DEVELOPING SOLAR ENERGY
REGULATORY POLICY

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FOREWORD

This report was prepared for The National Regulatory Research Institute (NRRI) under Contract No. EC-77-C-01-8683 with the U.S. Department of Energy (DOE), Economic Regulatory Administration, Division of Regulatory Assistance. The opinions expressed herein are solely those of the authors and do not reflect the opinions nor the policies of either the NRRI or DOE.

The NRRI is making this report available to those concerned with state utility regulatory issues since the subject matter presented here is believed to be of timely interest to regulatory agencies and to others concerned with utilities regulation.

Douglas N. Jones
Director

EXECUTIVE SUMMARY

This report presents the results of research efforts designed to determine the extent and nature of public utility commission attention devoted to solar energy regulatory issues. It also examines the regulatory needs and requirements of electric utilities and solar energy equipment manufacturers necessary to establish a solar energy regulatory policy. The results of this research can be used to design solar energy regulatory policy for public utility commissions.

As a first step in the research design, an extensive review of the literature was performed searching for those publications that have regulatory implications and relevance for the design of solar energy regulatory policy. That effort resulted in the identification of 64 articles, reports, and symposia papers. Summaries are presented in such a form as to provide commissions with relevant but abbreviated research sources where each citation contains enough information to be considered useful in setting solar energy regulatory policy.

To determine the nature and extent of commission attention devoted to solar energy regulatory issues, the study relied on information collected during visits made by the National Regulatory Research Institute (NRRI) staff to 46 public utility commissions from October 1978 to February 1979. The purpose of these visits was to assess the technical assistance needs and research requirements of public utility commissions. In general, the responses by commission staff to questions regarding rate design philosophy, rate-base treatment, accounting procedures or policy development issues were less than satisfactory for analytical purposes. However, it was established that most public utility commissions have not devoted a significant amount of resources to solar energy regulatory policy research and development.

Another major research objective of the study was to determine the regulatory policy needs and requirements of a selected group of electric utilities and solar energy equipment manufacturers. The opinions and attitudes of respondents from 150 electric utilities and over 700 solar energy equipment manufacturers were sought. Regarding specific regulatory issues that must be resolved or taken into account by public utility commissions in solar energy policy developments, this research effort produced a number of important findings of which two are highlighted here.

Electric utilities believe that public utility commissions have not used their authority to influence decisions on the development of solar energy systems. Utilities want public utility commissions to remain neutral on the development of solar energy systems in general and rate design in particular. Manufacturers want commissions to play a role in solar energy system development but not necessarily through promotional rates.

The results of the study, taken from observations of the literature review, the inventory of public utility commission activity, and the assessment of electric utilities and solar energy manufacturers, carried significant regulatory implications and identified several areas where public utility commissions require assistance in designing solar energy regulatory policy. In this spirit, the report devoted attention to transforming the research results into a product that is useful for utility regulators faced with public policy questions on solar energy issues. The material found in the final part of the report presents a case for regulatory neutrality as the basis for commission policy position that supports regulatory actions, methods or programs that neither impose penalties nor provide subsidies to the end user. Two tests are proposed for meeting regulatory neutrality.

With the concept of regulatory neutrality established, the report proceeds to offer four possible implementation strategies for solar energy regulatory policy. These strategies are described as passive, preferred, active and investment. Each of the four implementation strategies is based on the concept of regulatory neutrality. A particular strategy is applicable to any economic, political or regulatory environment in a state. The investment strategy is seen as the most controversial of the implementation strategies since it proposes that the utility can own the equipment and include it in the rate base on which it can earn a rate of return.

ACKNOWLEDGEMENT

The authors wish to express their appreciation for the opportunity to engage in this research to the National Regulatory Research Institute (NRRI) and to the U.S. Department of Energy (DOE) for its funding support. The Technical Review Committee at NRRI, staffed by Dr. Douglas N. Jones, Dr. Kevin A. Kelly, and Dr. Raymond Lawton, provided the authors with assistance in the form of rigorous review and helpful comments. Their support during times of competing priorities was encouraging.

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CHAPTER 1

SOLAR ENERGY REGULATORY POLICY RESEARCH DESIGN

Introduction

As the cost of energy generated by traditional means continues to escalate, interest in alternative energy sources takes on a new meaning for the general public, the scientific and engineering community, and the government. During the past decade, major interest has focused on the use of solar energy to generate electricity, to heat and cool buildings, and to heat water. For the general public, solar energy is often viewed as a "free good" that can be captured by the individual user and provide relief from rapidly rising utility bills. One part of the scientific and engineering community extolls the virtues of solar energy as an answer to the energy problem while another part of the group is equally emphatic in the negative, arguing that solar energy cannot be expected to provide the solution to the national energy problem. The federal government, through several research programs and most notably through passage of the National Energy Act, has raised expectations regarding the potential for solar energy as a viable solution to the energy problem in the United States.

The debate over the virtues and costs of solar energy as an alternative to traditional energy sources has caused much confusion for all parties interested in assessing the energy alternatives available to them. The question is should someone commit or reject resources for solar energy applications? The environment in which the solar energy debate takes place is fraught with political, technical, economic and environmental controversy. This debate takes on significant proportions not only for the utility industry but also for the utility regulators charged with determining policy for the entrance of this new technology.

The utility industry plays a significant role in this matter and faces a dilemma. What is the incentive for a utility to accept solar energy programs that, in some circumstances, could be disruptive to normal operating procedures and reduce revenue, and yet show support for national energy conservation goals? If a utility does support a solar energy program, under what conditions will such support most likely occur? How will back-up service, if any, be costed and priced? Will the public or the regulators view enthusiastic support of solar energy by a utility as another means of increasing its monopoly power?

The concerns of the utility become the responsibilities of the utility regulator in a public utility commission. While responsibility for the utility comes in assuring the company an adequate rate of return for providing high quality service, the utility regulator must also take into account the public interest which must be protected in the form of fair and equitable rates. The utility regulator, as does the utility executive, faces a dilemma. Indiscriminate support for solar energy programs could be harmful to company operations and might even penalize other customers on the system. On the other hand, the treatment of a solar energy equipment user in a manner that does not truly reflect the operating characteristics of this new technology could be harmful to its development and retard energy conservation programs.

The research effort in this study was conceived with the problems facing the utility regulator in mind. Regulatory response to the several issues of energy conservation, assuring the public of fair and equitable rates and providing for a rate of return to the utility, has been made somewhat more difficult by the controversy surrounding solar energy technology. Does solar energy require special regulatory treatment or can it be treated with methods and policy similar to that applied to traditional energy sources? What alternatives and strategies are available to the utility regulator for response to the problems and opportunities presented by solar energy technology? The research undertaken in this study is an attempt to provide the utility regulator with some answers to these questions or suggest directions that might be usefully pursued.

Purpose and Objective

The main research objective of this report is to determine the status of solar energy regulatory developments in public utility commissions and to assess the needs of electric utilities and solar energy equipment manufacturers for solar energy regulatory policy. Determination of the status of solar energy regulatory developments was accomplished by a thorough review of the literature and by conducting a technical assistance needs assessment of public utility commissions. Regulatory needs and requirements of electric utilities and solar energy equipment manufacturers were assessed by means of mail inquiry. Regulatory implications from these research findings form the base for developing solar energy regulatory policy that can be executed by choosing from four implementation strategies. The cornerstone of the solar energy policy presented in this report is the concept of regulatory neutrality. This is not to say that solar power should or should not be given preferential treatment by other government entities--tax incentives, direct program support of research and development, etc.--only that use of commission regulation to foster any particular technology should be avoided.

For ease of exposition, the definition of several terms and an explanation of certain phrases used herein is in order. Policy is defined as a definite method or course of action that is selected from among several possible alternatives, based on current knowledge, to guide and determine present and future decisions. The type of regulation referred to here is defined by that authority given to public utility commissions in state and local jurisdictions for regulating electric and gas utilities. Regulatory neutrality is defined as a policy position that embraces regulatory actions, programs or methods that neither impose penalties nor provide subsidies to the user. Solar energy systems, as used in this report, are taken to mean systems that use solar radiation collection to provide a space conditioning and water heating system for a building. Space conditioning is defined as any system or method that can provide heating and cooling.

Original Proposal and Work Plan

The original concept for this study was proposed by the National Regulatory Research Institute to the United States Department of Energy in a proposal submitted to the Office of Utility Systems in June 1978. That document proposed an in-depth study directed to identify and analyse tariffs, rate schedules, and riders being used by public utility commissions for solar energy applications. The major objective was to determine the economic rationale for developing solar tariffs and to document procedures for accounting treatment and administrative procedures. It was also proposed that the regulatory needs and requirements of electric utilities and solar energy equipment manufacturers be determined and be made an integral part of solar energy regulatory policy design. In addition, the study also intended to identify and document the status of public utility commissions' commitment to the development of a public policy position on solar energy. The results of this research could then be used in the development of a solar energy regulatory policy for public utility commissions.

This general research concept was accepted by DOE and, in October 1978, the NRRI prepared a work plan to study solar energy regulatory issues. The objective of the work plan was to investigate the major regulatory issues that influence the development of solar energy regulatory policy; the objective is defined by three basic work statements:

1. To conduct a review of the literature to identify the regulatory issues considered important to the development of solar energy systems;
2. To determine the extent and nature of commission (public utility commission) attention that has been devoted to the development of solar energy regulatory policy;
3. To examine the regulatory needs and requirements of the electric utility industry and suppliers (manufacturers) of solar energy equipment.

Results of this study will be submitted to DOE in a final report that will contain the research results in four subject areas. The first part of the final report should contain an analysis of the literature review on solar energy regulatory issues. The second part is to contain a presentation and analysis of the methods and economic rationale for the development of in-place solar energy rates and tariffs. The third part will present the regulatory policy "needs," as expressed by a sample of electric utilities and solar energy equipment suppliers (manufacturers). The last part will then contain an analysis of some of the regulatory implications identified as a result of the investigation.

Research Method

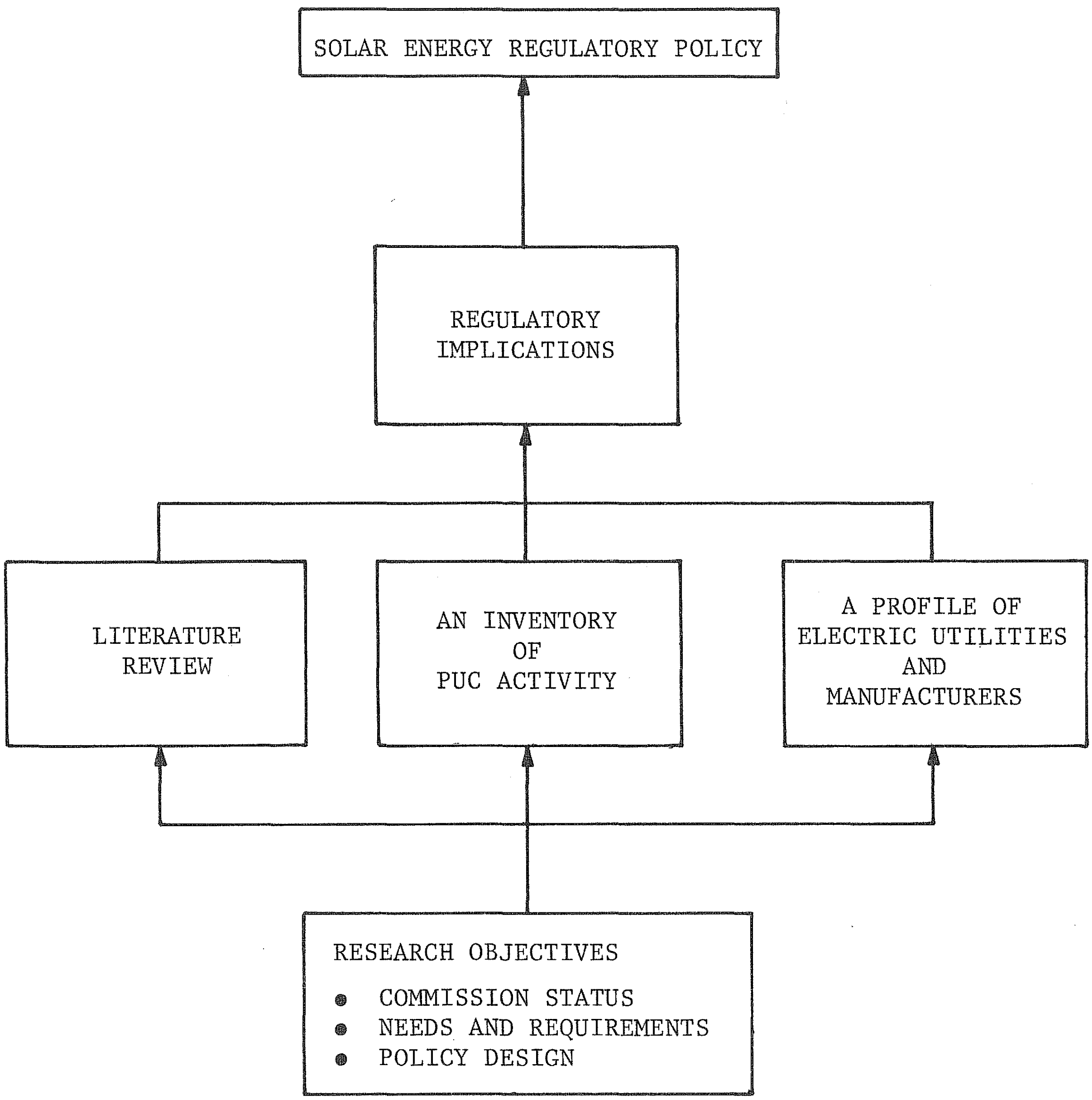
Three methods were used to meet the objective of this study. A basic diagram of the research design is presented in Figure 1-1. In brief, the research program was designed to look at past efforts, the status of present PUC activity, and the needs of a group of utilities and manufacturers for solar energy regulatory policy.

The first task was to conduct a literature search to identify those issues considered important for the development of solar energy regulatory policy by public utility commissions. Usually, a literature review is intended to provide the investigator with the necessary background and assessment of previous research undertaken. Although that was a prime motivation here, it was also a stated objective: to provide each commission with information that could be applied directly in its efforts to draft a solar energy regulatory policy. Accordingly, this report has a cross section of the literature deemed relevant for commission application. As a result of this effort, Chapter 2 of this report contains 64 articles, reports and symposia papers that were identified, reviewed and summarized.

The literature selected represents issues determined to have regulatory implications that should definitely be considered in the development

FIGURE 1-1

RESEARCH DESIGN--SOLAR ENERGY REGULATORY ISSUES



of solar energy regulatory policy for space heating, cooling and water heating. Issues that impinge directly on the powers and the authority of the public utility have been highlighted where appropriate; other closely related issues which are likely to surface during the course of solar energy regulatory deliberations are also presented. A list of the direct, indirect and regulatory policy issues dealt within the literature review is presented in Table 1-1.

An inventory of the efforts and commitment of public utility commissions to the development of solar energy regulatory policy was accomplished using three means of information gathering. In 1978, the NRRI conducted a brief research project to determine which public utility commissions had approved a solar energy tariff. The results of that effort entered into this report. From October 1978 through February 1979, the NRRI staff conducted on-site needs assessments of 46 public utility commissions. In the course of the visits, an attempt was made to collect information about the extent of commissions in solar energy regulatory developments. Finally, the third source of information is taken from data supplied by 84 electric utility companies queried concerning their needs and requirements for solar energy regulatory policy. This is a major task of the research design and is presented in more detail in Chapter 4. The findings from the inventory effort are presented in Chapter 3 of this report. An overview of public utility commission activity in solar energy regulatory policy and tariffs is presented in Table 1-2.

The ability to determine the needs and requirements of a group, as an aid prior to the design of regulatory policy, is seen as an advantage with benefits accruing to those being regulated and to the regulators. Results from such analysis are seen as a very important step in the design of solar energy regulatory policy. The objective of the research task described in Chapter 4 is to determine specifically the regulatory needs and requirements of a target group consisting of electric utilities and solar energy equipment manufacturers.

TABLE 1-1

REGULATORY ISSUES COVERED
IN THE LITERATURE REVIEW

DIRECT	
	Cost-of-Service Methods
	Rate Design
	Rate-Base Treatment
	Utility Finances
INDIRECT	
	Tax and Financing Incentives
	Market Feasibility
	Research and Development
	Environmental Impact
	Federal Antitrust
	Legislation
POLICY	
	Promotional
	Government Involvement
	Utility Financing and Ownership
	Cooperation with State Energy Office
	Rate Discrimination
	Time-of-Use Pricing

TABLE 1-2

A SUMMARY OF SOLAR ENERGY REGULATORY ACTIVITY BY PUBLIC UTILITY COMMISSIONS

Commission	Tariff[a]	Policy
California		X
Colorado		X
Connecticut	1	
Illinois	4	
Kansas	1	
Michigan	1	
New Hampshire	2	
New York	1	
North Carolina	2	
South Carolina	3	
Texas	2	
Utah	1	
Wisconsin	1	
	19	

[a] Number of Tariffs

The ability to generalize a company position regarding the design of policy may benefit the electric utility directly and the manufacturer indirectly. Regulatory policy may have a greater potential for success if the advice and counsel of those being regulated is sought beforehand. If electric utilities support the policy, then solar energy equipment manufacturers will find product design, production planning and market forecasting occurring under more stable conditions. Such conditions could lead to more company entrants to manufacture equipment, and the resultant competition could lower prices to the consumer. The direct beneficiary of this condition would be the general public now faced with decisions as to solar energy system applications and purchase. It is toward this objective--the determination of regulatory needs and requirements--that the discussion is directed in Chapter 4.

The regulatory implications taken from the observations and findings produced as a result of the literature review, the inventory of public utility commissions, and the regulatory needs assessment form a base for the development of regulatory policy and is the subject of the research presented in Chapter 5. A case is presented for the concept of regulatory neutrality which is defined as a policy decision that is neutral among competing technologies. Applied to a regulatory example, the following tests are proposed for application:

1. Any action, program, or method must be non-discriminatory and should be applicable to all customers in a service class.

2. The rate structure for customers in that service class must use a cost-of-service methodology to track costs that, in turn, produce cost base rates.

Once the concept of regulatory neutrality is established, the chapter proceeds to present four possible implementation strategies that could be used by public utility commissions in the design of solar energy regulatory policy. The four strategies are described as passive, preferred configuration, active and investment. Each strategy meets one or both tests for regulatory neutrality and can be applied dependent on local political and economic conditions.

CHAPTER 2

REVIEW OF THE LITERATURE ON SOLAR ENERGY REGULATORY POLICY

Introduction

This chapter presents the results of a literature review on research for solar energy technology applications. More specifically, the literature review was performed to identify those issues considered important for the development of solar energy regulatory policy by public utility commissions. As a result of that effort, 64 articles, reports, and symposia papers were identified, reviewed, and summarized. Detailed outlines are present for all but 16 of the summaries.

The main objective of this chapter is to provide commissioners and commission staff with an overview of research on important issues in the development of solar energy regulatory policy. Each issue, as treated in the identified article, has been determined to have regulatory implications and as such may be a barrier in the development of solar energy regulatory policy for space conditioning and water heating.[1] Regulatory implications are defined as those issues that impinge directly on the powers and the authority of public utility commissions and also include closely related topics that are likely to surface during debate over proposed solar energy regulatory policy. Thus, the literature that treats issues of direct concern to commissions such as cost-of-service, rate structure, rate-base treatment and revenue adequacy has been selected and highlighted. In addition, topics determined to be on the periphery

[1] Space conditioning is defined to include both solar space heating and cooling.

of utility regulation such as tax incentives, equipment financing, environmental impact, legislative issues and other legal matters have also been included.

Although the literature search was wide in scope, studies in some categories are only briefly mentioned or not included. For example, a significant portion of the technical literature deals with solar physics and the engineering of solar energy system equipment. However, the acticles on solar physics are totally absent here and the engineering studies selected for this review are by no means a representative sample of the literature. This is in keeping with the objective of selecting only those engineering articles that were judged to have regulatory implications such as those suggesting the use of rate structure or rate-base treatment as incentives. Among the many potential uses of solar energy, only the literature dealing with space conditioning and water heating was reviewed. For example, the use of solar energy as a substitute for generation of electricity by conventional fuels is treatly only incidentally.

Basic Information Sources

Highly general material from mass market publications was omitted. Research published before the middle 1950's is not covered in this review. Those interested in pursuing research in worldwide developments in solar energy prior to 1955 will find Applied Solar Energy Research published by the Stanford Research Institute a valuable document.[2]

The following bibliographies and journals were thoroughly reviewed and are considered to be the fundamental sources of research in solar energy applications.

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[2] E. J. Burda, Editor, Applied Solar Energy Research (Phoenix: The Stanford Research Institute, 1955).

1. U.S. Department of Energy, Energy Research Abstracts, 1-3 (Oak Ridge, Tennessee: Technical Information Center, 1976-1978).

   This publication contains abstracts of "all scientific and technical reports, journal articles, conference papers and proceedings, books, patents, theses and monographs originated by the U.S. Department of Energy."

2. Solar Thermal Energy Utilization prepared for the National Science Foundation (University of New Mexico: Technology Application Center, 1957-1974).

3. U.S. Atomic Energy Commission, Technical Information Center, Solar Energy: A Bibliography, National Technical Information Service TID-3351 (December 1974).

4. Energy: A Key Phrase Dissertation Index (Ann Arbor, Mich.: University Microfilms International, 1976).

   Six thousand dissertations written between 1966 and 1975 were identified in this index.

5. Barbara Harrah and David Harrah, Alternate Sources of Energy, (Metuchen, N.J.: The Scarecrow Press, 1975).

   This is a bibliography on solar, thermal, wind and tidal energy and environmental architecture.

6. Solar Energy, 1-19 (Victoria, Australia: Perganon Press, 1957-1978).

   This is the quarterly journal of the International Solar Energy Society.

Some of the literature thought to be relevant to the investigation was not pursued because of difficulty in obtaining the material. Time and budget limitations were also constraints that had to be reconciled in the literature search. However, those articles that either could not be located or only slightly related to the research objective of this study are presented at the end of this chapter.

The Solar/Utility Interface

In conducting the search, articles were primarily chosen that focused their research on the role of the public utility in what has been called the solar/utility interface. It is this interface that is of concern to policymakers in Washington and for regulators at the state level. Therefore, public utility commissions that seek to formulate solar energy regulatory policy require a thorough understanding of the regulatory issues that influence this interface. Table 2-1 identifies the general issue areas covered by each article reviewed. Each article, report or paper is identified by the author(s) or publishing agency, the year of publication followed by a short description of the article identifying its focus and the type of regulatory policy issue treated.

Background Articles

The articles presented in Table 2-1 cover a broad spectrum of research and thinking on the solar/utility interface. A significant number are concerned primarily with economic issues. Several provide excellent overviews and general assessments of solar energy developments. In this regard, the studies by The General Electric Company (#10 and #11), TRW (#50 and #51), and Westinghouse (#59 and #60) are valuable. All three studies were released in 1974 and, in general, support a promotional solar energy development policy.

In a 1972 study, the National Science Foundation (NSF) (#35) called for the federal government to take a lead role in research and development to be used as inputs into solar energy program planning. This study was sponsored by the Federal Energy Administration (FEA) Project Independence 1974 research effort (#57). Several constraints to solar energy development were identified in that study, one being the degree of preparation by regulatory agencies for increased use of solar power by consumers. A number of incentives for utility companies (tax incentives, equipment ownership, tax free utility bonds) and state regulatory agencies (issue solar operating certificates, develop technical standards, enforce regulations) are suggested. The "incentives" for state regulatory commissions may be judged by the regulatory community as questionable incentives.

TABLE 2-1

FOCUS OF LITERATURE ON REGULATORY ISSUES
OF SOLAR ENERGY SYSTEM DEVELOPMENT

Author(s)	Focus and Regulatory Policy Issues	Extent of Review*
1. Asbury and Mueller (1977)	Solar/utility interface; a critical economic assessment of technological match.	S, O
2. Baron (1978)	Solar as consumer of non-renewable resources; problems of a promotional policy.	S, O
3. Bezdek and Ezra (1977)	Cost/benefit analysis of alternate tax incentive programs.	S, O
4. California PUC (1977)	Role of state and utility in solar energy development; benefits of a promotional policy.	S, O
5. Comins and Behler (1978)	Rate structures; cross-subsidies among classes of utility customers as a barrier.	S, O
6. Commoner (1978)	Support for government promotion of solar energy.	S, O
7. Davis (1975)	Solar-assisted gas water heater; utility ownership as a promotional policy.	S, O
8. Dean and Miller (1976)	Law and utilities; commission jurisdictions; rate discrimination as regulatory policy.	S, O
9. Dedrick (1977)	California PUC opinions; rate-base treatment utility ownership.	S, O

*S = summary
O = outline

TABLE 2-1 CONTINUED

Author(s)	Focus and Regulatory Policy Issues	Extent of Review*
10. General Electric Company, Vol. I (1974)	General assessment and feasibility; impact on utilities.	S, O
11. General Electric Company, Vol. II (1974)	General assessment and feasibility; suggested government policies for promotion.	S, O
12. Feldman (1975)	Peak-load pricing as an incentive.	S, O
13. Feldman and Anderson (1976)	Existing utility pricing as a barrier and peak-load pricing as an incentive.	S, O
14. Feldman et al. (1976)	Public utilities and solar energy interface; public policy options and their impact.	S, O
15. Freeman (1977)	Utility role as a promoter of solar using rate base and ratemaking as an incentive.	S, O
16. Freeman (1978)	Utility role; rate base treatment legal and regulatory problems.	S, O
17. Gregory (1977)	Utility role in ownership, marketing and maintenance.	S
18. Greiner (1977)	Utility role; research and development policy issues.	S

*S = summary
O = outline

TABLE 2-1 CONTINUED

Author(s)	Focus and Regulatory Policy Issues	Extent of Review*
19. Habicht (1977)	Marginal cost pricing; utility ownership and regulatory policy guidelines.	S, O
20. Harral (1977)	Modifying rate structures in Pennsylvania to promote solar energy systems.	S, O
21. Hirshberg (1977)	Federal tax incentives and utility involvement.	S, O
22. Holmes (1977)	Environmental impacts of solar energy.	S, O
23. Hughitt (1977)	Utility role and support for rate-base treatment.	S, O
24. Jones et al. (1976)	Regulatory policy options; ratemaking and cost-of-service as an incentive.	S, O
25. Kitt et al. (1977)	Utility role; marginal cost pricing, regulatory policy.	S, O
26. Kraemer (1977)	Legal; solar shade control.	S, O
27. Lawrence (1977)	Utility role and consumer interests.	S, O

*S = summary
O = outline

TABLE 2-1 CONTINUED

Author(s)	Focus and Regulatory Policy Issues	Extent of Review*
28. Lof, Close, Duffie (1968)	Cost issues and possible solutions.	S
29. Lof (1977)	Economic analysis; interface with utilities.	S, O
30. Lorsch (1976)	Cost-of-service analysis of two Pennsylvania utilities.	S, O
31. McCormack (1977)	Utility role.	S
32. McGarity (1977)	Economic feasibility in 20 U.S. cities.	S
33. MITRE (1973)	Cost/benefit feasibility of seven applications.	S, O
34. National Bureau of Standards (1977)	Review of state legislation in 1976.	S
35. National Science Foundation (1972)	Forecast and general assessment of solar energy as a national resource.	S, O
36. National Solar Heating and Cooling Information Center (1978)	State legislation summary in 37 states.	S

*S = summary
O = outline

TABLE 2-1 CONTINUED

Author(s)	Focus and Regulatory Policy Issues	Extent of Review*
37. Peterson (1976)	Incentives; forecasts utility pricing.	S, O
38. Profozich (1978)	Economic overview; case study of New Mexico utility.	S, O
39. Reid et al. (1977)	Financing; computer cost analysis of solar energy systems in Tennessee.	S
40. Reid and Hendricks (1977)	Tax credit analysis.	S
41. Robbins (1976)	Legal and institutional barriers; utility regulation; legislative incentives.	S, O
42. Schulze et al. (1976)	Economic feasibility; energy price decontrol policy strategies.	S
43. Scott et al. (1974)	Market analysis of solar water heating in Florida; attitudes of lenders.	S
44. Scott (1977)	Incentives and forecasts; solar water heating demand.	S, O
45. Smackey (1978)	Utility role in marketing and joint ventures with solar system manufacturers.	S, O

*S = summary
O = outline

TABLE 2-1 CONTINUED

Author(s)	Focus and Regulatory Policy Issues	Extent of Review*
46. Solar Engineering Magazine (1979)	Utility role; California survey results.	S
47. Southern California Gas Company (1976)	Utility role; solar assisted gas energy water heating market analysis; public policy.	S, O
48. Thomas et al. (1978)	Utility role and legal issues; ratemaking.	S, O
49. Thorpe (1977)	Utility role economic feasibility; rate structure.	S
50. TRW, Vol. I (1974)	Economic feasibility.	S, O
51. TRW, Vol. II (1974)	Utility role; rate structure; economic feasibility.	S, O
52. Tybout and Lof (1970)	Economic feasibility by location.	S
53. U.S. Congress, Joint Economic Committee (1977)	Economic analysis; policy incentive alternatives.	S, O
54. U.S. Department of Energy (1978)	Utility role; utility pricing, incentives, and policy options.	S, O

TABLE 2-1 CONTINUED

Author(s)	Focus and Regulatory Policy Issues	Extent of Review*
55. U.S. ERDA, Creating Energy Choices for the Future (1976)	Rate structures; policy options.	S
56. U.S. ERDA, Solar Energy in America's Future (1977)	Roles for solar energy in the United States; utility role; utility rates as a barrier.	S, O
57. U.S. FEA, Project Independence (1974)	Economics; barriers to commercialization.	S, O
58. U.S. Federal Trade Commission (1978)	Developing competition in solar energy system industry; anti-trust issues.	S, O
59. Westinghouse, Summary (1974)	General assessment; regulatory encouragement policy.	S, O
60. Westinghouse, Vol. I (1974)	Social and environmental issues; utility role.	S, O
61. Williams (1977)	Gas utility role; benefit and risk analysis.	S, O
62. Yarosh (1977)	Florida solar energy industry; demand analysis.	S
63. Zillman (1977)	Utility role; anti-trust issues.	S, O
64. Zillman and Deeny (1976)	Legal issues.	S, O

*S = summary
O = outline

A 1976 United States Energy Research and Development (ERDA) report (#55) shows a shift in program emphasis from tax and accounting incentives to a consideration of allowing "natural" market forces to influence solar energy commercialization. The move toward research on specific utility economic issues by the federal government is even more evident in a 1977 study conducted by Stanford Research Institute for ERDA (#56). The S.R.I. study concluded that more research on utility rate structures was required since present rate structures (declining block) can encourage utilities to work against the development of solar energy.

The U.S. Department of Energy published an important document in 1978 (#54) that provides an excellent discussion of an analysis of policy options for solar energy. This report appears to provide a balanced treatment of incentives, solar/public utility interface, utility pricing, antitrust matters and other heretofore disregarded issues such as rate and service discrimination. This study also provides a discussion of the regulatory issues that would surface as a result of an application submitted by a nonutility shared solar energy system. Finally, attention is called to a 1978 report published by the U.S. Federal Trade Commission, Bureau of Competition (#58) which provides commissions with the federal government view on antitrust and competition policy in solar energy development.

California Public Utilities Commission

The public position of a state commission regarding solar energy regulatory policy was provided by the California Public Utility Commission (PUC) in two reports written by the California PUC staff. The California PUC study (#4) describes in detail a suggested role for electric and gas utilities including financing of equipment and the development of off-peak rates for solar energy customers. The California PUC has determined that utilities should not sell or own solar energy equipment. In addition, the California PUC staff has taken the position that it would oppose placing solar energy equipment in the utility rate base (#9).

Individual Utility Studies

Studies of individual utilities supporting solar energy customers are more numerous. A study by Lorsch (#30) for the National Science Foundation compares electrical energy demands of a winter-peaking utility to that of a summer-peaking utility in Pennsylvania. The study contains an analysis of the impact solar rate structures have on utility revenues for two different systems. The recommendations made in the study should be compared to a study by Harral (#20) that proposes the Pennsylvania PUC use rate structures as an incentive for promoting solar energy development. To a lesser degree, the work by Profozich for a New Mexico utility (#38) should be examined for its treatment of cost-of-service issues. The view of Southern California Gas Company is described in a report (#47) on Project SAGE (Solar Assisted Gas Energy). That study concluded that solar assisted gas energy water heating could become a viable business for the company.

Rate Design Research

The literature offers several good examples for the treatment of rate structure issues using peak load, marginal cost, and average cost pricing techniques such as the studies by Feldman (#12 and #14). In a 1977 study on the impact of alternative rate structures, Feldman and Anderson (#13) found that under average cost pricing, utility revenue mismatched with the costs imposed by solar users, while marginal cost pricing produced a much closer match. The study found that there was no incentive under existing rate schedules (declining block) to optimize design of solar energy systems.

Additional support for marginal cost pricing can be found in an article by Habicht (#19). Habicht takes the position that some alternate rate structures such as inverted rates or marginal cost based time-of-use rates can be structured in such a manner so as to act as incentive for solar energy development. Regulators and legislators interested in developing solar energy policy are offered guidance by Habicht that includes the collection, analysis and publication of utility cost and performance data as well as the importance of pursuing rate reform aggressively. Issues regarding marginal cost pricing and the question of pricing back-up service is given excellent treatment by Kitt et al. (#25). A study by Jones et al. (#24) shows that rates establishing a valid relationship between electric energy price and cost would substantially improve the economics of solar energy applications.

Rate Base Issues

The ownership and rate-base treatment of solar energy equipment can be treated as one regulatory issue. There are several studies in this review that provide support for utility ownership of a solar energy system. Davis in a 1975 study (#7) in Southern California found that solar assisted gas water heating could be competitive with conventional fuels "in this decade," if the gas utility was allowed to provide the marketing, distribution, maintenance and ownership of the equipment. Of course, the corollary issue in the ownership controversy is the rate-base treatment of such utility investments by the public utility commission. Freeman (#15 and #16) contends that solar investment is a legitimate utility function, is not unjustly discriminatory, is "used and useful," and therefore eligible for earning a rate of return. Freeman's work forms the base for the implementation strategies presented in Chapter 5 of this report.

Hughitt (#23) outlines seven factors that would influence a utility's decision to support solar energy development. The first factor is the position of the state PUC on solar development policy. Hughitt suggests that statutory constraints, historical precedent and a position such as that of the California PUC (against utility ownership and rate base allowance) would prevent a utility from supporting solar energy development. However, Hughitt does show how rolling into the rate base the cost of the solar installation to the consumer would help stretch existing utility capacity and serve additional customers.

Utility Involvement--Another View

To this point in the review, most studies cited have been supportive of utility participation in solar energy development. A more critical assessment is offered by Asbury and Mueller (#1) who show that solar energy systems and conventional electric utility systems are a technological mismatch; and, as a result, may represent a poor back-up for solar energy systems. Baron (#2) argues that the production of solar energy devices consumes considerable quantities of nonrenewable resources and are therefore counterproductive. Concern for utility involvement in solar energy development is expressed by Lawrence (#27) and Dedrick (#9). Finally, Holmes et al. (#22) shows that the environmental impact of solar space conditioning and solar thermal plants could outweight the benefits gained from the displacement of conventional fuels by solar energy.

Legal Issues and Incentives

Another major area of concern for public utility commissions is the legal issues that have surfaced as a result of solar energy developments. An excellent overview describing the uncertainties of present state law regarding solar energy are presented by Dean and Miller (#8). Robbins (#41) summarizes findings of the American Bar Federation as to the many legal and institutional barriers to the use of solar energy. Zillman and Deeny (#64) examined several legal issues concerning the use of solar energy and concluded that legal problems can be solved more easily than economic problems such as antitrust issues (Zillman #63). Specialized legal problems such as shade control are covered in the article by Kraemer (#26). Closely related to legal issues is the status of solar energy legislation in the several states. The National Bureau of Standards (#34) and the National Solar Heating and Cooling Information Center (#36) provide excellent reviews of state legislation that existed in the late 1970's.

Finally, several articles that discuss the role of tax incentives and the possible impact of increased installations on the utility load curves are presented. Hirshberg (#21) provides a balanced discussion of the advantages and disadvantages of tax credits from the consumer point of view and the impact on utilities. The effect of tax incentives and auxiliary fuel prices on the market impact of solar energy for space conditioning was studied by Peterson (#37). After analyzing several incentive schemes, Peterson concluded that additional research is needed on incentive impacts particularly as they relate to utility pricing decisions.

Scott (#44) found that regional differences in solar insolation and fuel costs should be reflected in an incentive program. The study concludes that incentives should be designed by state or region rather than at the federal level. The impact of decontrolled energy prices on various incentives and its implications for policy at the federal and state level is presented by Schulze et al. (#42). The study found that one policy to encourage solar energy development would be for the federal government to allow total decontrol of energy prices tempered by a windfall profit tax on energy producers and correction of the regressive impact of such a policy on low income groups.

Summary

The literature review presented in this chapter is intended to provide commissioners and commission staff with a cross section of research that could be useful in the development of solar energy regulatory policy at the state level. Every attempt was made to select articles and reports that treat subjects on solar energy matters that are central to the concern of the regulatory community. As a result, the review provides a reasonably well-balanced sample of published thinking on developments in solar energy policy. Despite the attempts to provide an objective overview of work in this area, there is a bias evident in the literature Close examination of the material presented in this review indicates that most of the authors lean toward the design of public policy that would encourage solar energy development. These promotional policies would include matters such as removing institutional barriers, designing favorable rate structures, providing various financial incentives and even relaxing antitrust laws to allow utilities to sell and own solar energy equipment. For those interested in promoting the development of solar energy, these policies will receive support. A public utility commission may want to take a position of neutrality on the matter; that is, develop a policy that neither encourages nor penalizes a solar energy user at the expense of other customers. Unfortunately, examples of neutrality in the literature were not identified.

The literature does provide some guidance in developing a policy neutrality. It is widely felt that traditional declining block rates can be identified as a rate structure that penalizes not only a solar energy user but also other general use customers as well. This finding would indicate that a commission should speed up the process of rate reform and should pursue the design of rate structures that would recover the costs of providing service and where the rate must account for customer costs, energy costs and demand costs. By separating the rates into such categories, the energy consuming public would, perhaps, more fully understand the rationale for utility pricing as it relates to solar energy applications. If such public awareness were achieved, the decision to install or not to install solar energy equipment would be made according to proper pricing signals. It is with this background that the literature review presented in this chapter may be pursued.

J. G. Asbury and R. O. Mueller, "Solar Energy and Electric Utilities: Should They Be Interfaced?" Science 195, No. 4277 (February 1977): 445-50.

Summary: Reevaluation of the economics of solar energy systems that interface with conventional electric utility supply networks. Concludes that solar energy systems and conventional electric utility systems are a poor technological match. Neither provides adequate backup for the other. Solar energy systems would not save capital costs for utilities, only the cost of off-peak electric utility fuels.

Outline:

I. Solar energy systems must be evaluated in the context of the systems they are designed to replace.
   A. Investigators have concluded solar energy can reduce requirements for fuel and capital for electric utilities;
   B. But investigators did not compare solar energy systems with the storage-augmented versions of conventional systems.

II. Solar collector break-even costs are estimated, using storage-augmented conventional systems for comparison.
   A. Comparing solar collection with electric resistance system, upper bound on solar collector break-even costs is about \$30 per square meter (about \$3.00 per square foot) where auxiliary energy is from coal-fired utility plants;
   B. For solar/heat pump comparisons, collector break-even costs are substantially lower than for electric resistance systems;
   C. There is little possibility that a solar thermal conversion system for electric power generation would be competitive with a storage-augmented baseload generating plant.

III. General problem of interfacing solar energy and electric utilities is treated in terms of two alternate scenarios.
   A. If off-peak electricity remains available, solar collection systems will be economical only if they deliver solar energy at a cost lower than the variable (fuel) cost component of off-peak electricity;
   B. If the utility's load curve becomes flat through off-peak or time-of-day pricing:
      1. Utility must have capacity for solar outages;
      2. Underutilization of capital because of need to back up solar energy systems results in higher unit cost of electricity than if customers used simple storage heating systems;
      3. Net benefit of solar collection equals the value of displaced electric utility fuels.

