Residential Solar Energy Policies: Extent of Public Support

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The decade of the 1970's marked the entrance into an era characterized by ever-increasing concern over energy supplies and costs. Events such as the 1973-74 Arab oil embargo and the 1976-77 natural gas shortage highlighted the United States' dependence on energy resources which are becoming relatively scarce and expensive. Although there have been ebbs and flows in the severity of the energy situation, many experts continue to conclude that the United States must control its appetite for oil and natural gas. Given that the United States, with 6 percent of the global population, accounts for one-third of the world's energy consumption each year (Stobaugh and Yergin, 1979), such a diet will not be easy to follow.

Housing holds great promise for energy reduction efforts. Currently, the residential sector accounts for about one-fifth of the nation's total energy consumption (Darley and Beniger, 1981), and it is estimated that as much as half of that energy is in some sense wasted (Executive Office of the President, 1977). Reliance on inefficient heating and cooling systems, inadequate insulation, and the preferred large single family detached dwelling are significant factors in the substantial amount of energy used in the residential sector (Dillman et al., 1977). Thus, housing is an appropriate sector for a concerted effort to reduce energy consumption.

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There exist several methods to curb the use of oil and natural gas in the residential sector. One method which is discussed a great deal, and is often viewed as a panacea for the energy problem, is the use of solar energy. Solar energy has the advantages of being readily available in most regions of the country, environmentally safe, and inexpensive once a solar system is adopted. Further, solar technology is now within the reach of most American households (U.S. Department of Energy, 1979). However, the actual contribution of solar heating to total energy use in homes is insignificant at the present time (Unseld and Crews, 1979).

While solar concepts for heating water and homes have existed for years, they have not been incorporated into building design primarily because of available cheap energy. With energy prices rapidly increasing, consumers are searching for alternatives which will help them cope with mounting energy bills. Solar energy is a possibility; however, it has a high initial cost, whether incorporated in a new structure or added as a retrofit (Reiger, 1978). The vast majority of consumers simply cannot justify the cost of solar heating systems, or question the return on their investment. Many consumers also lack the knowledge required to make decisions concerning the

adoption of solar heating systems. The high initial cost of purchasing solar heating systems and costs in time and effort to obtain the needed information to make a solar-related decision operate as barriers to the use of solar energy for heating homes.

The solution to some problems faced by households in the pursuit of residential solar heating systems might be found at the government level. If solar energy is viewed as an effective method to enhance energy supplies, which will provide benefits not only to those who adopt solar systems but to the population as a whole, it seems appropriate for government to encourage its use (Frank, 1981). Government, through policy decisions, can lower both monetary and informational costs of solar heating systems. In this way, the two major barriers preventing the widespread use of solar heating systems can be reduced. Basic economic theory suggests that as cost is reduced, an increased number of consumers enter the market. Thus, a reduction of solar costs by the government would, theoretically, increase the number of consumers purchasing solar equipment for their homes.

It is the purpose of this article to present the results of a statewide survey measuring public support for six government policies designed to encourage the use of residential solar heating systems. In addition, the effects of selected socioeconmic characteristics on policy support will be examined. Such an analysis will indicate the extent to which residential solar energy policies are supported, and whether support varies according to socioeconomic characteristics.

Rationale

There exist three reasons for determining support for residential solar energy policies. First, society cannot continue to function smoothly if it experiences severe energy shortages and high energy costs. Because of the nature of energy utilizing investments, it is necessary to think in terms of long range planning. In many cases, the capital good which uses energy is a major expenditure and therefore not often replaced. This is particularly true of the housing stock, which has an estimated life time of 40 years and is often used much longer. The composition of the housing stock cannot be rapidly altered; rather, the housing stock is added to at a rate of approximately 3 percent per year. The construction of the housing stock requires a considerable amount of the nation's resources. With growing concern over diminishing resources, it becomes increasingly crucial that all resources are used efficiently. If solar concepts are viewed as an effective way of contributing to energy supplies, it seems reasonable to encourage their inclusion in the construction of new housing units. If new housing units are built without solar concepts, but such are deemed necessary to add later, considerable resources will be required to retrofit homes resulting in an inefficient use of our nation's limited resources. Thus, the consideration of encouraging solar as a possible alternative to meet housing energy needs must be given high priority in the development of public policy.

