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The Economics of Solar Water Heaters : A Guide for Evaluating the Cost-Effectiveness of Active Solar Water Heating Systems in Maine

Maine Office of Energy Resources

THE ECONOMICS OF SOLAR WATER HEATERS

A GUIDE FOR EVALUATING THE COST-EFFECTIVENESS OF ACTIVE SOLAR WATER HEATING SYSTEMS IN MAINE

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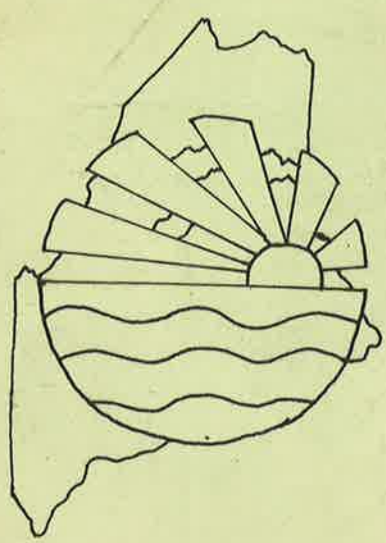

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SECTION I INTRODUCTION

The time has passed when solar water heating could be considered a novelty or a luxury. The technology and economics of solar water heaters have made them practical for families in Maine today. The reasons are several. One is the fact that it is possible to save much more money during the lifetime of the solar system than was spent on it originally. A second is that it works. A solar water heater system can provide at least 50% of your domestic hot water needs. And a third is that solar water heaters add to the resale value of the homes in which they are installed.

Other reasons for installing solar water heating NOW include the current economic climate and the tax incentives available at this time. The cost of electricity and fossil fuels is soaring and thus placing a burden on family budgets already strained by inflation. At the same time, families seeking to meet these increased costs through increased incomes face higher tax obligations. Installing solar water heaters can be a way out of this economic trap, since it allows families to control at least a portion of their energy costs.

However, while many families are convinced of the benefit of solar water heaters, they understandably want to know more about the economics of installing such a system in their home before making a commitment. It is for this reason that this guide was prepared. By using this guide, it is hoped that each family considering the installation of a solar water heater can determine its economic benefit and/or feasibility for themselves.

Section II of this guide explains how to perform a life-cycle cost analysis which balances the benefits against the initial cost of a solar system. Three methods of rating such a system are explained: the discounted payback period, the internal rate of return and a yearly cash flow method.

Price, quality, durability, utility rates, tax credits, etc. are among the many factors one should consider in purchasing a solar system. A detailed explanation of these considerations is given in Section III.

Section III introduces and explains the tables which have been developed and included at the end of this guide in order to help you determine the economic benefits of a solar water heating system for you and your family.

SECTION II ECONOMIC METHOD: THE LIFE CYCLE COST ANALYSIS

Most consumer goods, such as food, yield an immediate satisfaction or else enduring satisfaction which is impossible to measure, as in the case of a TV. It is usually fairly easy, when considering a purchase, to weigh the cost against the expected satisfaction.

A solar water heater, like an electric or gas water heater, delivers hot water. Yet, the solar water heater is far more expensive than the other two. How can an expensive solar water heater be a better deal than a cheap oil or electric model? The benefits you get from a solar water heater are measurable, yearly amounts of "free" energy from the sun for as long as the equipment lasts. This translates into yearly dollar savings. In order to measure the benefits, it is necessary to add up the expected solar energy contribution for the entire lifetime of the solar water heater and compare this to the initial cost. Economists call this type of analysis LIFE-CYCLE ANALYSIS (LCC). By considering what the equipment will produce over its life-cycle, one can discover if the overall benefits exceed the costs, and if so, by how much. By performing life-cycle analyses for various types of water heaters, it is possible to meaningfully compare conventional and solar water heaters and also various solar water heaters among themselves. Though a conventional gas or electric water heater is cheaper to buy initially, it may prove very expensive to run over its lifetime due to rising fuel costs.

To make use of the life-cycle cost analysis, one should examine at least three methods of rating the value of an investment such as a solar water heater. No one method gives the complete picture, but two or three methods together can be used for comparison purposes. These rating methods are:

1. The payback period
2. The internal rate of return
3. A yearly cash flow table

If you are intending to buy a solar energy system with cash, the first two methods--the discounted payback period and the rate of return--give the most useful indication of its value. If your purchase is to be financed with a loan, a yearly cash flow analysis will be useful as well.

The PAYBACK PERIOD tells you how many years it will take for the accumulated savings from the solar water heater to equal its purchase price. To give a clear picture of the actual cost the initial purchase price has been adjusted in Table I to account for tax credits and refunds, and the interest in the case of the system financed with a loan.

Unlike the payback period, the INTERNAL RATE OF RETURN takes into account the fuel savings expected over the system's entire lifetime. If you are in a position to purchase the system with cash then the INTERNAL RATE OF RETURN enables you to compare the savings from the solar investment with an alternative investment, such as putting the money in the bank, or buying stocks or bonds.

When comparing a solar investment with any other investment, it is important to remember that there is a tax advantage to the solar investment. Increasing your spending power by saving money, as with a solar system, is more advantageous than making money in an alternative investment. You maintain the same income level when you save money, so your tax liability will also remain the same. However when you put your money in a savings account or buy stocks the money you earn from these investments will increase your income, and subsequently your tax liability may also increase. So when comparing the savings from the solar system with potential income from an alternative investment it is important to adjust the earnings from alternative investments to reflect any increased tax liability.

If you will need to finance the system with a loan it is unnecessary to compare the solar investment with any alternative investment. The economic motivation for purchasing a solar system is different in this case. Individuals having the means to pay for a solar system with cash are looking for an investment which compares favorably with alternative investments. Financing a system with a loan implies a need to minimize monthly expenditures for energy. If you live on a limited budget spreading out the payment is your primary concern.