Seymour Baron, "Solar Energy - Will It Conserve Nonrenewable Resources," Public Utilities Fortnightly, 102, no. 7 (September 28, 1978): 31-36.

Summary: Solar energy will not achieve the degree of energy conservation anticipated because solar energy systems production uses considerable quantities of nonrenewable resources. A premature commitment to solar energy use will hurt the cause. Instead, efforts should be directed to developing solar energy technology that is less energy consuming.

Outline:

I. If solar energy systems are to be successful, the energy consumed to produce the materials, manufacture the solar panels and install and operate the system must be less than the energy recovered over the operating lifespan of the solar system.

II. For solar heating of residential buildings:
   - A. Total consumption of fossil and nuclear fuels to produce and operate solar-heated systems is a significant portion of the energy that will be recovered over the operating life of the solar energy panels;
   - B. If the panels need to be replaced, resource depletion is even greater;
   - C. A study in New England showed actual energy savings of only 17 percent despite designs based on 50 percent savings.

III. For solar thermal electric plants:
   - A. In the Southwest, such a plant will pay back the energy requirement for its construction in six years of operation;
   - B. Elsewhere, solar electric power expansion may be inhibited because of the large amount of energy required to construct the plants.

IV. For photovoltaic power, energy requirements of cell production are over 50 percent of the power output of the plant, assuming a 10-year life span for the cells.

V. Conclusion: "Solar energy, as presently under development, will not achieve the degree of energy conservation anticipated, since it consumes large quantities of nonrenewable resources."

VI. Instead of committing money to existing solar technology, the solar energy development program should:
   - A. Concentrate on designs and technological developments that are less energy consuming;
   - B. Build a 10-megawatt solar thermal electric pilot plant to develop realistic material requirements and operating experience. (A site near Barstow, California, has been selected for this plant.)

Roger H. Bezdek and Arthur A. Ezra, "Assessment of Incentives to Accelerate Market Penetration of Solar Heating and Cooling Systems," Proceedings of the 1977 Annual Meeting, the American Section of the International Solar Energy Society (Orlando, Fla.: June 6-10, 1977).

Summary: Costs and impacts of five different tax incentives and the base case of no tax incentives were analyzed for effects on production of solar-heating and cooling systems. A purchaser tax credit of up to $2,000, effective from 1978 through 1982, was found to be the most effective incentive.

Outline:

I. Different incentives were examined for their impact on market penetration of solar-heating and cooling systems.
   A. Base case: no incentives;
   B. Incentive I: Purchase tax credit of 40 percent of first $1,000 of system cost, 25 percent on next $6,400 of system cost, up to a maximum of $2,000 tax credit, effective 1978-1982;
   C. Incentive II: Installer investment tax credit of 20 percent, effective 1978-1982;
   D. Incentive III: Builder/developer tax credit of 20 percent of total solar-heating and air-conditioning system cost, effective 1978-1985;
   E. Incentive IV: Loans of 5 percent for 20 years for residential retrofit applications, effective 1978-1985;
   F. Incentive V: Purchaser's tax credit of 25 percent of the first $2,000 and 15 percent of the next $6,000 of system cost up to a maximum of $1,400 tax credit, effective 1978-1982;
   G. Incentive VI: Purchase tax credit of 40 percent of the first $1,000 of system cost and 25 percent of the next $6,400 of system cost for 1978 and 1979, 30 percent of the first $1,000 and 20 percent of the next $6,400 for 1980 and 1981, and 25 percent of the first $1,000 and 15 percent of the next $6,400 for 1982 and 1983.

II. Estimates were made of costs and impacts on the nation for the years 1980, 1982, 1985, 1990 and 2000.
   A. Annual production of solar-heating and air-conditioning systems measured in square feet of installed solar collector;
   B. Cumulative costs (in constant 1977 dollars) of different incentive programs to the federal government and to the private sector over the life of each program, from January 1, 1978 to December 31, 1982;
   C. Annual energy savings in quads (10^{15} Btu) per year;
   D. Jobs created (man years/year).

III. Assumptions:
   A. No market penetration of solar-cooling systems through 1985;
   B. Solar systems competitive only against electric water and space-heating systems through 1985.

IV. Results showed Incentive I both more effective and more expensive.

A. Incentive II was dropped early because it showed little promise;
B. Results for 1985 for other incentives, in order of magnitude from greatest to smallest, are as follows for production, energy savings and jobs: I, III, VI, V, IV;
C. Estimated cumulative capital expenditures by 1985 for three incentives were as follows:

	Total Investment (billions)	Total Expenditures (millions)
I	15.0	630
III	14.0	560
IV	3.3	200

California Public Utilities Commission Energy Conservation Team, A Study of the Viability and Cost-Effectiveness of Solar Energy Application for Essential Uses in the Residential Sector in California, San Francisco, Cal., October 7, 1977.

Summary: The role of solar energy in supplying California's future energy needs and role of the state in developing this potential are explored. Concludes that it is desirable for the state to promote the accelerated use of solar energy. Suggests possible utility role in financing and servicing solar energy systems.

Outline:

I. Role of the state and the state's utilities in overcoming barriers to solar implementation in California.
   A. It is desirable for the state to promote the accelerated use of solar energy because:
      1. Solar energy can be substituted for conventional energy sources in ways that are, or are expected soon to be, cost-effective;
      2. Existing government subsidies of conventional energy sources have impaired solar energy's ability to compete;
      3. Government actions can be taken to eliminate the cost disparity and facilitate the transition to the use of renewable and more abundant energy resources.
   B. Current solar market:
      1. Solar energy can be most effectively used to heat water and buildings;
      2. Solar energy systems clearly may be installed in new buildings and may, in most cases, be retrofitted in existing buildings.
   C. Barriers to solar energy use:
      1. The major problems that emerged during CPUC hearings are;
         a. Cost-effectiveness,
         b. First cost barriers,
         c. Financing,
         d. Consumer protection,
         e. Need for solar energy to be seriously considered as a primary source of hot water and eventually of space conditioning in new buildings.
      2. The commission staff believes that an aggressive state and federal incentive package can be put together to resolve these problems.
   D. Economic constraints:
      1. The use of solar energy is cost-effective to society as a whole when the marginal cost of a Btu of energy delivered by an installed solar energy system, when compared on a life-cycle basis, is equal to the marginal cost of an incremental Btu of natural gas or electricity;
      2. But such an analysis does not reflect the choice confronting a consumer considering an investment in a solar energy system;

3. Tax credits can be of major importance in overcoming the first-cost barrier for both retrofit and new building markets;
4. Long-term, low-interest financing can help place solar on a comparable basis with other sources of energy;
5. If long-term, low-interest loans are not available through banks or public financing, utilities can finance solar energy systems in the same way that the state has recommended for insulation.

E. Consumer protection:
1. State should be involved in:
   a. Development of standards,
   b. Equipment performance testing,
   c. Evaluation and certification of installers,
   d. Assurance that there are warranties for equipment,
   e. Consumer information.
2. Utilities could perform the system maintenance function:
   a. System maintenance would ideally be performed by a separate service industry;
   b. If access to such providers were not available statewide, utilities could do it;
   c. Utilities are in a position to provide maintenance because they are certain to have continuous, long-term contact with consumers;
   d. The staff does not recommend that utilities be the only providers of service.
3. The staff sees no need for utilities to monitor solar energy systems in their service areas at ratepayer expense:
   a. This has been suggested as a way to collect data on how well solar energy systems work under actual operating conditions;
   b. It is not necessary if the state or an independent testing agency undertakes standard setting in a timely manner.

F. Building standards:
1. The state should develop building standards that stimulate the use of solar energy in new buildings;
2. The standards should:
   a. Require solar-compatible plumbing and building orientation;
   b. Mandate solar water heating by a certain date when it is cost-effective on a life-cycle basis;
   c. Require life-cycle analysis of heating and water-heating systems for all new buildings that include solar energy systems an option.
3. Advantages of requiring solar equipment under building standards:
   a. Easier to sell and finance solar-equipped buildings;

b. Would provide a steady market that might help:
(1) stabilize the industry,
(2) lower prices.

II. Technical and economic feasibility of domestic solar energy systems.

III. Roles of agencies and industries and recommended incentive programs for solar domestic hot water-heating systems.

A. Role of state energy commission:
1. Develop standards,
2. Prepare lists including brand names and models of solar systems or hardware that meet or exceed the adopted standards.

B. Role of utilities:
1. Utilities should provide their customers with solar information, including brand names, on request;
2. Utilities should provide assistance to their customers in maintaining their solar energy systems;
a. The utility should visit the customers' premises on request and assist in isolating problems with the solar energy systems,
b. The utility should refer the customer to his contractor for needed repairs;
c. The utility should assist the customer to assure that the five-year warranty on a recommended system is carried out properly by reputable contractors;
d. If the contractor and manufacturer who installed and provided the system are both bankrupt, the utility should effect needed repairs under the warranty.
3. A utility should assist its customers in financing the net cost after credits (not to exceed $1,000 per system) of certified solar domestic water-heating systems with low-interest (7 percent) loans until a significant sales level of solar systems business is established;
4. Electric utilities should develop incentive off-peak rates, preferably from late night to dawn for use by those customers who will back up their solar domestic water-heating systems during the utility's specific off-peak hours;
5. The gas utilities should continue to provide lifeline quantities of natural gas to customers with solar energy systems:
a. With a properly designed solar domestic water-heating system, it is very likely that a customer will require no gas at all five to six months a year in warm parts of California;
b. During the winter months, the lifeline quantity normally allotted to domestic water heating could be used to supplement the customer's essential heating needs.

C. Ratepayers' subsidy of solar energy systems:
1. ratepayers' subsidy for assisting in the development of solar energy should be limited to:

a. The variables outlined in this report,
b. Development of domestic solar water heating and direct (passive) space-heating and conditioning systems.

2. The suggested informational activities and rate designs can be carried out reasonably well within current utility budgets;
3. Utility service calls to determine customer maintenance problems with solar domestic water-heating systems should not present significant burdens to ratepayers given that utilities now visit their customers' premises frequently by customer invitation;
4. The financing, at low-interest rates, of solar water heating systems is also an insignificant burden.

D. Line extension credit rules:
1. Line extension credit rules should permit equal credit to electric and gas customers who choose to use solar domestic water-heating systems and to those who elect to use conventional electric or gas hot water heating systems;
2. It is hoped that line extension credit allowances will be reduced in the future.
    a. They should be used to encourage energy conservation, rather than increased use of energy;
    b. But customers who install energy-saving solar energy systems should be permitted to realize maximum credit allowances.

E. Gas priorities:
1. The priority for single-family residential gas use, now the highest priority provided in California, will remain unchanged when gas is used for backup energy in solar residential applications;
2. When natural gas is used in new large residential complexes in excess of 50 Mcf per day, natural gas priority may not be the same as for single-family residential uses.

F. Master meter issues:
1. New applications for natural gas supplies for large residential complexes that plan to master meter the natural gas usage and provide heat to residential users via central hot water systems should be handled case by case;
2. Residential complexes with solar water-heating installations together with other conservation measures should be considered for exemption from the need to convert to individual meters.

G. Utilities' potential advantage over private enterprise:
1. Utilities have a significant competitive advantage over private contractors for purchase of solar energy systems:
    a. They can get better prices,
    b. They can install more cheaply,
    c. They have established customer service departments.
2. The staff of the Energy Conservation Team does not recommend to state policy makers that utilities become involved

in direct sales of solar energy systems unless the state legislature first determines that solar energy is a utility service and amends the public utilities code to so prescribe;

3. Since the business activity of a utility subsidiary engaged in a nonutility business may not be within the regulatory control of the California PUC, the regulated utility should be precluded from promoting the sale or installation of solar energy systems by nonutility subsidiaries.

H. Recommended legislative actions to assist the development of an expanded solar energy market in California:
   1. A new solar tax credit bill to provide a straight 50 percent state income tax credit unaffected by receipt of any federal tax credit;
   2. Legislation to set forth clearly what solar rights should be retained by the public;
   3. Establishment of degree to which utilities should become involved in the manufacture, direct sales or the leasing of solar equipment;
   4. Legislation to provide state-assisted, low-interest loans for domestic water heating and direct (passive) solar space-conditioning-retrofit applications;
   5. Exemptions of solar energy systems from valuations by assessors when determining the assessed value of residential property.

Claudia Comins and David Behler, "Shedding Some Sun on Rate Design," The Power Line 4, no. 5 (November 1978): 4-6.

Summary: Utility arguments for special solar surcharges do not hold since existing rate structures are frought with cross-subsidies among different classes of consumers. Rate structures amenable to solar users are the same as those advocated by utility reformers. Rate structures should protect small users and reduce peak consumption.

Barry Commoner, "The Solar Transition," in The Solar Market: Proceedings of the Symposium on Competition in the Solar Energy Industry, U.S. Federal Trade Commission, Bureau of Competition (Washington, D.C.: U.S. Government Printing Office, 1978), pp. 283-94.

Summary: Solar energy sources can fill one-fourth of the 10 percent energy shortage expected by 1985 if the government actively promotes it. General means for promotion are suggested.

Outline:

I. Studies by Federal Energy Administration lay groundwork for a national energy plan that would promote a transition to renewable energy resources.
   - A. Administration's National Energy Plan does not provide for development of energy-producing capacity capable of yielding enough energy to meet future demand;
   - B. FEA studies address problem of meeting future demand through replacement of:
     1. All technology for producing nonrenewable energy;
     2. Energy-using technologies unsuited to solar forms.

II. Solar energy sources could provide 2.5 percent out of the 10 percent energy shortage projected by 1985 by the General Accounting Office.
   - A. Ways of promoting solar energy in order to reduce the projected shortage by one-fourth include:
     1. A loan program for solar collectors;
     2. Public works funding for methane production from urban garbage and sewage;
     3. A federal purchase program for photovoltaic cells and wind power;
     4. Agricultural subsidies to promote on-farm energy production from organic matter.
   - B. Existing energy-using devices that are incompatible with a solar source should be replaced with comparable devices that can be operated on either a conventional or a solar energy source;
     1. Oil or coal-burning-heating systems incompatible with solar energy systems should be replaced by heating systems that can burn natural gas or a solar fuel (methane);
     2. Decentralized operation and high-thermodynamic efficiency would aid solar energy development.
   - C. Cogeneration of heat and electricity based on natural gas is an ideal way to meet requirements of solar sources.

III. Approaches to accomplishing the solar transition:
   - A. Basic problem is when and how to switch from conventional to solar energy use:
     1. Remaining U.S. petroleum and natural gas resources are adequate to meet expected demand during a transition to a solar economy;
     2. Problem is determining point at which cost of conventional fuel equals cost of solar replacement, given that:

a. Cost of producing conventional fuels will rise exponentially;
b. Cost of the solar replacements will remain constant.

B. Without active steps to promote solar energy, the costs of conventional and solar sources may become equal at a point in time so that no capital remains to invest in solar technology;

C. Options for increasing solar energy use are:
   1. Deliberately increasing the price of conventional energy;
   2. Cutting the cost of solar technologies through use of public funds, a better option because it:
      a. Would not disrupt the economy and hurt the poor;
      b. Would permit rational planning and introduction of solar technologies, rather than using the narrow criterion of profitability.

Edgar B. Davis, "Solar Assisted Gas-Energy Water-Heating Feasibility for Apartments," Solar Energy, 17, No. 2 (1975): 237-43.

Summary: Study of patterns of energy use show solar energy could be competitive with conventional fuels for hot water heating in southern California in this decade, especially for apartments. Analysis is made from the point of view of a gas utility company owning the solar energy equipment.

Outline:

I. Solar water heating could result in a significant reduction of demand for conventional energy supplies in southern California, according to an earlier study.

II. Solar water heating is especially appropriate for multiple unit dwellings.
   - A. General reasons include:
     1. High-energy use for gas water heating compared to gas space heating or electric air conditioning;
     2. More flexibility in the technical approach;
     3. Capital investment is great enough to allow business arrangements that help overcome the "first-cost" barrier (initial investment cost).
   - B. Advantages of having a utility involved:
     1. Housing industry is very concerned with first cost;
     2. Marketing, distribution and maintenance of solar energy collection and conversion equipment by a utility are logical extensions of their existing business;
     3. Utility would provide an aggregated market;
     4. Monthly billing based on energy used or capacity available would amortize the utility's investment;
     5. Utility ownership guarantees the failure of innovation--will not undermine property values.

III. Experiment was conducted with Southern California Gas Company on solar water heating for apartment buildings.
   - A. Options considered had gas utility retain ownership of the equipment by:
     1. Offering the equipment on a lease service basis; or
     2. Expansion of existing natural gas energy business to include the supply of solar energy.
   - B. Experiment provided:
     1. Definition of a baseline system;
     2. Estimate of system cost and performance;
     3. Identification of alternative design approaches.

IV. Conclusions
   - A. There are no technical barriers to implementation of solar water heating in southern California;
   - B. Solar water heating in southern California will become competitive with all gas water heating when the value of the fuel saved is about \$2.50-\$3.00 per 10^6 Btu;
   - C. Over two-thirds of the natural gas consumed in water heating could be saved by the use of solar energy across the southern United States;
   - D. Peak loads are not a problem in southern California because:
     1. Seasonal variation is insignificant;
     2. Solar hot water systems can be designed so that highest hourly demands for gas are at off-peak hours.

Norman L. Dean, and Alan S. Miller, "Utilities at the Dawn of a Solar Age," North Dakota Law Review 53, No. 329 (1976): 329-58.

Summary: Significant uncertainty exists concerning appropriate policies and the impact of current law in the areas of regulatory commission jurisdiction over solar energy systems, service and rate discrimination affecting users of solar systems and utility participation in the solar market. Few generalizations are possible because of differences among utilities and states. Action to promote solar energy should be taken at all levels of government.

Outline:

I. Overview of regulation of utilities.

II. A crucial issue affecting development of solar energy is whether utilities may discriminate in rates and service in ways that either favor or hinder development of solar heating and cooling:
- A. State laws prohibit "unjust" discrimination;
- B. Federal antitrust laws may outlaw rates or services that single out users of solar energy for special treatment;
- C. It appears a utility may not refuse to provide backup electricity for structures with solar-heating and cooling systems;
- D. The type of rate structure used by a utility is critical in determining whether a user of solar energy will save money.

III. Whether state public utility commissions have jurisdiction over multiuser solar energy systems depends on interpretation of state statutes.

IV. Role of public utilities in solar commercialization:
- A. Some utilities are already experimenting in the solar market;
- B. Desirability of utility participation in the solar market is a question;
- C. Policy alternatives:
  1. Regulate utility participation;
  2. Prohibit utility participation;
  3. Allow utilities to participate in the solar market as financiers.

V. Suggested roles for levels of government:
- A. Federal
  1. Systematic effort to resolve technical issues;
  2. Clearinghouse for information.
- B. State legislature
  1. Broad policy issues;
  2. Subsidies.
- C. PUC's
  1. Rate structures;
  2. Scope of jurisdiction;
  3. Particular programs.

C. T. Dedrick, California Public Utilities Commission, "Solar Energy Assessment from the Standpoint of State Regulatory Bodies," in Symposium Papers, The Role of Utility Companies in Solar Energy (Washington, D.C.: Institute of Gas Technology and Gorham International, November, 1977), pp. 129-37.

Summary: California PUC staff feels utilities should not become involved in the solar energy business.* PUC is likely to oppose allowing installation of solar energy systems to be included in utilities' rate base.

Outline:

I. PUC staff has concluded that water heating is the only prospective cost effective use of solar energy available now.

II. PUC staff feels utilities should not become involved in solar energy unless the legislature finds solar installations are a public utility:
   - A. Utilities might guarantee warranties or make loans;
   - B. But they should not be the owners or purveyors of equipment.

III. Advantages of public utility involvement for encouraging rapid development of solar energy:
   - A. Ability to order large numbers of solar collectors;
   - B. Good reputation;
   - C. Enormous existing staffs;
   - D. Operating communications systems.

IV. It is also argued that competitive advantage of utility companies would stultify competition.

V. California PUC likely to oppose putting installation of solar energy systems into rate base.

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* For summary and outline of full staff report, see California PUC, Energy Conservation Team, A Study of the Viability and Cost-Effectiveness of Solar Energy Application for Essential Uses in the Residential Sector in California.

General Electric Company, Solar Heating and Cooling of Buildings (Phase 0), Feasibility and Planning Study, Final Report, Vol. I, Executive Summary, prepared for the National Science Foundation (May 1974).

Summary: Summary of work performed in the first step (Phase 0) of a program to assess the feasibility and merits of the use of solar energy for heating and cooling buildings and providing hot water. The technical, economic, societal, legal and environmental factors of solar energy use were studied. Problems and potential solutions were idenitfied. Proof-of-concept experiments were planned. Study found heating and cooling with solar energy could save considerable fuel and recommended that a program involving both private and public sectors be developed.

Outline:

I. Major results:
   A. Heating and cooling with solar energy can replace large quantities of fuel;
      1. The energy savings in 2000 AD represents 20 electric generating plants, each 1000 MW, operating at a 90 percent load factor.
   B. Use of solar energy will reduce pollution;
   C. The required industrial base and public acceptance for achieving beneficial results from solar energy must be developed over time with a program involving both private and public sectors;
   D. Early proof-of-concept experiments are an excellent starting place;
   E. The next phase, after the proof-of-concept experiments, should be wide use in government buildings;
   F. The market growth of solar energy systems during the 1980's can be influenced more by early industrial participation than by the availability of cost-effective applications;
   G. Projections of market penetration show adoption of solar heating and cooling at an accelerated rate as we enter the 21st century;
   H. The development of a $10 billion-a-year solar industry by the year 2000 would contribute to economic growth.

II. Impacts on utilities:
   A. Utilities will have decreased sales because of solar energy systems, but how much is hard to tell;
   B. Solar energy systems are most effective at providing energy at the time-of-day when the electric utilities experience their peak load;
   C. Off-loading of only two percent of the energy demand by 2000 AD would mean that the effect of peak use of solar energy would be relatively small.

General Electric Company, Solar Heating and Cooling of Buildings, (Phase 0), Feasibility and Planning Study, Final Report, Vol. II. Technical Report, NSF/RA/N 021B (Philadelphia, Pa.: May 1974).

Summary: The results of a study to assess the feasibility and practical merits of the use of solar energy to heat and cool buildings and provide hot water are reported. The projected captive potential for cost-effective solar energy installations by the end of the century is 40 million buildings. Annual energy savings, if these were solar equipped, could exceed 1500 billion kilowatt hours. Cost-effective captive potential is dominated by new construction. Introduction of cost-effective solar air-conditioning equipment would substantially increase energy savings. The most important government policies needed to stimulate solar heating and cooling are: proof-of-concept experiment implementation; early introduction of solar energy systems on government buildings; economic incentives to encourage a life-cycle approach to heating and cooling systems; legal safeguards and minimizing zoning restrictions; and sponsorship of research and development for economical, and reliable equipment, especially for cooling.

Outline:

I. Widespread use of pollution-free inexhaustible solar energy to heat and cool buildings and provide hot water could significantly reduce the dependence of the United States on imported fuels.
   A. Heating and cooling with solar energy can replace large quantities of fuel;
   B. The reduction of pollution as a result of solar energy use will attain as ever-increasing significance as total energy consumation increases;
   C. The industrial base and public acceptance required for achieving these beneficial results must be developed over a period of time with a planned program involving both the public and private sectors;
   D. To use solar energy for widespread heating and cooling in the future requires that the tools, techniques and industries be developed today.
      1. Early proof-of-concept experiments are an excellent starting place;
      2. The next phase should be expanded use in government buildings.

II. Methodology of study

III. Assessment of captive potential:
   A. Assessment showed the potential market for solar energy equipment by the year 2000 to be 39 million buildings;
      1. Figure was arrived at by using evaluations and assumptions to assess the percentage of all buildings representing a a realistic captive potential;
      2. Consideration was given to climate areas, building types, sitings, retrofit versus new installations and technical and economic feasibility
   B. Achievement of the captive potential by the year 2000 is limited by:
      1. Commitment of risk capital;

    2. Development and enplacement of manufacturing capacity;
    3. Training personnel;
    4. Overcoming consumer inertia to new products.
  C. Strong government support will be required to make the commercial market viable by 1982.

IV. Social and environmental study
  A. Environmental impacts:
    1. Reduced land use and pollution associated with conventional energy production;
    2. Increased consumption of materials used in manufacturing solar energy collectors and components.
  B. Economic impacts:
    1. Capital investment needs could be a constraint on growth of solar energy use since solar energy systems do not significantly reduce the capital needed for new electric generating capacity;
    2. Development of a billion-dollar-a-year solar collector and component industry by 1995 would contribute to national economic growth through:
      a. Construction of new factories;
      b. Increased employment in manufacturing and installation;
      c. Need for repair and replacement;
      d. Improved trade balance due to reduced dependence on fuel imports and, possibly, increased export sales of solar energy hardware.
  C. Industrial and utility impacts:
    1. Manufacturers will be faced with specialized marketing requirements;
    2. Solar energy systems improve the baseloading capability of electric utilities to satisfy the kind of demand solar energy systems cannot.
      a. Solar energy systems are most effective at the time of day when electric utilities experience their peak loads;
      b. It is therefore appropriate to consider solar energy systems as a potential utility company business area;
      c. The timing of utility involvement is not crucial.
        1. The scenario forecasts on offboarding of only two percent of the heating and cooling demand by AD 2000;
        2. In regions of the country where solar energy system penetration may have exceeded the national average by that date and where peak electric generating capacity has not fully kept pace with the growth of demand, the effect could be felt much earlier.
    3. Utility companies are likely to:
      a. Monitor the development of solar energy technology to some extent and in certain regions become involved in planning and development;
    4. But the impact time frame for utility programs will likely vary as local conditions require;
    5. A more immediate issue for the utility companies is the rate

structure to be applied to the provision of electricity or gas to buildings which use these sources only to supplement solar energy systems.

a. In these cases, full utility hook-up, maintenance and accounting services will be required, but solar will be reduced;

b. It can be argued that this favors a declining block rate structure for the utilities, but declining block rates have come into disfavor as promoting excessive energy use;

c. Other schemes to equalize utility costs between solar energy systems supplementation and full service customers will no doubt be introduced.

D. Policy and legal impacts:
   1. The eventual effect of solar energy systems as a non-polluting source is its most important policy characteristic;
   2. Changes in the law may be necessary for the regulation of externalities in the use of solar energy technology.

E. Social impacts

F. Barriers to acceptance:
   1. Cost;
   2. Institutional barriers to innovation.

G. Incentives, including rate structure incentives to utilities serving solar energy system homes and commercial buildings;

H. Alternative ownership and management arrangements
   1. Leasing company
   2. Gas utilities:
      a. Gas utilities that foresee shortages of natural and synthetic gas could find advantages of ownership of simple solar energy systems;
      b. In their case, the economic comparison with the cost of energy from a solar energy system is the marginal cost of extra gas in times of shortage.
   3. Electric utilities:
      a. Ownership by an electric utility of the collector and storage components of a large number of solar energy system installations would require a large amount of capital;
      b. If solar energy systems could be used to reduce the peak-load requirements on the utility, the capital needed could be compared to:
         1. Capital needed for the peaking capacity that would be saved;
         2. The value of solar energy used to the cost of peak power.
      c. To assure that a suitable portion of the solar energy captured is reserved in storage for the hours and days when maximum peaking capacity is required by the utility, some form of management of the on-site solar energy system by the remote electric utility control center would be required.

V. Preliminary Cost Study

VI. Recommendations for Proof-of-Concept Experiments

Stephen L. Feldman, "Financial Incentives for the Adoption of Solar Energy Design: Peak-Load Pricing of Back-Up Systems," Solar Energy 17, no. 4 (1975): 339-43.

Summary: Without peak-load pricing, utilities will have to charge users of solar energy rates that inhibit the spread of solar energy systems. Differences in marginal costs of peak and off-peak supply of gas and electricity should be determined both for users of solar energy and conventional fuels. Appropriate meters must be available to make possible a peak-load pricing schedule for solar energy consumers.

Outline:

I. Combined capacity of full-sized backup and solar energy systems has diseconomies for:
   A. Building owners, because they must provide two full-sized systems when neither is used to the extent that one conventional system would be;
   B. Utility companies, because weather conditions where insulation is inadequate usually coincide with peak-loading conditions;
   C. The United States, because the expense of providing two heating systems simultaneously would constrict the construction industry.

II. Solar energy systems could reduce peak-load requirements if:
   A. There was enough sunshine in the particular geographical area;
   B. There was enough solar heat storage capacity;
   C. Metering and billing systems allowed a utility to compose a rate structure to pass on savings to solar energy users.

III. Recommendations:
   A. Make available appropriate meters;
   B. Determine difference in marginal costs for peak and off-peak use for both solar and conventional fuels;
   C. Establish a peak-load-pricing schedule.

Stephen L. Feldman, and Bruce Anderson, <u>Utility Pricing and Solar Energy Design, Final Report</u>, prepared for the National Science Foundation, NSF/RA-760409 (September 1976).

<u>Summary</u>: Purpose of study was development of a methodology to assess the impact of solar space conditioning on electric utilities. Effect of utility pricing on cost-effectiveness and design of solar buildings was examined. Measures of the extent of the impact of solar space conditioning were made from perspectives of building owner, electric utility and national economic efficiency. Primary conclusion is that each utility-building interface is unique: variations in solar-building designs have different impacts on utility loads, peaks and costs. Study found there was no incentive under existing rate schedules to optimize design of solar energy systems.

<u>Outline</u>:

I. Previous studies have not accurately measured the economic feasibility of solar energy systems:
   A. Previous studies have computed the average annual performance of a solar building;
   B. A true measure of the economic efficiency of solar energy systems must include the calculation of all costs incurred to produce space conditioning compared to all costs of an alternative system;
   C. Computation of the true costs of supplying auxiliary energy to solar buildings requires determination of the effect of auxiliary use on both coincident peak and load factor for the utilities and the associated costs of these effects.

II. Study Objectives:
   A. Determine the impact of solar energy designs for the residential and commercial sectors upon the diurnal, seasonal and annual load curves of electric utilities in representative parts of the country;
   B. Assess the inefficencies of present pricing policy in utilities with regard to various solar buildings;
   C. Develop new pricing schemes as they would be applied to mixed solar and conventional systems;
   D. Assess the financial incentives for different solar energy-building designs as these incentives reflect savings that solar energy consumers would accrue from peak-load pricing.

III. To satisfy the study objectives, a model was developed that examines the interface between electric utilities and buildings using solar energy systems.
   A. Model procedures:
      1. Model two buildings, a solar building and an identical one with conventional space conditioning;
      2. Calculate the amount of electricity demanded for each building under average and extreme weather conditions characteristic of a utility's service area;
      3. Compare economic efficiency of the two buildings from the point of view of the utility, the building owner and the general public .

B. Utility companies used in study:
   1. Wisconsin Power and Light;
   2. Public Service Company of New Mexico;
   3. New England Electric System;
   4. Others in less detail:
      a. Georgia Power,
      b. Arizona Public Service,
      c. Sacramento Municipal Utility District.

IV. Summary inferences from results of the analysis:

A. No general statement can be made on impact of solar heating and air conditioning (SHAC) on the load curve of the electric utility industry;

B. Impact depends on several variables affecting each utility:
   1. Ambient weather conditions;
   2. Load curves;
   3. Generation mixes;
   4. Design of storage and collector;
   5. Passive design of the solar building.

C. Impact of existing rate structures:
   1. In every case that was examined, under present rates, the solar and conventional buildings are subsidized by other customer classes;
   2. There is no incentive under existing rate schedules to optimize the sizing of the design of SHAC or the passive system.

D. Impact of alternative rate structure:
   1. Under average cost-pricing schemes, utility revenue from solar energy will be highly mismatched with the costs imposed by solar users;
   2. Under marginal cost pricing, mismatching of revenue and costs is much less likely;
   3. Demand energy charges (Hopkinson tariff) are inefficient because of the poor relationship between the building peak and the utility peak;
   4. Marginal cost pricing for solar users more adequately reflects societal costs than does average cost pricing;
   5. Immediate effect of marginal cost pricing might be a transfer of investment from solar equipment to thermal energy storage.

E. Issue of capacity effect of solar energy systems may not exist in some cases.
   1. If the solar user is willing to forego and limits the number of days when peak-auxiliary energy is used, it may be less expensive to use this alternative to increase storage sizing;
   2. The long-run costs of all components and behavioral modifications should be equated.

Stephen L. Feldman et al., Public Utility and Solar Energy Interface: An Assessment of Policy Options, Clark University, final report to the Energy Research and Development Administration (December 1976).

Summary: Study reviews, assesses and critiques existing research and ongoing activity in the interface between the public utility industry and solar energy systems for buildings. Study suggests policy options and determines their potential impact.

Outline:

I. State of the art:
   A. Review of federal and state legislation suggests that the solar utility interface has not been identified as a major concern to the various solar-heating and cooling demonstration programs;
   B. But review of 25 recent research projects addressing the solar-utility interface suggests this problem is being corrected.

II. Technology configurations affecting the solar-building utility interface.
   A. Solar building design:
      1. Construction industry uses two methods to provide comfort:
         a. Architectural solutions (relying on the building itself);
         b. Mechanical solutions.
      2. Discussion is summarized in:
         a. Matrix showing all solutions' potential impacts on the utility energy demand balance;
         b. Matrix evaluating each potential solution with regard to five decision-making parameters:
            (1) Site,
            (2) Climate,
            (3) Building size, type, configuration,
            (4) Utility load profile,
            (5) Use patterns, comfort.
   B. Telemetry:
      1. Successful use of control technology of the off-peak sub-system will assist utilities in their total load management programs;
      2. Primary mechanisms available to utilities for load control:
         a. Application of powerline carrier techniques, principally ripple control, for control of consumer electrical appliances;
         b. Application of both metering and powerline carrier techniques for more efficient tariffs.
   C. Utility energy storage:
      1. Large, centralized utility energy storage systems may become viable, competitive technologies;
      2. But widespread use of utility energy storage is not anticipated by the time solar buildings have an impact on utilities.
   D. Market penetration:
      1. Studies of market penetration of solar-heating and cooling (SHAC) systems have failed to consider sufficiently the role of public utilities;

2. Utility's role in determining SHAC system market penetration:
   a. Utility rate schedules are one form of indirect load management being investigated;
   b. Average cost pricing encourages the least efficient use of resources;
   c. Time-of-day pricing approaches a more efficient use of resources for society.
3. Scenario for the timing of solar building impact on utilities:
   a. Using TRW projections, the solar space-heating utility interface will not become significant before 1990;
   b. Using TRW, solar hot water heating will have an impact seven to 10 years earlier.
4. Implications of utility ownership of SHAC systems:
   a. Alternative ownership policies (all of which have precedents):
      (1) Public utilities could be given exclusive monopoly franchises to provide SHAC systems;
      (2) Utilities could be denied a monopoly on solar energy systems, but permitted to enter the solar energy business as part of their activities as regulated public utilities;
      (3) Utility solar energy activities could be done by a separate, unregulated, utility affiliate;
      (4) Utilities prohibited from owning on-site solar energy systems or the energy derived from them.
   b. Arguments against solar energy system ownership by utilities:
      (1) Lack of evidence that SHAC systems represent a natural monopoly;
      (2) Possibility that regulated utilities could use solar technology to recapture some of the monopoly profits that regulation takes away;
      (3) Problem of determining the responsible party when solar equipment causes building damage (through leaking, for example) or increased maintenance costs.
   c. Arguments for utility ownership include possible optimized solar design for utility load management;
   d. Third alternative [4(a)(3)] for utility ownership may offer the best balance between regulation and competition.
5. Utility manager perceptions and consumer attitudes:
   a. Utility manager perceptions were obtained on 30 policy options:
      (1) Guaranteed loans and promotion of total energy systems on buildings were perceived to be the most beneficial policies both for utilities and consumers;

(2) Interests of utilities and consumers were perceived to be at odds on favorable rate schedules for solar structures and five other policies.

b. Survey of solar adopter posture toward public utilities found:

(1) Although primary motivation for adopting solar energy trends to be noneconomic, economic factors are also important;

(2) Negative impact of solar energy on public utility loads is perceived to be of minor importance;

(3) Solar-utility policy options that eliminate first-cost barrier or lead to more efficient load management were well received;

(4) Imposition of higher rates for solar energy users was perceived as unfair.

E. Analysis of options within the solar-utility interface

1. Methodology:

a. Set of public policy matrices was developed;

b. Feasibility of each option was evaluated;

c. Options found feasible were analyzed to determine their ramifications for technological configurations;

d. Impacts of changed technological configurations were in turn analyzed;

2. Feasibility of alternatives:

a. Technical and administrative feasibility:

(1) Feasible policy options are existing policy, no policy, solar consumer income tax deductions, low interest loans, increases in nonrenewable fuel cost, prohibition of use of solar hot water during utility peak periods, time-of-day pricing, decentralized thermal energy storage, interruptible utility service, and grants and subsidies to utilities;

(2) Incentives for solar-assisted heat pumps are low in feasibility.

b. Posture of gas utilities:

(1) Option of increases in nonrenewable fuel costs implies deregulation of gas prices;

(2) "No action" option would not improve position of gas utilities;

(3) Interruptible service has precedents for large consumers;

(4) Gas utilities look favorably on grants and subsidies to utilities and present ERDA program;

(5) Gas utilities might look favorably on utility ownership and control.

c. Posture of electric utilities:

(1) Options viewed favorably are interruptible service, grants and subsidies, utility ownership and control, decentralized thermal energy storage, denial of peak-period electricity to solar water-heating customers, and present ERDA policy;

(2) Solar consumer income tax deductions and low-interest loans are seen as promoting nonutility optimal designs;

(3) Policy advocating increases in nonrenewable fuel costs is viewed as highly unfavorable.

d. Posture of solar energy industry:

(1) Industry looks favorably on options of utility grants and subsidies, solar consumer income tax deductions and low-interest loans;

(2) Decentralized thermal energy storage and no action option are viewed unfavorably.

e. Posture of building industry:

(1) Building industry is favorable to low-interest loans, solar income tax deductions grants and subsidies;

(2) Utility ownership and control are looked on unfavorably;

(3) No action is looked on unfavorably.

f. Posture of energy consumers:

(1) Consumers view favorably income tax deductions, low-interest loans, interruptible service, no-peak consumption of electricity for solar hot water heaters and utility ownership and control;

(2) Consumers view unfavorably direct utility grants and subsidies, an increase in nonrenewable fuel costs and no action.

3. Impacts of alternatives:

a. Technical configurations:

(1) Current handcrafted, unsubsidized solar buildings show impact of no-action alternative by fact that utility system load profiles are ignored;

(2) Solar consumer income tax deductions and low interest loans are likely to produce nonoptimized designs;

(3) If price of conventional fuels were raised above marginal social cost through taxation, solar energy systems would be oversized and utility backup underused.

b. Gas utilities:

(1) Present ERDA program provides few substantial incentives to interface solar buildings with gas utilities;

(2) Income tax deductions and low-interest loans would not induce consumers to interface solar energy systems properly with the gas utility.

c. Electric utilities:

(1) For most options, impacts are the same for gas and electric utilities;

(2) For options of time-of-day pricing, decentralized thermal energy storage and denial of peak-period electricity to solar water-heating customers, impact is greater on electric utilities than on gas utilities.

d. Solar energy industry:
   (1) Time-of-day pricing may inhibit solar energy system penetration and promote thermal energy storage without collectors;
   (2) Same reasoning applies to option of direct promotion of thermal energy storage.

e. Building industry:
   (1) Impact of utility ownership and control would be positive;
   (2) Low-interest loans would help the building industry;
   (3) Income tax deductions would primarily affect the upper tail of the building market.

f. National economic efficiency:
   (1) If increases in nonrenewable fuel costs lead to marginal social costs equating price, this policy is highly desirable;
   (2) Other desirable policies are time-of-day pricing, interruptible service, utility ownership and decentralized thermal energy storage.

g. Solar consumers:
   (1) Time-of-day pricing would promote thermal energy storage without solar energy systems in the short run;
   (2) Income tax deductions, low-interest loans and increases in nonrenewable costs have impacts that are favorable to solar consumers.

h. Reduction in conventional energy consumption:
   (1) Comes about most directly by increasing costs of nonrenewable fuels;
   (2) May not come about as efficiently through time-of-day pricing since more total energy may be consumed during off-peak hours.

i. Energy efficient building design:
   (1) Increase in nonrenewable fuel costs is option best directed to efficient building design;
   (2) Time-of-day pricing and decentralized thermal energy storage may have a negative effect on building design because of the trade-off between capital investment savings and energy savings.

j. Other consumers of electricity and gas:
   (1) Utility ownership and control and decentralized thermal energy storage may provide lower energy costs to conventional consumers;
   (2) Time-of-day pricing and off-peak electricity for solar users should have the same effect, but it is not clear yet that they will.

k. Income distribution:
   (1) Time-of-day pricing is equitable for income distribution;
   (2) All other options discriminate against consumers with lower incomes.

