
1995	21118.	24868.	3750.	17.76	119666.	350.	1036486.	26236.	0.
1996	21930.	25835.	3905.	17.81	124166.	967.	1195038.	30772.	0.
1997	22719.	27071.	4352.	19.16	128855.	1236.	2010381.	44612.	0.
1998	23537.	28144.	4607.	19.57	133727.	1221.	2489633.	56176.	0.
1999	24385.	29351.	4966.	20.36	138789.	1351.	2673647.	65305.	0.
2000	25263.	30578.	5315.	21.04	144048.	1337.	4109980.	113768.	0.

COST SUMMARY

YEAR	FUEL COST	OPERATING EXPENSE	PROPERTY TAX	FIXED CHARGES	CUMULATIVE INVESTMENT	ANNUAL COST	ANNUAL COST PRES. WORTH	CUMULATIVE ANNUAL COST	CUM ANN COST PRES. WORTH
1985	2375255.	3181.	0.	58889.	300147.	2437325.	2176183.	2437325.	2176183.
1986	2641975.	19844.	0.	230111.	1172836.	2891930.	2305428.	5329252.	4481609.
1987	2937968.	41105.	0.	403273.	2055420.	3382347.	2407488.	8711598.	6889095.
1988	3247918.	55349.	0.	576219.	2936898.	3879487.	2465484.	12591083.	9354575.
1989	3543229.	66240.	0.	660619.	3367068.	4270088.	2422963.	16861168.	11777536.
1990	3924303.	82022.	0.	794804.	4050992.	4801130.	2432402.	21662288.	14209937.
1991	4333666.	108121.	0.	1034747.	5273939.	5476532.	2477305.	27138832.	16687239.
1992	4590055.	135589.	0.	1309332.	6673453.	6034976.	2437426.	33173808.	19124656.
1993	4877692.	174226.	0.	1743278.	8885207.	6795194.	2450415.	39968992.	21575072.
1994	5287038.	212631.	0.	1994358.	10164920.	7494025.	2412875.	47463024.	23987936.
1995	5916614.	251624.	0.	2197716.	11201404.	8365953.	2405011.	55828976.	26392944.
1996	6569381.	297494.	0.	2432183.	12396441.	9299058.	2386836.	65128032.	28779776.
1997	7125053.	359955.	0.	2826619.	14406819.	10311626.	2363158.	75439664.	31142944.
1998	7798480.	437728.	0.	3315085.	16896448.	11551293.	2363622.	86990912.	33506560.
1999	8531468.	529297.	0.	3839655.	19570096.	12900417.	2356857.	99891280.	35863408.
2000	9294217.	674822.	0.	4646031.	23680064.	14615068.	2384033.	114506320.	38247440.
TERM	116590704.	7958122.		34703248.		159252016.	25977424.	273758208.	64224880.

END EFFECT FINAL YEAR FUEL ESCALATION
0.7000 PU. ESCALATED AT 0.0700 PU.
0.2200 PU. ESCALATED AT 0.0650 PU.
0.0800 PU. ESCALATED AT 0.0500 PU.

ECONOMIC ANALYSIS
PUBLIC SERVICE COMPANY OF COLORADO
PWC BASE CASE - SOUTHWEST PROJECT
STUDY NO 30
STUDY PERIOD 1985 TO 2000
END EFFECTS PERIOD 20 YEARS

TABLE 6.6-17
PUBLIC SERVICE COMPANY OF COLORADO
15 YEAR EXPANSION PLAN
BASE CASE

INFLATION RATES -
INVESTMENT = 0.0600
OPERATION & MAINT = 0.0600
FUEL (SEE TABLE 3.2-1)

DISCOUNT RATE = 0.1200

LEVELIZED FIXED CHARGES

CONVENTIONAL	NUCLEAR	PEAKING	TRANSMISSION
0.1962	0.1962	0.1962	0.0

ALL COSTS IN THOUSANDS OF DOLLARS

YEAR	MW PEAK LD	MW CAPACITY	MW RES	PC RES	TOTAL GWH	NEW CAPACITY MW	NEW CAPACITY INVEST	NEW CAPACITY OPER EXP	TRANS INVEST
1985	3716.	4178.	462.	12.43	21139.	0.	0.	0.	0.
1986	3932.	4578.	646.	15.43	22249.	400.	399709.	4237.	0.
1987	4152.	4978.	826.	19.89	23431.	400.	480416.	5092.	0.
1988	4381.	4978.	597.	13.63	24728.	0.	119846.	1270.	0.
1989	4645.	5578.	933.	20.09	26065.	600.	687188.	7284.	0.
1990	4910.	5978.	1068.	21.75	27538.	400.	369691.	3919.	0.
1991	5195.	5978.	783.	15.07	29087.	0.	44831.	475.	0.
1992	5481.	6578.	1097.	20.01	30653.	600.	572915.	6073.	0.
1993	5811.	6578.	767.	13.20	32426.	0.	202430.	2146.	0.
1994	6152.	7378.	1226.	19.93	34459.	800.	626479.	6641.	0.
1995	6513.	7378.	865.	13.28	36446.	0.	221356.	2346.	0.
1996	6881.	8178.	1297.	18.85	38477.	800.	1313904.	13927.	0.
1997	7301.	8178.	877.	12.01	40677.	0.	464247.	4921.	0.
1998	7731.	9178.	1447.	18.72	42758.	1000.	1934969.	20511.	0.
1999	8174.	9178.	1004.	12.28	45308.	0.	683689.	7247.	0.
2000	8634.	10178.	1544.	17.88	47634.	1000.	2640528.	27989.	0.

COST SUMMARY

YEAR	FUEL COST	OPERATING EXPENSE	PROPERTY TAX	FIXED CHARGES	CUMULATIVE INVESTMENT	ANNUAL COST	ANNUAL COST PRES. WORTH	CUMULATIVE ANNUAL COST	CUM ANN COST PRES. WORTH
1985	323145.	0.	0.	0.	0.	323145.	288522.	323145.	288522.
1986	365926.	4237.	0.	78423.	399709.	448586.	357610.	771731.	646132.
1987	416372.	9584.	0.	172681.	880126.	598636.	426097.	1370366.	1072229.
1988	476923.	11429.	0.	196194.	999971.	684546.	435041.	2054912.	1507270.
1989	502918.	19399.	0.	331021.	1687159.	853337.	484206.	2908250.	1991476.
1990	570898.	24482.	0.	403554.	2056850.	998933.	506090.	3907183.	2497567.
1991	650432.	26426.	0.	412349.	2101680.	1089207.	492702.	4996386.	2990269.
1992	672909.	34084.	0.	524755.	2674595.	1231747.	497482.	6228131.	3487751.
1993	777261.	38275.	0.	564472.	2877025.	1380007.	497645.	7608135.	3985395.
1994	896857.	47212.	0.	687387.	3503504.	1631455.	525285.	9239588.	4510679.
1995	1041718.	52391.	0.	730817.	3724859.	1824925.	524622.	11064512.	5035298.
1996	1196164.	69462.	0.	988605.	5038764.	2254231.	578605.	13318742.	5613899.
1997	1390785.	78551.	0.	1079689.	5503008.	2549026.	584171.	15867764.	6198067.
1998	1381726.	103774.	0.	1459330.	7437975.	2944831.	602571.	18812592.	6800637.
1999	1623380.	117248.	0.	1593470.	8121663.	3334098.	609127.	22146688.	7409762.
2000	1816326.	152272.	0.	2111541.	10762190.	4080140.	665559.	26226832.	8075317.
TERM	25344976.	1795729.		15772037.		42912736.	6999994.	69139552.	15075311.

END EFFECT FINAL YEAR FUEL ESCALATION
1.0000 PU. ESCALATED AT 0.0800 PU.

END OF DATA

TABLE 6.6-18
PUBLIC SERVICE COMPANY OF COLORADO
15 YEAR EXPANSION PLAN
SOLAR THERMAL-200 MWh STORAGE

ECONOMIC ANALYSIS
PUBLIC SERVICE COMPANY OF COLORADO
PWC ST2 - $810 PER KW INVEST - SOUTHWEST PROJECT
STUDY NO 30
STUDY PERIOD 1985 TO 2000
END EFFECTS PERIOD 20 YEARS
INFLATION RATES -
INVESTMENT = 0.0600
OPERATION & MAINT = 0.0600
FUEL (SEE TABLE 3.2-1)

DISCOUNT RATE = 0.1200

LEVELIZED FIXED CHARGES

CONVENTIONAL	NUCLEAR	PEAKING	TRANSMISSION
0.1962	0.1962	0.1962	0.0

ALL COSTS IN THOUSANDS OF DOLLARS

						-------NEW	CAPACITY---------		
YEAR	MW PEAK LD	MW CAPACITY	MW RES	PC RES	TOTAL GWH	MW	INVEST	OPER EXP	TRANS INVEST
1985	3716.	4178.	462.	12.43	21139.	0.	0.	0.	0.
1986	3932.	4588.	656.	16.68	22249.	410.	374166.	6907.	0.
1987	4152.	5000.	848.	20.42	23431.	412.	465121.	9087.	0.
1988	4381.	5000.	619.	14.13	24728.	0.	117630.	2348.	0.
1989	4645.	5600.	955.	20.56	26065.	600.	687188.	7284.	0.
1990	4910.	6014.	1104.	22.48	27538.	414.	423712.	8205.	0.
1991	5195.	6014.	819.	15.77	29087.	0.	63918.	1989.	0.
1992	5481.	6614.	1133.	20.67	30653.	600.	572915.	6073.	0.
1993	5811.	6714.	903.	15.54	32426.	100.	331530.	9410.	0.
1994	6152.	7443.	1291.	20.99	34459.	729.	660645.	11691.	0.
1995	6513.	7543.	1030.	15.81	36446.	100.	378485.	12293.	0.
1996	6881.	8276.	1395.	20.27	38477.	733.	1155089.	17510.	0.
1997	7301.	8376.	1075.	14.72	40677.	100.	571117.	15359.	0.
1998	7731.	9476.	1745.	22.57	42758.	1100.	2107734.	30232.	0.
1999	8174.	9676.	1502.	18.38	45308.	200.	1049950.	27857.	0.
2000	8634.	10458.	1824.	21.13	47634.	782.	1924838.	38135.	0.

COST SUMMARY

YEAR	FUEL COST	OPERATING EXPENSE	PROPERTY TAX	FIXED CHARGES	CUMULATIVE INVESTMENT	ANNUAL COST	ANNUAL COST PRES. WORTH	CUMULATIVE ANNUAL COST	CUM ANN COST PRES. WORTH
1985	323145.	0.	0.	0.	0.	323145.	288522.	323145.	288522.
1986	363276.	6907.	0.	73411.	374166.	443594.	353630.	766739.	642152.
1987	409642.	16409.	0.	164668.	839286.	590718.	420462.	1357456.	1062614.
1988	468543.	19741.	0.	187747.	956916.	676031.	429630.	2033487.	1492243.
1989	493798.	28210.	0.	322573.	1644104.	844580.	479237.	2878068.	1971481.
1990	557228.	38107.	0.	405705.	2067816.	1001040.	507158.	3879107.	2478638.
1991	634182.	42382.	0.	418246.	2131734.	1094810.	495236.	4973916.	2973875.
1992	655209.	50998.	0.	530652.	2704649.	1236858.	499546.	6210772.	3473421.
1993	753171.	63463.	0.	595698.	3036179.	1412336.	509303.	7623106.	3982724.
1994	863617.	78967.	0.	725316.	3696824.	1667899.	537019.	9291005.	4519739.
1995	997888.	95998.	0.	799575.	4075309.	1893460.	544325.	11184463.	5064060.
1996	1140113.	119268.	0.	1026203.	5230395.	2285584.	586652.	13470048.	5650710.
1997	1320634.	141783.	0.	1138256.	5801508.	2600723.	596018.	16070770.	6246727.
1998	1295525.	180522.	0.	1551793.	7909240.	3027841.	619556.	19098608.	6866280.
1999	1510689.	219210.	0.	1757794.	8959188.	3487693.	637188.	22586288.	7503466.
2000	1663335.	270498.	0.	2135447.	10884026.	4069280.	663787.	26655568.	8167251.
TERM	23210144.	3189954.		15950594.		42350688.	6908309.	69006256.	15075561.

END EFFECT FINAL YEAR FUEL ESCALATION
1.0000 PU. ESCALATED AT 0.0800 PU.

END OF DATA

ECONOMIC ANALYSIS
PUBLIC SERVICE COMPANY OF COLORADO
PWC ST6 - $1151 PER KW INVEST - SOUTHWEST PROJECT
STUDY NO 30
STUDY PERIOD 1985 TO 2000
END EFFECTS PERIOD 20 YEARS

TABLE 6.6-19
PUBLIC SERVICE COMPANY OF COLORADO
15 YEAR EXPANSION PLAN
SOLAR THERMAL-600 MWh STORAGE

INFLATION RATES -
INVESTMENT = 0.0600
OPERATION & MAINT = 0.0600
FUEL (SEE TABLE 3.2-1)

DISCOUNT RATE = 0.1200

LEVELIZED FIXED CHARGES

CONVENTIONAL	NUCLEAR	PEAKING	TRANSMISSION
0.1962	0.1962	0.1962	0.0

ALL COSTS IN THOUSANDS OF DOLLARS

						-------NEW	CAPACITY---------		
YEAR	MW PEAK LD	MW CAPACITY	MW RES	PC RES	TOTAL GWH	MW	INVEST	OPER EXP	TRANS INVEST
1985	3716.	4178.	462.	12.43	21139.	0.	0.	0.	0.
1986	3932.	4568.	636.	16.17	22249.	390.	381292.	6948.	0.
1987	4152.	4958.	806.	19.41	23431.	390.	477742.	9172.	0.
1988	4381.	4958.	577.	13.17	24728.	0.	121197.	2373.	0.
1989	4645.	5558.	913.	19.66	26065.	600.	687188.	7284.	0.
1990	4910.	5948.	1038.	21.14	27538.	390.	450325.	8443.	0.
1991	5195.	5948.	753.	14.49	29087.	0.	73321.	2073.	0.
1992	5481.	6548.	1067.	19.47	30653.	600.	572915.	6073.	0.
1993	5811.	6648.	837.	14.40	32426.	100.	385880.	9917.	0.
1994	6152.	7338.	1186.	19.28	34459.	690.	688237.	11927.	0.
1995	6513.	7438.	925.	14.20	36446.	100.	449301.	12946.	0.
1996	6881.	8129.	1248.	18.14	38477.	691.	1134697.	17232.	0.
1997	7301.	8229.	928.	12.71	40677.	100.	632535.	15901.	0.
1998	7731.	9329.	1598.	20.67	42758.	1100.	2180466.	30911.	0.
1999	8174.	9529.	1355.	16.58	45308.	200.	1204141.	29295.	0.
2000	8634.	10178.	1544.	17.88	47634.	649.	1737037.	35935.	0.

COST SUMMARY

YEAR	FUEL COST	OPERATING EXPENSE	PROPERTY TAX	FIXED CHARGES	CUMULATIVE INVESTMENT	ANNUAL COST	ANNUAL COST PRES. WORTH	CUMULATIVE ANNUAL COST	CUM ANN COST PRES. WORTH
1985	323145.	0.	0.	0.	0.	323145.	288522.	323145.	288522.
1986	362256.	6948.	0.	74809.	381292.	444014.	353965.	767159.	642487.
1987	407062.	16537.	0.	168542.	859034.	592141.	421474.	1359299.	1063961.
1988	465333.	19903.	0.	192321.	980231.	677557.	430600.	2036956.	1494561.
1989	490288.	28381.	0.	327148.	1667419.	845817.	479939.	2882673.	1974500.
1990	551998.	38527.	0.	415501.	2117744.	1006026.	509684.	3888699.	2484184.
1991	627962.	42912.	0.	429887.	2191065.	1100760.	497928.	4989456.	2982112.
1992	650439.	51560.	0.	542292.	2763981.	1244290.	502548.	6233743.	3484660.
1993	741731.	64570.	0.	618002.	3149861.	1424303.	513618.	7658045.	3998278.
1994	850887.	80371.	0.	753034.	3838098.	1684292.	542297.	9342337.	4540575.
1995	978468.	98140.	0.	841187.	4287399.	1917794.	551320.	11260129.	5091893.
1996	1118624.	121260.	0.	1063814.	5422096.	2303698.	591302.	13563826.	5683191.
1997	1290694.	144437.	0.	1187917.	6054629.	2623049.	601135.	16186871.	6284324.
1998	1259095.	184013.	0.	1615725.	8235094.	3058834.	625898.	19245696.	6910222.
1999	1460089.	224349.	0.	1851977.	9439232.	3536416.	646090.	22782112.	7556308.
2000	1606115.	273745.	0.	2192784.	11176267.	4072645.	664336.	26854752.	8220643.
TERM	22411696.	3228255.		16378871.		42018832.	6854176.	68873536.	15074820.

END EFFECT FINAL YEAR FUEL ESCALATION
1.0000 PU. ESCALATED AT 0.0800 PU.

TABLE 6.6-20

SOLAR THERMAL EXPANSION PLANS
PUBLIC SERVICE COMPANY OF COLORADO

Year	Solar Capacity Installed (MWe)	Conventional Capacity Removed MWe Type	200 MWh Storage	600 MWh Storage	Penetration (Percent)
1986	100	Coal	90	110	2.2
1987	100	Coal	88	110	4.0
1988					
1989					
1990	100	CT	86	110	5.0
1991					
1992					
1993	100				
1994	100	CT	171	210	6.8
1995	100				
1996	100	Coal	167	209	8.6
1997	100				
1998	100				
1999	200				
2000	200	Coal	418	551	12.8
Total	1,300		1,020	1,300	12.8

NOTE:

CT = Combustion Turbine

TABLE 6.6-21
ARIZONA PUBLIC SERVICE COMPANY
15 YEAR EXPANSION PLAN
BASE CASE

ECONOMIC ANALYSIS
ARIZONA PUBLIC SERVICE COMPANY
PWC BASE CASE SOUTHWEST PROJECT
STUDY NO 20
STUDY PERIOD 1985 TO 2000
END EFFECTS PERIOD 20 YEARS

INFLATION RATES -
INVESTMENT = 0.0600
OPERATION & MAINT = 0.0600
FUEL (SEE TABLE 3.2-1)

DISCOUNT RATE = 0.1200

LEVELIZED FIXED CHARGES

CONVENTIONAL	NUCLEAR	PEAKING	TRANSMISSION
0.1962	0.1962	0.1962	0.0

ALL COSTS IN THOUSANDS OF DOLLARS

YEAR	MW PEAK LD	MW CAPACITY	MW RES	PC RES	TOTAL GWH	NEW CAPACITY MW	NEW CAPACITY INVEST	NEW CAPACITY OPER EXP	TRANS INVEST
1985	4345.	4703.	358.	8.24	21773.	100.	15800.	0.	0.
1986	4544.	5063.	519.	11.42	23048.	360.	228726.	0.	0.
1987	4808.	5363.	555.	11.54	24303.	300.	420877.	0.	0.
1988	5046.	5663.	617.	12.23	25665.	300.	359090.	0.	0.
1989	5284.	5963.	679.	12.85	26941.	300.	336701.	0.	0.
1990	5522.	6213.	691.	12.51	28251.	250.	301768.	0.	0.
1991	5759.	6513.	754.	13.09	29564.	300.	319874.	0.	0.
1992	5997.	6663.	666.	11.11	31029.	150.	245842.	0.	0.
1993	6235.	6913.	678.	10.87	32281.	250.	224412.	0.	0.
1994	6472.	7263.	791	12.22	33678.	350.	447370.	0.	0.
1995	6710.	7463.	753.	11.22	35034.	200.	386103.	0.	0.
1996	6948.	7663.	715.	10.29	36498.	200.	273922.	0.	0.
1997	7186.	7963.	777.	10.81	37835.	300.	505056.	0.	0.
1998	7423.	8163.	740.	9.97	39320.	200.	605317.	0.	0.
1999	7661.	8463.	802.	10.47	40671.	300.	562958.	0.	0.
2000	7899.	8463.	564.	7.14	42073.	0.	335034.	0.	0.

COST SUMMARY

YEAR	FUEL COST	OPERATING EXPENSE	PROPERTY TAX	FIXED CHARGES	CUMULATIVE INVESTMENT	ANNUAL COST	ANNUAL COST PRES. WORTH	CUMULATIVE ANNUAL COST	CUM ANN COST PRES. WORTH
1985	328525.	0.	0.	3100.	15800.	331625.	296093.	331625.	296093.
1986	333165.	0.	0.	47976.	244526.	381141.	303843.	712765.	599937.
1987	355134.	0.	0.	130552.	665403.	485686.	345702.	1198451.	945638.
1988	372601.	0.	0.	201006.	1024493.	573606.	364537.	1772057.	1310175.
1989	413820.	0.	0.	267066.	1361193.	680886.	386353.	2452943.	1696528.
1990	454341.	0.	0.	326273.	1662961.	780614.	395483.	3233557.	2092011.
1991	493478.	0.	0.	389032.	1982835.	882510.	399203.	4116067.	2491214.
1992	553330.	0.	0.	437266.	2228677.	990596.	400085.	5106663.	2891299.
1993	615524.	0.	0.	481296.	2453089.	1096819.	395524.	6203482.	3286823.
1994	673407.	0.	0.	569070.	2900459.	1242476.	400044.	7445958.	3686867.
1995	751419.	0.	0.	644823.	3286562.	1396241.	401386.	8842199.	4088253.
1996	833346.	0.	0.	698566.	3560484.	1531911.	393203.	10374107.	4481454.
1997	895026.	0.	0.	797658.	4065539.	1692683.	387919.	12066787.	4869369.
1998	987256.	0.	0.	916421.	4670857.	1903676.	389530.	13970460.	5258899.
1999	1073369.	0.	0.	1026873.	5233811.	2100243.	383706.	16070701.	5642604.
2000	1157163.	0.	0.	1092606.	5568843.	2249770.	366986.	18320454.	6009589.
TERM	12516081.		0.	8161161.		20677232.	3372904.	38997712.	9382494.

END EFFECT FINAL YEAR FUEL ESCALATION
0.9300 PU. ESCALATED AT 0.0500 PU.
0.0700 PU. ESCALATED AT 0.0400 PU.

