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ASSESSING THE IMPACT OF PEAK-LOAD ELECTRICITY PRICING AND SOLAR TAX CREDITS ON THE ADOPTION OF SOLAR ENERGY

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With the substantially higher prices of oil, interest in alternative energy sources has mushroomed. Congress has passed major new legislation on energy and is continually considering new energy bills. One important set of legislation was the set of 1978 energy acts which included tax incentives for development of solar energy and regulations designed to encourage peak load pricing of electricity. The purpose of this paper is to evaluate the effects of these two policies on consumer decisions to invest in solar energy.

The existing literature on this topic does not provide clear answers on the impacts of these policies. Bright and Davitan concluded that, from a systems perspective, solar energy was economic only when peak load pricing was utilized. From a homeowner perspective, Asbury and Mueller concluded that with peak load pricing of electricity, economics of solar energy are considerably worse than with flat or declining block electricity pricing.

In this study we developed a model for comparing the life cycle cost of alternative home heating systems under varying energy prices, alternative government energy and tax policies, and alternative electricity pricing schemes. The major objectives were (1) to estimate the life-cycle heating cost for resistance electric heat, heat-pump, and active solar energy systems, and (2) to assess the impact on these costs of the federal solar tax credit, peak-load electricity pricing policies, and state property tax exemptions for solar systems.

The solar tax credit and peak-load pricing regulation are contained in the Energy Tax Act of 1978 and the Public Utility Regulatory Policies Act

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of 1978 respectively.[1,2] The solar tax credit provides for a tax credit of 30 percent of the first $2000 expended and 20 percent of additional expenditure up to $10,000 total. The maximum credit is $2200 on a $10,000 or higher solar investment. Peak load pricing is encouraged by requiring state regulatory authorities to consider the following federal standard:

> The rates charged by any electric utility for providing electric service to each class of electric consumers shall be on a time-of-day basis which reflects the costs of providing electric service to such class of electric consumers at different times of the day unless such rates are not cost-effective with respect to such class...[3]

A large number of states have partially or totally exempted solar systems from the state property tax and others are considering this step. Consequently, we also evaluated the effect of this policy on solar energy investments.

Method of Analysis

Discounted cash flow techniques were used to compare the different heating systems and policies. Analytical results are presented as system life-cycle costs. To obtain life-cycle costs, all operating cost were discounted to the present and added to capital cost to yield total present value cost. The life-cycle cost is merely the annuity whose present value is the total present value cost. The life-cycle cost annuity is the annualized total cost of the system including both operating and investment cost.[4]

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[1] U.S. Congress, Senate, Energy Tax Act of 1978, Conference Report No. 95-1324, 95th Cong. 2d sess., 1978, H.R. 5263, p. 3.

[2] U.S. Congress, Public Utility Regulatory Policies Act of 1978, Pub. L. 95-617, 95th Congress, 2d sess., 1978, H.R. 4018, 92 stat. 3122, 16 USC 2621.

[3] Ibid.

[4] It is roughly the same as the mortgage payment on the solar capital cost plus annualized operating cost.

The computerized model uses the FCHART method of calculating the monthly solar energy fraction and calculates the monthly cost of energy from the backup system.[1/] The model uses either fixed collector size or optimizes collector size given the other input variables. Either rock or water storage may be used. Electricity pricing may be peak load or conventional declining block pricing. Any of the systems may be operated with or without storage. Of course, several of the possible combinations of electricity pricing, heat storage, and system choice could be ruled out prior to the analysis. For example, with conventional electricity pricing and resistance heat, storage would not be used. The model is designed to compare the remaining set of viable options.

Data and Assumptions

The data and assumptions developed for this analysis are designed to reflect the usage conditions of an average family of four living in an 1800 square foot home in Indianapolis, Indiana. Monthly average weather data from Indianapolis was used to calculate solar system performance. Table 1 summarizes the input data used for the analysis.

Capital cost

The electric resistance heating case with no storage is the base case. Capital cost of this sytem was set at zero and the incremental capital cost of other systems was used. For example, both heat pump and solar systems use electric resistance heat as a backup, so their capital cost is the incremental cost above the resistance heat duck system and basic controls assumed to exist for all systems.

[1/] The complete computer program is available from the authors on request.

