BY THE COMPTROLLER GENERAL

Report To The Congress

OF THE UNITED STATES

Commercializing Solar Heating: A National Strategy Needed

Commercializing solar heating systems could be the first successful step the Nation takes in making the transition from finite energy sources to inexhaustible ones. To accomplish this will require a concerted effort by all levels of government and private industry.

This report discusses the

--constraints facing the use of solar heating systems,

--effectiveness of ongoing efforts to overcome these constraints, and

--potential effectiveness of the National Energy Act in encouraging the use of solar heating systems.

In general, GAO found that, although numerous Federal and State programs are underway, a concerted effort to commercialize solar heating does not exist, and existing Federal financial incentives will most likely have little impact in helping solve the Nation's energy problems.

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COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

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To the President of the Senate and the
Speaker of the House of Representatives

This report discusses the adequacy of the Nation's efforts to commercialize solar heating systems. Accordingly, this report discusses (1) constraints facing the use of solar heating systems, (2) the effectiveness of ongoing efforts to overcome these constraints, and (3) the potential effectiveness of the National Energy Act in encouraging the use of solar heating systems.

Copies of this report are being sent to the Director, Office of Management and Budget; the Secretary of Energy; and the chairmen of energy-related congressional committees.

Comptroller General
of the United States

COMPTROLLER GENERAL'S REPORT TO THE CONGRESS

COMMERCIALIZING SOLAR HEATING: A NATIONAL STRATEGY NEEDED

D I G E S T

Although there are many ways of using energy from the sun, solar heating systems warrant particular attention because of their advanced position of being economically and technically accepted relative to other solar technologies. Solar heating devices also have a large potential for use since more than 40 percent of the Nation's energy is used for heating purposes. Thus, the successful widespread commercialization of these systems becomes extremely important if solar is to begin helping the Nation meet its energy needs. (See p. 1.)

In order to provide a perspective on what is being done to commercialize solar heating systems, this report examines

--constraints which impede the widespread use of solar heating systems,

--the effectiveness of ongoing efforts to overcome these constraints, and

--the potential effectiveness of the National Energy Act in encouraging the use of solar heating systems. (See p. 3.)

CONSTRAINTS WHICH IMPEDE THE WIDESPREAD USE OF SOLAR HEATING

Although the technical feasibility of using solar heating for a wide range of residential, commercial, and industrial applications is well established, many constraints tend to discourage consumers and businesses from investing in solar heating equipment. (See p. 5.)

Economic constraints

High capital costs, long payback periods, and large financial risks make solar heating systems appear economically unattractive.

Solar heating devices can cost anywhere from $1,000 for some solar water heaters to more than $500,000 for large commercial applications. Since these costs are usually in addition to a conventional backup system, many buyers are reluctant to make the added investment.

Long payback periods also discourage potenial buyers of solar heating systems. For example, when compared with electrical heating in many parts of the Nation, solar water heaters require about 10 years to pay for themselves, and even longer when compared against oil and gas water heaters. Combined water and space heating systems for residential and commercial use generally have longer payback periods than solar water heaters. In many cases, these payback periods range up to 20 years or more.

Finally, because most solar manufacturers have been selling equipment for only a few years, there is little factual information on the solar heating system's performance, reliability, and life expectancy. To the potential consumer, this makes investments in solar heating systems risky. (See p. 5.)

Lack of consumer protection

Technical problems, such as pump failures or corrosion of solar collectors, have plagued some solar heating systems, while others have been poorly constructed and leak or produce little heat. Fraudulent business practices, such as solar manufacturers overstating potential energy savings, have been alleged in a number of States. These problems tend to erode the public's confidence in solar energy and discourage potential buyers.

Warranties to protect consumers against the above problems, are in many cases, lacking within the solar industry. For example, of the 56 solar manufacturers GAO contacted, only 7 (12 percent) would guarantee in any way the performance of their collectors. (See p. 11.)

Institutional constraints

Institutions, through their normal practices, may also discourage consumers from investing in solar heating devices. Lenders, for example, may be reluctant to finance solar heating systems because of questions about the systems' reliability, useful lives, and market values. Utilities, through their electric rate structures, can influence the economic viability of solar heating systems which use electrical backup.

Although many lending institutions are concerned about the future market value of a solar heating system, none of those that GAO contacted has refused to finance such systems. Similarly, GAO found no instances where utilities have adopted rate structures, although some were proposed, aimed at discouraging the use of solar heating systems. Both solar industry and Government officials are concerned that these potential problems may become serious as solar heating becomes more commonplace. (See p. 14.)

Regulatory and legal constraints

Lack of laws guaranteeing the solar user's access to sunlight (sunrights) and increased property taxes resulting from installing a solar energy system were both mentioned by solar manufacturers and Government officials as impediments to using solar heating.

A number of builders pointed out that some potential buyers were concerned that trees or buildings not on their property may eventually block the sun from their collectors. Property tax increases attributable to owning a solar system were considered a greater problem because such increases can lower the economic benefits of owning a solar heating system. For example, using a full-value tax rate of $12.50 per thousand, a $10,000 solar heating system would most likely increase an owner's property tax by about $125 a year. This additional cost lengthens the payback period of solar heating, thereby lowering its economic attractiveness. (See p. 17.)

EFFECTIVENESS OF ONGOING EFFORTS TO ENCOURAGE THE USE OF SOLAR HEATING SYSTEMS

Both Federal and many State governments are working to remove one or more constraints. State efforts have emphasized financial incentives to help reduce the high capital costs, long payback periods, and financial risks associated with using solar heating systems, thereby attempting to make these systems more economically attractive to consumers. Since 1974, 22 States passed laws exempting solar equipment from State sales taxes or offering income tax incentives to homeowners and businesses installing solar heating systems.

Many States also have enacted legislation aimed at removing legal constraints to using solar energy systems. For example, 27 States have laws reducing the amount of increased property taxes resulting from installing solar heating devices. (See pp. 22 and 33.)

The Federal Government's activities, although not complete, have generally focused on (1) developing standards governing the design, installation, and performance of solar heating systems; (2) cooperating with industry in developing a certification process to verify how well solar equipment meets existing standards; (3) developing model legislation and codes; and (4) creating a network of regional solar energy centers. (See p. 22.)

Appropriate standards, coupled with an effective certification process, can provide consumers and businesses with a better idea of what to expect from solar heating systems and, in addition, provide the needed basis for comprehensive warranties that the industry now lacks. Model legislation and codes can be used by State and local governments to remove legal impediments to solar energy's use. Finally, regional solar energy centers could become an important tool for coordinating Federal and State programs.

In reviewing State and Federal efforts, GAO found that they have not yet evolved into a comprehensive and uniform approach to effectively encourage the use of solar heating systems.

--States' financial incentives vary considerably. Based on GAO's review of the three most common types of incentives (sales tax exemptions for solar equipment, tax deductions, and tax credits or rebates) enacted between late 1974 to mid-1977, it appears that many State incentives have not been of sufficient monetary value to significantly encourage the use of solar heating systems. Most subsidize only a small fraction--less than 25 percent--of a solar heating system's cost. Within the past 2 years, two States recognized this limitation and passed new legislation providing incentives of greater monetary value. (See p. 22.)

--Although some standards, such as "interim property standards," have been formulated by the Federal Government, other standards governing the installation and performance of solar heating devices have yet to be drafted. Even when standards are developed, there is uncertainty among Government and industry representatives concerning the extent to which they will be used. For example, standards governing how well solar heating systems should work are not scheduled to be completed until late 1979. Even then, the extent to which they will be incorporated into local building codes or adopted by solar manufacturers is unknown. Some solar manufacturers and State officials are concerned that Federal standards may be too rigid or not applicable in their regions. (See p. 26.)

--A certification program has been slow in developing. Federal officials are cooperating with private industry in developing a plan for certifying and rating solar collectors and water heating systems. As of March 1979, however, this plan had not been developed. In contrast to the Federal efforts, some States have developed

procedures which do provide some degree of consumer protection. Two States have even developed their own certification process. (See p. 28.)

--Attempts to remove legal constraints by various State governments have generally not been uniform and in some instances appear ineffective. For example, the most common legislative action taken by State governments has been to exempt the value of solar energy systems from property taxes. In reviewing these efforts, GAO found inconsistencies in States' efforts for applying such exemptions. Some States provide for partial exemption while others provide for full exemption. Another State only allows the exemption for a few years, while others allow the exemption for substantially longer periods or indefinitely. And finally, some States have delegated to local or county governments the authority to exempt property taxes on solar energy systems. In such cases, the response by local governments has varied and, in a least one State, it has been negligible. (See p. 30.)

--Although the concept of regional solar energy centers was announced in March 1977, as of March 1979, these centers had not yet fully implemented their specific plans for coordinating commercialization activities at the State and local level. (See p. 36.)

EFFECTIVENESS OF THE NATIONAL ENERGY ACT IN ENCOURAGING THE USE OF SOLAR HEATING

The President, on November 9, 1978, signed five bills which make up the National Energy Act. The act contains the following provisions aimed at encouraging the use of solar heating systems:

--A non-refundable income tax credit for individuals who install solar equipment in their principal residence.

--Business tax credits for investments in solar equipment.

--A $100-million program to provide support for loans to owners of one- to four-family dwellings who install solar heating and cooling equipment in their residential units.

--A $100-million program for demonstrating solar devices in Federal buildings. (See p. 43.)

The tax credit provisions--which are the cornerstone of the Federal initiatives--are likely to have their biggest impact on encouraging the use of solar water heaters for residential use. The Department of Energy estimates that, under the tax credit provisions, about 1.9 million homes will be using solar heating devices by 1985. Of these about 1.6 million will be solar water heaters.

Because of their high cost and economic drawbacks, the use of other solar heating applications--solar space or combined water and space heating systems for residential use and commercial solar heating--are not expected to have as much of an impact. According to Department of Energy officials, by 1985 only about 300,000 homes are expected to be using solar space heating systems. Similarly, only about 24,000 businesses are expected to be using any form of solar heating by 1985. (See p. 44.)

GAO found that other provisions of the National Energy Act will not be nearly as significant as what is expected to result from tax credits. For example, GAO estimates that only about 20,000 homes will be using solar heating devices as a result of the recently enacted loan support program. (See p. 48.)

Overall, if successful, the initiatives enacted under the National Energy Act should greatly expand the solar industry. However, in terms of energy saved or replaced by 1985, the impact will not be

large. According to the Department of Energy, the energy saved by solar heating will account for less than one-half of 1 percent of the Nation's energy demand in 1985. (See p. 42.)

CONCLUSIONS

Although both Federal and many State governments are trying to remove constraints facing the widespread use of solar heating systems, their efforts have not yet evolved into a comprehensive and uniform approach to encouraging the widespread use of solar heating systems on a nationwide scale.

Existing State efforts, at best, represent a variety of fragmented commercialization strategies. Some appear to have had little impact on encouraging the use of solar heating systems. Other States have done nothing to foster the commercialization of solar heating systems. Federal efforts aimed at developing standards for solar equipment and model legislation for removal of legal barriers are incomplete, and there is no nationally recognized certification process for evaluating solar devices against existing performance and quality standards. (See p. 38.)

In view of the passage of Federal financial incentives for solar heating systems as well as the continuation of State efforts to commercialize solar heating systems, GAO sees a need for a clearly defined national commercialization strategy for solar heating systems. Such a strategy, in addition to showing Federal leadership, should be designed to

--pull together all existing efforts at the State and local levels into a single effective commercialization strategy and

--initiate actions in those States which have done little or nothing to commercialize solar heating systems.

Such a strategy would clarify the roles of various levels of government, demonstrate

what needs to be done to successfully commercialize solar heating systems, and set goals and time frames for overcoming existing constraints. Moreover, it would provide a framework for commercializing other solar technologies that will follow.

Federal efforts aimed at developing standards, a certification process, and model legislation should be expedited so that the recently passed Federal financial incentives do not unnecessarily precede the efforts to assure the public that solar heating systems are good investments. (See p. 38.)

Federal financial incentives have the potential for greatly expanding the use of home solar water heating systems by 1985. This could also lead to an expanded solar industry which could be self-sustaining after 1985. By 1985, however, the energy saved or replaced due to these incentives will not be significant in helping the Nation meet its energy demand.

Because of the small impact these incentives are likely to have, GAO believes the Congress--as has been the case with some State legislatures--will be called upon to act on further incentives. This may be particularly true to encourage the use of solar heating systems in the commercial sector. Thus, it is important that the Congress have sufficient and accurate information on the success of these financial incentives. GAO believes that the Department of Energy should take steps to track the success of these incentives and annually report its findings to the Congress. This reporting can also act as a conduit for recommending ways to improve the overall incentives program and keep the Congress abreast of efforts to pull together an overall clearly defined national strategy. (See p. 49.)

RECOMMENDATIONS

The Secretary of Energy should:

--Establish a detailed commercialization strategy for solar heating systems. This strategy should, as a minimum, identify constraints to using solar heating systems and indicate how best to overcome these constraints. Also, it should clearly delineate the roles and responsibilities of the Federal, State, and local governments and industry in commercializing solar heating systems as well as set specific goals and time frames for overcoming these constraints.

--In cooperation with other Federal agencies, expedite efforts to (1) develop standards governing the installation, design, and performance of solar heating systems; (2) prescribe a certification process for verifying that solar heating systems meet these standards; and (3) formulate model legislation and codes for overcoming legal constraints.

--Work together with State and local governments in implementing the components of the strategy. Procedures and guidelines should be established for providing informational and other appropriate assistance to the States.

--Monitor the success of the various provisions of the National Energy Act aimed at encouraging the use of solar heating systems and annually report the findings to the Congress. Such reports should include not only the number of installations resulting from the various incentives but also the equivalent energy savings.

--As part of these reporting procedures, inform the Congress on ways to improve the overall effectiveness of the National Energy Act provisions, including the magnitude of additional incentives that might be needed to encourage greater use of those solar heating applications--especially commercial applications--which, without additional incentives, are projected to have very little use prior to 1985.