END OF DATA

TABLE 6.6-22
ARIZONA PUBLIC SERVICE COMPANY
15 YEAR EXPANSION PLAN
SOLAR THERMAL-200MWh STORAGE

ECONOMIC ANALYSIS
ARIZONA PUBLIC SERVICE COMPANY
PWC ST2 - $631 PER KW INVEST - SOUTHWEST PROJECT
STUDY NO 20
STUDY PERIOD 1985 TO 2000
END EFFECTS PERIOD 20 YEARS

INFLATION RATES -
INVESTMENT = 0.0600
OPERATION & MAINT = 0.0600
FUEL (SEE TABLE 3.2-1)

DISCOUNT RATE = 0.1200

LEVELIZED FIXED CHARGES

CONVENTIONAL	NUCLEAR	PEAKING	TRANSMISSION
0.1962	0.1962	0.1962	0.0

ALL COSTS IN THOUSANDS OF DOLLARS

						-------NEW	CAPACITY---------		
YEAR	MW PEAK LD	MW CAPACITY	MW RES	PC RES	TOTAL GWH	MW	INVEST	OPER EXP	TRANS INVEST
1985	4345.	4716.	371.	8.54	21773.	113.	33654.	2279.	0.
1986	4544.	5076.	532.	11.71	23048.	360.	247652.	2416.	0.
1987	4808.	5393.	585.	12.17	24303.	317.	402106.	2561.	0.
1988	5046.	5693.	647.	12.82	25665.	300.	339193.	2714.	0.
1989	5284.	5993.	709.	13.42	26941.	300.	336701.	0.	0.
1990	5522.	6243.	721.	13.06	28251.	250.	301768.	0.	0.
1991	5759.	6561.	802.	13.93	29564.	318.	310495.	3233.	0.
1992	5997.	6711.	714.	11.91	31029.	150.	235900.	3427.	0.
1993	6235.	6979.	744.	11.93	32281.	268.	254128.	3632.	0.
1994	6472.	7329.	857.	13.24	33678.	359.	478868.	3850.	0.
1995	6710.	7548.	838.	12.49	35034.	219.	393445.	4081.	0.
1996	6948.	7748.	800.	11.51	36498.	200.	281704.	4326.	0.
1997	7186.	8071.	885.	12.32	37835.	323.	478467.	4586.	0.
1998	7423.	8471.	1048.	14.12	39320.	400.	711933.	14583.	0.
1999	7661.	8703.	1042.	13.60	40671.	232.	566376.	20610.	0.
2000	7899.	8703.	804.	10.18	42073.	0.	187197.	10923.	0.

COST SUMMARY

YEAR	FUEL COST	OPERATING EXPENSE	PROPERTY TAX	FIXED CHARGES	CUMULATIVE INVESTMENT	ANNUAL COST	ANNUAL COST PRES. WORTH	CUMULATIVE ANNUAL COST	CUM ANN COST PRES. WORTH
1985	326059.	2279.	0.	6603.	33654.	334940.	299054.	334940.	299054.
1986	327923.	4831.	0.	55192.	281306.	387946.	309268.	722887.	608322.
1987	346778.	7682.	0.	134085.	683412.	488545.	347737.	1211431.	956059.
1988	360761.	10857.	0.	200635.	1022604.	572253.	363677.	1783684.	1319735.
1989	401233.	11509.	0.	266696.	1359305.	679437.	385531.	2463121.	1705266.
1990	440962.	12199.	0.	325903.	1661073.	779064.	394698.	3242185.	2099964.
1991	475703.	16164.	0.	386822.	1971568.	878688.	397474.	4120873.	2497437.
1992	530659.	20560.	0.	433105.	2207468.	984324.	397552.	5105197.	2894990.
1993	587407.	25426.	0.	482965.	2461595.	1095798.	395156.	6200991.	3290145.
1994	639249.	30802.	0.	576919.	2940463.	1246969.	401491.	7447957.	3691636.
1995	710580.	36732.	0.	654113.	3333909.	1401424.	402876.	8849379.	4094512.
1996	785039.	43262.	0.	709383.	3615613.	1537683.	394685.	10387062.	4489195.
1997	838469.	50443.	0.	803258.	4094080.	1692169.	387801.	12079230.	4876996.
1998	910596.	68052.	0.	942939.	4806012.	1921586.	393194.	14000816.	5270188.
1999	968476.	92745.	0.	1054061.	5372387.	2115283.	386454.	16116097.	5656641.
2000	1033098.	109233.	0.	1090789.	5559582.	2233121.	364270.	18349200.	6020911.
TERM	11174162.	1288182.		8147587.		29609920.	3361924.	38959136.	9382834.

END EFFECT FINAL YEAR FUEL ESCALATION
0.9300 PU. ESCALATED AT 0.0500 PU.
0.0700 PU. ESCALATED AT 0.0400 PU.

END OF DATA

TABLE 6.6-23
ARIZONA PUBLIC SERVICE COMPANY
15 YEAR EXPANSION PLAN
PHOTOVOLTAIC - NO STORAGE

ECONOMIC ANALYSIS
ARIZONA PUBLIC SERVICE COMPANY
PWC PV0 - $485 PER KW INVEST - SOUTHWEST PROJECT
STUDY NO 20
STUDY PERIOD 1985 TO 2000
END EFFECTS PERIOD 20 YEARS

INFLATION RATES -
INVESTMENT = 0.0600
OPERATION & MAINT = 0.0600
FUEL (SEE TABLE 3.2-1)

DISCOUNT RATE = 0.1200

LEVELIZED FIXED CHARGES

CONVENTIONAL	NUCLEAR	PEAKING	TRANSMISSION
0.1962	0.1962	0.1962	0.0

ALL COSTS IN THOUSANDS OF DOLLARS

YEAR	MW PEAK LD	MW CAPACITY	MW RES	PC RES	TOTAL GWH	NEW CAPACITY MW	NEW CAPACITY INVEST	NEW CAPACITY OPER EXP	TRANS INVEST
1985	4345.	4759.	414.	9.53	21773.	156.	33177.	742.	0.
1986	4544.	5119.	575.	12.65	23048.	360.	247146.	787.	0.
1987	4808.	5476.	668.	13.89	24303.	357.	420332.	834.	0.
1988	5046.	5776.	730.	14.47	25665.	300.	358512.	884.	0.
1989	5284.	6076.	792.	14.99	26941.	300.	336701.	0.	0.
1990	5522.	6326.	804.	14.56	28251.	250.	301768.	0.	0.
1991	5759.	6686.	927.	16.10	29564.	360.	327832.	1053.	0.
1992	5997.	6836.	839.	13.99	31029.	150.	254277.	1116.	0.
1993	6235.	7148.	913.	14.64	32281.	312.	253493.	1183.	0.
1994	6472.	7498.	1026.	15.85	33678.	350.	478196.	1254.	0.
1995	6710.	7762.	1052.	15.68	35034.	264.	407643.	1329.	0.
1996	6948.	7962.	1014.	14.59	36498.	200.	296754.	1409.	0.
1997	7186.	8328.	1142.	15.89	37835.	366.	514034.	1493.	0.
1998	7423.	8728.	1305.	17.58	39320.	400.	718280.	4748.	0.
1999	7661.	9078.	1417.	18.50	40671.	350.	624227.	6710.	0.
2000	7899.	9078.	1179.	14.93	42073.	0.	283749.	3556.	0.

COST SUMMARY

YEAR	FUEL COST	OPERATING EXPENSE	PROPERTY TAX	FIXED CHARGES	CUMULATIVE INVESTMENT	ANNUAL COST	ANNUAL COST PRES. WORTH	CUMULATIVE ANNUAL COST	CUM ANN COST PRES. WORTH
1985	326898.	742.	0.	6509.	33177.	334149.	298347.	334149.	298347.
1986	329622.	1573.	0.	54999.	280323.	386194.	307871.	720343.	606218.
1987	349387.	2501.	0.	137468.	700655.	489356.	348314.	1209699.	954533.
1988	364279.	3535.	0.	207808.	1059166.	575622.	365818.	1785321.	1320350.
1989	404797.	3747.	0.	273869.	1395867.	682413.	387219.	2467734.	1707569.
1990	444577.	3972.	0.	333076.	1697635.	781624.	395995.	3249358.	2103565.
1991	480241.	5263.	0.	397396.	2025467.	882900.	399379.	4132258.	2502944.
1992	536088.	6694.	0.	447286.	2279744.	990067.	399871.	5122322.	2902815.
1993	593750.	8278.	0.	497021.	2533237.	1099048.	396328.	6221369.	3299143.
1994	646495.	10029.	0.	590843.	3011433.	1247366.	401618.	7468732.	3700761.
1995	718546.	11959.	0.	670822.	3419076.	1401327.	402848.	8870055.	4103609.
1996	795170.	14085.	0.	729045.	3715830.	1538300.	394843.	10408353.	4498452.
1997	850991.	16423.	0.	829898.	4229864.	1697312.	388980.	12105662.	4887429.
1998	928607.	22157.	0.	970825.	4948144.	1921588.	393195.	14027247.	5280620.
1999	994617.	30196.	0.	1093298.	5572370.	2118111.	386971.	16145358.	5667590.
2000	1065537.	35564.	0.	1148969.	5856116.	2250071.	367035.	18395424.	6034624.
TERM	11525042.	419408.		8582160.		20526608.	3348332.	38922032.	9382957.

END EFFECT FINAL YEAR FUEL ESCALATION
0.9300 PU. ESCALATED AT 0.0500 PU.
0.0700 PU. ESCALATED AT 0.0400 PU.

TABLE 6.6-24

ARIZONA PUBLIC SERVICE SOLAR EXPANSION PLANS

	Solar Capacity Added (MWe)	Solar Thermal 200 MWh Storage Conventional		Photovoltaic No Storage Conventional	
		Type	MWe	Type	MWe
1985	100	CT	87	CT	43
1986					
1987	100	Coal	83	Coal	43
1988					
1989					
1990					
1991	100	Coal	82	Coal	40
1992					
1993	100	CT	82	CT	38
1994					
1995	100	CC	81	CC	36
1996					
1997	100	Coal	77	Coal	34
1998	200	-	-	-	-
1999	200	Coal	268	Coal	150
2000					
Total	1,000		678		384

NOTES:

