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COMPARISON OF CONVENTIONAL AND SOLAR-WATER-HEATING PRODUCTS AND INDUSTRIES

REPORT

July 11, 1980

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This work has been supported by the San Francisco Office, Office of Solar Applications, Department of Energy, under the direction of Fred Glaski.

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FOREWORD

The President has established a goal that would require the installation of at least one million solar water heaters by 1985 and 20 million water heating systems by the year 2000. The goals that have been established require that the solar industry be sufficiently mature to provide cost-effective, reliable designs in the immediate future. The objective of this study was to provide the Department of Energy with quantified data that can be used to assess and redirect, if necessary, the program plans to assure compliance with the President's goals. The results from this study deal with the product, the industry, the market and the consumer. All issues are examined in the framework of the conventional hot water industry. Conclusions are reached regarding the commercial status of the industry and recommendations are made for appropriate government actions in support of the industry.

This work was supported by the San Francisco Office, Office of Solar Applications, DOE, under the direction of Fred Glaski.

APPENDICES

EXECUTIVE SUMMARY

SOLAR HOT WATER - A STATUS REPORT

Based on the results of this solar hot water assessment study, there is documented proof that "the solar industry is blessed with over 20 good solar hot water systems." A total of eight generic types are currently being produced, but a majority of the systems being sold are included in only five generic types. The good systems are well-packaged for quality, performance and installation ease. These leading systems are sized and designed to fit the requirements of the consumer in every respect. Significant product features such as thermal capacity, thermal recovery rates, aesthetics, lifetime, warranties and documentation are available to satisfy the needs of any consumer.

The most recent economics are extremely encouraging for the large scale implementation of solar energy. "For the first time, solar hot water heaters are competitive with conventional gas water heaters" when applying the most recent federal and state incentives and today's increased energy costs. Of course, solar hot water continues to be cost competitive with electricity in most areas even without the federal and state incentives. The new, larger tax incentives should merely accelerate the introduction of solar hot water.

The solar hot water heating industry is not without its problems as this is an infant industry. Products continue to be plagued with difficulties at the delivery end due to a lack of understanding on the part of those installing and servicing the products. This delivery end also suffers from a lack of understanding of the best methods for selling the product. At the supplier end, there are problems also, including: some design deficiencies, improper materials selection and, occasionally, the improper selection of components and subsystems. These, in total, are not serious problems in the better systems and will be resolved as this industry matures.

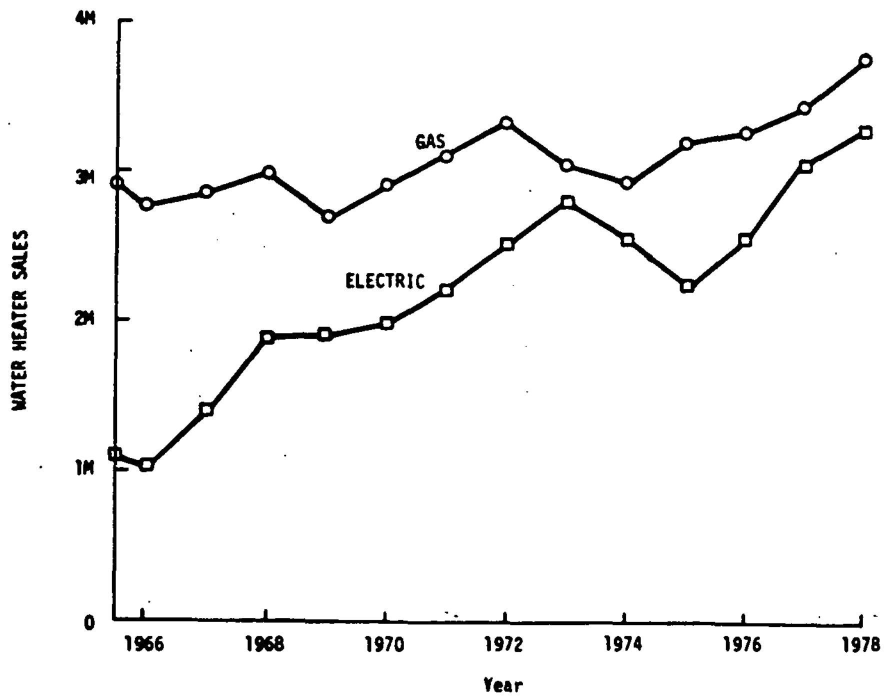
A particularly encouraging observation is the composition of the industry itself which is made up of both large and small companies. The list of major solar hot water companies includes four of the six major conventional hot water suppliers as well as a leading HVAC company, all of whom are geared to producing, distributing, installing, and servicing the product being sold.

The market potential for solar hot water systems is superb. Currently almost half of the conventional water heaters in the U.S. are electrically fueled. A majority of these new sales are occurring in the regions best matched to solar hot water, principally in the "sunbelt" of these United States where the new construction market is substantially higher than elsewhere in the United States. These southern regions of the United States are advantageous for other reasons as well: First, electric hot water sales are nearly three times gas water heater sales. Second, the "sunbelt" has a greater availability of sunshine coupled with generally higher electric fuel costs.

MARKET POTENTIAL

Data describing the historical trends for gas and electric water heater sales is shown in the following curve.

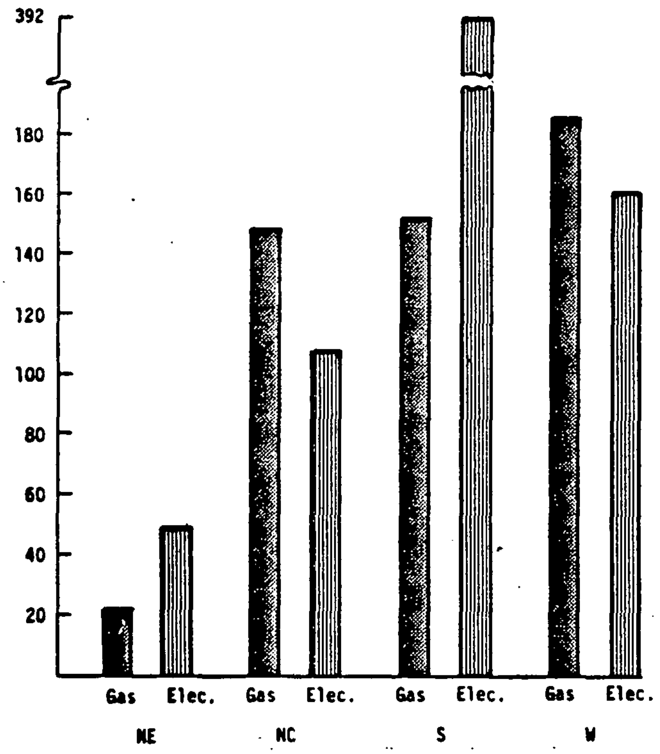
CONVENTIONAL WATER HEATER SALES



These sales, when disaggregated by single and multi-family markets, identify a disproportionate ratio of sales in the multi-family vs. single family markets as shown in the Figure below. Multi-family water heaters tend to be smaller which is disadvantageous to solar water heater economics.

Regional market data is favorable to solar water heating as the less competitive electric water heaters are sold in larger quantities in the most favorable climatic regions of the South and West (shown below).

REGIONAL WATER HEATER INSTALLATIONS - 1978



COMPETITIVE POSTURE OF SDHW SYSTEMS

Design Comparisons:

The design features of conventional and solar water heaters were found to be similar as shown in the following table:

Comparison Of Product Features For
Solar And Conventional Residential Water Heaters

	Solar		Electric		Gas	
	Median	Range	Median	Range[1]	Median	Range[2]
Specifications						
Capacity--Gallons	82	66- 120	52	20- 66	40	30- 50
Recovery--Gal/hr @ 90° Rise		6- 11 (+Aux.)		17- 25		20- 60
Input Rate, Btu/hr		4500-7200 (+Aux.)[3]		13-20,000		29-60,000
Efficiency, %		NA		78- 83		48- 52
Lifetime Efficiency Loss, %		5- 15		5- 15		5- 15
Life--Years (Water Dependent)		10- 20		8- 11+		8- 11
Warranty, Years		1- 10		5- 10		5- 10
Tank Liners		GLASS Stone (Cement)		GLASS		GLASS

[1]Range for conventional electric heaters that are usually installed. Models are available in capacities up to 120 gallons. Btu/hr input and recovery rates will vary accordingly.

[2]Range for conventional gas heaters that are usually installed. Models are available in capacities up to 100 gallons. Btu/hr input and recovery rates will vary accordingly.

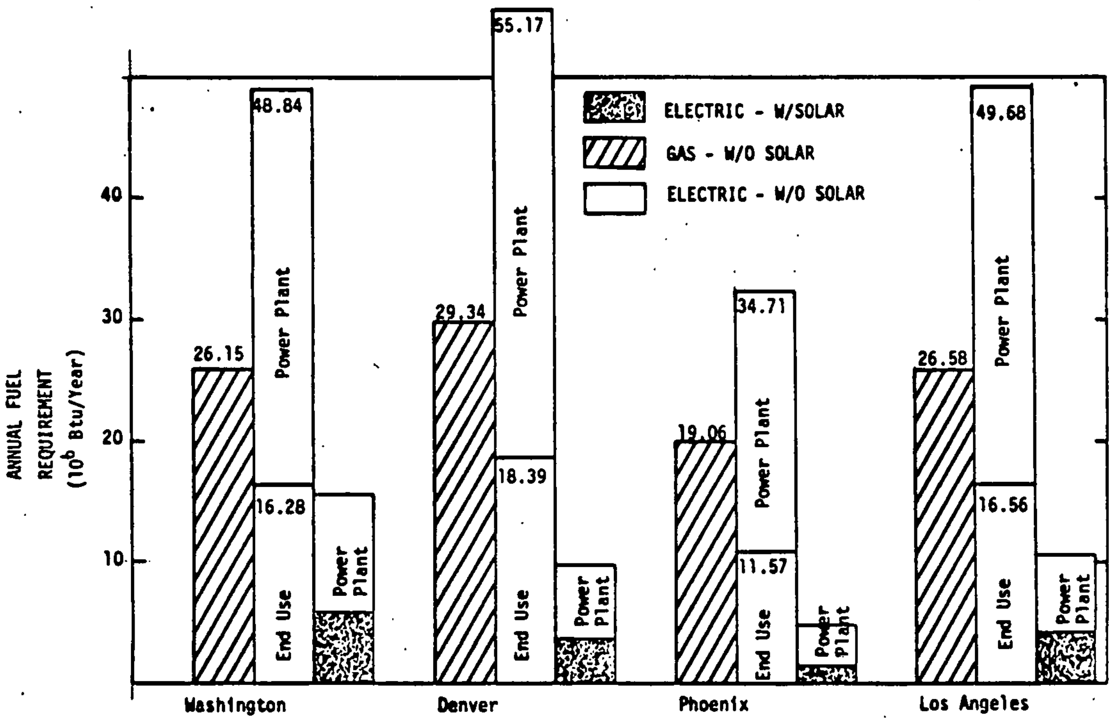
[3]Maximum instantaneous solar input assuming clear day solar insolation of 300 Btu/ft^2 hr; 60 ft^2 of net collector area, and a system efficiency range of 25 to 40.

The solar water heater has additional equipment which impacts performance, economics, and reliability. Although storage capacities, recovery rates, and heat input rates are different, the solar option is equal or better than the conventional equipment. Lifetimes and lifetime efficiency performance are comparable.

Performance:

The comparative performance of solar equipment was established for a large cross-section of the U.S. by comparing four cities: Washington, D.C., Denver, Phoenix, and Los Angeles. Fuels displaced for the solar option was compared to conventional gas and electric options. Significant energy savings were identified for the solar option, as much as 80%.