AGENCY COMMENTS

The Department of Energy did not take exception with any of GAO's conclusions or recommendations. In commenting on a draft of this report, the Department pointed out that it is in the process of developing a program plan which, among other things, will present a national commercialization strategy. This plan is due to be provided to the Congress in December 1979. (See p. 40.)

A complete copy of the Department's letter commenting on a draft of this report is contained in appendix IV. (See p. 64.)

MATTERS FOR CONSIDERATION BY THE CONGRESS

GAO believes that the provisions of the National Energy Act represent logical new initiatives for encouraging the use of solar heating systems. However, in recognizing the limited impact these provisions will most likely have by 1985, further proposed incentives are likely to come before the Congress over the next few years. Such has been the case in some State legislatures. Additionally, the technical and economic status of the various solar heating applications can change considerably over the next few years, which may necessitate new incentives or modifications to existing ones so that solar heating systems can be successfully commercialized. Because of this, GAO believes the Congress--prior to enacting any additional incentives--should take steps to be assured that any new incentives result in meaningful energy savings. This can be accomplished through Congress' legislative and oversight processes by closely monitoring the success of solar demonstration projects, ongoing Federal as well as State efforts to remove non-financial constraints, and the impact of the various solar incentive provisions of the National Energy Act. If need be, the Congress may even wish to require the Department of Energy to submit information as part of its budgetary process, or an addendum to any legislative proposals, showing the impact

in terms of energy saved that any new initiatives for encouraging the use of solar energy are likely to have. (See p. 51.)

RECENT PRESIDENTIAL INITIATIVES

While GAO was preparing its final report for publication, the President, in a message to the Congress dated June 20, 1979, outlined major elements of a national solar strategy. This strategy sets forth a goal for solar energy use and includes legislative proposals and directives for various Federal agencies aimed at achieving that goal.

GAO did not evaluate these recent presidential initiatives but pointed out that certain elements could help in establishing a coordinated national strategy for commercializing solar heating. (See p. 51.)

Contents

ABBREVIATIONS

DOE	Department of Energy
ERDA	Energy Research and Development Administration
FEA	Federal Energy Administration
FHA	Federal Housing Administration
FmHA	Farmers Home Administration
GAO	General Accounting Office
HUD	Department of Housing and Urban Development
Kwh	Kilowatt hour
NASA	National Aeronautics and Space Administration
NBS	National Bureau of Standards
NEA	National Energy Act
NEP	National Energy Plan
SERI	Solar Energy Research Institute
VA	Veterans Administration

CHAPTER 1

INTRODUCTION

Dwindling supplies of oil and natural gas, environmental concerns, and rising fuel costs are among the many factors spurring the Nation's search for alternative energy sources. Solar energy is one alternative, if developed and successfully used, that will offer many benefits. As an energy source, it is virtually inexhaustible, widely distributed, and generally believed to introduce minimal environmental effects when used. Furthermore, a wide variety of technologies can convert the sun's energy directly or indirectly into useful energy. Wind energy conversion and photovoltaic systems (solar cells), for example, have been used for years to generate small quantities of electricity. Solar heating systems are now being sold in many parts of the Nation for water and/or space heating purposes. Agricultural and forest residues and other biomass products are also being used as an energy source.

Although many solar technologies are known to work, their use has remained extremely limited. This is primarily because most solar energy systems are generally viewed as uneconomical and risky investments with little practical use in meeting the energy requirements of homes or businesses. Changing this view of solar energy systems will be essential if solar energy is to make a meaningful contribution towards meeting the Nation's energy needs.

Among all the solar technologies, solar heating systems warrant particular attention because of their advanced position of being economically and technically accepted relative to other solar technologies. According to Department of Energy (DOE) officials, about 200 companies are now selling or attempting to sell solar devices for use in water and/or space heating. Since over 40 percent of the Nation's energy is used for heating purposes, solar heating also has a large potential market. Thus, the successful commercialization of these systems becomes extremely important if solar is to begin helping the Nation meet its energy needs. Furthermore, the successful commercialization of these systems should encourage the acceptance of other solar technologies that will follow. As with other energy sources, the Federal Government's role in commercialization will greatly influence the time frame and degree to which solar heating will be used.

FEDERAL ROLE IN COMMERCIALIZATION

Historically, the Federal Government has promoted and regulated all major energy sources--coal, oil, gas, hydroelectric, and nuclear--to some degree through various financial and nonfinancial incentives.

Financial incentives alone have taken many forms, such as research and development for nuclear energy, direct subsidy in building hydroelectric facilities, the depletion allowance for the oil industry, and regulation of interstate natural gas distribution. The price tag associated with these financial incentives and others has been considerable. For example, in a December 1978 report, the Pacific Northwest Laboratories--a DOE facility--estimated that Federal incentives used to encourage the development of various energy sources have carried a price tag in excess of $160 billion through 1977. The estimated cost of these incentives, by energy source, is shown in the table below.

Estimated Cost of Incentives Used to Stimulate Energy Production

Energy source	Estimated Cost (in billions of 1976 dollars)
Nuclear	$18.0
Hydro	15.3
Coal	9.7
Oil	101.3
Gas	16.5
Total	$160.8 1/

In addition to financial incentives, the Federal Government has also taken other actions, such as removal of specific obstacles, to help assist in developing an energy source. For example, under the Price-Anderson Act (42 U.S.C. 2210), the Government and private insurance companies have jointly insured nuclear powerplants to cover public liability claims that might arise from an incident at a commercial nuclear

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1/Figures do not include incentives to encourage the production of electricity.

powerplant. It has been acknowledged by both Government and industry that the Price-Anderson Act was an important step toward developing nuclear power.

In short, the Federal Government has historically fostered the development and commercialization of major energy sources and has influenced national energy consumption patterns through a variety of incentives. At times, however, the promotion of one energy source has been at the expense of another. The Rural Electrification Act (7 U.S.C. 901), for example, has been cited by Government officials as a major reason why a small, but well established, wind energy industry declined in the Midwest in the 1930s. Similarly, many solar proponents have argued that past and present incentives, such as regulated natural gas, distort the economics of solar heating in the marketplace.

To make the economics of solar heating more attractive to a larger number of potential buyers, many State governments have enacted a variety of financial incentives over the past few years. During this time, the Congress has considered a variety of incentive proposals aimed at enhancing solar heating's competitive position with other subsidized energy sources. More than 40 solar incentive bills of various kinds were introduced during the 95th Congress. Some of these, such as the National Energy Plan (NEP), called for tax credits to encourage the installation of solar equipment, while others, such as the "Solar Energy Development Bank" bill would authorize low interest loans.

After taking these various incentive proposals into consideration, the Congress, on October 15, 1978, passed five bills which make up the National Energy Act (NEA). On November 9, 1978, the President signed these bills into law. Within these bills are various provisions aimed at furthering the use of solar heating systems. Thus, the Congress--through this legislation--has given the Federal Government a major role in commercializing solar heating systems. This role is consistent with the existing role the Federal Government is playing in regard to researching and demonstrating solar heating systems pursuant to various pieces of legislation, such as the Solar Heating and Cooling Demonstration Act of 1974 (Public Law 93-409).

This report discusses the adequacy of the Federal Government's, as well as State governments', efforts in commercializing solar heating systems. As such, this report

--identifies constraints facing the use of solar heating systems and what needs to be done to overcome these constraints (ch. 2);

--reviews the effectiveness of ongoing efforts to encourage the use of solar heating systems (ch. 3); and

--evaluates the potential effectiveness of the NEA in encouraging the use of solar heating systems (ch. 4.)

SCOPE OF REVIEW

In conducting our review, we contacted manufacturers of solar equipment, building industry representatives, and officials in 12 States--Arizona, California, Colorado, Florida, Maryland, Massachusetts, Minnesota, New Mexico, New York, Pennsylvania, Texas, and Virginia--in order to obtain their insights and experiences in trying to commercialize solar heating systems. In all, we contacted 56 solar manufacturers and 40 companies that have designed or built solar installations. Similarly, we contacted, and reviewed the policies of other organizations, such as lending institutions, utilities, and insurance companies, which can have a significant impact on the future use of solar heating. In addition, we obtained information for this report from program documents, reports, correspondence, and other records at the following agencies: DOE, National Bureau of Standards (NBS), Department of Housing and Urban Development (HUD), National Aeronautics and Space Administration (NASA), Federal Housing Administration (FHA), Veterans Administration (VA), and Farmers Home Administration (FmHA).

CHAPTER 2

CONSTRAINTS WHICH IMPEDE THE WIDESPREAD USE OF SOLAR HEATING

Solar heating's technical feasibility is well established and has a long history of successful use. Uncertainty remains, however, concerning the future prospects of solar heating in light of the following:

--Economic constraints.

--Lack of consumer protection.

--Institutional constraints.

--Regulatory and legal constraints.

In general, these constraints tend to discourage consumers and businesses from investing in solar heating equipment. To commercialize solar heating systems successfully these constraints must be understood and appropriate actions taken to overcome them.

ECONOMIC CONSTRAINTS

Investments in solar heating will become commonplace only when solar heating becomes economically attractive when compared to other energy sources. Many factors now discourage consumers and businesses from investing in solar heating systems. Among the more significant are (1) long payback periods, (2) high capital costs, and (3) financial risks. Other factors which may affect the economics of solar heating applications, such as property tax increases and availability of reasonable financing for solar installations, are discussed in other sections of this chapter.

Long payback periods

A typical solar heating device usually consists of a solar panel which collects the sun's heat, a heat transfer medium (usually air or liquid) which carries the collected energy to points of storage and use, a storage device, and

equipment for distributing the heat. 1/ Since adequate sunlight is not always available, solar heating systems usually cannot provide 100 percent of the heating requirements in any given application. Thus, conventional heating systems are necessary to supplement the use of solar heating.

Because such backup systems are necessary, the economics of solar heating is usually viewed in terms of how much conventional energy would be saved by comparing the incremental cost of owning and operating a solar heating system against the accumulated fuel saved by using the system. The estimated payback period, which can be determined from such an analysis 2/ represents the time required for the initial capital cost of the solar heating system to be entirely recovered through fuel savings. This payback period, however, varies considerably, depending on the type of application.

Residential applications

For residential applications, solar heating systems are generally used for either water heating or combined water and space heating. The economics of such applications must take into consideration numerous factors such as present and expected fuel costs, prices of the solar heating systems, performance and location of the systems, and how the systems are financed. Because of these factors, solar industry officials and builders agree that each application should be evaluated separately.

Generalizations, however, can be useful in presenting an overview of the economic attractiveness of using solar heating for residential use. Over the past few years, various studies have analyzed the economic viability of solar heating

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1/Other solar heating systems, which use architectual principles to maximize solar heat gain in the winter and minimize solar heat gain in the summer, are referred to as "passive systems." Many passive systems are estimated to be economical now. However, the wide variety of possible ideas, little hard data on the performance of such systems, and no specific industry attempting to sell these systems precluded us from discussing passive systems in detail. Nevertheless, it should be recognized that many of the constraints discouraging the use of active solar systems also apply to passive solar systems.

2/Such analysis is referred to as "life cycle costing."

systems. Although these studies may differ somewhat depending on the assumptions used, they have generally concluded that

--solar water heating is more economical than solar space heating;

--solar heating is more economical when compared with electricity than when compared with oil and gas as a heating source; and

--currently, the most economical applications of solar heating have about a 10-year payback.

For example, studies produced by the Energy Research and Development Administration (ERDA) 1/, and later by DOE, have generally shown that solar water heaters, when compared with electrical heating, have about a 9- to 13-year payback. Combined space and water heating systems, when compared with electrical heating, have--although slightly longer--similar payback periods. However, when either solar water heating systems or combined systems are compared against other energy sources--gas, oil, electric heat pump--their payback is more typically about 20 years or more.

Although solar heating systems may eventually pay for themselves, there is no general agreement among Government and industry officials as to what constitutes a reasonable and economical payback period. Some consumers are now willing to invest in solar heating systems as evidenced by the existence of a small solar industry. However, many industry and Government officials believe that before widespread use of solar heating systems can be achieved, these devices must pay for themselves in 8 years or less. According to Government officials, this would imply cost reductions or financial incentives covering 25 to 50 percent of a solar heating system's cost. For example, a 50-percent reduction in the cost of solar water heaters would reduce a payback period of 9 to 13 years to about 4 to 7 years. Such cost reductions would also make solar water heaters more attractive when compared with oil or gas.

1/Prior to the establishment of DOE on October 1, 1977, ERDA--which was absorbed by DOE--had responsibility for developing solar energy systems.

Commercial and industrial applications

Commercial and industrial applications of solar heating include a variety of uses such as water and/or space heating for apartments, motels, schools, doctors' offices, and preheating hot water for industrial use. Solar heating for these uses cannot be generalized as easily as solar hot water or space heating in residential applications because the energy requirements and the system's cost differ widely among various uses. Because of this, the economic potential most likely would have to be examined on a case-by-case basis.

Some commercial establishments with high hot water requirements, such as motels, could find solar heating systems an attractive alternative. Overall, however, the prospect of businesses and industries using solar heating devices does not appear as favorable as for residential use. According to DOE officials and some solar industry officials, as well as builders, one of the primary reasons solar heating devices are less attractive to business is that businesses and industries usually require a rapid payback on investments. Most indicated that businesses are looking for a 3- to 5-year payback period when making decisions on using solar heating systems.

Few commercial or industrial applications can presently meet this payback criteria. For example, in our review we identified five commercial or industrial solar heating projects where officials responsible for the projects were able to estimate their first year's fuel cost savings. Based on this information, we estimated the payback period for each project. The results are shown in the following table.