1. Market penetration:
   (1) The price of nonrenewable fuel increases the cost competitiveness of solar energy systems more than those options designed to lower first costs;
   (2) Methods that lower first costs may be directed to technologically specific approaches that may become technologically obsolescent.

John Freeman, "Solar Energy as a Utility Operation," in Symposium Papers, The Role of Utility Companies in Solar Energy (Washington, D.C.: Institute of Gas Technology and Gorham International, November 1977), pp. 71-77.

Summary: Including solar energy systems in the rate base is among alternative strategies for a utility. State regulatory framework, as well as other factors, should be considered by utility looking at rate base approach. This approach requires that it be demonstrated that solar investment is a legitimate utility function and that investment in solar installations in customers' residences is not unjustly discriminatory.

Outline:

I. Complexity of utility choice of strategy differs for central and dispersed solar energy systems.
   A. For centralized power generation, the factors determining how aggressively a utility would pursue a solar strategy include:
      1. Climatic factors;
      2. Cost-competitiveness of technologies.
   B. Introduction of decentralized solar energy systems into a utility's system complicates problems of applying new rate concepts;
      1. Putting theory of rate reform into practice is hard;
      2. Each utility system is unique;
      3. Administrative complexity and consumer understanding of the rate structure must not be ignored by searching for an economically pure set of rate policies;
      4. Conflicting objectives may not be totally resolvable;
      5. There is no such thing as a standard solar energy system;
      6. Individual consumer who installs a solar energy system becomes an autonomous, unregulated energy producer capable of delivering usable Btu's for a variety of domestic purposes;
      7. There is no method for the utility to forecast or monitor accurately the contribution from a multitude of unique, dispersed solar energy systems in its service area.

II. There are four possible utility strategies:
   A. Solar energy systems installed on the customer's property are considered solely a concern of the builder and/or occupant:
      1. The utility's responsibility would end at the meter;
      2. The utility would do its best to establish rates that are neutral with respect to solar energy systems.
   B. The utility attempts to demonstrate that widespread implementation of "preferred" configuration of solar energy systems and conventional systems would provide the most economically advantageous total energy costs to the consumers in its service area:
      1. The utility determines that there is a "preferred" application for dispersed solar energy systems in its service area;

2. Rate policies would be advocated to promote the preferred configuration;
3. A public education program would be undertaken;
4. Such a strategy might be accompanied by;
   a. Sizing of customer storage;
   b. Attractive off-peak storage rates;
   c. Customer load management devices.

C. The utility becomes actively involved in the sale, installation and financing of solar energy systems in its service area.
   1. The utility would perform technical analyses and provide warranties on system performance and reliability;
   2. Financing would be arranged through local-lending institutions and provided directly by the utility;
   3. The utility might lease solar energy systems;
   4. For ratemaking, most of the financial impact of the utility would be below the line.

D. Dispersed solar energy systems installed in customers' residences are treated as utility property for ratemaking purposes:
   1. Cost of Btu's produced in an individual's facility would be treated as a "supply" of usable energy to the entire service area;
   2. The cost of the solar energy system would be rolled in and treated as a rate base investment;
   3. The property would be considered "used and useful" and depreciable for tax purposes.

III. Factors a utility should examine if it is considering a rate base approach:

A. State regulatory statutes:
   1. Within the state regulatory framework, it must be established that the solar investment activity is a legitimate utility function:
   2. It must be demonstrated that the investment in solar installation in customers' facilities is not unjustly discriminatory;
   3. Alleged environmental benefits of solar energy must be established through legislated authority or regulatory interpretation.

B. Federal antitrust law:
   1. It can be argued that action by a state regulatory commission could exempt the solar investment activity from the antitrust laws.
   2. Utility program must be designed to minimize monopolistic influences subject to action under Sherman Anti-Trust Act.

C. Natural Gas Act:
   1. As long as FPC allocation procedures use a fixed base period, saving of gas by solar investment would allow a utility to serve more low-priority users or increase the number of high-priority users;
   2. Relocation of gas away from utilities engaged in an aggressive solar investment program would penalize those utilities and their customers.

D. Supplementary financing involving subordinated debentures or subsidiary financing might be needed;

E. Treatment of the solar investment for tax purposes:
   1. If it can be demonstrated that the investment is utility property, tax advantages like accelerated depreciation and tax credits could be available;
   2. A ruling should be sought from the IRS and state regulatory commissions as to eligibility, depreciable life and other aspects of taxes on solar investments.

John Freeman, "Utility Alternatives for Solar Energy," Public Utilities Fortnightly (January 5, 1978): 20-23.

Summary: Utilities ought to be promoting solar energy use. Various strategies are available, but only a pure rate base approach places the solar supply option on an equal basis with other supply investments by the utility. Rate base approach treats residential solar energy systems as utility property for ratemaking purposes. The approach would, however, raise several legal and regulatory problems.

Outline:

I. For centralized solar energy generation, climactic factors and cost competitiveness of promising technologies should be investigated.

II. For decentralized solar energy systems, the issues are more complicated.
   - A. Fundamental problems:
      1. New rate concepts;
      2. Lack of a standard solar energy system;
      3. Lack of method for utility to use to forecast or monitor contribution of many unique, dispersed solar systems in the area.
   - B. Alternative strategies for utility:
      1. Promote neutral rates;
      2. Promote preferred application of solar energy systems in a service area;
      3. Become actively involved in sale, installation and financing of solar systems;
      4. "Rate base" approach: treats dispersed solar energy systems installed in customers' residences as utility property for ratemaking purposes.

III. Only the rate base approach results in an allocation of capital for new Btu on an equitable basis by allowing solar Btu to compete with conventional Btu at the margin.

IV. But the rate base approach would create regulatory and legal problems:
   - A. State regulatory statutes;
   - B. Federal antitrust laws;
   - C. Public Utilities Holding Company Act (shouldn't be a problem);
   - D. Natural Gas Act;
   - E. Financing of solar systems;
   - F. Depreciation.

V. The utility rate base approach might turn out to be the most equitable and effective method for utilities to deal with solar energy if:
   - A. Existing tax credit program does not work; and,
   - B. Need for solar effort becomes critical.

Derek P. Gregory, "New Potentials for Solar Energy - Technology and Systems," in The Role of Utility Companies in Solar Energy, Symposium Papers (Washington, D.C.: Institute of Gas Technology and Gorham International, November 1977), pp. 7-17.

Summary: Solar energy is a threat to utilities because it can be harnessed without utility help. But it is also an ally because it will appear on the scene about the same time as the availability of conventional energy to the utilities declines. Passive solar energy systems can do nothing but decrease the utility company role. Active ones could mean a considerable loss of business for the utility, together with an unfavorable load factor. However, the use of the utility as a backup could also encourage utility participation in ownership, marketing or maintenance of the equipment. For community systems, utility participation is especially important. There will be a major role for utilities in central solar energy systems because individuals or small companies cannot handle units that size.

P. C. Greiner, Edison Electric Institute, "Investment of Capital Requirements and Financing," in Symposium Papers, The Role of Utility Companies in Solar Energy (Washington, D.C.: Institute of Gas Technology and Gorham International, November 1977), pp. 45-51.

Summary: The electric utility industry is interested in solar energy. Most utilities in the United States have some kind of solar energy project going. Edison Electric Institute tests and those of utilities say that solar energy will not help alleviate peak demand. Heat pumps are the most economically efficient solar collector today. Insulation is less expensive initially, can save more energy and has a shorter payback period. Nuclear energy, particularly the breeder reactor, is the most promising source of abundant, inexpensive electricity. The electric utilities do believe solar energy will eventually be commerialized and are doing their part by pumping millions of dollars into research and demonstration. Utilities cannot be expected to completely finance the technical or practical development of solar energy.

Ernst R. Habicht, "Electric Utilities and Solar Energy: Competition, Subsidies, Ownership and Prices," in The Solar Market: Proceedings of Symposium on Competition in the Solar Energy Industry, U.S. Federal Trade Commission, Bureau of Competition (Washington, D.C.: U.S. Government Printing Office, 1977), pp. 229-42.

Summary: No one knows whether solar energy systems will be economical. Sensible policy on electric rate design would result in a narrow, deep market for solar energy systems. Marginal cost methodology must be applied comprehensively and correctly. Alternate rate structures that may encourage solar energy use are suggested.

Outline:

I. Relationship of electric utilities to solar energy:
   A. Few people today have any idea whether the solar industry will flourish or whether it will perish when integrated with electric power:
      1. The structure of marginal electricity costs varies dramatically around the country;
      2. Most rate designs fail to convey true costs.
   B. Proper policy is to apply marginal cost analysis comprehensively and correctly;
      1. Underpricing discourages solar market;
      2. Overpricing will produce a weak solar market that is bound to collapse when regulators and utilities realize costs outweigh benefits.
   C. Alternative rate structures that may encourage solar energy use:
      1. Inverted rates;
      2. Sales at marginal cost with gradually decreasing excess revenues returned to users in accordance with their historic consumption;
      3. System of tradable energy use entitlements whose value falls to zero when all energy is priced at marginal cost.
   D. Good applications for solar energy:
      1. Hot water heating for summer-peaking utilities;
      2. For systems with a substantial component of hydroelectric generation.

II. Criticisms of Asbury and Mueller article "Solar Energy and Electric Utilities: Should They Be Interfaced," Science, no. 4277 (February 1977) that concluded solar energy is not competitive with storage-augmented conventional systems:
   A. Failed to study marginal cost structures for individual utilities;
   B. Analyzed the wrong sequence of deploying elements of solar energy systems;
   C. Erroneously concluded solar energy would replace few, if any, additions to electric utility capacity;
   D. Failed to notice conditions under which competition between solar and electric storage systems may abate.

III. Ownership of solar energy systems by electric utilities:
   A. Arguments for utility ownership:
      1. Only the utility faces full opportunity costs of solar energy;

2. Consumers in master-metered buildings may never have incentive to invest in cost-minimizing technology;
3. Residential and consumer mobility mitigates against long-lived investment on the consumer's side of the meter.

B. Arguments against utility ownership:
1. Utilities tend to invest in gold-plated solar technology because it increases the rate base;
2. Utilities are not structured to handle the task:
a. few have structure interlacing planners and policy makers to seek out cost minimizing technologies;
b. problem of switching from supervision of a few large investments to many small ones.

C. Ownership is not really an important issue:
1. In the short run, the problem of stifling solar energy development is more serious than ownership;
2. In the long run, the question of who owns solar energy will become moot as average energy costs grow closer to marginal energy costs.

IV. Advice to regulators and legislators:
A. Collect, analyze and publicize cost and performance data;
B. Speed rate reform;
C. Encourage the solar energy industry to target efforts to applications where economic need and technological performance overlap;
D. Expand government's role where regulatory barriers preclude sensible economic outcomes (e.g., constraints on revenue);
E. Tax incentives, direct grants via utilities, innovative approaches;
F. Address social equity issue separately from energy user subsidies.

William B. Harral, "The Potential Effects of Alternate Rate Structures on the Utilization of Solar Energy," (Statement to Pennsylvania Public Utility Commission on behalf of Governor's Energy Council, September 1977).

Summary: Employment of solar energy systems would reduce the daily peaks in electric demand and moderate the growth of electric consumption as well as the consumption of other energy sources. Comment on rate concepts being reviewed by Pennsylvania PUC. Any modifications of the present rate structure that reward the low-use customer by lowering the cost of the initial block of increasing the cost of tail blocks, and/or rewards the off-peak customer, would enhance the feasibility of employing solar energy as an alternative to conventional energy sources.

Outline:

I. To make solar energy a viable energy source, solar energy systems must be economically competitive with conventional systems.
   A. Use of solar energy systems for thermal applications in buildings can reduce electric utility fuel and capital requirements;
   B. New rate structures should not unduly penalize customers who are able to reduce consumption through use of solar energy systems;
   C. New rate structures should allow solar-assisted customers who are able to divert electrical consumption to off-peak times to realize appropriate savings for consuming more low-cost power.

II. Comments on rate concepts being studied by the Pennsylvania PUC:
   A. Discount prices for decreased consumption would:
      1. Be an incentive to convert to a solar system;
      2. But would penalize the consumer who has already converted to solar as well as a regular consumer who is already conserving.
   B. Gradual or immediate inversion of the rate structure: The greater the portion of the rate structure that is inverted, the more economical it becomes to install larger solar energy systems that rely on smaller amounts of electricity to supply backup energy;
   C. Peak-period metering: the greater the price differential between peak and off-peak electricity, the more economical it becomes to install larger storage capacity;
   D. Seasonal pricing: This alternative structure alone may not have much impact on the solar customer because the savings realized from a solar energy system may be negated by the increased cost of nonheating electricity requirements;
   E. Marginal cost pricing: Marginal cost pricing should provide monetary incentives both for the use and storage of solar energy.
   F. Rates for large and small residential users:
      1. Lower rate schedules for customers with electric space or water heating would decrease the potential savings of a

solar unit, making the investment less attractive;

2. Lowering the initial blocks of an electric rate structure for low-use customers (lifeline, etc.) would make a solar investment more attractive.

G. Rates for interruptible service: Commercial firms could be induced to employ solar furnaces and storage to meet their hot water requirements.

H. Demand metering and limiting: A pricing system that would reward off-peak consumption would foster the utilization of solar energy.

Alan S. Hirshberg, Booz, Allen & Hamilton, Inc., "Overview of the Impact of Federal Incentives on Solar Heating and Cooling Economics," in Symposium Papers, The Role of Utility Companies in Solar Energy (Washington, D.C.: Institute of Gas Technology and Gorham International, November 1977) pp. 115-21.

Summary: Tax credits for solar energy systems have advantages and disadvantages. Utility involvement in solar energy would aid in ensuring designs compatible with utility loads. But involvement could dilute a utility's internal planning resources and would be resisted by "consumer advocate" groups.

Outline:

I. Overview of technical and economic status of solar heating and cooling.

II. Impact of incentives on economics of solar water and space heating for single-family residences:

  A. Consumer decision criteria according to a Booz, Allen study:
    1. Loss period should be one year or less;
    2. Break even period should be five years or less;
    3. Payback period should be less than 20 years.

  B. Effects of tax credits:

	Level of Tax Credit Required
Washington, D.C.	32%
Boston	26%
Grand Junction, Colorado	none
Los Angeles	none

  C. Advantages:
    1. Stimulates retrofit market more effectively;
    2. Provides financial benefits directly to purchasers;
    3. Easily implemented;
    4. Can be phased out faster than loan guarantees.

  D. Disadvantages of tax credit:
    1. Does not actually negate down payment requirements or reduce purchase price;
    2. Could stimulate the market before high-quality products can be assured;
    3. Could slow market growth while potential purchasers waited for passage of proposed tax credit;
    4. Could discourage manufacturing cost reductions;
    5. Does not give adequate incentives to low-income people;
    6. Impact on federal budget could be significant.

III. Implications of solar energy business for utilities:

  A. Utility involvement in solar energy design will help ensure designs compatible with utility load profiles;

  B. Involvement in solar energy may provide additional flexibility and help protect valuable industrial markets that might otherwise switch to nonutility fuels.

  C. Involvement in solar energy could have disadvantages of:
    1. Dilution of internal utility planning resources;
    2. Resistance from "consumer advocate" groups.

John G. Holmes et al., "Environmental and Safety Implications of Solar Technologies, " in Proceedings of the 1977 Annual Meeting, American Section of the International Solar Energy Society, Orlando, Fla., (June 6-10, 1977).

Summary: Summary of studies on environmental impact of eight solar technologies. Among the eight technologies are heating and cooling, solar thermal electric systems and total energy systems. Concludes that: (1) Solar heating and cooling may cause environmental problems of drinking water contamination and waste disposal; (2) Solar thermal electric systems may cause land use problems, disrupt ecosystems and cause problems from misdirected solar radiation; (3) Total energy systems may cause waste disposal and safety problems as well as problems of utility load management and consumer pricing.

Outline:

I. The paper summarizes an eight-volume report prepared for the Environmental and Resource Assessments Branch of the Division of Solar Energy of the Energy Research and Development Administration.
   - A. The report identifies key environmental issues associated with the ERDA-funded technologies of heating and cooling, solar thermal electric power, total energy systems, agricultural and industrial process heat, ocean thermal energy conversion, wind energy, photovoltaics and fuels from biomass;
   - B. Issues identified in the report were used to initiate needed research within ERDA.

II. Environmental problems of solar heating and cooling of buildings:
   - A. Potable water contamination could result from leakage of solar heat transfer fluids into domestic water supplies;
   - B. System fluid waste disposal could cause water pollution;
   - C. Impact on utility revenues and pricing policies is unclear.

III. Environmental problems of solar thermal electric plants:
   - A. Misdirected solar radiation could cause fires, burns and glare;
   - B. Significant portions of agricultural land could be displaced;
   - C. Local climate and ecology could be altered;
   - D. Boom towns with inadequate local services and facilities might appear during construction.

IV. Environmental problems of solar total energy systems:
   - A. Total energy systems may generate wastes that are difficult to dispose of safely;
   - B. Misdirected radiation and working fluid handling will pose safety problems;
   - C. If total energy systems rely on utility-supplied auxiliary power, problems of utility load management and consumer pricing could result:
     1. Inclement weather will force solar users to switch to the auxiliary system at the same time, straining utilty capacity.
     2. Measures to alleviate this problem include:
        - a. On-site fossil fuel-fired auxiliary boilers;
        - b. Off-peak thermal storage charging.

J. K. Hughitt, Washington Gas Light Company, "The Corporate Solar Decision," in Symposium Papers, The Role of Utility Companies in Solar Energy (Washington, D.C.: Institute of Gas Technology and Gorham International, November 1977), pp. 53-69.

Summary: Factors that will influence utility decision to become involved in solar energy are reviewed. Rolling into rate base the cost of solar installation to the consumer would help utility to stretch existing capacity. This approach would have serious regulatory consequences. The company would collect for its services by rolling in its costs as a two-part rate similar to present demand/commodity rate.

Outline:

I. Factors that will dictate utilities' role in solar energy are:
   A. Initial market entry;
   B. Legal and regulatory constraints;
   C. Available energy alternatives.

II. Constraints on the utility:
   A. Solar energy must be integrated with the utility operation in such a way that it provides maximum cost benefits to the consumer while providing an acceptable business position to the utility;
   B. Solar energy must prove to be attractive to existing ratepayers as well as to utility stockholders.

III. Factors that will have an impact on the corporate decision to get involved in solar energy:
   A. Public utility commissions:
      1. Any plan by a utility to participate in solar energy would require a review by the local PUC and probably a formal proceeding;
      2. In view of statutory constraints and pending NEA and California experience, it is doubtful PUCs will pursue utility participation.
   B. For companies registered with the Securities and Exchange Commission as holding companies, solar energy may be unable to pass the test of being incidental and related to the regulated utility business;
   C. Amendments to corporate charters may be needed to allow utility participation in energy conservation activities, including solar energy;
   D. State corporation and utility statutes may have to be amended to allow a utility to participate in the commercialization of solar energy;
   E. Financing a large-scale solar energy program as a utility activity may require amending utility mortgages that, in turn, would require approval of the bondholders;
   F. The pending National Energy Act may significantly clarify the role of a utility and its options in solar energy.

IV. Corporate structure alternatives for providing solar energy service:
   A. Utility function;
   B. Nonutility function;
   C. Subsidiary corporation;

D. Division of parent company;
E. Joint ventures by parent or subsidiary;
F. Consortium of utilities.

V. Primary alternative business approaches for utility involvement in solar energy:
   A. Sale of solar energy packages directly to consumers, without necessarily increasing rate base or adding to utility's energy supply;
   B. Providing solar energy in conjunction with utility service at a rate that fully compensates for the cost of installation;
   C. Rolling into the rate base the cost of the solar installation to the consumer:
      1. This would help utilities to stretch existing capacity and serve additional customers;
      2. This alternative faces serious regulatory consequences because it is a significant departure from historic utility service;
      3. Approach views utility as a supplier of energy rather than one providing a commodity the consumer uses to generate energy;
      4. The company would collect for its services by rolling in its costs as a two-part rate similar to a demand/commodity rate now charged by the power company:
         a. Demand charge covers fixed cost;
         b. Commodity rate covers cost of energy consumed.

R. G. Jones et al., National Conference of State Legislatures, Analysis of State Solar Energy Policy Options prepared for the Federal Energy Administration (June 1976).

Summary: Consolidation of two reports, one by Booz, Allen & Hamilton funded by the FEA and one by National Conference of State Legislatures funded by the National Science Foundation. Solar market economics, tax incentives and the relationship of solar energy to electric utilities are discussed. Purpose is to aid state governments considering actions to stimulate the market for solar energy. Concludes that the state policy with the most significant impact on solar thermal market penetration rates is the establishment of new electric utility rate structures. Says rates establishing a valid relationship between electric energy price and electric energy cost would substantially improve the economic attractiveness of solar energy applications, including space cooling.

Outline:

- I. Questions to be evaluated before a government considers actions it might take to stimulate the solar market:
  - A. Is there a market, and, if so, is there a need for government stimulus?
  - B. What are the costs of a government stimulus and does the outcome justify it?
  - C. Should government assume the role of selecting the solar product or system that should be marketed?
  - D. Are existing state policies in conflict with the solar commercialization goal?
- II. Solar market economics:
  - A. Solar thermal systems in water-heating and space-heating applications offer substantial economic benefits over their lifetimes where electricity is the alternative;
  - B. Solar thermal systems may offer economic benefits over their lifetimes for water-heating applications when natural gas is available at prices typical of current regulatory practice;
  - C. Solar thermal space-cooling systems are only marginally competitive with conventional systems, but modifications to electric rate structures might substantially improve their competitiveness.
- III. Tax incentives:
  - A. Effective tax incentives would be expensive in terms of lost revenues:
    - 1. Sales and property tax exemptions and income tax deductions would be inexpensive to the state and offer only small savings to solar users;
    - 2. The creation of rebatable tax credits at 25 percent or more of solar thermal system costs is a feasible mechanism for the establishment of effective solar thermal system subsidies but would be expensive.
  - B. State tax measures offer non-economic incentives by establishing government support for nascent industry, thus favorably affecting consumer confidence.

IV. Solar energy and electric utilities:
   A. Widespread application of solar thermal technology could result in net electric sales displaced by solar energy:
      1. Booz, Allen study, on basis of interviews with utility executives, concluded utilities viewed solar energy as a threat and possibly even to be discouraged;
      2. But potential loss of electric sales to solar energy is similar to potential loss from competing fuels or consumer economies;
      3. Public policy requires a net electric sales reduction.
   B. Appropriate solution to conflict between solar energy and electric utilities is establishment of a valid relationship between electric energy price and electric energy cost:
      1. Failure of electric rate structures relate accurately to unit prices to unit costs is the source of the potential "load factor" conflict between solar thermal systems and electric utilities;
      2. The conflict applies equally well to conservation measures and renewable energy resource applications;
      3. Establishment of valid relationship between electric price and cost would substantially improve the economic attractiveness of solar thermal applications, including space cooling;
      4. Establishment of such a relationship would create strong incentives for solar users to acquire systems designed for optimum patterns of use from both the utility and public policy viewpoints;
      5. State regulatory bodies are moving to accomplish the necessary rate structure revision.

V. Aspects of utility involvement as considered in Booz, Allen & Hamilton study:
   A. Administration of a loan program through utility companies is a particularly attractive option for solar energy systems because:
      1. A billing system already exists;
      2. Potential exists for future interfacing between utility power and solar energy systems.
   B. Effects on load factors of various utility responses to solar applications:
      1. Restructuring that retains volume dependent rate structures:
         a. Flat rate structures would not significantly improve solar energy system competitiveness;
         b. Inverted rates would not either.
      2. Rate restructuring with peak off-peak pricing:
         a. Peak off-peak rate structures can:
            (1) Increase attractiveness of solar energy systems;
            (2) Encourage design of solar-cooling systems.
         b. Climatic conditions limit the extent to which solar technology can displace demand for peak power;
         c. Utilities fear creation of "new, unexpected or unpredictable" peaks;

d. Special meters are expensive;
e. Market reception is uncertain;
f. Pilot experimental programs should be established.

3. Special rates for solar users:
   a. Discriminatory pricing for solar users might be designed so as to encourage use of solar energy systems with capacity to minimize the utility's peak-hour load;
   b. Such a rate might be subject to legal challenge.
4. Demand charges for solar users when their demand for electricity was greater than an established limit would be of marginal value:
   a. Demand changes would offer a means for utility to recover cost of maintaining sufficient capacity to meet the intermittent demands of the solar user;
   b. This method would have little effect on the utility load curve.

C. Active utility participation in developing the solar energy market would be beneficial to the solar industry and end users:
   1. Utility ownership of solar energy systems would allow the utility to control demand for auxiliary power so as to reduce peak demand;
   2. Participation should not be expected at utility expense;
   3. There is essentially no economic rationale for gas utilities to become actively involved in a solar energy incentive program.

Howard P. Kitt, Charles M. Frazier, and Irwin M. Stelzer, "The Participation of Electric Utility Companies in the Solar Energy Industry," in The Solar Market: Proceedings of the Symposium on Competition in the Solar Energy Industry, U.S. Federal Trade Commission, Bureau of Competition (Washington, D.C.: U.S. Government Printing Office, 1977), pp. 198-213.

Summary: Results for competition of various levels of utility participation in solar energy. Dilemma of solar energy is that without conventional utilities, solar energy is impractical; but if solar users are charged to reflect the cost of the rarely used but essential backup, the total costs of solar installation could be prohibitive.

Outline:

I. Possible conflict between energy and antitrust policies in development of solar energy:
   - A. Energy policy wants maximum rate of development for solar energy;
   - B. Antitrust sees danger to competitive process in allowing entry into solar industry to be subject to rules set by the electric utilities or their regulators;
   - C. Utilities can be viewed as:
     1. Consumers of solar energy;
     2. Competitors of suppliers of solar-produced energy.

II. Use of solar energy for power generation:
   - A. Development of central thermal power would probably mean no significant change in traditional utility role;
   - B. Direct conversion by solar cells does not have economies of scale, so might be competitive with conventional generation.

III. Dispersed use of solar energy:
   - A. The trouble with economic analysis done so far on solar energy:
     1. It is assumed the cost of new technology will decrease and that of old technology will increase;
     2. But an increase in electricity rates will drive up costs of new technologies,or new technologies will force a drop in the growth of electricity rates.
   - B. Utilities would greet solar energy enthusiastically even though it reduces their conventional business if it also reduces financial or environmental pressures;
   - C. Dispersed solar electric generation could result in a collision of regulated and competitive philosophies;
     1. If the idled capacity would be used for meeting other loads, there would be no problem;
     2. If utility facilities were made redundant by a switch to solar cells:
        - a. The utility would want to continue to earn on the undepreciated portion of its investment in the facilities;
        - b. The regulator would not want to transfer that burden to the utilities' remaining customers.
     3. The solution may be for solar cells to be used as back-up service at a rate that includes the utility's sunk investment in non-transferable.
   - D. Use of solar energy for heating:
     1. Most analysts agree that solar energy is now competitive for water heating;

2. Problems with solar space heating:
   a. Weather changes mean storage needed;
   b. Capacity needed for a utility to service solar users would be the most expensive in the system because of its low use.

E. Impact of solar cooling on utilities would not be so straightforward:
   1. It is not likely that a user of solar cooling would have electrical backup;
   2. But supplemental window air conditioners might be used, leading to higher costs for all consumers.

F. Dilemma of pricing of backup for solar energy:
   1. Utilities should price backup to reflect:
      a. Marginal costs,
      b. Costs of providing service with different use of existing capacity if those costs differ signficantly.
   2. Result of correct utility pricing could be to make price of solar energy prohibitive;
   3. There has been little effort to solve this problem because of lack of data showing what the impact would be of a solar load on any particular utility.

IV. Utilities and solar hardware:
   A. Utilities as suppliers of solar hardware:
      1. Possible that utilities would refuse to connect customers who didn't buy or lease their solar equipment;
      2. But unlikely utilities would want to supply solar hardware.
   B. Utilities' role in formulating or enforcing standards for solar hardware:
      1. Standard setting by utilities has potential for competitive abuse;
      2. But there are advantages to utility participation:
         a. Current service vacuum;
         b. Utilities' expertise;
         c. Effects of solar energy system reliability on utility;
         d. Cost of incorrect purchase high.
      3. Suggestions for standard-setting framework:
         a. Independent testing agency such as National Bureau of Standards;
         b. Commission with representatives from different interests to review standards;
         c. Presumption in favor of use of solar equipment meeting standards with utilities able to rebut with respect to its own service area before its state regulatory commission.

Sandy F. Kraemer, "Solar Shade Control" (Proceedings of the 1977 Annual Meeting of the American Section of the International Solar Energy Society, Orlando, Fla., June 6-10, 1977).

Summary: New laws will have to be developed to assure the availability of direct solar radiation to solar energy systems. Proposed legal solutions are unnecessarily complex. Solar shade control laws declaring a shadow of a tree on a solar collector a public nuisance would solve a major problem for solar energy systems.

Outline:

I. Studies in Colorado Springs, Colorado, indicate that control of shade from trees may solve 60 to 70 percent of shade problems during primary hours of solar collection at the winter solstice.

II. Most direct and simplest approach to the protection of a solar collector from a shadow is found in local or state police power to declare a shadow on a solar collector a public nuisance:
   A. Voluntary granting of solar easements by good neighbors will seldom occur;
   B. Proposed legal solutions based on theories of zoning eminent domain, private nuisance, transferable development rights and prior appropriation doctrine are unnecessarily complex and would often discourage the use of solar energy systems;
   C. Solar shade control laws would be a valid exercise of police power;
   D. Solar shade control law would require no bureaucratic proceedings, no commission or government costs and is preventive in nature.

III. Model solar shade control act.

S. C. Lawrence, "Consumer Action Now, Solar Energy's Perspective From the Consumer's Standpoint," in _Symposium Papers, The Role of Utility Companies in Solar Energy_ (Washington, D.C.: Institute of Gas Technology and Gorham International, November 1977), pp. 123-28.

Summary: Consumers are concerned with the potential role of utilities in solar energy development. Nonutility forms for disseminating solar energy should receive full attention. For example, in California and Florida, some municipal utilities are using a leasing program.

Outline:

I. Consumer needs in solar energy:
   A. Information;
   B. Trained professionals;
   C. Protection;
   D. Training;

II. Consumer concerns with involvement in solar energy programs:
   A. Utilities "owning the sun";
   B. Establishing who will pay for damages;
   C. What will happen if customer doesn't make payments on solar equipment.

III. Nonutility forms of disseminating solar energy should receive full attention and some funding:
   A. In California and Florida, some municipal utilities are using a leasing program;
   B. There should be a great deal more discussion on the subject.

George O. G. Lof, D. J. Close, and J. A. Duffie, "A Philosophy for Solar Energy Development," <u>Solar Energy</u> 12, no. 2 (1968): 234-50.

Summary: Looks at reasons for failure of some solar processes versus success of others. There have been economic, social or political reasons for failure as well as technical ones. Need careful study of needs for solar power systems, operational costs, availability of repair service, size of market and other factors for any commercial effort. For home/heating, high-capital cost has been major barrier. Need careful surveys of regional house-heating costs plus market analyses for this application.

George O. G. Lof, "Remarks," in The Solar Market: Proceedings of the Symposium on Competition in the Solar Energy Industry, U.S. Federal Trade Commission, Bureau of Competition (Washington, D.C.: U.S. Government Printing Office, 1977), pp. 243-45.

Summary: Solar heating is not going to get any cheaper. But it is competitive now in some places and will become competitive elsewhere as other fuels become more expensive. Aspects of interface between utilities and solar energy systems discussed briefly.

Outline:

I. Solar heating equipment is already being mass produced, so it is not going to get cheaper.

II. But solar heating can compete with electricity:
   A. Solar heat is already competitive in New York, Boston and other places because of high electric rates;
   B. Escalation of electric rates means solar energy will be competitive elsewhere within the life span of existing good solar-heating equipment;
   C. Solar heat can compete under other conditions:
      1. Residential electricity customers with solar-heating systems will be able to store enough electric heat to guarantee power companies they will not use solar energy at peak periods;
      2. Solar heating can compete with off-peak electric rates.

III. The more natural combination is with gas utilities because of declining gas supplies:
   A. Many uses of gas may be outlawed;
   B. It is natural for gas companies to expand into the solar business.

IV. Major interfaces between solar energy, and gas and electric utilities:
   A. Auxiliary energy supply;
   B. Participation of utilities in supply of solar-heating systems as:
      1. Manufacturers;
      2. Marketers;
      3. Financers;
      4. Lessors.
   C. Direct generation of electricity.

Harold Lorsch, Implications of Solar Space Conditioning on Electric Utilities, Franklin Institute Research Laboratories, prepared for National Science Foundation (December 1976).

Summary: Compares electrical energy demands of residences in the service areas of the Philadelphia Electric Company (summer peaking) and the Pennsylvania Power and Light Company (winter peaking) heated by electric resistance heating, direct solar heating with electric backup and solar-assisted heat pumps. Market projections of solar heating are made, and the effects on the generating, transmission and distribution systems of the two utilities determined in five-year intervals through the year 2000. Costs to serve and revenues are compared, possible rate scenarios investigated and the effects of different rate structures on the rate of introduction of solar heating evaluated.

Outline:

I. Study deals with effects of residential solar heating on electric utilities:
   - A. Two specific utilities serving adjacent territories were chosen;
   - B. The two are a representative sample of U.S. electric utilities:

Philadelphia Electric Company	Pennsylvania Power and Light Company
winter peaking	summer peaking
urban	rural
heavy industrial consumption	little industrial consumption
oil fueled, to become nuclear	coal fueled
combustion turbines and hydro generation	combustion turbines and hydro generation

   - C. All effects were evaluated in five-year intervals from 1975 to the year 2000;
   - D. Study was limited to a comparison of electrically heated homes with and without solar assistance;
   - E. Effort was concentrated on the effects of solar heating in single-family homes as representing all residential dwellings;
     1. Market for single-family homes is well defined and exists throughout the country;
     2. Multiple dwellings are expected to use solar heating less.
   - F. Solar air conditioning and retrofits of solar space-heating systems to existing homes were not included in the study because:
     1. They are economically less attractive than new solar-heating systems;
     2. Few such systems are expected to be installed in the study region by the end of the century.
   - G. Methodology:
     1. Detailed energy consumption calculations were performed using hourly weather and solar data at the two locations;
     2. Market penetration rates were calculated by each utility in its service area;
     3. Diversity analyses were performed to determine the effect of the solar heated homes on residential demands;
     4. Adding nonresidential and residential demands permitted the construction of integrated load models.

5. Generation costs and other system characteristics were calculated in five-year intervals through the year 2000;
6. Present costs to serve and revenues for conventional and solar-heated homes were determined by the utilities;
7. Any revenue excess or deficiency for the solar-heated homes was evaluated;
8. Contractor estimated future revenues on the assumption that future rates would be designed to permit a utility to recover its cost to serve customers using electric resistance heating.

H. Policy alternatives were evaluated on basis of:
   1. Results of study;
   2. Desirability of reducing consumption from scarce fossil fuels;
   3. Maintenance of financial health for the utility industry;
   4. Minimization of total societal costs.

II. Conclusions:

A. The solar-heating customer presents the utility with a load factor that is 40 to 50 percent lower than the load factor of a conventional electric resistance-heating customer:
   1. This presents a revenue problem to winter-peaking utilities;
   2. It is less of a problem to summer-peaking utilities;

B. In four out of five years, the peak electrical winter demand of a solar-heated home in eastern Pennsylvania with electrical backup is virtually equal to, and occurs at the same time as, that of an electric resistance-heated home;

C. Under all rate structures that recover the cost to serve through an energy charge alone, electric utilities will suffer revenue deficiencies from solar-heating customers;
   1. This is true unless these customers are charged a different energy rate from that of the conventional heating customers.
   2. The reason this is true is that:
      a. Utility revenues are decreased in proportion to energy savings;
      b. The other components of the utilities' cost-to-serve (demand-related costs and customer-related costs) are identical for solar and conventional customers.

D. Due to the expected slow rate of introduction of solar heating, no critical financial or systems' problems will be caused within this century to the electric utilities participating in the study:
   1. Participating utilities will not have to modify generation, transmission or distribution systems as a result of the use of solar heating;
   2. These conclusions may not hold true for the southwestern United States.

E. If solar-heating customers are charged the full cost to serve, their monetary savings from using solar heating are less than their energy savings:
   1. The ratio of monetary savings to energy savings is lower for customers of utilities using capital-intensive generation and higher for energy-intensive generation;

2. As utilities increase their fraction of capital-intensive generating capacity, the ratio decreases over time;
3. Actual dollar savings, however, will continue to increase because of the expected general escalation in utility costs.

F. The winter-peaking utility in the study would suffer a deficiency in revenue equal to approximately 30 percent of its cost to serve a solar heating customer having a 70 percent solar dependency;

G. The summer-peaking utility participating in the study would obtain a small revenue excess from solar-space and water-heating customers in 1975 that would disappear in the early 1980s and change into a steadily growing revenue deficiency:
1. According to current tariffs, such customers would be charged the regular residential rate;
2. Conventional electric-heating customers are charged a residential space-heating rate about 40 percent lower.

H. Encouraging solar-heating and covering the costs to serve solar heating customers of electric utilities may constitute opposing requirements;

I. The reduction in electrical energy requirements due to the use of solar heating results in a reduction in the marginal cost of fuel used for electric generation:
1. This cost avoidance amounts to $400 per solar customer for one utility in 1980;
2. Under present rate structures, this cost avoidance is beneficial to all utility customers;
3. This may provide a rationale for charging the solar heated customer a lower rate than the cost to serve him.

J. The solar-heating systems analyzed in the report were operated to minimize perceived customer cost under current rate schedules:
1. They were operated to minimize seasonal auxiliary energy use;
2. This is the usual way of operating such systems under current rate structures;
3. But the thermal storage device contained in all solar-heating systems could be used to decrease utility system demand peaks.

K. A market penetration of 5 to 10 percent of new electrically heated, single-family homes is predicted for solar-heated homes with electrical backup heating by the year 2000.

III. Electric rate structure alternatives:

A. The assumption that load leveling reduces costs is not necessarily true:
1. Daily load leveling during the most critical periods of the year will not improve the operation of the Pennsylvania Power and Light Company:
    a. The hourly load of this utility is quite flat on the day of its annual system peak;
    b. The decreased demand at night is needed to remove slag from its coal-burning boilers.

2. A study by the Philadelphia Electric Company showed that seasonal load leveling to produce equal monthly peaks throughout the year would result in insignificant savings:
    a. Planned maintenance is now performed during the spring and fall periods of lower peak demand;
    b. If all monthly peaks are equal, additional generation capacity must be built to take the place of generators being maintained at any given time.

B. Scenarios assuming rates similar to present rates:
  1. Rate scenarios may be considered, given the following set of conditions:
      a. Solar heating presents electric utilities with a class of residential customers with virtually equal peak demands but lower load factors than other customers in residences of the same size;
      b. The class of customers is small but readily identifiable;
      c. Residential electric rate structures will not change significantly, given the historic slow rate of change in utility tariffs.
  2. The rate scenarios that may occur are:
      a. Maintain tariffs unchanged, including solar-heating customers in the same class with other residential (nonheating) customers:
          (1) This would result in a very small increase in cost to all residential customers;
          (2) Such a rate offers little incentive to the solar-heating customer:
              (a) For low solar dependence, say 50 percent, this rate may prevent the introduction of solar-heating systems in many U.S. locations;
              (b) This is so because the rate was designed for electrical "bare" load (like lights) that consume little energy compared to heating.
      b. Include solar-heating customers in same class with other residential-heating customers:
          (1) For utilities that offer residential heating rates, a significant revenue deficiency would result under this option;
          (2) Since the deficiency, in the case of PECO, would be spread over a relatively small number of residential-heating customers, it would result in a noticeable cost increase for all conventional electric-heating customers.
      c. Establish a separate rate for solar-heating customers:
          (1) Such a rate would be designed for utilities to recover the cost to serve those customers;
          (2) Such a rate might tend to inhibit the introduction of solar heating;
          (3) The Colorado Public Utility Commission recently ordered the Public Service Company of Colorado to hold such a rate in abeyance:

(a) The company was proposing a standby rate levying a charge of $60 on a solar-heating customer for each month during which any electric-heating energy was consumed by the backup system to the solar-heating system;

(b) The financial penalty was so heavy that it virtually would have halted the spread of solar heating in the state.