For equipment financed with a loan, a YEARLY CASH FLOW TABLE will show you how much your yearly loan payment will be offset by savings on your fuel bill. Since savings increase year by year due to rising fuel costs, each year a larger portion of the yearly loan payment is offset by the savings. For this reason, solar water heaters financed with a loan are about as cost-effective as those paid for in cash.

The cash flow changes according to the type of financing. On a yearly cash flow basis it is better to finance a solar system with a first or second mortgage than with a home improvement loan. The actual cost of the system will be greater when it is financed with the original mortgage. But you will realize larger savings sooner than with any other method of financing.

SECTION III FACTORS AFFECTING THE DECISION TO BUY

A. Price

This is one of the most important factors. Information from those who have purchased solar water heating systems shows that very similar systems may vary widely in price, yet the efficiency and durability of some of the higher priced systems may not yield sufficient fuel savings to justify their added cost. Purchase price is an item worth examining with care.

B. Quality and Durability

Generally, better quality equipment will last longer; and the longer a system lasts, the more money it will save, because yearly savings will increase at a greater rate as time goes on, due to fuel cost escalation. Examine the hardware, and, if possible, the installations previously done by your installer. If you have questions about what you should look for in purchasing a solar water heater, complete the Information Request Sheet found at the end of this pamphlet. The Office of Energy Resources (OER) will provide you with the Sunshine Handbook, a consumer's buying guide designed to help you avoid possible problems with purchasing solar energy equipment.

C. Utility Rates

Your own utility rates are another prime consideration. Needless to say, you will save more with a solar water heater if you are paying relatively high utility rates.

In order to make use of the charts in this guide, it is important that you determine, with accuracy, the rates you are paying for fuel. To do this, you will need to look carefully at your recent utility bills. A utility bill commonly has four components: a service charge, the flat rate for power, a cost for fuel adjustment and various taxes. The service charge applies to all customers regardless of consumption. The flat rate is the base cost per kilowatt hour (Kwh), and generally remains the same over a long period of time.* The fuel adjustment charge is added on to the flat rate to account for the costs the utility incurs when using fuels of varying expense. For instance, currently it is more expensive to generate electricity with oil than hydro power. So if the utility uses more oil than usual during a given period the fuel adjustment charge is generally higher for that time. The various taxes are also based on consumption and hence will rise as an individuals electrical usage increases.

Since electricity is often used for a variety of tasks other than heating water all households using it would be billed for the service charge each month. So when determining how much you are paying for each Kwh subtract the service charge from your most recent bill. Then divide the remaining amount by the total number of kilowatt hours and the sum will be the applicable electricity cost for you.

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* Some Maine utility companies are experimenting with different rate structures in an attempt to reduce peak loads and encourage conservation. They are now experimenting on a limited basis with "time of use rates" which charge the highest prices during the periods of greatest demand. These rates may be available to the general public in the near future.

The formula is:

> total cost per kilowatt hour = flat rate/Kwh + cost for fuel adjustment/Kwh + taxes ÷ the number of kilowatt hours

If you need help with this step contact your local utility and they will be glad to explain your bill.

Currently it costs less to heat the same amount of water with oil than with electricity. However the fuel savings are still sufficient to recoup the initial investment within the life of the solar system. Oil prices of about 80¢ per gallon approximately corresponds with electricity at 3¢ per Kwh, taking oil burner efficiencies into account. If you currently heat your water by a tankless system with a heating coil in the boiler used for heating your home, savings through solar energy will still be significant since the furnace will not need to operate at all during the summer months and will operate less during the winter--especially if you keep your thermostat low.

Supply is another factor to consider when comparing oil against solar. It has become apparent during the 1970's that international politics can have a distinct effect on the availability of home heating oil. During February, 1979 the fuel oil supply in Maine became extremely tight. Fortunately the weather warmed up and hence the demand decreased, staving off the possibility of homes having to go without oil. In future years it will be a continual struggle to bring fuel oil reserves up to adequate levels before the heating season. Self sufficiency is just one of the many non economic benefits of solar energy.

D. Federal Solar Legislation

Cost-effectiveness of solar energy systems has improved substantially with the passage of the National Energy Act (NEA) which provides a tax credit of 30% for the first $2,000 and 20% on the next $8,000 invested in solar energy equipment for residential use. For most people, this is equal to a price reduction of $600 on a $2,000 solar energy system.

Business Investment Tax Credits (ITC) are also available, whereby a business installing a solar water heating unit may claim a 10% refundable ITC in addition to the currently existing 10% ITC.

Future legislation recently proposed by the Carter Administration includes a $450 million Solar Development Bank to provide loan assistance to persons installing solar equipment in their homes.

E. Maine Solar Legislation

By an Act of the 108th Maine Legislature the following two tax incentives have been provided to residents installing solar equipment:

1. Your property tax assessment cannot be increased because you have installed solar heating, cooling or hot water equipment on your house. Any person wishing this exemption should file with their local tax assessor or Board of Assessors.

2. Any Maine Sales Tax paid on a solar heating, cooling or hot water system, which has been certified by OER, will be refunded. To receive the tax refund, buyers should contact OER and request the proper forms.

The 109th Maine Legislature recently passed several important pieces of solar legislation:

1. A law calling for a voluntary certification program for solar installers. All installers carrying this certificate will have taken a state certified course on proper solar installation and passed a certification test. When purchasing your solar system contact the OER and find out if this program is in place yet. If so be sure the installer you choose has received the proper certification.

2. A Maine taxpayer installing a renewable energy system will receive credit on his or her state income tax of 20% of the purchase price or $100 whichever is less. The credit applies only to new installations and is allowable only for the year in which the installation is completed. Renewable energy systems include both active and passive solar systems. Therefore all of the domestic hot water systems currently available in Maine would be eligible for the credit.