Examples of Payback periods for

Selected Commercial Applications (note a)

	System's cost	Estimated payback (note b) (years)
Domestic hot water for an apartment building	$ 47,900	20+
Space heating for a small office building	13,500	20+
Water heating for an industrial laundry	180,000	19
Space heating for a large office building	400,000	20+
Water heating for a large motel	270,000	14

a/Examples are from specific demonstration projects funded by the Department of Energy.

b/Calculations assume a 10-percent yearly increase in fuel cost for the first 10 years, 5 percent thereafter, and no maintenance cost.

As the table shows, the payback periods for these commercial and industrial applications are somewhat long. Because of this, together with the short payback periods generally required by businesses, DOE officials and a number of solar industry representatives believe cost reductions of greater than 50 percent or more are necessary if these applications are to become attractive to business.

High capital cost

Although the payback periods for solar heating systems may be reasonable to some potential buyers, high initial cost may discourage these investors. In new residential construction, for example, a solar water heating system may add from $1,000 to $2,000 or more onto the price of a house; a combined water and space heating system may add from $8,000 to $14,000 or more to the price. Thus, the purchaser of a solar home is faced with the decision to initially pay for the

system or to finance a higher mortgage. A larger down-payment also may be required as a result of the higher initial cost of a solar house. According to solar manufacturers and Government officials, many potential buyers are reluctant to make this additional investment. Most families with moderate or low incomes are probably unable to finance this additional cost. A similar problem can exist for any business or organization with limited financial resources.

Because of the additional cost of solar heating systems, most solar manufacturers and builders we contacted viewed solar heating's near-term use to be for persons in the upper income bracket or financially secure businesses. Solar water heating, because of its lower initial cost, was seen to have a somewhat wider range of potential buyers.

In short, even if the payback period is reasonable, potential buyers with limited financial resources may be precluded from making any long-term investment in solar heating. Some studies have suggested the need for special incentives, such as low interest loans or grants, geared to such income groups.

Financial risks

Today's investments in solar heating systems must be made without accurate historical data on the system's performance, reliability, and life expectancy. Most solar manufacturers we contacted have been producing solar equipment for only a few years and generally do not have such data. With little factual information regarding such factors as the systems' performance and reliability, many builders we contacted were skeptical about using solar heating systems, especially for space heating. As a result, they do not recommend solar space heating systems to their prospective buyers. They place a higher priority on heavy insulation in ceilings and walls, and installation of storm windows, storm doors, and heat pump systems, which they believe are more cost effective and less risky. Solar manufacturers and builders, however, were more optimistic about using solar water heaters. They believe solar water heaters are less costly, and simpler to design and install than other solar heating applications and, thereby, entail less financial risk.

The Federal Government is currently attempting to obtain data on various applications through a number of demonstrations. These demonstrations include residential and commercial heating applications. In addition, the Federal Government also has a number of industrial experiments using solar heating systems. These demonstrations and experiments will continue through 1979 and should help provide consumers

with information on performance, reliability, and life expectancy that they need to determine if the financial risk of owning solar heating systems is acceptable.

LACK OF CONSUMER PROTECTION

Recent interest in solar heating has brought numerous systems and companies into the marketplace. The growth in the solar industry, however, has been accompanied by some poorly designed systems, installation mistakes, and fraudulent business activities. Warranties presently offered by the solar industry give consumers little protection against these problems.

Poorly designed systems and installation mistakes

A number of companies we contacted have experienced such obvious technical problems as pump failures, valves sticking, the peeling off of protective glazing on solar panels, temperature control problems, and corrosion. Generally, solar industry officials did not view these problems as major and believed design or equipment changes could rectify such problems as they occur.

The National Bureau of Standards, which performs tests on solar panels for DOE, has observed similar problems. The following are some examples.

--Outgassing: This is the build-up of materials on the inside of a collector cover plate. It is caused by the decomposition of materials such as sealants or insulation in the collector. This decomposition emits gas, which can build up on the inside of a collector. This reduces the amount of sunlight entering the collector, thereby reducing efficiency.

--Color change in selective coating: Selective coatings are put on the face of collectors to absorb more sunlight. A color change on the face of the collector indicates a change in the optical properties of the selective coating and results in decreased collector efficiency.

--Condensation: In some collectors, moisture can collect on the inside surface of the cover plate. This obstructs radiation entering the collector and reduces efficiency.

--Plastic cover plate failure: Some plastics have poor resistance to ultraviolet radiation or are unable to

withstand the high temperature when collectors are not in operation. The covers can break or melt, which results in reduced collector efficiency and damage to the collectors.

Other problems have been identified which can be traced to the improper installation of solar equipment. According to some solar manufacturers and builders, improper installation of solar equipment can cause such problems as leaks, rotting of the roof at the point where the collectors are attached, and collectors blowing off rooftops. In an experimental project being conducted by the New England Electric Company on 100 solar water heaters, for example, a number of problems such as malfunctioning controls, inadequate pipe insulation and freeze-ups severely limited the performance of the solar heating systems. Although it was originally hoped that the solar equipment would reduce water-heating costs by 50 percent, because of the aforementioned problems, the overall average energy savings during the first 6 months of operation amounted to only 17 percent. According to a solar energy consultant assigned to the project, the problems occurred mainly because the majority of participating manufacturers and installers had little or no practical experience with solar water heaters. Simple problems, according to the consultant, must be worked out before solar water heating can be considered economical. He also stated that many of the systems have since been fixed, and their performance has been significantly improved. The project is scheduled to be completed in 1979.

False advertising

Many Government and solar industry officials are concerned that some companies overstate the expected energy savings from using their solar heating systems. In at least one instance, court action has been taken to block an extravagant claim. The Attorney General for Iowa, after determining the solar equipment sold by one company could not possibly meet its claim, obtained a court injunction to prohibit the advertising of this system. In another instance, the Assistant Attorney General for the State of Florida told us he is trying to obtain an injunction to stop the sale of solar equipment produced by an out-of-State manufacturer. He stated that the equipment does not function as advertised, thereby amounting to a fraudulent business practice.

False advertising and misleading statements have also been made in a few instances by businesses selling or attempting to sell solar systems in Arizona. When such instances come to the attention of the Arizona State Solar Energy Office officials, they notify the State Attorney

General's Office. The Attorney General's Office in turn contacts the businesses involved and requests that they stop false or exaggerated advertising. Claims of false advertising have also been the subject of Better Business Bureau inquiries in Colorado and a number of other States.

Warranties provide little consumer protection

Warranties can protect consumers from many of the aforementioned problems. For solar equipment, they generally take two forms: (1) those that guarantee the system will not breakdown and/or (2) those that guarantee the system will perform at a certain level of proficiency.

Most solar manufacturers we contacted offer some type of warranty to assure consumers their solar systems will work. However, many company warranties are for only a relatively short duration, as shown in the following table.

Length of Warranties Offered by Solar Manufacturers

Length of warranties	Number of manufacturers	Percent of total
15 years	0	0.0
10 years	6	10.7
5 years	18	32.1
2-3 years	9	16.1
1 year	15	26.8
0-1 year	8	14.3
Total	56	100.0

Although nearly all these solar manufacturers told us their solar heating systems will last 15 years or longer, the table shows that many of these companies warrant the equipment for only 1 year or less. In addition, many of the warranties provide only limited coverage. Some do not provide coverage for installation mistakes, labor cost of repairing the system, or glass breakage. Others cover only malfunctioning of the solar collectors.

Some solar manufacturers also provide performance warranties. However, we found only 7 of 56 solar manufacturers (12 percent) who would, in any way, warrant the performance of their systems. According to solar industry officials, the many variables associated with assessing the performance of a collector, such as insolation in the area and the siting of a home, make it difficult to predict performance with reasonable accuracy.

At the present time, consumers have little assurance that any performance claims will be met and no adequate assurance of the system's reliability. Since nearly all solar collectors work to some degree, many solar manufacturers and Government officials are concerned about consumer protection and the future of the solar industry if inefficient or poor quality systems get into the marketplace. They see a need for an industry mechanism which can establish design, installation, and performance criteria, and can test and certify solar heating equipment against such criteria. Preliminary work in this area has been undertaken by industry and the Government. A discussion on these ongoing efforts is contained in chapter 3.

INSTITUTIONAL CONSTRAINTS

Institutions may pose key problems in making solar heating an attractive energy option. Lending organizations, utilities, and insurance companies have been mentioned by Government and solar industry officials as possible obstacles to the widespread use of solar heating applications. Opposition from these organizations, stemming from their traditional practices and characteristics, could discourage buyers and seriously affect the commercialization of such applications.

Lending institutions

Many studies indicate lenders are reluctant to finance solar systems because of questions concerning the systems' reliability, useful lives, and market values. For example, a report by HUD, dated February 1977, entitled "Home Mortgage Lending and Solar Energy" stated

> "* * * the market place will serve as the definitive arbiter of value, with the knowns, unknowns, virtues and liabilities of solar systems reflected in the price consumers are willing to pay for new and used homes that incorporate solar energy devices. But right now, and for the next few years, this information will be lacking in most markets, and lenders will have to proceed in the absence of

"any significant volume of experience in the sale of comparable homes.

What they will necessarily consider--and what those promoting solar must consider--is the possibility that the market value of a solar installation (in terms of resale of the property) may be less than the costs associated with it, and that loans offered will therefore be a proportionally smaller part of the additional sales price."

Problems in obtaining loans for solar equipment and mortgages for houses with solar heating were mentioned in our review. In one case, for example, a builder told us he does not plan to install any more systems because of the hesitancy of lenders in his area to finance the cost.

Most lending institutions we contacted had no policies exclusively established to govern the financing of a solar heating system. Usually, loan approvals would be made on a case-by-case basis and primarily based on the borrower's credit worthiness. Although no lending institutions that we contacted had refused to finance such systems some have placed requirements or conditions on loans for solar heating systems. For example, one of the institutions we contacted required that solar systems be designed by a registered professional engineer and charges $100 (even if the loan is refused) to verify such systems. Another institution requires onsite examination of the system and its appearance before any loan is approved.

Some Federal lending institutions--VA and FmHA--have also been concerned about problems with financing solar heated homes because of their uncertain market value. FmHA officials, for example, said they will finance only those systems that they have evaluated as being economically feasible and cost effective. All loan applications for solar heated homes will be sent to the national office for evaluation before any financing is allowed.

Setting standards for the design, installation, and performance of solar equipment and certifying that solar equipment can meet these standards should give assurance to lending institutions that solar heating systems are a good investment. As mentioned previously, efforts in this area have begun and are discussed in chapter 3.

Utility pricing

Utility companies, through their electric rate structures, can influence the economic viability of those solar heating

systems employing electrical backup systems. As a general rule in the UNited States, unit rates, cents per kilowatt-hour (Kwh), decrease as the level of energy consumption increases. For example, under a typical system, the consumer would pay about 3 cents a Kwh for the first 100 Kwh used, about 2 cents a Kwh for the next 400 Kwh used, and less than 2 cents a Kwh for the next 500 Kwh used. This type of rate structure is referred to as "declining block." Some utilities also offer special low rates to all electric homes, industries, and other large users of electricity.

The declining block rate structure produces a minor disincentive for the solar energy user, in that the solar user can end up paying more per kwh even though he is using less electricity. In our review, utility pricing of this type was not cited as a significant problem, but could be as more people switch over to solar heating applications.

Solar manufacturers are more concerned about utilities adopting a more discriminatory policy, such as a demand/energy rate. 1/ Under a demand/energy rate, the consumer's bill is based on the total energy used (Kwhs) and on his maximum demand during a billing period. For a solar energy user who uses much less total energy but requires a large demand during prolonged periods of cloudy weather, this rate structure could minimize any economic benefit derived from using solar heating devices.

Utility officials who have attempted to adopt such a rate structure believe it will more accurately reflect the cost of providing service. This is because demand costs, those costs of providing and maintaining the facilities to meet the maximum demand in a utility's system, are independent of the costs of generating and transmitting energy. These officials are concerned that solar users will continue to require a large demand capacity but, in total, use little energy. As a result, the nonsolar user will be paying for the necessary back-up facilities.

This is not a major problem at this time because solar heating use is very limited and some utilities have excess capacity. However, if solar heating becomes commonplace and utilities are required to build additional facilities to meet

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1/A demand/energy rate structure was approved by the Public Utility Commission of Colorado on February 9, 1976; however, on October 26, 1976, the Commission, after holding hearings, decided to make such a structure optional for the consumer.

the back-up energy demands of solar users, more serious problems can arise, particularly with respect to the question of who should pay for the additional capacity.

Insurance rates

Owning a solar heating system may pose some additional insurance liabilities. Possible problems cited by the insurance company officials include increased fire hazards due to the high temperatures created in the solar collector, damage to property from water leaks, bodily injury and/or property damage from antifreeze leaks, and possible structural damage because of the additional weight of collectors.

Although Federal officials believe these to be significant problems, we did not not find them to be serious at the time of our review. None of the insurance companies we contacted has increased rates for solar users. However, insurance company officials believe if an abnormal amount of claims accompany the widespread use of solar heating, then higher insurance premiums will be required.

Setting uniform standards for the design, installation, and performance of solar equipment, and certifying that solar equipment meet these standards should give greater assurance to insurance companies that solar systems are safe and reliable.

REGULATORY AND LEGAL CONSTRAINTS

Regulatory and legal constraints refer to existing regulations or laws, or the lack thereof, that could impede the widespread use of solar energy. Sunrights, building codes, and property tax laws are frequently referred to as impediments to solar heating.

Sunrights

It is generally accepted that property owners in the United States do not have exclusive rights to the solar energy that reaches their land after slanting across property owned by others. In our review of the solar industry, we found that sunrights are not yet a major problem. However, solar industry and Government officials are concerned about future problems when solar heating becomes more commonplace. In this regard, access to the sun may become more critical for commercial and industrial applications than for single family houses because the former are often located in zones permitting high rise structures. A few builders we contacted did point out that some potential buyers were concerned that

trees not on their property may eventually block the sun from their collectors.