(4) The claim that solar-heating customers are not fundamentally different from other heating customers is not borne out by data:

(a) The lowest annual energy consumption of a single-family residential-heating customer determined by the PECO survey was still 40 percent higher than that of the solar customer;

(b) The annual energy consumption of solar-heated homes is comparable to that of one- or two-bedroom apartments without electric heat:

i. Such customers have peak demands only about one-third as high as the solar-heating customers;

ii. They are on the residential rate, not the residential heating rate;

iii. Thus, neither the load patterns of, nor the revenues from, such customers are similar to those of solar-heating customers in single-family homes.

C. Rates to encourage solar heating:

1. It may be argued that solar-heating customers should be subsidized:

   a. The United States has embarked on a national program to develop solar energy to conserve scarce fossil fuel resources;

   b. A case can be made for returning a portion of the utility's fuel cost saving attributable to the solar customer;

   c. But the same argument applies to any utility customer practicing energy conservation;

   d. It is extremely difficult to determine actual marginal fuel costs for customers using different methods of reducing their energy consumption below that of the average of their class.

2. Peak-load rates:

   a. Many utility operators admit that marginal cost pricing is theoretically preferable but claim that it is impractical;

   b. Rate scenarios that use the principles of marginal cost pricing:

      (1) Apply a combination of demand rate and energy rate to residential customers;

(a) Such a rate would allocate costs more equitably among residential customers and would cause higher charges to customers with peak-load demand;
(b) Many utilities have already established the cost to serve their residential customers in terms of power demand and energy consumption.
(3) Permit the solar customer to use a residential off-peak rate:
(a) This would be lower than present all-electric space-heating rates;
(b) They would not inhibit the use of solar heating.

E. Effect of energy storage:
1. The thermal energy storage device in all solar-heating systems could be used to decrease utility peaks;
2. But heavy reliance on the stored auxiliary energy would increase annual electric energy consumption while reducing utility peaks;
3. Computing the costs of storing auxiliary energy versus the costs of not doing so is beyond a homeowner's capability.

IV. Recommendations:
A. Determine the true costs to the nation of different incentives for the introduction of solar heating;
B. Investigate the coincidence of clear or cloudy daytime periods in the northeastern United States with utility system winter peaks;
C. Evaluate the operational and energy characteristics of solar-heating systems designed and operated to reduce utility system peaks, especially:
1. The use of enlarged thermal storage devices;
2. Operation of the storage device by the homeowner;
3. Operation of the storage device by the utility.
D. Determine the ratio between peak and off-peak rates that would make each of the above systems economically attractive both to consumers and utilities;
E. Explore the merits of oil-fired auxiliary-heating systems.

Mike, M. C. McCormack, "Keynote Address," in <u>Symposium Papers, The Role Of Utility Companies in Solar Energy</u> (Washington, D.C.: Institute of Gas Technology and Gorham International, November 1977), pp. 1-6.

Summary: Utilities are ideally suited to install, engineer and finance the installation of solar energy systems. Existing solar-heating systems are about as efficient and cheap as possible. We should not expect dramatic breakthroughs. We should avoid reliance on complicated systems that have not been mass produced or field tested.

Arthur E. McGarity, Solar Heating and Cooling: An Economic Assessment (Washington, D.C.: U.S. Government Printing Office, 1977).

Summary: A methodology for assessing the economic feasibility of solar heating is applied to 20 cities in the United States. Potential for reductions in costs of solar energy and the effects of increases in prices of conventional fuels are included in the assessment. Results show there may be considerable potential for residential solar energy systems.

MITRE Corporation, Systems Analysis of Solar Energy Programs, Report MTR-6513, prepared for the National Science Foundation (December 1973).

Summary: One of a series of four reports that cover a MITRE Corporation study of the NSF five-year solar energy research program. Seven major applications of solar energy were analyzed in terms of expected costs and benefits expected. Heating and cooling of buildings, wind energy systems and utilization of organic materials appear to be best capable of achieving commercial application within a few years. Process heat systems, solar thermal systems, photovoltaic systems and ocean thermal gradient systems appear to need continued federal support beyond the initial five-year NSF program for solar energy systems. Solar heating and cooling of buildings are "ready now but application slowed by institutional constraints." The other three reports in the series are Solar Energy Research Program Alternatives, Solar Energy Proof of Concept Experiments and Dissemination and Utilization of Solar Energy Research.

National Bureau of Standards, State Solar Energy Legislation of 1976: A Review of Statutes Related to Buildings (Washington, D.C.: U.S. Government Printing Office, 1977).

Summary: Report reviews state legislation enacted in 1976 on solar energy use in buildings. Legislation provided tax incentives for the installation of solar devices, support for the proposed Solar Energy Research Institute, solar standards, solar energy offices, studies, building requirements and solar projects. The acts are reproduced as well as abstracted. State officials responsible for the legislation are listed.

National Science Foundation/National Aeronautics and Space Administration Solar Energy Panel, An Assessment of Solar Energy as a National Energy Resource (Washington, D.C.: U.S. Government Printing Office, 1972).

Summary: Joint NSF/NASA panel assessed potential of solar energy as a national energy resource. Assessed state of technology for all applications of solar energy, as well as power from wind, ocean thermal differences and useful energy from replenishable organic materials. Report recommends research and development programs to develop potential in those areas considered important. Recommends that environmental, social and political consequences of solar energy use be continually appraised and the results employed in development program planning.

Outline:

I. Areas covered in study:
   A. Status of solar utilization techniques;
   B. Major technical problems;
   C. Impact of solar energy applications by 2020, assuming development of practical solar energy systems:
      1. Impact on U.S. energy consumption;
      2. Impact on electric utility industry:
         a. No impact listed for thermal energy for buildings;
         b. Modest impact from thermal conversion for electric power generation;
         c. Major impact from:
            (1) photovoltaic ground stations;
            (2) photovoltaic space stations;
            (3) wind energy conversion systems;
            (4) ocean thermal difference.
   D. Recommended long-range research and development programs.

II. Conclusions:
   A. Solar energy could make a major contribution to future U.S heat and power requirements;
   B. There are no technical barriers to wide application of solar energy to meet U.S. needs;
   C. Solar energy will become competitive with conventional fuels in the near future:
      1. By 2020, solar energy could provide up to 35 percent of U.S. heating and cooling load for buildings;
      2. Building heating could reach public use within five years;
      3. Building cooling could reach public use in six to 10 years.
   D. The large-scale use of solar energy would have a minimal effect on the environment.

III. Recommendations:
   A. The federal government should take a lead role in developing a research and development program for the practical application of solar energy to the heat and power needs of the United States;
   B. Environmental, social and political consequences of solar energy use should be continually appraised and the results employed in planning for development programs.

National Solar Heating and Cooling Information Center, State Solar Legislation (Rockville, Md: National Solar Heating and Cooling Information Center, 1978).

Summary: Summaries of legislation providing financial incentives for solar energy in 37 states, safeguarding a solar user's access to sunlight in 12 states, setting solar equipment standards in five states and altering building codes to encourage solar installation in three states. Included in summaries are bill numbers, brief descriptions and contacts for further information.

Craig H. Peterson, "The Impact of Tax Incentives and Auxiliary Fuel Prices on the Utilization Rate of Solar Energy Space Conditioning," prepared for the National Science Foundation (January 1976).

Summary: A solar energy market simulation model was used to estimate the effects of alternate tax incentives on the market impact of solar energy for space heating and cooling, and water heating. The effects of utility surcharges or discounts for conventional energy used as solar auxiliary were also considered.

Outline:

I. Introduction:
   A. Operation of flat-plate solar heating, cooling and water-heating systems;
   B. Recent studies for NSF ("Phase 0 Studies") all concluded that the amount of total national energy demand supplied by solar energy would remain relatively small, even by the end of the century;
   C. Rate of solar energy use may be affected by pricing decisions of gas and electric utilities:
      1. Impact of large numbers of solar energy systems on utility demand patterns has not yet been definitely established;
      2. If use of solar energy systems necessitates extra utility capacity, and if regulatory commissions assign extra capacity costs to solar users, those users will be paying a premium.
   D. Arguments for government intervention;
   E. Proposals for federal and state action to increase the rate of solar energy use.

II. Alternative proposals for government incentives:
   A. Sales tax exemption for purchase of solar heating, cooling and water-heating equipment;
   B. Property tax exemption for solar equipment;
   C. Rapid amortization of solar equipment;
   D. Income tax credits or deductions for purchases of solar equipment;
   E. Interest rate subsidies for financing solar equipment.

III. Results show nature and magnitude of effects of alternative government incentives:
   A. With no incentives and no utility surcharge or discount, 6.3 percent of the total heating, cooling and water-heating load could be supplied by solar energy by 1985; 32.5 percent by the year 2000:
      1. Optimistic results are largely explained by use of the Denver SMSA as the region for study;
      2. Greatest impact of solar energy is on larger rental apartments because of tax advantages to corporate ownership.
   B. Percentage heating, cooling and water-heating load that could be supplied by solar energy by the year 2000 for different incentives and utility surcharges or discount:

	Percent of load by year 2000	Difference from baseline projection
Baseline projection: No incentives	32.5	--
Property tax exemption	38.6	+ 6.1
Tax deduction	37.7	+ 5.2
Tax credit	39.0	+ 6.5
2% interest rate subsidy	37.7	+ 5.2
7% interest rate subsidy	48.5	+16.0
50% surcharge on auxiliary fuel	28.5	- 4.0
10% surcharge on auxiliary fuel	32.1	- 0.4
10% discount on auxiliary fuel	32.9	+ 0.5
50% discount on auxiliary fuel	29.6	- 2.9

C. Reason that 50 percent discount on auxiliary fuel reduces solar use is that as cost of auxiliary power decreases, optimum collection size also decreases;

D. Additional work is needed on incentives, particularly on the impacts of utility-pricing decisions.

Russell J. Profozich, "The Economics of Solar Power," Congressional Research Service (May 29, 1978).

Summary: General discussion of the economics of solar-heating and cooling facilities installed directly on the user's premises. Summary provided of NSF study "Solar Heating and Cooling: An Economic Assessment" showing that with mass production and advanced design, solar energy systems could be competitive with conventional fuels in many American cities. Suggested that further work is needed on the effects on utilities of auxiliary use of conventional systems. Simplified review of how a solar energy conversion system works.

Outline:

I. General review of how a solar energy conversion system works and possible design changes that could improve efficiency and lower cost of solar energy collection.

II. Cost-benefit analysis has been prepared by National Science Foundation*.

III. Current efforts to promote solar energy:
   - A. Federal government research;
   - B. Tax credits up to $2,200 for individuals in conference version of National Energy Act;
   - C. Property tax exemptions in 17 states for residential investment;
   - D. Income tax benefits in seven states for residential investment in solar-heating devices.

IV. Solar energy and public utilities:
   - A. To determine cost-effectiveness of entire system, we need to know effects of auxiliary use of conventional fuels on utilities;
   - B. A study of a New Mexico utility found:
     1. Solar installations reduced customer demand on system at time of system peak;
     2. For other systems, study found substantial peak-energy consumption.
   - C. Should ensure that:
     1. Customer be aware of costs he is imposing;
     2. Customer pay rates reflecting cost of supplying him.

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* For outline and summary, see 32. "McGarity" (1977).

R. L. Reid et al., "Economics of Solar Heating with Homeowner-Type Financing," Solar Energy 19, No. 5 (November 1977): 513-18.

Summary: Economics of solar space and hot water heating for houses in Tennessee. Intended to illustrate a type of study that can be made for a geographical region to help small investors decide whether to install solar energy systems.

R. L. Reid, and R. C. Hendricks, "Effects of Tax Credits on the Economics of Solar Heating for Homeowners," in Proceedings of the 1977 Annual Meeting, American Section of the International Solar Energy Society, Orlando, Fla., June 6-10, 1977.

Summary: Study shows improvement in economics for a homeowner accruing from a tax credit for a solar energy system. A tax credit would stimulate solar-assisted heating and cooling for both new and retrofit construction. The systems would be competitive with electric heating but not with gas.

Richard L. Robbins, "Law and Solar Energy Systems: Legal Impediments and Inducements to Solar Energy Systems," Solar Energy 18, no. 5 (1976): 371-79.

Summary: Summary of findings by American Bar Federation, an affiliate of the American Bar Association, on legal and institutional barriers to use of solar energy. Many changes will be necessary including, in some states, changes in utility regulation or legislation.

Outline:

I. The American Bar Federation, an independent affiliate of the American Bar Association, has prepared about 35 model bills for use at all levels of government in removing legal and institutional barriers to solar energy use and encouraging that use.

II. Impediments to solar energy use:
   A. Right to sunlight;
   B. Zoning ordinances;
   C. Building codes and materials, and installation requirements;
   D. Labor laws;
   E. Public utility issues:
      1. Utilities may want to sell, install, service and operate solar devices, and present regulations may make this impossible;
      2. Private groups may want to share solar energy systems and need "public utility" status to do so;
      3. Problems of utilities providing backup power for solar energy users:
         a. New forms of metering, billing and control over energy use to reduce costs to solar energy users;
         b. New rates to minimize peak loads;
         c. Coordination of needs of many solar energy users;
         d. Altered minimum rates if they affect solar installation;
         e. Effects on other utility services of solar energy users.
   F. Patents.

III. Inducements to solar energy use:
   A. Fiscal:
      1. Tax exemptions;
      2. Income tax deductions;
      3. Sales tax rebates.
   B. Solar skyspace protection;
   C. State regulation of financial institutions so as to encourage banks to encourage solar energy use;
   D. State housing agency actions:
      1. loans;
      2. research and development;
   E. Prosecution of unfair practices;
   F. Use of solar energy systems for new construction or major building alteration could be required in such a way as not to impose an unreasonable burden on owners.

William D. Schulze et al., University of New Mexico Department of Economics, Solar Energy: Policy and Prospects, prepared for the National Science Foundation (Washington, D.C., July 1976).

Summary: Economic feasibility of near-term solar energy sources with energy price decontrol. Decontrolled energy prices are projected state by state for the United States. Feasibility for solar residential space heating, for full application of solar energy to a mixed load community in the Southwest and for an application of solar process heat to industry are analyzed. Policy strategies are discussed.

Outline:

I. Price decontrol leading to steep price increases is not the solution to the U.S. energy problem:
   A. Domestic oil and gas reserves are undergoing rapid depletion, and long-run domestic supplies will be relatively insensitive to price decontrols;
   B. Although increased energy prices will stimulate alternative technologies, these alternatives will all require large amounts of continued capital investment:
      1. Financial institutions may not be able to provide needed capital;
      2. Current structure of capital markets may be inappropriate for conservation and alternative energy technology investments.
   C. Regressive effects on low-income groups of decontrol of energy prices cannot be ignored.

II. Comparative costs of space heating under energy price decontrol:
   A. Comparison between natural gas and heat pump prices across 48 states yields least cost energy alternative to solar energy;
   B. Life-cycle-costing techniques were used to make a comparison;
   C. Present cost comparisons of solar energy to traditional energy forms at controlled prices on a yearly basis will almost certainly fail to demonstrate solar feasibility:
      1. Costs of liquid collector designs are prohibitive for large-scale applications of solar energy;
      2. Air systems appear more promising than water systems with respect to life expectancy and future costs.
   D. Under a scenario of decontrolled energy prices, the clear and indisputable picture that emerges is that solar feasibility begins in the northern tier of states and with very few exceptions, systematically moves southward:
      1. Conventional fuel prices begin to increase so fast that consumers have incentive to look elsewhere;
      2. With most gas supplies located in the south central and southwestern states, prices generally increase as one moves north;
      3. Higher heating loads as one moves north allow high-fixed costs of solar energy to be spread over a larger Btu base;
      4. For new construction, solar energy for home heating becomes feasible between 1976 and 1990:

a. Through 1990, new construction that incorporates both insulation and solar home heating results in a 56 percent energy savings over traditional housing energy use patterns;
b. But major energy savings from these sources depends on development of retrofit applications.

III. Total solar energy applied to a mixed load community:
   A. Hypothetical 2,000 dwelling unit community:
      1. Hypothetical locale was consistent with climatic and engineering data from Albuquerque, N. M.;
      2. Assuming municipal ownership, total annual revenue requirements were calculated using an upper and lower bound for interest rates.
   B. Results:
      1. Price parity is achieved in 1976 with a 2.5 percent real interest rate under the energy price decontrol scenario;
      2. Feasibility of the total solar energy concept is limited by community density but could have greater impacts in applications that possess high densities, such as large public buildings, hospitals and offices;
      3. In mixed load applications, the geographic trend for solar feasibility over time may be from south to north, in contrast to results for space heating alone.

IV. Example of solar process heat for industrial use.

V. Policy issues:
   A. Even with decontrol of prices of traditional energy sources, solar energy will not be competitive unless there is a federally coordinated program to remove the financial and institutional constraints on its efficient use;
   B. Because of inflationary distortions and the way financial institutions operate, it is nearly impossible for homeowners to compare fuel cost savings with the additional mortgage payment or annual cost of a loan associated with adding a solar energy system to a home;
   C. State legislatures have provided tax incentives to reduce the burden associated with the high initial cost of solar energy systems;
   D. Low-interest loans are the most powerful tool for achieving economic feasibility of solar energy systems under continued price control of other energy sources;
   E. The best policy is total decontrol of energy prices with taxes on windfall profits of energy producers and correction of the regressive impact on low-income groups;
   F. Other recommendations to federal government:
      1. Encourage the use of life-cycle-costing techniques;
      2. Maintain a stable fiscal policy and relatively loose monetary policy to facilitate high levels of housing turnover and make capital available to industry;
      3. Stimulate research in the area of retrofitting solar installations.

Jerome E. Scott et al., Demand Analysis, Solar Heating and Cooling of Buildings, Phase I Report, prepared for the National Science Foundation (December 1974).

Summary: Contains reports of two separate projects: (1) An assessment of the solar water heater industry in south Florida; (2) Attitudes and expectations of supporting lending institutions toward use of solar energy for space heating and cooling of single-family residences. Nearly three-fourths of the financiers believed solar energy would be a feasible alternative energy source for heating and cooling single-family residences within the next 10 years.

Jerome E. Scott, Delaware University, Solar Water Heating Economic Feasibility, Capture Potential and Incentives, prepared for The National Science Foundation (Washington, D.C., February 1977).

Summary: Results of a comprehensive investigation of solar water heating in residential applications. Technical and economic characteristics of residential water heating are discussed, including designs for various regions of the country, installation cost analyses, solar contribution simulations, optimum system size calculations, and payback and monthly budgeting effects. Discussion of incentives and their likely effects. Presentation and research on homeowner attitudes and demand functions. Estimates of market penetration for solar water heating through the year 2000 are made by region and fuel type. Forecast of impact on acceptance of solar energy systems with a federal tax credit.

Outline:

I. Technical and economic characteristics of residential water heating:
   - A. Designs for various regions of the country;
   - B. Installation cost analysis;
   - C. Solar contribution simulations;
   - D. Optimum system size calculations;
   - E. Payback and monthly budgeting effects;
   - F. Implications for incentives:
     1. Seasonal impact on utility loads:
        - a. The amount of alternative fuel displaced by solar water heaters is much greater in summer months especially in the densely populated colder regions with low-winter insulation;
        - b. Electric utilities with summer peak loading would benefit, whereas those with winter peaks would be adversely affected;
        - c. Unless a favorable balancing is possible, many utilities might react negatively to losing part of their base-load.
   - G. Regional differences in insolation and fuel costs:
     1. Regional differences have implications for distribution of income for federal incentives such as tax credits or low-interest loans;
     2. If incentive programs do not reflect regional differences, areas of high insolation and high-electric power rates would benefit greatly while other areas might not be helped enough to make solar heating economically justifiable;
     3. Incentives such as federal tax credits should be designed by states or regions rather than at the federal level.
   - H. New versus existing residences:
     1. Buyers of new homes are likely to respond to a tax credit to reduce the impact of the added down payment;
     2. Owners of existing homes may respond favorably to a tax credit but may also require longer term financing to avoid upsetting monthly budgets.

I. Except for locations such as Phoenix, Arizona, where insolation and power costs are high, solar water heaters are a difficult selling proposition:
   1. The first five years' savings typically do not equal the incremental down payments that must be made;
   2. Payback periods usually exceed the average expected time spent at one residence;
   3. Future savings' estimates depend on forecasts of future fuel prices, and many Americans are skeptical toward promises about the future, especially on innovations.

II. Incentives and research design:
   A. Alternative incentives:
      1. Income tax credit;
      2. Income tax deduction;
      3. Favorable loan terms;
      4. Sales and property tax exemptions;
      5. Incentives for solar businesses.
   B. Incentives to be investigated for possible implementation because they offer most leverage in overcoming barriers that retard final demand:
      1. Tax credit;
      2. Procedure for making available longer term financing at home mortgage rates for the retrofit buyer.
   C. Research design for estimating homeowner demand functions for solar water heaters.

III. Consumer acceptance:
   A. Results of homeowner research:
      1. Many respondents had almost no exposure or interest in solar water heating;
      2. Acceptability decreased markedly with increasing first cost;
      3. Homeowners appear unwilling to accept life-cycle-cost arguments;
      4. Respondents said seven years was the maximum acceptable before total fuel savings paid for the higher initial cost;
      5. A vast majority of homeowners believed the federal government should provide incentives;
      6. Uncertainty regarding long-term reliability, durability and performance may be as important as first cost in explaining the reluctance of homeowners to buy solar water heaters;
      7. Fuel cost savings was the most frequently cited reason why consumers said they would buy a solar water heater;
      8. Home-seekers more favorably disposed to a solar alternative:
         a. Had more education;
         b. Perceived less performance risk or financial risk;
         c. Were less dogmatic.

IV. Market penetration model:
   A. Quantitative model for projecting solar water heater market penetration through the year 2000;
   B. Model used 1976 marginal fuel rates by state.

V. Analysis of market penetration of solar water heating with a tax credit:
   A. Total market penetration:
      1. With a $350 tax credit, 20 percent of all single family residences would be equipped with solar water heaters by the year 2000;
      2. Market penetration in the first decade is nearly three times as high with the credit as without.
   B. Penetration of the new home market is considerably greater than for the retrofit market;
   C. Market penetration is different for different climatic regions and best for Texas, southern California, Florida, Arizona, New Mexico and Nevada;
   D. Penetration is greatest where electricity is the alternate fuel;
   E. Potential for fuel savings in single-family residences amounts to 1.5-trillion cubic feet of natural gas, 300-billion kilowatt-hours of electricity and 58-million barrels of oil over a 25-year period;
   F. Impact on federal tax revenues of a $350 tax credit would not be great and would be far outweighed by fuel savings.

VI. Assuming all collectors were made of copper, the effect on copper consumption, with or without a tax credit, would not be great.

Bruce M. Smackey, "Should Electric Utilities Market Solar Energy," Public Utilities Fortnightly 102, no. 7 (September 28, 1978) :37-43.

Summary: Investigation of possible roles for a utility in marketing solar energy systems for residential hot water heating. Recommendation that utilities undertake programs jointly with manufacturers and installers for commercialization of solar energy. Solar energy will only succeed if utilities help market it.

Outline:

I. Study for a Pennsylvania utility was undertaken to investigate possible roles for utilities in marketing solar energy:
    A. Residential study in New England by Arthur D. Little highlighted problems:
        1. Installation crew;
        2. Variable performance of solar collectors.
    B. Methodology of Pennsylvania study was to interview utility personnel, solar collector manufacturers, area bank personnel and members of the Governor's Energy Council;
    C. Assumptions of study:
        1. Primary function of solar energy systems is retrofit;
        2. Prospective purchasers will agree to have electric resistance as backup.

II. Possible utility activities in order of increasing degrees of involvements to screen vendor performance claims and reduce consumer uncertainty:
    A. Sponsor public information programs on solar energy;
    B. Aid in installation:
        1. Conduct installer training programs;
        2. Certify installers;
        3. Make available to public a list of suggested manufacturers and approved installers.
    C. Aid in quality assurance:
        1. Require installer to post performance bond for workmanship as a condition of certification;
        2. Inspect installations and investigate consumer complaints;
        3. See that faulty work is repaired or replaced at no cost to customers.
    D. Participate in advertising with manufacturers and installers;
    E. Homeowner contracts with utilities for installation of solar collector systems;
    F. Joint programs with manufacturers where manufacturer responsible for installation, utilities for marketing;
    G. Utility designed solar energy systems built to utility specifications;
    H. Participate in financing:
        1. Encourage financial institutions to provide loans to homeowners;
        2. Joint programs with banks where area banks provide long-term installment loans and utilities bill customers monthly;

3. Utility financing at competitive interest rates;
4. Customer leasing of solar energy systems from a utility with options to buy.

III. Findings suggest if solar energy is ever to be adopted by many homeowners, utilities will have to help market it:

A. Cost comparisons show nonadopters of solar energy would pay more for hot-water heating if there were a lower off-peak charge;

B. Utilities should be in joint programs with manufacturers and installers because:

1. Solar energy is likely to be profitable;
2. This is a good organizational structure for commercial success;
3. It might keep government from making further incursions into the supply and sale of energy;
4. The use of solar energy at times of peak load could bring savings in capital for added capacity.

Solar Engineering Magazine 4, No. 1 (January 1979): 15.

Summary: Debate over public utility involvement in solar energy is polarized in California. CAL SEIA member poll found 57 out of 73 members preferred limited involvement (publicity and education); eight, no utility involvement; 10, no restrictions on utilities. SEIA Board of Directors passed resolution to encourage utility involvement.

Southern California Gas Company, Los Angeles, California, Project SAGE: Solar Assisted Gas Energy Project, DSE/4691-76/1 (August 1976).

Summary: Report on conditions necessary for solar assisted gas energy water heating for multifamily dwellings to become a viable business activity of a gas utility. Report contains description of the field installations and tests being used to evaluate new versus retrofit installations, market assessment, and evaluation of alternative policies and strategies.

Outline:

I. Background and objectives of project SAGE:
   A. Project SAGE developed out of a multi-disciplinary effort focused on the broad problem of introducing solar energy in the U.S. building industry on a scale which would have a significant impact on the demand for fossil fuels:
      1. Regional character of the building industry led to the focus on southern California;
      2. Residential water heating is a significant consumer of energy in southern California;
      3. Water heating is a fast growing user of energy;
      4. Water heating in apartments was found to be the least expensive application of solar energy and therefore the most likely to achieve commercial use in the near term.
   B. This report is part of the third phase of a four-phase project to determine the conditions necessary for solar assisted gas energy water heating for multifamily dwellings to become a viable business activity of a gas utility:
      1. Phases I and II led to construction of a pilot plant at the California Institute of Technology Jet Propulsion Laboratory, funded by Southern California Gas Company;
      2. Phase III includes:
         a. Field installations and tests to evaluate new versus retrofit installations;
         b. Market assessment of the potential for a SAGE water heating system;
         c. Assessment of possible GASCO business arrangements;
         d. Determination of the requirements for widespread utilization of solar energy using SAGE as a case study;
         e. Evaluation of alternatives and strategies which would contribute to the widespread use of SAGE water heating.
      3. Phase IV would be a trial commercial venture of SAGE water heating.

II. Pilot plant description and thermal performance.

III. System economic analysis:
   A. Retrofit of SAGE system on an existing apartment building was found to be 59 percent more expensive than installation of SAGE system on a new apartment building;
   B. Neither the retrofitted system nor the system installed in the new building could compete with current gas rates;
   C. At current electricity rates, the retrofitted system could compete with electricity if costs were amortized over 20 years at eight percent interest;

D. At current electricity rates, SAGE water heating for new construction could compete with electricity if costs were amortized over 10 years at 15 percent interest;

E. Maintenance costs of the SAGE water heating system were found to be minimal.

IV. Market assessment, use and policy analysis:

A. Market assessment was being conducted by GASCO at the time of the report, including:
   1. Preferred ownership arrangements;
   2. Market plans;
   3. Views of regulatory agencies to that type of venture.

B. Requirements which must be met for industry to use SAGE were developed;

C. Alternative policies and strategies that could be taken by federal and state agencies:
   1. Incentives for consumers:
      a. Property tax deduction;
      b. Income tax deduction;
      c. Income tax credit;
      d. Direct subsidy;
      e. Use and sales tax elimination;
      f. Guaranteed and insured loans;
      g. Availability of mortgage money;
      h. Low interest federal financing;
      i. Guaranteed insurance
      j. Accelerated depreciation;
      k. Investment tax credit.
   2. Incentives for producers:
      a. Tax incentives;
      b. Research and development grants or tax credits;
      c. Architects and builders; technical assistance and compensation for delays.
   3. Market incentives:
      a. Public utility financing of solar energy systems;
      b. Deferral of payment of capital gains tax on profits from technological ventures if the profits were promptly re-invested in solar energy technology operations;
      c. Solar-equipped buildings built under government contract;
      d. Regulatory agencies' rates of return allowed on utility company manufacture and lease of solar energy equipment;
      e. Direct subsidies for:
         (1) R & D and information gathering and dispensing facilities;
         (2) Construction and operation of demonstration pilot plants;
         (3) Capital and operating costs incurred with commercial-scale projects.
      f. Deregulation of domestic fossil fuels.

William A. Thomas et al., Overcoming Legal Uncertainties About Use of Solar Energy Systems (Chicago: American Bar Foundation, 1978).

Summary: Report identifies legal barriers to the use of solar energy systems and suggests appropriate remedies. Four suggested statutes are included. For utilities, the legal problem is establishment of service policies and rate structures that are equitable to the utilities, small and intermittent energy users and traditional utility consumers.

Outline:

I. Legislators can stimulate public acceptance of competitively priced solar energy systems:
   A. Unfortunately, it may be difficult to discuss the merits of different legislative proposals without creating the assumption that something should be done immediately;
   B. Suggested statutes deal with problem of making legislation reasonable by:
      1. Emphasizing necessity of studies;
      2. Defining technical terms carefully;
      3. Encouraging administrative flexibility.

II. An important consideration is how responsibilities and powers should be allocated among various levels of government:
   A. Federal government has a role;
   B. But local and state governments will deal directly with most of the legal issues concerning the use of solar energy.

III. Relevant legal issues for state and local governments:
   A. Regulation of building materials and design;
   B. Financing and marketing arrangements;
   C. Role of public utilities;
   D. Land use planning;
   E. Access to sunlight.

IV. The role of utilities:
   A. Most establish service policies and rate structures that are equitable to the utilities, small and intermittent energy users and traditional utility consumers;
   B. Questions to be answered:
      1. Should the public utilities be encouraged to market solar energy systems?
      2. For tax purposes, should a house or a shopping center with a solar collector be considered a power producer?
      3. Should solar energy cooperatives be formed under present or new utility regulations?
      4. Would several neighbors who install a solar energy system to distribute energy only among themselves be subject to regulation as a public utility?

V. Suggested statutes:
   A. An act to establish a solar energy development commission:
      1. Commission is required to conduct a comprehensive study of ways the state can encourage the use of solar energy systems;

2. Commission's duties include assessment of:
    a. The financial, legal and physical capabilities of every energy utility in the state:
        (1) To use solar energy systems;
        (2) To distribute solar energy.
    b. The feasibility of creating new public utilities that use solar energy systems as a partial or sole source of energy;
    c. The desirability of requiring the public utility commission to:
        (1) Adopt equal rate schedules for auxiliary energy supplied to users of solar energy systems and for other consumers, except where the PUC or a utility shows that capital costs needed to supply the auxiliary energy justify differential rates;
        (2) Adopt rate schedules or other regulations that would favor users of solar energy systems;
        (3) Evaluate development plans for new energy-generating facilities to ensure that proper consideration is given to the use of solar energy systems and to the need for supplying auxiliary energy to solar energy systems within the service area.

B. An act to authorize solar skyspace easements;
C. An act to encourage the use of solar energy systems;
D. An act to provide real property tax and income tax incentives for the use of solar energy.

Thorpe, B. J., General Electric Company, "Economics of Commercial Solar Systems," in The Role of Utility Companies in Solar Energy, Symposium Papers, (Washington, D.C.: Institute of Gas Technology and Gorham International, November 1977), pp. 33-44.

Summary: General Electric estimates that direct sale of solar energy systems could result in lower prices for consumers. GE did evaluations with an unnamed utility showing that even on present electrical systems, a solar-assisted heat pump with day/night metering would be cost-effective now. So, solar energy is competitive now within narrow market segments. Using life-cycle costs, by the mid-1980s, solar energy is expected to offer cost advantages over other alternatives even after the planned expiration of solar tax credits. Passing cost savings in conventional fuels onto solar customers who brought about the savings could improve the economics of solar energy.

TRW Systems Group, Solar Heating and Cooling of Buildings (Phase 0), vol. I, Executive Summary, prepared for The National Science Foundation (May 1974).

Summary: Report summarizes results of a study to establish the technical and economic feasibility of using solar energy for heating and cooling buildings. Report concludes that solar energy will reduce projected fossil fuel consumption in the year 2000 by a very small amount. Conventional systems augmented by solar energy can be designed that would reduce total national energy consumption by one percent by the year 2000, if construction-integrated solar energy collection systems are developed in conjunction with variable pressure ratio heat pumps.

Outline:

I. Conclusions and recommendations:
  A. The solar energy systems market and associated energy savings are highly dependent on solar energy system costs.
    1. TRW will evaluate integrated low-cost solar system designs that require consideration of the entire building as an energy package;
    2. An important part of such systems is a variable pressure ratio heat pump.
  B. To assure timely and successful implementation of solar energy systems, the building industry infrastructure (code agencies, financial institutions, insurance companies, labor and government regulators) must become involved at the very beginning of the effort.

II. Significant study results:
  A. Market capture potential:
    1. Market capture potential for solar hot water and space heating reaches about $1 billion per year by the year 2000, with the majority of the market for new construction;
    2. Hot water-heating systems are substantially more competitive than space-heating systems for all building types and regions;
    3. Solar cooling of buildings is not cost-competitive to any significant extent during this century;
    4. Multifamily low-rise apartments are the most advantageous markets for solar energy systems;
    5. Market capture for single-family residences is lower than for apartments, primarily because of preferential electrical utility rates;
    6. The lowest capture rate is for commercial buildings because of low-heating requirements and low-fuel rates;
    7. Among the four major regions of the country (West, Northeast, South and Central) the South and West regions account for 70 percent of the total new construction market capture for solar energy systems in the year 2000;
    8. The yearly retrofit market represents about 25 to 35 percent of total solar energy system installations between 1980 and 2000;

9. Although the yearly dollar market for solar energy systems is large by the year 2000, the total energy contribution varies only from about .13 to .24 quads (1 quad = 10^{15} Btu per year) depending on the availability of government incentives, abolition of preferential electric utility rates or a solar energy system cost reduction of $2,590;
10. One reason for this low-total-energy capture is that total-installed solar energy system costs generally range from about $13/ft^2 to $20/ft^2, depending on system size and function;
11. In order for the solar energy system market to increase significantly, a much more extensive effort is required to integrate the solar system design with building design, reducing monumental capital costs:
    a. If this were done, a 1.5 quad level of solar heating and cooling of buildings by the year 2000 might be achieved;
    b. This would constitute about four percent of the total building heating and cooling load or about one percent of total national energy requirements in that year.

B. Social and environmental aspects of solar energy development:
1. The public is favorably disposed toward solar energy:
    a. People expect it to be widely used within the next decade;
    b. People feel its successful implementation will require a joint effort of government and industry;
    c. Public optimism on solar energy and willingness to use it is influenced by degree to which they see energy crisis as "real."
2. Level of public knowledgeability on solar energy is significantly greater in cities having active solar energy demonstration and research activities;
3. The amount of energy consumed in producing solar-heating and cooling equipment is modest;
4. Some building code revisions will be required to permit widespread introduction of solar energy systems (e.g., a shift to performance-oriented rather than to prescriptive codes);
5. Quality standards must be established, and approvals and certifications by the appropriate agencies must be obtained to avoid any opposition to solar energy systems by the insurance industry;
6. In determining the maximum mortgage liability a home buyer can assume, the financial community must be educated to consider the operating savings associated with solar energy.

III. Study methodology:

A. Eighteen climatic regions were identified;
B. Five building types were selected;
C. Fourteen cities were selected;
D. Four system functions were defined;
E. Building loads were calculated for hot water, space heating and cooling and dehumidification;

F. Three reference system designs were identified;
G. System operation requirements were determined;
H. Cost analyses and capture potential assessments were conducted;
I. The social, environmental and economic impacts of the use of solar energy systems were determined;
J. Three proof-of-concept experiments were recommended;
K. Phase 1 and 2 development plans were prepared;
L. A utilization plan for implementation and commercialization of solar energy systems was prepared.

IV. Utility company impact:
A. Because the total energy contribution from solar energy systems will be small and gradually implemented, it is unlikely there will be any negative impact on utilities;
B. Contribution of solar energy systems will, at best, result in a slowing of conventional energy supply growth rather than an actual reduction;
C. A possible long-term concern of utilities is the implication for capital of maintaining a standby energy production capability for assuming the solar energy system increment during long periods of inclement weather;
D. For gas companies, use of solar energy would permit expansion of the customer base without increasing the consumption of natural gas.

TRW Systems Group, Solar Heating and Cooling of Buildings (Phase 0), vol. II, Final Report, prepared for the National Science Foundation (May 1974).

Summary: Detailed findings of a study to establish the technical and economic feasibility of using solar energy for heating and cooling buildings. Impact on utility companies considered. Utility company interest in solar energy was high. Rate structure for auxiliary power to solar energy systems cannot be predicted accurately without operating experience. (Only the section on utility company impact is outlined.)

Outline:

I. Introduction:
   A. Solar energy could be a threat or an opportunity to utility companies;
   B. If utilities do not participate in the development of solar energy, they could be faced with higher capital costs and lower sales.

II. Results of discussions held with several utility companies to determine attitudes toward solar energy use:
   A. Interest was high, but the systems are not well enough developed for companies to be specific;
   B. Most utilities are closely following solar developments;
   C. Typically, utilities follow solar developments by assigning a member of the research department to monitor them on a halftime basis;
   D. Utilities are more receptive to solar electric-generating stations than to individual heating and cooling applications;
   E. Utilities are also receptive to solar-assisted heat pump systems;
   F. Gas utilities were more interested than electric utilities.

III. Utility ownership of solar equipment:
   A. A utility company may incorporate solar energy by installing, maintaining and leasing solar equipment to consumers;
   B. In many cases, utilities now own and operate on-site equipment;
   C. When reliable solar hardware becomes available, there is a good possibility that utility companies will provide on-site service to large complexes;
   D. Utilities probably would not be interested in owning equipment on an individual homeowner's property because of:
      1. Lack of control of trees;
      2. Liability in case of leaks;
      3. Mobility of consumers;
      4. Uneconomical to install and maintain small energy sources through a community:
         a. There is no averaging or diversity factor;
         b. There are no economies of scale because of difficulties of transporting low-grade heat over any significant distance.

IV. Auxiliary service for solar energy systems;
  A. Many utilities have special provisions for customers with generating equipment of their own who want backup service:
    1. Provisions compensate utility for capital investment on fixed cost basis, plus fuel and operating costs for energy used;
    2. Provisions fairly allocate costs;
    3. Same policy applied to solar energy equipment would be very expensive.
  B. New policy could be established providing auxiliary power only at off-peak times:
    1. This could even out daily variation in demand;
    2. It could provide incentive to utility to supply auxiliary power at a much reduced rate compared to present standby power.
  C. Rate structure for auxiliary power to solar energy systems cannot be predicted accurately without operating experience:
    1. During initial period, effect on utility system will be small;
    2. Eventual rate will depend on operating characteristic of a particular utility:
      a. If solar-heating systems reduce revenues of summer-peaking utilities without reducing power that must be available to meet peak air-conditioning demands, solar energy systems will increase the real costs of electricity even though saving energy;
      b. If a utility is winter peaking, solar equipment may reduce the cost of electricity.

V. Results of survey on solar water heater industry in three countries suggest public utility companies will play a significant role in success or failure of a solar water-heating industry in the United States.