Second, policymakers would benefit from information regarding the degree of public support directed at various residential solar energy policies. It is not enough for policymakers to examine adoption rates of solar heating systems for evaluation of the effectiveness of present programs. The situation may not be one of lack of support for certain policies, but lack of knowledge that such policies exist. For example, a nationwide survey by the Solar Energy Research Institute (Pilgrim et al., 1981) found that a majority of the people interviewed were unaware of the 40 percent federal income tax credit for solar installation in homes. Further, the characteristics of solar energy suggest a slow adoption rate. Consumers need time to adjust their behavior as they purchase new homes or retrofit their present homes. Determining support for policies would provide policymakers with a better perception of the public's attitudes toward solar use as opposed to merely looking at specific adoption rates.

Finally, rising costs of residential fuels are creating a financial burden for many American families. Between February 1980 and February 1981 the costs of securing fuel oil, coal and bottled gas increased 23 percent (U.S. Department of Labor, 1981). Families can attempt to cope with increasing costs in two ways. They can conserve through changes in their life style, such as turning down the thermostat in winter. Alternatively, families can reduce energy use through

capital investments intended to make their homes more energy efficient and/or economical to heat and cool. Previous research conducted by the Bureau of Sociological Research (White and Rudakov, 1979) found that in Nebraska, households basically were resisting changes in life style. However, the majority of the households had undertaken significant investments in order to reduce energy use in their homes—they had weatherstripped, caulked, added storm windows, and insulated. Economic ability and incentives appear to be the driving forces behind investment decisions. The larger investment required by solar heating systems is undoubtedly difficult for many families to afford. However, if the cost of solar heating systems were to be reduced, households might prefer making such an investment to the alternative of modifying life styles. Government programs encouraging solar use may well be strongly supported by households as a way to cope with increasing energy costs.

Policy Directions

Given that solar is a viable energy alternative for residential heating in the years ahead, the question becomes: should government be involved in its promotion? Government involvement is generally justified when the provision of a good or service is perceived to be in the public interest. Public policy is also appropriate when benefits from an exchange accrue to people other than those who create them, an exchange characterized by positive externalities (Heyne, 1980). With the existence of externalities, support for solar policies would come not only from those who anticipate benefits from the policy because of expected solar adoption, but also from those who anticipate indirect benefits in terms of lower fuel costs, a cleaner environment, and reduced dependence on others.

In recent years several solar-related policies have been formulated and implemented to encourage the diffusion of solar heating systems into the housing stock. One strategy entails incentives (i.e., tax credits, rebates, low cost loans, and direct subsidies) aimed at guiding and encouraging consumers to act in a particular way; in this case, the purchase of solar heating systems. Incentive-based programs are not mandatory as are regulations, but are designed to induce consumers to move in certain directions. Incentive programs most frequently work through the marketplace, by making certain actions less expensive to accomplish. Incentives can be used to lower the cost of solar and, according to the law of consumer demand, theoretically increase the number of consumers purchasing solar heating systems. Incentive policies often have a more subtle effect on consumers than do regulatory strategies. A consumer still has a choice, but the energy efficient choice will cost less.

A second strategy which has been implemented to promote solar adoption is that of providing information. Information-based strategies (i.e., information and demonstration centers) attempt to change consumers' habits of energy use by pointing out the economic and other advantages of solar energy. The assumption is that potential purchasers must know the relative advantages of their choice in order to make informed decisions in the market, balancing initial cost against operating costs over the years (Healy and Hertzfeld, 1976). Government funded agencies are charged with publishing information, making suggestions, and providing cost saving ideas. Demonstration centers can also be established so that consumers can gain information first hand.