Although access to the sun is more of a perceived problem at this time, many Government officials believe it could develop into a serious problem. Accordingly, some action has been taken at the State level. These actions are discussed in chapter 3.

Building codes

Building codes are a collection of standards and regulations that govern building construction in a specific jurisdiction. The purpose of such codes is to protect public health and safety by specifying how buildings are to be constructed.

Interfacing solar heating with present building codes has presented some problems. New York and Massachusetts building codes, for example, preclude the use of toxic antifreeze, a common ingredient of solar heating systems in areas where temperatures go below freezing. In order to meet these codes, solar manufacturers told us they are forced to use a less efficient external heat exchanger or develop a non-toxic antifreeze. Building codes can also require manufacturers to design their solar collectors to meet structural height and weight standards for rooftop installations.

Several manufacturers and builders of solar equipment informed us that they have experienced some difficulties in passing building code inspections. The manufacturers and builders attributed this problem to the lack of knowledge about solar heating on the part of inspectors; however, for the most part, only minor changes or additions were needed to correct the problems. According to some Government and solar industry officials, if local building codes are strictly enforced, they could cause delays and additional expense in processing permit applications. Government officials believe the best long-term solution to this problem is developing design, installation, and performance standards. Such standards could then be integrated by States and localities into local building codes.

Property tax laws

Property taxes are presently collected in all States. They may be levied at the county or municipal level, or at both. Commercial properties and factories are also subject to property taxation.

It is generally agreed that installing a solar heating system in a building increases the market value of the building, although as previously discussed, the amount of such increase is uncertain. The increased market value may result in a higher assessed value and consequently higher property taxes. For example, using a full-value tax rate of $12.50 per thousand, a $10,000 solar heating system would increase the property tax by about $125 a year. Such costs tend to lengthen the payback period of solar heating and, thereby, lower its economic viability.

Many States have passed, or are considering, legislation that would reduce or eliminate property taxes associated with solar heating systems. These efforts are discussed in chapter 3.

OTHER POSSIBLE CONSTRAINTS

Some studies and Government officials have speculated on a number of possible impediments to solar energy. Some of these impediments are

--shortage of materials for constructing solar heating systems,

--opposition from groups with vested interest in continuing the Nation's dependence on fossil fuels, and

--labor disputes among unions concerning the installation of solar systems.

These were not mentioned to us by solar manufacturers or builders as being significant obstacles. To what extent they may eventually affect the future of solar heating is not clear.

CONCLUSIONS

Although the technological feasibility of using solar heating is well established and solar heating systems are being successfully sold and used, a number of constraints limit their widespread use. Generally, these constraints tend to discourage prospective buyers from investing in solar heating systems.

The more significant constraints include

--economic constraints in the form of long payback periods, high capital costs, and financial risks;

--lack of consumer protection against technical problems, installation mistakes, and fraudulent business activities;

--institutional barriers, such as organizations which will not finance the cost of a solar heating system; and

--unresolved legal issues concerning sunrights, property tax laws, and building codes.

In order to increase the role of solar heating in providing energy to meet this country's energy demands, these constraints must be overcome.

Financial incentives, such as tax credits, can help reduce the payback period and high capital cost, and lower the financial risk associated with using solar heating systems, thereby making these systems more economically attractive. However, solar heating applications are all at various levels of economic viability. Some systems, such as solar water heaters, are already being sold throughout the country. Incentives for these applications should make them more attractive to a larger number of buyers. Most likely, Government assistance would have to cover at least 25 to 50 percent of the systems' cost to significantly reduce the payback period and thereby increase their use. Stimulating other applications, such as commercial and industrial uses of solar heating, does not appear as favorable. Substantial Government incentives, possibly covering greater than 50 percent of the solar system's cost, would be required to begin making these applications attractive to businesses.

Other actions that would be needed to further stimulate the use of solar heating systems include the development of effective standards governing the design, installation, and performance of solar heating devices, and a effective process which would verify that solar equipment meets these standards. These standards and a certification process would provide consumers with a clear idea of what to expect from solar heating systems and, in addition, provide the necessary basis for comprehensive warranties that the industry now lacks. They would also provide institutions, such as lending organizations, with assurances that solar heating systems are safe, reliable, and a good investment. Finally, these standards could become the basis for amending or changing local building codes so they do not impede the use of solar heating devices.

To successfully commercialize solar heating systems State governments must have an important role. For example, State governments can

--amend their property tax laws to exempt solar installations from increased assessments,

--enact legislation to protect the users' access to sunlight, and

--amend local building codes so they do not unnecessarily discourage the use of solar heating devices.

Recognizing the necessity of State governments in commercializing solar heating systems was highlighted in the National Energy Plan when it was first announced in April 1977. NEP called for a joint Federal-State program to overcome many of the constraints facing the commercialization of solar heating systems. Partly in response to the plan and partly on their own initiative, many States have taken steps to remove or lessen many of these constraints. The effectiveness of their efforts as well as the ongoing Federal efforts are discussed in the following chapter.

CHAPTER 3

EFFECTIVENESS OF ONGOING EFFORTS TO ENCOURAGE THE USE OF SOLAR HEATING SYSTEMS

Efforts to remove or lessen constraints which limit the use of solar heating systems began when Arizona and Indiana, in 1974, enacted landmark legislation offering tax relief to homeowners who install solar heating systems. Since that time, numerous other State governments have passed a variety of legislation aimed at making solar energy systems more attractive to potential buyers.

The Federal Government also has initiated efforts to encourage the use of solar heating systems. These include (1) developing standards governing the design, installation, and performance of solar heating systems; (2) cooperating with industry in developing a certification process that would verify how well solar equipment meets existing standards; (3) developing model legislation and codes; and (4) creating a network of regional solar energy centers.

These efforts, however, do not represent a single comprehensive strategy but rather a variety of individual efforts--some of which are more effective than others. Financial incentives which have been enacted, in many cases, do not appear to be of sufficient monetary value to significantly encourage the use of solar heating systems. Comprehensive and uniform standards are not complete, and there is no nationally recognized certification process in operation for evaluating solar devices against existing standards. Finally, efforts by State governments to remove legal barriers have been piecemeal.

MOST STATE INCOME OR SALES TAX INCENTIVES HAVE LITTLE IMPACT

Since 1974, 22 States have enacted legislation which either exempt solar equipment from State sales taxes or offer income tax breaks to homeowners and businesses which install solar heating systems. (See app. I for a listing of States). With respect to the income tax incentives, these have generally taken two forms at the State level, namely

--tax deductions which allow a taxpayer to deduct part or all of a solar heating system's cost in computing net income for State income tax purposes or

--tax credits which allow taxpayers, when computing their State income tax, to subtract part of a solar heating system's cost from their tax liability.

In most cases, these incentives cover 25 percent or less of a solar heating system's cost. As a result, they have little impact on shortening the payback period or lowering the initial capital investment.

Sales tax exemptions

Five States have exempted solar equipment from various State sales or business taxes. In many States, this exemption would amount to only a 4- to 6-percent reduction in the cost of solar heating devices. As a result, it is doubtful that an incentive of this magnitude, by itself, would measurably increase the use of solar heating systems.

The State of Texas, for example, has exempted from its sales tax the sale, lease, or rental of solar energy devices. This exemption means, at most, a 5-percent reduction in the cost of solar heating devices. State officials told us that the incentive, which has been in effect since 1975, has had little or no impact on encouraging the use of solar heating systems.

In conjunction with this sales tax incentive, the State also initiated solar incentives which affect its franchise tax--a complicated but minor tax levied on corporations doing business in Texas. The incentive affecting the franchise tax enables any corporation to deduct from its taxable capital assests the amortized cost of a solar energy device over a 5-year period. However, this incentive also amounts to very little. According to the Governor's Energy Advisory Council, the savings attributable to this incentive on a $100,000 solar energy system amortized over 5 years would amount to only $85 per year for each of the 5 years. Officials of the State Comptroller's Office did not believe the exemption was ever used.

Income tax deductions

Nine States have enacted legislation which allows a taxpayer or business to deduct part or the entire cost of a solar heating system in computing taxable income for State income tax purposes. Based on our review of the effectiveness of such legislation enacted in Arizona, it appears that incentives of this type, at least at the State level, do little to encourage the use of solar heating systems.

Arizona's income tax deduction incentive became effective in May 1975 and initially allowed an amortization period of 5 years. To increase the public response to the incentive, the amortization period was reduced to 3 years in June 1976. Although no mechanism was established to determine the success of this legislation, Arizona State officials believe the incentive has had only a very limited impact. According to officials at Arizona's Solar Energy Office, the monetary savings attributable to the incentive, on the average, amount to only 3 or 4 percent of a solar system's cost. The Assistant Director of the State's Energy Office estimated that only 30 people have taken advantage of the tax deduction.

Recognizing the limited impact the tax deduction incentive was having, new legislation was passed in the fall of 1977 allowing a taxpayer to take a tax credit covering 35 percent of a solar system's cost or $1,000, whichever is less. Arizona State officials expected the public response to increase significantly with an incentive of this magnitude.

Income tax credits

Since 1974, 13 States have passed legislation which allows taxpayers to subtract (take a tax credit) part of a solar heating system's cost from their tax liability. Among these States, the monetary value of the incentive varies from 10 percent to 55 percent of the system's cost. In most States, the maximum credit allowed is $1,000 for homeowners. Some States allow businesses to take a credit.

Based on our review of the effectiveness of existing legislation passed in New Mexico and California, it appears that incentives of this type would have to cover at least 25 percent of the system's cost to effect a measurable increase in the use of solar heating systems among homeowners.

In the spring of 1975, New Mexico became the first State to enact income tax credit incentives for solar heating systems. The New Mexico law provides for a tax credit of 25 percent of the cost of solar equipment used in heating the taxpayer's principal residence. The State will grant a rebate if the tax credit exceeds the taxpayer's liability, but neither credit nor rebate can exceed $1,000. According to New Mexico State officials, 21 claims were approved in the taxable year 1975, 72 were approved in 1976, and an estimated 125 to 150 are expected to be approved in 1977. Although the number of claims has remained small, New Mexico State officials believe the program has been successful in making the public aware of solar energy as a heating option.

These officials stated further that they felt tax credits covering 25 percent of the cost were the minimum necessary to start encouraging the public to use solar heating systems.

California, in the spring of 1976, also enacted a solar tax credit incentive. Under the California law, the taxpayer was allowed to take a direct credit against his State income tax for the year in which the solar system was purchased. The credit was limited to the lesser of 10 percent of the system's cost or $1,000. Although California State officials set up a system to measure the effectiveness of this solar incentive, they were, nevertheless, doubtful about its success. A State commissioned study, which was completed after the incentive legislation was enacted, indicated that a 25-percent credit was the minimum incentive needed to significantly increase solar installations. Thus, California enacted new legislation in September 1977 which provides for a tax credit of 55 percent, not to exceed $3,000, of a solar energy system's cost for residential use. The legislation also includes provisions to encourage commercial applications. A tax credit of 25 percent, or $3,000, whichever is greater, is allowed for these applications. California energy officials hope this incentive will stimulate 20,000 solar installations in 1979. The law is scheduled to remain in effect until January 1, 1981.

EFFORTS TO DEVELOP STANDARDS AND A CERTIFICATION PROCESS

Both Government and industry officials agree on the importance of developing reasonably uniform standards governing the design, installation, and performance of solar heating devices. They also agree on the importance of having a certification process to verify that solar heating systems meet existing standards. Standards and the accompanying certification process together can help remove or lessen many of the noneconomic constraints to using solar heating devices. For example, they can be useful in providing

- --consumer protection against technical problems and fraudulent business activities;
- --the needed information for consumers to weigh the risk of using solar heating devices and ascertain if that risk is acceptable;
- --assistance to industry in developing comprehensive warranties;

--assurance to lending organizations and others that solar heating systems are safe, reliable, and good investments; and

--the basis for amending local and State building codes.

Some standards have been formulated by the Federal Government, State governments, and private industry. Other important standards are not yet completed nor are they likely to be completed within the next few years. Similarly, a federally-directed certification process is not operational to verify that solar devices meet existing standards. Some States, however, have developed procedures which do provide some degree of consumer protection. Two States have even developed a certification process.

Standards development

Standards are important to solar heating systems for the same reasons they are important for other products and services. They help ensure acceptable levels of quality by setting criteria for strength, effectiveness, fire resistance, durability, and safety. Once established, they provide for possible enforcement through permits, inspection, and testing.

Our review showed that some standards have been completed and other efforts are underway. However, it may be years before reasonably uniform standards are completely developed and recognized by industry. This may hamper the widespread use of solar heating systems and possibly lead to fragmented and piecemeal standards at the State or local level.

Thus far, the Federal Government, some State governments, and various private organizations have set some standards for solar heating systems. Efforts are also underway to coordinate the activities of many of these organizations.

In the Federal sector, HUD and DOE, using the services of NBS, have drafted important standards. They included (1) "Interim Performance Criteria for Solar Heating and Combined Heating/Cooling Systems," dated January 1975; (2) "Interim Performance Criteria for Solar Heating and Cooling Systems in Commercial Buildings," dated November 1976; (3) "Interim Performance Criteria for Solar Heating and Cooling Systems in Residential Buildings," dated November, 1978; and (4) "Intermediate Minimum Property Standards for Solar Heating and Domestic Hot Water Systems," dated July 1977. Some of these standards have been used by State governments in specifying

what systems should qualify for government support.

Other solar standards have been developed by private organizations. The Sheet Metal and Air Conditioning Contractor's National Association, for example, has developed installation standards for solar heating systems. The International Association of Plumbing and Mechanical Workers has developed a Uniform Solar Energy Code with major emphasis on piping. The American Society for Heating, Refrigerating, and Airconditioning Engineers has developed and published test procedures for determining the thermal performances of solar collectors and thermal storage devices.