Richard A. Tybout and George O. G. Lof, "Solar House Heating," Natural Resources Journal 10 (April 1970): 268-326.

Summary: Authors establish optimum designs for solar heating equipment in eight different world climates, then project equipment costs. They conclude that, in regions of the world where fuel costs are high, solar heat costs are usually lower than electric heat and close to costs of heat from conventional fuels.

U.S. Congress, Joint Economic Committee, The Economics of Solar Home Heating (Washington, D.C.: U.S. Government Printing Office, 1977).

Summary: Economic analysis of the role of residential solar water and space heating as an alternative source of energy. Costs of conventional fuels and solar energy are compared state by state. Study concludes that solar energy systems would be feasible if prices of conventional fuels rose. But probability of widespread use of solar energy systems is reduced if interest rates remain high. Policies to speed development of solar systems are suggested.

Outline:

I. Scenario of future decontrolled energy prices for conventional fuels.

II. Cost and performance of solar energy system.

III. Comparison of decontrolled fossil fuel costs to costs of solar alternative by state for 1976/1980, 1985 and 1990:
   - A. Feasibility of solar residential space heating begins in the northern tier of states and moves south through time;
   - B. Solar water heating would be feasible in a mixture of southern and eastern states in the late 1970s and early 1980s;
   - C. By 1990, solar space heating and/or water heating would be feasible in all but six states.

IV. National energy savings by 1990 estimated for single-family's dwellings under decontrolled prices scenario:
   - A. For water heating of all residences, solar use could reduce fossil fuel demand by 4 percent;
   - B. For space heating of new construction, solar use could reduce fossil fuel demand by 1.5 percent if insulation were improved.

V. Feasibility with curtailments and price controls assessed compared to electric heat:
   - A. Solar heat is already competitive with electric heat pump electricity in 24 states;
   - B. Solar heat is competitive with electric resistance heat in 27 states;
   - C. If natural gas use were curtailed, solar water heating would be feasible in every state but Washington;
   - D. Retrofitting of solar space heating may not be as infeasible as has been assumed.

VI. Need a "federally coordinated program to facilitate the transition from non-renewable to renewable energy resources," within the context of national energy policy:
   - A. The policy least distorting to the market is decontrol of energy prices;
   - B. If prices remain controlled, solar energy must be encouraged through:
     1. Subsidies;
     2. Low-interest loans;
     3. Graduated mortgages; and
     4. Property tax incentives (a dozen states now have such incentives).

U.S. Department of Energy, Analysis of Policy Options for Accelerating Commercialization of Solar Heating and Cooling Systems (Washington, D.C., 1978).

Summary: Detailed analysis and evaluation of options for incentives for solar energy. Report is based on eight research projects carried out for ERDA. Chapter on interface of public utilities and solar energy reviews, assesses and critiques existing research and ongoing activity and determines potential impact of policy options.

Outline:

I. Economic and financial incentives

II. Solar energy/public utility interface

- A. Objectives:
  1. Identify and assess the range of technology options that are commercially feasible;
  2. Identify current trends in the solar energy market;
  3. Identify problem areas;
  4. Determine range of impact of policy options.
- B. Methods of evaluating solar building performance:
  1. Variety in methods of evaluating performance of solar space conditioning systems stems from differences in degree of emphasis given to utility considerations;
  2. Booz, Allen & Hamilton report (1976) sees solar energy systems affecting utilities in two ways:
     - a. Decreased utility revenues;
     - b. Impacts on generating capacity.
  3. Report by the National Conference of State Legislatures sees impact of solar energy systems on utilities as:
     - a. Reduction in net sales;
     - b. Possible reduction in load factor.
  4. Paper by Gleser and Platte recommends developing solar energy systems that have been optimized to meet both consumer and utility needs;
  5. Impacts on the following sectors have inherent diseconomies:
     - a. For building owners, cost of a two-component system (solar plus auxiliary);
     - b. For utility companies, having to provide peak-period capacity constantly to cover occasional auxiliary load;
     - c. For the United States, added costs of second space-conditioning system could constrict the building industry.
- C. Review and summary of 21 studies on the interface between solar energy and utilities:
  1. Solar Assisted Gas Energy (SAGE) experiment on domestic hot water heating;
  2. Feldman and Anderson investigation of relationship between solar space-conditioning design and the load curves of electric utilities (see #13 in this review);
  3. Lorsch investigation of impact of solar energy on the Philadelphia Electric Company and the Pennsylvania Power and Light Company (see #30 in this review);

4. Converse study monitoring and simulating the performance of solar space-conditioning systems;
5. Llavira investigation of impact of solar cooling and hot water heating on the Puerto Rico Water Resources Authority;
6. Department of Natural Resources Commonwealth of Puerto Rico, demonstration of solar space cooling in a factory;
7. ERDA, EPRI and Potomac Electric Power Company experimental residential design;
8. Committee on Nuclear and Alternative Energy Systems of National Academy of Sciences study on interrelationship among energy conservation, nuclear and alternate energy systems through the year 2010.
9. EPRI studies:
    a. Summary of solar energy activity involving electric utilities;
    b. Public Service Company of New Mexico and Long Island Lighting Company study on solar building impacts on electric utilities;
    c. Study to examine impacts on the electric utility industry of energy conservation and solar heating and cooling on a national scale;
    d. Program leading to the demonstration of utility-preferred solar-heating and cooling systems for commercial buildings in five to 10 geographical regions of the U.S.;
    e. New Bedford Gas and Edison Light Company study to compare and determine incremental value of:
        1. Energy conservation in design;
        2. Load management using storage of off-peak electric power.
    f. Study on methods of improving heat pumps;
    g. Study to develop test center for EPRI solar program.
10. Southern California Gas Company, ERDA and Mission Viejo Company "minimum energy dwellings";
11. New England Electric System project to install 100 residential solar water-heating systems;
12. Glaser and Platte investigation of economic impact of a model residential solar energy system on a growing electric utility;
13. Peterson paper examining ramifications of various regulatory scenarios upon allocation of resources for energy production between solar space-conditioning systems and conventional electric generation;
14. Westinghouse examination and demonstration of potential for optimal use of off-peak power.

D. Utility pricing and the feasibility of solar energy systems:
    1. Utility load control techniques in addition to pricing:
        a. Indirect control with rate incentives and consumer education to shift consumer demand away from system peak;
        b. Direct control by utilities offering interruptible service at reduced rates to:

        (1) Industrial customers;
        (2) Residential customers using water heaters equipped with time or radio-controlled switches.
  2. Utility costs and efficiencies of current rate schemes for recovering these costs:
     a. Declining block rate (or average cost rate) schedule;
     b. Energy/demand rate (or Hopkinson rate) schedule.
  3. Impact of solar space conditioning on utility loads:
     a. Studies of impacts of solar-heating and cooling systems on electric utility load factors have produced conflicting results;
     b. Blanket assumptions of impacts are unwarranted.
  4. Relative impact of rate schedule on solar and conventional customers:
     a. Under average cost rates, a solar building is being subsidized by other electric consumers (because it uses more peak energy);
     b. Under the Hopkinson rate tariff, the solar user may be penalized because the tariff is tied to the individual's peak whether or not it coincides with the system's peak;
     c. Marginal cost pricing makes solar energy more expensive:
        (1) Conventional user consumes more electricity than the solar energy user;
        (2) Thus, the conventional user stands to save more money using off-peak power than does the solar energy user.
     d. Interruptible rate schedule might alleviate the capacity problem for the utility and allow the user to establish a trade-off between his reduced rate and his level of discomfort;
     e. Consumer might provide his own back-up.

E. Market penetration:
  1. Studies of market penetration of solar-heating and cooling systems have failed to consider sufficiently the role of public utilities;
  2. Utility's role in determining SHAC system market penetration:
     a. Utility rate schedules are one form of indirect load management being investigated;
     b. Ownership and promotion of SHAC systems by utilities could be an effective form of load management;
     c. Utilities must consider a number of energy sources and storage options that might compete with solar energy.
  3. Issues in assessing impact of different rate schedules on solar buildings:
     a. Degree to which solar energy can be competitive with gas or electricity depends on the applicable rate schedule;
     b. Cost to society.

(1) Average cost pricing encourages the least efficient use of resources;
(2) Time-of-day pricing allows for a more efficient use of resources.

c. "Fairness" of rates:
(1) Analysis has shown solar buildings are subsidized by electric utilities;
(2) More economically efficient solar buildings would be built if less discriminatory rates were employed.

4. Scenario for the timing of solar building impact on utilities;
5. Implications of utility ownership of solar-heating and cooling systems:
    a. Alternative ownership policies (all of which have precedents):
        (1) Exclusive monopoly franchises to provide solar heating and cooling;
        (2) Deny utilities a monopoly on solar energy systems but permit them to enter the solar energy business as part of their regulated public utility activities;
        (3) Utility solar energy activities provided by a separate unregulated utility affiliate;
        (4) Prohibit utilities from owning on-site solar energy systems or the energy derived from them.
    b. Arguments against solar energy systems ownership by utilities:
        (1) Lack of evidence that SHAC systems represent a natural monopoly;
        (2) Potential for regulated utilities to use solar technology to recapture some of the monopoly profits that regulation takes away;
        (3) Problem of determining the responsible party when solar equipment causes building damage or increased maintenance costs;
        (4) Antitrust;
        (5) Administrative and legal costs associated with attempts to include solar costs in the rate base.
    c. Arguments for solar energy system ownership by utilities:
        (1) Such a policy might ensure use of solar-heating and cooling systems as a tool in electric utility load management programs;
        (2) Pure competition in the solar industry may be undesirable:
            (a) Instability of prices and supply;
            (b) Product quality.
    d. Other factors related to solar energy system ownership:
        (1) Necessary interconnectedness of solar energy system and auxiliary source;
        (2) Increased government regulation;
        (3) Impossibility of assessing utility ownership of solar-heating and cooling systems until marginal cost pricing is instituted;

(4) Increasing marginal cost of conventional energy supply.

e. Examination of implications of various ownership alternatives suggests that best solution may be unregulated competitive ownership of solar-heating and cooling systems by utilities.

F. Utility manager perceptions and consumer attitudes

G. Analysis of options within the solar utility interface

III. Legal and regulatory issues:

A. Solar access;

B. Antitrust issues;

C. Property tax law;

D. Mortgage law;

E. Labor law;

F. Mobile homes;

G. Mandatory installation;

H. Utility law.

1. Law on rate and service discrimination:

a. In general, state utility commission cases and decisions suggest utilities have substantial freedom to treat different classes of customers differently:

(1) A discriminatory practice is more likely to be found reasonable if it produces indirect benefits to all customers;

(2) Utilities may treat different classes of customers in different ways if there is a reasonable basis for distinguishing them.

b. Federal antitrust laws may also outlaw rates on services that single out owners of solar energy systems for special treatment;

c. There may be constitutional restraint on the ability of a utility to discriminate for or against solar energy systems.

2. Service discrimination:

a. A utility <u>may not</u> refuse to provide backup electricity for structures with solar-heating or cooling systems unless it can demonstrate a compelling case that backup service would cause substantial harm to the utility's existing customers;

b. A gas company <u>may</u> refuse to provide gas connections to new residences that <u>do not</u> install solar heating and cooling equipment.

3. Rate discrimination:

a. Declining block rate discriminates against solar energy system users;

b. If all-electric rate were denied to solar energy system users, it could lead to costs of service higher than expected;

c. Demand/energy rate could hurt solar users, as was brought out in Colorado PUC hearings;

d. Solar advocates in Colorado PUC case supported time-of-day pricing;

e. Lifeline rates may benefit solar users whose needs for supplemental energy are small enough;
f. Interruptible service may also benefit solar systems.

4. PUC jurisdiction over multiuser solar energy systems:
   a. This will depend on interpretation of commission statutes;
   b. Consequences of PUC jurisdiction:
      (1) Most significant burden PUC jurisdiction would place on shared solar energy systems would be the duty to apply for certificates of public convenience and necessity;
      (2) If a shared solar system is found to be a public utility it must:
         (a) File reports and accounts;
         (b) Serve all customers who demand service within a given area;
         (c) Submit its rate schedules to the PUC for approval;
         (d) Continue providing service until given permission to discontinue;
         (e) Provide safe and adequate service;
         (f) Comply with limitations on the issuance of securities.
5. Direct involvement of utilities in the solar energy business:
   a. Federal antitrust laws and state policies prohibiting anticompetitive practices would probably prohibit exclusive marketing rights for utilities.
   b. More likely that utilities will be allowed to compete with other distributors:
      (1) A utility is likely to view a regulated mode as desirable because of the opportunities for cost sharing and risk spreading;
      (2) Regulation would also offer the opportunity for manipulation of expenses, say utility critics;
      (3) Competitors of a utility in the solar business would challenge PUC jurisdiction, hoping to prevent the utility from obtaining the advantages associated with a regulated rate of return.
6. Restriction of utility participation in the solar market:
   a. There is no legal basis for PUC jurisdiction unless the activity affects a utility's regulated business;
   b. But a sufficient nexus between solar energy and other energy services may exist to justify jurisdiction if a PUC chose to exercise it.
7. Utilities might undertake to act as financiers or insurers:
   a. This is likely to be an undesirable role for the utility because the utility must assume all risks, but without the benefit of financial profit from inclusion of solar expenses in its rate base;
   b. But a PUC might force a utility to finance public purchase of solar collectors.

IV. The time is ripe for legislative and administrative action on regulatory policies.
V. ERDA patent policy.
VI. Building codes, standards and warranties.
VII. Marketing, manpower, consumer and environmental issues.
VIII. Regional aspects of incentives program.

Creating Energy Choices for the Future vols. 1 and 2, U.S. Energy Research and Development Administration, Bulletin no. 76-1 (Washington, D.C., June 1976).

Summary: National plan summarizing ERDA's current views on energy technologies needed for the United States to achieve long-term energy independence. Says the "principal barrier to successful commercialization of solar systems is their lack of competitiveness with available conventional systems and fuels." Other barriers are (1) home or building buyers prefer lower initial costs; (2) a strong reluctance by builders, developers, lending institutions and other major components of the construction industry "to accept the risk of introducing a new technology to an already high risk industry." The overall strategy in solar research, development and demonstration "is to lower costs and improve reliability to the point where natural economic forces will achieve expeditious commercialization."

U.S. Energy Research and Development Administration, Division of Solar Energy, Solar Energy in America's Future 2nd edition, DSE-115-2, (March 1977)

Summary: Report documents Stanford Research Institute study of potential roles that solar energy could have for meeting U.S. energy needs over the next 45 years. Says much more research is needed on utility rate structures "to focus on the regional nature of load patterns and generation system characteristics." Present rate structures can encourage electric utilities to work against solar energy.

Outline:

I. Methodology:
   A. Computer simulations of different energy supply projections were developed by varying the input parameters of energy demand and energy costs;
   B. Three of the projections were developed into broad scenarios for solar energy;
   C. Implementation measures needed to realize the scenarios were delineated;
   D. Economic, socioeconomic, sociopolitical and environmental issues associated with different energy futures were identified and compared with the scenarios.

II. Implementation problems if solar energy is emphasized:
   A. Reduction of the cost gap is the most critical implementation measure;
   B. Redesign of utility rate structures is an option that appears to offer important benefits but has not yet been carefully explored.

III. Possible results of use of solar energy systems for utilities:
   A. If a utility has its peak load during the summer to meet air conditioning demand and if solar energy systems contribute most during the winter to meet heating demand, then the use of solar energy will cause the utility to generate and sell a larger percentage of electricity during peak periods:
      1. Electricity generated during peak-load periods is as much as eight times as expensive to produce as baseload electricity;
      2. Present rate structures do not reflect the difference in cost between baseload and peak load;
      3. Thus, the widespread use of solar energy in this example would result in:
         a. A loss of profit to the utility;
         b. Hearings for utility rate increases.
   B. High market penetration of solar energy systems could complicate or reverse the situation:
      1. Solar energy systems might become so common the peak load for a utility might be shifted from summer to cloudy, cold winter days;
      2. In this case, the auxiliary heating requirements of the solar-heating systems would be the cause of the peak load and could justifiably be exposed to the peak-load price;

3. Thus, peakload pricing has different impacts depending on the level of market penetration of solar energy systems:
   a. At modest levels of solar penetration, peak-load pricing would help solar penetration by holding down winter rates;
   b. At a high level of solar penetration, peak-load pricing could reduce solar use.

C. Solar energy systems could benefit gas and electric utilities through the load-leveling opportunities created by the inherent storage capacity of most solar energy systems:
   1. These storage systems can store thermal energy during nighttime, off-peak periods;
   2. Thus, solar-heating systems would not necessarily aggravate the peak of even a winter-peaking utility, provided that these individual systems were appropriately integrated into the utility system to permit systemwide control of storage heating.

U.S. Federal Energy Administration Project Independence, <u>Project Independence Blueprint Final Task Force Report, Solar Energy</u>. Prepared under the direction of the National Science Foundation (November 1974).

Summary: Report contains the final technical analysis of the Project Independence Interagency Solar Task Force chaired by the National Science Foundation. The task force was formed in April 1974 to provide estimates of potential production capabilities of the solar industry and resources necessary to achieve these levels of production. The task force considered two alternative strategies for six solar energy technologies, including heating and cooling of buildings. The first assumed continuation of existing policies. The second assumed changes in policies or practices that would permit an expansion of potential production. The report concludes that economically viable solar energy conversion systems can be developed and installed in substantial numbers well before the year 2000 to provide significant quantities of energy and power for the United States.

Outline:

I. Objective of program for solar heating and cooling of buildings is to establish a technological base for widespread use of solar energy to heat and cool all kinds of buildings throughout the United States.

II. Magnitude of solar contribution will depend on:
   1. Amount, type and location of new building construction;
   2. Competition offered by conventional fuels.

III. Calculations of variables related to market penetration, using A.D. Little study, show annual demand for 44,470 solar energy units by 1990 with no policy changes and by 1985 with policy to accelerate solar development.

IV. Summary of estimates of solar energy utilization in Btu x 10^{12} per year:

	1985	1990
Arthur D. Little		
Business as usual, Oil $4/bbl	90	181
Oil $11/bbl	280	550
Accelerated, Oil $4/bbl	180	610
Oil $11/bbl	550	1,490
General Electric		
Market penetration (new construction)	80	190
Westinghouse		
Capture potential	28	41
Maximum possible		128
TRW Systems Group		
Low		406
Medium		2,030
High		4,060
Heating requirements of new construction since 1974	14,839	21,703
Capture potential of solar-heating and cooling systems since 1974	8,409	12,703

V. Data sheets giving minimum acceptable supply price, accumulated capital investment, maximum annual production of solar energy, accumulated manpower and accumulated materials required for years 1980, 1985 and 1990.

VI. Policy measures required to supplement research and development:
   A. Federal:
      1. Installation of units on government buildings;
      2. Combination of tax, loan and depreciation policies.
   B. State and local:
      1. Tax concessions;
      2. Zoning ordinances;
      3. Building codes;
      4. Inspection practices;
      5. Sun rights.

VII. Major constraints to achieving utilization goals:
   A. Resource requirements (not an important constraint);
   B. Technology transfer;
   C. Reduction of first costs through system cost reduction and encouragement of mass production and widespread distribution;
   D. Building and safety codes;
   E. Sun rights;
   F. Regulatory agencies' preparation for advent of solar power;
   G. Participants in housing construction.

VIII. Incentives to consumers for solar energy systems:
   A. Households:
      1. Direct assistance:
         a. Income tax deduction;
         b. Income tax credit;
         c. Direct subsidy.
      2. Availability of mortgage money;
      3. Guaranteed and insured loans;
      4. Low-interest federal financing;
      5. Federal requirements for energy demand reductions via solar energy;
      6. Direct federal insurance or reinsurance of private insurance company policies.
   B. Commercial buildings:
      1. Investment tax credit;
      2. Accelerated depreciation.
   C. Institutional buildings: use of direct construction grant programs;
   D. Government buildings: require solar equipment.

IX. Incentives for producers of solar energy:
   A. Architects and builders:
      1. Technical assistance;
      2. Compensation for delays.
   B. Manufacturers:
      1. Tax incentives;
      2. Government expenditures for research and development;
      3. Tax credit for research and development expenditures.

X. Incentives for utilities:
   A. Making stockholders' utility bonds income tax free;
   B. Utility financing of consumer purchase of solar-heating and cooling units;
   C. Tax incentives:
      1. Accelerated depreciation;
      2. Modifications in capital gains tax.

XI. Incentives involving regulatory agencies:
   A. Regulatory agencies can influence solar energy development through powers to:
      1. Issue certificates allowing utility companies to operate;
      2. Determine economic and accounting systems that encourage or discourage investments;
      3. Develop technical performance standards;
      4. Enforce regulations.
   B. Example of an incentive involving a regulatory agency is proposed FPC experiment to compare advantages of such strategies as having utilities own solar equipment and renting the equipment to homeowners or commercial customers.

XII. Direct subsidies to solar energy industry:
   A. Research and development;
   B. Construction and operation of demonstration -- pilot plants;
   C. Capital and operating costs involved in commercial scale development.

U.S. Federal Trade Commission, Bureau of Competition, The Solar Market: Proceedings of the Symposium on Competition in the Solar Energy Industry (Washington, D.C.: Government Printing Office, 1978).

Summary: Symposium to examine competitive aspects of the developing solar energy industry: (1) solar energy standards and their development; (2) oil company involvement in the solar industry; (3) impact of federal grants on the development of the industry; (4) marketing of solar energy. Description of solar activities of federal agencies. Aim of the symposium was "to ensure that competition policy toward solar energy will evolve in an informed and timely manner."

Outline:

I. Opening remarks by FTC Chairman Michael Pertschuk and Henry Marvin, Director, Division of Solar Technology, Department of Energy.

II. Competition, consumers and standards:
   - A. Review of standards being developed by solar industry for solar equipment and installations (Sheldon H. Butt, President, Solar Energy Industries Association);
   - B. Review of antitrust law applicable to setting and enforcing product standards. (Joel E. Hoffman, Wald, Harkroden & Ross);
   - C. Effect on consumers of development of solar standards (Susannah Lawrence, Consumer Action Now).

III. Oil company involvement in the developing solar industry:
   - A. Oil companies should not be barred from involvement in the solar energy industry (Thomas E. Damper, University of Michigan);
   - B. Solar industry should be watched for departures from competition since immaturity of industry makes it vulnerable (Richard L. Schmalensee, Associate Professor of Applied Economics, MIT);
   - C. Government R & D administrators should be aware of the hazards that might result if the solar industry were to be largely populated by firms having the same interests (Lionel Kestenbaum, Bergson, Borkland, Margolis & Adler);
   - D. Issue of competition is peripheral to central task "of creating and installing technologies that would constitute a low-cost, ecologically beneficient and inexhaustible energy system" (Robert A. Solo, Professor of Economics, Michigan State University).

IV. The solar market: utilities and small business:
   - A. Problem for public utilities and their regulations is not to block or retard, intentionally or inadvertently, the adoption of cost effective solar technologies (Rober Noll, California Institute of Technology);
   - B. Determination of an appropriate rate for electric utility companies in the solar energy industry involves a possible conflict between energy and antitrust policies (Howard P. Kitt, Charles H. Frazier and Irwin M. Stelzer, National Economic Research Associates, Inc.);

C. Solar energy sources can fill one-fourth of the expected 10 percent energy shortage expected by 1985 (Barry Commoner)*;

D. Solar energy development involves legal considerations applicable to small business, large, nonutility business, utilities and funding and spending agencies (Donald N. Zillman, Arizona State University);

E. Questions of competition, subsidies, ownership and prices are involved in integrating solar energy with electric utilities. (Ernst R. Habicht, Director, Environmental Defense Fund Energy Program)*;

F. Remarks by George O. G. Lof*, Alfred E. Kahn, Jerry D. Geist.

V. Government involvement in solar energy: remarks by representatives of Department of Energy, Department of Housing and Urban Development, National Bureau of Standards, Small Business Administration, Office of Technology Assessment of the U.S. Congress.

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* Separate summaries and outlines under, 6. Commoner (1978), 19. Habicht (1977), 63. Zillman (1977).

Westinghouse Electric Corporation, Solar Heating and Cooling of Buildings (Phase 0), Final Report, Executive Summary, prepared for the National Science Foundation (May 1974).

Summary: Report summarizes results of a comprehensive analysis of technical, economic, social, environmental and institutional factors affecting the feasibility of using solar energy for the heating and cooling of buildings. Report concludes solar-heating and cooling systems could become competitive in most regions of the country in the 1985-1990 period. Of seven population groups surveyed on solar energy systems, energy suppliers were the least enthusiastic about proposed solar models and the benefits of currently feasible solar energy systems in general. Regulatory encouragement to utilities is among the areas listed for federal and state action to accelerate solar energy use.

Outline:

I. Introduction:
   A. More than 25 percent of total energy used in the United States is for heating and cooling of buildings and providing hot water;
   B. This study is initial phase (Phase 0) of three-phase program planned by the National Science Foundation (Phase 1: design of systems; Phase 2: construction, test and evaluation of systems);
   C. Study covers factors affecting and determining eventual commercial viability of using solar energy for heating and cooling of buildings:
      1. Technical;
      2. Economic;
      3. Social and environmental;
      4. Institutional.
   D. Since residential heating and air-conditioning systems are considered to have a useful life of 15 years, solar and conventional systems in this study were analyzed on a 15-year life-cycle-cost basis;
   E. If solar development is left to the free market, solar energy systems will become competitive with conventional heating and cooling when the equipment operation, maintenance and fuel costs of the one are similar to those of the other over their projected useful life;
      1. This will happen about 1985;
      2. General acceptance and widespread use will follow in two to three decades.
   F. A broad effort in RD&D will be needed to shorten the timespan needed to achieve widespread use.

II. Principal findings:
   A. Principal potential market in the United States for solar energy systems can be divided into five regions by differences in climatic conditions:
      1. Northeast;
      2. Southeast;
      3. Gulf coast;

4. Great Lakes;
5. West.

B. Residential and commercial buildings comprise the major demand.

C. Market needs:
1. Solar heating only;
2. Solar-assisted heat pump;
3. Solar heating and cooling.

D. Economic considerations:
1. None of the above solar energy systems is now competitive with oil or gas systems on a significant scale;
2. Solar-heating systems first became competitive in California in the 1975-1980 period;
3. By 1980, solar heating will be competitive in several regions, primarily for commercial and institutional structures;
4. There can be a renewal of a market for solar energy systems for hot water only in appropriate regions of the country;
5. Solar heating and cooling can become competitive in most regions by 1985-1990;
6. Further reductions in collector costs are necessary if solar energy is to capture a large market;
7. On the average, it will cost several thousand dollars more to equip a single-family residence with a solar energy system than with a conventional system;
8. Retrofitting a single-family residence is not likely to become economically feasible on a signficant scale;
9. Retrofitting solar energy systems on larger buildings is approaching economic feasibility on a life-cycle basis;
10. There is a gap between the near-term costs for solar energy systems and the additional costs consumers would be willing to pay;
11. Government incentives related to financing, regulating and controlling the construction of buildings will be required to encourage commercial exploitation during the initial period of marginal benefits to industry and users.

E. Social and environmental considerations:
1. Seven population groups were surveyed on solar energy:
   a. They were architects, builders, labor, manufacturers, energy suppliers, financiers and potential consumers;
   b. Results indicated broad spectrum of reaction from interest to skepticism;
   c. Enthusiasm for solar heating and cooling drops off rapidly as the system becomes more expensive;
2. Of the seven groups canvassed, energy suppliers were the least enthusiastic about the proposed solar models and the benefits of currently feasible solar energy systems in general;
3. The objections of the energy suppliers centered on:
   a. High cost;
   b. Technical complexity;
   c. Constantly fluctuating demand on their services;
   d. General skepticism on consumer acceptance.

F. Institutional considerations:
   1. Existing building and safety codes do not appear to require major changes;
   2. Existing channels of marketing, distribution and servicing can be adapted to the requirements of solar designs;
   3. Involvement and action by land use and zoning planners in local governments will be necessary to establish the precedents on zoning and protection of sunlight that will stimulate utilization;
   4. Nonresidential building contractors have the necessary technical resources to install and service solar energy systems;
   5. Residential building contractors will require more support;
   6. Federal, state and local government programs, including regulatory encouragement to utilities, will be needed to stimulate investment in solar energy;
   7. Adoption by financial institutions of eligibility standards and feasibility evaluation methods that recognize life-cycle-operating-cost benefits are important to make available financing in spite of higher initial costs.

III. Recommendation: an experiment should be directed to application of solar energy to heating and cooling of a large building in the Southeast.

Westinghouse Electric Corporation, Solar Heating and Cooling of Buildings (Phase 0). Final Report, vol. I. prepared for the National Science Foundation (May 1974). (NSF RA-N-74-023B) and vol. II. (Appendices - NSF RA-N-74-023C)

Summary: Comprehensive analysis of technical, economic, social, environmental and institutional factors affecting feasibility of using solar energy for heating and cooling buildings. Amount of fossil fuel that can be saved by using solar energy will build slowly to a possible 50-million barrels a year by 1990. In the next century, sales of solar energy systems could reach $10 billion. Seven population groups were surveyed on solar energy. Among energy suppliers, 45 percent thought solar energy was a reasonable energy source in the next 10 years.

Outline:

I. Social and environmental study:
  A. Surveys of architects, builders, labor, manufacturers, energy suppliers, financiers and potential consumers were conducted to delineate constraints on solar energy systems:
    1. Results indicate costs of residential solar-heating and cooling units should be held to a maximum of $5,000 more than conventional systems;
    2. Solar heating and cooling systems could require maintenance as often as every six months and repairs as often as once a year and still be acceptable.
  B. Results of survey of energy suppliers:
    1. Respondent profile:
      a. Sixty respondents from 44 states;
      b. Sixty percent electric power suppliers, 40 percent natural gas;
    2. Selling and installing of heating and/or air-conditioning units was reported by only a small percentage of the companies as part of their normal services;
    3. Twelve percent felt solar energy was a reasonable alternative energy source in the next five years; 45 percent in the next 10 years;
    4. Many respondents felt energy crisis would accelerate conversion to solar heating and cooling;
    5. Factors most often cited as leading to acceptance of solar-heating and cooling systems:
      a. Need to eliminate dependence on fossil fuels;
      b. Environmental acceptability of solar energy.
    6. Factors cited most often as leading to rejection of solar-heating and cooling systems:
      a. Lack of dependability during extended periods of bad weather;
      b. Size of system;
      c. Possibility of frequent maintenance and repair.
    7. Necessary conditions:
      a. Insulation was not viewed as a problem;
      b. Increased skilled labor, increased space for heating

equipment and increased space for insulation were "slightly unacceptable" factors.

8. Specified costs for solar heating and cooling were consistently rated more acceptable for new homes than existing ones;
9. Forty-three percent respondents felt reductions of 31 to 50 percent on fuel costs were necessary to make solar heating and cooling attractive to the public.

C. Follow-up survey of energy suppliers was conducted on acceptability of a proposed solar-heating and cooling system:
   1. Energy suppliers were least enthusiastic of four groups surveyed;
   2. Objections of suppliers:
      a. Cost;
      b. Collectors too big, ugly, heavy;
      c. Difficulty of predicting and planning for an area's energy needs.
   3. Suppliers did not feel they would be hurt severely beyond a reduction in growth;
   4. Issues that energy suppliers said could affect solar unit design (by frequency):
      a. Availability of replacement parts;
      b. Size of units;
      c. Effects on appearance of homes;
      e. Maintenance training;
      f. Building code compliance;
      g. On-site standby for system failures;
      h. Need to place smaller load on electric power system;
      i. Compatibility with utilities' growth planning;
      j. Total cost of solar and conventional units.
   5. Energy suppliers foresaw need for minimum or demand rate for solar users for backup power;
   6. Suggestions for ways of handling demand rates:
      a. Individual contracts with fuel companies maintaining standby supplies;
      b. A "commitment charge" for homeowners similar to a bank line of credit;
      c. Assessment of a minimum monthly rate;
      d. If suppliers had reduced capacity because of widespread solar energy use, calls on supplies from another source ("interruptible loads").

II. Federal, state and local government policies and incentives are part of study's "preliminary utilization plan" for solar energy:
   A. Barriers listed would be present for any innovation in the construction industry;
   B. Period of precommercialization will require general recommendations on regulatory policy.

John H. Williams, Insights West, Inc., "Solar Energy and the Gas Utility" (Paper prepared for the American Gas Association, February 1977).

Summary: Benefits and risks of involvement of gas utilities in commercialization of solar energy. Concludes that solar heating could be a profitable business for a gas utility.

Outline:

I. Considerations relating to participation of gas utilities in marketing thermal solar energy systems:
   A. Why gas utilities are well positioned to be innovators in solar energy;
   B. Factors making this a good time for marketing solar energy;
   C. List of risks:
      1. Economic;
      2. Regulatory and legal.
   D. Examples of actions now being taken in U.S. communities;
   E. Alternate business configurations for utility entry into the solar energy business;
   F. Potential government incentives to consumers trying solar energy.

II. Solar energy compared to other fuels:
   A. Used American Gas Association computer program to evaluate life-cycle costs;
   B. At cost of $8 to $14 per square foot (achievable by 1980-1982), attractive returns and acceptable payback times (two to eight years) shown;
   C. Problems with economic evaluation:
      1. Changing designs;
      2. Unknown life spans.

Marvin M. Yarosh, Keith D. Beaty, and Rajesh Talwar, "The Florida Solar Energy Industry," Proceedings of the 1977 Annual Meeting, the American Section of the International Solar Energy Society, Orlando, Fla., (June 1977).

Summary: Report on study in mid-1976 to identify solar energy products being manufactured and distributed in Florida and availability of technological and design services in solar energy. Found that demand for solar energy equipment seemed insufficient to sustain the number of companies in the field. Improved understanding is needed by potential purchasers of solar energy systems as to limitations of the equipment.

Donald N. Zillman, "Solar Energy, Public Utilities and the Competitive Economy," in The Solar Market: Proceedings of the Symposium on Competition in the Solar Energy Industry, U.S. Federal Trade Commission, Bureau of Competition (Washington, D.C.: U.S. Government Printing Office, 1977) pp. 214-28.

Summary: Antitrust consequences of public utility involvement in development of solar energy. Concludes that cautious study and restraint are the best policies right now. Overprotection of small business could nurture inefficiency, and threats of antitrust action against utilities could deter development of solar energy.

Outline:

I. Review of major antitrust statutes as they apply to regulated utilities.

II. Competitive consequences of alternative patterns of development of solar energy:

- A. No involvement of utilities in marketing:
  1. Reaction of utilities depends on effect of solar business on utility peak-load requirements;
  2. Problem for state public utility commissions is to try to place exact costs on different users.
- B. Participation of utilities in supplying solar hardware for heating and cooling systems:
  1. Possible areas for utility participation include production, installation, maintenance and financing;
  2. Lively competition is likely because of:
     - a. lack of economies of scale;
     - b. desire for maintenance and replacement guarantees by a reputable business;
  3. Needed prior to utility entry into solar business:
     - a. study of consumer preferences, costs, regulatory reaction;
     - b. preparation to counteract possible publicity campaigns by environmental or consumer groups fearful of utility efforts to "monopolize the sun;"
  4. Whatever the utilities' approach to the solar hardware business, regulatory agencies can find a jurisdictional basis;
  5. Potential competitive consequences:
     - a. Utility company order to a manufacturer might eliminate competitors;
     - b. If all equipment costs can be added to the rate base, high technology solutions might be chosen instead of economically efficient ones and less sophisticated equipment squeezed out of market;
     - c. Utility effort to get customers to use only solar equipment provided by the utility;
     - d. Utility attempt to persuade regulatory commissions it requires a monopoly over solar devices in an area;
     - e. Utility attempts at discriminatory pricing or subsidization.

6. Programs allowing eventual owner purchase of rental solar equipment could deflate fears of utility company takeover of solar energy.

III. Solar electric generation may be the most significant use of solar energy in the long run:
   A. Generation could take place through:
      1. Central station;
      2. Single structure or neighborhood installations.
   B. "Backyard" electric generation raises regulatory questions:
      1. Backup power;
      2. Residence owners trying to sell surplus power;
      3. Loss of validity of "natural monopoly" theory leading to question of whether utilities should be allowed to retain their exclusive franchises.

IV. Cautious study and restraint is the best policy right now:
   A. Overprotection of small business might nurture inefficient producers;
   B. Irrational threats of antitrust action against utilities could deter solar development.

Donald N. Zillman, and Raymond Deeny, "Legal Aspects of Solar Energy Development," Arizona State University Law Journal (1976): 25-58.

Summary: Examination of legal issues related to use of sun as energy source. Survey of current government activity in development of solar energy. Concludes that legal problems can be solved more easily than economic ones.

Outline:

I. Solar energy has potential for heating and cooling buildings, electrical generation and specialized uses.

II. Plans for widespread solar energy use will have to contend with pre-existing property law:
   - A. Common law doctrines:
     1. Easements;
     2. Restrictive covenants;
     3. Nuisance.
   - B. Public law doctrines:
     1. Building codes;
     2. Zoning.

III. Since 1973, local, state and federal laws specifically dealing with solar energy have been passed:
   - A. Review of federal legislation:
     1. NSF and NSF-NASA research;
     2. Solar Heating and Cooling Demonstration Act of 1974;
     3. Energy Reorganization Act of 1974;
     4. Solar Energy Research, Development and Demonstration Act of 1974;
     5. Federal Non-nuclear Energy Research and Development Act of 1974;
     6. Since 1974, the federal government has cut back its commitment to solar energy.
   - B. Review of state legislation:
     1. Detailed review of Arizona legislation;
     2. Legislation in other states that has focused on tax incentives, creation of state agencies to handle solar energy matters and land use.
   - C. Review of local action:
     1. Santa Clara, California: NSF study;
     2. Davis, California: ordinances;
     3. Kiowa, Colorado: zoning protection to solar collectors;
     4. ABA preparing model ordinances.

IV. Major remaining problems:
   - A. Division of support between big and small business in solar energy development;
   - B. Debate over whether to support research or demonstration;
   - C. Extent of government role.

LITERATURE NOT REVIEWED

Below is a list of the literature that appeared most relevant to a review of issues on solar energy regulation but was not searched. Complete citations are not available in some cases.

Booz, Allen & Hamilton, Inc., The Effectiveness of Solar Energy Incentives at the State and Local Level - An Overview, prepared for the Federal Energy Administration, March 1, 1976.

Bossong, Ken, The Case Against Private Utility Involvement in Solar/Insulation Programs, Washington, D.C.: Center for Science in Public Interest, 1977.

Braun, G. W. et al., Assessment of Solar Heating and Cooling for an Electric Utility Company, paper presented at 1975 International Solar Energy Congress and Exposition at Los Angeles, California, July 1975. Research performed by Jet Propulsion Laboratory for Southern California.

Dickson, Charles, Marc Eichen and Steven Feldman, "Solar Energy and U.S. Public Utilities: the Impact on Rate Structure and Utilization," Energy Policy, September 1977, pp. 195-210.

Feldman, Stephen, "Non-Conventional Incentives for Adoption of Solar Design: Peak-Load Pricing and Off-Peak Solar Construction for Commercial and Residential Buildings," at Clark University, funded by NSF.

Feldman, S. L., R. M. Wirthshafter, M. Abrash, C. Carter, B. Anderson, P. W. Sullivan, J. T. Kohler and J. Breese, The Impact of Active and Passive Solar Building Designs on Utility Peak Loads, Division of Solar Energy, ERDA Interim Report No. EG-77-G-01-4029, September 30, 1977.

Hirschberg, Alan and Richard Schoen, "Barriers to the Widespread Utilization of Residential Solar Energy the Prospects for Solar Energy in the U.S. Housing Industry," Policy Sc. 5, No. 453, 1974.

Peterson, H. Craig and Bruce N. Owen, "Use and Abuse of the Regulatory Process in Developing Solar Energy Space Conditioning Industry," (N.P.), 1977, NSF/RA-770457.

Schoen, Richard and Jerome Weingart, "Institutional Problems of the Commercial Application of New Community Energy System Technologies, with Emphasis on Solar Conversion Systems," Ford Foundation Energy Policy Project, November 1973, draft.

White, Sharon S., et al., Commercial Solar Demonstration: Legal Alternatives, Implications and Financing of Solar Heating and Cooling by a Municipal Corporation, Santa Clara, California, Community Center (Springfield, Va: NTIS, Dept. of Commerce, 1976).