CT = Combustion Turbine

CC = Combined Cycle

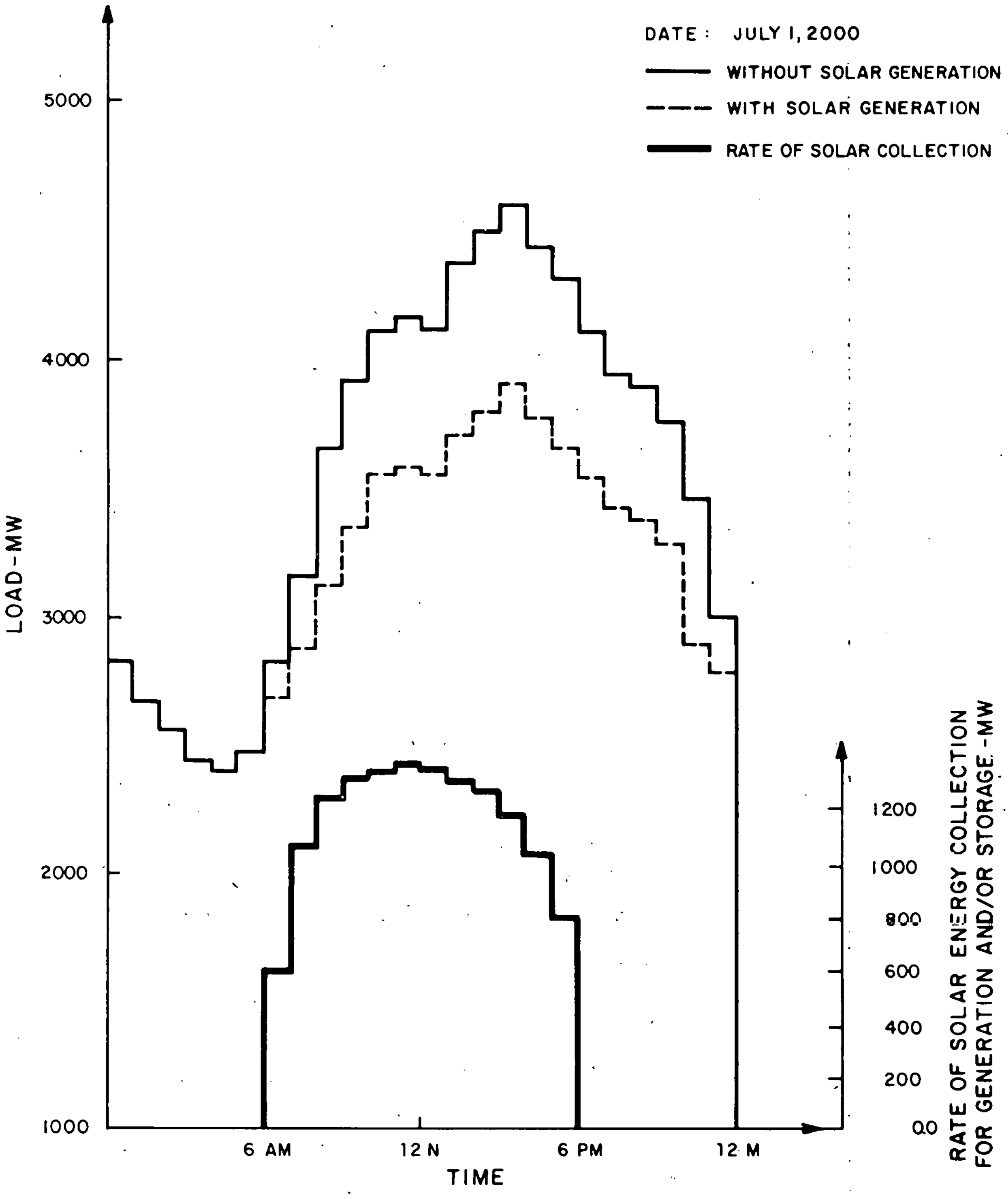


FIGURE 6.5-1
PUBLIC SERVICE COMPANY OF NEW MEXICO
LOAD DEMAND
700MW SOLAR THERMAL, 6-HOUR STORAGE

SOUTHWEST PROJECT

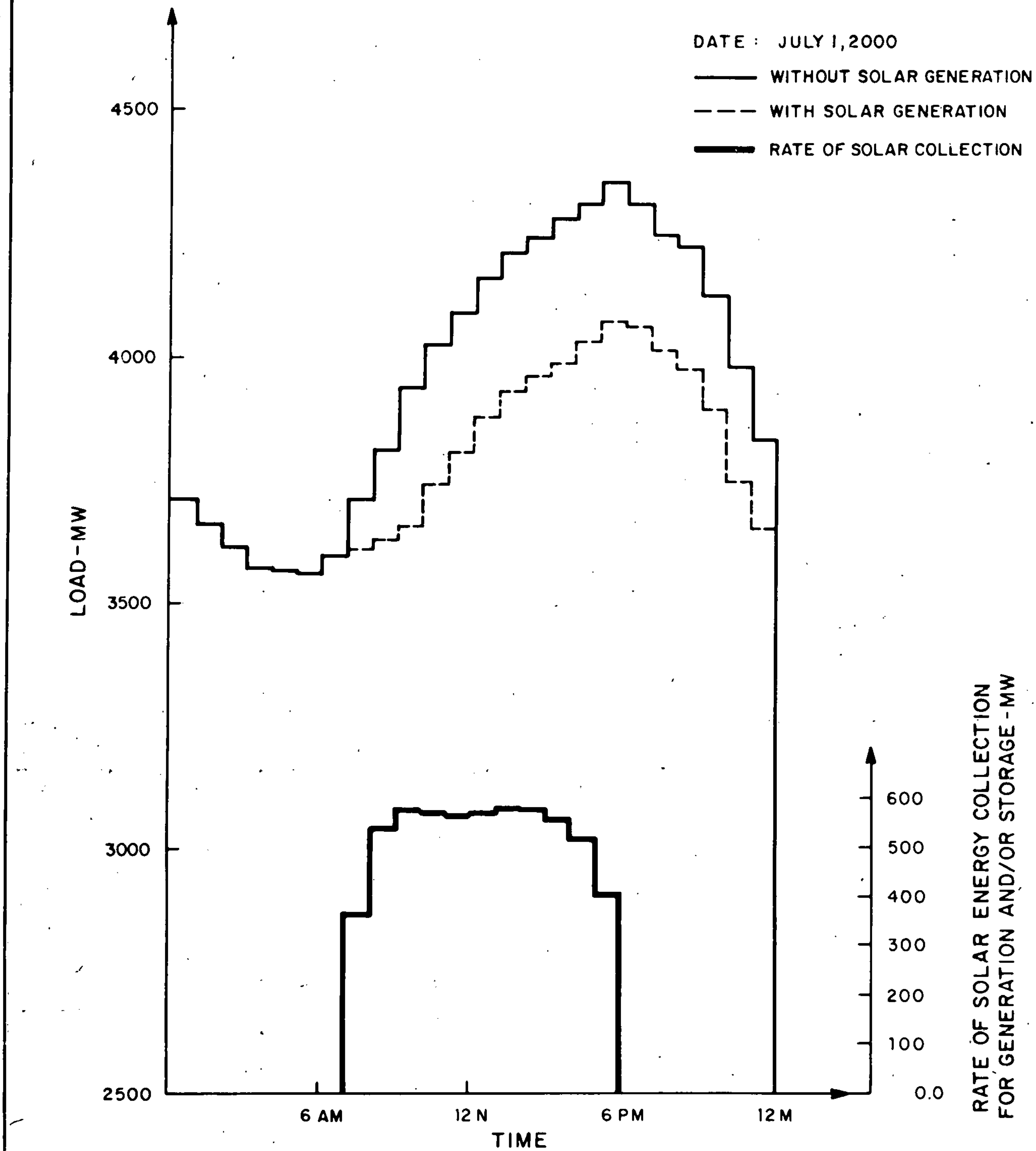


FIGURE 6.5-2
SALT RIVER PROJECT
LOAD DEMAND
300 MW SOLAR THERMAL,
6-HOUR STORAGE

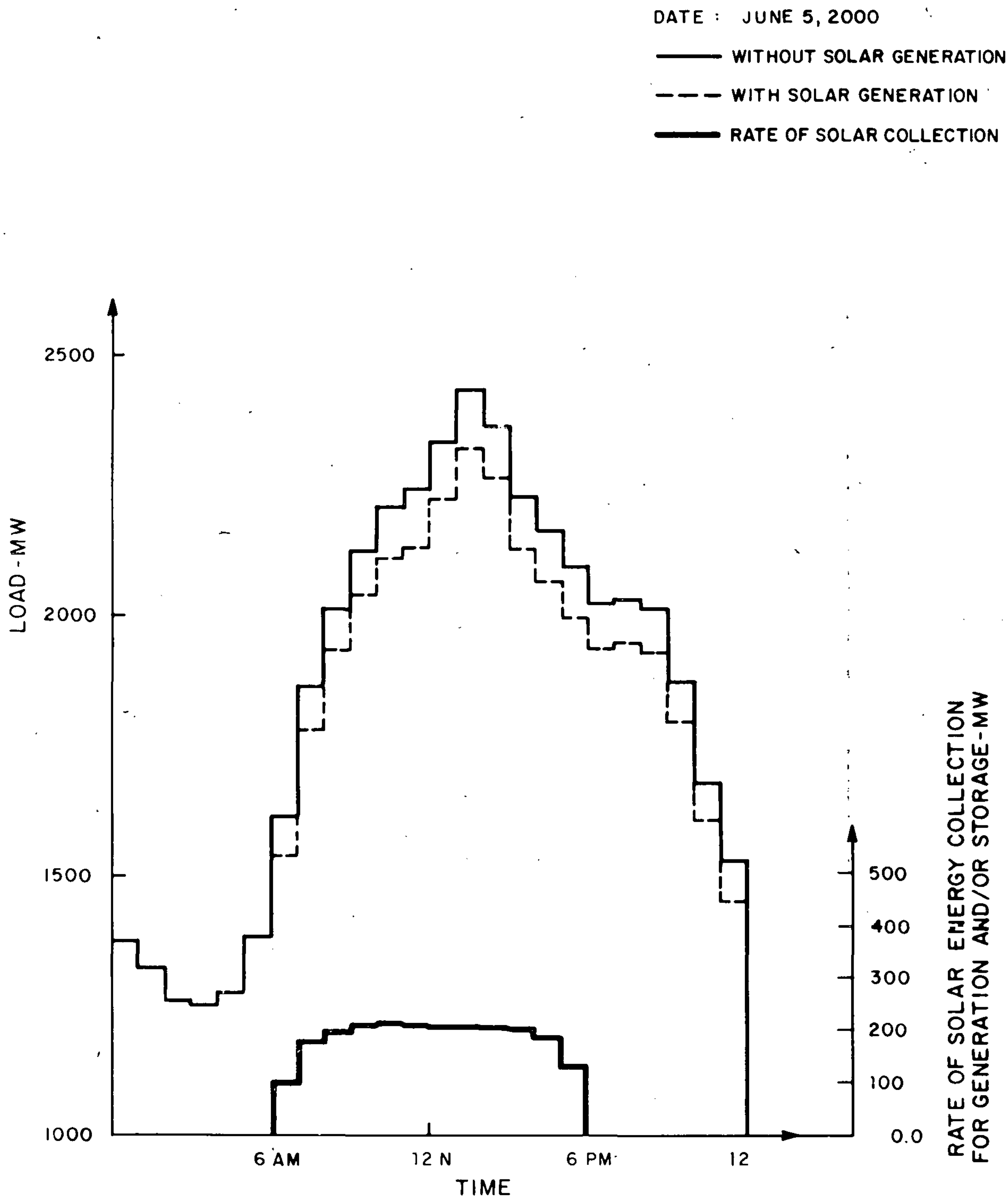


FIGURE 6.5-3
EL PASO ELECTRIC COMPANY
LOAD DEMAND
100 MW SOLAR THERMAL,
6-HOUR STORAGE

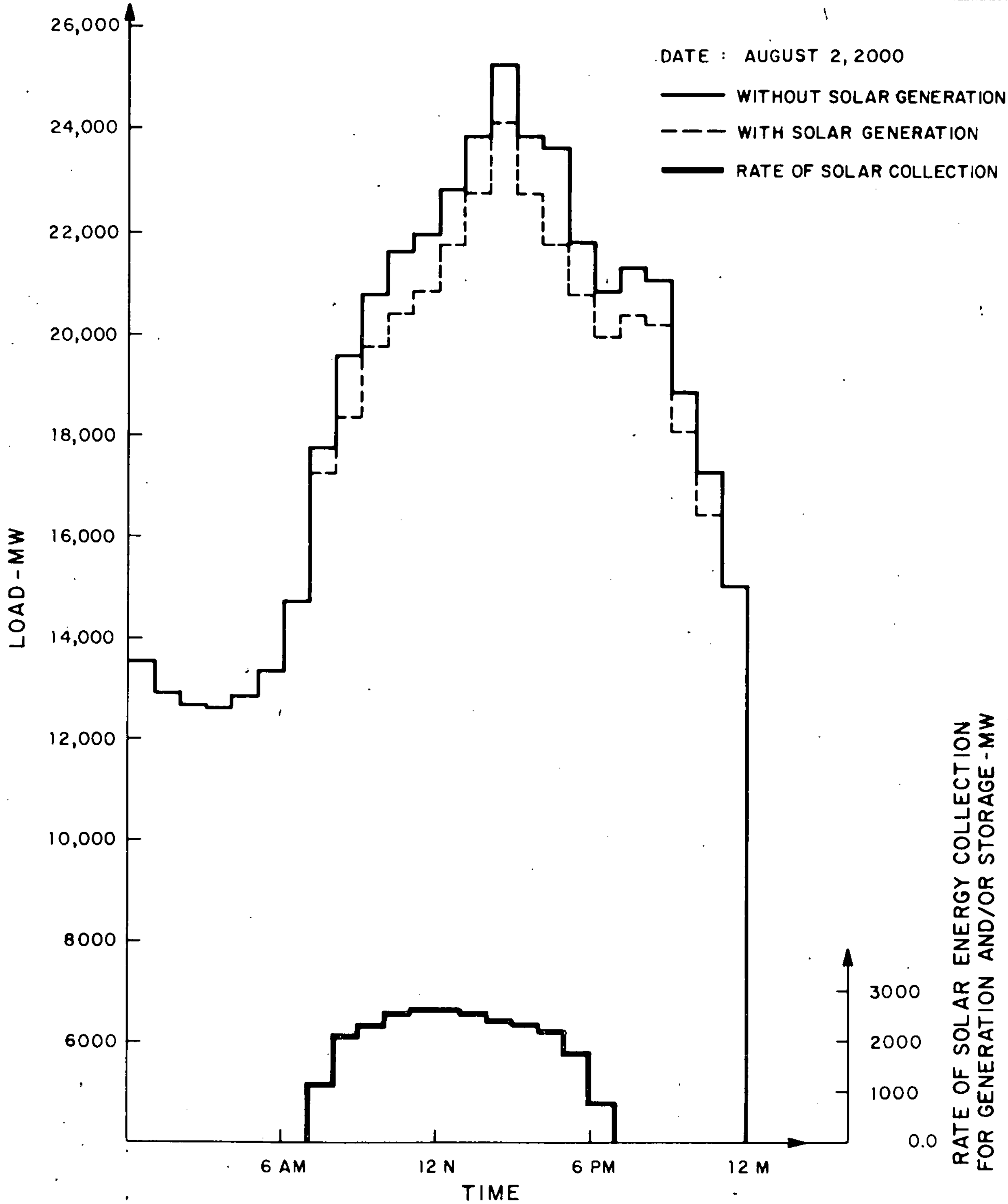


FIGURE 6.5-4
SOUTHERN CALIFORNIA EDISON COMPANY
LOAD DEMAND
1200MW SOLAR THERMAL, 6-HOUR STORAGE

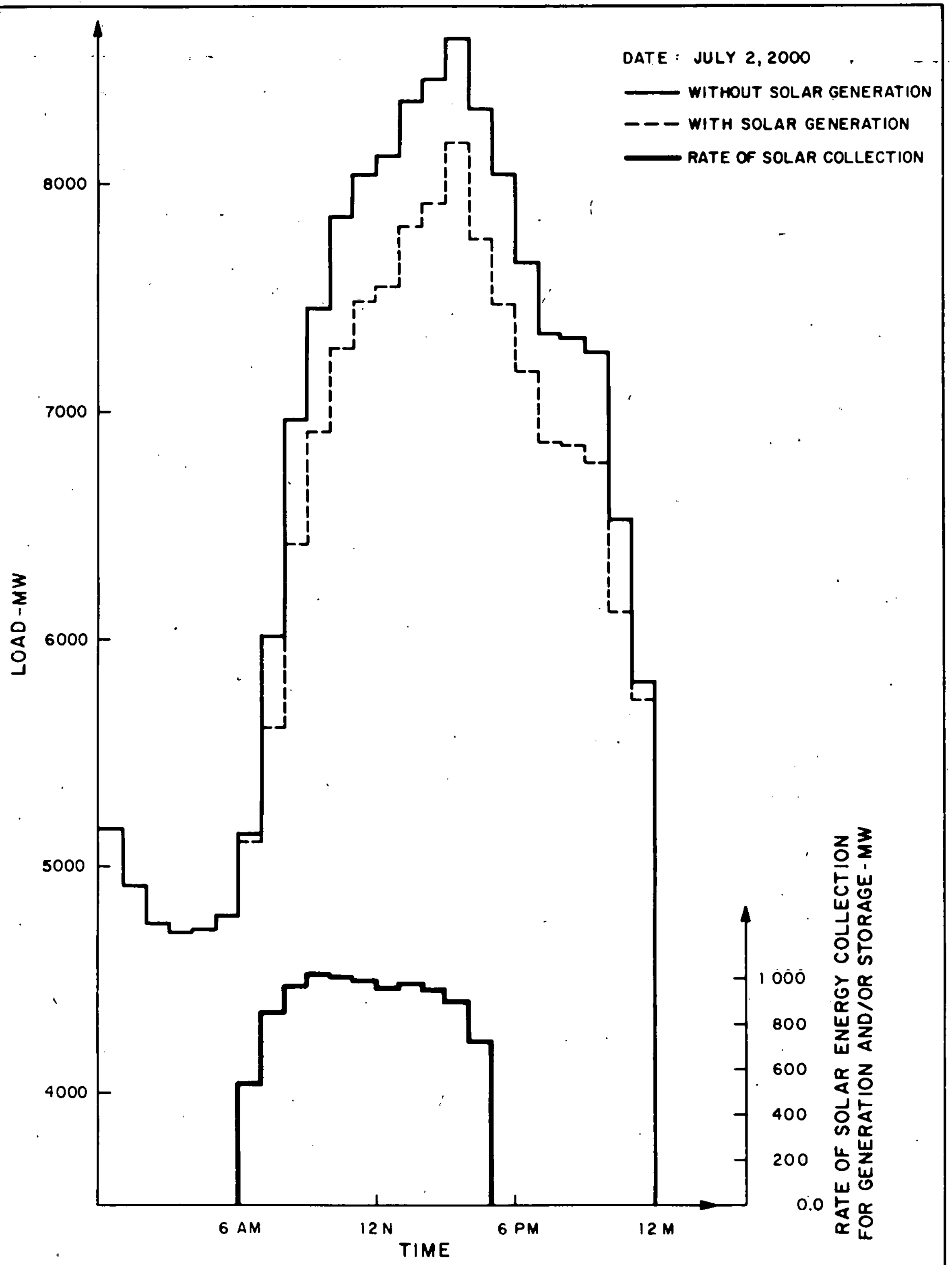


FIGURE 6.5-5
PUBLIC SERVICE COMPANY OF COLORADO
LOAD DEMAND
600MW SOLAR THERMAL, 6-HOUR STORAGE

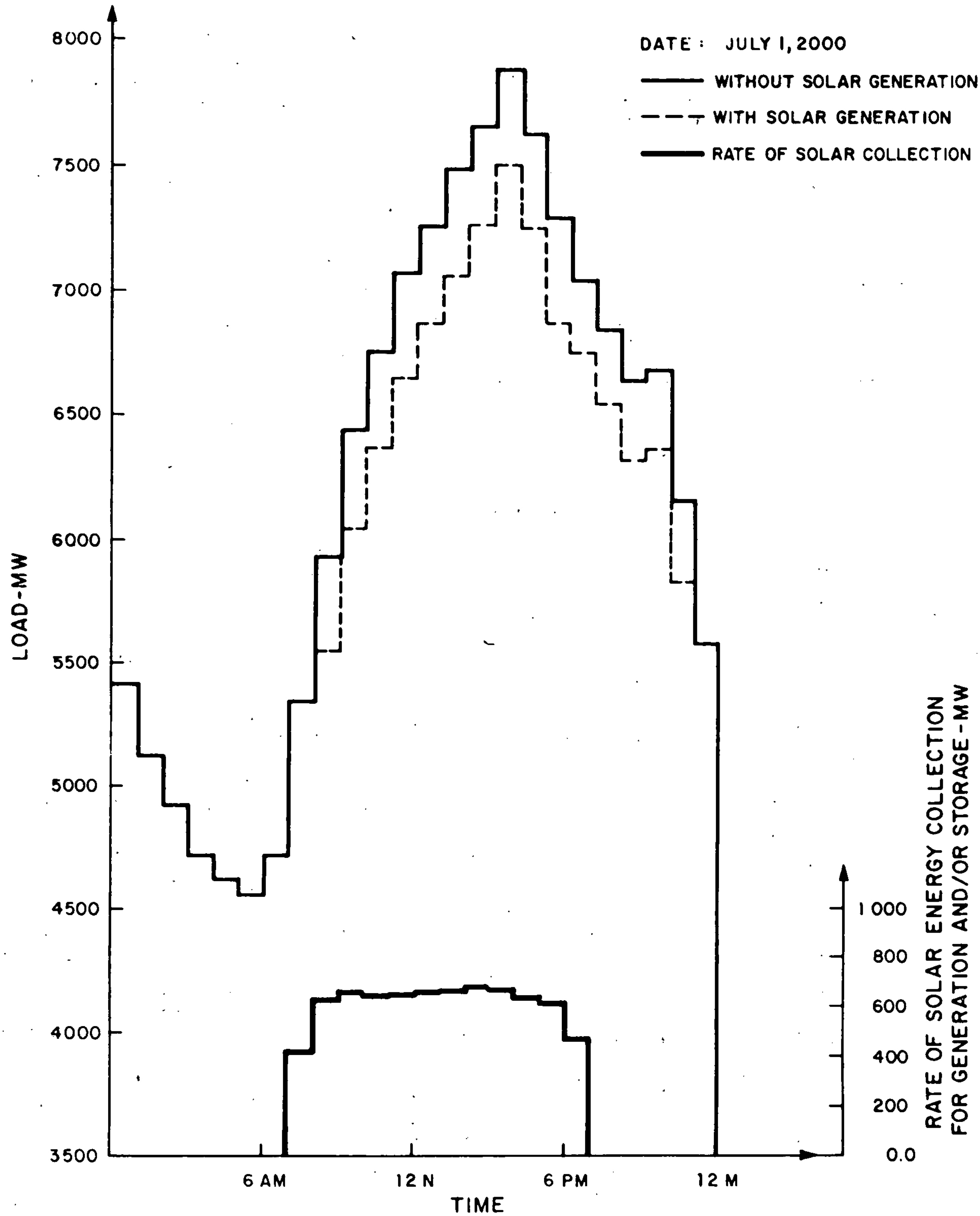


FIGURE 6.5-6
ARIZONA PUBLIC SERVICE COMPANY
LOAD DEMAND
400MW SOLAR THERMAL, 6-HOUR STORAGE

SOUTHWEST PROJECT

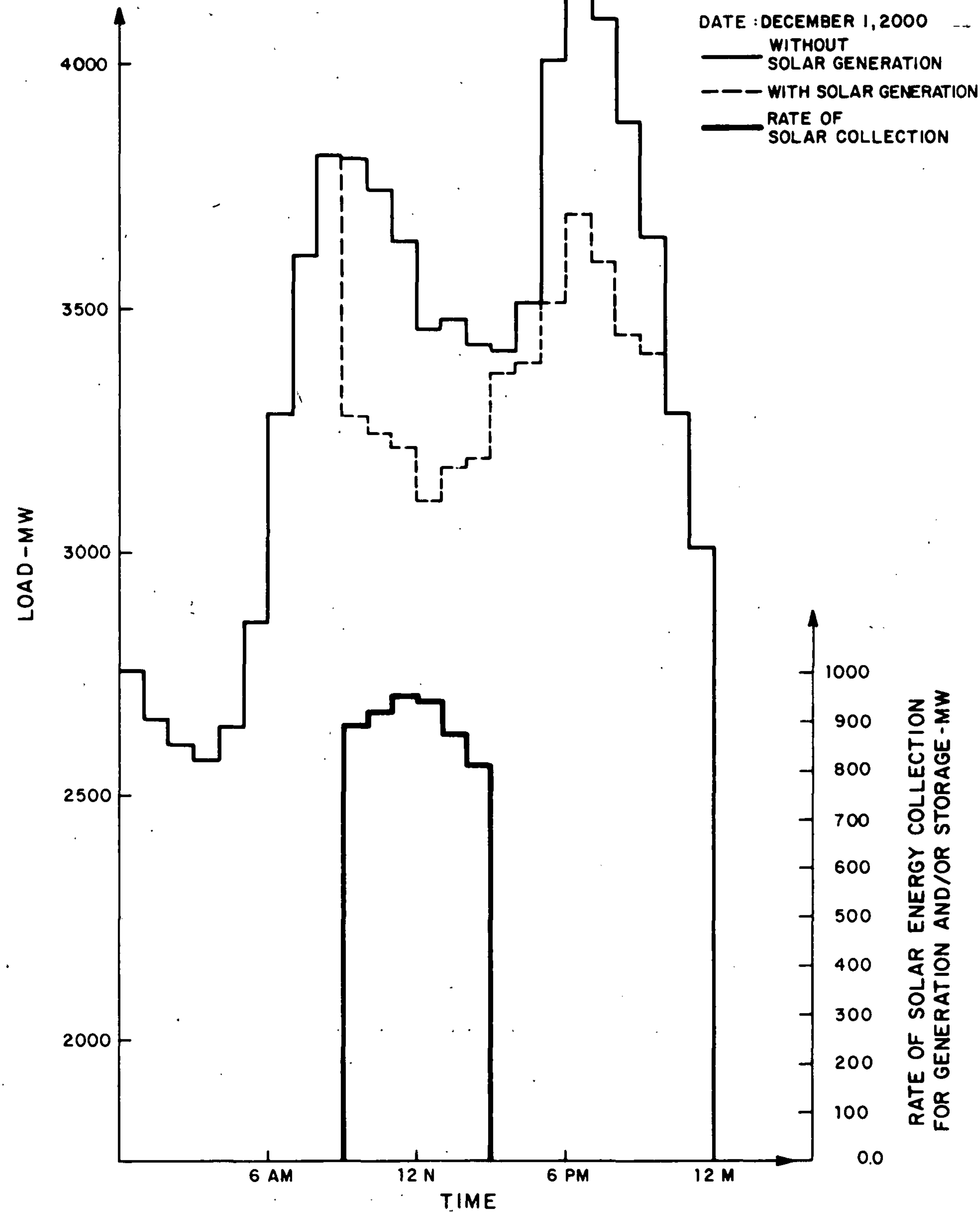


FIGURE 6.5-7
PUBLIC SERVICE COMPANY OF NEW MEXICO