NOTE: The tables and costs in this pamphlet were developed prior to the passage of this law. Hence they do not reflect the additional $100 savings.

3. An Act establishing a minimum warranty of five years against defects in the materials or manufacture of solar collectors and a one year warranty against failure of the solar system as a result of improper installation.

F. Resale Value

Increasing fuel costs make solar equipment on a house a valuable feature if you want to sell the home in the future. Solar hot water has only come to the fore in recent years. Hence there is little real information on the resale values of a solar water heater since few existing systems have been resold. However, based on comparisons with items of similar original value (that have no monetary return), it would appear that after an initial depreciation of 20% the annual depreciation would be between 4-5%, assuming the system is properly maintained. So the resale value of a $2000 10 year old solar water heater, with an overall life expectance of 25 years, would be $960. It is conceivable that the resale value would be even higher because of the potential for the next owner to recoup his investment.

In the economic analysis it was assumed that the system would have no resale value after 25 years. This does not mean that the system will have completely degenerated by that time. Certain durable components such as the tank, collector bracket, and parts of the collector would still be functional. Metallic surfaces exposed to fluid will have corroded to some extent and would necessitate replacement.

G. Fuel Price Increases

The economic performance of a solar water heater and any solar energy system is highly dependent on the price of fuel it saves. Since many economists are predicting a 10% per year cost escalation for fossil fuels and electricity, we chose this number in order to perform the economic analysis presented in this guide. In 1973 and 1974, prices for imported oil jumped about 400%. This was soon reflected in an near doubling of electric rates in New England which uses oil-fired plants to generate most of its electricity. The savings projected in this guide should thus be considered conservative. In fact the price of heating oil has risen over 35% during the past year, and with additional OPEC price increases on the horizon it is difficult to estimate just how high the price of oil will go. When you install a solar system however the price you pay for that energy will remain the same for as long as you own the system. And if fuel costs jump dramatically once again, so will the savings realized from a solar system.

H. Financing the System

Once you have decided that a solar water heater would be feasible in your home, the final step is determining the best method of payment. Some of the factors governing this decision were discussed in Section II. The three typical situations encountered when purchasing a solar system are, 1) the individual who can afford to buy the system outright with cash; 2) borrowing the money for a retrofit installation on an existing home; and finally, 3) a financed system installed in a new or newly purchased home.

The individual with the financial resources to buy the system with cash is in the most opportune position from an investment standpoint. The ratio of actual cost to final savings is the highest in this case, as you will see in the Tables in Section IV. Unfortunately many people cannot afford to buy the system outright.

A primary concern of many middle income families is the minimization of monthly expenses, not the total savings realized over the lifetime of the investment. Middle income homes comprise the broadest solar hot water market. The current mode for financing a solar system with a loan is a Home Improvement Loan. Based on a survey of Maine banks, 2 year loans of under $2000 are available at 16-18% simple annual interest. A 5 year term at 13% may be obtained on a loan of over $2000. Generally if you have to take a 2 year loan, the cash flow advantage of spreading out the payment is negated by the short term and the high interest rate. Anyone who can afford to make two $800 payments for a typical 2 panel system can probably afford to make one initial payment of $1300. Spreading the payments out over 5 years is worthwhile. It does raise the actual cost of the system but it improves the annual cash flow.

Adding the cost of the solar system on to the purchase price of a new or newly purchased home allows you to include it in the original mortgage. Currently this is the most advantageous financing method. In fact the rate of return is higher than that of a system paid for with cash.

Spreading the payment over the length of the mortgage, 25 to 30 years, optimizes the cash flow by minimizing the difference between the annual mortgage payment and the annual savings. This allows the owner to realize larger savings right from the start, although it does reduce the total savings over the lifetime of the system. For example, after 25 years the total savings from a 3 panel system (compared against electricity) would be $8392 if the system were fully paid for at the start. Comparatively, the savings over the same period on a system included in the original mortgage would be $6332. The difference simply being the interest paid on the mortgaged system.

I. The Solar Investment vs. the Non Solar Investment

Using example #7 from Table I as the base case, the following account demonstrates the advantages of the solar investment.

EXAMPLE:

Mr. E installs an electric hot water heater for $400 for his family of four. Ms. S decided to install a solar hot water heater with electric back-up for $1900 for her family of four. The solar system is designed to provide 65-70% of her family's hot water needs.

NOTE: If Ms. S were choosing a system for a new home the cost difference would be less because when evaluating the alternative she could effectively subtract the cost of a conventional system. Every home must have some means of heating water so it is the additional cost of solar that we are concerned with. Since a solar system is entirely self contained there is no need for a conventional electric or oil hot water heater in a new home. In the case described here Ms S already had a conventional hot water heating so her additional cost is $1900, however, if she were comparing systems for a new home the additional cost for solar would only be $1500.

Although the initial cost of Ms S's solar water heater is high, her fuel costs over the years will be less than a third of those of Mr. E. As electricity prices grow, the cost difference turns out to be important.

Assuming the average cost of electricity is now 4¢ per kilowatt hour and grows at the rate of 10% per year. Mr. E will pay about $6,200 for electricity over a 15 year period. Ms. S will pay one third that amount. Furthermore Ms. S's system will have paid for itself in 7 years; that is; in the 7th year, her total electricity savings will exceed $1500, or more than the difference between her system and the conventional heater of Mr. E. From then on except for minimal maintenance costs Ms. S's solar system provides her with essentially free energy for two-thirds of her hot water needs.