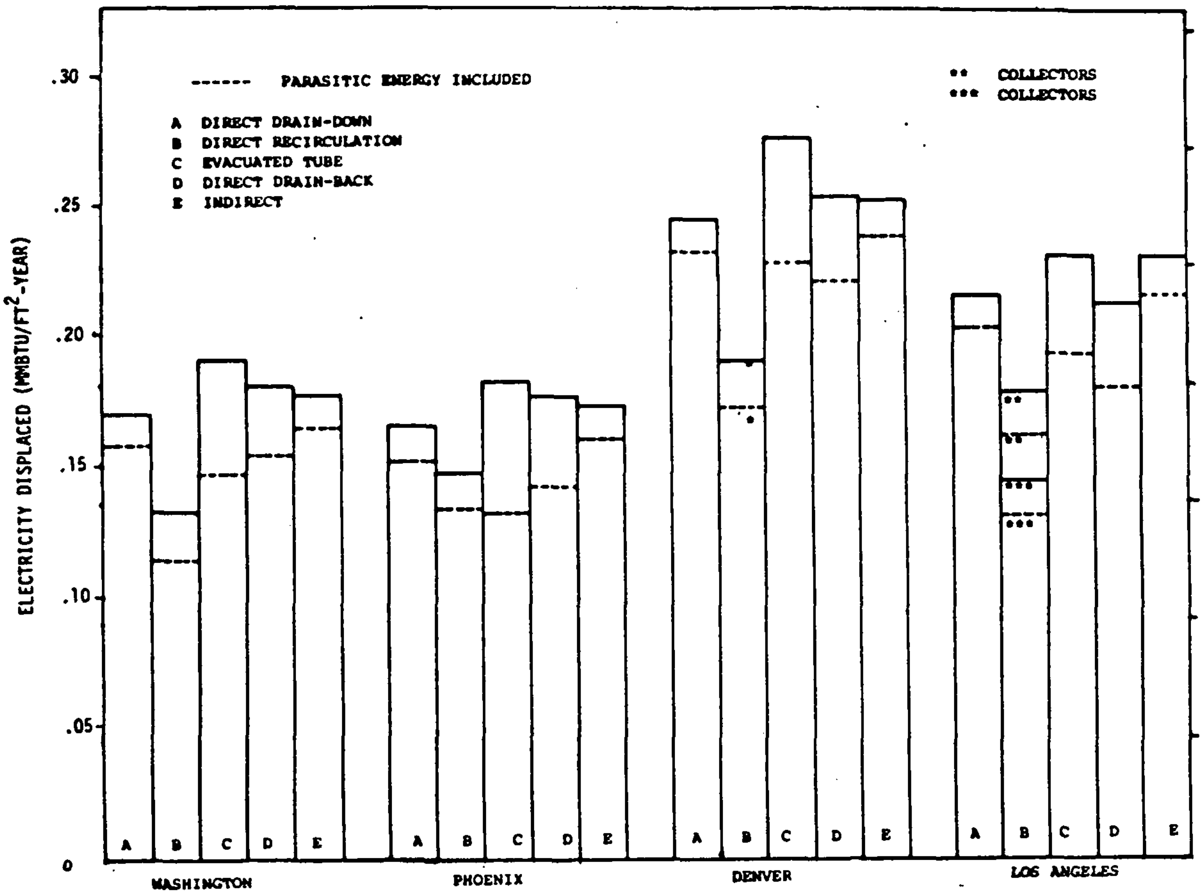
The performance results for conventional and solar water heaters are summarized in the following Figure:



CONVENTIONAL HOTWATER SYSTEMS
ANNUAL FUEL USAGE: GAS & ELECTRIC

The five most popular generic types were also compared for the same four cities to assess the relative energy return per unit collector area. In comparing individual cities, it was noted that there was very similar performances for all generic types except the recirculating design. However, energy return per unit area differed substantially between cities, primarily due to supply water temperature differences, and insulation.

COMPARISON OF THERMAL PERFORMANCE - SOLAR HOT WATER SYSTEMS



The annual fuel requirements for conventional gas and electric water heaters in Phoenix and Denver varied from 19.1 to 29.3 MM Btu and 11.6 to 18.4 MM Btu, respectively.

Solar water heater analysis demonstrated energy delivery differences for the solar systems from a low of ~130,000 Btu/ft^2 year (for Phoenix) to a high of ~280,000 Btu/ft^2 year (for Denver). It was also noted in this study that parasitic energy losses can be significant for the recirculating concepts and to a lesser extent for the drainback designs. It is possible for a well designed SDHW system (that minimizes parasitic energy consumption) to displace at least 200,000 Btu/ft^2 year of conventional fuels in high solar, high load regions.

Economics:

For the residential user, the criteria most often used to justify expenditures in new equipment is first cost and monthly cash flow. Although first costs of solar equipment today has been an impediment to mass market penetrations, effective use of monthly cash flow could be used to overcome this obstacle. But, the consumer needs information on monthly cost of owning a solar water heater compared to the cost of purchasing gas or electricity for water heating.

The economic parameters used in the analysis are summarized in the following table:

LIST OF ECONOMIC FACTORS
USED IN ANALYSIS

Factor	Value
General Inflation Rate	0.075
Maintenance Cost	5% annually
Downpayment	20%
Fuel Escalation Rate:	
Gas	12% annually
Electricity	10% annually
*Tax Credit:	
Current Tax Credit (Federal & State)	30%
Proposed Tax Credit (Federal & State) (Colo.)	70%
Market Discount Rate	8.5%
Interest Rate:	
Home Mortgage	11%
Low Interest Option (e.g. Solar Bank)	5.5%
Home Improvement Loan	22%

*Deferred Tax Credit -- tax credit recovered at the end of the first year

*Instant Tax Credit -- tax credit received at the same time when solar system is installed

The analysis was conducted for four cities (Phoenix, Los Angeles, Denver, and Washington). Fuel rates and costs were collected from a survey of local utilities and are summarized as follows:

	Electricity ($/MM Btu)	Gas ($/MM Btu)
Denver	16.86	2.46
Washington	12.78	3.64
Phoenix	12.85	2.75
Los Angeles	16.86	3.05

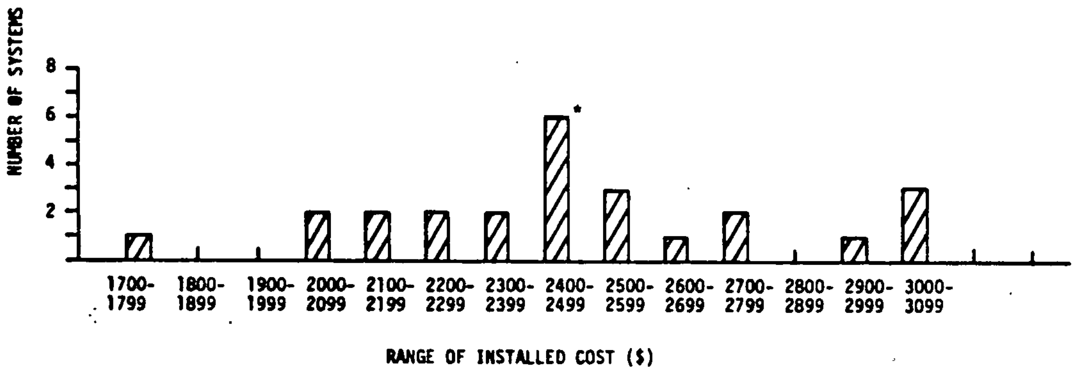
Information was also collected to determine the amount of the various fuel types that are offset by solar when it displaces electricity. The following table is a summary of fuel types used in electric generation for the four cities considered in the analysis:

FUEL BASIS FOR GENERATION OF ELECTRICITY IN FOUR CITIES

	% Generation by Fuel Type			
Fuel Type	Phoenix	L.A.	Denver	D.C.
Oil	10.0		0.1	14.7
Gas/Oil	48.4	37.7	11.3	
Gas		1.1	4.1	0.7
Coal	41.3	43.0	13.3	53.4
Coal/Oil				31.2
Coal/Gas			44.7	
Hydroelectric	0.2	18.3	13.9	
Nuclear			12.6	

The capital cost of solar water heaters was determined from the product data survey. The first cost (installed) of solar water heaters varied between $1700 and $3100 with a median installed cost of $2500 as shown in the following Figure:

SOLAR HOT WATER SYSTEM INSTALLED COST



*NOTE: Validated with Sacramento and State of Arizona Studies
- $2300 for Open Loop Systems
- $2550 for Indirect Systems

These costs are approximately ten times higher than the cost of conventional gas and electric heaters (~$240).

As was mentioned earlier, the bottom line (from the consumer's viewpoint) is monthly cost compared to electricity or gas water heating. The following table summarizes the results for the monthly cost of owning a solar water heater in four cities compared with gas and electric water heating. A 0% discount rate was used and thus these are actual dollars averaged over the 20 year system life. Costs of the solar system (including the cost of backup fuel) were compared for different financial scenarios using both an instant and deferred tax credit of 40%. Instant tax credit strategies assume the seller will provide a tax credit loan which can be applied to the downpayment.

AVERAGE MONTHLY COST ($)

Tax Credit Rate: 40%

City	Conventional		Solar (Direct Draindown)					
			Deferred Tax Credit			Instant Tax Credit		
	Electric	Gas	Home Mortgage	Solar Bank	Improvement Loan	Home Mortgage	Solar Bank	Improvement Loan
Phoenix	31	15	26	25	33	16	15	20
Washington	43	25	34	36	43	25	25	29
Denver	63	20	30	30	38	19	21	23
Los Angeles	55	22	30	31	39	20	20	26

From this analysis, it was noted that the SHW system competes with electricity in all locations and will even compete with gas when an instant tax credit is available.

A present value life cycle cost analysis was also performed for the conventional and solar systems. Results are shown in the following table for all five major generic types.

Present Value of Life-Cycle Cost ($)

City: Denver

Tax Credit Rate: 40%

System	Deferred Tax Credit			Instant Tax Credit		
	Home Mortgage	Solar Bank	Improvement Loan	Home Mortgage	Solar Bank	Improvement Loan
Conv. Electric	7140	-	-	7140	-	-
Conv. Gas	2310	-	-	2310	-	-
Drain-Down	3360	3470	4355	2318	2258	2700
Recirculation	4123	4217	5176	2997	2930	3408
Evacuated Tube	5292	5479	6508	4310	4311	4824
Drain-back	4066	4180	5050	3043	2986	3420
Indirect	4106	4182	5226	2880	2803	3325

SOLAR HOT WATER SYSTEM QUALITY

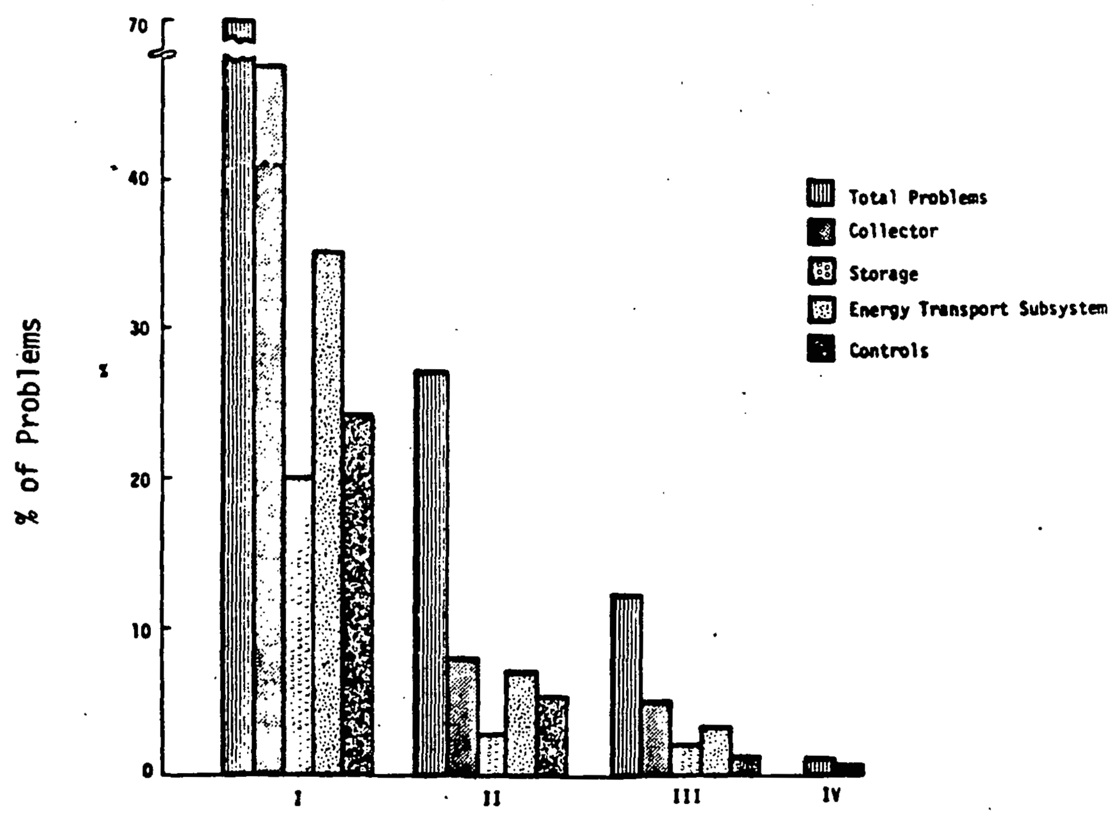
In assessing the overall quality of solar hot water products (as with any consumer product), one must be careful to recognize that problems are going to occur and a distinction must be made between the routine problems and those which create catastrophic failure or consumer disenchantment with a technology as a whole. The consumer is not interested in any product which creates repeated service calls or does not satisfy the fundamental objectives of his purchase, which, in this instance, is utility savings.

With this philosophy in mind, the critical problem areas were identified as: system installation, materials failures, control malfunctions and design deficiencies.

In the early days of this infant industry, back in 1974 and 1975, system failures where endemic and almost too numerous to mention. As evidence the history of the HUD demonstration program is used.

FIGURE 3.16

PROBLEM SUMMARY - MAJOR SUBSYSTEMS IN HUD DEMONSTRATION SITES*



*Letter Report to HUD, NBS, May 10, 1979.