TABLE 1

DATA AND ASSUMPTIONS

<u>Heat load parameters</u>	
Number of occupants in house	4
Hot water usage (gallons per day)	80
Hot water delivery temperature (F^o)	140
Water inlet temperature (F^o)	58
Building heat load (BTU/hr.)	30,000
<u>Solar system parameters</u>	
Overall system efficiency (%)	40
Storage size per ft.^{2} collector (ft.^{3})	2
Collector cost ($/ft.^{2})	15,10
Storage cost ($/ft.^{3})	1
Collector fixed cost ($)	900
Maintenance cost (% of initial cost)	.5
Insurance (% of initial cost)	.5
Collector life (years)	15
<u>Tax and finance related</u>	
Property taxes ($ per $100 of assessed value)	11.5372
Property tax assessment (% of market value)	15
Homeowner tax bracket (%)	30
Solar tax credit	30% of first $2000 20% of investment over $2000 up to $10,000
Mortgage period (years)	20
Interest rate (nominal %)	10
(real %)	4
Down payment (%)	25
<u>Other system parameters</u>	
Heat pump seasonal performance factor	1.6
Heat pump capital cost ($/ton)	800
Storage size	50 percent of January daily heat load
Resistance furnace cost ($)	400
<u>Prices</u>	
Declining block electricity	
600-1000 KWH ($/KWH)	.03355
over 1000 KWH ($/KWH)	.02566
Peak load electricity pricing*	
- summer (May 15 to September 15)	
peak ($/KWH)	.090
off-peak ($/KWH)	.014

TABLE 1 (Continued)

- other seasons	
peak ($/KWH)	.0732
off-peak ($/KWH)	.014
Annual electricity price increase (% nominal)	10,12

*Peak hours are 8:00 a.m. to 9:00 p.m. weekdays.

A heat pump provides both heating and cooling whereas the other systems provide only heating. Therefore, the cost of a 2.5 ton air conditioner was added to the capital cost of all other systems. The air conditioner was assumed to be the same efficiency as heat pump air conditioning, so operating costs for cooling were not included for any system. Also, the heat pump used in this analysis has a built-in electric resistance back up, so the cost of the resistance furnace was deducted from the heat pump cost to put all systems on a comparable basis.

Electricity prices

Declining block electricity prices reflect the rates in effect for Indianapolis customers of Public Service Indiana in first quarter 1979. For peak load (time of day) rates, we used those proposed by Commonwealth Edison Company of Illinois.[1/]

Storage

Storage size was calculated differently for solar and other systems. Storage volume for solar is a function of collector area. For the resistance and heat pump systems, storage is sized to store in off peak hours sufficient heat to be certain of satisfying heating demand during the peak hours.

Analytical Results

As indicated earlier, our objective is to determine the extent to which government policies to (1) promote peak load electricity pricing, and (2) encourage solar development by offering tax breaks, achieve contradictory

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[1/] Peak load pricing experiments have not been conducted in the Indianapolis area. The rates used in this study are one of a series of rates used in the peak load pricing experiment undertaken by the utility.

results. A secondary objective is to assess the relative economics of the alternative systems under the household and weather conditions assumed for this analysis.

Table 2 displays the annualized cost per kwh for each system and policy option. The results are displayed over a range of solar heating fractions. The results in Table 2 assume a collector costs of $15 and $10 per square foot.[1/] The results in Table 2 assume that storage is used with solar and under peak load electricity pricing. From the results displayed in Table 2, it is clear that the heat pump is cheaper than any of the solar or resistance alternatives under any policy set.[2/] This is a very interesting result in part because the heat pump often is not included in comparisons between electric resistance and solar systems in the existing literature.

Much of the existing literature only compares electric resistance heating with solar. Making this comparison, we find that under most conditions with declining block electricity pricing, at least one of the solar options is preferable to electric resistance heating. With the higher collector cost and no tax incentives, electric resistance is somewhat cheaper. But with either the solar tax credit or solar property tax exemption or both or with the lower collector cost, solar is the preferred alternative. However, under no circumstance is a solar system large enough to supply 50 percent of the January heat load the lowest cost option.

[1/] The collector cost figures include only the variable collector cost. The fixed cost of plumbing, pumps, controls, etc., was held constant for both cases.

[2/] This result is critically dependent on the heat pump performance factor assumed in this analysis. In particular, it is not known how the performance factor might change if the heat pump is allowed to operate only during the normally colder off peak hours to charge heat storage. Estimation of the change, if any, in the performance factor is beyond the scope of this study.