CHAPTER 3

ACTIVITIES OF PUBLIC UTILITY COMMISSIONS IN THE DEVELOPMENT OF SOLAR ENERGY TARIFFS

Introduction

The purpose of this chapter is to present the most current information as to the extent and nature of activities being pursued by public utility commissions in the development of solar energy regulatory policy. The primary objective is to identify and document states which have approved tariffs, rate schedules or riders for use by customers with solar energy equipment. The second objective is to identify tariffs that are not specifically labeled for solar energy applications but with modification could be used for a solar energy customer. A third objective is to determine the status of solar regulatory policy developments in public utility commissions. Finally, there is a summary of solar energy regulatory developments for each public utility commission for which information was available.

Information Sources

The information presented in this chapter is taken from three sources. One source is a research project conducted by NRRI in the summer of 1978.[1] That study was an attempt to determine which public utility commissions have approved a solar energy tariff. As a result of that effort, 16 specific rate schedules applicable to, or designed specifically for, solar energy applications in nine states for 10 investor-owned utilities were identified. The NRRI found PUC approved

[1] A Profile of Utility Rates Used for Solar Energy Applications. The National Regulatory Research Institute, Columbus, Ohio (1979).

schedules and tariffs in Illinois, Kansas, Michigan, New Hampshire, New York, North Carolina, South Carolina, Utah and Wisconsin. Two of the solar energy tariffs were designed for natural gas customers in Illinois.

A second source for information is taken from visits by NRRI staff to 46 public utility commissions from October 1978 to February 1979. The purpose of the visits was to determine the type of technical assistance needs and requirements by public utility commissions. In the course of the visits, NRRI staff collected information about the extent of commission interest in solar energy applications and the status of developments concerning solar energy regulatory policy.

A third source of information is taken from a task that is part of this research project. In May and June of 1979, the NRRI queried 150 investor-owned electric utilities concerning their needs and requirements of public utility commissions regarding the development of solar energy regulatory policy. As part of this investigation, each electric utility was asked to say whether the company provided service to customers under a commission-approved solar energy tariff. The responses were used as a cross check on information collected during the NRRI visits to assess state needs. An analysis and discussion of the investor-owned electric utility research on issues of regulatory policy in solar energy is presented in Chapter 4 of this report.

A Summary of Information from NRRI Visits to PUC's

During the 1978-1979 state needs assessment visit by staff from NRRI to 46 public utility regulatory commissions, the NRRI asked commission staff about the status of development of rates and tariffs for solar energy systems. Commission staff identified by the NRRI to be most appropriate to provide a knowledgeable response were asked whether a special rate schedule or tariff applicable for an electric or natural gas customer using a solar energy system had been approved by the commission. If the response was "yes," a copy of the applicable rate schedule or tariff was requested. As a result of this effort, it was determined that in addition to the nine states previously identified, PUC-approved solar tariffs were also found in Connecticut and Texas.

In addition, an attempt was made to determine if the commission had undertaken a study or performed an analysis for the design of the tariff, whether the tariff encouraged or penalized the solar energy user, what the commission procedure and position was on accounting methods and engineering issues related to ratemaking for solar energy applications.

The commissions were asked what procedures had been established to handle utility expenditures for the support of solar energy systems such as those related to operating expenses, investment, rate-base treatment, and its effect on the rate of return. The cost-of-service method applied and the relationship of expenditures on solar energy systems to the uniform system of accounts was also explored, where applicable.

The NRRI asked whether the commission required that solar energy systems be designed with particular engineering features such as load management control devices and special meters, and whether the tariff applied to space heating, space cooling, water heating or a combination of these functions.

All commissions were also asked whether a supplemental energy rider, stand-by tariff or special rate for supplemental energy service was in effect that could be used or modified for solar energy applications. If there were such applications, documentation was requested. Finally, the commissions were asked if they had any solar tariff proposals under investigation or study and whether they were aware of any public agency, utility company or university that had solar energy tariffs under study. Table 3-1 presents a profile of solar energy regulatory policy activities for the 51 public utility commissions.

TABLE 3-1

A PROFILE OF SOLAR ENERGY TARIFF DEVELOPMENTS
BY PUBLIC UTILITY COMMISSIONS

JUNE 1979

Public Utility Commission	Tariff In Effect	Tariff Being Considered	Modifiable Tariff	Another Organization Considering Tariff	No Action Being Taken	No Information
Alabama			X			
Alaska						X
Arizona					X	
Arkansas					X	
California		X				
Colorado		X				
Connecticut	X					
Delaware			X	X		
District of Columbia			X			
Florida			X			
Georgia					X	
Hawaii		X				
Idaho			X			
Illinois	X					
Indiana					X	
Iowa			X			
Kansas	X					
Kentucky					X	
Louisiana					X	
Maine					X	
Maryland					X	
Massachusetts					X	
Michigan	X					
Minnesota			X			
Mississippi					X	
Missouri			X			

TABLE 3-1 (continued)

Public Utility Commission	Tariff In Effect	Tariff Being Considered	Modifiable Tariff	Another Organization Considering Tariff	No Action Being Taken	No Information
Montana				X		
Nebraska						X
Nevada					X	
New Hampshire	X					
New Jersey	X					
New Mexico				X		
New York	X					
North Carolina	X					
North Dakota				X		
Ohio					X	
Oklahoma					X	
Oregon					X	
Pennsylvania			X	X		
Rhode Island					X	
South Carolina	X					
South Dakota					X	
Tennessee					X	
Texas	X		X			
Utah	X					
Vermont			X	X		
Virginia			X			
Washington		X				
West Virginia					X	
Wisconsin	X					X
Wyoming					X	

Summary of Responses

In general, the quantitative results regarding rate-design philosophy, rate-base treatment or accounting procedures were less than satisfactory for analytical purposes. In states where tariffs were in place, commission staff would not render an opinion whether solar rate schedules penalized, encouraged or were neutral to the user. This would seem to imply that solar rate design studies have not been instituted by even those commissions with solar energy tariffs in place.

Regarding any expenditures by utilities for solar energy in such activities as customer education, financing arrangements or research and development, it was a general consensus that such expenditures would be treated as operating expense. The question of rate-base treatment could not be answered since most public utility commissions have not formulated a firm public policy position regarding utility ownership of solar energy equipment. Similarly, the accounting treatment of solar investments will be dependent on whether such investments will be considered to be "above the line" or "below the line." Until this is determined--more than likely during a rate-case proceeding--commission staff will not have a definite public policy position on solar energy application.

After the analysis of the information collected by NRRI staff, two conclusions can be drawn. The first is that a majority of state public utility commissions have not committed significant resources to the development of solar energy regulatory policy. The second conclusion is, based on observed responses, commissions do not perceive solar energy regulatory policy to be an important issue. However, several commissions have been identified to be in the forefront of solar regulatory policy development. The California Public Utilities Commission, despite the absence of a solar tariff, has been active in supporting experimental designs by utilities and the publication of research on solar energy issues. Two publications by the California PUC staff are reported in the literature review chapter of this report.

In July 1979, the Colorado Public Utilities Commission, in a generic rate case, presented a policy for solar energy and heat storage rates. The Colorado PUC has taken the position that utility regulation in solar energy development should be flexible to accommodate new technology to the extent possible while remaining neutral between competing technologies.[2] Furthermore, the Colorado PUC believes that the pursuit of a neutral policy will be conducive to the orderly development of non-traditional methods of technology without penalizing other customers. The following excerpt from a summary of the generic rate-case proceeding further develops the policy position of the Colorado PUC regarding solar energy application.

> The commission discusses the distinctive usage pattern of solar customers and the appropriateness of present and proposed rate structures to the solar sector. It is noted that an appropriate rate which will recognize the difference in cost to the utility of recharging during peak and off-peak hours can be designed. Such a rate will be applicable both to solar customers and to non-solar customers with similar heat storage attributes. The appropriate residential and commercial heat storage rate is a simple time-of-day kilowatt-hour usage rate to be offered on a mandatory basis for all new residential and commercial heat storage customers after sufficient time has elapsed to permit adequate education to customers.

Each utility is directed to file such rates after the effective date of the decision (January 27, 1978) to become effective 18 months later (July 1981). (Public Service Company of Colorado is the major electric and gas utility under PUC jurisdiction.)

The Colorado PUC and, to a lesser degree, the California PUC appear to have progressed furthest of any public utility commission in the development of a solar energy regulatory policy; but neither had approved a solar energy tariff as of the publication of this report. This is <u>not</u> to slight the effort made by a number of

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[2]Summary of Decision No. C79-111, Generic Rate Proceeding, Case No. 5693, issued by the Public Utilities Commission of the State of Colorado on July 27, 1979.

commissions that have devoted resources to the issues raised by solar energy technology developments. For example, the NRRI was able to identify 11 states where riders, schedules or tariffs have been approved by a state utility regulatory commission for solar energy applications. The 11 states identified are Connecticut, Illinois, Kansas, Michigan, New Hampshire, New York, North Carolina, South Carolina, Texas, Utah and Wisconsin.

Although a tariff, rider or schedule has been approved in each of the states, the NRRI was unable to identify any public policy position for solar energy application developed by the public utility commission. Representatives of public utility commissions in California, Colorado, Nevada, New Jersey and Washington said that a solar tariff was under consideration. The NRRI also identified 12 state utility regulatory commissions as having tariffs, rate schedules or riders that could be modified for solar energy applications. However, this finding could only be verified for the Texas PUC where a rider is being used for solar application by the Texas Power and Light Company and the Dallas Power and Light Company.

In six cases, the state utility regulatory commission said that another agency or organization had the tariff under study. It was found that 17 state utility regulatory commissions have not taken any action in the development of solar energy tariffs or policy. The status of solar energy developments in Alaska and Nebraska were not able to be identified.

A Profile of Solar Energy Regulatory Development in Public Utility Commissions

The remaining section of this chapter presents a summary of information collected by NRRI staff for each state public utility commission on the activity and development of solar energy policy and tariff design. In almost every case, the information presented is from the state needs assessment visits by NRRI. Any new information collected since the last visit in February 1979 has also been included in this summary.

The information for each public utility regulatory commission varies in length and is dependent on the extent of solar energy regulatory developments in each state. A description is presented of each tariff, rider or rate schedule identified either as specifically for solar energy application or modified for solar energy application. In general, the description includes a name of the utility, a descriptive title for the tariff, and the date it became effective.[3] Since there is a close association with possible applications of time-of-use rates and off-peak to solar, any knowledge of studies or research by the public utility commission has been noted.

Alabama Public Service Commission (PSC)

The Alabama PSC has not approved a solar tariff but does have a nighttime tariff schedule that could be adopted for solar energy users. The Alabama Power Company is experimenting with solar energy technology.

Alaska Public Utilities Commission (PUC)

The NRRI did not visit the Alaska PUC and was unable to determine the extent of solar energy regulatory policy development by the PUC.

Arizona Corporation Commission

The Arizona Commission does not have a rate or tariff for solar energy applications in effect.

Arkansas Public Service Commission (PSC)

The Arkansas PSC does not have a solar tariff in effect and does not have a program for the development of solar energy regulatory policy.

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[3] Copies of the said tariffs can be obtained directly from the utility or The National Regulatory Research Institute.

California Public Utilities Commission (PUC)

The California PUC does not have a solar energy tariff in effect but is examining an off-peak rate for solar energy users. The PUC does not have a supplemental rider, stand-by tariff or special rate for supplemental energy service that could be applied or modified for solar energy tariffs. As a matter of policy, the PUC supports solar applications with gas back-up, rather than electric back-up.

Colorado Public Utilities Commission (PUC)

In July 1979, the Colorado PUC established a policy for solar energy users in rate proceeding. (Decision No. C79-111, Generic Rate Proceeding, Case No. 5693, issued by the Public Utilities Commission of the State of Colorado on July 27, 1979.)

Connecticut Public Utilities Control Authority (PUCA)

The State of Connecticut has two tariffs applicable to solar energy users. Connecticut Light and Power operates under Rate 18, Controlled Water Heating Electric Service, approved by the PUCA on November 28, 1978. The City of Hartford also has a solar energy tariff in effect.

Delaware Public Service Commission (PSC)

The Delaware PSC does not have a solar energy tariff in effect, but the PSC says a tariff for cogeneration is being developed that might be modified for use in solar energy applications. A study relevant to solar energy tariffs is being conducted at the University of Delaware. The PSC has completed a study for the use of marginal cost pricing for setting electric rates in Delaware.

District of Columbia Public Service Commission (PSC)

The District of Columbia PSC does not have a solar energy tariff in effect. The Washington Gas & Light Company has filed for a stand-by tariff that the PSC says might be modified for users of solar energy systems.

Florida Public Service Commission (PSC)

The Florida PSC does not have a solar energy tariff in effect but does have under study an optional off-peak tariff for solar energy applications similar to an optional off-peak rider now in effect for standard use customers.

Georgia Public Service Commission (PSC)

The Georgia PSC does not have a solar energy tariff in effect and the PSC does not have a program for the development of a solar energy regulatory policy.

Hawaii Public Utilities Commission (PUC)

Although NRRI staff did not visit the Hawaii PUC, a generic hearing was underway that was to examine solar energy rate designs. At least one utility company is actively involved in gathering information for a more extensive study of the subject.

Idaho Public Utilities Commission (PUC)

The Idaho PUC does not have a tariff for solar energy applications but the PUC has a rate schedule for stand-by service to commercial customers that might be modified for customers using solar energy systems. The PUC has completed a study on the application of TOD rates for utilities in Idaho.

Illinois Commerce Commission

The Illinois Commerce Commission has approved four solar energy tariffs for three utilities.

1. Central Illinois Light Company, Residential Solar Assisted Electric Space Heating Rate 4, passed August 30, 1977.

2. Commonwealth Edison Company, Rate 14E Residential Service - Solar Assisted Electric Space Heating, passed October 14, 1977.

3. Northern Illinois Gas Company, Rider 15 - Solar Assisted Space Heating Gas Service - Experimental, applicable to Rate 1, passed February 1, 1978.

4. Northern Illinois Gas Company, Rider 15 - Solar Assisted Space Heating Gas Service - Experimental, applicable to Rate 4, passed February 1, 1978.

Indiana Public Service Commission (PSC)

The Indiana PSC does not have a tariff for solar energy users, but the PSC reported that experiments on solar energy are underway at Purdue University. The PSC said that utility company costs associated with solar energy would be considered to be operating expenses and reviewed case by case.

Iowa State Commerce Commission (ISCC)

The Iowa SCC does not have a solar energy tariff in effect but does have an experimental rate for wind power. The SCC reported that it does not have a solar tariff proposal under investigation.

Kansas State Corporation Commission (SCC)

The Kansas SCC approved an experimental off-peak storage rider for Kansas Gas and Electric Company on September 21, 1977. (Schedule OPS-977).

Kentucky Public Service Commission (PSC)

The Kentucky PSC does not have a solar energy tariff in effect and the PSC did not report any activity on the development of solar energy regulatory policy.

Louisiana Public Service Commission (PSC)

The Louisiana PSC does not have a solar energy tariff in effect and does not have a program for development of a solar energy regulatory policy.

Maine Public Utilities Commission (PUC)

The Main PUC does not have a solar energy tariff in effect and does not have a program for the development of solar energy regulatory policy. The PUC has completed a study on the use of marginal-cost pricing for setting electric rates by utilities in Maine.

Maryland Public Service Commission (PSC)

The Maryland PSC does not have a tariff for solar energy users in effect or under consideration. The PSC has currently under review the responses of Baltimore Gas and Electric and Delmarva Power and Light to order No. 62568 that calls for new pricing policies by the utilities.

Massachusetts Department of Public Utilities (DPU)

Massachusetts does not have a solar energy tariff in effect but the DPU said Massachusetts Electric and Boston Edison were both experimenting with rates for solar users. Western Massachusetts Electric has a recently approved a time-of-day tariff that could be modified for solar energy applications.

Michigan Public Service Commission (PSC)

The Michigan PSC has approved a solar tariff. The tariff was developed out of staff proposals in rate cases. Utility expenses associated with service to solar energy users are treated as normal operating expenses. When the NRRI talked to PSC staff in December 1978, the PSC was in the process of re-evaluating solar rates, looking particularly at space heating rates and commercial applications. At present, the Detroit Edison Company offers solar energy users M.P.S.C. No. 8 Experimental Solar Assisted Water Heating Service Rate, approved May 1, 1978.

Minnesota Department of Public Service (MDPS)

Minnesota does not have a solar energy tariff in effect and the PSC has taken no action on development of rates and tariffs for solar energy users. The Minnesota Energy Agency is active in the development of solar energy policy for the state. The agency requested funding from the legislature for a demonstration project in solar energy application and to study the removal of remaining legal barriers to solar energy use.

Mississippi Public Service Commission (PSC)

The Mississippi PSC does not have a solar energy tariff in effect and the PSC reported no activity on the development of a tariff for solar energy users.

Missouri Public Service Commission (PSC)

The Missouri PSC does not have a tariff for solar energy users. The PSC does have an existing tariff for providing gas to interruptible customers of a newly approved synthetic gas plant that could be modified for solar energy users. The use of marginal cost pricing has been proposed for setting electric rates in Missouri.

Montana Public Service Commission (PSC)

The Montana PSC does not have a solar energy tariff in effect.

The Montana Power Company proposed a stand-by tariff that the PSC staff determined would have penalized solar users. The tariff was rejected by the PSC.

Nebraska Public Service Commission (PSC)

The NRRI did not visit the Nebraska PSC and has no information on the development of solar energy policy or tariffs in the state.

Nevada Public Service Commission (PSC)

Nevada does not have a solar energy tariff in effect and the PSC reported no action on the development of a solar energy regulatory policy. PSC staff said the state energy agency was responsible for developing solar energy policy.

New Hampshire Public Utilities Commission (PUC)

The New Hampshire PUC has approved two solar energy tariffs by means of special contract.

1. Public Service Company of New Hampshire - Special Contract of New Hampshire and Total Environmental Action, Inc. - Contract No. NHPUC-37. Approved January 21, 1977.

2. Public Service Company of New Hampshire and Restricted Customer. Approved May 31, 1977.

New Jersey Board of Public Utilities (BPU)

Rockland Electric Company of New Jersey filed for approval of Service Classification No. 7 but was not approved by the BPU. Service Classification No. 7 was intended for customers with cooling storage who also have hot storage and solar systems, and cooling storage only. The application for service was denied by the BPU but the rider is included for examination in the Appendix.

New Mexico Public Service Commission (PSC)

The New Mexico PSC does not have a solar energy tariff in effect. No activity was reported by the PSC on the development of solar energy regulatory policy.

New York Public Service Commission (PSC)

The New York PSC approved a solar tariff for Orange and Rockland Utilities, Inc. - Solar Assisted Space Heating and Water Heating - Rate PSC No. 2 (Electricity). The effective date was June 1, 1978. The PSC has completed a number of studies on marginal cost pricing and TOD rates are in effect for industrial class customers.

North Carolina Utilities Commission

The commission has approved experimental rate schedules for two types of solar energy applications for customers of Duke Power Company.

1. Duke Power Company - Schedule RWX(NC) Residential Service, Water Heating - Electric/Solar Uncontrolled Water Heating (Experimental), approved July 1976.

2. Duke Power Company - Schedule RAC(NC) Residential Service, All-Electric/Solar (Experimental), approved July 1976.

Accounting procedures for utility expenditures for the support of solar energy systems will be developed when the solar sector grows as a customer class.

North Dakota Public Service Commission (PSC)

The North Dakota PSC does not have a solar energy tariff in effect. The PSC reported a contract has been approved for the purpose of an experiment being conducted in the state. Accounting procedures have not been considered, according to the staff representative contacted.

Public Utilities Commission of Ohio

The PUC of Ohio does not have a solar energy tariff in effect.

The PUC does not have a program for the development of solar energy regulatory policy.

Oklahoma Corporation Commission (OCC)

The OCC does not have a solar energy tariff in effect and does not have a program for the development of solar energy regulatory policy.

Oregon Public Utility Commission (PUC)

The Oregon PUC does not have a solar energy tariff in effect. The Oregon PUC reported that solar energy policy has been developed by the state energy office.

Pennsylvania Public Utility Commission (PUC)

The Pennsylvania PUC does not have a solar energy tariff in effect. Pennsylvania Power & Light is planning to file a rate for solar energy applications. The PUC has a rate that may be modified for solar energy applications.

Rhode Island Public Utilities Commission (PUC)

The Rhode Island PUC does not have a solar energy tariff in effect. The PUC does not have a program for the development of solar energy regulatory policy.

South Carolina Public Service Commission (PSC)

The South Carolina PSC has approved three solar energy tariffs.

1. Duke Power Company - Schedule RWX(SC) Residential Service, Water Heating - Electric/Solar with Uncontrolled Water Heating (Experimental).

2. Duke Power Company - Schedule RAX(SC) Residential Service, All-Electric/Solar (Experimental).

3. Duke Power Company - Schedule CAX(SC) General Service, All-Electric/Solar (Experimental).

South Dakota Public Utilities Commission (PUC)

There is no solar tariff in effect in South Dakota, but the commission reports an interest in studying the matter.

Tennessee Public Service Commission (PSC)

The Tennessee PSC does not have a solar tariff in effect and does not have a program for the development of solar energy regulatory policy.

Public Utility Commission of Texas (PUC)

The PUC of Texas has approved one tariff (1) and a rider (2) designed for direct solar application. An electric tariff for residential wind powered generation (3) could be modified for solar energy application. A seasonal service rate schedule (4) also appears to have solar application.

1. Texas Power & Light Company, Residential Energy Conserving Systems Rider Water and/or Space Heating Rider REC - Experimental, approved May 30, 1978.

2. Dallas Power & Light Company, Schedule RH Residential Space Heating Service Rider, effective in certain service areas on various dates in July 1978.

3. Southwestern Public Service Company, Electric Tariff for Experimental Electric Service for Residential Wind Powered Generation. Approved May 1979.

4. J-A-C Electric Cooperative, Inc., Bluegrove, Texas. Schedule WG (Seasonal Service), effective date June 1, 1978.

The City Public Service Board of San Antonio has approved a solar tariff that has been in effect since August 1976.

Utah Public Service Commission (PSC)

The Utah PSC has a tariff for electric customers using solar energy systems. Utility expenses associated with solar energy use have been "treated as such." The PSC staff said that Utah has a rate for supplemental energy service that could be modified for application to solar energy users. The existing tariff is Utah Power & Light Company, Electric Service Schedule No. 5A State of Utah, Residential Service - All-Electric with Solar Assisted Hot Water Heating, effective May 2, 1978.

Vermont Public Service Board (PSB)

The Vermont PSB does not have a solar energy tariff in effect. Contracts are in effect for utility experiments and there is a "domestic supplemental service agreement" for windmills and hydro power that the board says could be modified for solar energy users. Research and development by the Central Vermont Public Service Corporation is treated as operating expenses by the PSB.

Virginia State Corporation Commission (SCC)

The Virginia SCC does not have a solar energy tariff in effect, nor does the commission have a program for developing solar energy regulatory policy. The Virginia Electric Power Company (VEPCO) has a pilot program for time-of-day rates that could be modified for solar energy application.

Washington Utilities and Transportation Commission (UTC)

The Washington UTC does not have a solar energy tariff in effect. A study of rate reform has recently been completed and will be the subject of a future generic hearing.

West Virginia Public Commission (PSC)

The West Virginia PSC does not have a solar energy tariff in effect. The PSC does not have a program for the development of solar energy regulatory policy.

Wisconsin Public Service Commission (PSC)

The NRRI did not visit the Wisconsin PSC, but was able to document the existence of at least one tariff that is applicable for solar energy customers: Wisconsin Power & Light Company, Supplemental Energy Off-Peak Service Amendment 249 Schedule R2-2.1. Effective date October 10, 1977. Wisconsin Power and Light has a time-of-day rate that could be applicable for a solar energy user.

Wyoming Public Service Commission (PSC)

The Wyoming PSC does not have a solar energy tariff in effect. The PSC does not have a program for the development of solar energy regulatory policy.

CHAPTER 4

A PROFILE OF ELECTRIC UTILITY AND SOLAR ENERGY EQUIPMENT MANUFACTURER NEEDS FOR REGULATORY POLICY

Introduction

The identification of impediments and barriers to the development of solar energy systems is an important step in the development of solar energy regulatory policy for public utility commissions. Examples of solar energy technology application for space conditioning and hot water heating can be drawn from almost every region in the United States. Unfortunately, the installation of solar energy systems for space conditioning and water heating is proceeding at a pace that is too slow to be a significant factor in helping the United States meet its energy management conservation goals.

One major factor that influences the slow growth of solar energy system installation is the relatively high initial capital outlay required of the user. To a degree, this problem has been lessened by favorable public policy decisions regarding financing and tax incentives. However, the cost of the solar energy system equipment still remains high when compared to the benefits received by the user. With increased volume and the use of mass production techniques, the cost of equipment may come down but this will occur if potential users can measure real cost savings and economic benefits from such installations.

Such benefits include a reduction in monthly utility bills and assurances that future commitments by the utility for building more expensive new generating capacity has been deferred or at least delayed. On the other hand, the utility is concerned that increased installation and use of decentralized solar energy systems will shift load curves, alter operations and reduce revenue. The uncertainty caused by the introduction of a new energy source has caused some utilities to be somewhat reluctant in their commitment to the development of solar energy systems.

An important partner in this picture is the manufacturer of solar energy equipment. Uncertainty caused by the slow acceptance of solar energy systems by the public and the unclear role of public utilities in the support of solar energy developments has caused solar energy equipment manufacturers to be cautious in their commitments to a production schedule that would bring down the cost of solar energy systems. The manufacturers would feel more comfortable if the questions facing the public caused by the uncertain role or support of utilities could be resolved.

Regulatory Requirements Profile-Research Design

Since investor-owned utilities operate under the authority of the public utility commission, some of the uncertainties would be resolved if the commission developed regulatory policy for solar energy applications. For the public, it would mean certainty regarding such issues as the cost of back-up service and impact on total energy costs. For the utility, it would mean a defined policy for such issues as rate structure, treatment of expenses and investments and revenue requirements. The public armed with such information could more wisely choose energy alternatives. The public utility operating under well defined regulatory guidelines would, in turn, provide the incentives for the solar energy equipment manufacturers to develop a production schedule to meet the demands of a market that is no longer constrained by uncertainty.

To develop solar energy regulatory policy in such an environment, the public utility must be in a position to resolve some very complex economic and legal issues. Certainly it can be agreed among all parties that regulatory policy for solar energy systems development can only be set by the public utility commission. With that mandate, public utility commissions need to formulate policy on such issues as rate reform, rate-base treatment and revenue requirements for the utility. More specifically, the development of solar energy regulatory policy will require the public utility commission to come to grips with the issues whether to accept or reject rate structures based on embedded average cost pricing, the role of the utility in marketing, financing and ownership of solar energy equipment and several other thorny legal issues that have significant implications for regulators. Solar is a new energy source with its own set of economic, technical and legal issues. As a result, regulators may welcome proposals from other sources to provide input in solar energy policy design.

In the formulation of regulatory policy, public utility commissions could benefit from input provided by utilities and solar energy equipment manufacturers so that their needs and requirements can be taken into account or at least considered. The results presented in this chapter is intended to provide public utility commissions with a profile of needs and requirements as expressed by a group of investor owned electric utilities and solar energy equipment manufacturers.

The first task in the research effort was to design a method for collecting common information from both the manufacturer and the utility. Information regarding company commitments to solar energy research was requested only of utilities. Therefore, the research design allows for comparisons between the two groups on similar questions as well as a profile for matters specific to utilities.

The second task was to select a group of "companies" made up of electric utilities and solar energy manufacturers from which to collect the required information. One hundred and fifty investor owned electric utilities questioned by the Electric Power Research Institute (EPRI) for a 1977 survey of electric utility solar energy activities were selected to make up one part of the sample.[1] The National Solar Heating and Cooling Information Center provided a list of 703 solar energy equipment manufacturers which made up the other part of the sample.[2] That list provided manufacturer contacts in all but seven states. The two groups together represented 853 companies of which 17.6 percent were electric utilities.

Results of the Analysis

One hundred and thirty six solar energy equipment manufacturers ("manufacturers") representing 19 percent of those contacted provided NRRI with information. However, 84 investor owned electric utilities ("utilities") responded or 56 percent of those contacted. A general overview of manufacturers and existing respondents from each state is presented in Table 4-1.[3] Examination of Table 4-1 shows that 27 companies in California and 18 companies in Florida provided the most respondents making up one-third (33%) of the total manufacturer group. The third highest state to respond was New Jersey with eight companies followed by 32 states with responses ranging from one to seven companies. Seventeen states and the District of Columbia are not represented in the final list of manufacturer respondents.

The distribution of manufacturer respondents by major regions is presented in Table 4-2. Almost two-thirds of the manufacturers came from the West and the South. The Northeast was represented by 21.3 percent of the respondents while the North Central division could account for 14 percent of the manufacturers responding. This geographic distribution indicates that respondents have a distinct sun-belt point of view.

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[1] Electric Utility Solar Energy Activities, Electric Power Research Institute ER-646-SR, Special Report (February 1978).

[2] The list included utilities in 47 states and the District of Columbia.

[3] Exhibits 1 and 2 are samples of the inventory form used to gather information from manufacturer and utility contacts.

TABLE 4-1

PARTICIPATING SOLAR ENERGY EQUIPMENT MANUFACTURERS AND ELECTRIC UTILITIES BY STATE

State	Manufacturers			Utilities		
	Number of Contacts	Number of Responses	Percent of Total Responses	Number of Contacts	Number of Responses	Percent of Total Responses
Alabama	8	3	2.2	1	1	1.2
Alaska	0	0	0	0	0	0
Arizona	23	5	3.7	4	4	4.8
Arkansas	0	0	0	2	2	2.4
California	154	27	19.9	9	4	4.8
Colorado	30	7	5.1	4	4	4.8
Connecticut	26	1	.7	3	2	2.4
Delaware	2	0	0	1	1	1.2
District of Columbia	2	0	0	1	0	0
Florida	72	18	13.2	5	4	4.8
Georgia	9	0	0	5	0	3.6
Hawaii	2	0	0	1	0	0
Idaho	1	1	2.7	1	2	2.4
Illinois	23	4	2.9	3	2	2.4
Indiana	4	2	1.5	8	4	4.8

TABLE 4-1 (Cont'd)

State	Manufacturers Number of Contacts	Manufacturers Number of Responses	Manufacturers Percent of Total Responses	Utilities Number of Contacts	Utilities Number of Responses	Utilities Percent of Total Responses
Iowa	13	0	0	4	2	2.4
Kansas	6	3	2.2	4	0	0
Kentucky	3	1	.7	1	1	1.2
Louisiana	1	0	0	3	1	1.2
Maine	3	0	0	1	0	0
Maryland	13	5	3.7	2	0	0
Massachusetts	26	6	4.4	5	3	3.6
Michigan	17	1	.7	2	1	1.2
Minnesota	8	1	.7	3	3	3.6
Mississippi	0	0	0	1	0	0
Missouri	10	1	.7	3	4	4.8
Montana	1	1	.7	1	1	1.2
Nebraska	5	0	0	2	0	0
Nevada	4	0	0	2	0	0
New Hampshire	10	2	1.5	2	0	0
New Jersey	34	8	5.9	3	0	0
New Mexico	8	0	0	2	1	1.2
New York	28	7	5.1	8	3	3.6
North Carolina	13	2	1.5	2	2	2.4
North Dakota	0	0	0	2	2	2.4
Ohio	24	5	3.7	4	2	2.4

TABLE 4-1 (Cont'd)

State	Manufacturers Number of Contacts	Manufacturers Number of Responses	Manufacturers Percent of Total Responses	Utilities Number of Contacts	Utilities Number of Responses	Utilities Percent of Total Responses
Oklahoma	6	0	0	2	1	1.2
Oregon	6	1	.7	5	3	3.6
Pennsylvania	32	3	2.2	3	2	2.4
Puerto Rico	0	1	.7	0	0	0
Rhode Island	6	0	0	3	0	0
South Carolina	4	2	1.5	0	0	0
South Dakota	0	0	0	5	3	3.6
Tennessee	5	2	1.5	1	0	0
Texas	27	4	2.9	9	6	7.1
Utah	2	1	.7	1	0	0
Vermont	4	2	1.5	3	2	2.4
Virginia	13	3	2.2	0	0	0
Washington	10	4	2.9	7	3	3.6
West Virginia	0	0	0	0	0	0
Wisconsin	4	2	1.5	5	4	4.8
Wyoming	1	0	0	1	1	1.2
Totals	703	136	100.0	150	84	100.0

TABLE 4-2

MANUFACTURERS AND UTILITIES PARTICIPATING
IN THE PROFILE BY AGGREGATED CENSUS REGION

	Manufacturers		Utilities	
	Number	Percent	Number	Percent
Northeast	29	21.3	12	14.3
North Central	19	14.0	27	32.1
West	47	34.6	23	27.4
South	40	29.4	22	26.2
Puerto Rico	1	.7	0	0
	136	100.0	84	100.0

Further examination of Table 4-1 shows that the state with the most utility responses was Texas with six. Four utilities responded from each of seven states including California and Florida. New Jersey, the third-highest state in number of manufacturer respondents, did not have one utility respond. The list of utilities did not include contacts in the states of Alaska, South Carolina, West Virginia and the Commonwealth of Puerto Rico. These three states, added to the 14 states where responses from utilities were not received, mean that about a third of the states are covered. Examination of Table 4-2 shows that the geographic distribution of utilities is somewhat more evenly distributed among the four major geographic divisions than was found with manufacturers.

Use of Authority

The first two questions attempted to determine how utilities and manufacturers felt about the use of commission authority to influence either, in a positive or negative manner, consumer decisionmaking with regard to the use of solar energy systems.[4] Question one asked for a general impression or observation on the use of authority by commissions. Slightly more than half (52.4%) of the utilities and about four out of ten (42.6%) manufacturers answered in the negative to this question (see Table 4-3). Those answering yes to question one were probed further in the second part of the question. Thirteen utility respondents (68.4%) felt that commission authority was used favorably, while only 17 (42.5%) of the manufacturers shared this opinion. A very small number of utility and manufacturer respondents viewed the use of the commission as neutral.

The second question is identical to the first except it focused on a specific commission in the state served by the company. Almost two-thirds (65.5%) of the respondents from the utilities said that their state commissions had not used its authority to influence consumer decisions on solar energy. Four out of ten manufacturers (40.4%) shared

[4] A copy of the Regulatory Requirements Profile for Solar Energy System used for collecting information from solar energy manufacturers and electric utilities can be found at the end of this chapter.

TABLE 4-3

USE OF AUTHORITY BY PUBLIC UTILITY COMMISSIONS*

		Question 1				Question 2			
		All Commissions				Own Commission			
		Manufacturers (N=136)		Utilities (N=84)		Manufacturers (N=136)		Utilities (N=84)	
Use of Authority	Yes	48	35.3%	21	25.0%	46	33.8%	16	19.0%
	No	58	42.6%	44	52.4%	55	40.4%	55	65.5%
	No Opinion Expressed	30	22.0%	19	22.6%	35	25.7%	13	15.4%
		Question 1 (Part 2)**				Question 2 (Part 2)**			
Characterization of Authority	Favorable	17	42.5%	13	68.4%	16	38.1%	14	87.5%
	Unfavorable	14	35.0%	2	10.5%	18	42.8%	0	00.0%
	Neutral	9	22.5%	4	21.1%	8	19.1%	2	12.5%

* Percentage is based on the total respondents in each group.
**Percentage is based on the total "yes" respondents answering the question.

this view. Again, those answering yes to this question were asked to indicate if the use of authority was favorable, unfavorable or neutral. Out of 16 utility respondent, 14 felt that such commission authority was used favorably while two indicated that it was neutral. Manufacturers (42.8%) felt that the commission in their state used its power in an unfavorable manner. As in the case with question one, only a small number of manufacturers and utilities felt that the commission in their state used its authority in a neutral manner.

These results indicate that manufacturers and utilities have the opinion that commissions have not taken action to develop a publicly recognized position regarding solar energy regulatory policy. As a general overview of the responses to questions one and two, it can be concluded that respondents from the utility and manufacturer groups felt that commissions have not used their authority to influence consumer decisions on the use of solar energy systems. On the other hand, when the commissions do use their authority, utility respondents were much more inclined than the manufacturing respondents to call it favorable. As to the issue of neutrality, only small percentages from the utility and manufacturer respondents felt that such an effect was accomplished. It would seem, therefore, that if commissions have embarked on a conscious policy of neutrality--that is, fostering a policy that neither encourages nor penalizes a solar energy user--that policy is not being perceived by manufacturers and utilities.

Role of Participants in Solar Energy System Development

The third question was designed to determine the policy role of several participants in solar energy system development as seen by the manufacturer and the utility. Five groups identified as participants in solar energy system development were electric utilities, state regulatory commissions, state energy offices, solar equipment manufacturers and consumers. A sixth category was left open for other participants suggested by the respondents. The manufacturers and utilities were asked whether they thought each of the participants should have "sole responsibility," "shared responsibility" or "no responsibility" for establishing policy for certain functions in solar energy system development. The roles for which the companies were asked to assign responsibility were promotion, informing the public, developing tariffs for back-up service, establishing equipment standards, and installing and maintaining equipment.

The results from this part of the research showed considerable agreement between manufacturers and utility respondents. In general, both manufacturers and utilities said responsibilities should be shared in several policy roles for solar energy system development. Each of the six policy roles identified in question three have been analyzed and are presented in the following section of this chapter.

Promotion

The responsibility for actively promoting solar energy system installations is a difficult issue to resolve. If an electric utility actively promotes solar energy installation, this support may be interpreted wrongly by the public. Should the state regulatory commission choose to promote solar, such action may be viewed as a breach of regulatory neutrality. Promotion for new products has generally been the role of the manufacturer. Yet in the special case of solar, the promotion of this new energy alternative may require a new approach. It is with these issues in mind that this question was asked of the two company groups.

As to responsibility for promotion, the majority of both company groups agreed that the electric utility, the commission and the state energy office should share that responsibility. (See Table 4-4). Having the consumer involved as a participant in this role was overwhelmingly rejected. With regard to the role of the commission in promotion, just over 60% of the electric utilities said the commission should have no responsibility for promotion. This finding would suggest that the utility and the manufacturer view the role of the commission as one that does not include a promotional policy for solar

TABLE 4-4 PROMOTION

Participants in Solar Energy Systems Development	MANUFACTURERS			UTILITIES		
	Sole responsibility	Shared responsibility	No responsibility	Sole responsibility	Shared responsibility	No responsibility
Electric utility M=105 U=69	4 / 3.8%	57 / 54.3%	44 / 41.9%	0 / 0.0%	44 / 63.8%	25 / 36.2%
State regulatory commission M=101 U=64	3 / 3.0%	56 / 55.4%	42 / 41.6%	0 / 0.0%	25 / 39.1%	39 / 60.9%
State energy office M=116 U=73	11 / 9.5%	93 / 80.2%	12 / 10.3%	6 / 8.2%	58 / 79.5%	9 / 12.3%
Solar equipment manufacturer M=125 U=80	38 / 30.4%	87 / 69.6%	0 / 0.0%	31 / 25.8%	48 / 60.0%	1 / 1.2%
Consumer M=84 U=52	2 / 2.4%	34 / 30.5%	48 / 57.1%	1 / 1.9%	19 / 36.5%	32 / 61.5%

M=number of manufacturer respondents that answered the question.

U=number of utility respondents that answered the question.

energy development. The results also show that eight out of ten respondents from both company groups agreed on the state energy office for a shared responsibility in promotion activities. This would suggest that the state energy office may be the most logical agency for taking the lead role in the promotion of solar energy systems. Such an arrangement would most likely be supported by the manufacturer and the utility.

Informing the Public

The next part of the questionnaire was an attempt to determine if role responsibility can be identified for educating the public. Here the respondents were asked to indicate whom should have the responsibility for consumer education and informing the public. Since this question followed immediately after the question on promotion, the intention was to see if the respondents drew a distinction between promotion and informing the public.

Considerable agreement among the two company groups was evident regarding the role of participants for informing the public. (See Table 4-5). For the role of informing the public, it was agreed to be a shared responsibility among a group that included the electric utilities, the state energy office, the manufacturer, and to a lesser degree, the commission. However, the response of the electric utility group requires elaboration. Just over half of the utility group respondents (51.7%) felt that informing the public was not a proper role for the commission. Only one-third of the manufacturers (32.1%) felt the same way. On the other hand, a clear majority of both company groups felt that informing the public was the responsibility to be shared among the utility, the manufacturer and the state energy office. The analysis of this data suggests that the lead responsibility for public information and education should fall to the state energy office. A majority of both groups agreed that the consumer should not have any responsibility for informing the public.