NOTE: All problems include construction and operation with many of the operating problems occurring during start-up.

The percentage of failures was extremely serious in Cycle 1, but the problems diminished very rapidly as Cycle 4 was approached. The solutions are attributed to a maturation of the industry as the industry began to understand the product and how to deal with the product in the operational environment.

The sources of problems today can be drawn from a recent survey of the supply and delivery elements of the industry who were interviewed to identify their understanding of today's problems.

Collector and control problems dominated the attention of both groups. It was noteworthy that 35 of the 142 organizations interviewed indicated that no problems currently exist in the industry.

SYSTEM/COMPONENT PROBLEMS -- SURVEY RESULTS *

Problems Reported	83 Manufacturers	59 A&Es
o Collectors	27	17
o Controls	14	16
o Insulation	4	5
o Installation	1	5
o Blowers	3	4
o Storage	17	7
o Energy Transport Subsystems	7	9
No Problems	25	10
Don't Know	--	15

* Final Report to Solar Energy Industry: DHR, August 1979

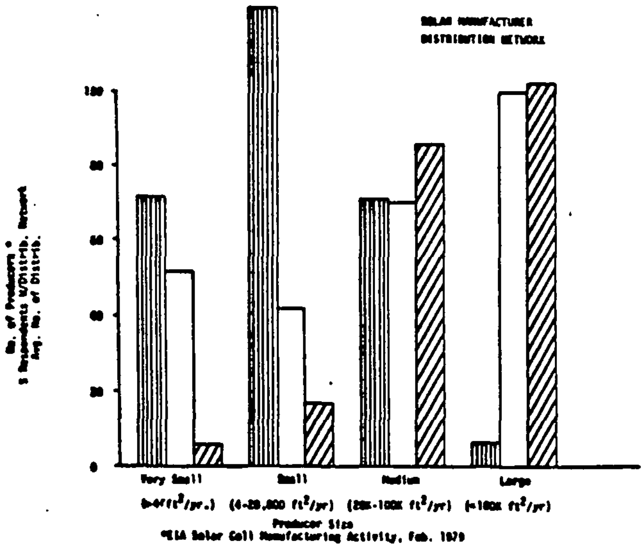
Despite these encouraging trends, there is a concern for the longer range reliability of the designs as scaling and corrosion occur and glycol mixtures degrade. Perhaps the industry has not paid adequate attention to the designs to insure that operational systems will not scale, corrode, or freeze with time and use. Draindown and drainback designs might be modified to reduce fresh water and air from the system. Glycol mixture monitors could be developed and added and other diagnostic instruments could be included to assist the user in watching over the operation of the system to alert him as the system drifts toward a catastrophic failure condition.

SOLAR INDUSTRY

New ventures are often times characterized by a few very important characteristics: financial staying power, adequate distribution of a product, identification with brand name, and proprietary concepts. The twelve leading solar hot water industry suppliers were examined and it was noted that many of these leaders have two or more of those primary requirements.

All of these leaders have strong financial backing; many of them with financial resources exceeding those found in the conventional water heating industry today.

The distribution, installation, and service organization developed by the leaders is amongst the best in the industry. In the following Chart, it is noteworthy that the larger manufacturers all have distributor organizations and on an average have over 100 for each company. Five out of the 12 leaders have a strong brand name image, including four of the leading conventional hot water system suppliers and one HVAC firm. Most of the remaining seven companies have respected names with which a consumer can identify.



All of these 12 companies have carefully documented the product in the form of sales brochures, installer manuals, service manuals, and owner manuals. They also have developed distributor training programs with the intent of insuring that the product is properly installed. Unfortunately, at the distributor end the financial resources and motivations are not sufficient to insure that all installers participate in the training programs and therein lies, as we have stated earlier, some of the problems. With a little push and with time this problem should be alleviated.

CONCLUSIONS

The results of this report are many; dealing with the product, industry, the market, and the consumer. The conclusions of chapter 6 in this report can be summarized as follows:

- Product Availability - An adequate supply of packaged solar hot water systems are currently available. These systems look and act like the conventional competition. The best products are available in most major metropolitan areas. The product suppliers recognize the importance of matching the design to the marketplace and therefore are currently supplying six different generic configurations.

- Product Quality - Solar hot water systems are maturing very rapidly, and are performing well, with remarkably few problems. The leading problems that do exist are related to installation, improper materials selection, and design inadequacies. The products are protected with adequate warranties.

  On the negative side, it is important to note that some of the designs are very susceptible to scaling, corrosion, and ultimate freezing and failure, mostly associated with the design configuration. The consumer and the industry would be best served if: 1) the product were more carefully evaluated before entering the marketplace and, again, shortly after entering the marketplace; 2) the consumer were provided simple diagnostic tools by which he can maintain a watchful eye on systems in operation.

- System Performance - Most of the designs should perform quite adequately when matched to the climatic environment. The homeowner can expect to provide 60 to 80% of the solar hot water with these systems. Some of the systems being sold will not perform to the levels claimed as they have been erroneously represented, usually due to an over optimistic collector performance prediction.

- Economics - Solar hot water economics have improved substantially as the utility costs have continued to escalate and state and federal governments have introduced new, more exciting, incentive programs. Solar hot water systems compete very favorably against most electric utility rates and are now beginning to compete very favorably with gas water heaters.

- Industry Involvement - The solar hot water industry is blessed with a sufficient number of large and small business enterprises, producing well designed and documented products. It was extremely encouraging to note that five of the twelve top leaders were already involved in the hot water and HVAC industries and had the necessary distribution outlets for a successful commercial venture. Many of the leading organizations producing products have the strong financial backing, manpower resources, manufacturing resources, and the total organizational capability to produce, deliver, and maintain the product in the field.

- Solar Hot Water Sales Potential - The solar hot water system is superbly matched to the best market environments. It competes most favorably in the single family residence as a replacement for the electrical water heater in the high radiation environments of the southern and western states. The only negative aspect in the sales projections is the high ratio of multi-family units to single family units which require smaller water heaters and are therefore less economical.

RECOMMENDATIONS

There are several actions which the government could support to accelerate the commercialization of this hot water technology and provide a better product to the consumer. These actions are as follows:

- o Create a materials information center which could be made available to manufacturers. The information center could also conduct special tests for the smaller manufacturers.
- o Promote quality systems through government sponsored systems test programs as a part of existing and impending federally sponsored programs, such as; RCS, Federal Buildings Program, Military Purchase Programs, and other federal purchases.
- o Support improved and simplified data collection of installed systems to identify systems performance and reliability. This information could be useful in rating SHW systems.
- o Provide industry with support for installer training programs to be operated and taught by manufacturers.
- o Provide continued government support for existing tax credit programs at their current levels to insure the rapid introduction of SHW into the residential sector.

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CHAPTER 1

STUDY OVERVIEW

1.1 INTRODUCTION

On June 20, 1979, President Carter in a National Address* established as a national goal the displacement of 20% of this nation's fossil energy through the use of renewable energy resources by the year 2000. In the President's address and a later Department of Energy Study, a goal was established calling for at least one million solar water heaters by 1985 and 20 million water heating systems by 2000. If these national goals are to be satisfied, government program and policy changes may be necessary. The Department of Energy (DOE) must give immediate attention to the assessment and possible redirection of current programs and strategies. With solar water and space heating comprising the majority of the 1985 goal, it is imperative that a plan to accomplish the overall objectives be implemented immediately.

1.2 PROGRAM OBJECTIVE

The objective of this task was to provide the Department of Energy with quantified data which can be used to assess and redirect, if necessary, government program plans to assure compliance with the President's goals. Data compiled as a result of this task was to be used to establish the technology readiness and the industry's capabilities to implement the technology into the anticipated marketplaces. Emphasis was placed on the identification of the products which currently exist in the marketplace; the performance, reliability, economics, and the problems which are currently being encountered in the industry. This data was used in a commercial assessment based on available solar products and their delivery system. Competing conventional water heater products were analyzed and an assessment was made of the maturity of the solar water heater industry.

*Remarks of the President upon Announcement on Solar Policy and Dedication of White House Solar System, The West Terrace, June 20, 1979.

1.3 PROGRAM ISSUES

In conducting this commercialization assessment, it was necessary to determine the current status of the solar water heating industry within the framework of the competing conventional industry. Through a comparison of the two industries, an assessment was made of possible barriers to large scale commercialization. In conducting these comparisons, several keys questions had to be answered:

- Does a sufficient quantity of solar products exist with proven performance/economics to compete with the conventional options?
- Does the solar industry have the necessary maturity and resources to produce, distribute, and service the products in commercial quantities?
- What are the requirements of the consumers in a major market scenario?
- What is the character of the marketplace as the technology reaches that marketplace?

By answering these questions, it will be possible to develop an effective commercialization strategy and a proper role for the government can then be recommended for that strategy.

1.4 PROGRAM ACTIVITIES

The major activities in this study have included:

- Data compilation of solar and conventional hot water products and the organizations producing these products
- Characterization of typical products, organizations, and markets
- Determination of performance and economics
- Determination of solar hot water product quality
- Description of producer organizations

- o Characterization of consumer product requirements
- o Comparison of solar products in compliance with consumer needs
- o Identification of the current status of the solar hot water heating industry within the guidelines established by the conventional water heating industry

An overview of the study methodology is shown in Figure 1.1 (following page). The study was divided into four areas: (1) data collection, (2) data aggregation and selection, (3) data analysis, and (4) data interpretation.

1.4.1 Study Methodologies

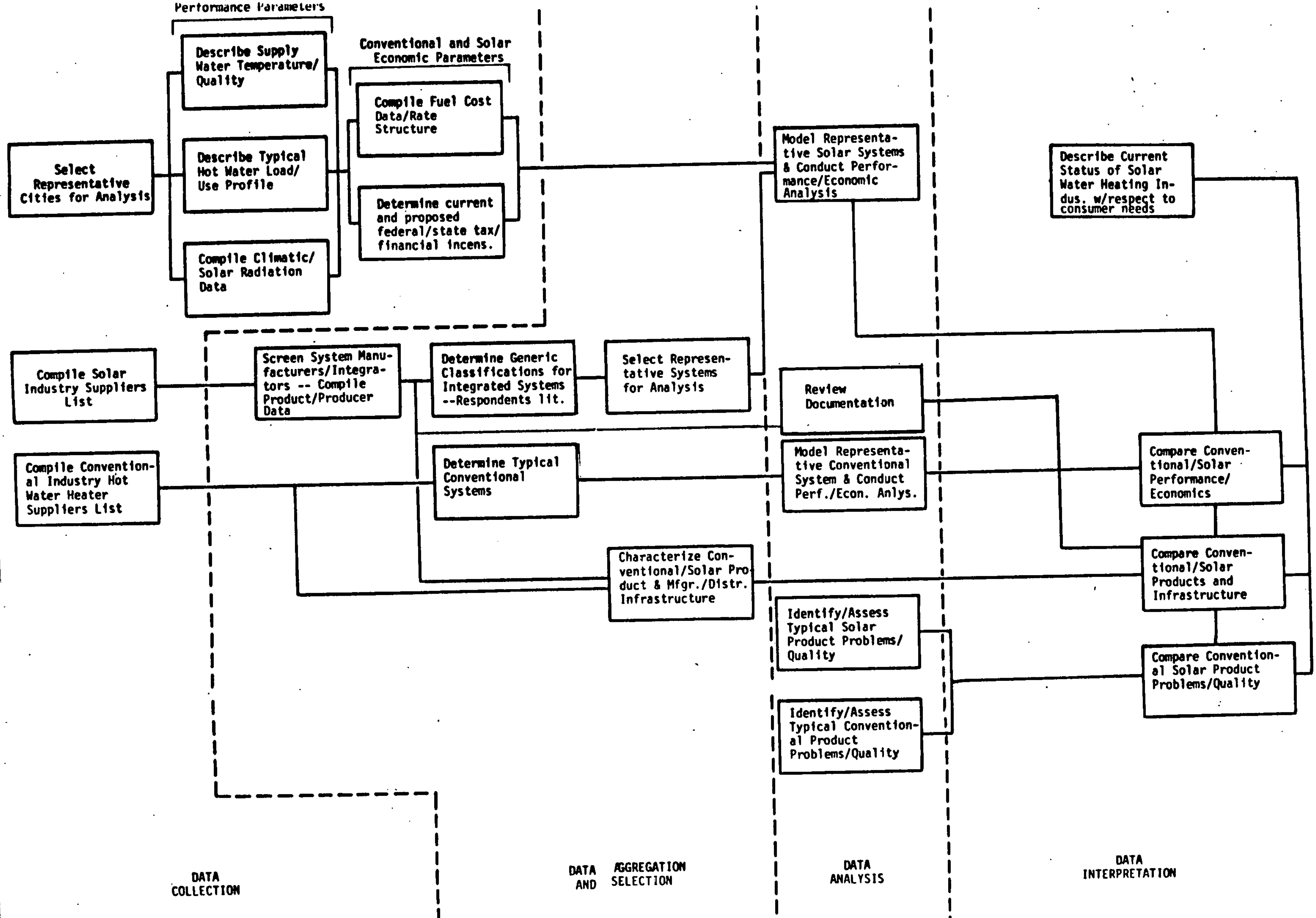
Resolution of the program issues relating to the product, producer, and consumer required an organized management of the information in order to aggregate, analyze and conclude appropriate responses to the basic issues.