LOAD DEMAND
700MW SOLAR THERMAL, 6-HOUR STORAGE

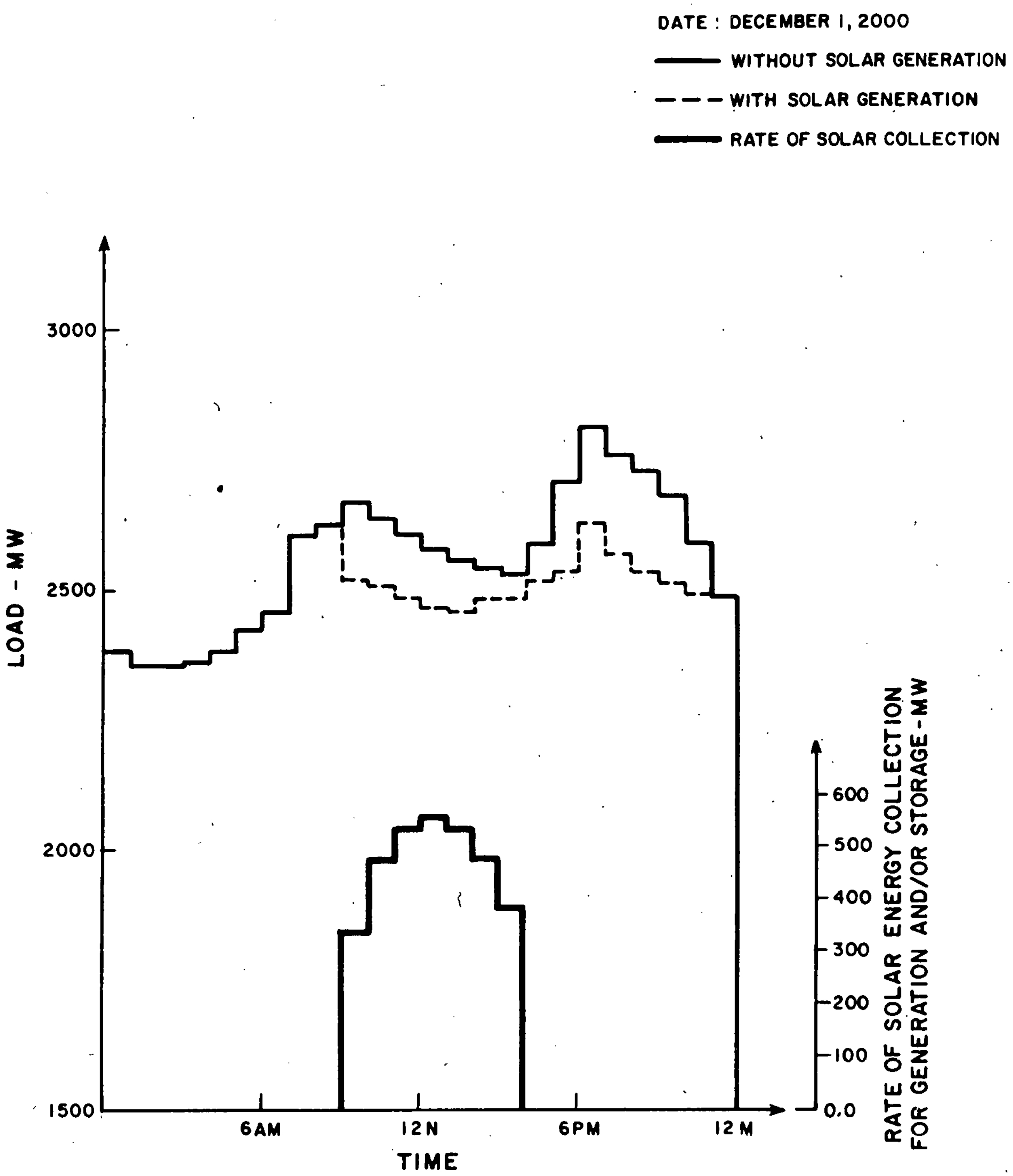


FIGURE 6.5-8
SALT RIVER PROJECT
LOAD DEMAND
300MW SOLAR THERMAL,
6-HOUR STORAGE

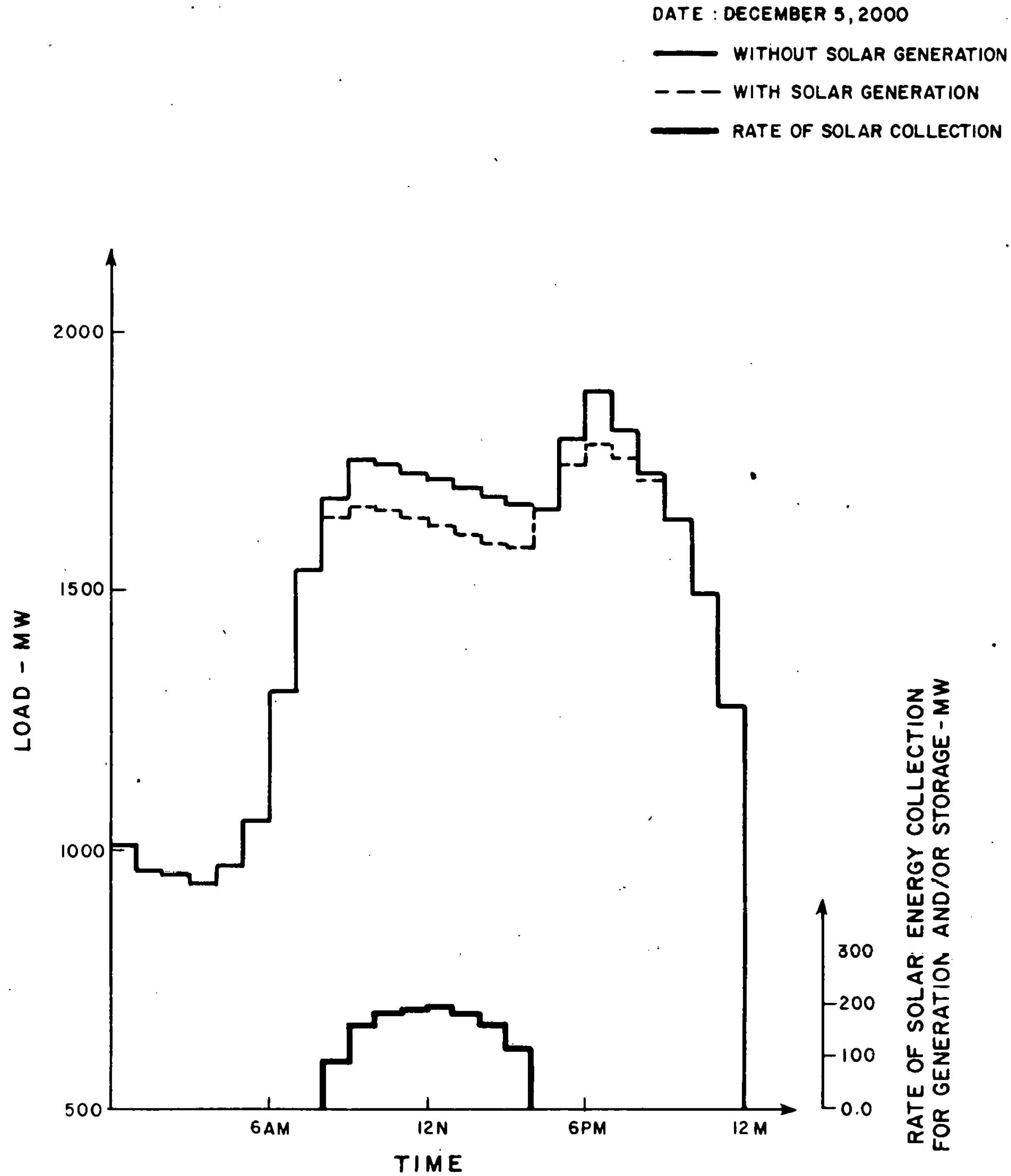


FIGURE 6.5-9
EL PASO ELECTRIC COMPANY
LOAD DEMAND
100 MW SOLAR THERMAL, 6-HOUR STORAGE

SOUTHWEST PROJECT

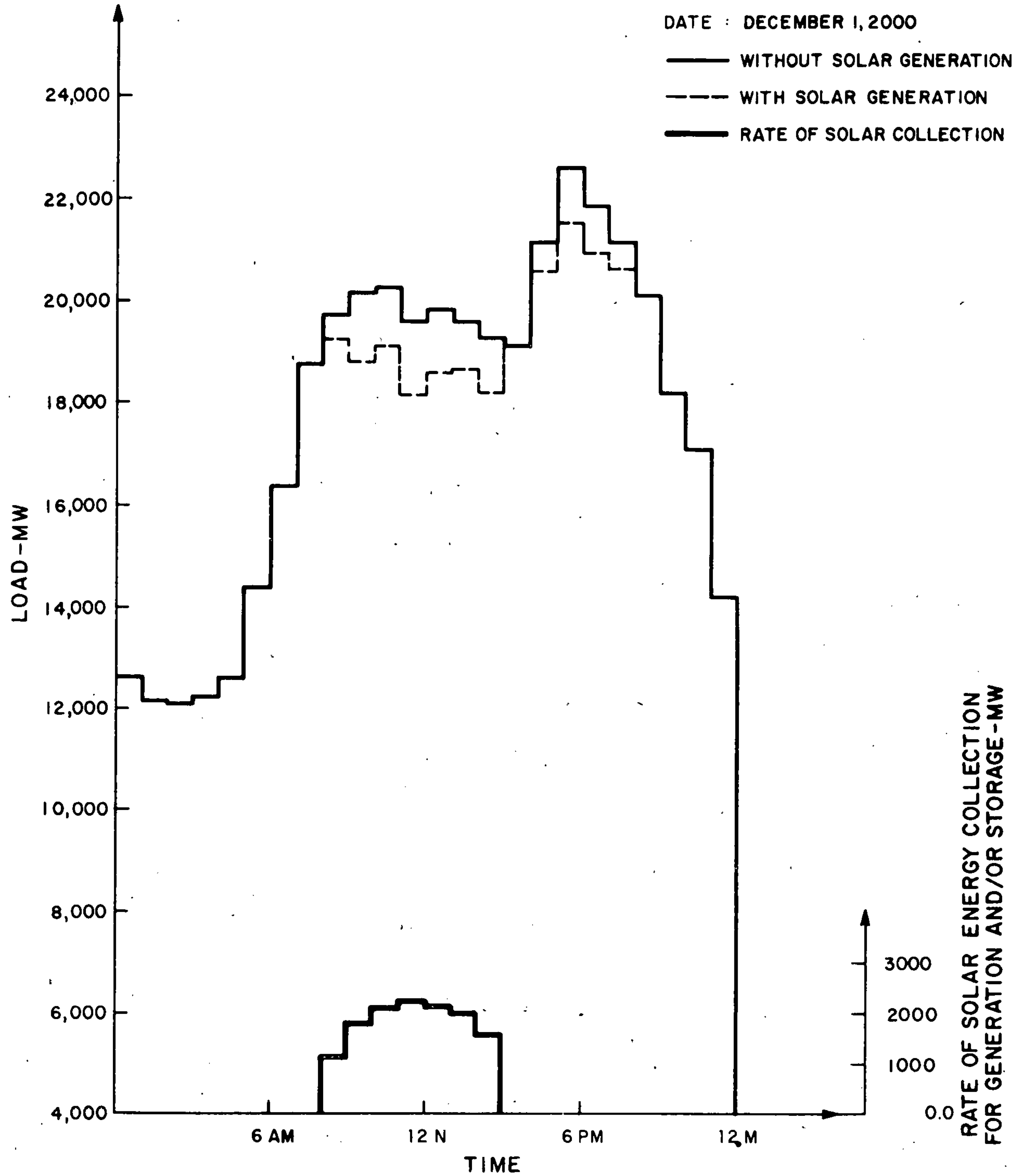


FIGURE 6.5-10
SOUTHERN CALIFORNIA EDISON COMPANY
LOAD DEMAND
1200MW SOLAR THERMAL, 6-HOUR STORAGE

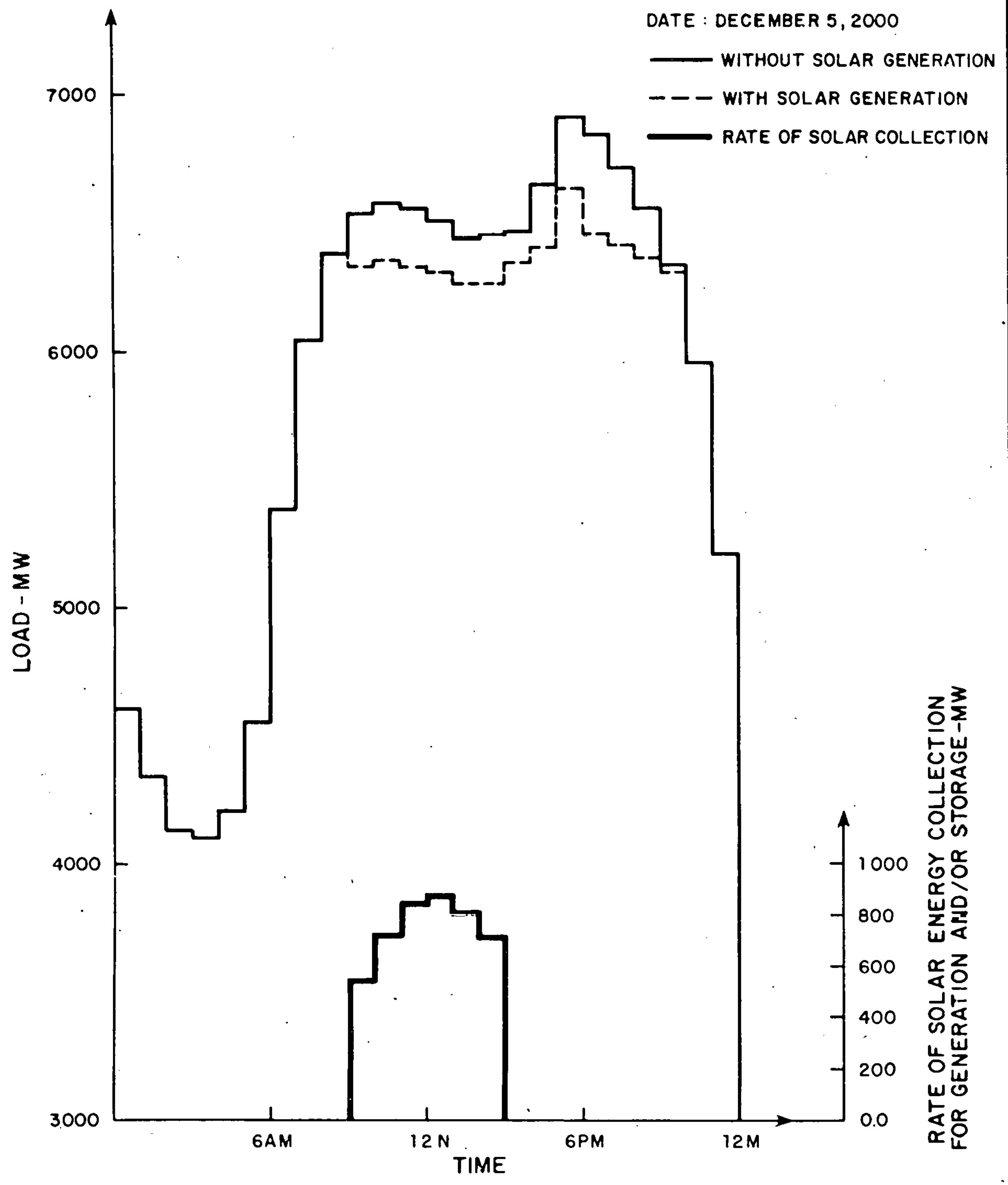


FIGURE 6.5-11
PUBLIC SERVICE COMPANY OF COLORADO
LOAD DEMAND
600MW SOLAR THERMAL, 6-HOUR STORAGE

SOUTHWEST PROJECT

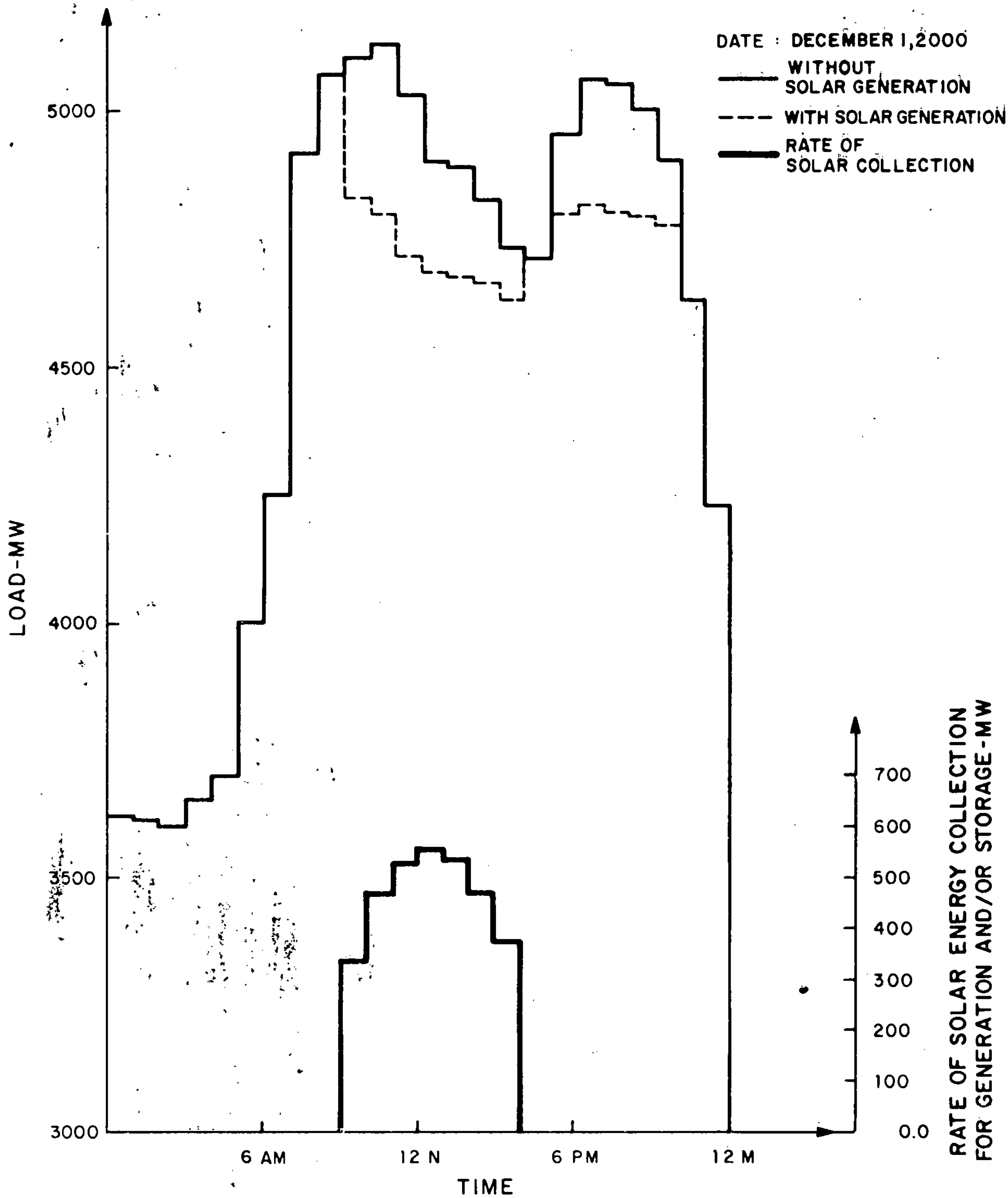


FIGURE 6.5-12
ARIZONA PUBLIC SERVICE COMPANY

LOAD DEMAND

400 MW SOLAR THERMAL
6-HOUR STORAGE

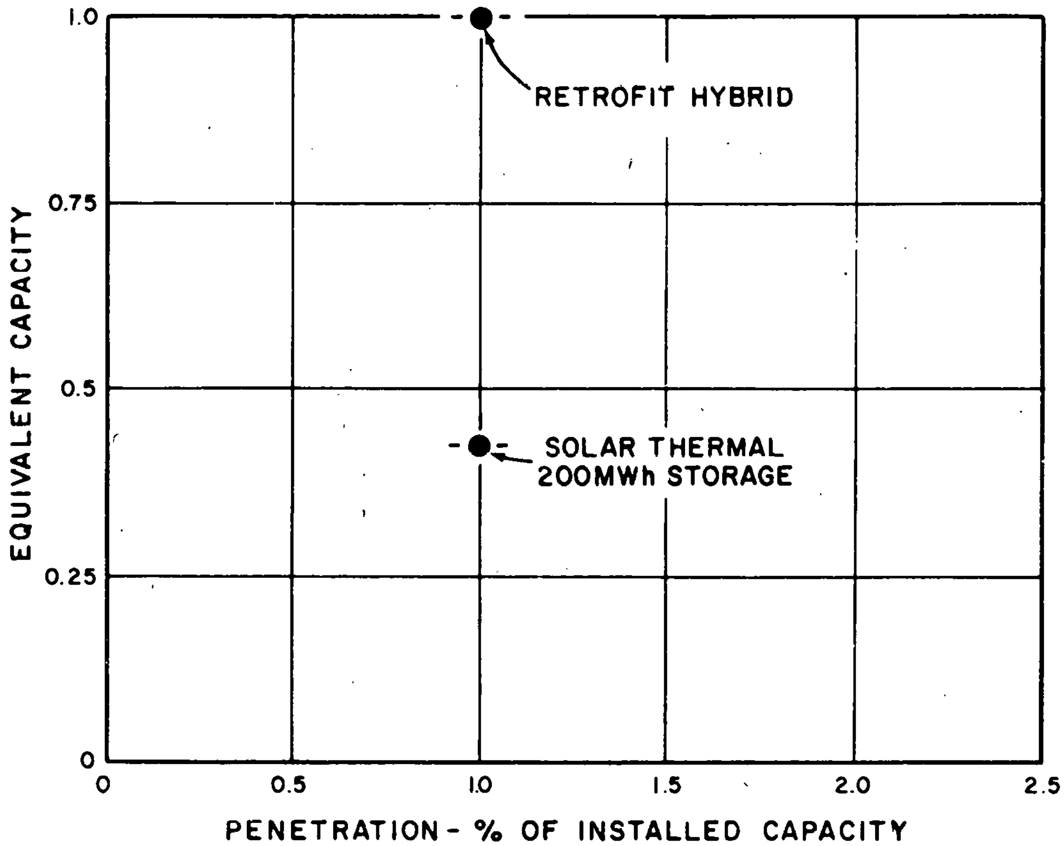


FIGURE 6.6-1
PUBLIC SERVICE COMPANY OF NEW MEXICO

EQUIVALENT COVENTIONAL CAPACITY REPLACED BY SOLAR GENERATION

SOUTHWEST PROJECT

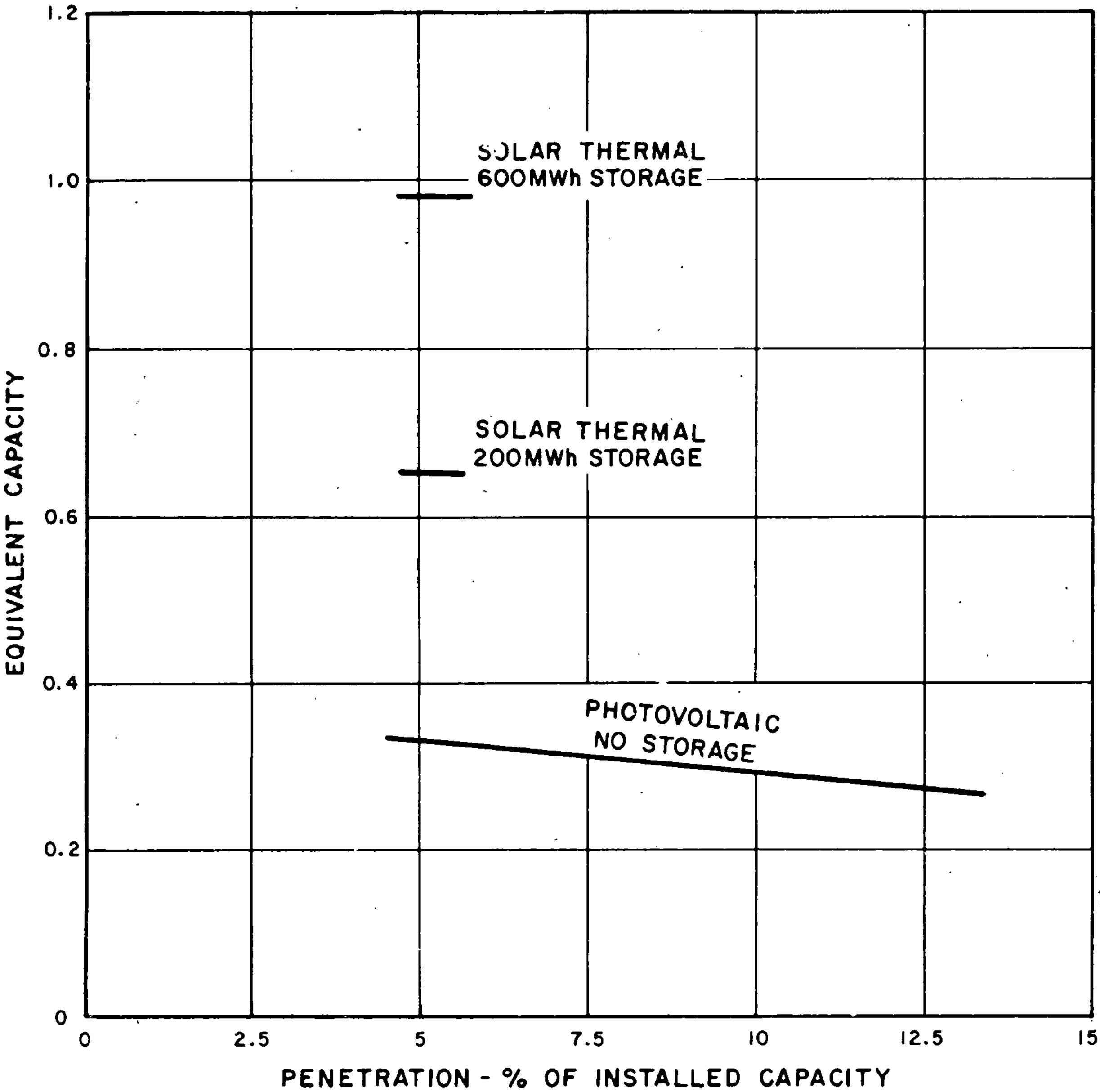