In addition to the above efforts, a few States--Florida and Minnesota, for example--have also set standards. These standards, according to energy officials within these States, emphasize the regional characteristics of their States. For example, according to State officials, solar systems used in Minnesota should be able to function during prolonged freezing weather, while systems sold in Florida would not have to meet that criterion. Officials of both States believe Federal standards can be used for guidance in formulating State standards. They are concerned, however, that Federal standards are being developed too slowly and, once developed, might be too inflexible to be of much use at the State level.

To coordinate the activities of these various organizations in developing solar standards, the American National Standards Institute established the Steering Committee on Solar Energy Standards Development. The purpose of this Steering Committee is to identify needed standards and formulate specific tasks leading to the development of nationally recognized solar standards. The Committee periodically publishes lists identifying those standards which need to be developed on a priority basis.

Although some standards have been completed, many others are still under development. For example, NBS, in cooperation with the American Society for Testing and Materials, is currently drafting standards governing the designs of various materials of solar energy systems. Some of these, such as standards for collector cover plates, will probably not be completed until 1980. These standards are particularly important because some existing problems with solar heating systems have been traced to these materials (See p. 11.). Other important standards being drafted by NBS in cooperation with private industry will provide a basis for how well solar collectors should perform (i.e., its efficiency and life expectancy). These standards are scheduled to be completed in late 1979.

Many Federal and industry officials are not sure how or when such standards, even when established, will be effectively used by State governments or by industry. According to some officials, some States may continue to develop their own standards, which may possibly lead to a proliferation of uncoordinated State and local codes. Other States may do nothing for lack of resources or interest.

Certification procedures

Standards must be implemented to be meaningful. To assure that solar heating systems meet existing standards, solar industry and Government officials agree solar devices should be certified to some extent. At the present time, however, no nationally recognized process for certifying the performance and quality of solar devices is operational. It is not clear what type of certification process will eventually be used or whether one or many will emerge since Federal and some State governments as well as private industry all have efforts underway.

The Federal Government, according to DOE officials, would prefer not to certify solar equipment or systems; however, it will play a role in accrediting laboratories capable of testing solar equipment and developing a certification plan that can be used by others. Because no nationally recognized process for certifying the performance and quality of solar devices is operational 1/, the Federal Government has funded some interim measures to assure the the public that solar systems work reasonably well.

In regard to accrediting laboratories, NBS is developing testing procedures for laboratories as well as identifying those laboratories capable of effectively certifying solar equipment. These efforts are aimed at developing a network of laboratories across the country accredited by a representative industry/professional organization. The laboratories will be able to test and validate the operating characteristics of solar components and systems. Test results and validation will then be available to the public.

1/ The Energy Tax Act of 1978 required the Secretary of the Treasury to establish a procedure under which a manufacturer of solar devices may request the Secretary to certify that the devices will be treated as qualifying property for purposes of the residential energy tax credit. One statutory requirment is that the solar device meet the performance and quality standards (if any) prescribed by the Secretary. Thus far none have been prescribed.

To facilitate developing a certification process, the Federal Government awarded a contract in September 1977 to the Solar Energy Research and Education Foundation to develop a plan for certifying, rating, and labeling solar collectors and water heating systems. This project is aimed at developing a system which can be used by private industry or State governments to certify the solar energy system's performance. This plan is expected to be issued June 1979.

The Federal Government has used interim measures to assure the public that solar heating systems work. In the Federal "hot water initiative" program created by HUD and DOE, grants were awarded in 11 eastern States to homeowners who installed qualifying solar water heaters on their residences. The qualifying solar systems were determined by State officials. However, the systems had to meet certain Federal criteria, such as (1) complying with existing HUD interim standards, (2) having a 5-year warranty on primary components, and (3) providing 50 percent of the annual hot water needs of the residences. To assist some States in qualifying solar hot water systems, the Polytechnic Institute of New York evaluated the performance of various solar heating systems and made recommendations on which systems should qualify for grants. DOE officials did not view this as certification, however, but rather as an interim measure until a formalized certification system is developed.

Although Federal efforts have not yet been completed, some States have moved ahead in developing their own certification system. The State of Florida has developed and successfully used since January 1977 a voluntary collector certification program. In Florida, solar manufacturers can have their collectors tested at the Florida Solar Energy Center for compliance with Florida standards and rated for performance. The collectors can then be approved to bear a label of certification. Although certification is presently voluntary, Florida officials may make certification mandatory in 1980.

Although Florida was the only State during our review that had an operational certification process, the State of California is in the process of implementing one to assure that systems eligible for the California tax credit meet standards set by the California Energy Commission.

In addition to the above efforts, the Solar Energy Industries Association--a private non-profit organization--announced a rating, labeling, and certification program in March 1979. Under this program, solar collectors can be tested and their performance rated on a label bearing the

organization's seal. Officials of this organization expect to eventually expand the program to rate collectors for safety and durability.

Although some States and private industry have taken the initial steps in developing a certification process, without Federal guidelines, it is unclear exactly what type of process will eventually emerge. Many questions, such as the following, have been raised by either solar manufacturers or State officials.

--To what degree will solar manufacturers be required to have their systems certified?

--Will other components besides solar collectors be certified?

--Will anyone certify that systems are installed properly?

--Who will actually certify, and, perhaps more importantly, who will authorize them to certify?

--Will a system certified in one State be automatically certified in another?

Since no timetable for developing a certification process has been set by Federal officials, it may be years before these questions are resolved.

EFFORTS TO REMOVE LEGAL BARRIERS

Legislative support for solar energy at the State level can be particularly important in removing legal barriers to using solar heating systems. Local tax structures, such as those dealing with property tax, for example, can be a significant impediment. Guaranteeing the future viability of solar heating may require zoning legislation or other laws to safeguard the solar user's access to sunlight.

Accordingly, a number of States have taken the initiative to remove legal barriers.

--Twelve States have passed laws to ensure the solar user's access to sunlight (sunrights). (See app. II for a listing.)

--Twenty-seven States have passed laws which can eliminate part or all of the increased property tax

attributed to owning a solar system. (See app. III for a listing.)

These initiatives do not represent a single strategy, however, but rather a variety of individual efforts, some more effective than others, for overcoming legal barriers.

Sunrights

Providing assurance to solar users or potential investors in solar heating systems that their access to sunlight will not eventually be blocked or partially blocked may be difficult because of existing housing patterns. For example, 1-acre development zoning may be good for solar but limit solar heating's use to upper income families. In more urbanized areas and established neighborhoods, regulations governing access to sunlight and foliage growth may be difficult to pass and more difficult to enforce. Because of the difficult nature of the problem, only twelve States have passed legislation guaranteeing to various degrees solar users' access to sunlight.

Among the States which have enacted legislation, two approaches have been taken to establish sunrights. New Mexico and Oregon have delegated the responsibility of developing sunrights zoning ordinances to local governments while other States, such as Colorado and Maryland, have provided procedures for recording voluntary solar easements.

With regard to the first approach, New Mexico State officials informed us that when attempting to pass a State-wide law guaranteeing property owners access to sunlight, a number of questions were raised:

--What remedy would a neighbor have against collector glare?

--Who should pay for foliage trimming and maintenance?

--How far away does a building have to be for exemption from shading restrictions?

State officials told us that each time the bill got into committee, the legislators wrestled over these and other legal ramifications, and regardless of how many amendments were tacked onto the bill, they could not fully agree. A compromise was finally reached with the passage of a bill in May 1977 which allows the State's local jurisdictions to enact ordinances or zoning restrictions to guarantee property owners access to sunlight.

As of March 1978, New Mexico State officials informed us that only 1 of the State's 32 counties had enacted a solar zoning ordinance. That county's ordinance states:

> "When a solar energy collection system is installed on a lot, accessory structures or vegetation on an abutting lot shall not be located so as to block the solar collector's access to solar energy."

Although the ordinance does not address all problems that may eventually arise, such as glare or existing and future structures not on an abutting lot which may shade the collectors, New Mexico State officials believe it to be an acceptable solution to the problem. New Mexico State officials stated some of the other counties are expected to enact similar legislation but that they also foresee similar problems occurring at the county level that occurred at the State level.

Colorado and Maryland have taken more direct actions by providing procedures for recording voluntary solar easements. Easements are limited rights to the use of another's land. Solar easements would be the limited right to enjoy the unhindered flow of sunlight across a neighbor's property. Under such a law, the solar homeowner would voluntarily bargain with his neighbors for such solar easements. There are some limits, however, to the usefulness of such legislation:

--Since solar easements are voluntary, courts cannot force their sale.

--They may be expensive.

--Their enforcement may involve long and costly lawsuits.

Since the most effective solution to the sunrights problems has yet to be determined, some State officials are hesitant to take action. They see a need for model legislation formulated by the Federal Government which can be adopted or modified to meet the States' needs. In this regard, HUD has funded the American Bar Foundation and the Environmental Law Institute to determine the extent to which "rights" to sunlight are necessary. This project is scheduled for completion in 1979.

Building codes

Little has been done at the State or local level to incorporate solar standards into local building codes. To encourage State and local governments to modify existing

codes and adopt reasonably uniform codes, the Federal Government is attempting to formulate model codes for solar devices which can be used by State and local governments.

At the State level, we found only two States--California and Florida--which have passed laws dealing with building code provisions. In both cases, these laws were aimed more at encouraging the future installation of solar devices than overcoming existing constraints that building codes pose (see p. 18). A 1974 Florida law provides that no single family residence shall be constructed in the State unless the plumbing is designed to facilitate future installation of solar water heating equipment. Similarly, a 1976 California law provides that any city or county may require new buildings to be constructed so as to permit the future installation of solar heating devices. Since neither law addresses safety, the safety of a solar heating device is usually determined by the local building inspector in these States.

In order to minimize the constraints building codes may have on commercializing solar heating systems and to foster the development of reasonably uniform codes throughout the Nation, DOE began funding a project in May 1978 with the Council of American Building Officials to develop a model code for solar heating and cooling of buildings. In addition to formulating model code documents which can be used by States and localities, the project is also expected to promote a greater understanding and acceptance of solar technologies among code officials. In this regard, DOE officials told us that many State governments as well as the major building code organizations are participating in the project. According to the project's schedule, the model code is to be distributed to State and local governments by October 1979.

Property tax exemptions

Solar heating systems generally increase the market value of houses and can result in higher assessed values and consequently higher property taxes. To remove this disincentive, 27 States have enacted a variety of legislation.

Some State governments, such as Connecticut, Maryland, New Hampshire, and Vermont, have enacted legislation which gives local or county governments the authority to exempt property taxes on solar energy systems. The effectiveness of this incentive will depend on the willingness of local and county governments to allow such exemptions. Within some States, local government may be responsive. For example, Connecticut in 1976 passed legislation giving local governments the authority to exempt solar energy systems

from increased property assessments. As of March 1978, 116 of Connecticut's 169 local governments (69 percent) enacted property tax exemptions for solar energy systems. In other States, local or county governments may not be as responsive. Maryland, for example, according to a State official, passed legislation in 1975 giving county governments the authority to exempt solar energy systems from increases in property taxes, but only 1 of the State's 23 counties (4 percent) has enacted property tax exemptions for such systems.

Legislation in other States has placed limits on the amount of the solar system's cost which is subject to the exemption or the time period for which the exemption is allowed. For example, Colorado's law provides that the valuation of all solar heating devices attached to or part of any building improvement shall be 5 percent of the actual value as determined by the tax assessor. Other properties in Colorado are assessed at 30 percent of their actual value. Other States, such as South Dakota, Oregon, and Hawaii, have placed time limits on the exemption. For example, Hawaii's exemption applies only to December 31, 1981.

EFFORTS TO DISSEMINATE INFORMATION AND DEVELOP TRAINING PROGRAMS

Because of the relative newness of solar heating technologies, many Government and industry officials see the need to disseminate information on solar heating systems and initiate educational training programs. Information dissemination about solar heating systems would be useful so that the general public, the building industry, lending organizations, and others could understand solar heating's applicability, usefulness, and economic value. These officials also see the need to train personnel how to correctly install and later service solar heating equipment.

Information dissemination

The Federal Government, many State governments, and numerous private organizations distribute information on solar energy. Although much of this information is useful in understanding solar energy systems, it is sometimes--depending on the source--contradictory and even misleading.

For the most part, information on solar heating within DOE is disseminated under the Solar Technology Transfer Program. The two DOE clearinghouses for information under this program are (1) the DOE Technical Information Center in Oak Ridge, Tennessee, and (2) the National Solar Heating and Cooling Information Center in Philadelphia, Pennsylvania. Other sources of information are DOE's Public Affairs

Office and its Energy Extension Service. Information from these sources within DOE are usually disseminated upon request.

To coordinate these various sources of information within DOE and target information to specific segments of society who would find this information most useful, DOE established a National Laboratories Outreach Program. Under the program, Government officials disseminate specific information to target audiences such as builders, engineers, lenders, etc. This program, however, was never fully implemented and has now been incorporated into the activities of the regional solar energy centers (see p. 36). In addition to DOE, other Fedaral agencies also distribute information.

In addition to the Federal efforts, almost all State governments we contacted disseminate some form of information about solar energy. We also found that utility companies, some lending insitutions, better business bureaus, and nearly every solar manufacturer routinely distribute information on solar energy systems.

Although a considerable amount of useful information is being disseminated, some information--depending on the source--has been contradictory and occasionally misleading. For example, information on how quickly a solar heating system will pay for itself varies considerably. Some solar manufacturers predict a payback in a few years while others, such as a utility company we contacted, predict a payback in about 25 years. Some information from solar manufacturers has even been termed fraudulently deceptive by consumer protection groups.

Educational training programs

The Federal Government and some State governments are in the process of developing training programs for installing solar devices. Although their respective programs differ considerably, they could be helpful in removing some of the problems which face the solar industry.

At the Federal level, the most significant actions have been through the Solar Technology Transfer Program. This includes (1) the development of an accredited home study course to train contractors how to install and maintain solar heating and cooling systems and (2) the development of a solar curriculum for vocational schools and a solar educational curriculum for elementary and secondary schools.