The first task in the study was to aggregate the solar hot water systems into generic classifications so that representative systems could be selected for performance/economic evaluations. In Figure 1.2, a flow of events is presented which was used in this selection process. After receipt of the respondents literature, the literature was sorted into acceptable and not acceptable classifications. An acceptable classification was based on the availability of good documentation pertaining to the design, packaging, sizing, installation, and servicing of the product. An acceptable hot water system also demonstrated reasonable product integration into minimal subsystem packages. These acceptable hot water systems were then classified by generic type using the classification system originally proposed by the National Bureau of Standards in their studies. Acceptable systems in each generic classification were then reviewed for quality and level of detail in the description of all the necessary performance parameters needed for the performance economic analyses.

Performance and economic analyses were conducted using the representative generic systems. It was determined that four

FIGURE 1-1

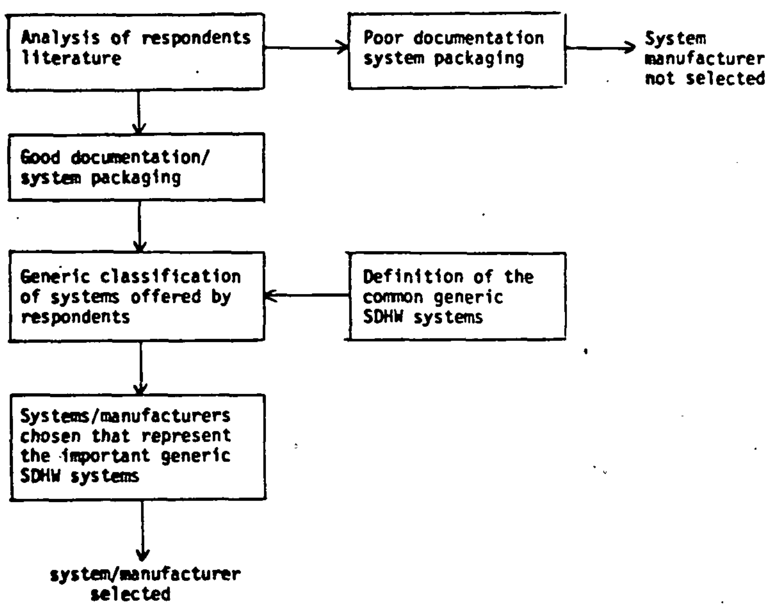
OVERVIEW OF STUDY METHODOLOGY



strategically located cities throughout the United States, having a range of economic and climatic conditions, could be used to assess the economic potential of solar hot water systems. Climates had to range from average climatic conditions and solar radiation levels encountered on the East Coast to the nearly ideal conditions found in the Southwest United States. Supply water temperatures were also a consideration and large thermal swings were considered a necessity although warmer supply water temperatures were also desired in the analysis. Local economic conditions were also considered in the selection process, including solar incentives, fuel costs, and local taxes. A final selection criteria for the test cities was the requirement that sufficient quantities of electric and gas heating hot water systems must be in use.

FIGURE 1.2

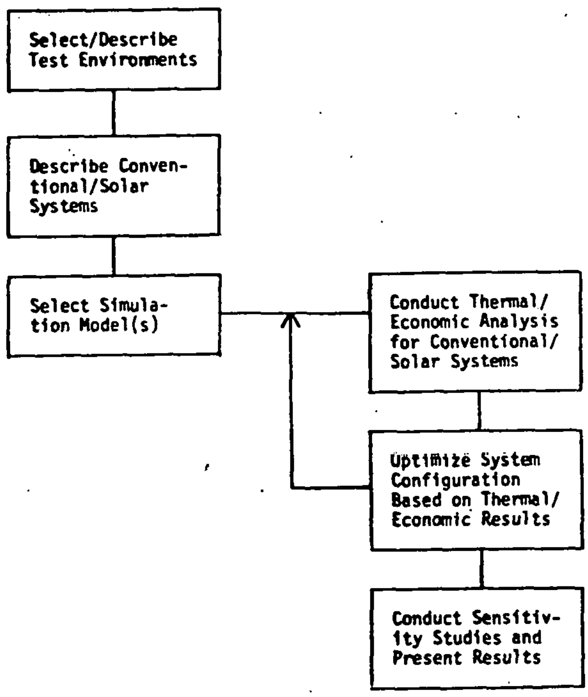
METHODOLOGY FOR GENERIC CLASSIFICATION
AND SELECTION OF REPRESENTATIVE SYSTEMS



The next step in the performance analysis procedure as shown in Figure 1.3 involved the analytical description of the conventional and solar systems used in the analysis. Design details had to be provided as required by the TRNSYS simulation model. Data requirements included component characterization and control algorithms.

FIGURE 1.3

METHODOLOGY FOR PERFORMANCE/ ECONOMIC ANALYSIS



The TRNSYS model was then used to conduct the thermal and economic analyses for both the conventional and the solar hot water systems in the selected four cities. After completing the initial analysis runs, it was necessary to reconfigure certain systems to assure an optimum balance between the competing generic systems.

In order to provide a capability for extrapolating certain data into the dynamic operating conditions across a broad spectrum of the United States, a sensitivity analysis was conducted. Parameters which were varied in the sensitivity analysis included financing options, interest rates, tax credit incentives, collector areas and alternate fuel options. While this sensitivity analysis may not necessarily provide a total capability for extrapolating the results of the study, it certainly permits an assessment of the potential of solar hot water heating systems in much of the water heating marketplace.

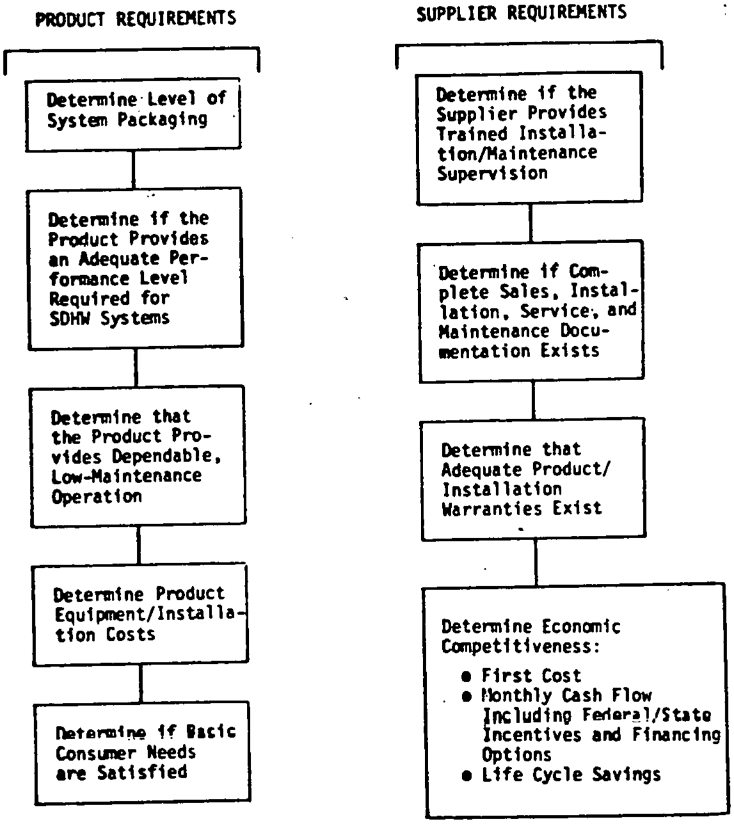
Still another key issue in this study was the consideration of product capabilities to satisfy consumer requirements. This determination was made on the basis of product quality, dependability, and cost. As a first step in this process, systems were reviewed for packaging and documentation of the total system. It was assumed that any good product must have complete documentation for the installer, service representatives, and the home owner. Without these, the product would be less than acceptable to the major market sectors. A second requirement for the product was the provision that the system must perform the normal functions of any hot water heating system, such that the consumer's basic needs are satisfied. A third requirement was the usual consumer's concerns for dependability and maintainability. A final requirement for the product involves its ability to be installed within the existing residential environment and at a resonable cost to the consumer.

Turning next to the requirements of the supplier for the equipment as shown in Figure 1.4, it was recognized that any good supplier of equipment of this complexity would need to provide trained installation and maintenance personnel with documentation and training expertise to insure a properly maintained service organization. This supplier must be willing to support his product with the necessary warranties usually found in the conventional industry. Finally, the supplier must provide the product and services at competitive prices on a cash flow basis when considering capital costs and operation/maintenance costs.

FIGURE 1.4

PRODUCT/SUPPLIER

EVALUATION METHODOLOGY



CHAPTER 2

CONVENTIONAL WATER HEATER INDUSTRY

2.1 INTRODUCTION

Data is provided for the conventional water heater industry to provide a basis for comparison of the solar energy industry and its products in order to identify characteristics which the solar industry should have to compete with the conventional industry. In Chapter 5, this data will be utilized for comparisons in a variety of categories, including: product compatibility with consumer requirements, performance, economics, reliability, industry structure, and the maturity of the solar product delivery systems.

2.2 DATA SOURCES

All of the information provided in this section was obtained from the Planco Corporation, who developed this information under separate DOE contract and provided this information to SAI for inclusion in this report. SAI is grateful to Dr. Robert Coates of the Planco Corporation for making this information available and providing the quality information included herein.

Six major sources of information were used by the Planco Corporation in the collection of this data, including:

- Gas Appliance Manufacturers Association
- Electric Power Research Institute
- United States Census Bureau
- Utility Surveys
- Industry Surveys
- Current Industrial Reports

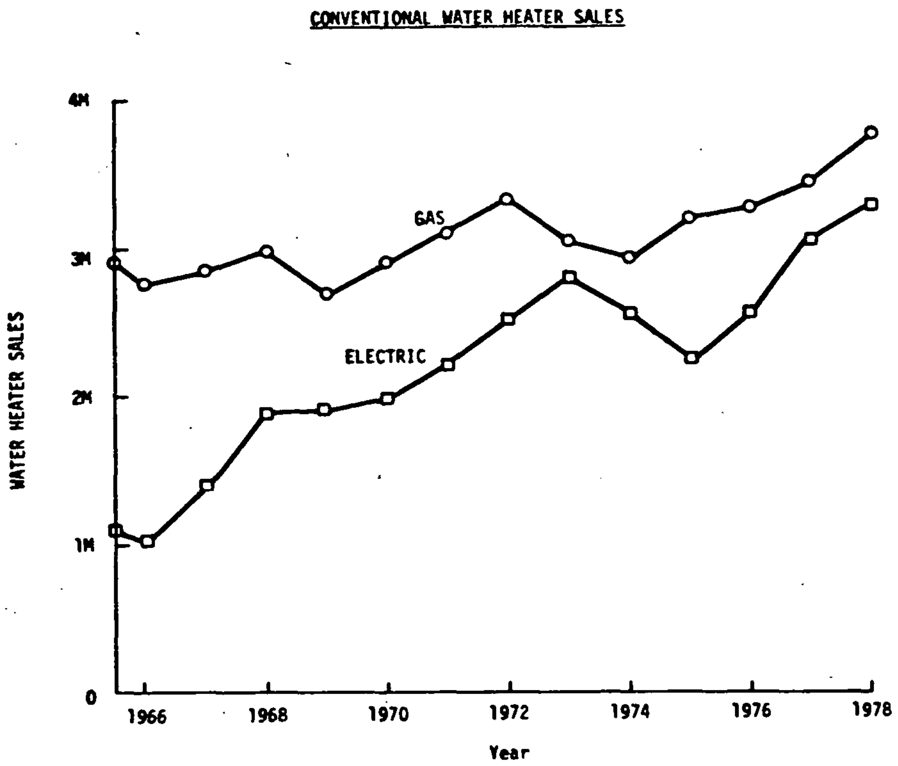
2.3 CONVENTIONAL HOT WATER HEATER SALES

Conventional hot water sales information is provided for annual shipments by fuel type, new/replacement markets, fuel types, regional sales, and residential/multi-family sales. Information is also included on the size distribution for residential hot water heaters. Additional sales data is provided for the four cities analyzed in this report by fuel type.

2.3.1 Shipments

Shipments of water heaters are shown in Figure 2.1 from 1965 to 1978. This information was obtained from the Current Industrial Reports and is subdivided into gas and electric sales. Oil water heaters were not included in this graph because their sales are less than 50,000 units per year, as compared to the three million plus units for gas and electric.