It is important to determine the extent of support for strategies supporting adoption of solar for residential heating. Each strategy requires resources in the form of tax monies. The mood of Americans today is to lower taxes and allow more of the purchasing decisions to be made by the individual; thus, there may not be general support for government solar policies at this time. If support does exist, it is important to determine which policies are most favored. It is also important to determine the types of people who are most supportive or nonsupportive of certain policies. Thus, a survey can serve the function of indicating what kinds of policies are most supported at an aggregate level and what policies are supported by different segments of the population.

Methodology

Data for this study were collected by means of a twelve-page questionnaire mailed to a sample of 1,600 Nebraska households during the Spring of

1981. Sample households were systematically selected from all telephone directories in the state. The use of the total design method for mail surveys (Dillman, 1978) resulted in the return of 912 completed questionnaires, 65 percent of the households to which questionnaires were presumably delivered. Although the methods employed to draw the sample and collect the data typically produce certain biases, participating households were found to be reasonably representative of the state as a whole (Combs, 1981).

The questionnaire contained a variety of items concerning the use of solar energy for residential heating. Included in the questionnaire was a page of items measuring support for residential solar policies to be implemented at the government level. Respondents were asked to indicate the degree to which they would support the following six policy alternatives: 1) tax credit (part of the cost of solar equipment would be deducted from taxes owed); 2) rebate (part of solar cost would be returned to the buyer in the form of cash); 3) low cost loan (money would be borrowed at a low interest rate to purchase solar equipment); 4) direct subsidy (low and middle income families would receive financial assistance to purchase solar equipment); 5) information (information on solar energy would be readily available to people desiring it); and 6) demonstration centers (solar systems would be set up and open to the public for observation). Response choices were: definitely no, probably no, unsure, probably yes, and definitely yes. Scores ranging from one (definitely no) to five (definitely yes) were assigned to responses. These data comprise the dependent variables of the study.

Selected socioeconomic characteristics were measured in the final three pages of the questionnaire, and these comprise the independent variables of the study. Socioeconomic characteristics and their measurement are as follows: age (number of years); education (number of years); income (amount of dollars earned in 1980 before taxes); occupation (dummy variable: blue-collar, white-collar); community size (number of community inhabitants); number in household (number of household members); tenure status (dummy variable: rent, own); structure type (dummy variable: non-single family dwelling, single family dwelling); and savings (amount of dollars in savings).

Data were analyzed using Pearson correlation and multiple regression analyses. The correlation analysis was utilized to assess the association between the residential solar policy options, and the association between policy support and socioeconomic characteristics. The multiple regression analysis was used to determine the relative and cumulative explanatory power of the socioeconomic characteristics in predicting policy support when considered simultaneously. It was assumed that the measurement techniques employed produced interval level data, which permitted analysis by means of multivariate parametric statistics. Any measurement error resulting from this assumption was reasoned to be compensated by the use of more powerful statistical techniques (Abelson and Tukey, 1970; Kim, 1975; Labovitz, 1970).

Results

Respondents were generally supportive of government involvement in encouraging the use of solar energy for residential heating purposes. However, support was found to differ depending upon the specific policy alternatives addressed. As shown in Table 1, there was overwhelming support for the two information-based policies: information and demonstration centers. Nine-tenths of the respondents indicated that they would probably or definitely support a policy to provide readily available information on solar heating systems, while 83.7 percent would support the creation of demonstration centers where the public could observe the operation of solar heating systems. It is encouraging that information-based policies received such a high level of support from respondents, given that such policies are relatively inexpensive to administer and enhance competition within the free market system.

The remaining four policy options involve the provision of government incentives to encourage the use of solar heating systems. Support for the incentive-based strategies was lower than that found for the information-based strategies, and considerable differences in support exist for these four options. The two incentive policies receiving the greatest support were tax credits and low cost loans. Approximately three-fourths of the respondents indicated support for tax credits, while a slightly lower percentage supported

low cost loans (72.0 percent). Although these two strategies are somewhat more expensive to administer than information-based programs, mechanisms for their implementation exist within the current institutional system.