Developing Tariffs for Back-up Service

The next level of the investigation focused on the role of the

TABLE 4-5 INFORMING THE PUBLIC

Participant in Solar Energy Systems Development	MANUFACTURERS Sole responsibility	MANUFACTURERS Shared responsibility	MANUFACTURERS No responsibility	UTILITIES Sole responsibility	UTILITIES Shared responsibility	UTILITIES No responsibility
Electric utility M=108 U=75	5 / 4.6%	65 / 60.2%	38 / 35.2%	2 / 2.7%	65 / 86.7%	8 / 10.7%
State regulatory commission M=106 U=60	3 / 2.8%	69 / 65.1%	34 / 32.1%	1 / 1.7%	28 / 46.7%	31 / 51.7%
State energy office M=127 U=77	18 / 14.2%	104 / 81.9%	5 / 3.9%	9 / 11.7%	66 / 85.7%	2 / 2.6%
Solar equipment manufacturer M=122 U=75	16 / 13.1%	105 / 86.1%	1 / .8%	11 / 14.7%	64 / 85.3%	0 / 0.0%
Consumer M=79 U=53	1 / 1.3%	31 / 39.2%	47 / 59.5%	0 / 0.0%	23 / 43.9%	30 / 56.6%

M=number of manufacturer respondents that answered the question.
U=number of utility respondents that answered the question.

participants in developing tariffs for back-up service to solar energy systems. Rate design has traditionally been the responsibility of the utility with the commission providing regulatory oversight. One would expect, therefore, that electric utilities would respond unanimously claiming sole responsibility for solar rate design (See Table 4-6). Almost two-thirds (64.0%) of the respondents from the electric utility group said that tariff design for back-up service should be a shared responsibility with the commission. Almost nine out of ten (87.5%) utility respondents expressed this opinion.

The utilities strongly expressed the opinion that the state energy office, the consumer and most emphatically the manufacturers, have no responsibility for developing tariffs for back-up service. This finding indicates that electric utilities may be receptive to accepting a joint effort with commissions in the design of tariffs for back-up service. On the other hand, only 3.3 percent of the manufacturers felt that electric utilities have sole responsibility for developing tariffs for back-up service. In fact, just over four out of ten (41.0%) manufacturers felt that electric utilities have no responsibility in this area and, to some degree, lean to the commission for leadership in tariff development. However, the data does suggest that the manufacturers' group has the opinion that developing tariffs for back-up service is a responsibility to be shared among the electric utilities, the commission, and the state energy office. The data also indicates that manufacturers look to the state energy office for taking a more active role in solar rate design.

Establishing Equipment Standards

Another thorny issue in the solar energy policy development arena is the definition and development of equipment standards. It is a generally accepted practice that the manufacturer would have the responsibility of setting standards for a product with government assisting when necessary. Again, the response from the two company groups leaned heavily to sharing of the responsibility among all participants except the commission. Just over half (52.7%) of the manufacturers and almost three-

TABLE 4-6 DEVELOPING TARIFFS FOR BACK-UP SERVICE

Participant in Solar Energy Systems Development	MANUFACTURERS Sole responsibility	Shared responsibility	No responsibility	UTILITIES Sole responsibility	Shared responsibility	No responsibility
Electric utility M=91 U=75	3 / 3.3%	48 / 52.7%	40 / 44.0%	25 / 33.3%	48 / 64.0%	2 / 2.7%
State regulatory commission M=111 U=72	31 / 27.9%	63 / 56.8%	17 / 15.3%	5 / 6.9%	63 / 87.5%	4 / 5.6%
State energy office M=99 U= 60	9 / 9.1%	67 / 67.7%	23 / 23.2%	1 / 1.7%	21 / 35.0%	38 / 63.3%
Solar equipment manufacturer M=86 U=52	8 / 9.3%	42 / 48.8%	36 / 41.9%	1 / 1.9%	4 / 7.7%	47 / 90.4%
Consumer M=74 U=51	4 / 5.4%	27 / 36.5%	43 / 58.1%	0 / 0.0%	18 / 35.3%	33 / 64.7%

M=number of manufacturer respondents that answered the question.
U=number of utility respondents that answered the question.

fourths (73.1%) of the utilities said that the commission had no responsibility in setting equipment standards. (See Table 4-7.) In fact, respondents were more in favor of including the consumer rather than the commission in sharing responsibility for setting equipment standards.

The data also shows that a majority of the two groups are in close agreement that the state energy office play a lead role in this area. Perhaps the state energy office is viewed as a lead coordinator having the capability to understand the needs and requirements of the manufacturer and the utility much better than the commission. This role would be a challenge for the state energy office since just over three-fourths (76.8%) of the manufacturers have the opinion that utilities have no responsibility in setting equipment standards while better than half (56.6%) of the utilities gave a preference for involvement in equipment standard setting. The potential for conflict between the manufacturer and the utility is apparent and should be considered before any programs are developed regarding the setting of solar energy equipment standards.

Selling Equipment

The issue of whom has responsibility for selling solar energy system equipment to the consumer usually breaks down to a choice between the manufacturer and the utility. Results from this investigation clearly supports the manufacturer. About eight out of ten (84.4%) utility respondents and three out of four (72.4%) manufacturers felt that the solar equipment manufacturer should have sole responsibility for selling equipment. (See Table 4-8). Only a third (31.3%) of the manufacturers were willing to share the responsibility of selling equipment with a utility. Based on the results of this investigation, it would be safe to conclude that the solar energy manufacturers should be given the opportunity and the sole responsibility for the sale of solar energy equipment.

Installing and Maintaining Equipment

Closely related to the question of equipment sales responsibility is

TABLE 4-7 ESTABLISHING EQUIPMENT STANDARDS

Participant in Solar Energy Systems Development	MANUFACTURERS Sole responsibility	MANUFACTURERS Shared responsibility	MANUFACTURERS No responsibility	UTILITIES Sole responsibility	UTILITIES Shared responsibility	UTILITIES No responsibility
Electric utility M=82 U=53	0 / 0.0%	15 / 18.3%	67 / 76.8%	0 / 0.0%	30 / 56.6%	23 / 43.4%
State regulatory commission M=95 U=52	7 / 7.5%	37 / 39.8%	49 / 52.7%	3 / 5.8%	11 / 21.2%	38 / 73.1%
State energy office M=102 U=70	15 / 14.7%	61 / 59.8%	26 / 25.5%	7 / 10.0%	46 / 65.7%	17 / 24.3%
Solar equipment manufacturer M=123 U=72	30 / 24.4%	84 / 68.3%	9 / 7.3%	15 / 20.8%	55 / 76.4%	2 / 2.8%
Consumer M=81 U=52	3 / 3.7%	36 / 44.4%	42 / 51.9%	1 / 1.9%	31 / 59.6%	20 / 38.5%

M=number of manufacturer respondents answering the question
U=number of utility respondents answering the question.

TABLE 4-8 SELLING EQUIPMENT

Participant in Solar Energy Systems Development	MANUFACTURER: Sole responsibility	MANUFACTURER: Shared responsibility	MANUFACTURER: No responsibility	UTILITIES: Sole responsibility	UTILITIES: Shared responsibility	UTILITIES: No responsibility
Electric utility M=90 U=48	0 / 0.0%	28 / 31.1%	62 / 68.9%	0 / 0.0%	7 / 14.6%	41 / 85.4%
State regulatory commission M=78 U=49	0 / 0.0%	3 / 3.8%	75 / 96.2%	0 / 0.0%	0 / 0.0%	49 / 100.0%
State energy office M=82 U=50	0 / 0.0%	14 / 17.0%	68 / 82.9%	1 / 2.0%	1 / 2.0%	48 / 96.0%
Solar equipment manufacturer M=127 U=77	92 / 72.4%	33 / 25.9%	2 / 1.6%	65 / 84.4%	11 / 14.3%	1 / 1.3%
Consumer M=71 U=44	0 / 0.0%	9 / 12.7%	62 / 87.3%	1 / 2.3%	3 / 6.8%	40 / 90.9%

M=number of manufacturer respondents answering the question.
U=number of utility respondents answering the question.

the issue of responsibility for installing and maintaining the equipment. It would follow logically that there should be a high degree of correlation between responses to this question and responses regarding responsibility for solar equipment sales. The data indicated that the sole responsibility appears to lay with the manufacturer since about half of the respondents felt this way. (See Table 4-9). However, the data also showed that just under half of the responses from both company groups called for electric utilities to share in the responsibility of installing and equipping solar energy equipment. This suggests that manufacturers and utilities would welcome an arrangement calling for shared involvement in the installation and maintenance of equipment. Therefore, when the issues of solar equipment sales, and installation and maintenance are taken together, it can be concluded that sales are the sole responsibility of the manufacturer but the installation and maintenance is judged to be one that would work as a shared responsibility with the electric utility.

The Middleman

A sixth category in the list of participants was left open ended for write-in candidates that respondents felt were important members in the development of solar energy regulatory policy. Analysis of the responses to this open category suggested that the manufacturers and utilities pointed to solar energy equipment dealers and installers as an important group that could influence solar energy developments. For example, these "middlemen," as described in the responses, are most responsible for selling, installing and maintaining equipment. Responses supporting middlemen were mostly attributed to the manufacturer group. (See Table 4-10). The frequency of responses clearly shows that greater consideration should be given to the middleman who is the retailer of equipment and the point of contact with the consumer especially for performing the sales, installation and equipment functions. Other participants, such as trade associations and the federal government, were named by some respondents.

A Combined Analysis of Sole and Shared Responsibility

Another means of interpreting the data is to combine the number of

TABLE 4-9 INSTALLING AND MAINTAINING EQUIPMENT

Participant in Solar Energy Systems Development	Manufacturers: Sole responsibility	Manufacturers: Shared responsibility	Manufacturers: No responsibility	Utilities: Sole responsibility	Utilities: Shared responsibility	Utilities: No responsibility
Electric utility M=86 U=49	1 / 1.2%	22 / 25.6%	63 / 73.3%	0 / 0.0%	13 / 26.5%	36 / 73.5%
State regulatory commission M=80 U=47	0 / 0.0%	5 / 6.3%	75 / 93.8%	0 / 0.0%	1 / 2.1%	46 / 97.9%
State energy office M=80 U=48	0 / 0.0%	9 / 11.3%	71 / 88.8%	0 / 0.0%	3 / 6.3%	45 / 93.8%
Solar equipment manufacturer M=118 U=76	54 / 45.8%	55 / 46.6%	9 / 7.6%	40 / 52.6%	35 / 46.1%	1 / 1.3%
Consumer M=82 U=59	3 / 3.7%	44 / 53.7%	35 / 42.7%	5 / 8.5%	39 / 66.1%	15 / 25.4%

M=number of manufacturer respondents answering the question.
U=number of utility respondents answering the question.

TABLE 4-10

RESPONSIBILITY OF MIDDLEMAN IN SOLAR ENERGY SYSTEM DEVELOPMENT *

Role of Middleman	Manufacturer N=136		Utilities N=84	
Promotion	9	6.6%	6	7.1%
Informing the public	8	5.9%	6	7.1%
Developing tariffs for back-up service	2	1.5%	1	1.2%
Establishing equipment standards	2	1.5%	7	8.3%
Selling equipment	21	15.4%	8	9.5%
Installing and maintaining equipment	44	32.4%	15	17.9%

*Percentage based on number responding from each group.

responses and shared responsibility and rank order the results for comparison between the manufacturer and the utility. An examination of Table 4-11 shows how manufacturers and electric utilities compare when responses for sole responsibility and for shared responsibility are combined. The comparison shows a high degree of agreement between the two groups when combined in such a manner.

What can be drawn from this analysis is verification of an earlier statement that a conflict between the manufacturer and the electric utility is more likely to occur over the issue of developing tariffs for back-up service than any other policy role. It appears that the resolution for heading off this potential conflict is to have the responsibility for tariff design be a shared responsibility among the manufacturer, the commission, the electric utility and the state energy office.

Role of the State Utility Regulatory Commission

The investigation then moved to focus on the specific role of the commission with regard to a number of policy actions that could be taken regarding solar energy system issues. Manufacturer and utility respondents were asked in question four either to agree, disagree or register a vote of no opinion. A small percentage chose not to answer the question at all. (See Table 4-12). The issues selected for analysis were chosen so as to best portray the wide spectrum of possible decisions ranging from passive to active policy actions that could be taken by a state regulatory commission. The major research objective was to determine what course of action the manufacturer and the utility would prefer a commission to take regarding solar energy system decisions. The results from this part of the investigation may be helpful in determining whether policy actions would be promotional, passive or neutral in their effect on solar energy system developments.

In general, the electric utility respondents felt that commissions should render policy decisions that would be neutral in effect while

TABLE 4-11

RANK ORDER OF ASSIGNMENTS OF RESPONSIBILITY TO PARTICIPANTS IN SOLAR ENERGY SYSTEM DEVELOPMENT (number of votes for shared or sole responsibility are in parentheses)

	Manufacturers	Utilities
Promotion	1. Solar equipment manufacturer (125)	1. Solar equipment manufacturer (79)
	2. State energy office (104)	2. State energy office (64)
	3. Electric utility (61)	3. Electric utility (44)
	4. State regulatory commission (59)	4. State regulatory commission (25)
	5. Consumer (36)	5. Consumer (20)
	6. Middleman (9)	6. Middleman (6)
Informing the public	1. State energy office (122)	1. State energy office (75)
	2. Solar equipment manufacturer (121)	2. Solar equipment manufacturer (75)
	3. State regulatory commission (72)	3. Electric utility (67)
	4. Electric utility (70)	4. State regulatory commission (29)
	5. Consumer (32)	5. Consumer (23)
	6. Middleman (8)	6. Middleman (6)
Developing tariffs	1. State regulatory commission (94)	1. Electric utility (73)
	2. State energy office (76)	2. State regulatory commission (68)
	3. Electric utility (51)	3. State energy office (22)
	4. Solar equipment manufacturer (50)	4. Consumer (18)
	5. Consumer (31)	5. Solar equipment manufacturer (5)
	6. Middleman (2)	6. Middleman (1)

TABLE 4-11 (Cont'd)

	Manufacturers	Utilities
Establishing equipment standards	1. Solar equipment manufacturer (114) 2. State energy office (76) 3. State regulatory commission (44) 4. Consumer (39) 5. Electric utility (15) 6. Middleman (2)	1. Solar equipment manufacturer (70) 2. State energy office (53) 3. Consumer (32) 4. Electric utility (30) 5. State regulatory commission (14) 6. Middleman (7)
Selling equipment	1. Solar equipment manufacturer (125) 2. Electric utility (28) 3. State energy office (14) 4. Middleman (21) 5. Consumer (9) 6. State regulatory commission (3)	1. Solar equipment manufacturer (76) 2. Middleman (8) 3. Electric utility (7) 4. Consumer (4) 5. State energy office (2) 6. State regulatory commission (0)
Installing and maintaining equipment	1. Solar equipment manufacturer (109) 2. Consumer (47) 3. Middleman (44) 4. Electric utility (23) 5. State energy office (9) 6. State regulatory commission (5)	1. Solar equipment manufacturer (75) 2. Consumer (44) 3. Middleman (15) 4. Electric utility (13) 5. State energy office (3) 6. State regulatory commission (1)

one would expect a much higher number of favorable responses for this action. It is also significant to note that half (50.7%) of the manufacturers felt that the commission should support utility rates that neither penalize nor promote use of solar energy systems. This would mean that a policy of neutrality for solar energy applications would find support among manufacturers as well as utilities.

Role of the Electric Utility

In question five, the investigation focused on the electric utilities as to their potential role in solar energy developments. It has been suggested in some quarters that electric utilities be given the authority to perform certain functions that are now forbidden by statute or by regulatory policy. For example, utilities may not be allowed to market, sell or own solar energy equipment; and in some states, they may also not be permitted to provide financing for such equipment. On the other hand, there are those who propose that the utility's only function should be to provide the consumer with solar energy product information. The line of inquiry in question five is an attempt to shed some light as to the proper role for electric utilities.

As to the question of utility ownership of equipment, this potentially controversial issue was viewed identically by the manufacturer and utilities (see Table 4-13). A majority of both groups was against ownership and only 17.9 percent of the utilities supported such a policy. In fact, more manufacturers (25%) favored utility ownership of equipment than did utility respondents. There was very little support among utility respondents for the marketing and sale, financing and leasing activities for solar energy systems. However, more than half (52.4%) of the utilities were in favor of utility companies providing product information on solar energy systems for customers.

Half of the manufacturers (50.7%) were in favor of utilities providing financing while almost two-thirds (63.1%) of the utilities were opposed to it. Less than one in 10 (7.1%) of the utility respondents

TABLE 4-13 ROLE OF ELECTRIC UTILITIES *

	Manufacturers N=136				Utilities N=84			
	for	against	neutral	no answer	for	against	neutral	no answer
ownership of solar energy systems	34 / 25.0%	84 / 61.8%	14 / 10.3%	4 / 2.9%	15 / 17.9%	45 / 53.6%	22 / 26.2%	2 / 2.4%
marketing and sale of solar energy systems	33 / 24.3%	81 / 59.6%	16 / 11.8%	6 / 4.4%	10 / 11.9%	45 / 53.6%	27 / 32.1%	2 / 2.4%
financing of solar energy systems for customers	69 / 50.7%	49 / 36.0%	13 / 9.6%	5 / 3.7%	6 / 7.1%	53 / 63.1%	24 / 28.6%	1 / 1.2%
leasing solar energy systems	47 / 34.6%	65 / 47.8%	16 / 11.8%	8 / 5.9%	11 / 13.1%	45 / 53.6%	27 / 32.1%	1 / 1.2%
providing only product information on solar energy systems for customers	49 / 36.0%	42 / 30.9%	40 / 29.4%	5 / 3.7%	44 / 52.4%	16 / 19.0%	22 / 26.2%	2 / 2.4%

*Percentage is based on number responding from each group.

could support such a policy. On the issues of ownership, marketing and sale, and leasing of solar energy systems, the two company groups were in close agreement as to these opportunities. Close examination of the data in Table 4-13 shows utilities were more likely to register a neutral position for each of the five possible policy actions than the manufacturer respondent. Strict interpretation of the results of this question would lead one to conclude that electric utilities are against the ownership, marketing and sales, leasing and financing of solar energy systems. On the other hand, what would the response be if it were proposed that ownership, financing and leasing were linked more closely with the question of rate-base treatment for such investments? As it stands now, the data shows a lack of interest by utilities in accepting new responsibilities for developing solar energy systems.

Effects of Rates and Tariffs

As in the case of solar energy equipment ownership by utilities, the issue of rate structure impact on solar energy applications is also controversial. The literature is generally in agreement that traditional declining block rates based on average and embedded costs is detrimental to solar energy applications. It has been argued that it would be a more appropriate alternative to use some form of time-of-use rate based on marginal cost pricing for solar energy systems rate design. Proposals have also been put forth in the literature that the rate structure that would give the greatest impetus to solar energy development would be a form of an inverted block rate. Clearly, such a rate structure would be promotional and artificially stimulate solar energy developments.

In question six, respondents were asked for their opinions on specific rate types and tariffs for back-up service by electric utilities to customers using solar energy systems (see Table 4-14). Asked about the effects of rates charged for back-up service, both utilities and manufacturers felt that the traditional declining block rate would hurt a solar energy systems program. More specifically, about four out of 10 (41.7%) of the utility respondents said a declining block rate would

TABLE 4-14 EFFECTS OF RATE TYPES ON SOLAR ENERGY SYSTEMS*

	Manufacturers N=136						Utilities N=84					
	most appro-priate	would help solar	would hurt solar	no effect	don't know	no answer	most appro-priate	would help solar	would hurt solar	no effect	don't know	no answer
traditional declining block rate	7 5.1%	10 7.4%	48 36.0%	14 10.3%	39 28.7%	17 12.5%	9 10.7%	4 4.8%	35 41.7%	20 23.8%	10 11.9%	6 7.2%
flat rate with a customer charge	9 6.6%	21 15.4%	27 19.9%	23 16.9%	35 25.7%	21 15.4%	10 11.9%	20 23.8%	8 9.5%	23 27.4%	17 20.2%	6 7.1%
time of day rate	17 12.5%	46 33.8%	16 11.8%	10 7.4%	28 20.6%	19 13.9%	14 16.7%	36 42.9%	5 6.0%	7 8.3%	16 19.0%	6 7.1%
seasonal rate	7 5.1%	28 20.6%	16 11.8%	17 12.5%	45 33.1%	23 16.9%	5 6.0%	23 27.4%	10 11.9%	13 15.5%	25 28.9%	8 9.5%
inverted block rates	9 6.6%	43 31.6%	9 6.6%	1 .7%	50 36.8%	24 17.6%	1 1.2%	41 48.8%	10 11.9%	7 8.3%	19 22.6%	6 7.1%

*Percentage based on number responding from each group.

hurt solar energy systems while more than a third (36%) of the manufacturers thought the same. Of the suggested alternatives to declining block rates, both groups leaned toward inverted block rates as a type of rate that would help a solar energy program. Almost half the utilities (48.8%) thought inverted block rates would help solar energy systems and 42.9 percent said time-of-day rates would be helpful to solar energy programs. The manufacturers were not in as much agreement as the utilities as only a third (33.8%) thought time-of-day rates would help solar energy systems. Inverted block rates were thought helpful by 31.6% of the manufacturers, but a larger percent (36.8%) said they did not know whether inverted rates would be helpful or harmful.

There was some tendency among manufacturers and utilities to think seasonal rates would help solar energy programs but large percentages of respondents from both company groups said they did not know what the effects of such rates would be. There was not a clear-cut opinion what the effects of a flat rate with a customer charge would be on solar energy system development.

Although 23.8 percent of the utilities said a flat rate with a customer charge would help solar energy programs, 27.4 percent said they thought it would have no effect. A quarter of the manufacturers said they did not know what effect such a rate would have.

The data shown in Table 4-14 indicate that a significant number from both company groups responded that they did not know what effect a particular rate would have on a solar energy user. Looked at in another way, neither group was able to clearly say with any conviction that a particular rate would be most appropriate for solar energy applications. This finding would suggest that more research on rate design is required to provide information to shift opinion from one based on lack of knowledge, which includes a "no opinion" response, to a more clearly defined position. Clearly such uncertainty must be resolved by means of more research on solar rate design in actual utility and consumer tests.

Appropriate Tariff Selection

In question seven, the investigation then attempted to determine the type of tariff that the manufacturers and utilities felt was most appropriate for use in applications for solar water heating only or applications calling for solar space and water heating. The choices given were a tariff designed especially for: an all-electric service home; residential service with water heating; customers with no electric space or water heat; special solar back-up service; or one tariff for all residential customers. Over 60 percent of the electric utilities said a tariff designed especially for solar back-up service was most appropriate for solar space and water heating (See Table 4-15). A lesser number (36.9%), but still a clear plurality, said such a tariff was appropriate for solar water heating alone. The manufacturers, however, favored having one tariff for all residential customers, both for solar water heating only and solar space and water heating.

This attempt at soliciting information for developing guidance in the development of a solar energy tariff proved to be less than satisfactory due to its complexity. If any conclusion can be drawn from this part of the investigation, it is that even knowledgeable persons working for utilities and solar energy equipment manufacturers need time and assistance in developing appropriate rate structure and tariffs for solar energy applications. There is also some evidence, based on the data in Table 4-15, that utilities would support a solar back-up service tariff for space and water heating applications.

Solar Energy Systems - Obstacles to Development

In the belief that it would be helpful to the design of regulatory policy, the companies were asked to express their opinion as to what they felt were the major obstacles facing solar energy system development. The responses were classified into six general categories. Although the companies were asked for one major obstacle, they often listed more of which only the first three were used in the analyses (see Table 4-16).

TABLE 4-15 APPROPRIATE TARIFF TYPES FOR ELECTRIC BACK-UP SERVICE*

	solar water heating only		solar space and water heating	
A tariff designed especially for:	manufacturers	utilities	manufacturers	utilities
an all-electric home	5 3.7%	3 3.6%	14 10.3%	9 10.7%
residential service with water heating	8 5.9%	13 15.5%	8 5.9%	3 3.6%
customers with no electric space or water heat	3 2.2%	5 6.0%	8 5.9%	2 2.4%
special solar back-up service	25 18.4%	31 36.9%	31 22.8%	51 60.7%
none of the above: there should be one tariff for all residential customers	41 30.1%	16 28.1%	47 34.6%	11 13.1%
don't know	18 13.2%	8 9.5%	19 14.0%	6 7.1%

*Percentage based on number responding from each group.

TABLE 4-16

MAJOR OBSTACLES FACING DEVELOPMENT OF SOLAR ENERGY SYSTEMS

Obstacles \ Rank Order	Manufacturers 1	Manufacturers 2	Manufacturers 3	Utilities 1	Utilities 2	Utilities 3
Economics	39 28.7%	9 6.9%	1 .7%	54 64.3%	8 9.5%	2 2.4%
Technology	1 .7%	3 2.2%	1 .7%	9 10.7%	12 14.3%	2 2.4%
Psychological and sociological factors	37 27.2%	22 16.2%	0 0.0%	4 4.8%	6 7.1%	1 1.2%
Climate	0 0.0%	0 0.0%	0 0.0%	5 6.0%	0 0.0%	2 2.4%
Government	44 32.4%	15 11.0%	2 1.5%	1 1.2%	1 1.2%	1 1.2%
Utilities	3 2.2%	3 2.2%	1 .7%	0 0.0%	0 0.0%	0 0.0%
Other	8 5.8%	3 2.2%	6 4.4%	5 6.0%	5 6.0%	0 0.0%
Total Responses	132 97.1%	55 40.4%	11 8.1%	78 92.9%	32 38.1%	8 9.5%
No response	4 2.9%	81 59.6%	125 91.9%	6 7.1%	52 61.9%	76 90.5%
Total Response and No Response	136 100.0%	136 100.0%	136 100.0%	84 100.0%	84 100.0%	84 100.0%

Analysis of the responses by manufacturers and utilities showed marked differences between the two groups as to the primary problems facing further development of solar energy systems. Three-fourths of the utilities mentioned economic factors either first, second or third. Technology was a distant second with about 10 percent of the utility responses. The government was mentioned by only three of the utility respondents.

Manufacturers pointed to government (32.4%) as the number one obstacle followed closely by economics (28.7%) and a category that can best be classified as psychological and sociological factors (27.2%).

Fifty-four utilities, 64.3 percent of the total, named an economic problem as their first or only response to the question. Of all utility responses, whether first, second or third, 64 out of 118 of the total (54.2%) had to do with economics. The problems of initial cost outlay and overall cost effectiveness were mentioned often.

"Currently, the costs of going solar cannot be economically justified in a reasonable time period to generate market interest," wrote one utility representative, expressing what appears to be a widely shared point of view.

The utilities also frequently mentioned technological problems, such as the reliability of solar energy systems, as an obstacle to their development. Technological problems were more frequently named as the second obstacle than the first, but accounted for almost a fifth (19.5%) of all the utility responses. This was in contrast to the manufacturers who named technological problems only seven times.

"Psychological and sociological factors" were defined to include public attitude, claims made for solar energy systems and information problems. A total of 11 utility responses, or 9.3 percent of the 118 responses that were given, dealt with issues of this type. Of those, four had to do with unproven or exaggerated claims for solar energy.

"Solar energy cannot live up to the expectations that are engendered by too many of its advocates" was one such utility response.

Seven utility responses (5.9%) mentioned limited sunshine or weather as a major obstacle. No manufacturer mentioned climatic factors. No utility blamed itself or its kind for standing in the way of solar energy system development. But seven manufacturers named utilities as an obstacle.

There were 10 utility responses and 17 manufacturer responses that did not fit the six categories used. "Other" responses from both groups of companies mentioned lack of standards, installation problems and the manufacturers themselves. "Lack of strong promotional effort by the industry itself" was one utility response.

The most optimistic response to the question on major obstacles was from a manufacturer who said, "There are really none. I have sold solar for five years and customers are gradually becoming accustomed and receptive to solar."

In responding to the question on major obstacles, many manufacturers mentioned problems that were classified "economic," but the emphasis was quite different from that of the utilities. The utilities tended to name the cost of the solar energy systems, plain and simple. Manufacturers did too: "Costs too much," said one manufacturer. "Wealthy don't need to save \$10-\$15/month." But many manufacturers contrasted the costs of fossil fuels with the cost of solar energy. Where government was not mentioned, or it was not suggested that such prices were artificial, these responses were also classified as "economic." Twelve manufacturers but no utilities mentioned financing as an obstacle. In the classification scheme, financing was classified as an economic obstacle. Thirty-nine manufacturers, 28.7 percent of the total, mentioned economic factors first, or made that their only response to the question on major obstacles. Combining first, second and third responses, found that there were 49 manufacturer responses naming economic factors or 24.7 percent of the total.

Thirty-seven manufacturers, 27.2 percent of the total respondents said problems of public attitude or lack of information were major obstacles. Misinformation, lack of information, public apathy and public reaction to energy supply issues were frequently mentioned. "Lack of public recognition of the existence of an energy shortage" was one such response. Another manufacturer said the major problem facing solar energy systems was "the seduction of the general public by 'kooks' who state that solar can solve all problems! This aids the formation of marginal manufacturers and dealers who in turn sell non-economic systems. Our state (AZ) is full of installations which will never pay out."

Government was the factor most often mentioned by the manufacturers as a major obstacle in development of solar energy systems. Forty-four manufacturers (32.4%) made responses that could be classified under this category. Out of the 198 total responses, 61 (30.8%) mentioned government activities or lack of them. Twenty-six respondents talked about government interference or regulation. "Hidden subsidies on other energy sources" was a typical response. Another was "Interference from federal and state - we should deregulate and get the government out of solar." But 10 responses called for more government action, blaming lack of government incentives for slow development of solar energy as an alternative fuel. "Lack of financial incentives," said one manufacturer. "Low interest loans and/or energy credits would help greatly."

The analysis of the company responses indicates that economic uncertainties are the most troublesome issues. These include the impact of increasing number of solar energy installations on revenues for utilities, the high cost of manufacturing solar energy systems for manufacturers, and for consumers, the high initial outlay costs for solar energy systems are most troublesome. All three groups might find well-designed cost/benefit analysis valuable to aid in their decisionmaking regarding commitments to solar energy systems.

From the manufacturers' point of view, it looks as though government interference and the lack of government programs (grouped as "government" in the classification) are the major obstacles. This problem might be overcome with more effective communication with manufacturers and a greater effort on the part of government to coordinate programs and to keep the public informed of its efforts.

The regulatory implication of these results is that the best policy for the regulator to pursue is one which neither penalizes nor encourages economic behavior that is neutral in effect. Manufacturers, utilities and consumers all have a basic set of requirements that can best be summarized as a need for reliable information to make decisions either to produce a product, provide a service, or make a purchase. Policies that either promote or subsidize one group could have a negative impact on another class of customers.

Characteristics of Manufacturers

Questions 8-11 collected information on solar manufacturer characteristics including the length of time a company had been in business and its sales volume and product mix. Analysis of this information shows a profile of a young industry made up of many small companies where the main line of sales is based primarily on solar energy equipment (see Table 4-17A). Almost half the manufacturers participating in the study had been in business four years or less. Almost two-thirds said they had been manufacturing solar energy equipment for four years or less (see Table 4-17B). Slightly less than half (47.1%) of those responding said they expected sales of less than $500,000 in calendar year 1979 (see Table 4-17C). Close to half (45.6%) manufactured only solar energy equipment (see Table 4-17D). An industry exhibiting such a profile is vulnerable to changes in the marketplace. Based on the level of technological simplicity of the basic product, we can expect the entry of new firms to be very rapid if the uncertainties clouding solar energy developments in this country are removed. It also means that the risk-taking entrepreneurs that have committed early in the development cycle could be harmed and cause them to exit the industry if regulatory policies cause undue and sustained uncertainty.

TABLE 4-17

CHARACTERISTICS OF MANUFACTURERS

A. Years in Business

years	number of manufacturers	cumulative frequency (percent)
3 or less	37	27.2
4	28	47.8
5	19	61.8
6-20	23	78.7
more than 20	25	97.1
no answer	4	100.0

B. Years Manufacturing Solar Energy Equipment

years	number of manufacturers	cumulative frequency (percent)
2 or less	28	20.6
3	31	43.4
4	29	64.7
5	30	86.8
more than 5	12	95.6
no answer	6	100.0

Characteristics of Utilities

A slightly different set of information was collected on characteristics of utilities participating in this study. An attempt was made to determine the level of effort utilities have made to any aspect of solar energy system development in questions 8-13 of the utility company profile (see Exhibit 2).

Half of the utilities reported they were devoting only one man year or less to solar energy system development in 1979 (see Table 4-18). Three-quarters had committed four man years or less to the area. But many utilities had supplemented their in-house commitment with outside consultants: 40 utilities (47.6%) said they had employed consultants to assist in some aspect of development of solar energy systems; 41 (48.8%) said they had not; three (3.6%) did not answer the question.

The company commitment issue was pursued one step further to determine specific areas where efforts were being made and resources committed. In general, it was determined that where companies had committed resources, it had gone for monitoring research, providing electric service and other areas of solar energy system development. Relatively little effort has been spent thus far on rate and tariff design (see Table 4-19). Fifty-three utilities (63.1%) said they were providing electric service to customers with solar energy systems. But only 29 (34.5%) said they were devoting resources to rate and tariff design. Other areas to which the utilities reported they had committed resources included construction and/or operation of solar energy systems (five companies) and providing information to customers (four companies).

As to the future, companies were asked to forecast what their resource commitments to solar energy systems would be in comparison to their present commitment level. Although the activities in solar energy system development reported by the utilities adds up to a small commitment at present, most said they expected to be committing more resources in the

TABLE 4-18

NUMBER OF MAN YEARS DEVOTED TO SOLAR ENERGY SYSTEM DEVELOPMENT BY ELECTRIC UTILITIES IN 1979

number of man years	number of utilities	cumulative frequency (percent)
1 or less	43	51.2
1.1 to 4	21	76.2
greater than 4	10	88.1
no answer	10	100.0

TABLE 4-19

AREAS OF SOLAR ENERGY SYSTEM DEVELOPMENT
TO WHICH UTILITY RESOURCES ARE COMMITTED

	number of utilities	percent of utilities*
monitoring progress in solar energy system development	69	82.1
engineering and technical research	50	59.5
marketing and economic research	43	51.2
providing electric service to customers with solar energy systems	53	63.1
tariff and rate design	29	34.5
other	23	27.4

*Percentage is based on number responding from the utility group (N=84).

next five years. Forty-nine companies (58.3%) said they expected to be devoting more resources to solar energy systems within five years, compared to their present commitment. No utility said it would be doing less. Eleven (13.1%) expected to be at the same level of resource commitment in the next five years. Twenty-one (25.0%) said they didn't know what their relative commitment would be.

Another element of the utility characteristic profile was to determine the number of solar energy customers for which the company is providing back-up service. Responses were to be placed in three customer classes for solar water heating only, solar water and space heating and solar space cooling (see Table 4-20). The number of customers using solar energy systems, where the companies reported a figure, was very low. Where the companies said they did have customers, the mode was between one and 10 customers for all categories of solar energy system use and all customer classes.

For solar water heating only, 16 utilities (19.1%) reported providing back-up service to between one and 10 residential customers; 11 (13.1%) to commercial customers. Twelve utilities (14.3%) reported providing back-up service to between 11 and 100 residential customers; one (1.2%) commercial customers. Five utilities (6.0%) said they were providing electricity to more than 100 residential customers using solar water heating, and two (2.4%) said more than 100 commercial customers were receiving such service.

For solar water and space heating, 20 utilities (23.9%) reported they were providing back-up service to between one and 10 residential customers; 16 (19.2%) to commercial customers. Ten utilities (11.9%) reported between 11 and 100 residential customers in this category; two, commercial customers. One electric utility said service was being provided to more than 100 customers using solar water and space heating.

No utility said they were serving more than 10 customers who were

TABLE 4-20 NUMBER OF CUSTOMERS WITH SOLAR ENERGY SYSTEMS BEING PROVIDED BACK-UP SERVICE BY ELECTRIC UTILITIES*

Customer Range	solar water heating only			solar water and space heating			space solar cooling		
	residential	commercial	other	residential	commercial	other	residential	commercial	other
0	0 0.0%	2 2.4%	0 0.0%	2 2.4%	5 6.0%	2 2.4%	13 15.5%	11 13.1%	4 4.8%
1-10	16 19.0%	11 13.1%	2 2.4%	20 23.9%	16 19.2%	0 0.0%	3 3.6%	7 8.4%	0 0.0%
11-20	6 7.2%	1 1.2%	0 0.0%	3 3.6%	1 1.2%	0 0.0%	0 0.0%	0 0.0%	0 0.0%
21-50	5 6.0%	0 0.0%	0 0.0%	5 6.0%	1 1.2%	0 0.0%	0 0.0%	0 0.0%	0 0.0%
51-100	1 1.2%	0 0.0%	0 0.0%	2 2.4%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%
more than 100	5 6.0%	2 2.4%	0 0.0%	1 1.2%	0 0.0%	0 0.0%	0 0.0%	0 0.0%	0 0.0%
no answer	51 60.7%	68 81.0%	82 97.6%	51 60.7%	61 72.6%	82 97.6%	68 81.0%	66 78.6%	80 95.2%

*Percentage is based on number of utilities providing service in that customer range (N=84).

using solar cooling systems. Seven (8.4%) said they had between one and 10 commercial customers using solar cooling. Two utilities each said they had one residential customer using solar cooling. One utility said it was providing electricity to 10 solar cooling customers.

Summary of Tariffs

For the most part, the electric utilities taking part in the study did not report much action on development of a tariff for solar energy system customers (see Table 4-21). Eight (9.5%) said a tariff had already had been approved by the state utility regulatory commission. Another 10 (11.9%) said a tariff had been proposed to the commission or they were waiting for a commission order. The largest group (33 companies, 39.3 percent) said they were studying a tariff for customers using solar energy systems. But nearly as large a group (27 companies, 32.1 percent) said they had no interest in developing such a tariff.

Perhaps the most significant observation from this part of the investigation is the number (32.1%) of the utilities that have no interest in the development of a solar energy tariff by the company. Perhaps this may be an indication that commission action is required to get a company to submit proposed tariffs as part of a rate case or during generic hearings.

A Summary of Major Findings

Several major observations can be excerpted and generalized from this study of regulatory policy needs as expressed by solar energy equipment manufacturers and electric utilities. In general, the research shows that the two company groups are searching for leadership and direction regarding solar energy policy development. The strong interest in pursuing a shared responsibility approach is certainly a major finding that should be taken into account in policy design. The following is a summary of other major findings from this investigation.

TABLE 4-21

STATUS OF TARIFFS FOR CUSTOMERS USING SOLAR ENERGY SYSTEMS

	number of utilities	percent of utilities
Under study by company	33	39.3
Proposed to the state commission	6	7.1
Approved by state commission	8	9.5
No active interest by company	27	32.1
Waiting for commission order	4	4.8
No Answer	6	7.2

- Electric utilities do not believe that their state public utility commissions have used their authority to influence decisions on solar energy systems.

- Utilities and manufacturers agree that responsibility for tasks related to solar energy system development should be shared among several types of participating organizations and groups. Tasks for which they think responsibility should be shared were promotion, informing the public, developing tariffs for back-up service, and establishing equipment standards.

- When the companies' choices assigning sole and shared responsibility are combined, it appears that manufacturers and utilities in general agree on the degree of responsibility of each class of participants relative to the other classes.

- Utilities want state regulatory commissions to remain neutral on the development of solar energy systems, certainly in the area of rate setting. Manufacturers want commissions to play a role but not necessarily by advocating promotional rates.

- Many manufacturers prefer that the role of utilities in solar energy development be minimized. Forty manufacturers (44.0 percent of those responding to the question) said utilities should have no responsibility for developing tariffs for back-up service to solar energy customers. Majorities of the manufacturers participating in development of the profile opposed utility ownership, marketing and sale of solar energy systems. Only 36 percent were in favor of utilities even providing product information.

- Both utilities and manufacturers tend to believe the traditional declining block rate would hurt a solar energy system program in their state. Both leaned towards inverted block rates as an aid to a solar energy system program.