Another way of looking at the economics of Ms. S's solar system is to compare the two systems from a savings point of view. Suppose Mr. E takes the $1500 he saves by not purchasing a solar system and puts it in the bank at 6%. Suppose also that Ms. S takes the money she saves in fuel bills from her solar system every year and puts it in the bank at 6%. If you compare the two investments after a 15 year period, it turns out that Ms. S has over 40% more money in the bank than Mr. E ($1500 at 6% compounded for 15 years is $3590; the value of the solar savings for the same period is $6040). Furthermore, Mr. E has to contend with $6200 in electric bills over that 15 year period. If you subtract all the solar costs of $4400 for Ms. S's system (purchase price, backup fuel cost and the cost of insurance and maintenance) from her savings of $6040 she is left with $1640. On the other hand, if you subtract Mr. E's electric bill for 15 years from his total savings he is left with a deficit of $2610.

SECTION IV EXPLANATION OF THE TABLES

A. Procedure Used to Produce the Tables

A mathematical computer program called FCHART has been in use for a number of years to predict the performance of various solar energy systems. OER used this computer program, a variety of utility rates, solar equipment prices and solar system performance data to arrive at the payback period, internal rate of return, and other performance results for a solar water heater in the Portland area.

The results apply to the majority of the state. System performance would improve slightly south of Portland, and decrease as you move further to the north. Overall the variation of performance results between Portland and the northern region of the state, Caribou for example, would range between 10-15%. The variation is not of sufficient consequence to disqualify the information in the Tables.

Details on the type of solar water heater which was analyzed, and the assumptions made when doing the analysis, can be found in the Appendix.

B. Table I

Table I identifies the primary physical and financial parameters assumed for each case. Each example is identified by a number. All subsequent references to specific systems will be referred to by those numbers. The number of collector panels, storage tank size and number of persons all reflect the current standard practice in the solar industry.

Deriving the actual cost from the initial cost paid to the solar dealer assumes that individuals take advantage of all the available incentives, such as tax credits. Another key factor in the actual cost estimate is the financing mechanism chosen by the buyer. Financing a loan or mortgage results in interest charges which are deductible from your federal income taxes. This expense is reflected in the actual cost figures for each example.

If you are borrowing money to pay for the system you will be borrowing the amount shown as the initial cost. It is assumed that the owner will then use his sales tax refund and the money he saves on his Income Tax, to make extra payments on the loan, thereby eliminating financing charges on that portion of the loan. This reduction of interest charges is reflected in the actual cost figure. Because the amount of the income tax credit may not exceed one's tax liability for that year, it may take two or more years to realize the full benefits of the tax credit.

Further economic and system performance assumptions are discussed in the Appendix.

C. Tables II, A, B, C

Table II is central to this guide and can be used by homeowners to calculate whether a solar system would be financially practical under varying conditions. The system is assumed to have a lifetime of 25 years.

To use these Tables, first ascertain the method you will use to finance the system, this will determine which table you should use. Then determine the price you are currently paying for gas or electricity. (See Section III, Item C.) On the left side of the tables, find the price nearest to what you are paying (if you are unable to determine the price, current average energy costs in June 1979 are 4.0¢ per kilowatt hour for electricity and 57¢ per gallon for oil). Then look across to the system which correlates with the number of persons in your family and read off the four economic performance figures. An explanation of these appears under Table II A.

D. Tables III A, B, C

These tables are an example of the yearly cash flows experienced with each financing mechanism. Because there will be no financing charges on the money realized from the tax credit, the figure shown as the initial cost is that which the owne will pay interest on. Column 10 probably holds the most significance for the home owner. This column indicates when the savings from the solar system exceed either the purchase price (in the case of a system financed with cash or a short term loan) or the annual mortgage payment (the amount of the annual mortgage payment can be found in Table I). A discussion of the individual variables precedes Table III A.

We hope that you have found this guide useful. Any comments or suggestions on how to make it more useful to the consumer will be welcomed by our office. Good luck with your decision!

Number of Occupants	Number of Collector Panels	Size of Storage Tank	Annual % of Hot Water from Solar	Initial cost before credit	Amount of Sales Tax Refund	Amount of Federal Income Tx Cdt.	Example Number	Financing Mechanism	Term of Loan	Interest Rate	Annual Loan Payment	Actual Cost (out of pocket)
2	2	65 gal.	73%	$1827	$91	$548	1	Cash	--------	----	----	$1279
							2	H.I.L.*	2 years	16%	$765	$1530
							3	Mortgage	25 years	10.5%	$128	$3200
3	3	80 gal.	71%	$2226	$111	$645	4	Cash	-----	----	----	$1581
							5	H.I.L.*	5 years	13%	$423	$2115
							6	Mortgage	25 years	10.5%	$157	$3925
4	4	80 gal.	70%	$2625	$131	$725	7	Cash	-----	---	----	$1901
							8	H.I.L*	5 years	13%	$508	$2540
							9	Mortgage	25 years	10.5%	$189	$4725
5	5	120 gal.	70%	$3000	$150	$797	10	Cash	-----	---	----	$2202
							11	H.I.L*	5 years	13%	$588	$2942
							12	Mortgage	25 years	10.5%	$219	$5475