FIGURE 6.6-2
SALT RIVER PROJECT
EQUIVALENT CONVENTIONAL CAPACITY
REPLACED BY SOLAR GENERATION

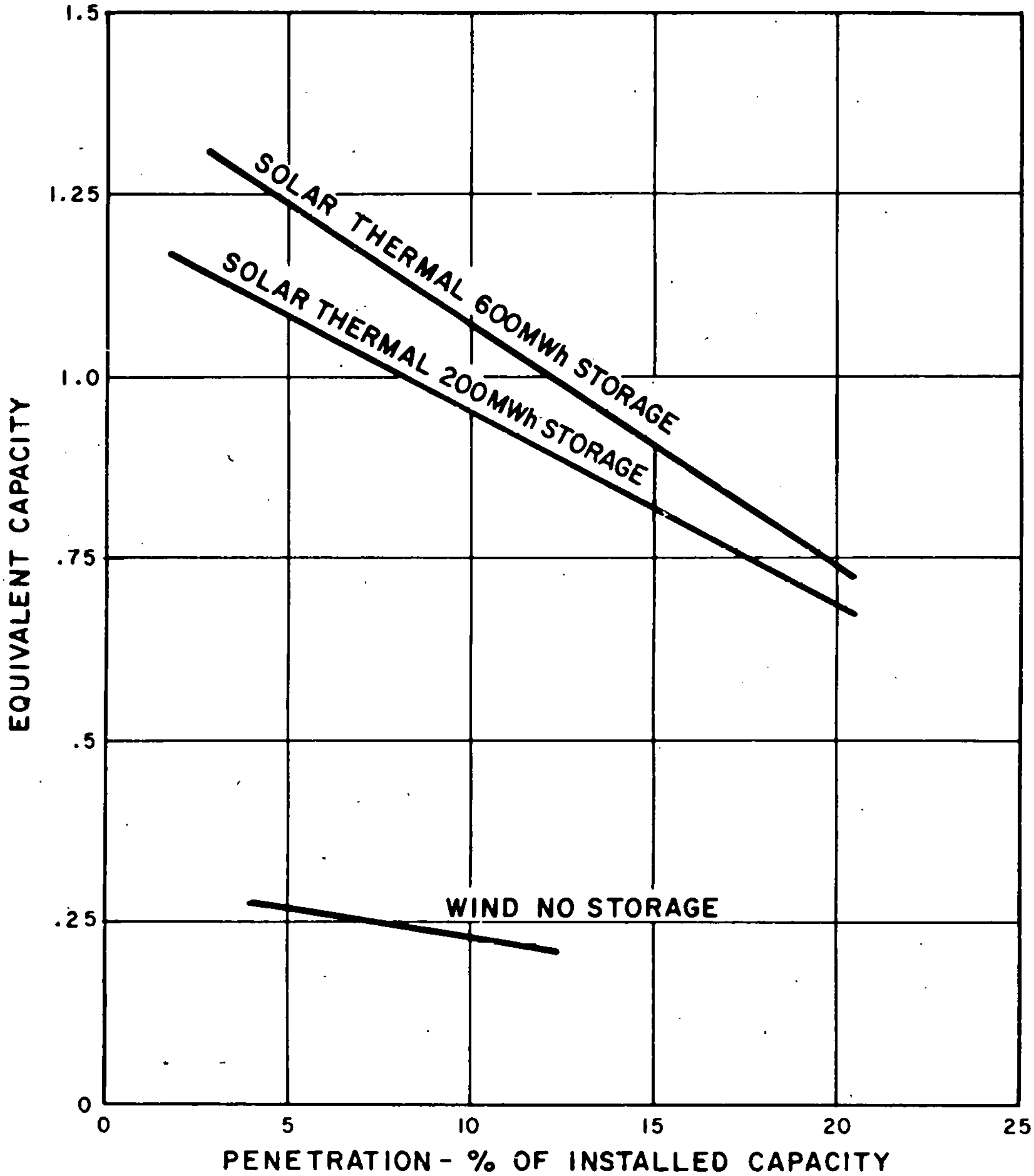


FIGURE 6.6-3
EL PASO ELECTRIC COMPANY
EQUIVALENT CONVENTIONAL CAPACITY
REPLACED BY SOLAR GENERATION

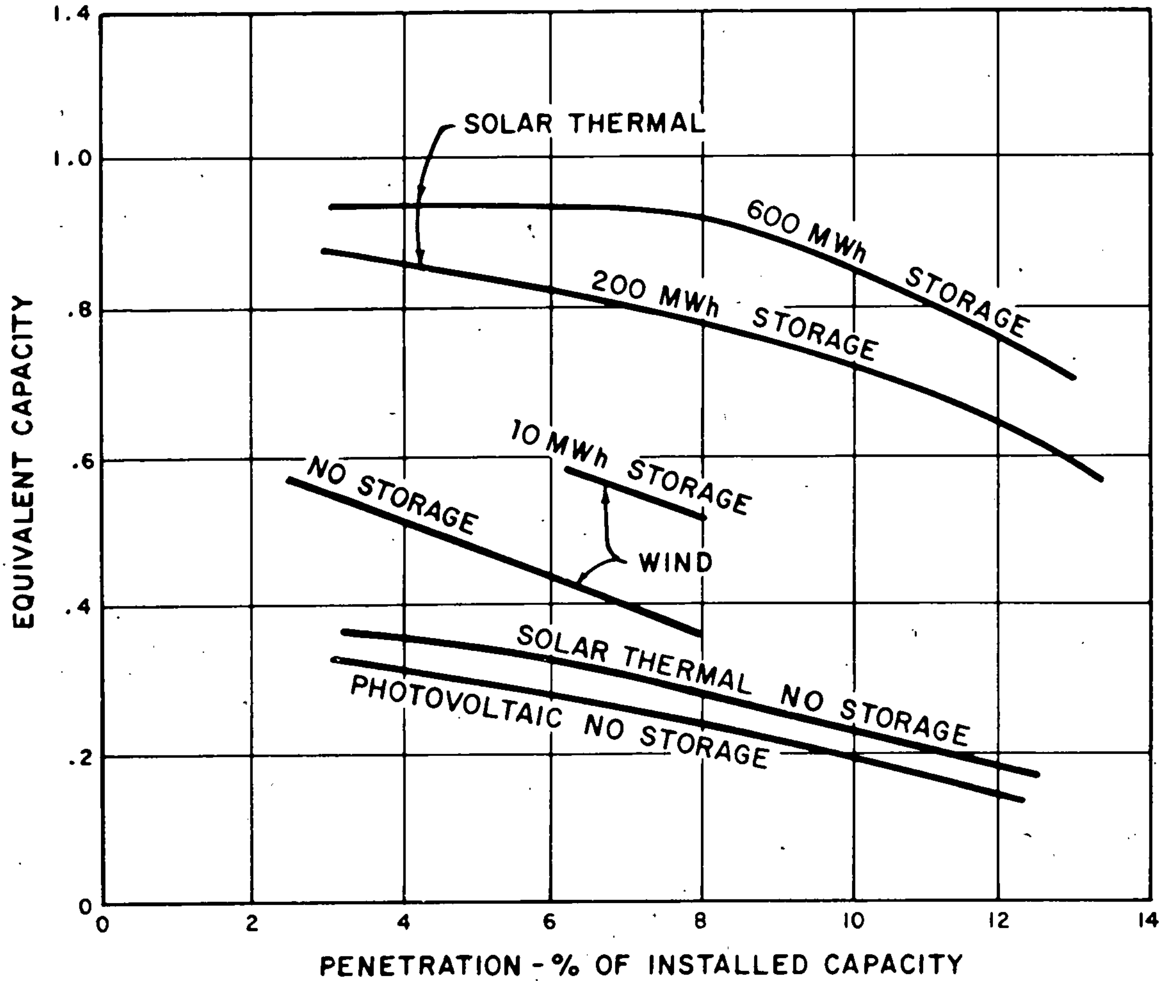


FIGURE 6.6-4
SOUTHERN CALIFORNIA EDISON COMPANY

EQUIVALENT CONVENTIONAL CAPACITY REPLACED BY SOLAR GENERATION

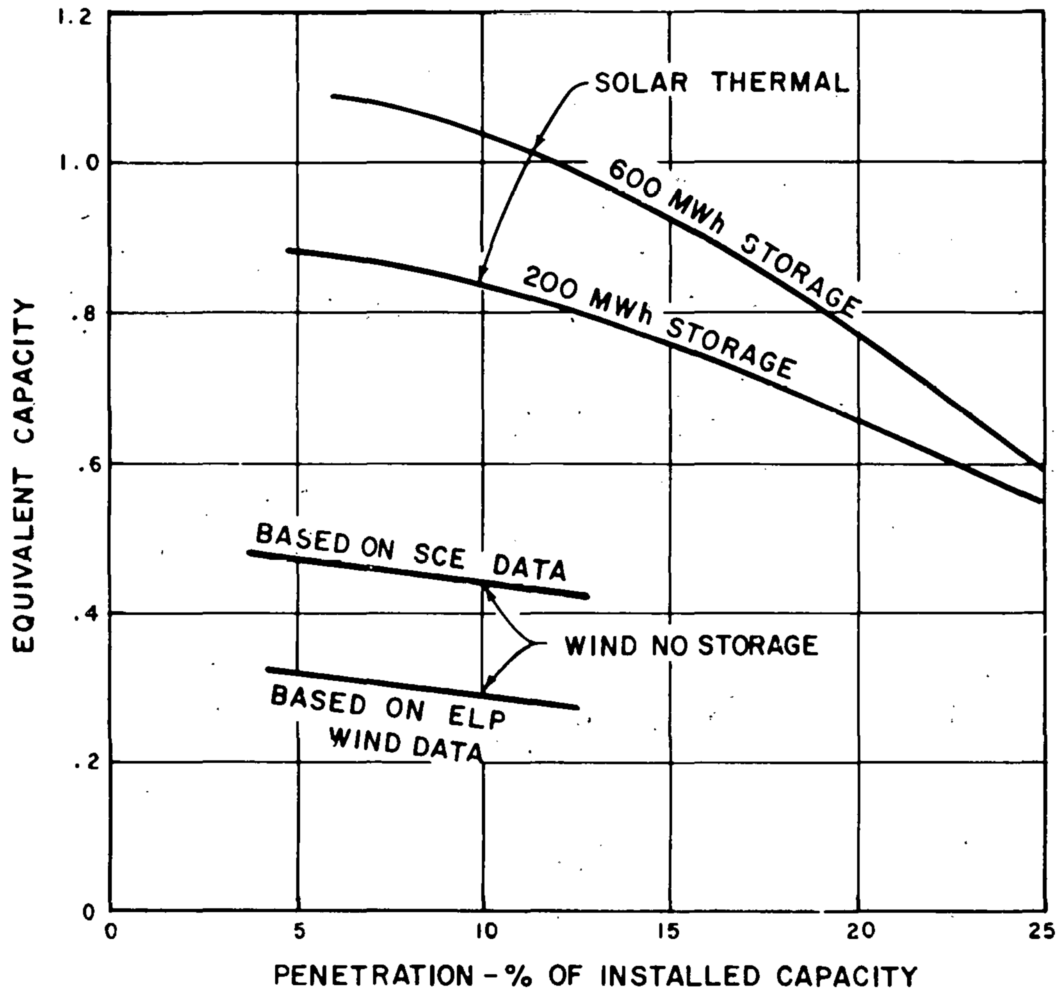


FIGURE 6.6-5
PUBLIC SERVICE COMPANY OF COLORADO
EQUIVALENT CONVENTIONAL CAPACITY
REPLACED BY SOLAR GENERATION

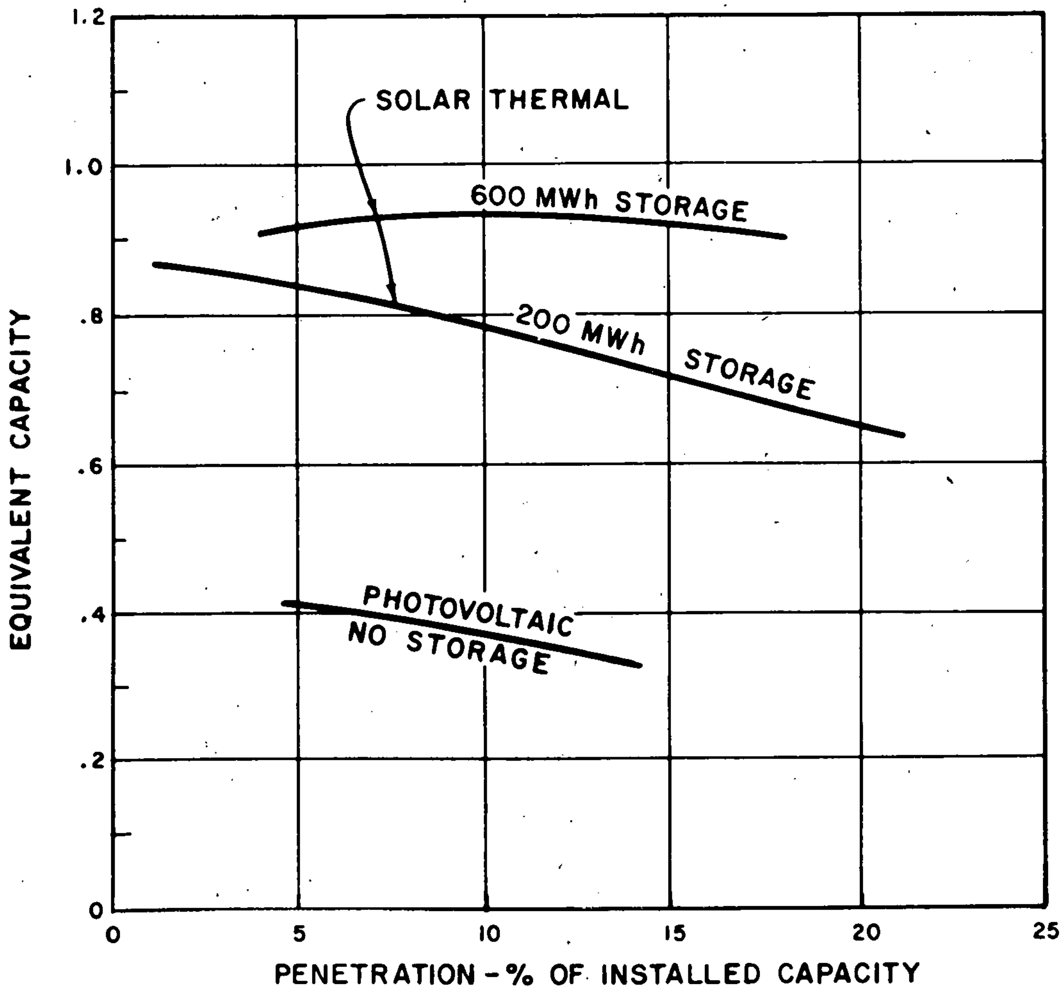


FIGURE 6.6-6
ARIZONA PUBLIC SERVICE COMPANY

EQUIVALENT CONVENTIONAL CAPACITY REPLACED BY SOLAR GENERATION

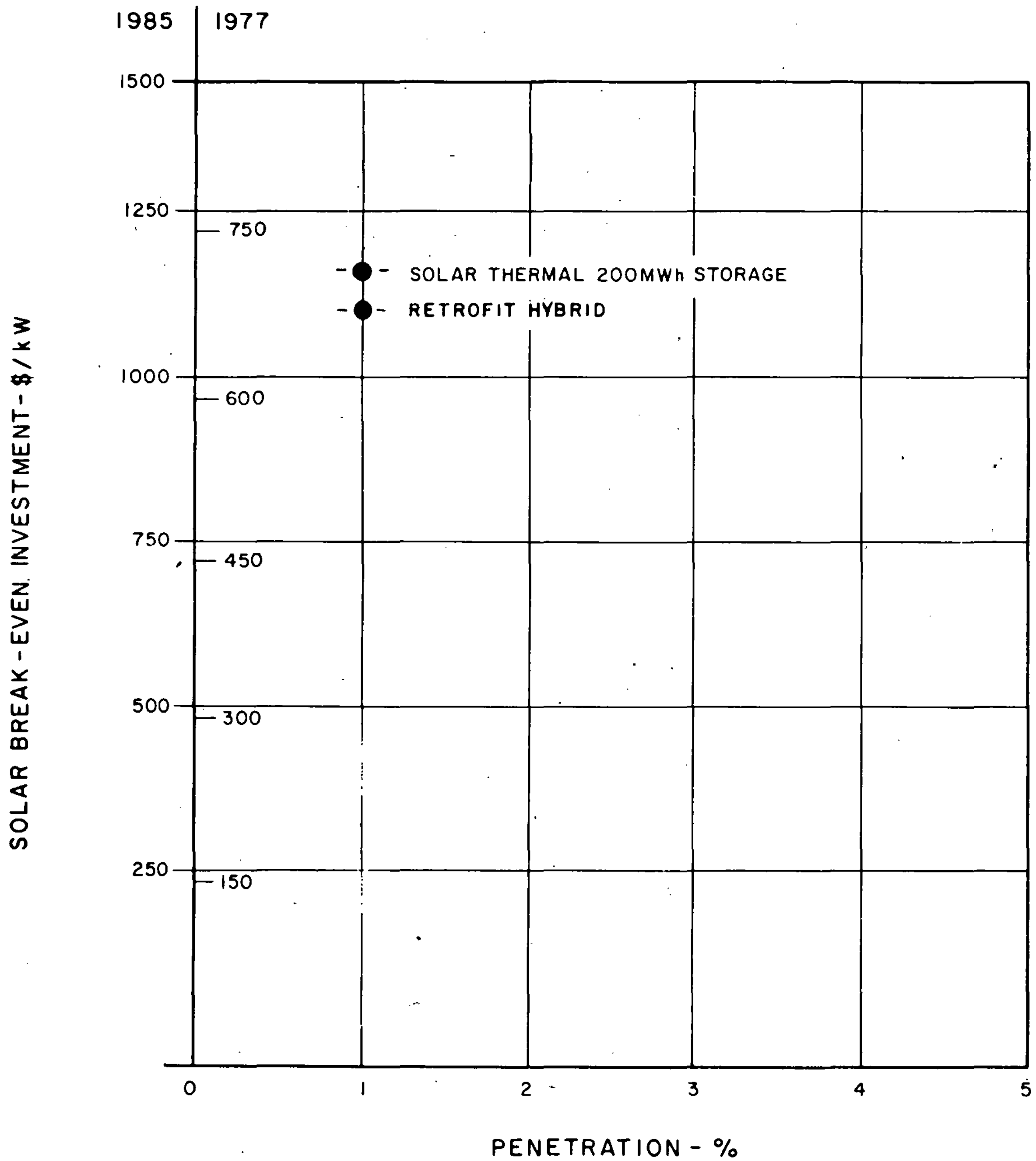


FIGURE 6.6-7

PUBLIC SERVICE COMPANY OF NEW MEXICO

SOLAR BREAK-EVEN INVESTMENT IN THE YEAR 2000

SOUTHWEST PROJECT

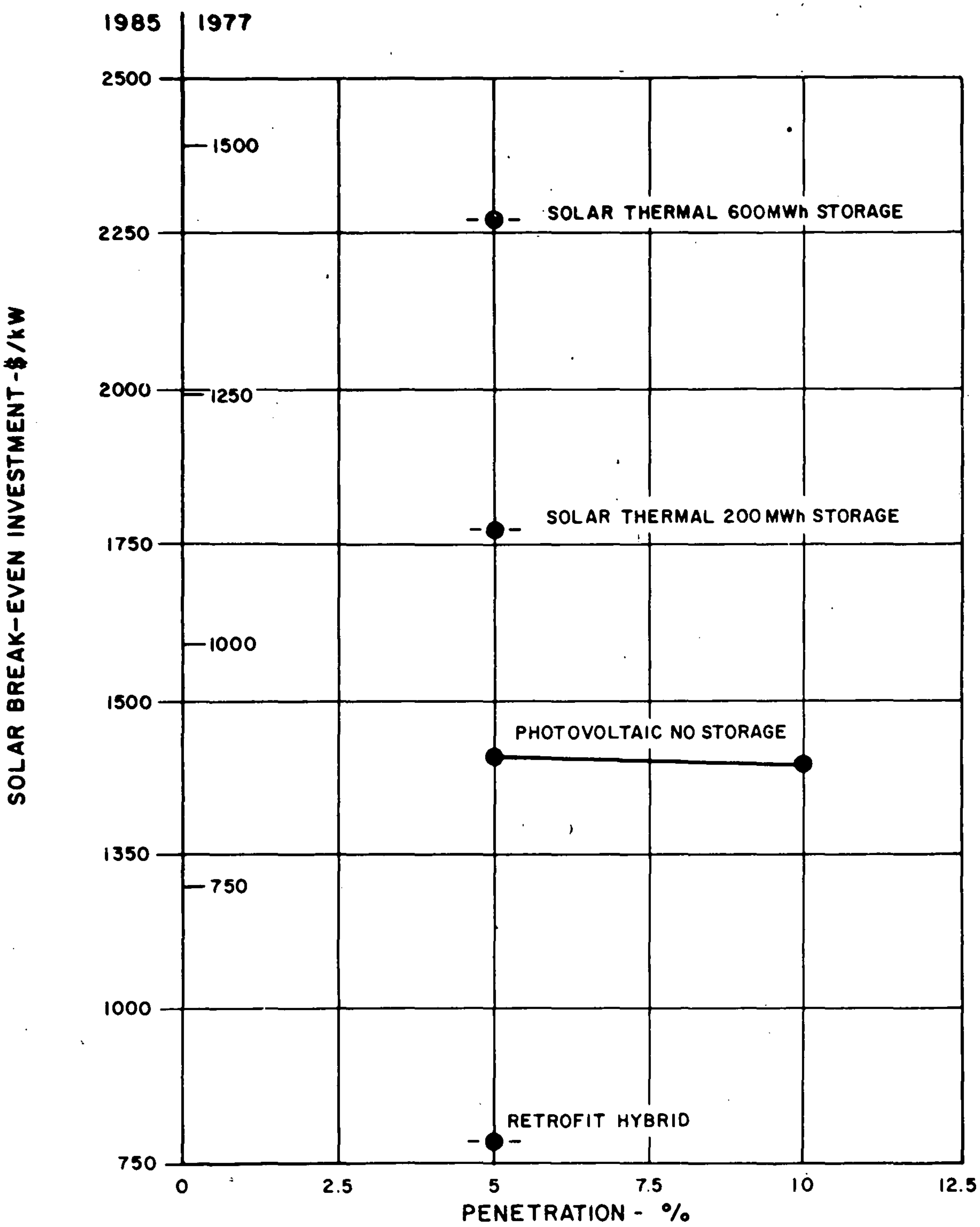
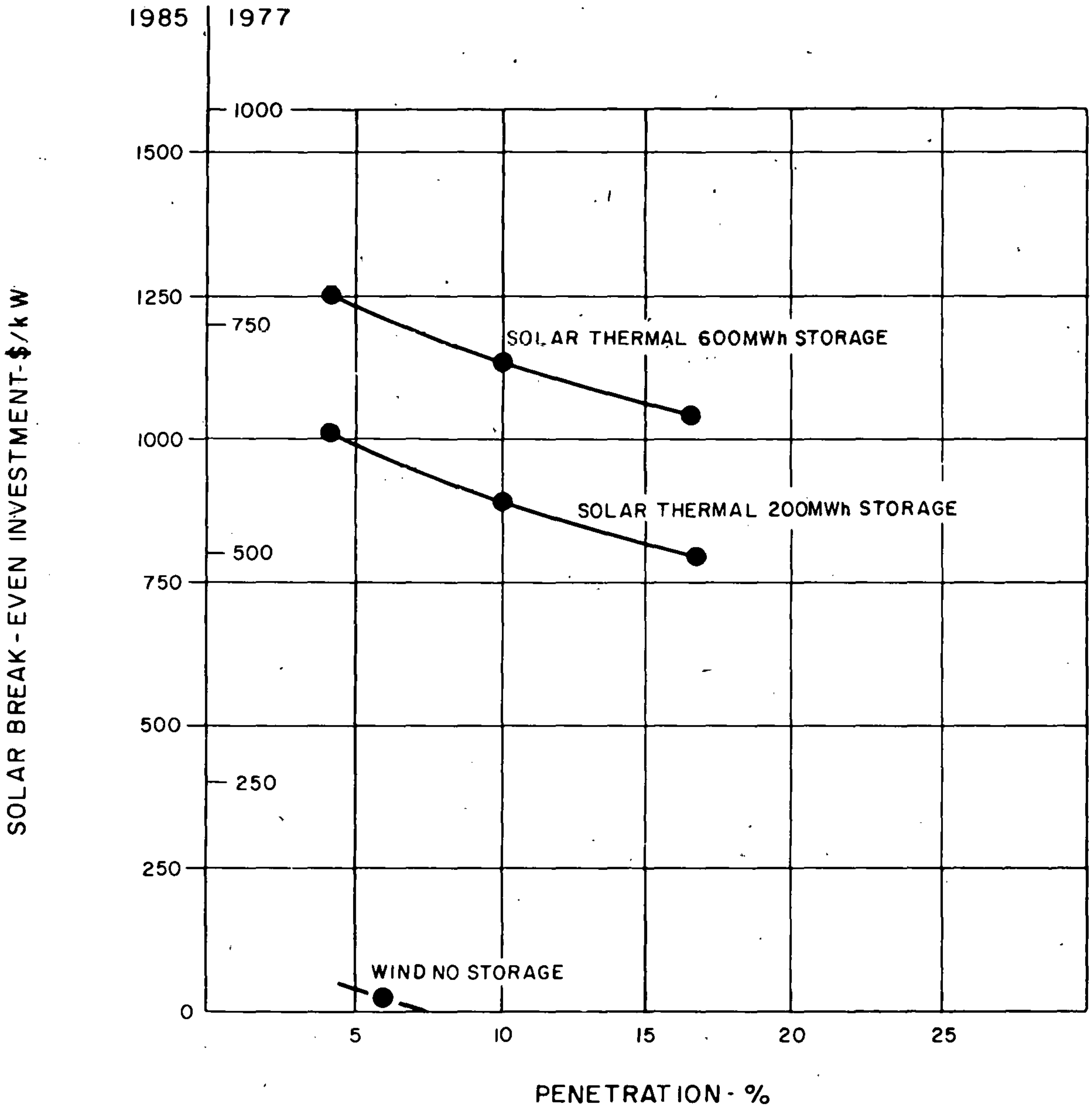
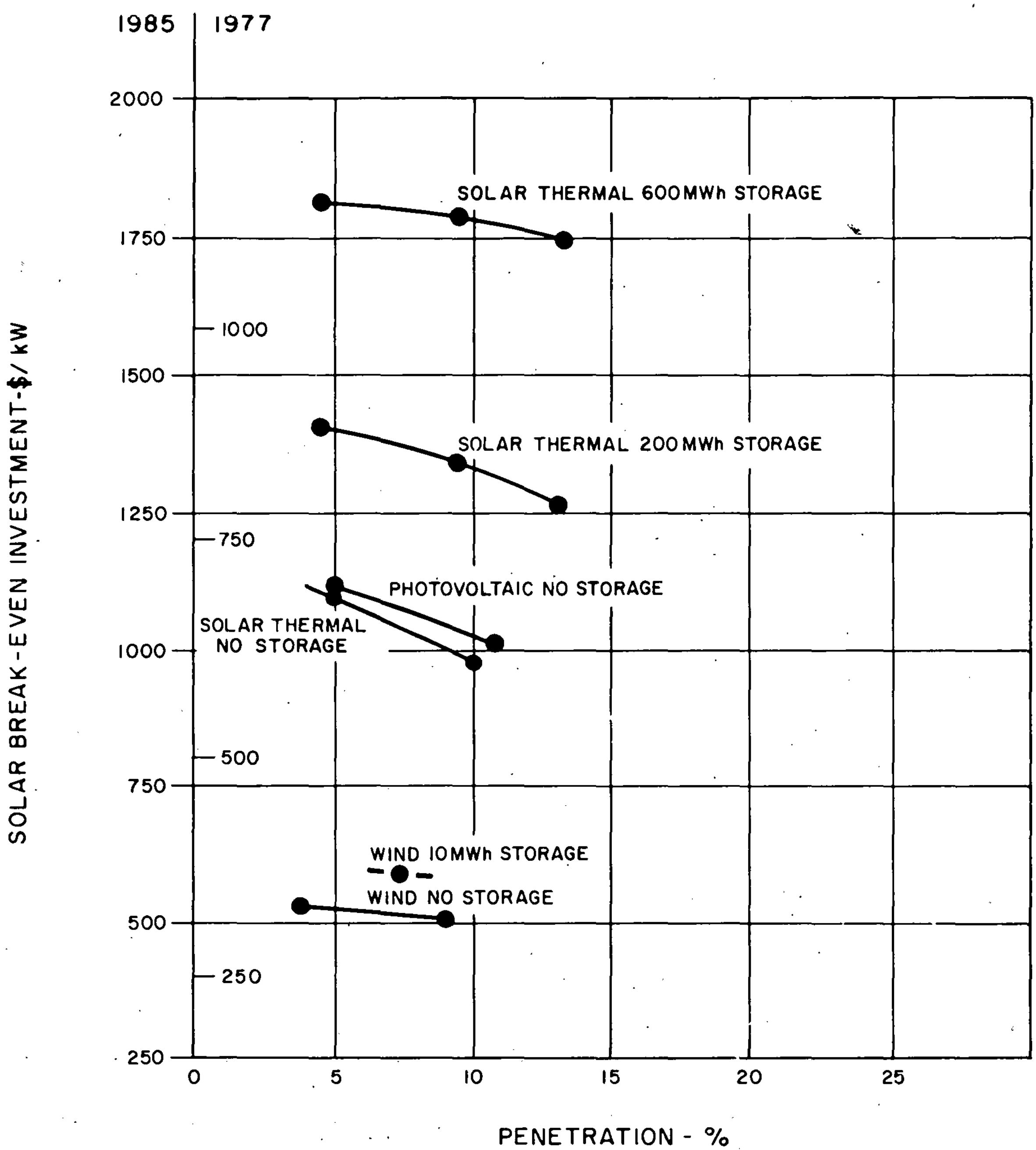