According to DOE officials, both programs have been developed and are expected to be implemented through the

regional solar energy centers. However, no timetable has been established for implementing these programs.

At the State level, a few States have initiated their own programs--with Federal assistance--to train building inspectors about solar energy systems. Other States have initiated different programs. For example, California's Office of Appropriate Technology is designing a statewide solar training curriculum to be available for community-based organizations and community college programs. Florida has, for some time, had a program to train prisoners to install solar heating equipment.

EFFORTS TO INITIATE COMMERCIALIZATION ACTIVITIES THROUGH REGIONAL SOLAR ENERGY CENTERS

The concept of a regional solar network was announced by ERDA, now DOE, in March 1977 along with the selection of a National Solar Energy Research Institute (SERI). 1/ The regional network approach, according to DOE officials, was a logical extension of SERI functions especially for DOE's commercialization efforts. This is because different locations throughout the Nation will have varying solar energy needs due to different climates and solar insolation characteristics.

This network is now comprised of four regional solar energy centers:

--Northeast Solar Energy Center, operated by the Northern Energy Corporation, Cambridge, Massachusetts.

--Mid-American Solar Energy Center, operated by the MASEC Corporation, Egan, Minnesota.

--Southern Solar Energy Center, operated by the Solar Project Committee, Atlanta, Georgia.

--Western Solar Energy Center, operated by the Western Sun Corporation, Portland, Oregon.

1/The creation of SERI was authorized on October 26, 1974, by the Solar Energy Research, Development, and Demonstration Act of 1974 (Public Law 93-473). In March 1977, the Midwest Research Institute was selected as the operating contractor for SERI to be located at Golden, Colorado.

These centers are intended by DOE to become the lead institutions for implementing DOE's solar commercialization activities. Accordingly, the activities of the National Laboratories Outreach Program are now being transferred to the regional centers.

Although the decision to create the network was announced over 2 years ago, each center's specific plan defining the missions and roles of the centers and how these are integrated into DOE's overall commercialization efforts has not yet been fully developed. DOE has, however, issued a preliminary program guide for the centers, dated February 9, 1979. The purpose of the guide is to assist the centers in developing their respective detailed implementation plans.

At the time of our review, these detailed implementation plans were not available. DOE officials, however, told us they expect to approve and fund the centers' second-half fiscal year 1979 plan by May 1979 and the centers' 1980 operating plan by September 1979.

The guide specifies five major functional areas of commercialization which the regional centers must address:

--Coordinating with State and local governments and other regional interest groups in planning, implementing, and evaluating regional solar commercialization programs.

--Eliminating barriers to solar energy's acceptance, and identifying and promoting incentives regarding the use of solar energy.

--Promoting the acceptance of solar energy through educational institutions in the region.

--Arranging for training of that portion of the labor force necessary to support solar commercialization.

--Identifying regional information requirements and the sources from which to collect that information.

While recognizing the important role these centers can have in commercializing solar heating and eventually other solar energy systems, it is difficult to assess their effectiveness without a sufficiently detailed and definitive plan laying out their respective missions and roles. It is unclear, for example, what specific role these centers will play in

developing a certification process, and encouraging States to adopt financial incentives.

CONCLUSIONS

Both Federal and many State governments have initiated efforts aimed at removing one or more constraints facing the widespread use of solar energy. At the State level, commercialization activities have generally emphasized financial incentives and the removal of legal barriers. The Federal Government's activities have generally focused on developing standards, cooperating with industry in developing a certification process, developing model legislation and codes for the removal of legal constraints, disseminating information, developing training programs, and creating a network of regional solar energy centers. These efforts, however, have not yet evolved into a comprehensive and reasonably uniform approach to commercializing solar heating systems. Furthermore, some existing efforts appear ineffective.

--In many cases, financial incentives at the State level are not of sufficient monetary value to encourage the use of solar heating systems.

--Some standards governing the installation and performance of solar heating devices are not yet developed, and even when developed it is not clear to what extent they will be used.

--Federally sponsored certification procedures intended to verify how well solar heating systems meet existing standards have been slow to develop. A few States have moved ahead and developed their own procedures.

--Attempts to remove legal constraints generally lack uniformity and, in some instances, appear ineffective.

--Although Federal officials expect the regional solar energy centers to play an important role in commercializing solar heating systems and interfacing with State and local governments, these centers have not fully implemented their respective commercialization plans.

There is a need, in our view, for a clearly defined national commercialization strategy for solar heating systems which will (1) pull together all existing efforts at the Federal, State, and local levels into a more effective approach for commercializing solar heating systems and (2) initiate actions in those States which have done little or nothing to

commercialize solar heating systems. Such a strategy, as a minimum, should

--identify the key constraints which limit the commercialization of solar heating systems and lay out the most appropriate actions needed to overcome these constraints;

--clearly delineate the roles and responsibilities of Federal, State, and local governments in overcoming these constraints;

--set specific goals and time frames for overcoming constraints; and

--spell out the type and magnitude of Federal assistance that will be available to implement the strategy.

Such a strategy, once established, should be useful in making visible to the State governments as well as the Congress and the public a well-conceived plan for commercializing solar heating systems. The Federal Government could then work together with the States to remove constraints to using solar energy systems. For example, State governments could focus their attention on adopting existing standards rather than on developing their own. In implementing the overall strategy, the regional solar energy centers--when fully operational--could play an important role in introducing Federal programs to State and local officials and at the same time capitalize on the experience and knowledge gained by some States in their pioneering efforts to commercialize solar energy.

Some of the components for the overall strategy are already being developed by the Federal Government--uniform standards, a certification process, and model legislation for removing legal constraints. However, some of these efforts appear to be developing slowly. For example, Florida has developed and successfully used a certification process since January 1977, while federally-sponsored efforts are still in the planning stage. We believe these efforts should be expedited and the overall strategy implemented as quickly as possible so that Federal financial incentives which were recently passed do not unnecessarily precede efforts to assure the public that solar heating systems are good investments.

To commercialize solar heating systems successfully in the shortest possible time, it is essential that a national commercialization strategy be developed and implemented at all levels of government. Such a strategy would, among other

things, clarify the roles of various levels of government and define what needs to be done to successfully commercialize solar heating systems. Moreover, it should provide a framework for commercializing other solar technologies that will follow.

RECOMMENDATIONS TO THE SECRETARY OF ENERGY

In order to foster the commercialization of solar heating systems successfully in the shortest possible time and be assured that recently passed Federal financial incentives do not unnecessarily precede efforts to assure the public that solar heating systems are good investments, we recommend that the Secretary of Energy:

--Establish a detailed commercializtion strategy for solar heating systems. This strategy should, as a minimum, identify constraints to the widespread use of solar heating systems and describe how best to overcome these constraints. Also, the strategy should clearly delineate the roles and responsibilities of the Federal, State, and local governments in commercializing solar heating systems as well as set specific goals and time frames for overcoming these constraints.

--In cooperation with other Federal agencies, expedite efforts to (1) develop standards governing the installation, design, and performance of solar heating systems, (2) prescribe a certification system for verifying that solar heating systems meet these standards, and (3) formulate model legislation for overcoming legal constraints to using solar heating systems.

--Work together with State and local governments in implementing components of the strategy. Procedures and guidelines should be established for providing informational and other appropriate assistance to the States for overcoming constraints to using solar heating systems.

AGENCY COMMENTS AND OUR EVALUATION

In commenting on our draft report (see app. IV), DOE did not take exception with any of our conclusions or recommendations. In fact, they pointed out that they are in the process of developing an accelerated commercialization plan with the following overall objectives:

--Developing a national commercialization strategy.

--Identifying and evaluating the barriers to the development and commercialization of solar energy.

--Recommending policies to remove the barriers and accelerating solar commercialization.

--Defining programs to be conducted to support solar commercialization.

This plan is due to be provided to the Congress in December 1979.

DOE also indicated that its comprehensive solar energy commercialization plan will place emphasis on more than one of the solar technologies. While we recognize that there are numerous solar technologies, we believe the focus of DOE's future efforts should be aimed at those solar technologies which are the closest to being economically and technically accepted and have a large potential for use. Solar heating systems, therefore, should have a high priority in any solar commercialization strategy.

CHAPTER 4

POTENTIAL EFFECTIVENESS OF NEA IN ENCOURAGING THE WIDESPREAD USE OF SOLAR HEATING DEVICES

After nearly a year and a half of deliberation, the Congress, on October 15, 1978, passed five bills which make up the NEA. On November 9, 1978, the President signed these bills into law. Within these bills are a number of initiatives aimed at encouraging the use of solar heating systems. The most significant of these include tax credits, a loan support program, and demonstrations of solar devices on Federal buildings.

Although procedures for implementing these initiatives have not yet been completely formulated, we nevertheless looked at their potential for encouraging the use of solar heating devices. We found that these initiatives do have the potential to greatly expand the solar industry. However, in regards to energy saved or replaced by 1985, these incentives are not likely to have much of an impact. Because of this, we believe the Congress--as has been the case with some State legislatures--will be called upon to act on further incentives to encourage the use of solar heating devices over the next few years.

PERSPECTIVE ON THE NEA

When the President announced his National Energy Plan in April of 1977, he recognized that certain solar technologies, such as solar hot water heating and space heating, could make a contribution in helping the Nation meet its energy demand. Accordingly, the President proposed a temporary Federal program of financial incentives to stimulate a large solar market. The President's goal was to encourage the use of solar energy in 2.5 million homes by 1985. Although this goal, when translated into energy saved, is rather small (less than one-half of one percent of the Nation's energy needs or about 0.2 quads 1/), DOE officials believe it would help create an expanded solar industry from which more substantial energy savings could be achieved in future years.

1/This would be equivalent to saving about 36 million barrels of oil a year.

While the Congress deliberated on the provisions of the NEP for encouraging the use of solar energy devices, a number of criticisms were raised. Some solar proponents claimed the provisions would not go far enough, while others contended it was premature to enact legislation for encouraging the use of most solar heating applications. Still others believed the President's goal would not be met under the NEP provisions. DOE, for example, estimated that about 1.9 million homes will be using solar heating systems by 1985 if the NEP's solar initiatives were enacted. Other Government agencies, such as the Office of Technology Assessment, as well as private organizations were not as optimistic as DOE. Many solar industry representatives continually pointed out to us that unless the Congress takes some positive steps to encourage the use of solar heating systems, the present solar industry would flounder.

Taking these criticisms into consideration, the Congress--after nearly a year and a half of deliberations--passed five bills 1/ on October 15, 1978, which make up the NEA. In regards to promoting the use of solar heating devices, NEA brought several provisions of the original NEP into being. The most significant of these are

--a non-refundable income tax credit 2/ for the residential installation of solar devices,

--a 10-percent refundable business tax credit for investments in solar equipment,

--a $100-million program to provide support for loans of up to $8,000 to owners of one to four family dwellings who purchase and install solar heating and cooling equipment on these residential housing units, and

--A $100-million program for demonstrating solar devices on Federal buildings.

1/The Public Utility Regulatory Policies Act of 1978 (Public Law 95-617, November 9, 1978), the Energy Tax Act of 1978 (Public Law 95-618, November 9, 1978), the National Energy Conservation Policy Act of 1978 (Public Law 95-619, November 9, 1978), the Powerplant and Industrial Fuel Use Act of 1978 (Public Law 95-620, November 9, 1978), and the Natural Gas Policy Act of 1978 (Public Law 95-621, November 9, 1978).

2/The total maximum credit allowable under the law is $2,200 on $10,000 of expenditures.

Although regulations for implementing these incentives have not yet been formalized by the appropriate Federal agencies, their effectiveness can still be estimated based on work previously done by DOE, from independent studies, or from the experiences of many State governments which have enacted solar incentives. The following sections of this chapter discuss the applicability, impact, and some shortcomings of these incentives for encouraging the use of solar heating systems.

EFFECTIVENESS OF TAX CREDITS

Tax credits have a distinct advantage over other forms of financial incentives because they are easy to administer and have minimal administrative cost. Furthermore, tax credits provide a high degree of public visibility in that they would become part of the Federal tax structure. Tax credits can also be tailored to reach a targeted population and limited to those solar heating systems that meet Government criteria for acceptability. Thus, tax credits have become the cornerstone of the Federal incentives to encourage the use of solar devices. The Energy Tax Act of 1978 allows tax credits for both individual residents and businesses who invest in solar equipment.

Impact on the residential sector

When reviewing the constraints facing the use of solar heating (chapter 2), it becomes clear that solar water heating systems for residential use are the most promising applications for widespread use. Solar water heating systems are relatively inexpensive when compared to other solar heating applications and generally have shorter payback periods. Accordingly, these systems represent far less risk to potential buyers, investors, and lenders. Almost all of the solar manufacturers we contacted have focused their markets, some exclusively, on solar water heaters. Some companies are beginning to offer complete solar water heating systems and are backing their systems with 5-year warranties. Many officials we contacted pointed out that solar water heaters have considerable advantages over other solar heating applications in that they are simple to install and encounter fewer technical problems once in operation. Furthermore, they added that energy savings were more predictable for solar water heaters since a family's hot water requirements were more consistent from year-to-year than their space heating needs, which are highly dependent on weather conditions.

Combined solar water and space heating systems for residential use, on the other hand, do not appear to be as economical as solar water heaters. Some economically attractive applications may exist, especially when compared with

electric resistance heating in those portions of the country with high electrical rates. However, when compared with electric heat pumps, oil, or gas, the economics are not very attractive. Furthermore, these combined systems are more difficult to design and install than water heaters. Generally, they require more collector space and a large energy storage system. Because of higher economic risks and the more complicated nature of the system, many builders and architects do not recommend solar space heating to prospective buyers. They place higher priority on heavy insulation, heat pumps, and other conservation measures.