* H.I.L. / Home Improvement Loan

TABLE IIA-SYSTEM FINANCED WITH CASH

UTILITY RATES		EXAMPLE #1 2 PANEL SYSTEM INITIAL COST=$1827 ACTUAL COST=$1279				EXAMPLE #4 3 PANEL SYSTEM INITIAL COST=$2226 ACTUAL COST=$1581				EXAMPLE #7 4 PANEL SYSTEM INITIAL COST=$2625 ACTUAL COST=$1901				EXAMPLE #10 5 PANEL SYSTEM INITIAL COST=$3000 ACTUAL COST=$2202			
ELEC ¢/Kwh	OIL ¢/Gal	AANS	SVGS	PYBK	IRR	AANS	SVGS	PYBK	IRR	AANS	SVGS	PYBK	IRR	AANS	SVGS	PYBK	IRR
7.0	$1.95	410	10267	8	17.1	629	15748	7	19.6	823	20585	7	20.6	1061	26530	6	22.1
6.7	1.86	389	9739	8	16.6	598	14964	7	19.0	783	19572	7	20.0	1009	25238	6	21.4
6.4	1.78	368	9212	8	16.0	567	14181	7	18.4	742	18559	7	19.4	958	23950	7	20.7
6.1	1.70	347	8684	9	15.5	535	13398	8	17.7	701	17546	7	18.7	906	22661	7	20.0
5.8	1.62	326	8156	9	14.9	504	12614	8	17.1	661	16533	8	18.0	854	21373	7	19.3
5.5	1.53	305	7629	9	14.3	473	11831	8	16.4	621	15521	8	17.3	803	20085	7	18.6
5.2	1.45	284	7101	10	13.6	442	11047	9	15.7	580	14508	8	16.6	752	18797	8	17.8
4.9	1.36	263	6579	10	13.0	411	10273	9	15.0	540	13507	8	15.9	700	17502	9	17.0
4.6	1.28	246	6158	10	12.5	379	9489	9	14.3	500	12494	9	15.1	649	16235	8	16.3
4.3	1.20	221	5524	11	11.6	348	8706	10	13.6	459	11481	9	14.4	598	14947	9	15.5
4.0	1.11	200	4996	11	10.9	317	7922	10	12.8	419	10468	10	13.6	543	13658	9	14.6
3.7	1.02	179	4468	1	10.1	285	7139	11	12.0	378	9456	10	12.7	495	12370	10	13.7
3.4	.94	157	3941	12	9.3	254	6355	11	11.1	337	8443	11	11.8	443	11082	10	12.8
3.1	.86	136	3413	13	8.5	223	5572	12	10.2	297	7430	11	10.9	392	9794	11	11.8
2.8	.75	115	2885	14	7.6	191	4788	12	9.2	256	6417	12	9.9	340	8505	11	10.[illegible]
2.5	.69	94	2358	15	6.5	160	4005	13	8.2	216	5405	13	8.8	288	7217	12	9.7

AANS: Average Annual Net Savings

This figure represents the average yearly fuel savings from the solar water heater, after maintenance and operating costs. Actual annual savings would be less than this during the first 10-15 years of operation and would then escalate as the cost of electricity or oil rises. This is demonstrated in Tables III A, III B, and III C in column 10, Savings with Solar. Table III A shows the Yearly Cash flow for a 4 panel solar system compared with electricity at 4¢/Kwh. The AANS of that system is $419. In Table III A you can see that the actual savings do not actually reach that level until after the 14th year.

SVGS: Savings

The total savings possible, after payback, over the lifetime (25 years) of the system.

PYBK: Payback Period

The number of years it takes for the yearly savings, after maintenance and operating costs, to equal the purchase price. The payback was determined using actual savings for each year.

IRR: Internal Rate of Return

This enables one to compare the returns on the purchase of the solar water heating equipment with other investments.

TABLE IIB-FINANCED WITH A HOME IMPROVEMENT LOAN

UTILITY RATES		EXAMPLE #2 2 PANEL SYSTEM INITIAL COST=$1827 ACTUAL COST=$1530				EXAMPLE #5 3 PANEL SYSTEM INITIAL COST=$2226 ACTUAL COST=$2540				EXAMPLE #8 4 PANEL SYSTEM INITIAL COST=$2625 ACTUAL COST=$2540				EXAMPLE #11 5 PANEL SYSTEM INITIAL COST=$3000 ACTUAL COST=$2942			
EL[illegible] ¢/ Kwh	[illegible]OIL ¢/ Gal	AANS	SVGS	PYBK	IRR	AANS	SVGS	PYBK	IRR	AANS	SVGS	PYBK	IRR	AANS	SVGS	PYBK	IRR
7.0	$1.95	400	10016	8	17.9	608	15215	7	24.4	798	19943	7	26.6	1031	25784	6	29.8
6.7	1.86	379	9488	8	17.3	577	14431	7	23.3	757	18931	7	25.2	980	24495	6	28.2
6.4	1.78	358	8960	8	16.6	546	13648	7	22.1	717	17918	7	24.0	928	23207	7	26.7
6.1	1.70	337	8432	8	15.9	514	12864	8	21.0	676	16905	8	22.7	877	21919	7	25.2
5.8	1.62	316	7905	9	15.2	483	12081	8	19.9	635	15895	8	21.5	825	20631	7	23.9
5.5	1.53	295	7377	9	14.5	452	11297	8	18.9	595	14880	8	20.4	773	19342	7	22.5
5.2	1.45	274	6849	10	13.8	420	10514	9	17.8	554	13867	8	19.2	740	18054	8	21.2
4.9	1.36	253	6328	10	13.0	389	9739	9	16.8	514	12866	8	18.1	670	16766	8	19.9
4.6	1.28	232	5800	10	12.3	358	8956	9	15.7	474	11853	9	16.9	621	15533	8	18.7
4.3	1.20	211	5272	11	11.5	327	8172	10	14.6	433	10840	9	15.8	568	14204	9	17.4
4.0	1.11	190	4744	11	10.7	295	7389	10	13.5	393	9827	10	14.6	516	12916	9	16.1
3.7	1.02	168	4217	12	9.8	264	6605	11	12.4	352	8815	10	13.5	465	11627	10	14.9
3.4	.94	147	3689	12	8.9	233	5822	11	11.3	312	7802	11	12.3	413	10339	10	13.6
3.1	.86	126	3161	13	8.0	201	5038	12	10.1	271	6789	11	11.1	362	9051	11	12.3
2.8	.75	105	2634	14	7.0	170	4255	12	8.9	231	5776	12	9.8	310	7763	11	10.9
2.5	.69	84	2106	15	5.9	139	3471	13	7.6	190	4764	13	8.4	259	6474	12	9.5

