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An Analysis of Investments in Residential Energy Conservation in Southeast Missouri

Ralph Gunderson

AN ANALYSIS OF INVESTMENTS IN RESIDENTIAL ENERGY CONSERVATION IN SOUTHEAST MISSOURI

Ralph Gunderson
Department of Economics
Southeast Missouri State University

Abstract

This study examines the economic feasibility of residential solar heating. Climatic and economic variables used in this report represent those of Cape Girardeau, Missouri. An annual cost model is used to determine the conditions under which solar heating achieves a reduced annual cost of heating relative to gas and electric heating systems.

1. INTRODUCTION

Recent increases in energy prices have, probably more than any other factor, convinced homeowners that tey must become conservationists - of energy. An important response of homeowners has been to "tighten" their homes, i.e. greater quantities of insulation, storm windows, weatherstripping, etc. These actions have resulted in significant cost reductions for homeowners. However, greater energy savings may be achieved through the adoption of solar heating units by homeowners. But, a major stumbling block toward actions in this direction is the uncertainty of the future course of key economic variables.

Several studies concerning the economics of residential use of active solar heating systems have been made. One of the early important efforts in this field was the Löf and Tybout study.(1) This and other early studies could not take into account the effects of the Arab oil embargo The embargo ended the dream of continuous sources of inexpensive energy supplies. As a result, resource economists have busied themselves with the development of projections of future energy supplies and the prediction of the course of energy prices in the future for homeowners. The only consensus which can be reached is concerning the direction of movement of future energy prices -upward. There has developed little, if any agreement surrounding expected rates of inflation of energy prices. This uncertainty adds to the difficulty of analyzing investments in energy conservation.

Many studies that involve comparative evaluations of solar and conventional heating systems assume a particular rate of inflation for fuel prices. As a result most authors acknowledge that different assumptions about the assumed rate of inflation would alter their results. The speculative nature of fuel forecasts has added the dimensions of uncertainty to the analysis of solar energy economics. The literature has recognized that the economics of solar heating must be interpreted in recognition of the life cycle savings in conventional fuel costs during the life of the system. In order to accurately evaluate the advantages of solar system investments, homeowners must be able to estimate future fuel prices. But these estimates must take into account the whims of governmental regulation; existing energy supplies; among other factors. In light of the apparent difficulty to accurately predict the future of energy prices, it would be beneficial to compare the feasibility of solar and conventional systems with alternative assumptions about the course of future fuel prices. This is true for other economic variables as well, such as the price of solar equipment, discount rate, taxes, insurance, maintenance, etc.

The purpose of this study, then, is to systematically estimate the impact of alternative assumptions of key economic variables on the relative cost of operating solar and conventional systems for Southeast Missouri. Information on economic and climatic variables was obtained from Cape Girardeau and is assumed to be applicable to the region.

2. ECONOMIC VARIABLES

This study is limited to the analysis of the impact of direct outlays made by homeowners in heating their residences. The consideration of positive or negative externalities is not made. The reason for omitting assessment of these factors is that only private costs are relevant factors in deciding upon the adoption of a solar heating system for a particular residence.

Emphasis is placed on the consideration of anticipated life cycle costs which will be incurred due to the operation of the heating system. This means that costs which will be incurred over the life of the system will be included, rather than considering only first costs. Thus, for the homeowner, life cycle cost analysis includes consideration of the following costs:

(1) Initial Acquisition Costs -including purchase price, installation and delivery. It was assumed that the cost of a solar unit is dependent on collector area. Therefore, the initial acquisition cost is stated in terms of dollars per square foot of collector area. Prices in the range of five to twenty-five dollars per square foot were considered.

(2) Annual Maintenance Costs - There is a basic lack of data on which an estimate of annual maintenance costs can be based. In addition, there is little uniformity among manufacturers of solar heating units regarding company warranties covering the operation of the equipment. The common solution to this problem is to state annual maintenance cost as a percentage of initial investment. For purposes ofthis study, annual maintenance cost was estimated at one percent of initial investment level.