The two policies receiving the least support were rebates, in which part of the cost of solar heating systems would be returned to the buyer in the form of cash, and direct subsidies to families with low and middle incomes. Slightly over half of the respondents indicated that they would probably or definitely support rebates, while 42.4 percent supported direct subsidies. These two policies would be the most difficult to implement of the various alternatives because of the lack of an appropriate institutional structure for rebates, and the large sums of money required for both rebates and direct subsidies.

Based on the above results, support is greatest for policies requiring the fewest dollars, and lowest for those requiring large amounts of funding. Further, the public tends to direct its support toward those policies which can be administered under the present institutional structure. However, it is important to realize that five of the six policy options received support from a majority of study participants. Thus, people are favorable toward government involvement in encouraging the use of solar heating systems, but place an emphasis on those strategies requiring the lowest feasible level of finanical support and which can be administered under the present institutional framework.

Table 2 presents a correlation matrix containing all six residential solar energy policies and indicates the direction and statistical significance of the correlations. An examination of the intercorrelations between the six policies provides the means to determine the extent to which people who support one policy alternative are amenable to supporting other policies. In examining Table 2, it is apparent that the correlations are all statistically significant. However, some relationships between the policy options are quite high while others are rather low. The policy alternatives cluster into the two types discussed above.

The two information-based policies (information and demonstration centers) correlate rather strongly (r = .543), while their associations with the incentive-based policies are somewhat weaker (r's ranging between .197 and .431). Correlations for the four incentive-based strategies (tax credit, low cost loan, rebate, and direct subsidy) range from a low of .356 to a high of .593. Therefore, respondents who indicated support for one information-based policy were likely to support the other information-based strategy, while those respondents supporting a particular incentive-based policy were likely to support the other incentive-based strategies. However, it is important to recognize that all residential solar energy policies are correlated with one another to some extent.

Table 1—Frequency Distributions (Percent) of Support for Residential Solar Policies

	Would You Support This Policy?						
Policies[a]	Definitely No	Probably No	Unsure	Probably Yes	Definitely Yes	$\bar{X}$[b]	s.d.[b]
	Percent						
Information	.9	1.8	6.6	38.7	52.0	4.39	.77
Demonstration centers	2.2	5.0	9.1	42.0	41.7	4.16	.94
Tax credit	6.3	8.0	9.6	41.2	34.9	3.90	1.15
Low cost loan	6.8	8.0	13.2	41.3	30.7	3.81	1.16
Rebate	13.7	16.1	18.8	30.9	20.5	3.29	1.33
Direct subsidy	17.8	20.4	19.4	28.3	14.1	3.00	1.33

[a]N's for the policies ranged from 857 to 867, depending on item nonresponse.
[b]Scores were assigned to responses as follows: 1 = definitely no; 2 = probably no; 3 = unsure; 4 = probably yes; 5 = definitely yes.

Table 2—Correlation Matrix of Residential Solar Policy Support

Policies		X_1	X_2	X_3	X_4	X_5	X_6
Information	X_1	1.000					
Demonstration centers	X_2	.543*	1.000				
Tax credit	X_3	.412*	.345*	1.000			
Low cost loan	X_4	.431*	.390*	.593*	1.000		
Rebate	X_5	.224*	.297*	.550*	.564*	1.000	
Direct subsidy	X_6	.197*	.336*	.356*	.501*	.533*	1.000

*$p < .001$

The question now to be addressed is: does support for residential solar energy policies differ across specified segments of the population? Theoretically, it might be expected that respondents varying in age, education, income, occupation, community residence, household size, tenure status, present structure type, and savings differ in their support of the policy options. For example, it seems reasonable to predict that respondents with high incomes and savings would tend to support tax credits; conversely, those with low incomes and savings would tend to support direct subsidies. Respondents with high levels of educational attainment might similarly be expected to support information-based strategies to a greater extent than those with less education.