FIGURE 6.6-8
SALT RIVER PROJECT
SOLAR BREAK-EVEN INVESTMENT
IN THE YEAR 2000



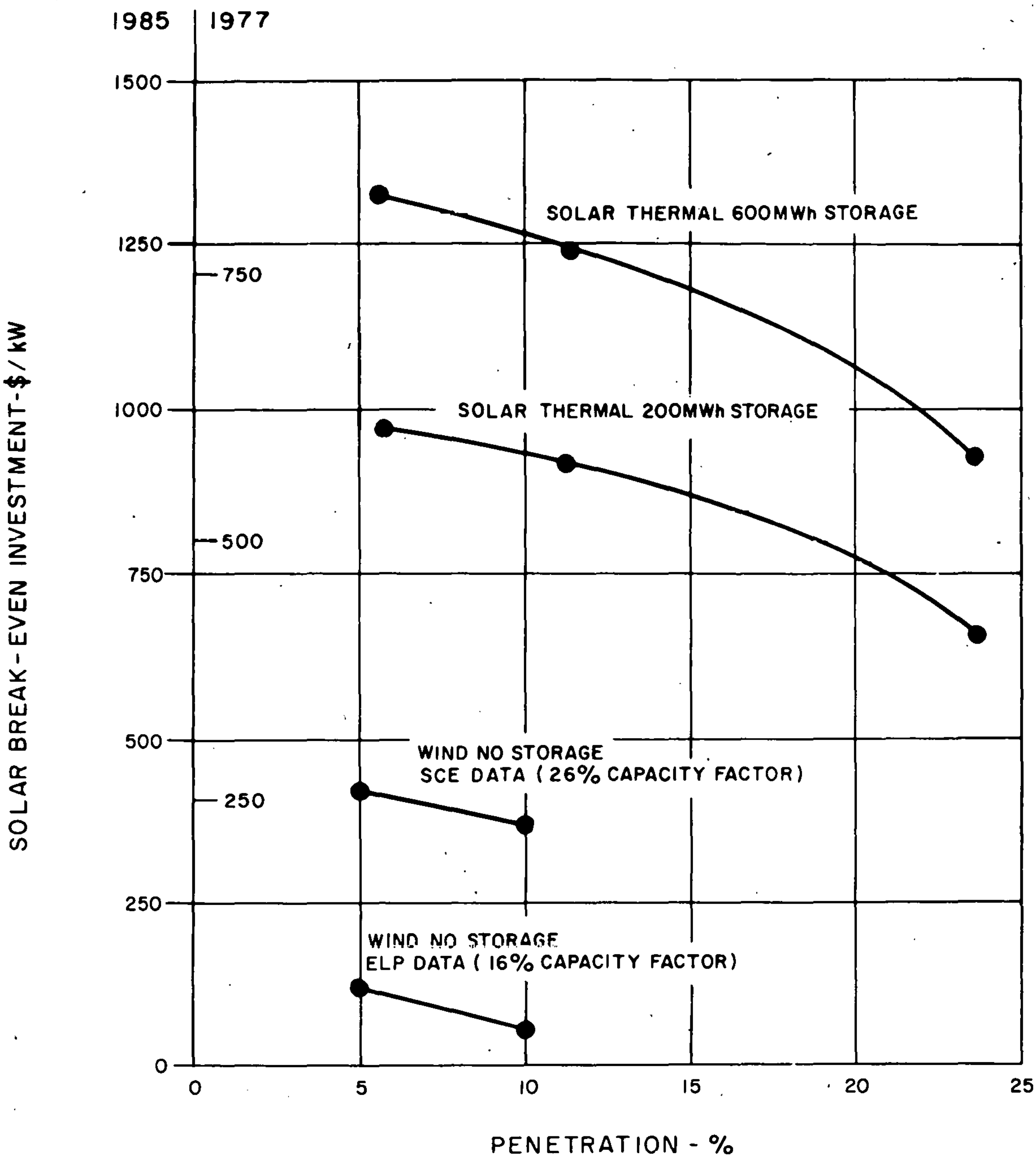
NOTE:
DIRECT ECONOMIC COMPARISON IN $/kW CANNOT BE MADE BETWEEN WIND AND OTHER TECHNOLOGIES DUE TO DIFFERENCES IN PLANT SIZING CRITERIA AND OPERATING CHARACTERISTICS.

FIGURE 6.6-9
EL PASO ELECTRIC COMPANY
SOLAR BREAK-EVEN INVESTMENT IN THE YEAR 2000



NOTE:
DIRECT ECONOMIC COMPARISON IN $/kW CANNOT BE MADE BETWEEN WIND AND OTHER TECHNOLOGIES DUE TO DIFFERENCES IN PLANT SIZING CRITERIA AND OPERATING CHARACTERISTICS.

FIGURE 6.6-10
SOUTHERN CALIFORNIA EDISON COMPANY
SOLAR BREAK-EVEN INVESTMENT IN THE YEAR 2000



NOTE:
DIRECT ECONOMIC COMPARISON IN $/kW CANNOT BE MADE BETWEEN WIND AND OTHER TECHNOLOGIES DUE TO DIFFERENCES IN PLANT SIZING CRITERIA AND OPERATING CHARACTERISTICS.