- Electric utilities participating in development of the profile believe a tariff designed especially for solar back-up service is most appropriate for solar space and water heating. The manufacturers favor having one tariff for all residential customers.

- Although the utilities report a small commitment now to solar energy system development, most say they expect to be devoting more resources to this area within five years.

- Utilities blame the cost of solar energy systems for preventing their development. Manufacturers blame government regulation, lack of government incentives, poor information about solar energy, and public attitudes, as well as economics.

EXHIBIT 1

The National Regulatory Research Institute

blished by the National Association
of Regulatory Utility Commissioners
at The Ohio State University
2130 Neil Avenue
Columbus, Ohio 43210
614/422-9404

REGULATORY REQUIREMENTS PROFILE FOR SOLAR ENERGY SYSTEMS

The objective of this inquiry is to determine the regulatory needs and requirements for solar energy systems. By solar energy systems we mean any equipment that uses solar energy to help heat or cool a building or for water heating. Please answer the questions by placing a check mark in the box or by providing the requested information that best represents **your company's** position on solar energy systems. Use additional paper if you want to expand on a response. Return the completed form to The National Regulatory Research Institute. Individual names will not be used in the report, only aggregates. If you have questions please call - **collect** - Dr. Richard Darwin or Ms. Vivian Witkind.

1. To your knowledge, have state utility regulatory commissions used their authority to influence decisions by consumers on the use of solar energy systems?

   Yes ☐ No ☐ No opinion ☐ Don't know ☐

   If your answer is "yes," how would you characterize their influence on the use of solar energy systems?

   Favorable ☐ Unfavorable ☐ Neutral ☐ Don't know ☐

2. To your knowledge, has a utility regulatory commission in a state served by your company used its authority to influence decisions by consumers on the use of solar energy systems?

   Yes ☐ No ☐ No opinion ☐ Don't know ☐

   If your answer is "yes," how would you characterize that state commission's influence on the use of solar energy systems?

   Favorable ☐ Unfavorable ☐ Neutral ☐ Don't know ☐

3. In each of the boxes place the letter you believe represents the appropriate role to be assumed by each participant. Use "A" if you believe the participant should have sole responsibility, "B" for shared responsibility and "C" for no responsibility. The Letter "A" should appear only once for each role.

PARTICIPANT

ROLE in Solar Energy Systems	electric utility	state regulatory commission	state energy office	solar equipment manufacturer	consumer	Other (please specify)
a. promotion						
b. informing the public						
c. developing tariffs for back-up service						
d. establishing equipment standards						
e. selling equipment						
f. installing and maintaining equipment						

4. Indicate whether you agree or disagree that a state utility regulatory commission should:

	Agree	Disagree	No Opinion
a. promote solar energy systems by means of utility rates	☐	☐	☐
b. support utility rates that neither penalize nor promote use of solar energy systems	☐	☐	☐
c. order a public utility to develop a solar energy system program	☐	☐	☐
d. encourage public utilities to sell equipment for solar energy systems	☐	☐	☐
e. forbid public utilities to sell equipment for solar energy systems	☐	☐	☐
f. wait for direction from the federal government on solar energy policy	☐	☐	☐
g. take no action on solar energy systems	☐	☐	☐

5. It has been proposed that electric utilities should be encouraged to engage in those activities that promote the use and acceptance of solar energy systems. Please check the box next to each activity that best expresses your company's position as to the involvement by electric utilities in that activity.

ACTIVITY	For	Against	Neutral
a. ownership of solar energy systems	☐	☐	☐
b. marketing and sale of solar energy systems	☐	☐	☐
c. providing financing of solar energy systems for customers	☐	☐	☐
d. leasing solar energy systems	☐	☐	☐
e. providing only product information on solar energy systems	☐	☐	☐

6. Many believe that solar energy systems can be influenced by rates charged for back-up service by electric utility companies. Please check the boxes below that represent your opinion of the effect each rate type would have on a solar energy systems program in your state.

	would be most appropriate	would help solar	would hurt solar	would have no effect	don't know
a. traditional declining block rate					
b. flat rate with a customer charge					
c. time of day rate					
d. seasonal rate					
e. inverted block rates					

7. For residential solar energy uses identified in columns A and B, choose from the list below the **one** tariff type you feel is the most appropriate for electric back-up service.

A tariff designed especially for:	**A** solar water heating only	**B** solar space and water heating
a. an all-electric home	☐	☐
b. residential service with water heating	☐	☐
c. customers with no electric space or water heat	☐	☐
d. special solar back-up service	☐	☐
e. none of the above: there should be one tariff for all residential customers	☐	☐
f. don't know	☐	☐

8. How many years has your company been in business? Number of years ___________

9. How many years has your company been manufacturing or selling solar energy equipment?

Number of years ___________

10. What are your expected sales of solar energy equipment in calendar year 1979?

Dollars in sales ________________

11. What percentage of your company's business comes from the sale of solar energy equipment?

_________ 100%	_________ between 6% and 25%
_________ greater than 50%	_________ between 1% and 5%
_________ between 26% and 50%	_________ less than 1%

12. What is the major obstacle to development of solar energy systems in this country?____________________

____

____

Yes, I would like a copy of the results of this national profile when it is available for distribution. ☐

Please return your completed profile to the NRRI by using the business reply form on the back of this page. To do so, fold the profile as it came to you, with the business reply form facing out. Then staple where indicated.

OSU

The Ohio State University

The National Regulatory Research Institute
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EXHIBIT 2

The National Regulatory Research Institute

blished by the National Association
of Regulatory Utility Commissioners
at The Ohio State University
2130 Neil Avenue
Columbus, Ohio 43210
614/422-9404

REGULATORY REQUIREMENTS PROFILE FOR SOLAR ENERGY SYSTEMS

The objective of this inquiry is to determine the regulatory needs and requirements for solar energy systems. By solar energy systems we mean any equipment that uses solar energy to help heat or cool a building or for water heating. Please answer the questions by placing a check mark in the box or by providing the requested information that best represents **your company's** position on solar energy systems. Use additional paper if you want to expand on a response. Return the completed form to The National Regulatory Research Institute. Individual names will not be used in the report, only aggregates. If you have questions please call - **collect** - Dr. Richard Darwin or Ms. Vivian Witkind.

1. To your knowledge, have state utility regulatory commissions used their authority to influence decisions by consumers on the use of solar energy systems?

   Yes ☐ No ☐ No opinion ☐ Don't know ☐

   If your answer is "yes," how would you characterize their influence on the use of solar energy systems?

   Favorable ☐ Unfavorable ☐ Neutral ☐ Don't know ☐

2. To your knowledge, has a utility regulatory commission in a state served by your company used its authority to influence decisions by consumers on the use of solar energy systems?

   Yes ☐ No ☐ No opinion ☐ Don't know ☐

   If your answer is "yes," how would you characterize that state commission's influence on the use of solar energy systems?

   Favorable ☐ Unfavorable ☐ Neutral ☐ Don't know ☐

3. In each of the boxes place the letter you believe represents the appropriate role to be assumed by each participant. Use "A" if you believe the participant should have sole responsibility, "B" for shared responsibility and "C" for no responsibility. The Letter "A" should appear only once for each role.

PARTICIPANT

ROLE in Solar Energy Systems	electric utility	state regulatory commission	state energy office	solar equipment manufacturer	consumer	Other (please specify)
a. promotion						
b. informing the public						
c. developing tariffs for back-up service						
d. establishing equipment standards						
e. selling equipment						
f. installing and maintaining equipment						

4. Indicate whether you agree or disagree that a state utility regulatory commission should:

	Agree	Disagree	No Opinion
a. promote solar energy systems by means of utility rates	☐	☐	☐
b. support utility rates that neither penalize nor promote use of solar energy systems	☐	☐	☐
c. order a public utility to develop a solar energy system program	☐	☐	☐
d. encourage public utilities to sell equipment for solar energy systems	☐	☐	☐
e. forbid public utilities to sell equipment for solar energy systems	☐	☐	☐
f. wait for direction from the federal government on solar energy policy	☐	☐	☐
g. take no action on solar energy systems	☐	☐	☐

5. It has been proposed that electric utilities should be encouraged to engage in those activities that promote the use and acceptance of solar energy systems. Please check the box next to each activity that best expresses your company's position as to the involvement by electric utilities in that activity.

ACTIVITY	For	Against	Neutral
a. ownership of solar energy systems	☐	☐	☐
b. marketing and sale of solar energy systems	☐	☐	☐
c. providing financing of solar energy systems for customers	☐	☐	☐
d. leasing solar energy systems	☐	☐	☐
e. providing only product information on solar energy systems	☐	☐	☐

6. Many believe that solar energy systems can be influenced by rates charged for back-up service by electric utility companies. Please check the boxes below that represent your opinion of the effect each rate type would have on a solar energy systems program in your state.

	would be most appropriate	would help solar	would hurt solar	would have no effect	don't know
a. traditional declining block rate					
b. flat rate with a customer charge					
c. time of day rate					
d. seasonal rate					
e. inverted block rates					

7. For residential solar energy uses identified in columns A and B, choose from the list below the **one** tariff type you feel is the most appropriate for electric back-up service.

A tariff designed especially for:	**A** solar water heating only	**B** solar space and water heating
a. an all-electric home	☐	☐
b. residential service with water heating	☐	☐
c. customers with no electric space or water heat	☐	☐
d. special solar back-up service	☐	☐
e. none of the above: there should be one tariff for all residential customers	☐	☐
f. don't know	☐	☐

8. In 1979 how many man years is your company devoting to any aspect of solar energy systems development?

man years ☐

9. Has your company employed consultants to assist in any aspect of development of solar energy systems?

Yes ☐ No ☐

10. If your company does have a commitment to the development of solar energy systems, to what areas are resources committed? Check all that are appropriate.

   a. monitoring progress in solar energy systems development ☐
   b. engineering and technical research ☐
   c. marketing and economic research ☐
   d. providing electric service to customers with solar energy systems ☐
   e. tariff and rate design ☐
   f. other ______________________

11. What is the status of a tariff for solar energy system customers in your company's service area?

   a. It is under study by the company. ☐
   b. One has been proposed to the state utility regulatory commission. ☐
   c. One has been approved by the state utility regulatory commission.* ☐
   d. There is no active interest by this company in the development of such a tariff. ☐
   e. We are waiting for an order from the state utility regulatory commission. ☐

*Would you please send us a copy of the approved tariff.

12. If your company does have a solar energy systems program, please write in for each category of user the number of customers to whom you are currently providing back-up service:

	Residential	Commercial	Other
a. solar water heating only	______	______	______
b. solar water and space heating	______	______	______
c. solar space cooling	______	______	______

13. Compared to present commitment, what resources will your company devote to solar energy systems in the next five years?

more ☐ same ☐ less ☐ don't know ☐

14. What is the major obstacle to development of solar energy systems in this country?______________________

____

____

Yes, I would like a copy of the results of this national profile when it is available for distribution. ☐

Please return your completed profile to the NRRI by using the business reply form on the back of this page. To do so, fold the profile as it came to you, with the business reply form facing out. Then staple where indicated.

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CHAPTER 5

REGULATORY IMPLICATIONS
AND
SOLAR ENERGY SYSTEM POLICY ALTERNATIVES

Introduction

With the completion of the three major research tasks, the study now turns to translating the findings into a product that is useful for the design of solar energy regulatory policy. The purpose of this chapter is to examine these regulatory issues and to discuss the implications the research findings will have on the development of regulatory policy. The presentation attempts to present a balanced view of the issues, but a case is made for the concept of "regulatory neutrality" as the cornerstone for the design of solar energy systems regulatory policy.

Regulatory Neutrality Defined

For the purpose of this study, the concept of regulatory neutrality was defined earlier as a policy position that embraces regulatory actions, programs or methods that neither impose penalties nor provide subsidies to the end user. Two criteria were proposed for achieving regulatory neutrality. The first criterion is for all customers in a service class to operate under the same tariff or rate structure. In the case of the customer who installs solar energy equipment, it can be said that regulatory neutrality has been exercised if the customer operates under a tariff that is applicable to other general service customers in that class. All customers are treated equally since no penalties or subsidies are possible under such a policy. However, this assumes that the new technology--the solar energy equipment installation--has similar cost characteristics to the technology being used to supply others in that customer class with energy. There is evidence in the literature to show that solar energy equipment technology has different operating and cost characteristics compared to conventional energy generating technology and, therefore, requires regulatory policy that recognizes the difference. A second test for regulatory neutrality is to require a cost-of-service analysis for the solar installation. In other words, a regulatory policy that imposes a similar rate or tariff on all customers may meet the requirements of the first test of regulatory neutrality, but not for the second. For those who view solar energy as a possible solution to rising energy costs, such a policy could artificially discourage the use and development of this new technology. This assumes that the true costs of solar energy in this instance were lower than the incremental cost of alternative sources.

As a result, utility regulators must consider the rate structure under which the solar energy system customer is operating because it could discourage use and be viewed as a penalty. There are certain approaches to rate design that could have such an effect on solar energy users. One such rate structure is the traditional average and embedded cost approach to rate design which produces a declining block rate structure. Another is designing rates based on end use. Rate design research indicates that a more suitable rate for solar energy system users may be provided by a form of incremental costing methodology that results in time-of-use or marginal cost rates. Despite the many arguments that can be made for and against certain costing and pricing methods, there is consensus among regulators that rates must in some way reflect the costs of providing that service. The policy, therefore, should be to require a cost-of-service study for solar energy systems that would allow for the design of rates that reflect the true cost of providing service to the customer class.

Developing cost of service studies to meet this objective is one intent of the Public Utility Regulatory Policies Act (PURPA) P.L. 95-617. A careful reading of its first three standards will provide the background for considering a new approach to rate design and regulatory policy.

1. Cost of Service. Rates charged by an electric utility for providing electric service to each class of electric consumers shall be designed, to the maximum extent practicable, to reflect the costs of providing electric service to such class, as determined under section 115(a).

2. Declining Block Rates. The energy component of a rate, or the amount attributable to the energy component in a rate, charged by any electric utility for providing electric service during any period to any class of electric consumers may not decrease as kilowatt-hour consumption by such class increases during such period except to the extent that such utility demonstrates that the costs to such utility of providing electric service to such class, which costs are attributable to such energy component, decrease as such consumption increases during such period.

3. Time-of-Day Rates. The rates charged by any electric utility for providing electric service to each class of electric consumers shall be on a time-of-day basis which reflects the costs of providing electric service to such class of electric consumers at different times of the day unless such rates are not cost-effective with respect to such class, as determined under section 115(b).

Additional support for the concept of regulatory neutrality regarding the treatment of solar energy application may be found in Section 210 of PURPA. Section 210 describes rules for cogeneration and small power production (though solar is not mentioned). If a solar energy installation as described in this report can be thought of as a small power producer, then it follows that electric utilities could operate by rules described in Section 210(b) and (c) for the purchase and sale of electricity to small producers. Such rules require any electric utility to purchase electric energy from any qualifying small power production facility. The rates for such purchase: (1) shall be just and reasonable to the electric consumers of the electric utility and in the public interest; and (2) shall not discriminate against qualifying cogenerators or qualifying small power producers. In a similar manner, prescribed rules requiring any electric utility to sell electric energy to a qualifying cogeneration facility or small power producer must do so under conditions identical to that described for purchases.

Section 210(d) also defines "incremental cost of alternative electric energy" which means the cost to the electric utility of the electric energy which, but for the purchase from such cogenerator or small power producer, such utility would generate or purchase from another source. Therefore, Section 210 (a,b,c,d) prescribes rules that can be argued as showing support for regulatory neutrality and a cost-of-service methodology that measures incremental cost--by analogy--applicable to solar.

In summary, regulatory neutrality as proposed in this chapter is a policy position that supports regulatory actions, programs or methods that neither impose penalties nor provide subsidies to the end user. Such a policy should meet two tests.[1]

1. Any action, program or method should be non-discriminatory and should be made applicable to all customers in a service class.

2. The rate structure for customers in that service class should use a cost-of-service methodology to track costs that will, in turn, produce rates that are cost based.

Finally, this report will not enter into any discussion as to which rate design is based on cost nor will there be any extensive analytical treatment of how certain rate structures discourage or encourage solar energy system use. Those interested in the treatment of these subjects are referred to representative sources mentioned in Chapter 3 of this report. The EPRI study on rate design and a publication by the NRRI are valuable sources for a discussion of issues and alternatives in this subject area.[2]

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[1] Another test for neutrality under this definition is that suggested by Pareto optimality. The method of measurement that is applicable appears to be some form of incremental cost pricing. Pareto optimality is said to exist when no change can be implemented that will make someone better off without making someone else worse off--each in his own estimation. The concept is synonymous with presumed economic efficiency.

[2] Electric Utility Rate Design Study, Rate Design and Load Control. A report to The National Association of Regulatory Utility Commissioners. (Palo Alto, California: Electric Power Research Institute, Nov. 1977). See also, Alternatives to the Ohio Energy Credits Program (The National Regulatory Research Institute, March 1979).

Regulatory Neutrality and Policy Making

The reason why the concept of regulatory neutrality is being proposed here is that it provides utility regulators with an approach that seems to be most appropriate in developing regulatory policy for non-traditional energy sources and their associated technologies. Specifically, in the case of solar energy system applications, the commission is faced with the difficult task of using traditional regulatory methods to formulate policy in an area where much uncertainty exists. Under such conditions, utility regulators do not knowingly want to cause harm to the new emerging technology by imposing a set of regulatory conditions that penalize and retard its development. On the other hand, the commission would presumably want to take a position that promotes development through a form of subsidization that penalizes competing technologies or other customers on the system.

A regulatory policy based on the concept of regulatory neutrality allows the commission to steer a middle course that would neither support advocates of solar energy systems seeking a promotional policy nor favor possible detractors with an interest in resisting a new technology. The task would then become one of identifying issue areas and conditions that should be considered by utility regulators in developing solar energy regulatory policy that would in effect be neutral.

A selective review and analysis of the literature in Chapter 2 revealed that numerous studies and research reports have presented arguments for a promotional policy using tax incentives and subsidies, while a small number have called attention to the regulatory obstacles that face solar energy system applications. Little attention was devoted to the concept of regulatory neutrality as defined in this report though such an approach is presumed to be traditional to public utility regulation.

The third chapter in this study reported on the present status and activities of public utility commissions regarding solar energy tariffs and policy developments. Several observations were made based on that effort and will be helpful in providing a better understanding of public utility commissions' commitment of resources to the matter. For example, it was found that commissions have not developed a clearly defined policy for solar energy applications nor are there many examples of commitments to such development.

The previous chapter presented an analysis of needs and requirements for solar energy regulatory policy from the viewpoint of electric utilities and solar energy equipment manufacturers. Results from this part of the investigation provided additional support for the design of solar energy system policy based on regulatory neutrality. As a result of these findings and observations, it is possible to offer certain guidelines that may be of value in the design of solar energy regulatory policy if the concept of neutrality is a goal.

Basic Solar Energy System Configurations

To better understand the material presented in this chapter, it is useful to provide some background regarding certain configurations, applications, and possible response strategies for solar energy system applications. There are two basic solar energy system configurations with regulatory implications. The first is the centralized power generation configuration where the solar energy system will be required to compete with traditional generating methods and technology. The problems of centralized power generation using solar energy presents the utility regulator with a challenge similar to that offered by any new power technology when first introduced.

Accordingly, many believe that the regulatory requirements for centralized solar energy system applications can be answered by traditional regulatory methods. The challenge offered by decentralized or dispersed solar energy systems may, however, pose more substantial difficulties. A dispersed solar energy system is defined as an autonomous, unregulated and relatively unpredictable producer of energy capable of producing usable Btu for consumption at that location. The research in this study and the discussion in this chapter are concerned only with developing policy guidelines for decentralized or dispersed solar energy system applications.

Some of the various design features of a dispersed solar energy system should be briefly mentioned. One problem is that they are not standard. For example, in terms of applications, it could be used for water heating, space heating, or air conditioning or could be used for a combination of the three. The system will more than likely have storage capability but the capacity may vary from a very short period (hours) to several days. As a result, a number of back-up energy sources may be required such as a heat pump, natural gas or fuel oil. A system may be designed to provide energy for almost all of the household consumption or for a small amount. Most important, the energy needs of the household could vary from season to season.

In addition to the configuration complexity of the dispersed solar system, it must be acknowledged that each utility system is also unique. The operating characteristics of a utility vary by season (summer vs. winter peaking), by day, by fuel source and by generating capacity. The specific system characteristics of utilities and the nonstandard features of solar system installations introduce a level of complexity that makes rate design very difficult and the development of solar regulatory policy particularly challenging.

Since this report focuses on dispersed solar energy systems, it is also helpful to identify the regulatory issues that surface when considering a configuration of this type. The user or installer of such a system includes the individual homeowner, a landlord of a multiple dwelling unit, commercial and industrial customers. The customer classes are similar to those found in traditional configurations but are different in that their prime motivation for installing a solar energy system is to reduce their utility costs rather than the quality of service. As such, the installer of a dispersed energy system will be concerned with the availability and cost of back-up service. For the utility regulator, the demand for this type of service requires a tariff for the solar energy system customer based, perhaps, on traditional rules for utility rate design. That is, the solar customer should be provided a rate structure that is fair and equitable yet simple to interpret and understand.

The utility, on the other hand, is also concerned with the rate structure since, in addition to equity and simplicity, it is interested in the revenue-generating consequences of any solar tariff. Revenue adequacy is of major concern for a utility, especially when the number of dispersed solar energy systems reaches a level that erodes the income of the company through supplanting some of its previous sales. Thus, the increased number of dispersed solar energy systems calling for back-up service will understandably influence the utility in its acceptance of or resistance to solar energy regulatory policy set down by utility regulators. With more back-up service customers, the utility may decide, for example, to more aggressively shape its solar customer service policy by requesting from the public utility commission authority to market, sell and maintain equipment that meets utility specifications. This is the so-called "preferred configuration" argument. For additional incentive, the utility may request that the equipment remain utility property and be considered as "used and useful" where the cost of such equipment is treated as an investment to be included in the rate base on which the utility can earn a rate of return.

Just what kind of arrangements would be accepted by the energy-consuming public is a question that also must be considered by utility regulators. As a result, there may be more effort and resources required to educate the public on such issues than there is in the development and design of solar energy regulatory policy. Public communications and education, although not specifically within the mandate of many public utility commissions, may again be a critical element in future regulatory policy-making.

There are other issues that clearly fall outside the authority of the public utility commissions, such as the treatment of public utilities by the state constitution. Some policy strategies may require changes in state statutes such as: (1) the ownership of equipment; (2) utility expenditures that can be considered investments for ratemaking purposes; and (3) requiring a utility to provide service to a customer on demand. Federal antitrust laws concerning the competitive issues of utility involvement in the solar equipment business would also have to be considered; where appropriate, mention of these conditions will be made briefly during the course of the discussions in this chapter.

In summary, the presence of solar energy systems in a state require that the public utility commissions develop policy that will provide guidelines for rate structure, revenue requirements, and rate-base treatment. This will lead to consideration of such issues as cost-of-service methodology, rate design, rate of return and account treatment of expenses and investments. It is within this environment that the use of traditional regulatory methods may be tested by the uncertainty caused by the appearance of a new technology.

How, then, does one introduce the concept of regulatory neutrality for a technology that operates in an environment of utility uniqueness with regard to operation and revenue requirements and nonstandard installation by a decentralized end user?

Solar Energy Policy Design

The concept of neutrality, if it is to have any meaning, must be based on economic principles acceptable to the regulatory community. The policy strategies which are proposed in this chapter are based on the fundamental principle that rates designed for back-up service to solar energy system applications should reflect the true costs of providing that service. Tracking of costs and designing cost-effective rates is a fundamental requirement for regulatory neutrality. Methods most often proposed for the determination of cost-based rates and which would seem to have special applicability here are marginal cost pricing and time-of-use pricing. By using either of these methods, it is argued that regulatory neutrality will more likely be achieved since the price of the back-up service to the customer reflects the cost of its production. It follows that the solar energy user would not be penalized nor subsidized at the expense of other non-solar customers on the utility system.

By accepting the use of cost-of-service methods that will track the costs for providing service and adopting an appropriate pricing scheme, a commission may find that the development of solar regulatory policy based on neutrality can be implemented by pursuing any of four possible courses of action. The four possible policy strategies are termed passive, preferred configuration, active and investment and are presented in Figure 5-1. The development of solar energy regulatory policy is viewed as a sequential process. Step one is to track costs; step two, price the service; step three, strategy selection; and step four, implementation. The next section of this chapter will focus on the selection of a strategy for developing a solar energy policy based on the concept of regulatory neutrality.

Solar Energy Policy Strategies

As mentioned, there are at least four possible strategies that a utility regulator could adopt in the development of policy for solar energy system installations. The strategies presented here were originally proposed for utilities.[3] Each suits the needs and requirements of a group of customers or a particular utility and also gives the utility regulator the latitude to consider the economic and political climate in the state. The four proposed strategies present the utility regulator with options that range from a conservative policy to one that has a high payoff for energy conservation but carries political risk.

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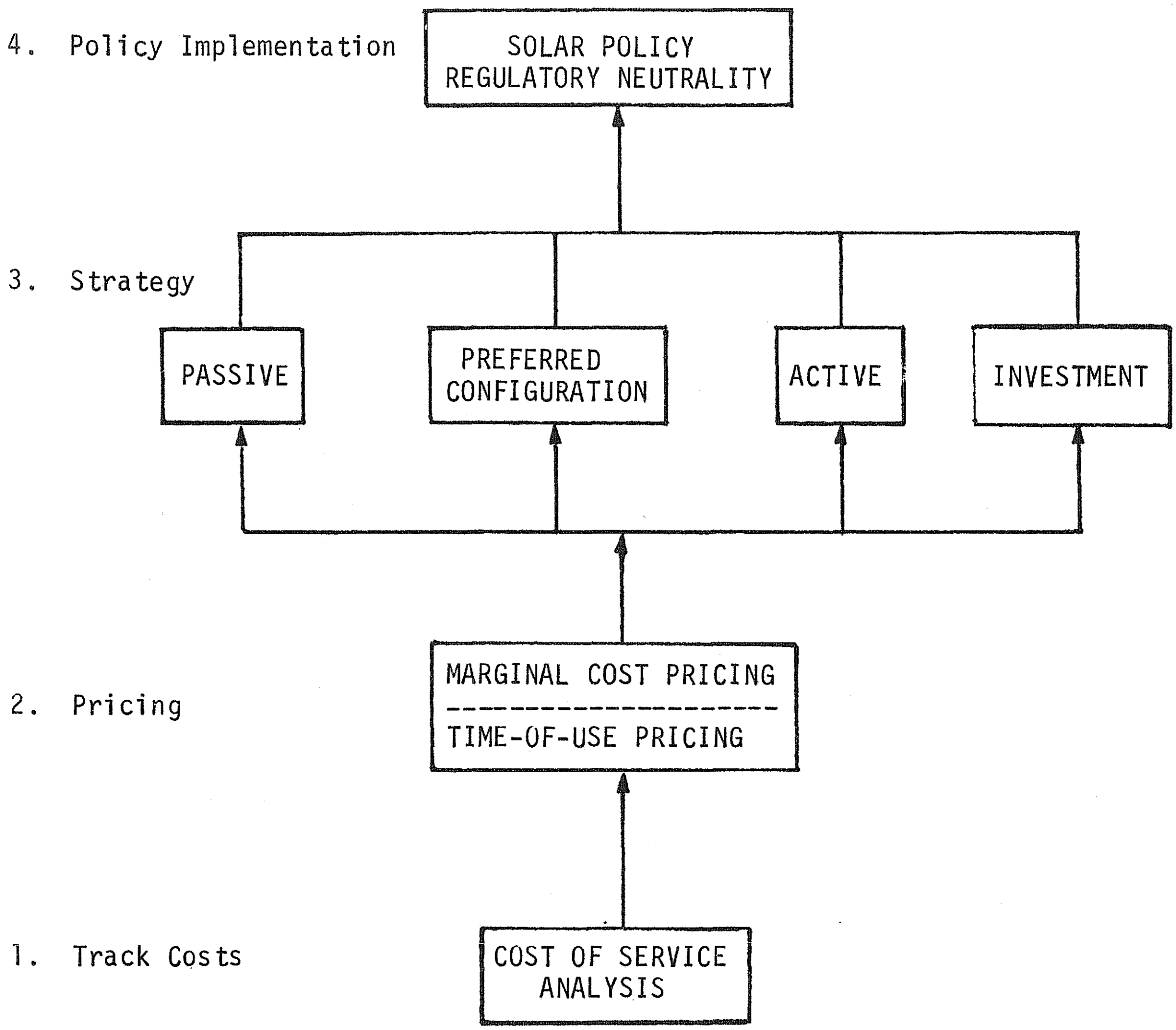
[3] John K. Freeman, "Utility Alternatives for Solar Energy," Public Utilities Fortnightly (January 1978).

FIGURE 5-1

SOLAR ENERGY REGULATORY POLICY STRATEGIES



Passive

The passive strategy is based on traditional approaches to regulatory problems. In other words, the commission could adopt a policy where the installation of a solar energy system is a matter of private concern for both the builder and the end user. The responsibility of the utility and the commission would end at the meter as it does now under present regulatory guidelines.

Should the customer request a supplemental back-up service, the utility would be required to provide service described by a tariff that is applicable to all other customers in that service class. The commission would require only that the rates for that class be cost based. Such a strategy can be considered neutral in effect; and since it is non-discriminatory, the benefits arise from the features of simplicity and ease of administration.

However, the utility may find this approach to be unworkable because it can be argued that cost-based rates for the many non-standard applications are difficult to determine since a cost-of-service analysis is virtually impossible to conduct. The passive strategy would be workable if the number of solar energy equipment users remains small; but as the number of users increases, utility operations may be effected. In this latter situation, the passive strategy can lead to an impasse, and the commission may want to consider a strategy that addresses the problem of the utility being unable to perform a cost-of-service analysis. The uncertainty caused by a myriad of nonstandard solar energy system installations makes a cost-of-service analysis very difficult to perform, and is, therefore, the principal weakness in the passive strategy approach.

Preferred Configuration

A strategy that calls for the standardization of solar energy installations can correct the major weakness in the passive strategy approach. Such an approach can be referred to as the preferred configuration. Pursuing this approach would require the design of dispersed solar energy system standards that are to be followed by all customers who install a solar energy system and seek back-up service from the utility.

A preferred configuration would make a cost-of-service analysis easier to perform and consequently provide the basis for the design of cost-effective rates. The commission would more than likely require that the utility show how a preferred configuration provides all customers in the service area with the most economically advantageous set of total energy costs. If the analysis indicated that the rate designed, based on the cost-of-service analysis for this preferred configuration are least-cost based, then such a policy can be considered to be neutral in effect.

Acceptance of the preferred configuration by the energy consuming public is, of course, not guaranteed. Such an arrangement smacks of a monopoly power, restricting market choice to the benefit of the utility and could make this strategy vulnerable. However, the acceptance of this strategy by energy consumers could be made possible by a public information and education program and the offering of a reliable least-cost system. Best results might be achieved if this strategy were implemented in full cooperation with the state energy office. Under this arrangement, the utility regulator would be responsible for the economic aspects of the program and the state energy office could be responsible for communication and education.

In addition to issues already discussed regarding this strategy, other matters to be considered by the commission include the account treatment for expenses incurred by the utility in the public education effort. Also important would be the question of providing funds to cover the costs of the education program incurred by the state energy office. If the preferred configuration also includes load management devices, appropriate treatment of these expenses and investments must be determined as between customer and utility.

Active

Another possible policy strategy is to allow the utility to become actively engaged in the marketing installation and financing of solar energy systems as opposed to outright ownership. The operational model for this strategy can be found in the several home insulation programs being proposed by utilities, public utility commissions and state energy offices. The utility would perform a technical analysis (energy audit) of the installation site and make equipment, cost and budget recommendations to the user. Systems installed by local contractors would meet utility standards for system performance and reliability. Financing would be provided by local lending institutions or such arrangements could be made with the utility. All equipment would be subject to open bidding by local suppliers and manufacturers. The financial impact on the utility could be minimized by merely expensing all these activities. This active approach could be combined with the preferred configuration strategy that would add appeal from the viewpoint of the utility.

Unfortunately, the active strategy may suffer from the lack of acceptance by both the energy-consuming public and the utilities. The public may still be convinced that the close involvement of the utility in selling preferred equipment designs benefits the utility at their expense. The utility may find that this strategy does not have the economic incentives required for full corporate commitment; and, as a result, the support for such a policy may be weak. Also recall from Chapter 4 that approximately eight out of 10 (84.4%) of the utilities reported that the solar equipment manufacturers should have sole responsibility for selling solar energy systems equipment. With regard to installation and maintenance of the equipment, the research also indicated that this role should be the responsibility of the solar energy equipment manufacturer. With lack of support from customers and the utilities, the commission may find that this strategy cannot be implemented. What then is the approach that would most likely bring utility support and customer acceptance?

Investment Strategy

Although each of the three strategies outlined can be found acceptable by utility regulators, it may be insufficient to receive support from the utilities and to meet energy conservation goals. Under the present method of operation in the United States, regulated public utilities are most responsive to proposals that favorably affect the rate base on which earnings are calculated. Attempts to include construction work in progress (CWIP) or insulation program investments in the rate base on which the utility company can earn a rate-or-return has gained the fervid support of utilities but have also been resisted by many utility regulators and consumer groups. Other inclusions such as environmental control equipment have not encountered controversy in rate-base treatment. Despite the possible controversy, a rate-base approach should be considered as an alternative strategy for implementing solar energy regulatory policy. In short, one could consider the solar energy system to be utility property; and, for rate-making purposes, treated as an investment and included in the rate base. In short, this is called the investment or rate-base strategy.

The justification for an investment strategy with these features is usually made in the following manner. Treat the dispersed solar energy system installed as an energy source and the BTU product generated as a supply available to the entire service area. The customer would then have two sources of supply: one from the solar energy system and the other, as needed, supplied by the main distribution network connected to the central generating facility. The dispersed and central BTU would be metered and the customer would be billed for the combined consumption. The costs for this configuration (equipment, installation and maintenance) would be rolled in with costs for other generating sources and would therefore be treated as a rate-base investment. The utility would also be eligible for any federal and state tax benefits for such investment.

The argument is made that only the investment strategy allows solar energy systems to compete on an equitable basis with other conventional fuel investments when incremental cost analysis is used. In slightly different terms, the rate-base strategy places the whole solar energy system alternative on equal terms with other utility supply investments. There is a logical appeal to the rate-base strategy as a policy alternative. It is an approach that is based on procedures and methods that are time honored in utility regulation and could be understood by the general public if proper measures for communication and education are taken.

Another positive feature of this approach is that it places the utility squarely in the forefront of energy conservation. Since the utility would be motivated by economic incentives (optimal use of capital resources and minimizing cost of operations), the utility customers would receive benefits either directly as a solar energy equipment user in the form of lower annual utility bills (through energy conservation) or indirectly in the form of deferred commitments to expenditures for expensive generating capacity investments (through capital conservation). In addition, the customer would be assured of long-term utility company support for the solar energy system installation with rates for the back-up service that--with good commission regulation--are fair and equitable. From the viewpoint of the utility regulator and the national energy policy maker, the investment strategy may be the most effective way to achieve energy conservation goals.

There are several significant obstacles to the implementation of the rate-base strategy. The California PUC, for example, has already gone on record in opposing the inclusion of utility solar energy equipment investments in the rate base. Other commissions may also reach this conclusion. The anti-utility attitude of the general public also presents a significant barrier to the acceptance of such a program. In the California case, the PUC position is based on substantial research and analysis of current conditions in that state. Presumably, changing conditions could call for a re-examination of this position. Regarding the reluctance of the public to accept an investment program of this type is a matter of restoring trust in regulatory policy through performance, education and communications by the utility and through consumer education by the state energy office and the public utility commission.

The statutes of the state may also present a significant barrier to the investment strategy. A ruling should be sought establishing whether utility investments in solar equipment are a legitimate function as defined in the state constitution and whether such investments can enter into ratemaking, review and the hearing process.

Perhaps the most substantial barrier to this approach is presented by federal antitrust laws. It could be argued that since the utility is a monopoly and that, in this case would be the only seller of solar devices, it has evaded competition and controlled prices. Violations of the Sherman Act are also possible since the utility acting in monopolistic and monopsonistic fashion controls the purchase, sale and installation of solar devices to the detriment of other vendors and could cause higher prices to the end user. These issues should be resolved ahead of time.

Creative design for the implementation of the investment strategy could diminish several of the obstacles described. For example, the public utility commission might require that the utility support all equipment and systems from vendors that meet certain standards, something akin to rulings in the telecommunications field with respect to terminal equipment. Competitive bidding should prevail. Utilities could be prohibited from owning manufacturing or installation companies engaged in such activities. Utilities would, however, be required to approve installations and set performance standards.

A first step in gaining the acceptance of the investment strategy by the energy-consuming public would require substantiation of the benefits and costs from such a program. Such justification calls for the adoption of a cost-of-service methodology that is most applicable to the utility system under analysis. Benefits must accrue to all customers on the system. These benefits can be best represented in the form of appropriate rates to the direct solar user and to other customers on the system while also providing a fair rate-of-return to the utility. Should the cost-of-service analysis indicate that solar energy technology warrants separate service class distinction and a rate structure that is base on time-of-use pricing, than such an option must be presented. If such a procedure is followed, then both tests for regulatory neutrality have been met and the investment strategy has a chance to succeed.

Perhaps the most important step in gaining public acceptance of the investment strategy, assuming cost-effectiveness is demonstrated, is the development of a public education program that would effectively present the benefits and costs of such a program. In today's regulatory environment, neither the public utility commissions nor the utilities may have the confidence of the public to make such a program effective. Recall from the research presented in Chapter 4 of this study that the state energy office was viewed by electric utilities and solar equipment manufacturers as the government agency with the best capability to undertake consumer education and communication programs. Including the state energy office in the design and implementation of the investment strategy may be crucial to any hope of success for this approach given the current mood of the country.

Summary

The purpose of this chapter is to present alternatives for the design of solar energy regulatory policy. Findings from a 50-state solar profile of PUC solar energy policy activity, a literature review and an inventory of attitudes by respondents from electric utilities and solar equipment manufacturers were used as the basis for the development of the alternatives. The foundation for the solar energy regulatory policy, prescribed in this chapter, centered on the concept of regulatory neutrality.

Regulatory neutrality was defined as a policy position that embraces regulatory actions, programs or methods that neither impose penalties nor provide subsidies to the user. Two tests were proposed for achieving regulatory neutrality. The first is that all customers be placed in a service class to operate under the same rate structure or tariff. If all customers in this service class are treated equally under the same tariff, then regulatory neutrality has been achieved. However, if discrimination results altered consumption behavior because the rate structure is inappropriate for certain users, another test for regulatory neutrality must be applied. The second test of neutrality proposed is for utility regulators to require cost-of-service analysis to track costs so that rates can be designed which reflect the costs of providing service to that class of customers.

Attention was directed to the dilemma of the utility regulator using traditional approached in developing of policy for a new technology. Uneconomic stimulation or retardation could artificially advance or stifle a program. A policy of regulatory neutrality, difficult as it is to attain, would seem to provide the utility regulators with an acceptable course for policy-making.

Solar energy systems were classified as centralized and dispersed with the latter identified as the focus of this report. In the design of solar energy regulatory policy for this stated direction, four basic steps were identified: tracking the costs; pricing the service; selecting a strategy; and implementing the strategy. Four strategy alternatives based on regulatory neutrality were proposed.

1. Passive. This strategy is based on traditional approaches to regulation where the installation of solar energy device is a matter of private concern. Utility responsibility ends at the meter, except for the burden to provide power when called upon to do so.

2. Preferred Configuration. This strategy corrects many of the problems associated with determining costs for providing back-up service to a customer under the passive strategy. It is also consistent with the "system integrity" argument regarding interties with other people's equipment.

3. Active. This strategy provides the utility with the opportunity to pursue an energy conservation program through voluntary means of providing installation and financing services.

4. Investment. This strategy is proposed for consideration as being one that has optimal benefits for the utility and the customer. Economic incentives are most notable for the utility since all expenditures for solar devices are included in the rate base. Determination of benefits based on a cost-of-service analysis and legal research to remove possible statutory barriers is required before such a strategy can be implemented.

Each alternative allows a utility regulator to implement the strategy most applicable for the political climate, utility structure, and conservation goals in that state.