Correlations between support for residential solar energy policies and selected socioeconomic characteristics are presented in Table 3. An examination of these correlation coefficients suggests that support for solar policies is not strongly influenced by socioeconomic characteristics. Of the 54 coefficients presented in Table 3, 38 are below .1 and only 11 are statistically significant. Further, even the significant associations are rather weak, with the correlation between age and support for tax credits being the largest ($r = -.306$). Of the nine socioeconomic variables

Table 3—Socioeconomic Correlates of Residential Solar Policy Support

	Policies					
Socioeconomic Variables[a]	Information	Demonstration Centers	Tax Credit	Low Cost Loan	Rebate	Direct Subsidy
Age	-.224*	-.097	-.306*	-.280*	-.298*	-.166*
Education	.147*	.001	.140*	.096	.032	-.043
Income	.088	.033	.078	.002	-.074	-.195*
Occupation	.062	-.034	.036	-.017	-.034	-.150*
Community size	.031	-.010	.091	.093	.092	.022
Number in household	.078	.019	.079	.071	.069	.013
Tenure status	-.111	-.095	-.064	-.098	-.114	-.120
Structure type	-.041	-.071	-.030	-.038	-.103	-.044
Savings	.026	.012	-.072	-.111	-.157*	-.232*

[a]For those cases where the coefficient's direction is unclear the following applies: A positive coefficient means that white-collar workers support a particular residential solar policy more than blue-collar workers (occupation); urban residents support it more than rural residents (community size); homeowners support it more than renters (tenure status); and single family home dwellers support it more than non-single family home dwellers (structure type).
*$p < .001$

included in the analysis, community size, number in household, tenure status, and structure type have almost no association with the policy alternatives. The variables of income and occupation are significantly associated with policy support in one instance each, and the variables of education and savings are significantly associated with policy support in two instances each. Age has the greatest influence on support for the policy alternatives (r's range from -.097 to -.306), with five of the six coefficients reaching statistical significance.

To arrive at a better understanding of how socioeconomic characteristics influence support for residential solar energy policies it is necessary to determine the separate and combined contributions of the socioeconomic variables to variation in the six policy alternatives. A multivariate analysis is therefore in order, so that potentially confounding effects of the socioeconomic variables on policy support can be controlled. The multivariate statistical technique employed here is multiple regression analysis, a technique which allows the determination of both the relative and cumulative effects of the various socioeconomic characteristics on policy support.

Table 4 shows the unstandardized regression coefficients which result from regressing the policy options on all nine socioeconomic variables separately. The coefficients presented in this table are generally consistent with those displayed in Table 3 with regard to size and directionality. The major exception is structure type, where directionality actually reverses. This is probably due to the extremely low relationship between structure type and policy support (b's range from .001 to .013). Consistent with results produced by correlation analysis, the beta weights are weak (42 of the 54 coefficients are below .1). Only six of the beta weights are statistically significant, with the largest being -.268 (between age and support for rebates). Thus, even the statistically significant betas are weak.

With regard to the relative effects of the socioeconomic variables on policy support, it is found that education, occupation, community size, number in household, tenure status, structure type, and savings do not significantly influence support for any of the six policy alternatives. Income significantly influences support for direct subsidies (b = -.184) while age significantly influences all policies except for demonstration centers. Age emerges as the sole socioeconomic characteristic which influences policy support, with older respondents indicating less support for all policy alternatives than their younger counterparts. However, even these beta weights are weak (b's range from -.066 to -.268).

The bottom row of Table 4 presents the total amount of explained varition (R^2) obtained by regressing policy alternatives on all nine socioeconomic variables. The R^2's range from a low of .033 (demonstration centers) to a high of .125 (rebate). This means that it is possible to explain between approximately 3 percent and 12 percent of the variation in policy support by knowledge of socioeconomic characteristics. These multiple coefficients of determination are relatively low although five of the six coefficients reach statistical significance. It can be concluded that knowledge of socioeconomic characteristics does not allow the prediciton of support for residential solar energy policies to any reasonable or substantively significant degree.