(3) Annual Fuel Costs - Annual fuel costs represent the amount of conventional fuel required by the back up heating system. They reflect the heating load not met by the solar heater as well as expected increases in energy prices. A building thermal load of 10 BTU/DD/ft^2 was assumed. (2) An average of 4,450 heating-degree days in Cape Girardeau was determined in consultation with a local utility company. A building area of 1,500 square feet was assumed. Solar units with a collector area of 135 and 360 square feet were assumed to provide 25 and 50 percent of the total annual heat load for the residence. The remainder of the heat was assumed to be provided by a back up heater using either natural gas or electricity.

(4) Insurance Expense - Many insurance companies find it difficult to determine the insurance rate for solar heating systems. A great diversity of factors affect the insurance rate of solar heaters, among them are: building material, type of fluid for circulation, type of construction, etc. For purposes of this study a rate of ten dollar per thousand dollars of insured value was assumed.

The economic analysis of the competing heating systems was accomplished by estimation of life cycle costs were forecast over the anticipated life of the investment and then used to determine the uniform annual costs. The general expression for determining the annual cost of heating is as follows: (3)

$$AC = \sum_{j=1}^{N} \frac{C_j}{(1 + i)^j} \; \frac{i(1 + i)^N}{(1 + i)^{N} - 1}$$

Where: AC = Annual cost of heating
N = Expected life of equipment
C_j = Cost of heating in year j

4. RESULTS

Figure 1 shows the estimated annual cost of heating with electricity and with a solar heating unit providing fifty percent of the energy required to heat the residence. The annual cost of the solar unit is given for purchase prices of $10, $14 and $18 per square foot of collector area. Calculations assumed a discount rate of nine percent. This graph shows the average annual rate of fuel (electricity) inflation which is required to achieve a reduced annual cost of heating for each of the three purchase prices. At a purchase price of ten dollars per square foot of collector area, a reduced annual cost of heating could be achieved if energy prices rise at an average of eight percent per year. At purchase prices of fourteen and eighteen dollars, a reduced annual cost was estimated for average inflation rates of eleven percent and fourteen percent, respectively.

Figures 2 and 3 present the estimated annual cost of heating with natural gas and with a solar heating unit providing fifty percent of the heat (Figure 2) and twenty-five percent of the heat (Figure 3). To determine the cost of gas heating, a price of $2.08 per thousand cubic feet of natural gas was assumed. In Figure 2 the annual cost estimates show that solar heating is very expensive compared to gas heating. Purchase prices of $4, $10 and $16 per square foot of collector area are shown in Figure 2. Of these, only the low price of $4 will yield a reduced annual cost of heating for solar energy. Even at this low price an average annual rate of fuel inflation of twelve percent is required.

Figure 3 is similar to Figure 2 except for the reduced solar fraction - twenty five percent. This reduced share of the heat load enables solar energy to be competitive act much higher purchase prices.

REFERENCES

1. G. Löf and R.A. Tybout, "Solar House Heating," Natural Resources Journal. Vol. 10, April, 1970.

2. Schultze, Ben-David, et. al., "The Economics of Solar Home Heating," paper prepared for the Joint Economic Committee of the United States Congress, January, 1977.