TABLE IIC-MORTGAGED

UTILITY RATES		EXAMPLE #3 2 PANEL SYSTEM INITIAL COST=$1827 ACTUAL COST=$3200				EXAMPLE #6 3 PANEL SYSTEM INITIAL COST=$2226 ACTUAL COST=$3925				EXAMPLE #9 4 PANEL SYSTEM INITIAL COST=$2625 ACTUAL COST=$4725				EXAMPLE #12 5 PANEL SYSTEM INITIAL COST=$3000 ACTUAL COST=$5475			
ELEC ¢/ Kwh	OIL ¢/ Gal	AANS	SVGS	PYBK	IRR	AANS	SVGS	PYBK	IRR	AANS	SVGS	PYBK	IRR	AANS	SVGS	PYBK	IRR
7.0	$1.95	334	8363	8	100	535	13394	7	100	710	17755	7	100	930	23428	6	100
6.7	1.86	313	7836	8	90.0	504	12611	7	100	670	16743	7	100	878	21960	6	100
6.4	1.78	292	7305	8	70.0	473	11827	7	100	629	15730	7	100	827	20672	7	100
6.1	1.70	271	6780	9	53.1	442	11044	7	100	588	14717	7	100	775	19383	7	100
5.8	1.62	250	6253	9	42.5	410	10260	8	100	548	13704	8	100	756	18095	7	100
5.5	1.53	229	5725	9	35.6	379	9480	8	90.0	507	12692	8	100	672	16807	7	100
5.2	1.45	208	5197	10	30.4	347	8693	9	60.0	467	11679	8	100	621	15519	8	100
4.9	1.36	187	4675	10	26.2	316	7906	9	45.0	427	10678	8	64.3	569	14224	8	100
4.6	1.28	166	4148	10	22.6	285	7135	9	36.2	386	9665	9	46.9	518	12957	8	80.0
4.3	1.20	145	3620	11	19.4	254	6352	10	29.9	346	8652	9	36.8	467	11669	9	53.0
4.0	1.11	123	3092	11	16.5	223	5568	10	24.9	305	7639	10	29.9	415	10380	9	39.6
3.7	1.02	102	2565	12	13.9	190	4758	11	20.8	265	6627	10	24.6	363	9092	10	31.0
3.[illegible]	.94	81	2037	12	11.2	160	4001	11	17.3	224	5614	11	20.3	312	7804	10	25.1
3.1	.86	60	1509	13	8.6	129	3218	12	14.0	184	4601	11	16.6	260	6516	11	20.3
2.8	.75	39	981	14	5.9	97	2434	12	10.9	143	3588	12	13.1	209	5227	11	16.2
2.5	.69	18	454	15	2.9	66	1651	13	7.7	103	2576	13	9.7	157	3939	12	12.5

SUMMARY OF FCHART VARIABLES

Column 8: Cost With Solar. The sum of the yearly cost for back up fuel, insurance and maintenance. These costs rise at the current rate of inflation, 6.5%.

Column 9: Savings With Solar. This represents the difference between solar water heating and conventional water heating with electricity or oil.

Column 10: Power of the Solar Savings: The solar savings from Column 9 are adjusted to account for inflation. So this figure represents the solar savings in 1979 dollars.

The Rate of Return on the Solar Investment: See IRR in Section V

Year Until Undiscounted Fuel Savings = Investment: See PYBK in Section V. The year in which the savings in Column 9 add up to the purchase price.

Years Until Undiscounted Fuel Savings = Mortgage Principal: The only situation in which this is a significant factor is Table III C. This means that the annual solar savings have exceeded the remaining mortgage liability, at which time the mortgage could conceivably be paid off in full.

Undiscounted Cumulative Solar Savings: The sum of all the savings in Column 9.

Present Worth of Yearly Total Costs With Solar: Represents the total cost of heating your water with solar energy over the 25 year lifetime of the system, including the purchase price, back up fuel cost, maintenance and operating expenses.

Present Worth of Yearly Total Cost Without Solar: This represents what it would have cost to heat your water with either oil or electricity during the same 25 year period.

Present Worth of Cumulative Solar Savings. The sum of the savings in Column 10. The only situation in which this figure is significant is when the system is paid for in cash. If the system is paid for all in one year the savings should be measured in dollars of the same value. If the system is paid for with a loan, particularly a mortgage, the interest paid reflects the conversion to dollars of current value. Thus the savings should be judged on the same terms.

TABLE IIIA

Yearly Cash Flow for a 4 Panel System
Financed With Cash

PORTLAND ME 43.65

****THERMAL ANALYSIS****

TIME	PERCENT SOLAR	INCIDENT SOLAR (MMBTU)	HEATING LOAD (MMBTU)	WATER LOAD (MMBTU)	DEGREE DAYS (F-DAY)	AMBIENT TEMP (F)
YR	70.1	41.08	0.00	16.69	7951.	

****ECONOMIC ANALYSIS****
SPECIFIED COLLECTOR AREA = 75. FT2
INITIAL COST OF SOLAR SYSTEM = $ 1901.
THE ANNUAL MORTGAGE PAYMENT FOR 1 YEARS = $ 0.