Because of differences in the economic as well as technical status of solar heating applications for residential use, it is generally recognized by DOE officials and the solar industry that enacted tax credits will have their most measurable impact on encouraging the use of solar water heaters. The following table shows DOE's estimated impact of the NEA's tax credit provisions 1/ on residential solar heating applications.

Cumulative Number of Solar Heated Homes, 1977-85 (note a)

Type of installation	Number of installations
	(000 omitted)
Solar water heated homes	1,574
Solar water/space heated homes	314
	1,888

a/The actual number of consumers who will respond to a given incentive is highly speculative. Other estimates are not as optimistic as DOE's.

1/As enacted, the law allows an individual to take a non-refundable credit covering 30 percent of the first $2,000 and 20 percent of the next $8,000 spent on installed solar equipment in his principal residence. Investments from April 20, 1977, to December 31, 1985, will be eligible if the equipment is used to heat or cool a home or provide hot water.

Because of the much greater impact the tax credit provisions of the NEA are likely to have on increasing the use of solar water heaters versus combined solar water and space heating systems, much of the solar industry will probably continue to focus its attention on selling solar water heaters. By 1985 other incentives or financial assistance may be necessary to increase the number of solar space heated homes to a level more comparable to homes using solar water heating devices.

Additional financial incentives may also be desired to increase the amount of energy saved or replaced by solar heating devices prior to 1985. Although DOE predicts that about 1.9 million homes may be using solar heating devices by 1985, this is equivalent to less than 0.2 quads. In other words, on a national scale the amount of energy saved is almost negligible. Therefore, even though passage of tax credits in NEA may create an expanded solar industry, the Congress may be called upon to enact further financial incentives to increase to a more substantial level the role solar heating can play in helping the Nation meet its energy demand. At least two States--both of which now offer greater monetary incentives for encouraging the use of certain solar heating systems than enacted under the NEA (see p. 24)--have reconsidered their initial efforts to encourage the use of solar heating devices and passed additional incentives to raise the usage of such devices to a more substantial level.

Impact on the commercial sector

Commercial and industry applications represent the highest potential markets for solar heating, but are the furthest from overcoming constraints to acceptability. The longer payback periods associated with these applications, coupled with the short payback periods usually required by businesses, make widespread use doubtful at this time. Technical problems and performance uncertainty are other major concerns to potential business investors. A system that breaks down or performs poorly causes annoying problems to a homeowner but may be even more detrimental to the operation of the business in terms of lost revenue.

Matching solar heating capabilities with commercial and especially industrial heating requirements offer a unique technical challenge for solar entrepreneurs. In many cases, solar equipment must be extremely reliable and meet specific heating requirements for such applications as crop drying and providing process heat for industrial applications. To make these applications attractive to a significantly large number of businesses, Government subsidies covering 50 percent or

more of the initial cost may be necessary. This is evidenced in present cost-sharing arrangements between DOE and private industry in the Federal Commercial Buildings Solar Heating and Cooling Demonstration Program. According to DOE officials, the average Government share of the costs for carrying out commercial demonstrations has been about 70 percent. Industrial applications for solar heating, according to DOE officials, may even require a larger percentage of Government support when they are ready to be demonstrated.

The recently enacted provisions of the Energy Tax Act of 1978 which are aimed at encouraging the use of solar heating for commercial applications do not provide for this magnitude of commitment. Under the act, businesses are allowed to claim an additional 10-percent credit for investments in solar equipment on top of the 10-percent credit now allowed for investments in business property. The cummulative value of this tax credit, however, does not compare favorably with the 50 percent or more subsidy that many solar manufacturers and Government officials believe is necessary to stimulate a large commercial market. Accordingly, the market response is not expected to be large. DOE estimates that under the Energy Tax Act provisions, only about 24,000 commercial establishments will be using solar devices by 1985. Energy savings attributable to this--on a national scale--would be negligible.

Possible drawbacks of using tax credits

In addition to the small impact tax credits would have on certain solar heating applications, they have other inherent drawbacks which may limit their potential usefulness.

--Certain segments of the population may be unable to receive the full benefit of the tax credit because they have little or no tax liability. To other individuals, despite the carry over of unused credit provision, the tax credit may be a poor stimulus because from year to year they have an uncertain tax liability or they do not want to wait a year or more before receiving the full benefit.

--Tax credits would be difficult to change or modify to better meet program goals.

--Obtaining detailed information on a few hundred thousand taxpayers who take the tax credit out of tens of millions may be difficult and costly and thereby limit program oversight and control.

The extent to which these shortcomings will limit the effectiveness of tax credits will depend on how well DOE integrates the tax credits with their other ongoing efforts to stimulate the use of solar heating systems (see ch. 3.)

EFFECTIVENESS OF THE SOLAR ENERGY FINANCING PROGRAM

Because of the high fixed capital cost associated with many solar heating systems and the large Government outlays, either directly through grants or indirectly through the credits (which would probably be necessary to significantly encourage their use), other Government actions, such as loans, may be more appropriate. One advantage of loan-type programs is that Government losses attributed to a loan program are not as immediate as Government subsidies, and are spread out over the life of the program (possibly 15 to 30 years or more). Furthermore, many solar heating applications would probably be financed through borrowing, instead of being paid for directly. Government loans would assure the potential investor that such financing is available.

Recognizing the potential usefulness of loans for stimulating the use of some solar heating applications, one of the acts comprising the NEA--The National Energy Conservation Policy Act of 1978--does authorize a program to facilitate solar energy loans. This program will be administered under the supervision of HUD.

Under the program, the Government will be authorized to purchase up to $100 million of reduced interest loans to owners of one to four family dwellings for the purchase and installation of solar heating and cooling equipment in these residential dwellings. Support of up to $8,000 for each unit will be available for 5 years, with loan repayments due within 15 years.

Although loans of this type can be an effective supplement to tax credits by providing support to those who may not have the tax liability to benefit from tax credits, the overall impact of this program will not be very significant in helping meet the President's goal. For example, if the average loan per residential dwelling is $5,000, then the entire program could provide support (directly or indirectly) for up to 20,000 homeowners. This would account for less than 1 percent of what the President expects in 1985.

Loans of this type would probably not be used to any great extent by individual homeowners to purchase solar space heating or combined water and space heating systems.

This is because such systems usually cost more than the $8,000 ceiling--in many cases $10,000 or more. 1/

THE DEMONSTRATION ON FEDERAL BUILDINGS PROGRAM

Under the National Energy Conservation Policy Act of 1978, the Federal Government is authorized up to $100 million to demonstrate solar technology in Federal buildings. According to DOE, this program will be designed to stimulate the manufacture of solar equipment, help lower the cost of solar energy systems, and thereby make such systems more attractive for widespread commercial use. This program, according to DOE officials, will build on the work already started by DOE under the National Program for Solar Heating and Cooling of Buildings. As of January 1979 DOE--through various Federal agencies--has initiated 38 projects which are attempting to demonstrate the usefulness of solar heating and cooling equipment. These projects range in size and type from solar heating a small office building costing about $16,000, facility costing an estimated $800,000. DOE estimates the total cost of the 38 projects to be about $8.5 million.

Because of the wide range of possible applications for using solar equipment on Federal buildings, it is extremely difficult to estimate the impact of such a program. Nevertheless, even if all funds were expended on the most useful and cost effective applications--solar heating--the resultant energy saved would be negligible. Extrapolating from the DOE demonstration program, we estimated that around 600 to 1,000 buildings would be affected by the NEA demonstration on Federal buildings program. Since the Government owns over 400,000 buildings, it would appear that this program will have little impact on meeting the Government's demand for energy, much less the Nation's.

CONCLUSIONS

On November 9, 1978, the President signed five bills which comprise the NEA. Within these bills are various financial incentives aimed at encouraging the use of solar heating systems, including tax credits, a loan support program, and demonstrations of solar devices on Federal buildings.

1/The cost of a combined solar heating and cooling system can range up to $14,000 or more.

We looked at the potential effectiveness of these financial incentives for encouraging the use of solar heating devices and found that they have the potential for greatly expanding the use of solar water heating systems in the residential sector by 1985. This could result in a "boon" for the solar industry. It could also lead to an expanded industry which could be self-sustaining in the post 1985 era.

By 1985, however, the energy saved or replaced attributable to these incentives will not be significant. DOE estimates only about 0.2 quads will be saved which, on a national scale, would account for less than one-half of one percent of the Nation's energy needs. The impact on solar heating use in the commercial sector (including industry) would even be less significant even though this is a potentially larger market for solar heating devices than the residential sector. Because of the minimal impact these incentives are likely to have in helping the Nation meet its energy demand, we believe the Congress--as has been the case with some State legislatures--will be called upon in the near future to act on further incentives to encourage the use of solar heating systems. Additionally, the Congress may also be called upon to modify existing incentives in order to better meet program goals or to assist those segments of the population which may not benefit from present incentives.

Because of the likelihood of the Congress deliberating on further financial incentives for solar heating systems, we believe it is imperative that the Congress have sufficient and accurate information on the success of the NEA provisions. Accordingly, we believe that DOE should take steps to track the success of ongoing and planned efforts and annually report to the Congress on the success of the NEA provisions. Such reporting can also serve as a conduit for recommending to the Congress ways to improve the overall incentives program and to keep the Congress abreast of DOE's efforts to pull together an overall national strategy for encouraging the use of solar heating systems.

RECOMMENDATIONS TO THE SECRETARY OF ENERGY

In order to ensure that the Congress has accurate and sufficient information on which to make decisions on further incentives for encouraging the use of solar heating systems, we recommend that the Secretary:

--Monitor the success of the various provisions of the NEA for encouraging the use of solar heating systems and annually report the findings to the Congress. Such reports should include not only the number of

installations resulting from the various incentives but also the equivalent energy savings. This would provide the Congress with a needed perspective on the extent solar heating is helping the Nation meet its energy demand.

--As part of these reporting procedures, inform the Congress on ways to improve the overall effectiveness of the NEA provisions including the magnitude of additional incentives that might be needed to encourage greater use of those solar heating applications--especially commerical applications--which, without additional incentives, are projected to have very little use prior to 1985.

MATTERS FOR CONSIDERATION BY THE CONGRESS

We believe that the provisions of the NEA represent a logical new initiative for encouraging the use of solar heating systems. However, in recognizing the limited impact these provisions will most likely have by 1985--even if the President's goal is met--further incentives are likely to come before the Congress over the next few years. Such has been the case in some State legislatures. Additionally, the technical and economic status of the various solar heating applications can change considerably over the next few years, which may necessitate new incentives or modification of existing ones so that solar heating systems can be successfully commercialized. Because of this, we believe the Congress--prior to enacting any additional incentives--should take steps to ensure that any new initiatives result in meaningful energy savings. This can be accomplished through Congress' legislative and oversight processes by closely monitoring the success of solar demonstration projects, ongoing efforts to remove nonfinancial constraints, and the impact of various provisions of the NEA. If need be, the Congress may even wish to require DOE to submit information, as part of its budgetary process or as an addendum to any legislative proposal, showing the impact in terms of energy saved that any new initiatives for encouraging the use of solar energy are likely to have.

RECENT PRESIDENTIAL INITIATIVES

While we were preparing this final report for publication, the President in a message to the Congress dated June 20, 1979, set a national goal of deriving 20 percent of the Nation's energy from the sun by the year 2000. To reach this goal the President also announced major elements of a national strategy

including new legislative proposals and directives for various Federal agencies.

Some of the more significant legislative proposals that could impact on the use of solar heating systems follow.

--Creation of a new National Solar Bank funded at an initial annual level of $100 million.

--A 20-percent tax credit, $2,000 maximum per home, for new homes built using passive solar designs.

--A new investment tax credit to encourage the use of solar technologies to provide process heat for use in industry and agriculture.

In addition to these legislative proposals, the President also announced the following directives which could be important in developing a concerted effort among all levels of government in commercializing solar heating systems. These include

--the establishment of a permanent Standing Subcommittee on Solar Energy within the Energy Coordinating Committee 1/ to monitor and direct the implementation of all solar programs across the government,

--a strengthening of current efforts to meet the consumers' need for valid information and assurance that solar equipment and systems purchased under Federal incentive programs will perform and last as expected,

--an acceleration of the development of one or more model solar building codes for use by States and localities, and

--the development of training programs for State and local officials so that solar building codes can be effectively administered.

We did not evaluate these recent initiatives. However, some of the directives could be helpful in pulling together a coordinated national strategy for commercializing solar heating systems if they are sucessfully implemented in the near future.

1/ The Energy Coordinating Committee was established by excutive order. The Committee has as members the major agencies which have responsibilities for solar energy.

STATES WHICH HAVE PASSED INCOME OR SALES TAX INCENTIVES

State	Description of Incentive
Alaska	A tax credit amounting to 10 percent ($200 maximum) of the cost of installing a solar system in the taxpayers personal residence is available. The credit applies to expenditures incurred between January 1, 1977, and December 31, 1982.
Arizona	The cost of solar devices on all types of buildings can be amortized over 36 months in computing net income for State income tax purposes. Income tax credit amounting to 35 percent ($1,000 maximum) of the cost of installing a solar device in a taxpayer's residence is also available. The credit percentage declines 5 percent per year until the law expires in 1984.
Arkansas	Individual taxpayers are allowed to deduct the entire cost of solar heating/cooling equipment from gross income for the year of installation.
California	An income tax credit amounting to 55 percent ($3,000 maximum) of the cost of installing a solar system in a home is available. The installed systems must meet criteria established by the Energy Resource Conservation and Development Commission. For any building, other than a house, where the cost of the system exceeds $6,000, the credit provided is $3,000, or 25 percent of the system cost, whichever is greater. The law expires on January 1, 1981.
Colorado	A personal and corporate income tax deduction is available equal to the cost of installing a solar energy device in a building.
Connecticut	Sales and use tax exemptions are provided for solar collectors. Exemptions expire October 1, 1982.