FIGURE 6.6-11
PUBLIC SERVICE COMPANY OF COLORADO

SOLAR BREAK-EVEN INVESTMENT IN THE YEAR 2000

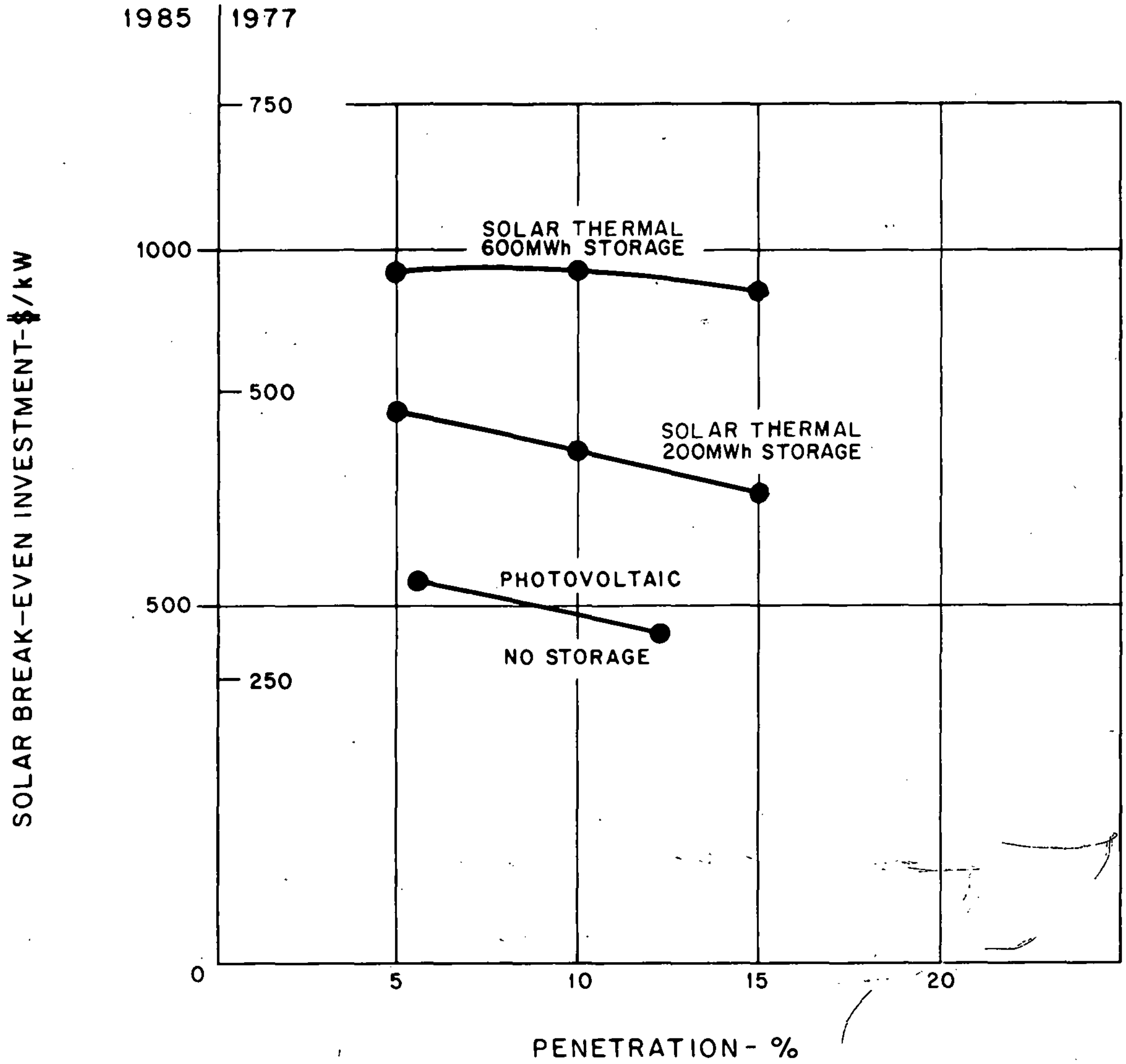


FIGURE 6.6-12
ARIZONA PUBLIC SERVICE COMPANY
SOLAR BREAK-EVEN INVESTMENT
IN THE YEAR 2000

SOUTHWEST PROJECT

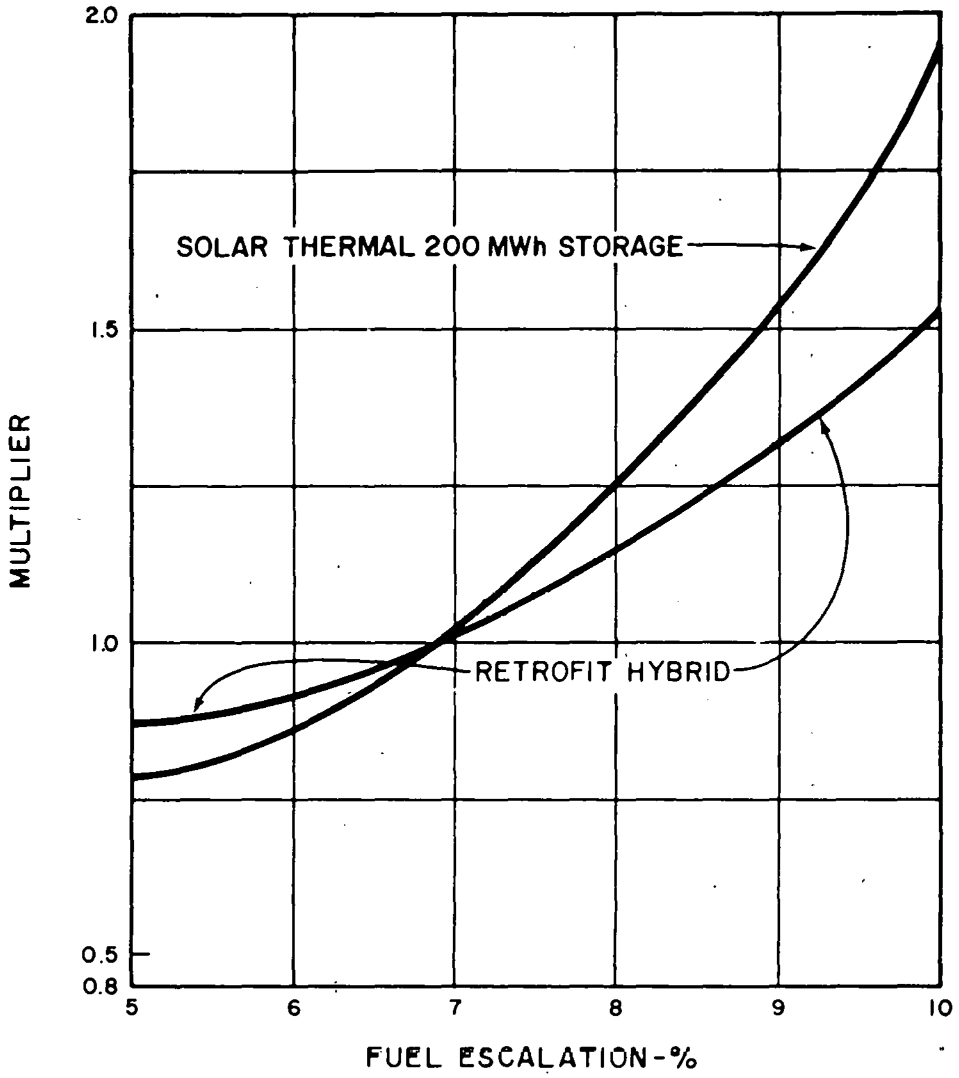


FIGURE 6.6-13
PUBLIC SERVICE COMPANY OF NEW MEXICO

MULTIPLIER TO REVISE BASE CASE SOLAR BREAK-EVEN INVESTMENT FOR CHANGES IN FUEL ESCALATION RATE

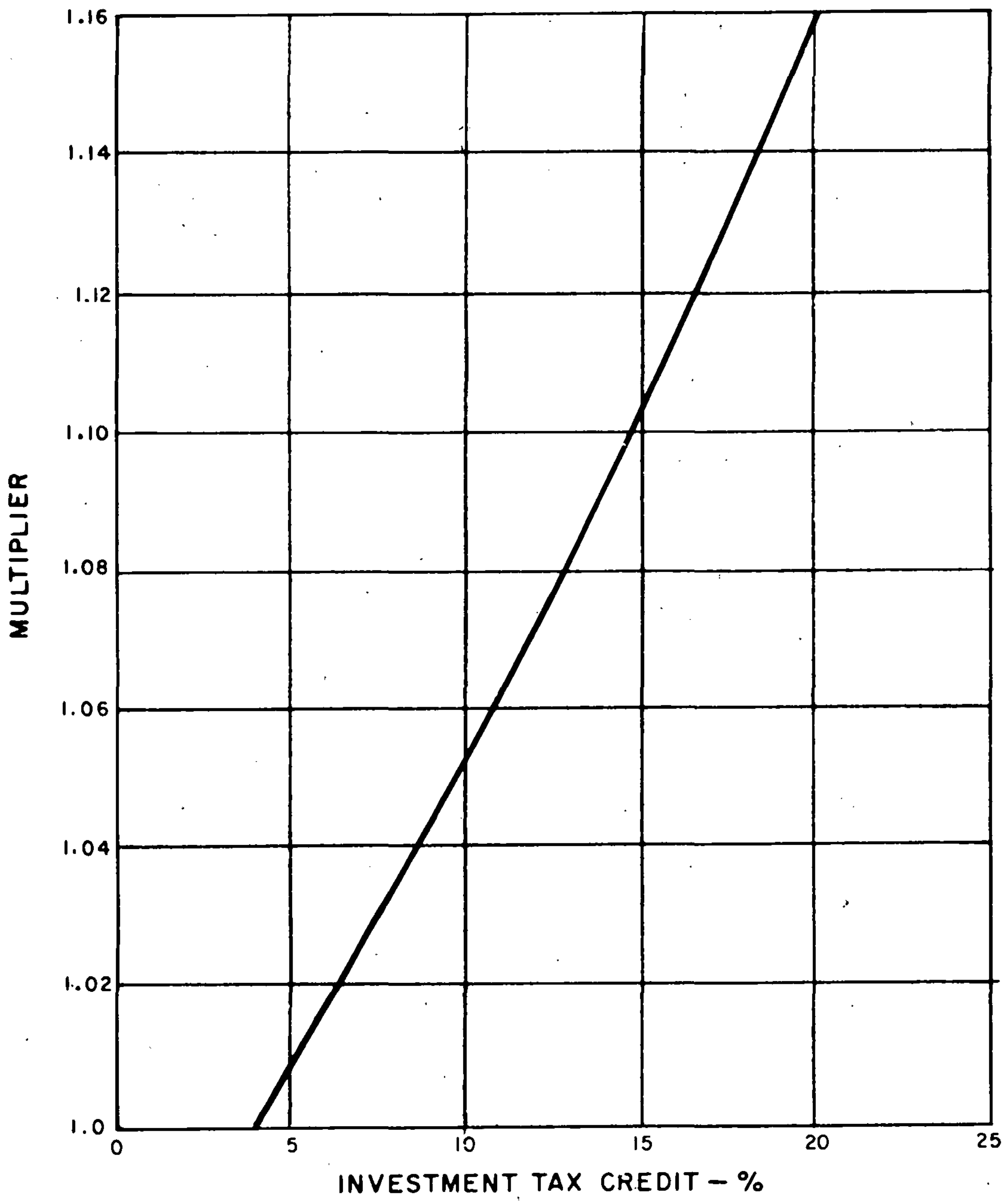


FIGURE 6.6-14

MULTIPLIER TO REVISE BASE CASE SOLAR BREAK-EVEN INVESTMENT FOR CHANGES IN INVESTMENT TAX CREDIT

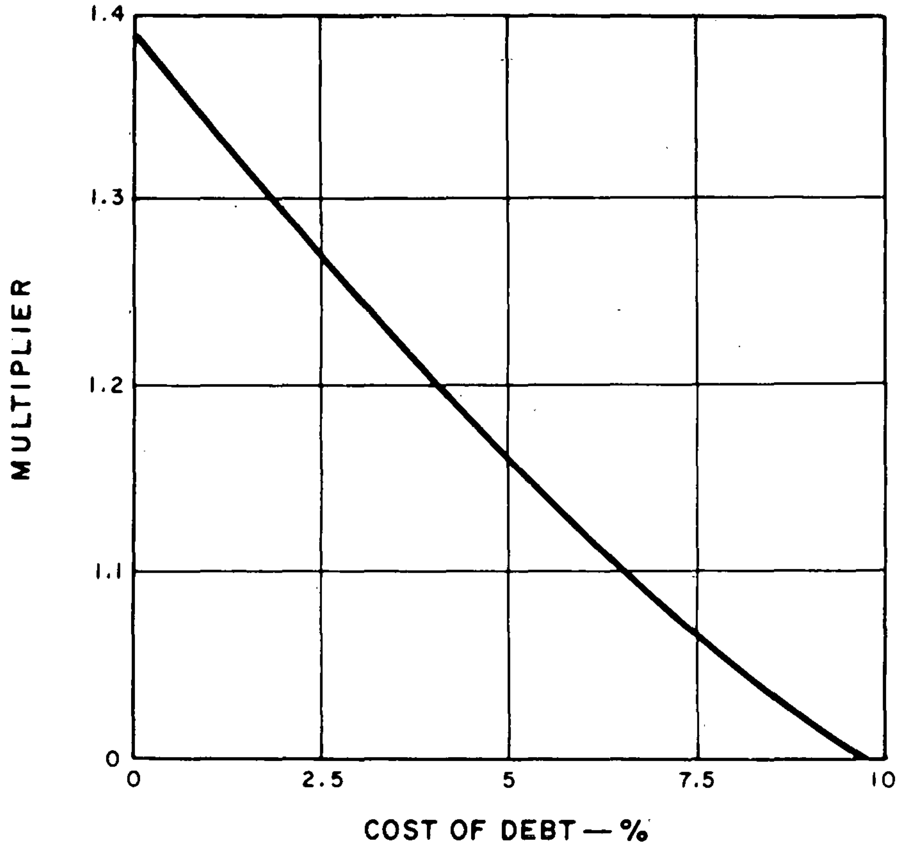


FIGURE 6.6-15
PUBLIC SERVICE COMPANY OF NEW MEXICO

MULTIPLIER TO REVISE BASE CASE SOLAR BREAK-EVEN INVESTMENT FOR CHANGES IN COST OF DEBT

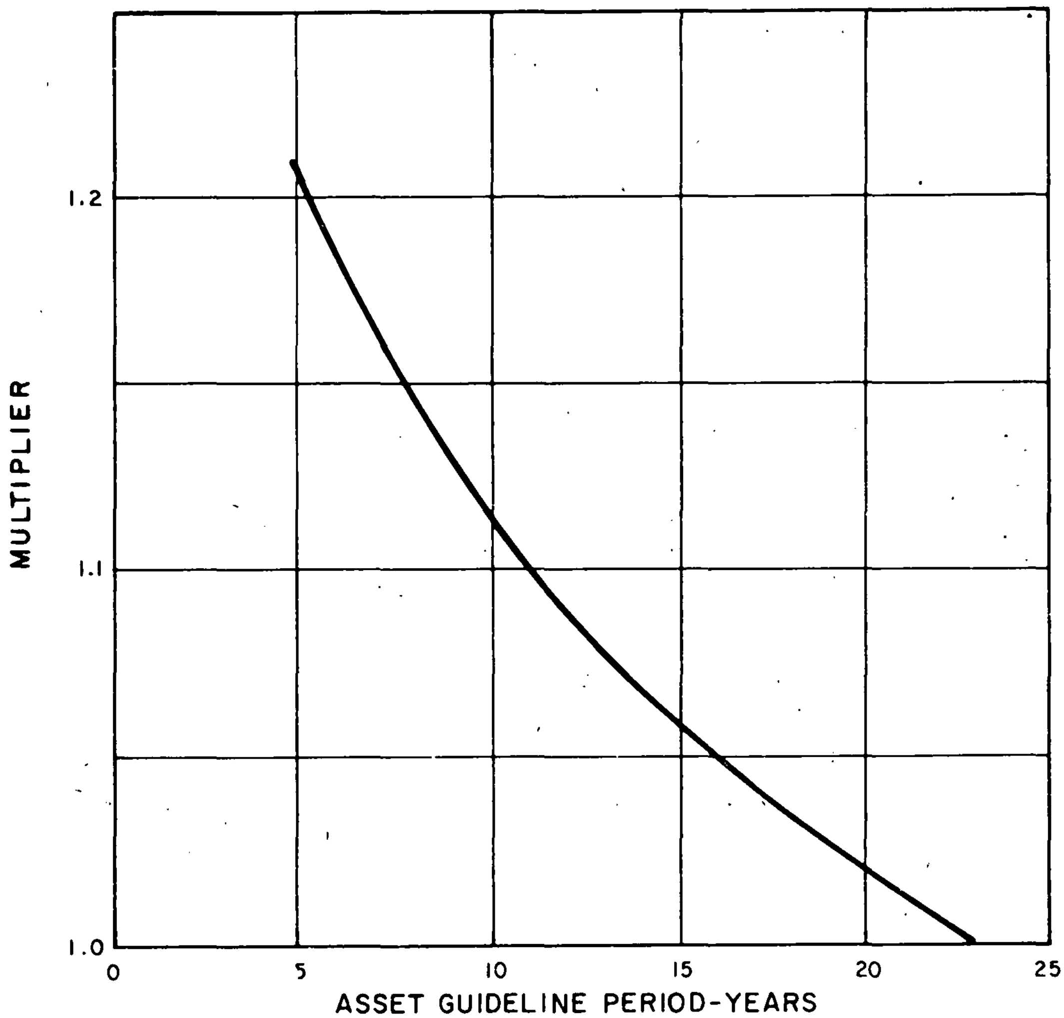


FIGURE 6.6-16

MULTIPLIER TO REVISE BASE CASE SOLAR BREAK-EVEN INVESTMENT FOR CHANGES IN ASSET GUIDELINE PERIOD

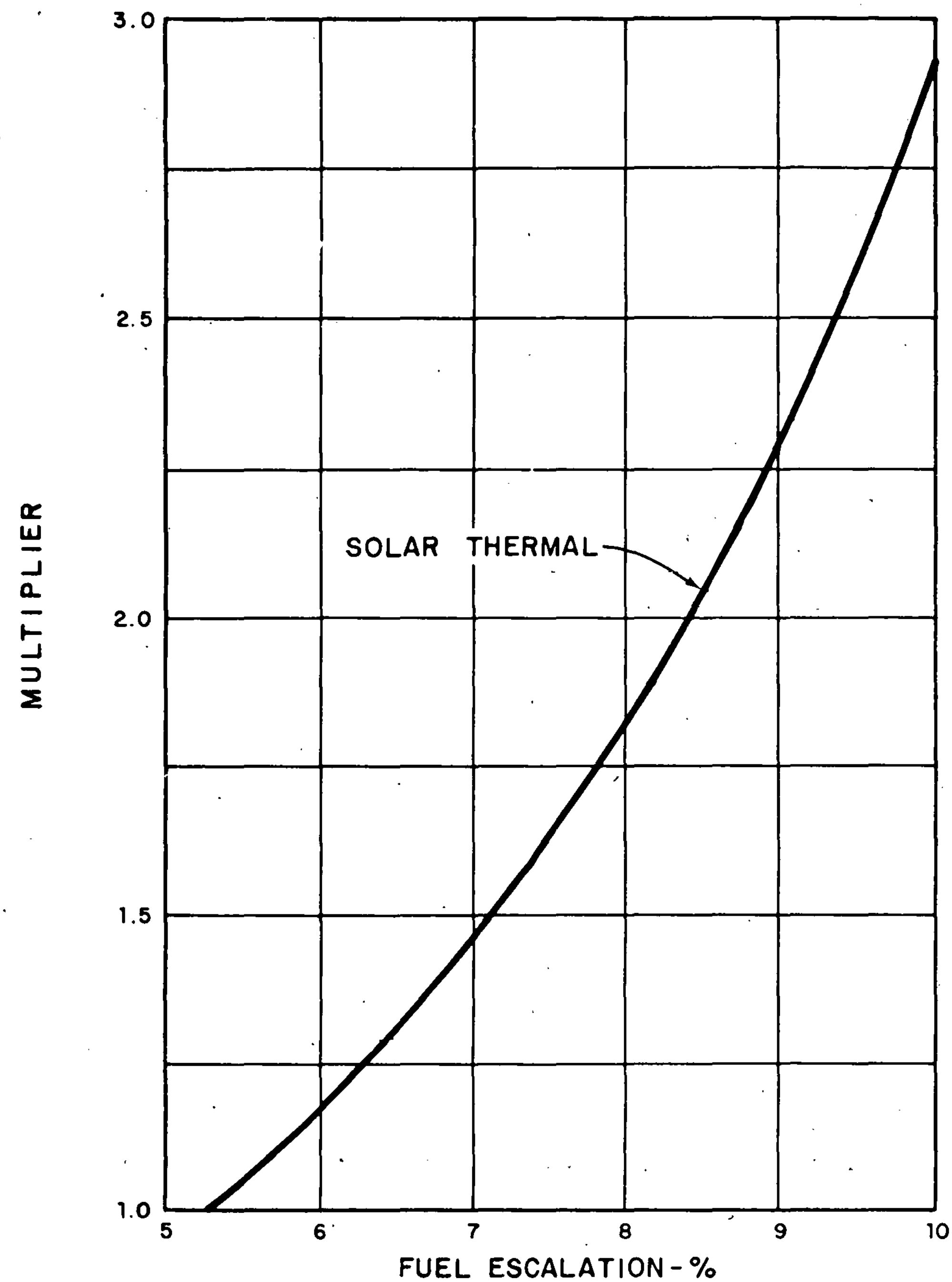


FIGURE 6.6-17
SALT RIVER PROJECT
MULTIPLIER TO REVISE BASE CASE SOLAR BREAK - EVEN INVESTMENT FOR CHANGES IN FUEL ESCALATION RATE