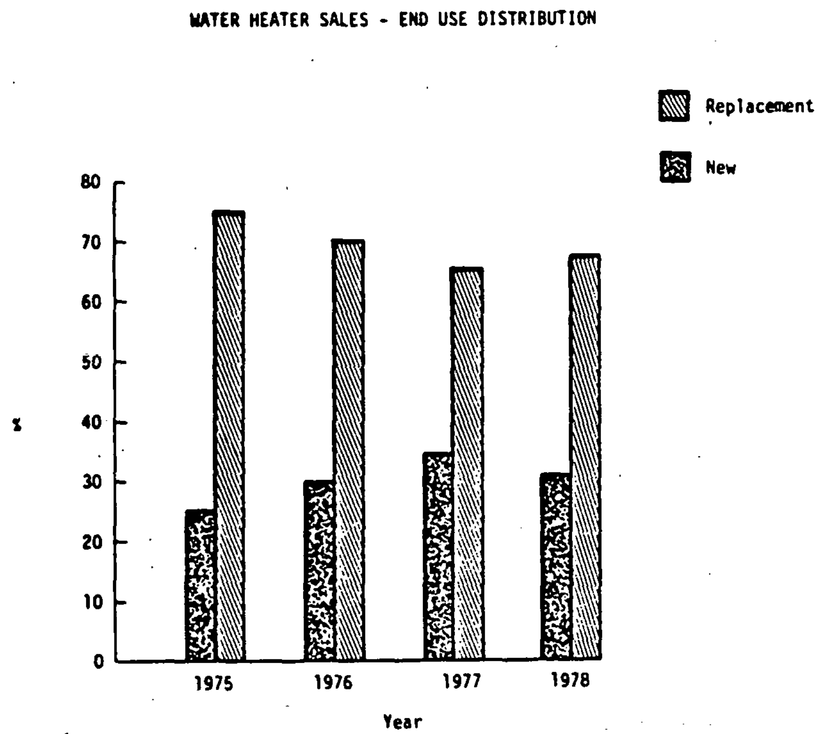
FIGURE 2.1



2.3.2 New/Replacement Sales Differential

The replacement market sales as shown in Figure 2.2 are more than two times the new construction sales. This information is secondary data derived by combining census data on construction with the shipments provided by the Current Industrial Reports. Small errors might be expected in this data, but, in general, the overall trends described in Figure 2.2 are indicative of relative sales volume. This new/replacement differential suggests a significant potential for retrofitting solar water heaters.

FIGURE 2.2

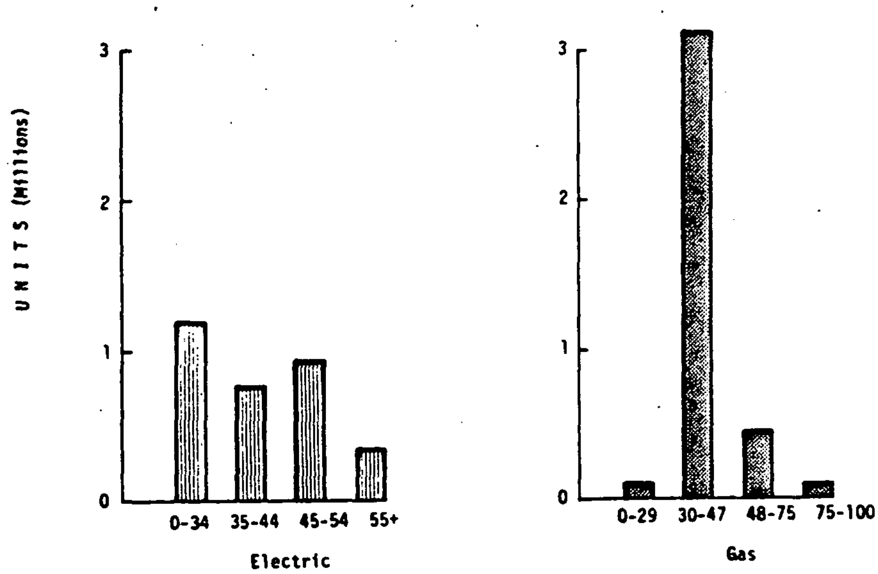


2.3.3 Water Heater Size Ranges

Water heater capacities are described in Figure 2.3 for 1978 and identifies a concentration of gas water heaters in the 30 to 47 gallon size range with most of the sales occurring in the 40 gallon size. On the other hand, electric water heaters enjoy much broader size distribution with a significant number of water heater sales occurring below the 34 gallon capacity. Many of the smaller electric water heaters are used in the multi-family construction market where a typical water heater will be much smaller than that used in a single family residence. Larger electric water heaters are used in areas where off-peak electric water heating is used or where the homeowner requires a larger thermal capacity to compensate the slower recovery rates of electric water heater products.

FIGURE 2.3

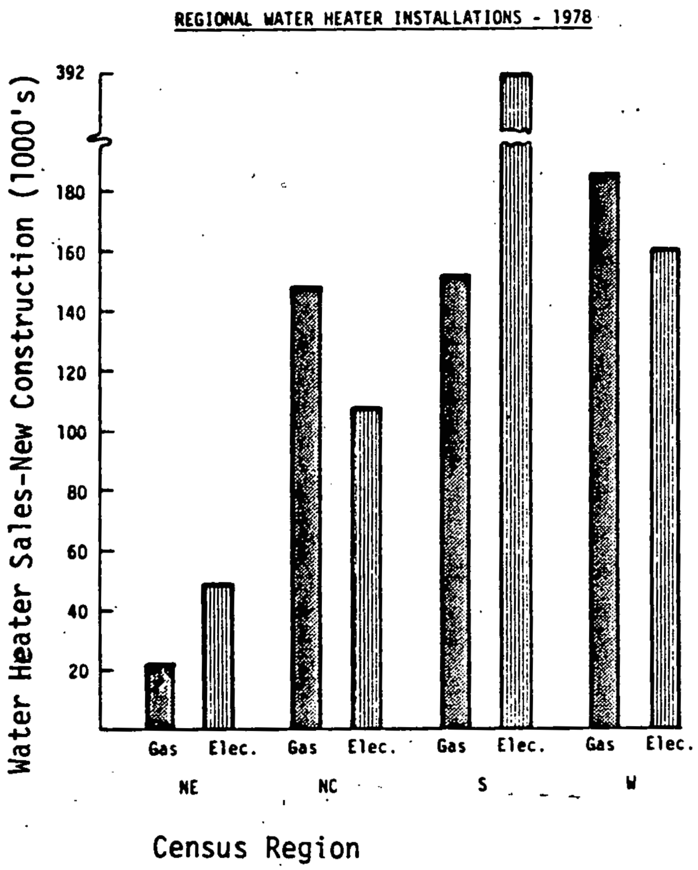
WATER HEATER SALES - SIZE DISTRIBUTION; 1978



2.3.4 Fuel Type Segregation

Solar water heaters are economically sensitive to the type of fuel displaced since the operating costs for electrically heated water is typically five times the cost of gas water heating. Unfortunately, the Census Bureau does not publish any regional figures on water heaters by type of fuel and, therefore, it became necessary in this study to derive the regional water heater sales by fuel type from secondary data sources. The data which was developed is shown in Figure 2.4.

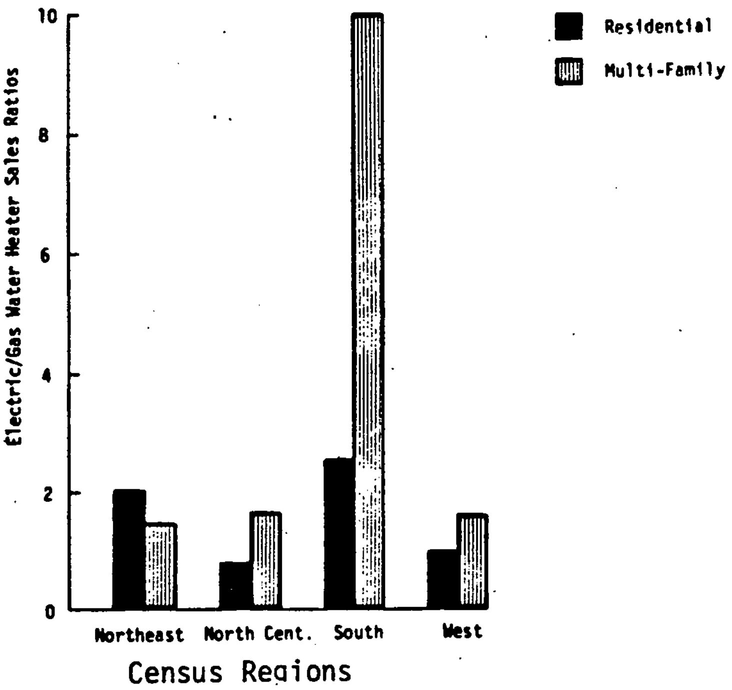
FIGURE 2.4



This regional sales data was further analyzed by segregation into single-family/multi-family sectors as shown in Figure 2.5. It is interesting to note from this data that in the South, electric water heaters outsell gas water heaters by a margin of over 2-1/2 to 1 in the single-family sector and by 10 to 1 in the multi-family market! It was also noted that the North Central and Western States have more gas sales than electric sales in the single-family market.

FIGURE 2.5

GAS & ELECTRIC REGIONAL SALES RATIOS FOR THE RESIDENTIAL/MULTI-FAMILY HOUSING 1978 MARKETS



The reasons for these differences are related to the availability of fuels in these specific census regions. In the South, because of the low heating loads, gas hook-ups are not as common and, therefore, the typical residence is usually more dependent on electric water heating. In the North Central and West, gas heating is very common and, therefore, most consumers select gas water heaters. It is expected that with the continued price differential between gas and electric costs, that a shift towards gas sales will continue until supply limitations discourage its use.

These differences are also expected to be affected by the emphasis of the electric utilities on water heating conservation measures to reduce electric consumption.

The correlation between water heating fuels to the customary heating fuels is further illustrated in Table 2.1, which describes the type of water heating fuel for each of the primary heating fuels; natural gas, fuel oil, electricity, LPG, and wood. This table illustrates the tendency of the consumer to heat his water with the same fuel as is used to heat the home.

TABLE 2.1

TYPE OF WATER HEATING FUEL BY TYPE OF PRIMARY HEATING FUEL

Type of Water Heating Fuel	Type of Primary Heating Fuel, %					
	Natural Gas	Fuel Oil, Kerosene	Electricity	LPG	Wood	Other/ Not Reported
Natural Gas	91	14	6			
Electricity	9	45	88	50	50	100
Fuel Oil, Kerosene		36				
Liquid Petroleum Gas		5		50		
Other/None/Not Reported			6		50	

2.3.5 SMSA Specific Fuels Data

In order to assess the relative market potential in the four standard metropolitan statistical areas described in this report, specifically Denver, Los Angeles, Phoenix and Washington, D.C., it was necessary to identify the stock of residential water heaters by fuel types. In Table 2.2, these water heater stocks are broken down by gas, electricity, LPG, other fuels and none. For comparison, the sales of residential water heaters in the new construction market is provided for the four SMSAs from 1973 through 1979 in Table 2.3.

TABLE 2.2

1970 STOCKS OF RESIDENTIAL WATER HEATERS BY TYPE OF FUEL AND STANDARD METROPOLITAN STATISTICAL AREA (SMSA)

Type of Water Heating Fuel	Denver	Los Angeles-Long Beach	Phoenix	Washington, D.C.
Utility Gas	351,087	2,191,407	241,367	246,560
Electricity	28,890	186,967	48,269	46,558
Bottled, tank, or LP gas	8,624	19,110	7,866	5,261
Other fuel	1,822	8,610	527	48,543*
None	1,804	25,887	4,604	2,881
TOTALS	392,227	2,431,981	302.633	349,803

* Includes 46,885 with fuel oil, kerosene, etc.

TABLE 2.3

INSTALLATIONS OF RESIDENTIAL WATER HEATERS
IN NEW CONSTRUCTION, IN THOUSANDS OF UNITS

Year	Denver	Los Angeles-Long Beach	Phoenix	Washington, D.C.
1973	36.1	39.8	35.1	37.2
1974	24.6	35.5	25.6	26.1
1975	10.9	22.1	13.2	17.4
1976	12.6	19.6	12.1	17.4
1977	18.2	28.3	20.5	20.5
1978	22.5	32.8	30.4	23.2
1979	24.1	31.2	39.9	23.4

2.4 CONVENTIONAL HOT WATER HEATER PRODUCTS

Information is provided for the conventional water heater product to identify its key design features as perceived by the consumer. Performance, economic and reliability information is included to provide a basis for comparison with solar water heaters. This combined information will be used to determine the suitability of a solar water heater as a replacement for the conventional water heater. This comparison will be conducted in Chapter 5 of this document.

Conventional water heaters are usually distinguished in the marketplace by fuel type, hot water capacity, recovery rates, and warranty lifetime, which is indirectly dependent upon the tank material. In addition to purchasing, based on these features, the consumer is also very sensitive to the first cost and will often use this as a primary purchase decision in this highly competitive industry.

2.4.1 Design Description

Gas water heaters as shown in Figure 2.5 (page 2-6) are very simple devices, usually consisting of a 40 gallon glass-lined storage tank insulated with R-3 fiberglass insulation. An external gas burner heats the water at temperatures usually ranging from 138^{o} to $150^{o}F$ although thermostatically the water temperature could be controlled at higher and lower temperatures than this range.