TABLE 2

LIFE-CYCLE HEATING COSTS UNDER ALTERNATIVE POLICIES, SYSTEMS, AND SOLAR COSTS

($/KWH)

% Solar	Property Tax and no solar credit		Property tax exempt and no solar credit		Solar credit with property tax		Solar credit and property tax exemption	
	$15 collector cost							
	DB	PL	DB	PL	DB	PL	DB	PL
0(R)	.0509	.0309	.0509	.0309	.0509	.0309	.0509	.0309
0(HP)	.0306	.0217	.0306	.0217	.0306	.0217	.0306	.0217
10	.0531	.0378	.0508	.0355	.0506	.0354	.0483	.0329
30	.0672	.0568	.0605	.0501	.0611	.0507	.0506	.0353
50	.0969	.0898	.0839	.0768	.0903	.0832	.0773	.0703
	$10 collector cost							
0(R)	.0509	.0309	.0509	.0309	.0509	.0309	.0509	.0309
0(HP)	.0306	.0217	.0306	.0217	.0306	.0217	.0306	.0217
10	.0497	.0344	.0480	.0326	.0477	.0324	.0459	.0306
30	.0563	.0459	.0514	.0411	.0517	.0413	.0469	.0365
50	.0752	.0680	.0658	.0587	.0685	.0614	.0592	.0521

NOTE:

DB = declining block

PL = peak load

HP = heat pump

R = resistance

This picture changes considerably if we assume peak load pricing for electricity. With peak load pricing, electric resistance is preferred over solar in all cases but one. Solar becomes economic only if 1) collector costs are lower, 2) state property tax on solar is exempt, and 3) the federal solar tax credit is in effect. Even then, a solar system supplying only 10 percent of the January heat load is economic.

The results in Table 2 assume a 4 percent real (10 percent nominal) increase in electricity prices. The results assuming 6 percent real rate of electricity price increase reveal the same general tendencies.

Taking another perspective on these results, we examine the impact of each of the policy options and major assumptions on the break-even amount of investment in solar. Excluding heat pump and peak load pricing and assuming a $15 collector cost and 10 percent annual electricity price increase, the break-even level of investment in solar is $2500 (less than 10 percent of January load). With the property tax exemption alone, the break-even investment increases to $3250, an increase of 30 percent. With both the property tax exemption and the solar tax credit and collector cost reduced to $10, the break-even investment increases to $8000, an increase of 220 percent over the no incentive higher cost case. The two incentives alone increase the break-even investment to $5100, a 104 percent increase. If electricity prices are expected to rise at 12 percent per year (nominal) instead of 10 percent, the break-even investment with no subsidies increases to $3500, a 40 percent increase

Summary and Conclusions

Several important points emerge from this analysis. First, as would be expected, the solar tax credit can be a powerful tool to encourage investment in solar energy. The solar tax credit alone brings about a doubling of the break-even solar investment assuming heat-pump and peak-load pricing are excluded.

Second, the solar tax credit incentive is not sufficient to make solar systems preferable to heat pump systems. With declining block electricity pricing, heat pump systems were always cheaper than either solar or resistance heat.

Third, with peak load pricing, electric heat options were always preferred to solar.[1/] The heat pump was the cheapest system under all policy options, and electric resistance heat was cheaper than solar energy in all but one case. What this indicates is that the peak load pricing policy, if put into effect, would nullify the effectiveness of the solar tax credit and property tax exemption policies. Consumers would be better off using electric heat than solar energy and likely would pursue that course.[2/]

In essence, the peak pricing policy, which conserves capital resources but consumes non-renewable energy, would overwhelm the solar tax credit designed to promote use of renewable energy. This result is not necessarily bad, but policy makers need more information on the results of their actions. To the extent that these results are compatable with the policy maker's intended objectives, no policy modification would be needed. However, if the lawmakers intended to provide a major stimulus to solar energy in lieu of other options, the policy set needs to be reconsidered.

[1/] This analysis assumed consumers could get their electric heat only--not their entire load--with peak pricing as has been done in the past with hot water heating. If consumers could get peak pricing only on an all or nothing basis, peak load pricing would loose some of the advantage shown in these results.

[2/] Heat storage electric furnace systems which are designed to take advantage of peak pricing rates have come on the market since the passage of the 1978 Energy Act.

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