The findings presented in Tables 3 and 4 are important. They suggest that support for residential solar energy policies has a broad base, varying little according to socioeconomic characteristics. Thus, government involvement in encouraging the use of solar heating systems in people's homes need not be overly concerned with selecting target populations. All segments of the population were found to support the identified policies to approximately the same extent.

Conclusion

The serious consideration of government involvement in encouraging the use of residential solar heating systems is essential, as traditional energy resources become increasingly scarce and expensive. Decisions made now by policymakers will impact the nation's energy situation for the foreseeable future. This is particularly true with regard to the residential sector, in which housing units have a long life span. Energy-related housing investments influence fuel

Table 4—Unstandardized Regression Coefficients for the Regression of Residential Solar Policy Support on Selected Socioeconomic Variables

Socioeconomic Variables[a]	Policies					
	Information	Demonstration Centers	Tax Credit	Low Cost Loan	Rebate	Direct Subsidy
Age	-.073*	-.066	-.170*	-.173*	-.268*	-.122*
Education	.006	-.092	.014	-.018	-.106	-.019
Income	.050	.058	.036	-.019	-.128	-.184*
Occupation	.001	-.011	-.013	-.001	-.013	-.020
Community size	.008	-.008	.041	.052	.063	.025
Number in household	.101	.002	.009	.014	.013	.009
Tenure status	-.252	-.267	-.029	-.079	-.173	-.230
Structure type	.008	.001	.009	.011	.013	.010
Savings	.069	.084	.011	-.033	-.002	-.161
R^2	.058*	.033	.070*	.074*	.125*	.097*

[a]For those cases where the coefficient's direction is unclear the following applies: A positive coefficient means that white-collar workers support a particular residential solar policy more than blue-collar workers (occupation); urban residents support it more than rural residents (community size); homeowners support it more than renters (tenure status); and single family home dwellers support it more than non-single family home dwellers (structure type).
*$p < .001$

consumption of homes over a long period of time; therefore, investments must be based on adequate information and economic considerations.

At the present time, the inadequate knowledge base and high initial cost of solar heating systems operate as barriers to the widespread adoption of such systems. Government involvement could partially remove these barriers. However, a multitude of factors will likely influence the extent of government participation in solar programs. One essential factor influencing government involvement is the degree of support for such programs emanating from the public.

The present study was designed to measure public support for residential solar energy policies, and to identify whether such support varied according to the socioeconomic characteristics of households. Results of the statewide survey reveal overwhelming support by the public for the provision of information concerning solar heating systems. Policy based on information would, in effect, reduce the transaction costs of searching, evaluating, and inspecting solar systems during the decision making stage of adoption. Slightly weaker support is indicated for the incentive-based programs entailing tax credits and low cost loans—which promote the actual adoption of solar heating systems by lowering initial costs. Two other incentive strategies, rebates and direct subsidies, are not strongly supported.

The data also indicate that support of solar policies does not vary to a considerable degree according to the socioeconomic characteristics of households. Rather, policy support draws from a broad public base, differing little in age, education, income, occupation, community of residence, number in household, tenure status, structure type, and savings. This finding suggests that favored solar policies are evaluated as beneficial by all segments of the population.

In conclusion, Nebraskans support government involvement in encouraging the widespread use of solar energy for residential heating purposes. Such support is particularly strong for information-based programs, and derives from all segments of the population. Before appropriate government involvement can be de-

termined, however, further research is required to answer two closely related questions. First, is public support for residential solar energy policies approximately the same across different regions of the United States? Second, what level of government should assume the responsibility and cost of promoting solar heating systems? When these two questions are answered, a productive strategy can be developed to spur the adoption of solar heating systems in this nation's residential sector.

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