Electric water heaters are also of a very simple construction. In the single family residence, a 52 gallon glass-lined water tank is usually used with 1-3/4" fiberglass insulation for an R 5.5 rating. Water temperature is thermostatically controlled using two internal electrical resistence heating elements located at the lower tank and at about mid-point in the water tank. Cathodic protection is provided with a magnesium anode rod which is sufficient to satisfy the warranty under standard operating conditions. Therefore, a five year warranty tank will have one-half the anode length of a ten year warranty tank.

2.4.2 Recovery Rates

Water heater recovery rates are rated in gallons per hour for a $90^{o}F$ temperature rise. A typical electric water heater will have a 4500 watt heating element for the 52 gallon tank and a 17 gallon per hour recovery rating. Somewhat larger heating elements are available and typical ranges for electric water heaters might go as high as 25 gallons per hour. Gas water heaters will have much faster recovery rates and usually range from 20 to 60 gallons per hour for a 40 gallon tank.

2.4.3 Warranty

Warranties play a very key role in the sale of conventional hot water products. Usually, warranties are five or ten years. In electric water heaters, the warranties will be dependent upon the design of the storage tank and the anode configuration. As stated earlier, the life of electric water heaters can be extended significantly by introducing a larger anode. Water quality and, more specifically, the hardness of the water, will also be significant factors in the lifetime of the unit. Under very hard water conditions, the life of a water heater is often shortened and failure can occur in five years but, under soft water conditions, the lifetime can be extended. There are experiences where water heaters have lasted over 25 years under ideal soft water conditions. Water condition is especially important to gas water heaters since the external combustion at high temperatures accelerates scaling and tank corrosion.

The typical consumer is conscious of the hot water tank liner material and is aware that glass-lined tanks will extend the lifetime of a conventional water heater. As a consequence, most conventional water tanks are glass-lined, although some stone-lined tanks are still available. Stone-lined tanks are usually avoided by the manufacturer because of the excess weight involved and subsequent shipping costs.

2.4.4 Performance

The performance of electric and gas water heaters differs substantially. Gas water heaters are lower in performance due to a combination of burner inefficiencies (18%), pilot light losses (14%), and storage tank thermal losses (16%). Combined inefficiencies in the gas water heaters result in an overall efficiency of 48 to 52%.

Electric water heaters have efficiencies of 78-81% with a majority of the losses occurring in the thermal insulation of the storage tank.

Efficiencies will decrease over the lifetime of the water heater, especially for the gas water heaters where combustion efficiency is reduced due to scaling. It is not unusual to have the overall efficiencies reduced as much as 15%. Electric water heaters are less susceptible to the scaling because of the internal heating element. Therefore, the decrease in efficiencies will be more typically 5%, although losses can double.

As stated earlier, the lifetime is dependent on the water conditions. Typical lifetimes of gas water heaters will be 8 to 11 years, whereas electric water heaters will have lifetimes in excess of 10 years, except under extreme hard water conditions or 5 year lifetime design conditions.

In addition to hard water conditions, other failure mechanisms for electric water heaters include failure of the heater element, thermostat, relief valve, and tank leakage.

Gas water heater failure mechanisms, like the electric water heater, will fail due to the thermostat, relief valve, and tank leakage; but, in addition, failure can result from the control valve, the pilot light, and the burner.

2.4.5 Conventional Water Heater Economics

Economic considerations include; first cost, monthly cash flow (including maintenance and operating costs), and life cycle costs.

Water heater first costs are closely aligned with the consumer price index and the construction cost index; but, in this highly competitive industry, water heater costs have lagged the construction cost index and the consumer price index from 1974 through 1978. The water heater price increases have been 5.6% versus 8-1/2% for the construction cost index. The exact water heater price index is shown in the table below for 1974 through 1978.

Year	Water Heater Purchase Price Index	Construction Cost Index
1978	176.8	175.7
1977	170.9	156.5
1976	166.0	143.9
1975	164.4	138.4
1974	142.0	126.9

Installed costs will vary significantly, by area, depending upon labor costs and the quality of the product. Installed costs in a survey of 33 cities revealed an interquartile range of $180 to $300 for a 40-gallon gas water heater having a five-year warranty. The interquartile range for electric water heaters was somewhat less and ranged from $150 to $200 for a 52-gallon water heater with a five-year warranty.

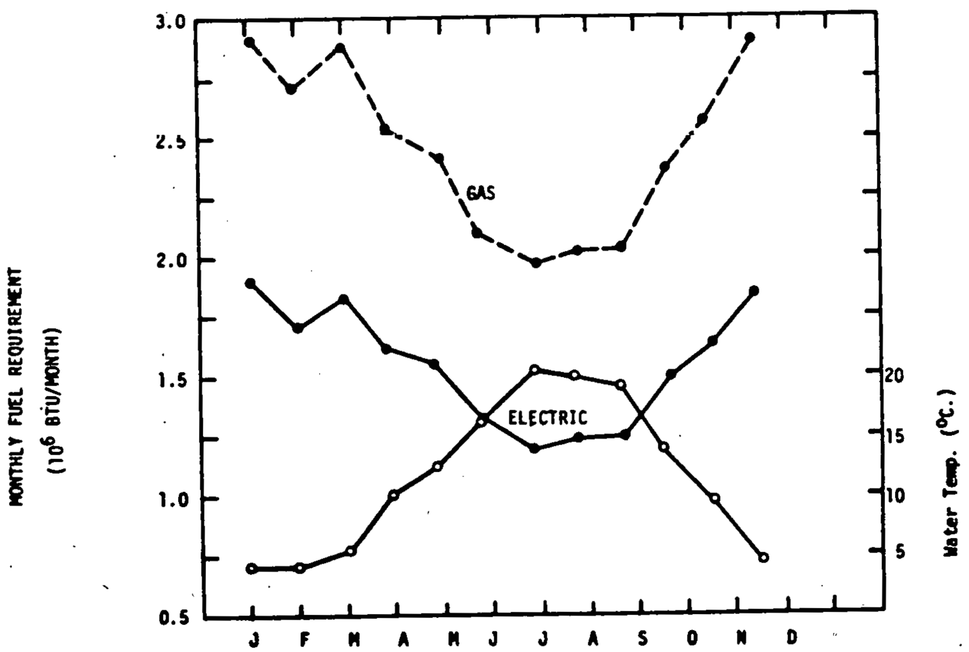
Operating costs of water heaters varies significantly across the country depending upon the fuel costs and water temperature. The economics of both conventional and solar water heaters is discussed in great detail in Chapter 4 and the reader is referred to that Chapter for the detailed economic parameters used for the conventional water heater analysis. The results of that analysis identifying the average monthly cost for conventional water heaters are shown in the following table.

AVERAGE MONTHLY COST ($) OF CONVENTIONAL WATER HEATERS
0% DISCOUNT RATE

City	Electric Water Heaters	Gas Water Heaters
Phoenix	31	15
Washington, D.C.	43	25
Denver	63	20
Los Angeles	55	22

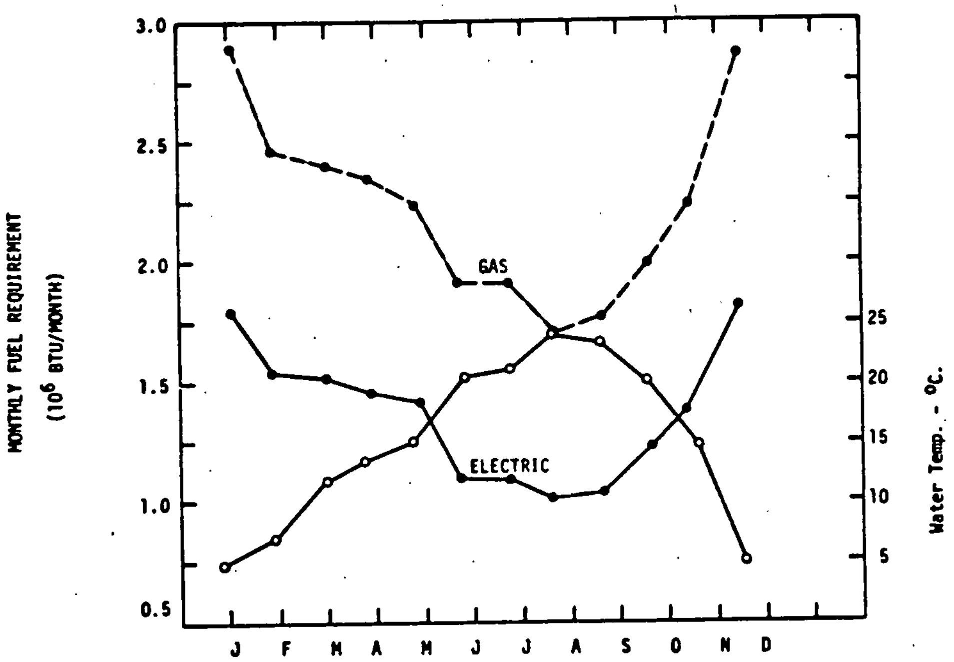
This chart illustrates a 2 to 1 difference in electric costs from Phoenix to Denver but a 2/3 difference in gas water heaters from Phoenix to Washington, D.C. The major cause for the difference in hot water economics is water temperature. This effect is best illustrated by the monthly performance values illustrated in Figures 2.6 through 2.9, which identifies a 2 to 1 difference in energy consumption due solely to the water temperature.

FIGURE 2.6



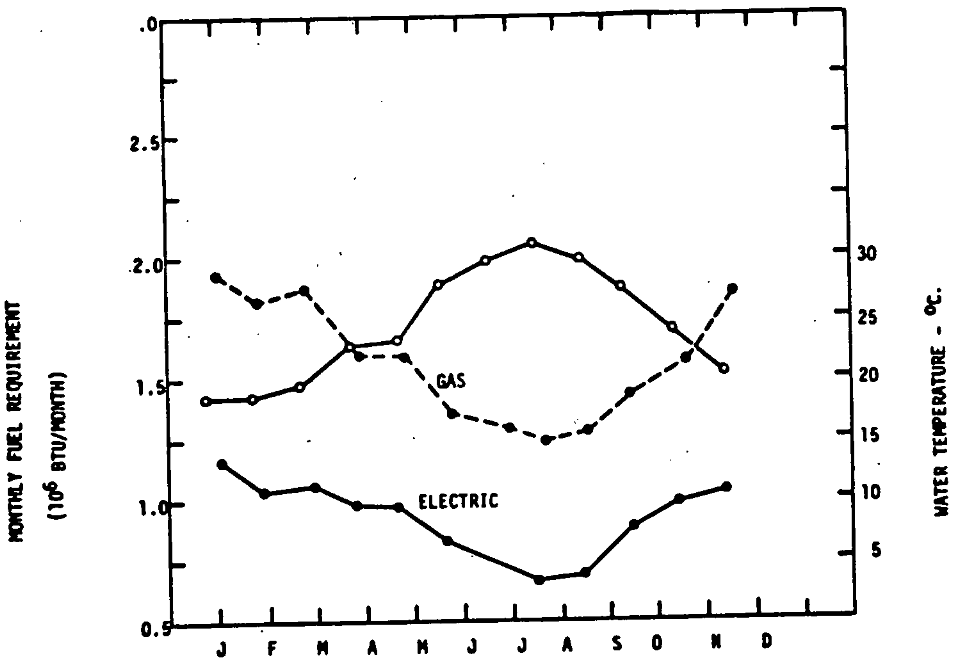
DENVER: Conventional Hot Water Systems
Monthly Energy Usage

FIGURE 2.7



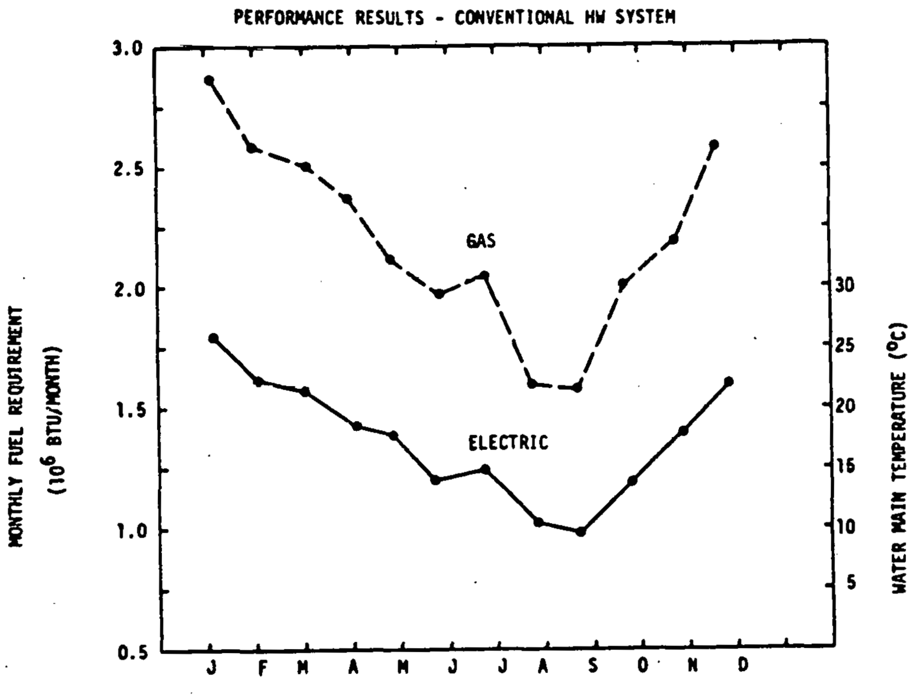
LOS ANGELES: Conventional Hot Water Systems Monthly Energy Usage

FIGURE 2.8



PHOENIX: Conventional Hot Water Systems Monthly Energy Usage

FIGURE 2.9



WASHINGTON: Conventional HW System
Monthly Energy Usage

2.4.6 Water Heater Infrastructure

There are four distribution concepts used in most commercial organizations: factory direct, one-step:factory-retailer-consumer, two-step:factory-distributor-retailer-consumer and a multi-step: factory-manufacturer's representative-distributor-retailer-consumer. All of the major water heater manufacturers use either the two-step or multi-step distribution concept except when dealing with mass retailers like Sears, Montgomery Wards, J.C. Penneys, etc., which employ a one-step distribution concept. The factory direct distribution concept is rarely used. In the usual two-step option, manufacturers rely on the distributor to accept the responsibility for developing dealer organizations and to relieve the responsibility of maintaining inventory at the regional levels.