State	Description of Incentive
Georgia	Sales and use tax refunds are provided for the purchase of solar equipment.
Hawaii	An income tax credit amounting to 10 percent of the cost of a solar system is available. The system must be placed in service between December 31, 1974, and December 31, 1981.
Idaho	The entire cost of installing a solar system in a residence can be deducted over a four year period. Deduction cannot exceed $5,000 in any taxable year.
Kansas	Individuals and businesses are allowed an income tax credit equal to 25 percent of the cost of a solar system (up to $1,000 for individuals and $3,000 for businesses). If individual credit exceeds tax liability, excess credit can be carried forward for 4 years. The system must be acquired prior to July 1, 1983. In addition, the taxpayer can amortize and deduct the cost of a solar system installed in a business over 60 months.
Maine	Provides a refund of sales or use tax paid on solar equipment certified by the Office of Energy Resources. The provision expires on January 1, 1983.
Massachusetts	A corporation may deduct the cost of a solar heating system from taxable income. There is also an exemption of retail sales tax from solar systems used in an individual's principal residence.
Montana	An income tax credit is provided for installation of a solar system in taxpayer's residence prior to December 31, 1982. The credit amounts to 10 percent of the first $1,000 spent and 5 percent of the next $3,000. A personal and corporate tax deduction is also available on the capital investment for a solar system. Maximum deduction for a

State	Description of Incentive
Montana (cont'd)	residence is $1,800 and $3,600 for a nonresidential building.
New Jersey	Solar systems are exempt from sales and use taxes. To qualify for exemption, the system must meet the standards set by the Division of Energy Planning and Conservation, State Department of Energy.
New Mexico	An individual income tax credit for 25 percent ($1,000 maximum) of the cost of a solar heating/cooling system installed in a residence or used to heat a swimming pool is available. If the credit exceeds tax liability, a refund is paid. A credit cannot be claimed if the taxpayer claimed a similar credit, deduction, or exemption on his Federal income tax return. The solar system must meet performance criteria prescribed pursuant to the Federal Solar Heating and Cooling Demonstration Act of 1974.
North Carolina	A personal and corporate income tax credit is available equal to 25 percent ($1,000 limit) of the cost of a solar heating/cooling system installed in a building. The system must meet performance criteria prescribed pursuant to the Federal Solar Heating and Cooling Demonstration Act of 1974.
North Dakota	An income tax credit, equal to 5 percent a year for 2 years, is provided for installation of a solar system.
Oklahoma	An income tax credit for 25 percent ($2,000 limit) of the cost of a solar system installed in a private residence is available. This law expires on December 31, 1987.
Oregon	A personal income tax credit for 25 percent ($1,000 limit) of the cost of installing a solar system in a home between January 1, 1978, and January 1, 1985, is available. The system must provide at least 10 percent

State	Description of Incentive
Oregon (cont'd)	of the home's energy requirements and must meet performance criteria adopted by the State Department of Energy.
Texas	An exemption from sales tax is provided on receipts from sale, lease, and rental of solar devices. A corporation may also deduct the amortized (60 months) cost of solar system used by the corporation from taxable capital.
Vermont	Personal and business income tax credits are available for installation of solar systems prior to July 1, 1983. Credit available is equal to the lesser of 25 percent of the cost of the system installed on real property, or $1,000 ($3,000 for businesses).
Wisconsin	Businesses may either deduct (in the year paid) or depreciate or amortize (over 5 years) the cost of installing a solar system. Also, an income tax credit is available to individuals for installation of a solar system. Amount of the credit depends on the installation year and the date the structure, to which the solar system is attached, appeared on the tax roll. If the credit exceeds tax liability, a refund is paid. The law applies to expenses incurred between April 20, 1977, and December 31, 1984.

STATES WHICH HAVE PASSED SUNRIGHTS LEGISLATION

State	Description of Legislation
Colorado	Provides for the creation, conveyance, and recordation of voluntary solar easements.
Connecticut	Allows municipal planning and zoning bodies to adopt regulations to encourage the use of solar energy.
Florida	Provides for the creation, conveyance, and recordation of voluntary solar easements.
Georgia	Provides for the creation, conveyance, and recordation of voluntary solar easements.
Idaho	Provides for the creation, conveyance, and recordation of voluntary solar easements.
Kansas	Provides for the creation, conveyance, and recordation of voluntary solar easements.
Maryland	Provides that negotiated restrictions on the use of land or water for the purpose of protecting solar access shall be enforceable in law and equity. Restrictions can be created by voluntarily negotiated easements, covenants, restrictions, or conditions between property owners.
Minnesota	Allows solar energy considerations to be included in comprehensive planning, local zoning, and subdivision regulations. Also provides for the creation, conveyance, and recordation of voluntary solar easements. In addition, any property depreciation caused by an easement shall be included in the property tax valuation of the property.
New Mexico	Declares that access to sunlight is a transferable property right. Also provides that disputes over solar access shall be resolved by a prior appropriation rule modified by court decisions.

APPENDIX II

State	Description of Legislation
North Dakota	Provides for the creation, conveyance, and recordation of voluntary solar easements.
Oregon	Adds solar energy considerations to comprehensive planning. Allows city and county planning commissioners to recommend ordinances governing building height for solar purposes.
Virginia	Provides for the creation, conveyance, and recordation of voluntary solar easements.

STATES WHICH EXEMPT PART OR ALL OF INCREASED PROPERTY TAX ATTRIBUTABLE TO OWNING A SOLAR ENERGY SYSTEM

State	Description of Exemption or Other Property Tax Incentive
Arizona	An exemption is provided from property tax increases which may result from the addition of a solar system to new or existing housing.
Colorado	Solar heating/cooling systems will be assessed at 5 percent of their original value when computing property taxes.
Connecticut	Local taxing authorities are able to exempt property equipped with a solar system from an increased assessment due to the system. Construction of the solar portion must commence between October 1, 1976, and October 1, 1991. Exemption extends for 15 years after construction and applies to new construction and retrofits.
Georgia	The governing authority of any county or municipality is allowed to exempt the value of a solar heating/cooling system from "ad valorem" property taxation. The taxing authority must act before July 1, 1986.
Hawaii	Solar systems are exempt from property taxation. This exemption applies from June 30, 1976, through December 31, 1981.
Illinois	An owner of a solar systems installed on real property may claim improvement value of a conventional system if that value is less than the value of the solar system. The systems must meet the standards set by the Illinois Department of Energy.
Indiana	An owner of real property with a solar heating/cooling system may annually deduct from the assessed value of the property the difference between the assessed value of the property with the solar system and the assessed value without the system. Deduction also applies to mobile homes.

State	Description of Exemption or Other Property Tax Incentive
Iowa	Solar energy systems are exempt from property tax assessment for the years January 1, 1979, to December 31, 1985.
Kansas	Reimbursement is provided of 35 percent of total property tax paid on the entire building or building addition if solar provides 70 percent of energy needed to heat/cool the building on an average annual basis. Reimbursement may be claimed for five successive years and the system must be installed before January 1, 1986.
Maine	Solar heating systems are exempt from property taxation for five years from date of installation. This exemption must be applied for. It expires on January 1, 1983.
Maryland	Buildings equipped with a solar heating/cooling system or a solar and a conventional heating/cooling unit shall be assessed for property tax purposes at no more than the value of a conventional system needed to serve the structure. Also, Baltimore City, any city within a county, or any county may provide a credit against local real property taxes for buildings using solar heating/cooling units. The amounts and definitions are at the discretion of the local jurisdiction.
Massachusetts	Solar systems are exempt from real estate taxes for 10 years after system's installation.
Michigan	Solar devices are exempt from real and personal property taxes. An exemption certificate must be obtained from the State Tax Commission. The Commission's authority to issue certificate ends on June 30, 1985.

State	Description of Exemption or Other Property Tax Incentive
Minnesota	The market value of a solar system installed in a building prior to January 1, 1984, is excluded from the market value of the building for purposes of computing property tax liability.
Nevada	A property tax allowance is available for solar heating/cooling installations in a residential building equal to the difference between the assessed value of the property with the system and the assessed value without it. The allowance may not exceed total value of the property tax accrued or $2,000, whichever is less.
New Hampshire	Each city and town may adopt (by local referendum) property tax exemptions for solar heating/cooling systems.
New Jersey	Owners of real property with a solar heating/cooling system may take an annual exemption from property taxes equal to the differences between the assessed value of the property with the system and the assessed value without. The exemption must be applied for and the system must meet the standards established by the State Energy Office. This law expires on December 31, 1982.
New York	A property tax exemption is available for the amount of difference between the assessed value of property with a solar system and the assessed value without. All exempted systems must be approved by the State Energy Office. The exemption extends for 15 years after approval and the system must be installed prior to July 1, 1988.

APPENDIX III

State	Description of Exemption or Other Property Tax Incentive
North Carolina	Buildings equipped with solar heating/cooling systems should be assessed for property tax purposes as if they were equipped with a conventional system only. This law expires December 1, 1985.
North Dakota	Solar heating/cooling systems used in buildings are exempt from property taxation for 5 years following installation.
Oregon	Property equipped with a solar system is exempt from "ad valorem" taxation in an amount equal to the difference between the value of the property with the system and the value without a solar system. This exemption is valid through December 31, 1997.
Rhode Island	A solar heating/cooling system installed in a building will be assessed at no more than the value of a conventional heating/cooling system necessary to serve the building. This law expires on April 1, 1997.
South Dakota	A property tax assessment credit for use of a solar system is available for either a residential or commercial application. The residential credit is equal to the greater of: (1) the difference between assessed valuation of property with system and assessed value without or (2) the installed cost of the system. The commercial credit available amounts to 50 percent of the installed cost of the system.
Tennessee	Solar systems are exempt from property taxation. Standards for those exempt systems will be developed by the Tennessee Energy Office. This law expires January 1, 1988.

State	Description of Exemption or Other Property Tax Incentive
Vermont	Towns may enact real and personal property tax exemptions for solar systems.
Virginia	County, city, or local governing body may exempt solar equipment from property taxation.
Washington	Solar systems are exempt from property taxation for 7 years after installation. The solar equipment must meet the minimum standards established by HUD. The opportunity to apply for the exemption extends to December 31, 1981.

APPENDIX IV

Department of Energy
Washington, D.C. 20585

March 5, 1979

Mr. J. Dexter Peach, Director
Energy and Minerals Division
General Accounting Office
Washington, D.C. 20548

Dear Mr. Peach:

We appreciate the opportunity to review and comment on the GAO draft report entitled "Commercializing Solar Heating Systems: A National Strategy Needed."

The report discusses commercialization of solar heating without addressing whether it is active or passive in design or whether it is to be used for water heating, space heating, agriculture process heating, industrial process heating, or industrial direct heating. Each of those classifications represents a different technology and corresponding readiness for commercialization.

We believe that consideration should be given to updating and including in the report major areas of concern as follows:

- Passive solar and domestic hot water: The report concentrates on active solar heating rather than considering all heating technologies. [See GAO note on p.66.]
- There are significant differences among Industrial, Agricultural, and Commercial Solar Applications as well as their readiness for commercialization. [See GAO note on p. 66.]
- The DOE solar program strategy and plans presently documented in DOE/CS - 0007, National Program for Solar Heating and Cooling of Buildings and DOE/CS - 0053, Solar Energy for Agricultural and Industrial Process Heat Program Summary which were not considered in the report. [See GAO note on p. 66.]
- No consideration is given to the extensive marketing and education programs being conducted. [See GAO note on p. 66]
- The report claims that the NEA tax credit will create a viable solar industry for the post 1985 era -- this is not supported by DOE nor the industry. [See GAO note on p. 66.]

- The report states that small quantities of agricultural and forest residues and biomass products are being used to save energy -- it is estimated that about two quads are being generated which we feel is more than a small amount. [See GAO note on p. 66.]

- The report incorrectly cites a Battelle Pacific Northwest Laboratory report estimate of aggregate energy subsidies for conventional energy sources to be $100 billion -- the cumulative amount is $200 billion and amounted to $10 billion in 1977. [See GAO note on p. 66.]

- In discussing specific restraints (lender and insurer reluctance, sunrights, building codes, property tax levies, materials shortages), the report generally concludes that they may not be significant problems -- we do feel that these are significant problems. [See GAO note on p. 66.]

In regard to the Accelerated Commercialization of Solar Energy, a program plan is due to be provided to Congress in December 1979. The overall objectives of the plan are to:

- Develop a national commercialization strategy.

- Identify and evaluate the barriers to the development and commercialization of solar energy (economic, legal, regulatory, institutional, social).

- Recommend policies to remove the barriers and accelerate solar commercialization.

- Define programs to be conducted to support solar commercialization.

Towards these objectives, the following program elements are being addressed:

- Needs for technology development, testing, etc.

- Solar commercialization planning.

- Economic modeling and analysis.

- Economic and financial incentives.

- Public utility/solar energy interface.

- Legal, regulatory, and institutional issues.

- o Employment and manpower issues.
- o Marketing and consumer issues.
- o Regional, State, and local issues.
- o International market analysis.

DOE is also working to identify barriers to solar energy unique to certain regions and States and recommend remedial action. An important aid to the States is the development of the Regional Solar Energy Centers which would conduct market studies, identifying those segments most available to solar and these market studies would be important elements in the commercialization process.

Phase I is currently underway. This consists of the development of a detailed implementation plan and the coordination of all activities within DOE. The implementation section of the plan will be consistent with the outcome of the Domestic Policy Review of Solar Energy, which is currently under Presidential consideration.

The development of a comprehensive solar energy commercialization plan will not place emphasis on only one of the solar technologies. A comprehensive strategy will recognize not only the differences in regional applications of the various solar technologies but also the differences in end-use applications.

We would be pleased to provide any additional information that is desired in this matter.

Sincerely,

Donald C. Gestiehr
Director
GAO Liaison

GAO note: These comments were in a prior draft of this report. Certain sections of the final report were revised to address DOE's comments. The conclusions and recommendations, however, have not changed.

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