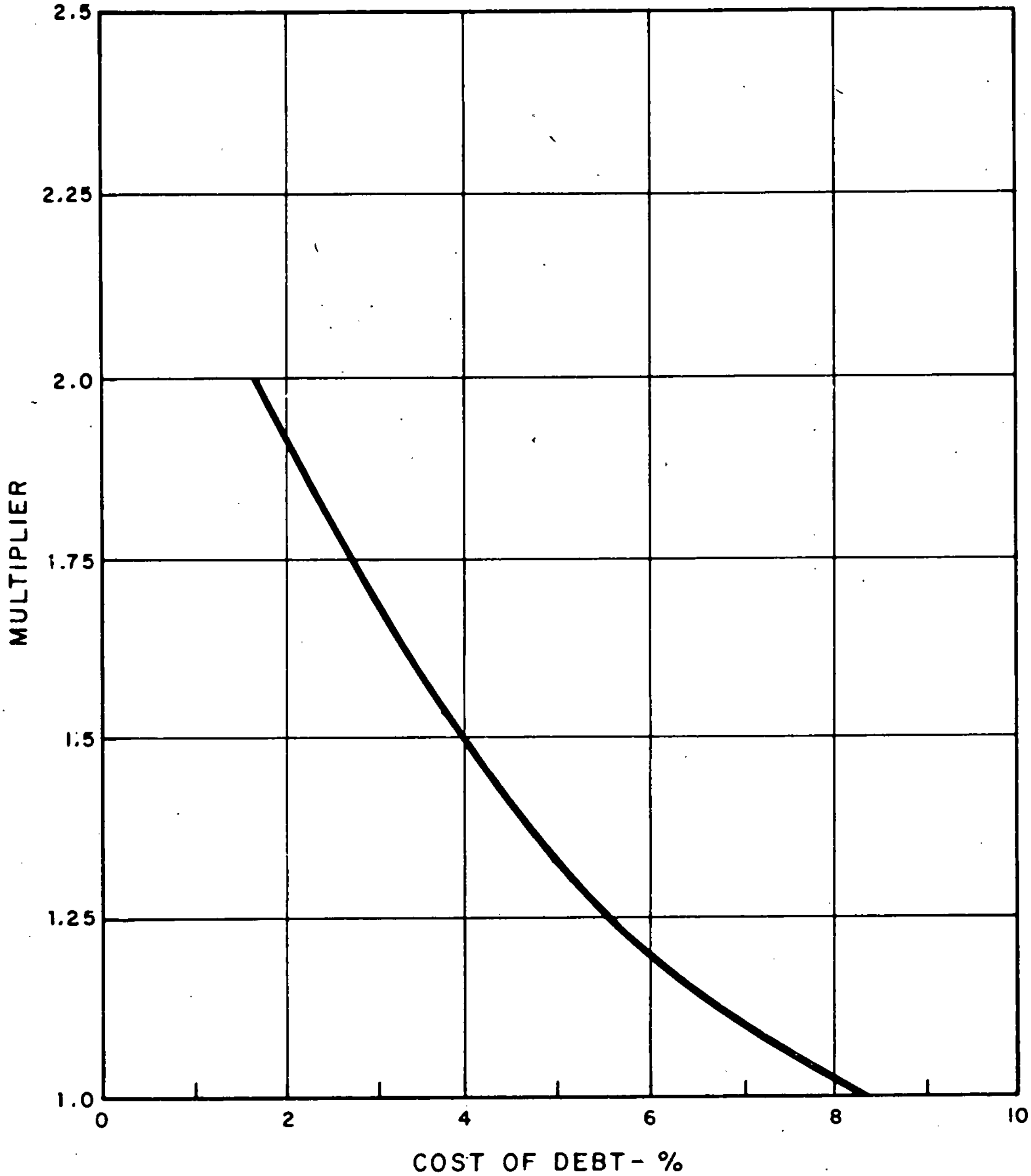


FIGURE 6.6-18
SALT RIVER PROJECT

MULTIPLIER TO REVISE BASE CASE SOLAR BREAK-EVEN INVESTMENT FOR CHANGES IN COST OF DEBT

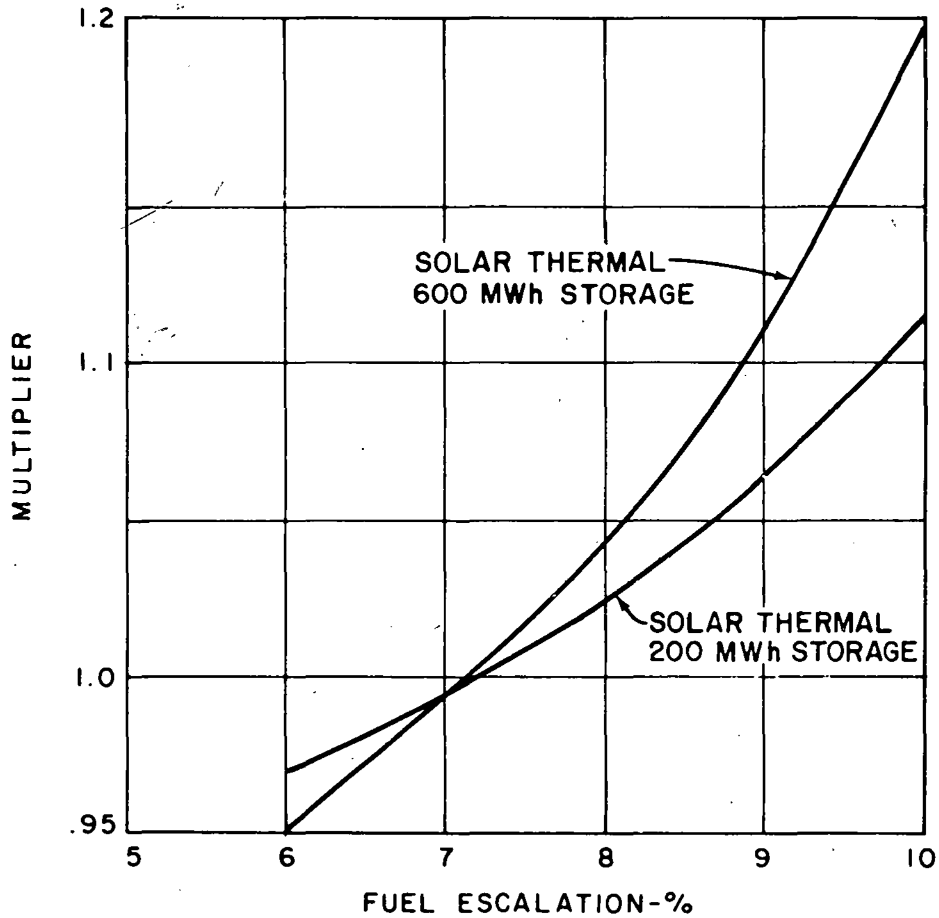


FIGURE 6.6-19
EL PASO ELECTRIC COMPANY

MULTIPLIER TO REVISE BASE CASE SOLAR BREAK-EVEN INVESTMENT FOR CHANGES IN FUEL ESCALATION RATE

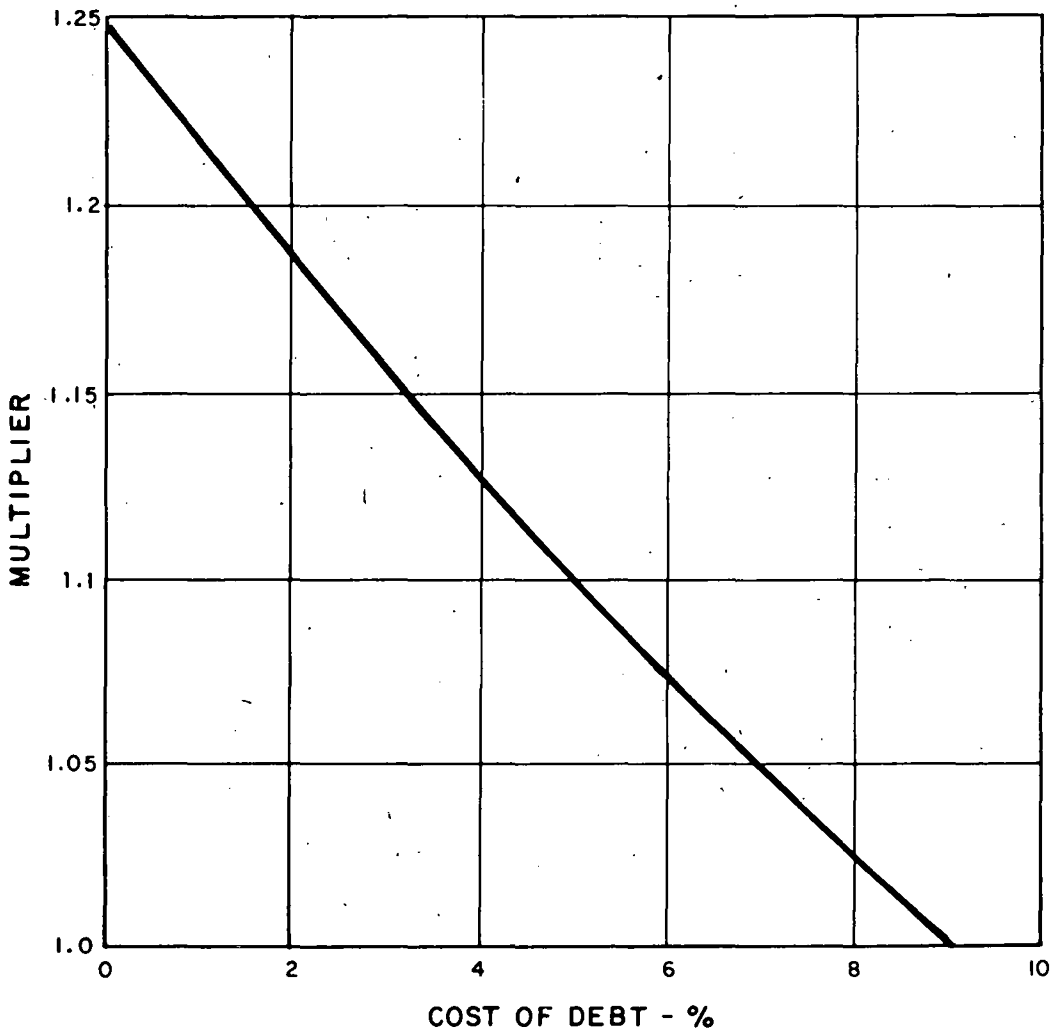


FIGURE 6.6-20
EL PASO ELECTRIC COMPANY

MULTIPLIER TO REVISE BASE CASE SOLAR BREAK-EVEN INVESTMENT FOR CHANGES IN COST OF DEBT

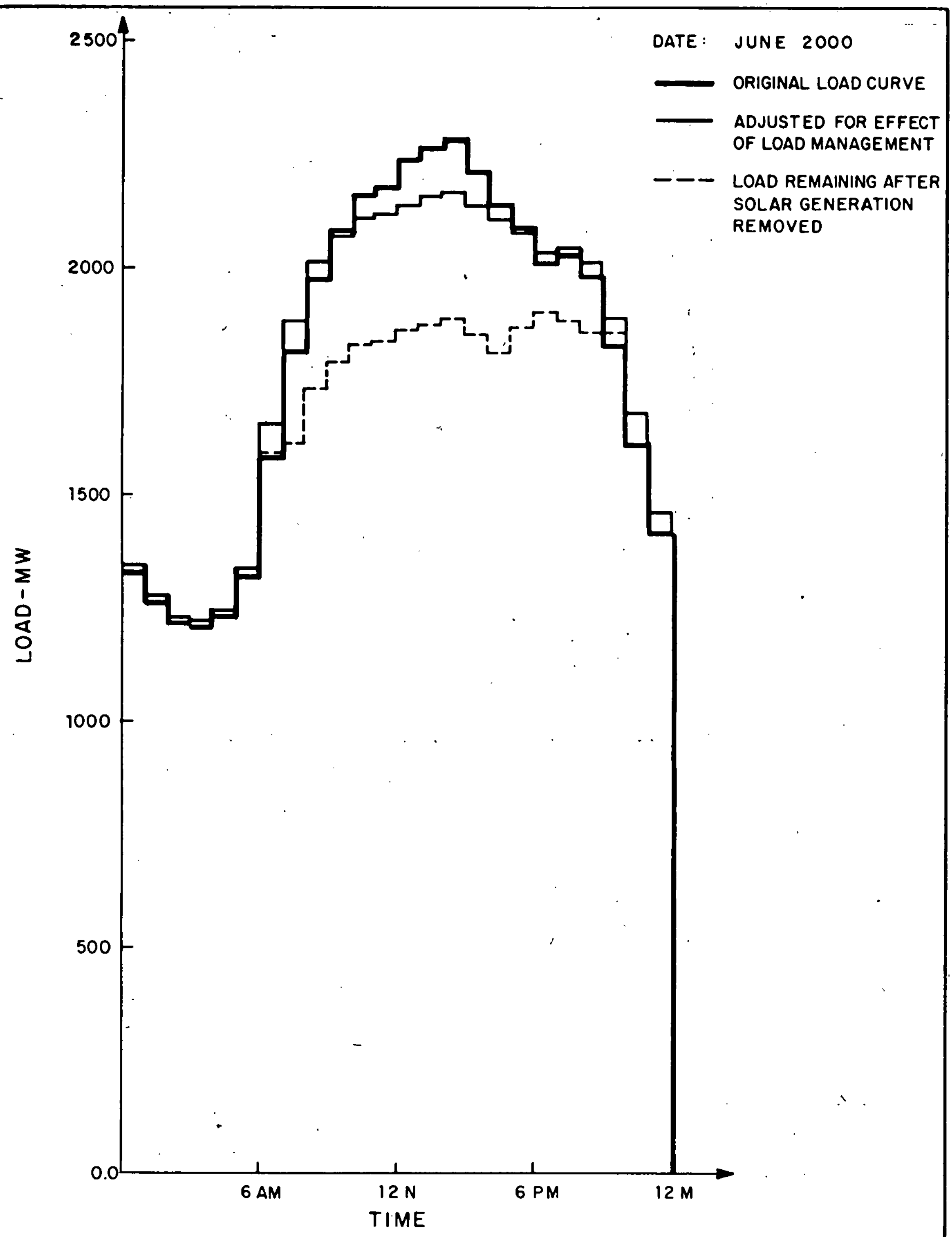


FIGURE 6.6-21
EL PASO ELECTRIC COMPANY
LOAD DEMAND
300 MW SOLAR THERMAL, 6-HOUR STORAGE

SOUTHWEST PROJECT

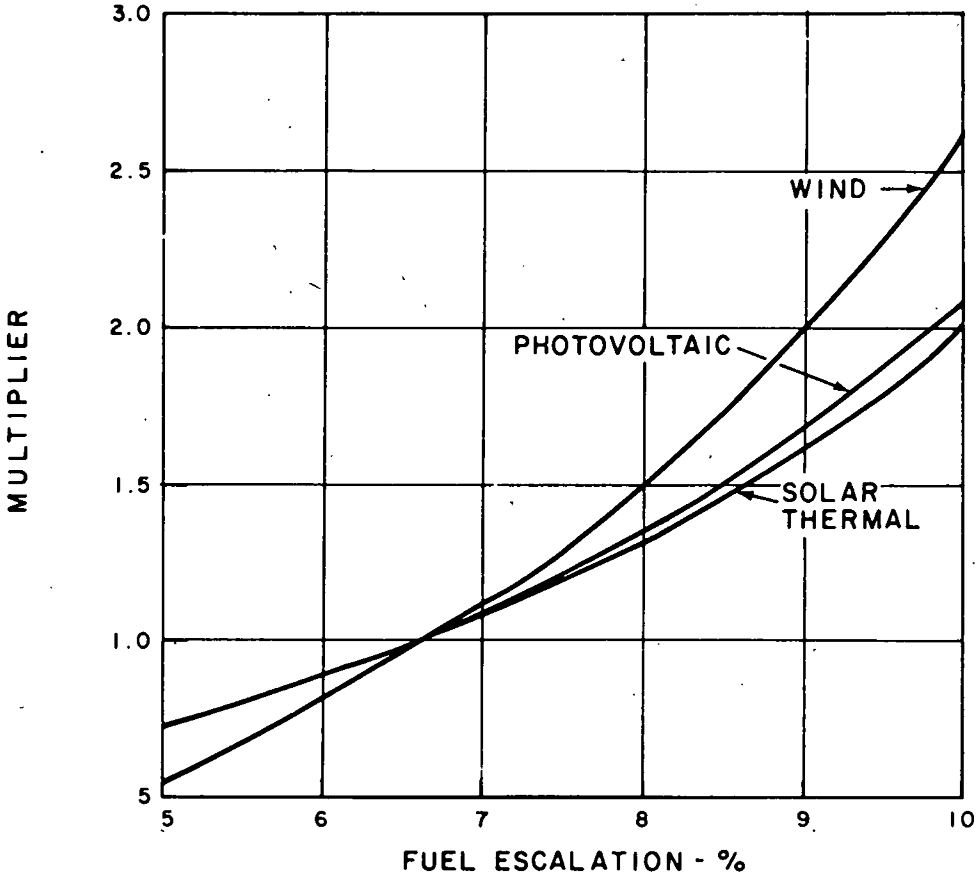


FIGURE 6.6-22
SOUTHERN CALIFORNIA EDISON COMPANY

MULTIPLIER TO REVISE BASE CASE SOLAR BREAK-EVEN INVESTMENT FOR CHANGES IN FUEL ESCALATION RATE

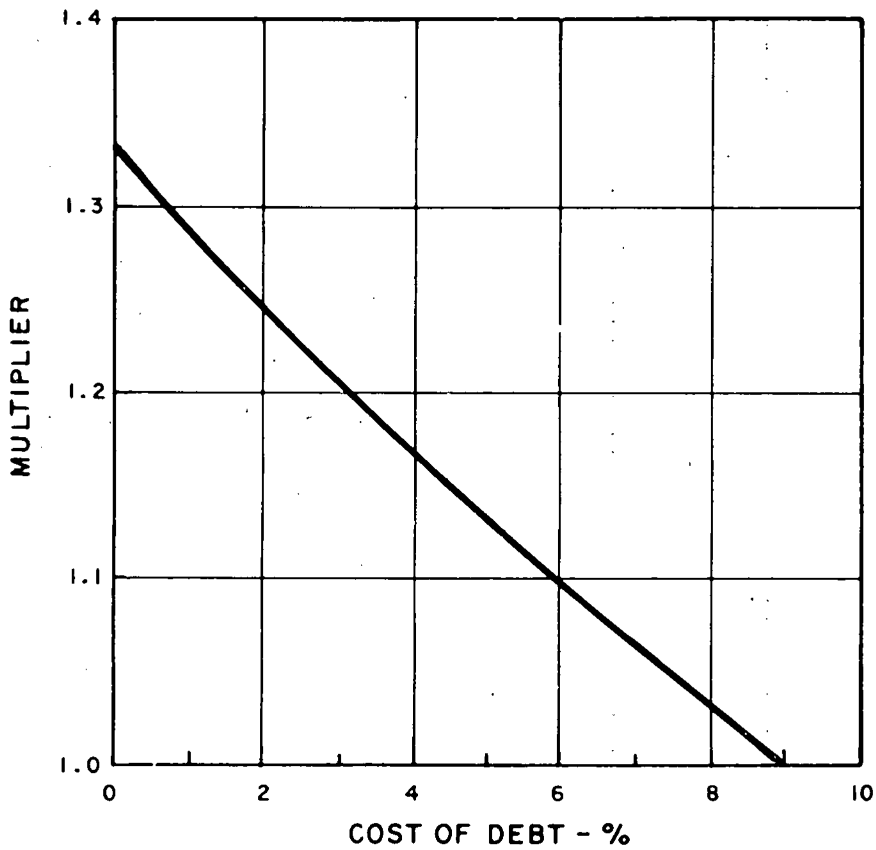


FIGURE 6.6-23
SOUTHERN CALIFORNIA EDISON COMPANY

MULTIPLIER TO REVISE BASE CASE SOLAR BREAK-EVEN INVESTMENT FOR CHANGES IN COST OF DEBT

SOUTHWEST PROJECT

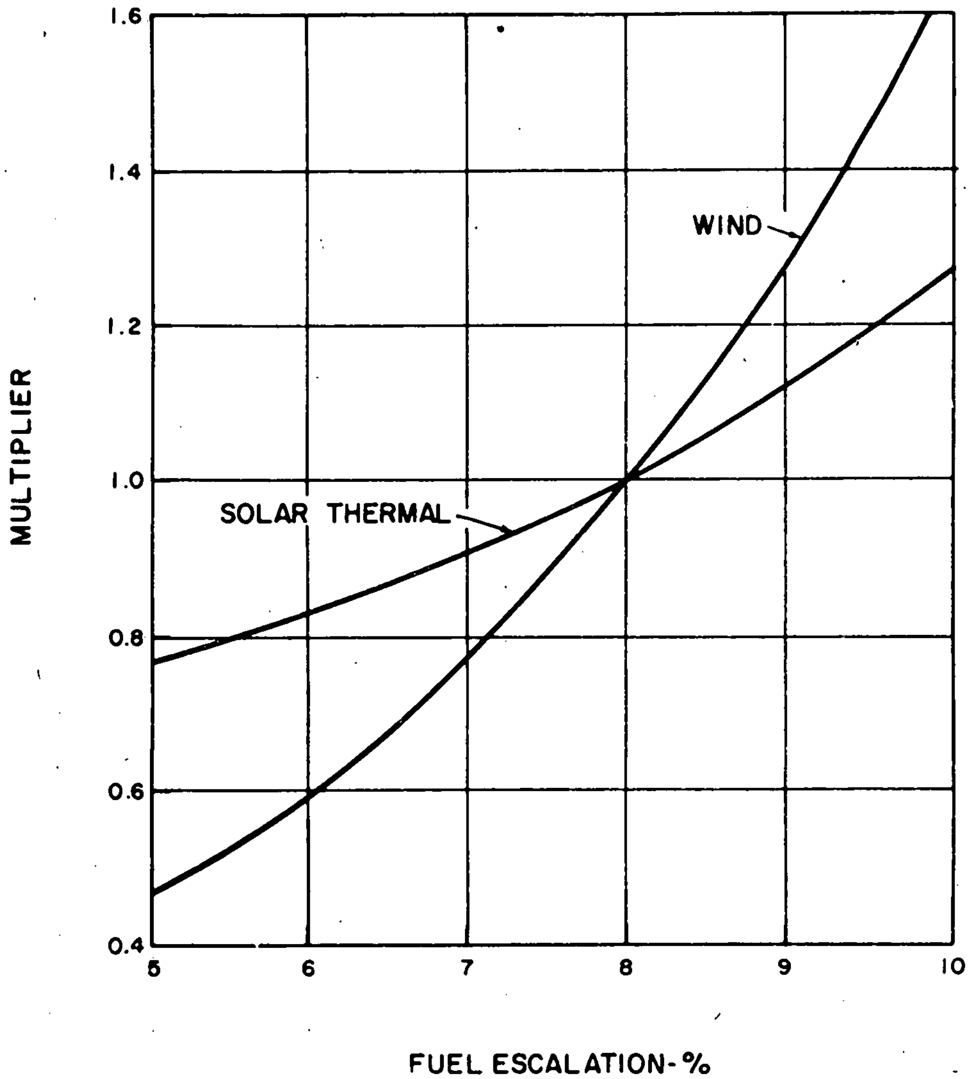


FIGURE 6.6-24
PUBLIC SERVICE COMPANY OF COLORADO

MULTIPLIER TO REVISE BASE CASE SOLAR BREAK-EVEN INVESTMENT FOR CHANGES IN FUEL ESCALATION RATE

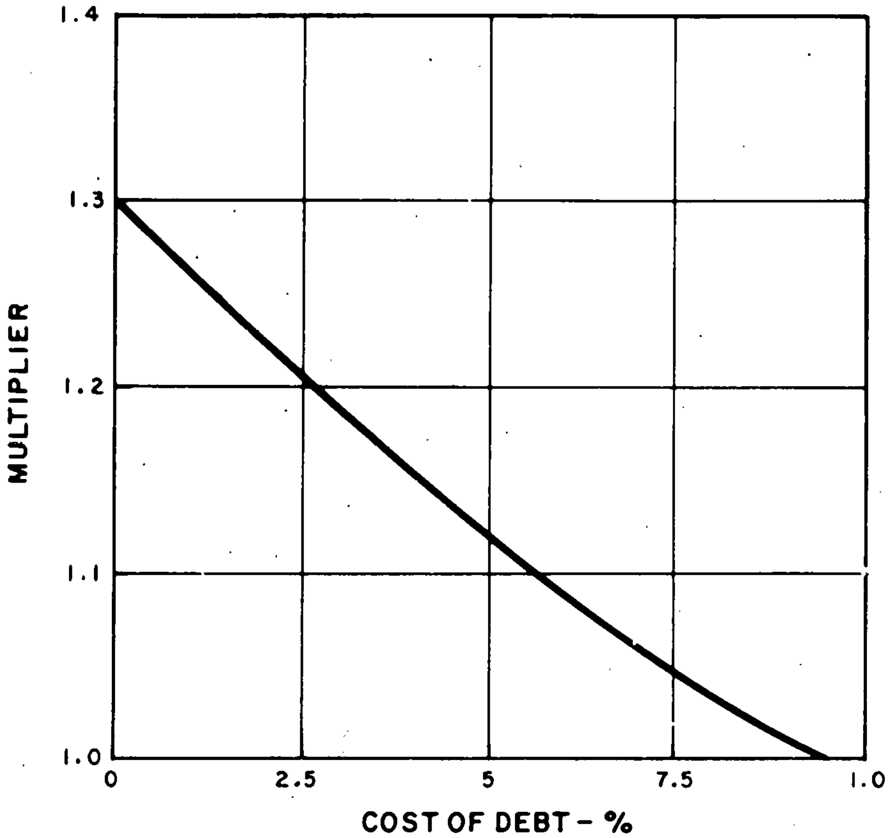


FIGURE 6.6-25
PUBLIC SERVICE COMPANY OF COLORADO

MULTIPLIER TO REVISE BASE CASE SOLAR BREAK-EVEN INVESTMENT FOR CHANGES IN COST OF DEBT

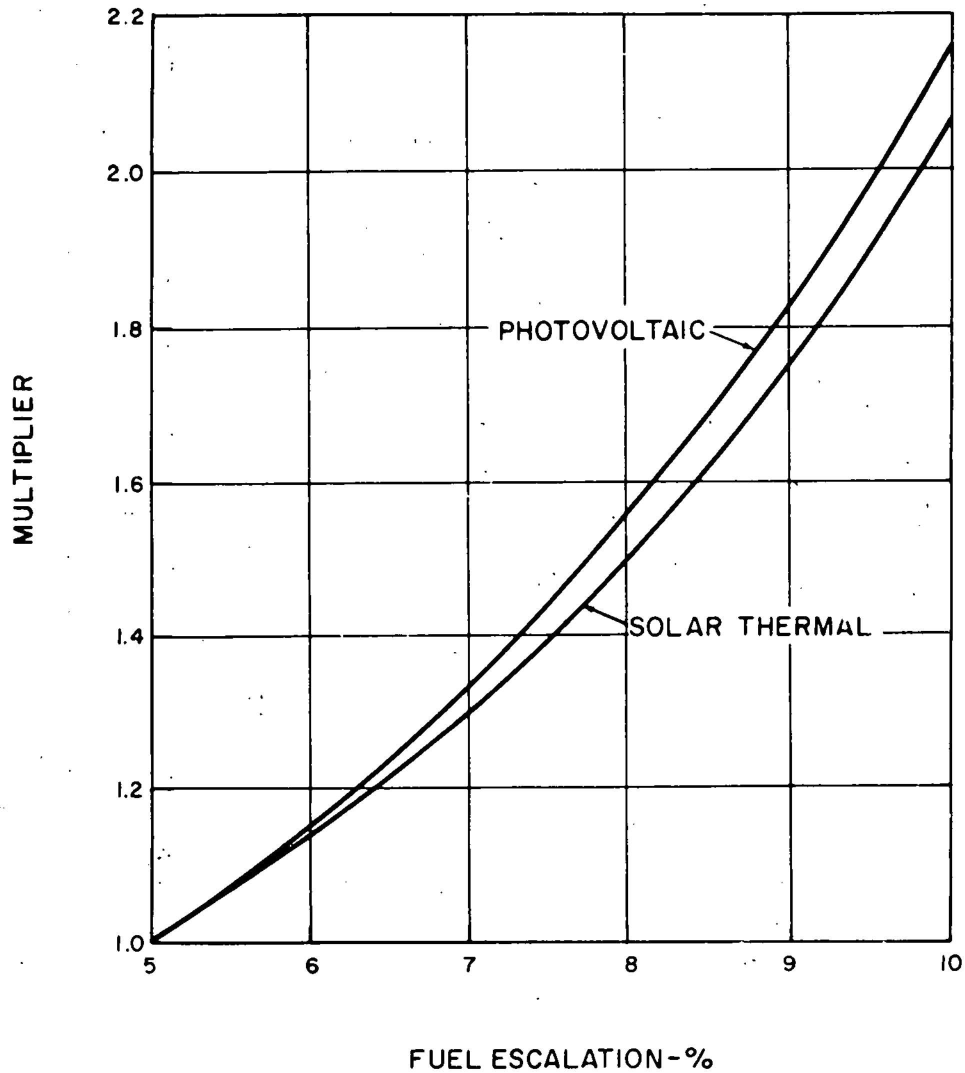


FIGURE 6.6-26
ARIZONA PUBLIC SERVICE COMPANY
MULTIPLIER TO REVISE BASE CASE SOLAR BREAK-EVEN INVESTMENT FOR CHANGES IN FUEL ESCALATION RATE

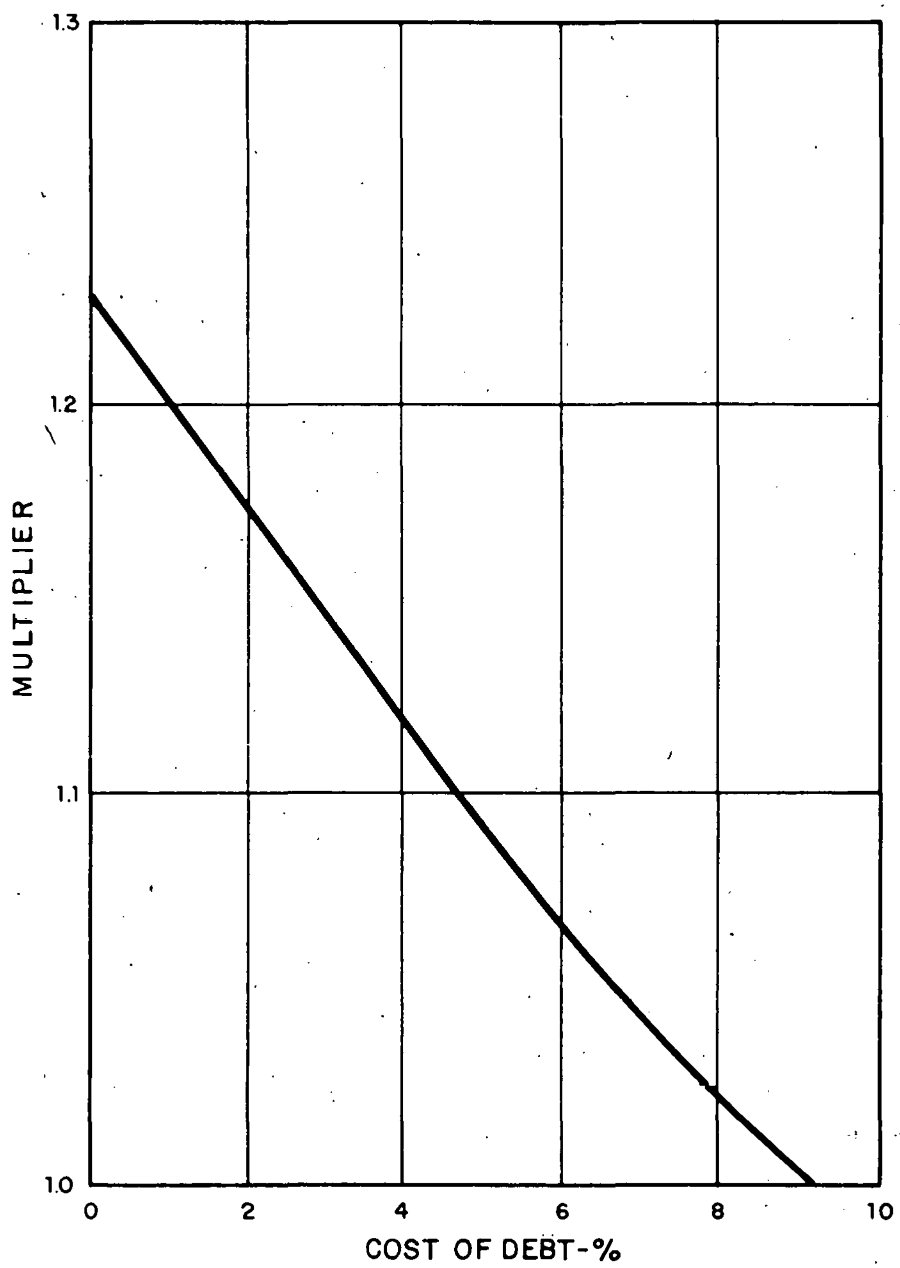


FIGURE 6.6-27
ARIZONA PUBLIC SERVICE COMPANY

MULTIPLIER TO REVISE BASE CASE SOLAR BREAK-EVEN INVESTMENT FOR CHANGES IN COST OF DEBT

SOUTHWEST PROJECT

GLOSSARY OF TERMS

Capital Recovery Factor –

Uniform end-of-year payment necessary to repay a debt of one dollar in "n" years at interest rate "i".

$$CRF = \frac{i(1+i)^n}{(1+i)^n - 1}$$

Capacity Value ($/kW) –

Investment in dollars in conventional capacity replaced by solar generation divided by the nominal rating of the solar capacity.

Fuel Replacement Value ($/kW) –

Dollar value of conventional fuel replaced by solar generation in the year 2000, levelized to reflect escalation through the year 2020, capitalized by dividing the result by the fixed charge rate, and reduced to $/kW by dividing by the nominal rating of the solar capacity.

Operation and Maintenance (O&M) Penalty- ($/kW) -

Dollar value of solar O&M in the year 2000 minus O&M of conventional capacity replaced by solar capacity, levelized to reflect escalation through 2020, capitalized by dividing the result by the fixed charge rate, and reduced to $/kW by dividing by nominal rating of the solar capacity.

Break-Even Investment ($/kW) –

Capacity value plus fuel replacement value minus O&M penalty.

One Year Analyses –

Analyses based on detailed system simulation for the year 2000 to determine break-even investment as described above.

15 Year Analysis –

Expansion of the 1 year analysis to include the 15 year period 1986–2000.

Present Worth Of Revenue Requirements (PWRR) –

Present worth of a series of annual expenses including fixed charges on investment, fuel, and O&M.

Fixed Charges –

Cost to a utility of ownership of equipment which includes interest on debt, return on equity, fit, depreciation, property taxes, and insurance.

Nominal Rating of Solar Generator –

Capability in MW of solar plant at noon on a clear day in December.

Maximum Rating of Solar Generation –

Generator rating minus auxiliary load, MW.

Investment Tax Credit –

Reduction in federal income tax of an amount equal to a specified percentage of an investment in the year the investment is made.

Levelized Fuel Cost –

Fixed fuel cost that produces the same present worth of fuel expense over a period "levelized" as the fuel cost that is escalated year-by-year over the same period.

Fixed Charge Rate –

Multiplier to convert initial investment into an annual expense of ownership; i.e., to compute fixed charges associated with a particular investment.

Equivalent Capacity –

Ratio of conventional capacity replaced by solar generation to nominal solar capacity installed.

Solar Penetration –

Ratio of solar generating capacity installed to total system generating capacity.

*U.S. GOVERNMENT PRINTING OFFICE : 1979 0-620-309/2478