YR	INTRST PAID	END OF YR PRINC	DEPRC DEDUCT	PROP TAX PAID	INC TAX SAVED	BACKUP FUEL COST	INSUR. MAINT COST	COST WITH SOLAR	SAVNGS WITH SOLAR	PW OF SOLAR SAVNGS
0	0	0	0	0	0	0	0	1900	-1900	-1900
1	0	0	0	0	0	58	19	77	118	115
2	0	0	0	0	0	64	20	84	130	124
3	0	0	0	0	0	70	21	92	144	134
4	0	0	0	0	0	77	22	100	159	144
5	0	0	0	0	0	85	24	110	176	155
6	0	0	0	0	0	94	26	120	194	168
7	0	0	0	0	0	103	27	131	215	181
8	0	0	0	0	0	113	29	143	237	195
9	0	0	0	0	0	125	31	156	262	210
10	0	0	0	0	0	137	33	171	289	226
11	0	0	0	0	0	151	35	187	320	243
12	0	0	0	0	0	166	37	204	353	262
13	0	0	0	0	0	183	40	223	389	282
14	0	0	0	0	0	201	43	244	430	304
15	0	0	0	0	0	222	45	267	474	327
16	0	0	0	0	0	244	48	293	524	352
17	0	0	0	0	0	268	52	320	578	379
18	0	0	0	0	0	295	55	351	637	408
19	0	0	0	0	0	325	59	384	703	440
20	0	0	0	0	0	357	62	420	775	473
21	0	0	0	0	0	393	66	460	855	509
22	0	0	0	0	0	432	71	504	943	548
23	0	0	0	0	0	476	75	551	1040	589
24	0	0	0	0	0	523	80	604	1147	634
25	0	0	0	0	0	575	86	662	1264	682

THE RATE OF RETURN ON THE SOLAR INVESTMENT(%)= 13.6
YRS UNTIL UNDISC. FUEL SAVINGS = INVESTMENT 10.
YRS UNTIL UNDISC. SOLAR SAVINGS = MORTGAGE PRINCIPAL 1.
UNDISCOUNTED CUMULATIVE SOLAR SAVINGS = $ 10468.
PRESENT WORTH OF YEARLY TOTAL COSTS WITH SOLAR = $ 6439.
PRESENT WORTH OF YEARLY TOTAL COSTS W/O SOLAR = $ 12635.
PRESENT WORTH OF CUMULATIVE SOLAR SAVINGS = $ 6195.

TABLE IIIB

Yearly Cash Flow for a 4 Panel System
Financed With a Home Improvement Loan

PORTLAND ME 43.65

THERMAL ANALYSIS*

TIME	PERCENT SOLAR	INCIDENT SOLAR (MMBTU)	HEATING LOAD (MMBTU)	WATER LOAD (MMBTU)	DEGREE DAYS (F-DAY)	AMBIENT TEMP (F)
YR	70.1	41.08	0.00	16.69	7951.	

****ECONOMIC ANALYSIS****

SPECIFIED COLLECTOR AREA = 75. FT2
INITIAL COST OF SOLAR SYSTEM = $ 1901.
THE ANNUAL MORTGAGE PAYMENT FOR 5 YEARS = $ 540.

YR	INTRST PAID	END OF YR PRINC	DEPRC DEDUCT	PROP TAX PAID	INC TAX SAVED	BACKUP FUEL COST	INSUR, MAINT COST	COST WITH SOLAR	SAVNGS WITH SOLAR	PW OF SOLAR SAVNGS
0	0	1900	0	0	0	0	0	0	0	0
1	247	1607	0	0	49	58	19	568	-372	-372
2	208	1275	0	0	41	64	20	583	-367	-367
3	165	901	0	0	33	70	21	599	-362	-362
4	117	478	0	0	23	77	22	617	-357	-357
5	62	0	0	0	12	85	24	637	-351	-351
6	0	0	0	0	0	94	26	120	194	194
7	0	0	0	0	0	103	27	131	215	215
8	0	0	0	0	0	113	29	143	237	237
9	0	0	0	0	0	125	31	156	262	262
10	0	0	0	0	0	137	33	171	289	289
11	0	0	0	0	0	151	35	187	320	320
12	0	0	0	0	0	166	37	204	353	353
13	0	0	0	0	0	183	40	223	389	389
14	0	0	0	0	0	201	43	244	430	430
15	0	0	0	0	0	222	45	267	474	474
16	0	0	0	0	0	244	48	293	524	524
17	0	0	0	0	0	268	52	320	578	578
18	0	0	0	0	0	295	55	351	637	637
19	0	0	0	0	0	325	59	384	703	703
20	0	0	0	0	0	357	62	420	775	775
21	0	0	0	0	0	393	66	460	855	855
22	0	0	0	0	0	432	71	504	943	943
23	0	0	0	0	0	476	75	551	1040	1040
24	0	0	0	0	0	523	80	604	1147	1147
25	0	0	0	0	0	575	86	662	1264	1264

THE RATE OF RETURN ON THE SOLAR INVESTMENT(%)= 14.6
YRS UNTIL UNDISC. FUEL SAVINGS = INVESTMENT 10.
CUMULATIVE SAVINGS NEVER EXCEEDED THE 'MORTGAGE PRINCIPAL
UNDISCOUNTED CUMULATIVE SOLAR SAVINGS = $ 9827.
PRESENT WORTH OF YEARLY TOTAL COSTS WITH SOLAR = $ 9412.
PRESENT WORTH OF YEARLY TOTAL COSTS W/O SOLAR = $ 19239.
PRESENT WORTH OF CUMULATIVE SOLAR SAVINGS = $ 9827.

TABLE IIIC

Yearly Cash Flow for a 4 Panel System
Financed In the Original Mortgage

PORTLAND ME 43.65

****THERMAL ANALYSIS****

TIME	PERCENT SOLAR	INCIDENT SOLAR (MMBTU)	HEATING LOAD (MMBTU)	WATER LOAD (MMBTU)	DEGREE DAYS (F-DAY)	AMBIENT TEMP (F)
YR	70.1	41.08	0.00	16.69	7951.	

****ECONOMIC ANALYSIS****

SPECIFIED COLLECTOR AREA = 75. FT2

INITIAL COST OF SOLAR SYSTEM = $ 1901.

THE ANNUAL MORTGAGE PAYMENT FOR 25 YEARS = $ 217.