3. E. Paul DeGarmo, Engineering Economy (New York: The Macmillan Co.), 1969.

FIGURE 1

ANNUAL COST OF HEATING
SOLAR FRACTION - 50%
ELECTRICITY

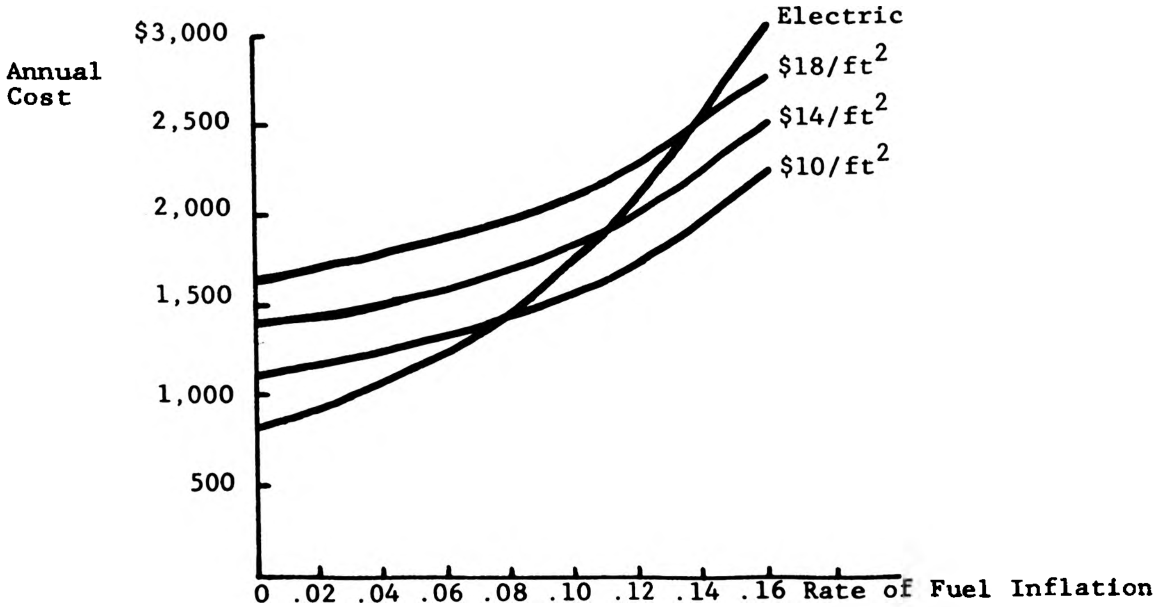

FIGURE 2

ANNUAL COST OF HEATING
SOLAR FRACTION - 50%
GAS

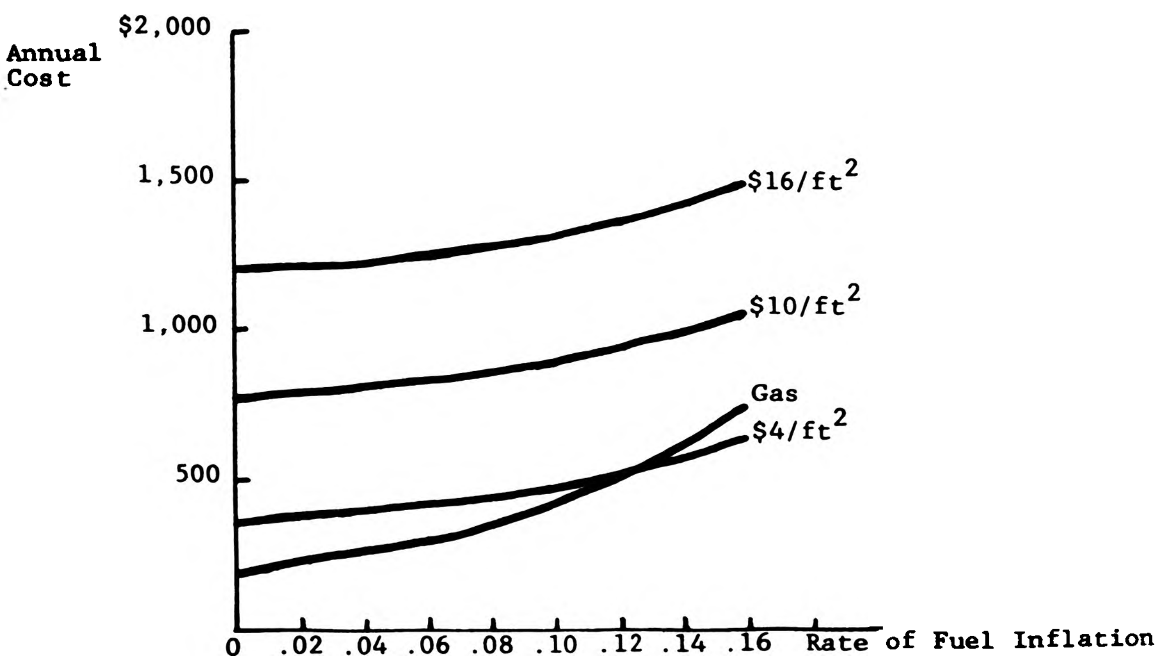

FIGURE 3

ANNUAL COST OF HEATING
SOLAR FRACTION - 25%
GAS