Product costs are affected significantly with the introduction of the middlemen. Although the manufacturer realizes an extremely low profit margin, usually less than 10%, the wholesaler will mark up the product between 10-35%, usually at the higher value. Dealer mark-ups are 35-40% plus installation. Overall, the manufactured cost will double due to the succession of mark-ups.

2.4.7 Major Conventional Water Heater Suppliers

Six manufacturers command 95% of the water heater sales. These manufacturers are: A.O. Smith, Bradford-White, Mor-Flo Industries, Rheem/Ruud, State Industries, and W.L. Jackson.

2.4.8 Licensing

In most states, installation or servicing of water heaters must be performed by licensed plumbers, although a homeowner can install in his private residence.

Licensing requirements vary from state to state. For a journeyman's license, Texas requires three years of experience and the successful completion of the state examination. Plumbing contractors must also possess a master's license (or employ someone who holds this license).

2.4.9 Training Practices

Classroom training in water heater installation/servicing is minimal. In Texas, plumbers' apprentices usually spend about twelve hours in the classroom studying both electric and gas water heaters. Presumably, apprentices gain most of their experience with water heaters on the job.

The state exams usually contain several questions about water heaters. In Texas, examiners require the candidates to physically identify various parts of the water heater, including the temperature and pressure relief valves, gas burner, thermostat, pilot light, thermocouple, and cold water inlet tube. Then, the examiner requires the person taking the test to adjust the gas burner to the proper air and gas mixture. This shop exam also requires a knowledge of the proper use of galvanized pipe, copper pipe, and the bending of copper tubes -- activities directly related to water heater installation. There are written questions on the proper sizing of the vents, the working pressure of gas, etc.

2.4.10 Codes

A number of different plumbing codes govern water heaters. These codes are usually administered by local authorities and are designed to provide minimum requirements for the "protection of the public's health, safety and welfare." Their scope includes the installation, alteration, repair, maintenance, replacement, and use of any plumbing system.

At this time there are five model plumbing codes:

- National Standard Plumbing Code
  Co-sponsored by the National Association of Plumbing-Heating-Cooling Contractors, Washington, D.C. and the American Society of Plumbing Engineers;
- BOCA Code, also called the Basic Plumbing Code
  Building Officials & Code Administration International
  Homewood, Illinois;
- Standard Plumbing Code (previously called Southern)
  Southern Building Code Congress International
  Birmingham, Alabama;
- ICBO Code
  International Conference of Building Officials
  Whittier, California; and
- Uniform Plumbing Code, also called IAPMO Code
  International Association of Plumbing & Mechanical Officials
  Los Angeles, California.

There is also a National Plumbing Code. Although not enforceable, this code has served as a guideline for the preparation of many local codes. In addition, the American Society of Mechanical Engineers (ASME) and the American National Standards Institute (ANSI) have been writing a plumbing code called A-40 for the past eight years.

Many states, counties, and cities have taken one of the five model codes and adapted it to their own environment. For example, Dallas has adopted the Uniform Plumbing Code. However, since it is colder in Dallas, they dig their pipes deeper, and have modified the code accordingly. The West is the closest to adopting a model code for a large region. Alaska, Montana, California, Hawaii, Nevada, and Idaho all require the Uniform Plumbing or IAPMO Code.

On the other hand, some states, cities and counties still write their own codes. The results are very erratic. For example, Wisconsin uses a Wisconsin State Plumbing Code; Illinois uses an Illinois State Code and BOCA, but the city of Chicago uses its own code.

In general, states, cities, and counties who write their own codes update them less frequently than those using one of the model codes. Therefore, they often lag in adopting the progressive changes. According to one BOCA official, substantial changes are taking place in the codes in the areas of safety features and performance requirements. There is now a trend toward two safety valve requirements: (1) A standard pinhole is required on the dip tube, and (2) the temperature and relief valve can no longer be replaced by cut-off valves. In addition, there is increased emphasis on the use of a safety pin and more attention is being given to where the overflow is connected to the floor drain. Finally, many of the codes now state that all water heaters must bear a label by an approved agency.

Energy efficiency is the second category of rapid change. Several states now require the installation of energy efficient water heaters. This trend toward energy conservation has resulted in several modifications in the codes including:

- Reduction of minimum temperatures from 120^{0} to 110^{0}
- Automatic vent dampers

2.4.11 Standards and Certification Requirements

Standards differ from plumbing codes in several ways. First, they are usually much more design specific. Second, they are only enforceable when included as part of a code. And third, they are often developed by members of an engineering society rather than by building officials and code administrators.

Three organizations play a key role in writing water heater standards -- the American National Standards Institute, the American Gas Association, and the Underwriters Laboratory.

American National Standards Institute (ANSI). The American National Standards Institute is the clearing house and recognized co-ordinating body for voluntary standards activity on the national level. Its purpose is to develop voluntary consensus standards in the private sector and to eliminate duplication of standards activities. Its members include some 900 companies and 200 trade, technical, scientific, professional, labor, and consumer organizations -- a true federation of standards-developing and standards-using organizations.

Although anyone may submit proposed standards to the Institute, ANSI only recognizes three methods for the development of evidence of the consensus needed for approval of American National Standards. They are: (1) accredited organization method; (2) American National Standards committee method; (3) canvass method. ANSI's requirements for due process and the right to appeal actions at several levels of review establish confidence in, and credibility for, the standards it approves. The three ANSI standards pertaining to water heaters were written by the American Gas Association.

American Gas Association (AGA). The American Gas Association laboratories establish certification requirements for gas appliances. The American Gas industry was one of the first in this country to develop ANSI standards. The committees that draw up these requirements follow one of the three methods approved by the American National Standards Institute. The committees are concerned first of all with safety; second, with a reasonable degree of durability, inseparable from safety; and third, with a reasonable operating efficiency when properly installed and used.

The AGA Testing Laboratories certify water heaters only for specific uses and specific operating conditions. The three AGA written ANSI standards pertaining to water heaters are:

- o Gas Water Heaters, Vol. I. ANSI Z21.10.1 and Addenda ANSI Z21.10.1a 1978. Automatic storage type with inputs of 75,000 BTU in 1 hr. or less

- o Gas Water Heaters, Vol. III. ANSI Z21.10.3 and Addenda ANSI Z21.10.3a 1978. Circulating tank, instantaneous and large automatic storage type water heaters
- o Gas Water Heaters, ANSI Z21.13 and Addenda ANSI Z21.13a Gas-fired low-pressure steam and hot water heating boilers

The 1979 addenda Z21.10.1b 1979 and Z21.10.3b 1979 to Gas Water Heaters Vol. I and III have been approved but are presently not available from AGA.

Underwriters Laboratories (UL). Underwriters Laboratories, Inc. is a not-for-profit organization founded to establish, maintain, and operate laboratories for the examination and testing of devices, systems and materials to determine their relation to hazards to life and property. The goal of all UL testing is safety for the public in the home, in industry, and in business. Two UL standards have been established for the performance and construction of water heaters. They are as follows:

- o Standard for Safety -- Household Electric Storage Tank Water Heaters UL 174
- o Standard for Safety -- Oil Fired Water Heaters UL 732

National Board of Boiler & Pressure Vessel Inspectors (National Board). The National Board of Boiler & Pressure Vessel Inspectors (more commonly referred to as the National Board) sets standards for large commercial boiler and pressure vessels.

The National Board is an organization that trains and commissions inspectors foreach state and in cities of the U.S. and provinces of Canada. The prime objective of the National Board can be summed up in the single word "safety." Specifically, its objectives are:

- o Uniform enforcement of boiler and pressure vessel safety laws, rules, and regulations
- o Uniform standards of approval for specific designs and structural details of vessels, appurtenances, and devices instrumental in the safe operation of boilers and pressure vessels
- o One uniform code of rules and one standard stamp designating compliance with that code
- o One standard of qualification and examination for the commissioned inspectors who enforce the requirements of the code

- Compilation and distribution of information vital to its members -- more than 3,800 commissioned inspectors, and other interested parties such as technical societies, manufacturers, installers, owners/users, and jurisdictional officials responsible for the public safety.

The National Board Commissioners follow the safety regulations of the ASME Boiler and Pressure Vessel Code and the Inspection Code of the National Board (ASME Code Section 8 deals with boilers and pressure vessels) in the manufacturing, installation, and repair of boilers and pressure vessels. If the vessels comply with the safety standards, a nameplate with a NAT'L BD seal, number and ASME symbol stamp goes on the vessel and it is registered with the National Board.

The National Board also administers the capacity certification for safety valves and safety relief valves in accordance with ASME Boiler and Pressure Vessel Code requirements. It maintains a testing laboratory for these valves.

American Society of Mechanical Engineers (ASME). The ASME Boiler and Pressure Vessel Code primarily pertains to commercial water heaters.

Over 6,000 engineers and related scientists participate in writing ASME Codes and Standards. The Boiler and Pressure Vessel Code is used in most of the states and in major cities in the states that have yet to reference the code. It is also used in all the provinces of Canada. This code has also been referenced in the safety regulations of seventy jurisdictional authorities, and a number of Federal Agencies include the ASME Boiler and Pressure Code as part of their respective regulations.

The two pertinent sections of the ASME Boiler and Pressure Vessel Code are:

- Section 4, Heating Boiler, 250 pages
- Section 8 (2 parts), Pressure Vessels, 500 pages

National Sanitation Foundation (NSF). The National Sanitation Foundation is a non-profit organization dealing with problems involving sanitation. It is dedicated to the prevention of illness, the promotion of health and the enrichment of the quality of American living. The NSF seal is widely recognized as a sign that the article to which it is affixed complies with public health requirements. Representatives of the public health profession, of business and industry, and of the public serve on its Board of Trustees, Council of Public Health Consultants, and various committees. The NSF fulfills the important purpose of arranging for a common meeting ground where industry and public health may discuss and solve common problems. The NSF standards specifying requirements for water heaters only apply to food service applications using spray type dishwashers. The standard is No. 5, Commercial Hot Water Generating Equipment.

General Services Administration (GSA). The standards division of the Federal Supply Service sets Federal specifications for water heaters used by all Federal agencies. They are:

- o Federal specification W-H-196J
  Water heater, electric and gas-fired, residential, Amendment 1, GSA-FSS, Dec. 20, 1976, approved by the Commissioner, FSS-GSA for the use of all Federal agencies
- o Federal specification W-W-H191B
  Heater, fluid, industrial (instantaneous, steam, water converter type)

U.S. Dept. of Housing & Urban Development (HUD). All HUD funded projects must comply with the following standard:

Chapter 5 of MPS (Minimum Property Standards) which specifies requirements for water heaters for any HUD funded projects

American Society of Heating, Refrigerating and Air Conditioning (ASHRAE). This society has concerned itself with the performance standards for energy conservation. It includes sections on water heaters:

- o ASHRAE 90-75. Performance Efficiency Standard -- Energy conservation in building design
- o ASHRAE/IE: 90.1-75R. This standard has not yet been approved

U.S. Dept of Defense. The military's specifications for their buildings are the same as GSA requirements.

Consumer Product Safety Commission. The Consumer Product Safety Commission has no specific standards for water heaters but does have an alert sheet in which the maximum temperature setting of 140° F is being evaluated. It went out for comment last spring and is pending action (Federal Register Spring 1979).