YR	INTRST PAID	END OF YR PRINC	DEPRC DEDUCT	PROP TAX PAID	INC TAX SAVED	BACKUP FUEL COST	INSUR, MAINT COST	COST WITH SOLAR	SAVNGS WITH SOLAR	PW OF SOLAR SAVNGS
0	0	1900	0	0	0	0	0	0	0	0
1	199	1882	0	0	39	58	19	255	-59	-59
2	197	1862	0	0	39	64	20	262	-47	-47
3	195	1840	0	0	39	70	21	270	-33	-33
4	193	1816	0	0	38	77	22	279	-19	-19
5	190	1789	0	0	38	85	24	289	-2	-2
6	187	1760	0	0	37	94	26	300	14	14
7	184	1727	0	0	36	103	27	311	34	34
8	181	1691	0	0	36	113	29	324	56	56
9	177	1651	0	0	35	125	31	338	80	80
10	173	1607	0	0	34	137	33	354	107	107
11	168	1559	0	0	33	151	35	371	136	136
12	163	1505	0	0	32	166	37	389	168	168
13	158	1446	0	0	31	183	40	409	204	204
14	151	1380	0	0	30	201	43	432	243	243
15	144	1308	0	0	28	222	45	456	286	286
16	137	1227	0	0	27	244	48	483	334	334
17	128	1139	0	0	25	268	52	512	386	386
18	119	1041	0	0	23	295	55	544	444	444
19	109	933	0	0	21	325	59	579	507	507
20	98	813	0	0	19	357	62	618	578	578
21	85	681	0	0	17	393	66	660	655	655
22	71	536	0	0	14	432	71	707	740	740
23	56	374	0	0	11	476	75	758	834	834
24	39	196	0	0	7	523	80	814	937	937
25	20	0	0	0	4	575	86	875	1051	1051

THE RATE OF RETURN ON THE SOLAR INVESTMENT(%)= 29.9

YRS UNTIL UNDISC. FUEL SAVINGS = INVESTMENT 10.

YRS UNTIL UNDISC. SOLAR SAVINGS = MORTGAGE PRINCIPAL 16.

UNDISCOUNTED CUMULATIVE SOLAR SAVINGS = $ 7639.

PRESENT WORTH OF YEARLY TOTAL COSTS WITH SOLAR = $ 11600.

PRESENT WORTH OF YEARLY TOTAL COSTS W/O SOLAR = $ 19239.

PRESENT WORTH OF CUMULATIVE SOLAR SAVINGS = $ 7639.

APPENDIX

The solar water heater used in our analysis for the tables is an active system, using water or anti-freeze for the heat transfer medium. Sunshine and other pertinent weather data are from the National Bureau of Standards and the National Weather Service for Portland, Maine. It is assumed that the collectors face due south and are tilted at 43 degrees, the approximate latitude of Portland. The systems supply an average of eighteen gallons of 130° water per person per day.

The period of economic analysis (the life cycle cost of the system) was chosen to be 25 years. Yearly maintenance, pump operation, insurance and anti-freeze replacement are calculated at 1% of the system cost (after tax credits) plus $15 (1979 dollars). Monetary values are discounted at the rate of 6.5% per year where appropriate. The fuel escalation rate is 10% per year. Utility rates, system costs, and financing terms were derived from a wide range of the best available sources.

INFORMATION REQUEST SHEET

I'm interested in further information on Solar. Please send me the following:

- ☐ A booklet on Federal and State solar legislation.
- ☐ A list of solar energy firms including: 1) manufacturers, dealers, distributors, installers, and manufacturer's representatives, 2) architects and engineers, 3) builders. (Circle the lists that you want.)
- ☐ A solar industry director, giving detailed information on products available from Maine solar dealers.
- ☐ A solar consumer handbook to show me how to shop for solar and avoid consumer mistakes.
- ☐ A Passive Solar Energy Booklet, to give me ideas about passive solar energy and the economic benefits for either, 1) consumers, 2) builders, and 3) architects. (Circle the booklet you want.)
- ☐ A solar hot water booklet explaining the fundamentals and economics of solar water heating.
- ☐ A pamphlet explaining where to obtain more information on solar energy.
- ☐ A pamphlet explaining solar energy basics.
- ☐ A book detailing 50 selected solar buildings in Maine using all types of solar energy systems.
- ☐ A book on the state-of-the-art in Passive solar energy as it is applicable to Maine.
- ☐ Source sheets for the following resources:
  - ☐ Colleges and Universities with solar related courses by State.
  - ☐ Vocational/Technical schools/courses-solar related.
- ☐ A solar energy bibliography listing references on:
  - ☐ Comprehensive solar bibliography
  - ☐ Solar retrofitting
  - ☐ Passive solar energy designs and systems
  - ☐ Solar assisted heat pumps
  - ☐ Solar directories
  - ☐ Practical and do-it-yourself projects for solar utilization
  - ☐ Energy conservation in buildings
  - ☐ Underground houses
  - ☐ Selective surfaces for solar collectors
  - ☐ Industrial applications of solar energy
  - ☐ Sources of climatic data
  - ☐ Concentrating collectors
  - ☐ Energy publications available from the Government Printing Office
  - ☐ Comprehensive bibliography for children and young adults
  - ☐ Solar greenhouse bibliography and list of plans
  - ☐ Sources of solar house plans
  - ☐ Solar system consumer tips
  - ☐ Eutectic salts
  - ☐ Solar catalogs
- ☐ Please keep my name and address on the solar mailing list, so I can be informed of any new developments in the field.

NAME ______________________________

ADDRESS ______________________________
(Street) (City) (State) (Zip)

Mail this page to: **The Maine Office of Energy Resources**
55 Capitol Street
Augusta, ME 04330

For further information on solar energy call (207)289-2195.