U.S. Dept. of Energy (DOE). The U.S. Department of Energy sets up procedures similar to those of the American National Standards Institute. DOE's procedures are specified in the following publication:

> Federal Energy Administration;
> Energy Conservation Program for Compliances and Test Procedures for Water Heaters (Federal Register, Oct. 4, 1977; Oct. 19, 1978; Sept. 7, 1979)

In addition to the standards governing water heaters, there are numerous standards covering the various components in a water heater. For example, the American National Standard for gas water heaters, Vol. I (for water heaters with inputs of 75,000 Btu per hour or less) lists the following standards:

Automatic Gas Ignition Systems and Components	Z21.20-1971, Z21.20a-1973, Z21.20b-1974
Pipe Threads	B2.1-1968
Welded and Seamless Wrought Steel Pipe	B36.10-1975
Manually Operated Gas Valves	Z21.15-1974
Gas Appliance Pressure Regulators	Z21.18-1973
Gas Appliance Thermostats	Z21.23-1971 Z21.23-1971, Z21.23a-1972, Z21.23b-1974
Automatic Valves for Gas Appliances	Z21.21-1974
Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems	Z21.22-1971, Z21.22a-1972, Z21.22b-1973
Draft Hoods	Z21.12-1971
Electrical Equipment and Wiring	C1-1975
Electric Fuse	C118.1-1973
Unified Inch Screw Threads	B1.1-1974
Slotted Head Cap Screws, etc.	B18.6.2-1972
Slotted and Recessed Head Machine Screws,etc.	B18.6.3-1972
Slotted and Recessed Head Tapping Screws,etc.	B18.6.4-1966
Square and Hex Bolts and Screws	B18.2.1-1972
Square and Hex Nuts	B18.2.2-1972

The ANSI standards for gas water heaters also specify a number of installation standards including:

National Fuel Gas Code	Z223.1-1974
National Electrical Code	C1-1975
Mobile Homes	A119.1-1975
Recreational Vehicles	A119.2-1975

SUMMARY OF STANDARDS BY ORGANIZATION

American National Standards Institute (ANSI)

Z21.10.1
Z21.10.1a-1978
Z21.10.1b-1979

Z21.10.3
Z21.10.3a-1978
Z21.10.3b-1979

Underwriters Laboratories (UL)

UL 174
UL 732

American Society of Mechanical Engineers (ASME)

Section IV
Section VIII

National Sanitation Foundation (NSF)

No. 5

FS

W-H-196J
W-H-196J, Amendment 1

U.S. Dept. of Housing & Urban Development (HUD)

Chapter 5 of MPS

American Society of Heating, Refrigerating and Air Conditioning (ASHRAE)

90-75

SUMMARY OF WATER HEATER STANDARDS

From Uniform Plumbing Code

Automatic storage type water heaters, Vol. I, with input less than 50,000 Btu per hour (14,650 W)	ANSI Z21.10.1(1971)
Circulating tank, Vol. III, instantaneous, and large automatic storage type water heaters	ANSI Z21.10.3(1971)
Electric water heaters	UL 174-1956
Gas fired steam and hot water boiler	ANSI Z21.13(1974)
Oilfired boilers	UL 726-1963
Oilfired water heaters	UL 732-1955
Relief valves and automatic gas shut-off devices for hot water supply systems	Z21.22(1971)
Boiler and pressure vessel code	ASME

From BOCA

Water heater drain valves	ASSE 1005-1967
Water heater, electric, residential	FS W-H-196J-1973 FS W-H-196J-1-1976
Water heaters, household automatic electric, storage type	ANSI C72.1-1972
Water heaters, gas, Volume I, automatic storage type water heaters with inputs of 75,000 Btu/hr. or less	ANSI Z21.10.1-1975
Water heaters, gas, Volume III, circulating tank instantaneous and large automatic storage type water heaters	ANSI Z21.10.3-1975

From National Standards

Water heaters, automatic storage type	ANSI Z21.10.1-1975
Water heaters, circulating tank	ANSI Z21.10.3- 5
Water heaters, electric storage tank	FS W-H-196J-1971; UL 174-1972

Water heater, instantaneous	FS WW-H-191b-1970
Water heater, side arm type	ANSI Z21.10.1-1975
Water heater drain valve	ASSE 1005
From ASHRAE	
Installation of oil fired water heaters	ANSI Z95.1
Gas fired water heaters for commercial and industrial needs	ANSI Z21.10.3, Vol. III
Installation of gas-fired water heaters	ANSI Z223.1
Low pressure heating boilers and low pressure, fired, portable hot water heaters	ASME Section IV
Unfired water heaters and pressure vessels	ASME Section VIII

2.4.12 Other Water Heating Options

In considering solar water heaters, it is important to recognize a number of other options available to the consumer. These other options include more efficient water heaters using higher insulation values, water conservation measures, and other water heating products. These other water heating products include heat recovery units, instantaneous water heaters, heat pump water heaters, and hot water boosters.

None of these other water heating products are new. Instantaneous water heaters have been widely used in Europe for a number of years. Heat recovery units (HRUs) are merely a heat exchanger adapted to the condenser of an air conditioner or heat pump. Heat pump water heaters have been under investigation since the 50's and boosters have been used by major hot water users such as restaurants for a number of years and are common in the home dishwasher.

2.4.13 Heat Recovery Unit

Manufacturers of the HRU include Sun Econ, GST Industries, Energy Conservation Unlimited, and Freidrich, a division of Wylain.

Planco, Inc. has surveyed these industries and identified that units are currently being manufactured and sold in fairly large quantities at the residential and commercial levels. Prices range from $350 to $700, installed. Commercial units cost considerably more, depending on the size of the unit.

Of the four water heater product options, the heat recovery unit probably presents the greatest competition to the solar water heater since this amounts to a fairly modest modification to an air conditioner or a heat pump and not only provides preheat of the water, but also improves the overall efficiency of the air conditioner or the heat pump. All that is required is a heat exchanger and a circulator.

An HRU attached to a 3-ton unit in California has been shown to provide savings ranging from 400 to 3000 kilowatts a year. At 5¢ per kilowatt hour, this translates into $20 to $150 savings per year. And this does not include the improved efficiency resulting for the air conditioner.

The HRU is particularly popular where air conditioning is a major requirement -- usually in the South and Southwest. The complete results of the Planco survey are shown in Table 2.5 (see following page).

Studies by Freidrich have shown that the HRU in the residential environment can produce 8.4 gallons of hot water with a 70-degree temperature rise from a 3-ton heat pump. The HRU will raise the EER of the heat pump from 7.5 to 10.3 with a 29% energy savings in the cooling mode and a 14% increase in the heating mode. In the commercial environment, the savings can exceed 50%. The details of the Freidrich analysis are shown in Table 2.6.

TABLE 2.5

SUMMARY OF ANSWERS OF TELEPHONE SURVEY OF MANUFACTURERS OF HEAT RECOVERY UNITS
April 18 and 21, 1980

	Sun Econ	GST Industries	Energy Conservation Unlimited	Friedrich
1. What percentage of your sales of heat recovery units goes to				
a. Residential	60%	50%	Mainly residential	90%
b. Commercial	40%	50%		10%
2. Where are most of the units installed?	A to A and A to W heat pumps because of year round	Heat pumps, refrigeration units and unitary	Can go to any A/C. Many go to heat pumps	A to A heat pump and water to A heat pump
3. What is the selling price of your				
a. Residential unit				
1. Price of unit at retail	$368	$325	NA	NA
2. Installed price	$500-700, depending on job	$475-500	$450-500	$350-450
3. Factory selling price	$184 -- varies with quantity	$250 -- varies with quantity	NA	$225
b. Commercial unit				
1. Price of unit at retail	$530	$500 to $2,600, depending on size	NA	Varies
2. Installed price	$1,200-3,500 -- varies greatly	Varies greatly with job	$850 but can go higher, varies	$550-600, can go higher
3. Factory selling price	$265	$390 to 2,000	NA	$350-400
4. Who generally installs the unit?	HVAC dealer	HVAC dealer	HVAC dealer	HVAC dealer
5. In what parts of the country are most of your units sold?	Mainly South, especially Florida and Texas, also going to Calif.	Sunbelt mainly, Calif. on East through South, being sold in Penn., Ohio, etc.	South mainly	Southeast part of the U.S.
6. How actively do you promote sales?	Very actively. Since Oct. sales take off	Setting up reps in every major area in the country	Very actively	Very actively
7. How much would you estimate your units save the user?				
a. In hot water?	About 4 to 8 gals. of hot water per ton of heat pump per hour	Could save up to 30% of water heating bill	When going, saves 100% of hot water	Don't know -- depend on applicat
b. In efficiency of A/C?	About 10% average	10%	10%	10% min.
8. What warranty do you give?	12 months	18 months	18 months	12 months
9. How would you say the market is growing presently?	Rapid growth. Expect sales to increase by 3 to 5 times in 1980. Hard to keep up with sales	Taken off. Have 10,000 units in field. Will have $3 million sales this year. They are number one.	Been in business for five years and each year sales have increased	Now growing fast

TABLE 2.6

ENERGY SAVINGS FROM A HEAT RECOVERY UNIT
OPERATING IN THE COOLING MODE

Air Cooling Capacity	Hot Water Heating		Power Input	Utilities Efficiency		
	Capacity	Recovery		Combined	Separate	Combined Energy
BTUH	BTUH	GPH	Watts	EER	EER	Reduction %
22,000	3,600	6.2	2,500	10.2	7.2	30%
26,000	4,200	7.2	3,100	9.7	7.0	28%
32,000	4,900	8.4	3,600	10.3	7.5	29%
42,000	5,900	10.1	4,800	10.0	7.3	26%
52,000	7,000	12.0	5,400	10.0	7.4	26%

ENERGY SAVINGS FROM A HEAT RECOVERY UNIT
OPERATING IN THE HEATING MODE

Air Heating Capacity	Hot Water Heating		Power Input	Utilities Efficiency		
	Capacity	Recovery		Combined	Separate	Combined Energy
BTUH	BTUH	GPH	Watts	COP	COP	Reduction %
22,000	2,900	5.0	2,800	2.6	2.2	14%
27,000	2,300	4.0	3,100	2.8	2.5	11%
29,000	2,900	5.0	3,200	2.9	2.5	14%
36,000	3,600	6.2	4,700	2.5	2.2	11%
52,000	3,300	5.7	5,900	2.8	2.2	9%

2.4.14 Heat Pump Water Heaters

Heat pump water heaters are manufactured by EUS, E-Tech, Fedders and a few smaller manufacturers located in the Southeast.

The heat pump water heater extracts its heat from the interior of the dwelling and therefore is a more practical device in the heavy air conditioning environments which would be: the residential market in the South and Southwest and the commercial market throughout the United States. It is doubtful that the hot water heat pump would be a practic device in the heavy heating regions of the country.

Heat pump water heater COPs range from 2-3. Energy savings are projected at 50 to 67%. Fedders in a private study predicts a 60% saving with a summer COP of 2.8 and a winter COP of 2.4. Test data to back up these claims are very sketchy but EUS under an ORNL contract in cooperation with utilities is currently testing 120 units.

The reliability is also unknown at this time although it is projected that the failure rate of a hot water heater should be somewhat higher than a conventional heat pump because it is expected to operate for significantly longer periods. Warranties range as high as 5 years by some of the manufacturers.

Installed cost of the unit is expected to be $550 to $700.

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CHAPTER 3

SOLAR WATER HEATING INDUSTRY

3.1 SOLAR INDUSTRY SURVEY

The solar industry survey included the following:

- o Determination of data sources required for the assessment of product performance, economics, and quality

- o Compilation of solar industry suppliers that market complete solar water heating systems

- o Screening of system manufacturers/integrators; determining generic classifications based on the respondents literature, and selection of representative systems for analysis

- o Compilation and analysis of performance and cost data from the respondents product literature

- o Review of the documentation provided by the respondents for completeness and quality

- o Assessment of problems encountered by the industry and specific designs

3.1.1 Data Sources

Data for this survey was collected from many sources. System suppliers and supply characteristics were identified using four different data bases:

- o National Solar Information Center

- o SERI Information Center

- o Solar Energy Industries Association:
  Solar Engineering Master Catalog '79 and
  Solar Industry Index

- Solar Engineering Magazine (December '79 issue)
  Deskbook Directory

Product data was obtained through a telephone survey in which brochures and manuals on collectors, systems, installation, costs, and warranties were requested. The documentation received was used to establish the product data base.

The product quality assessment was conducted using the product data supplied by the manufacturers through personal contacts and a literature review. Information used to describe the product quality was compiled from the major national laboratories:

Information Source	System Component
Los Alamos Scientific Laboratories	Collectors
Argonne National Laboratories	Collectors/Storage
Lawrence Berkeley Laboratories	Controls
Solar Energy Research Institute/ Solar Environmental Engineering Company	Controls

Site visits were made to test facilities at Wvlie Laboratories in Huntsville, Alabama, and Florida Solar Energy Center, who were evaluating systems provided by TVA as part of the Solar Nashville Program. Additional site visits were also made to manufacturers and installations to support the quality assessment study.

3.1.2 Solar Survey Methodology

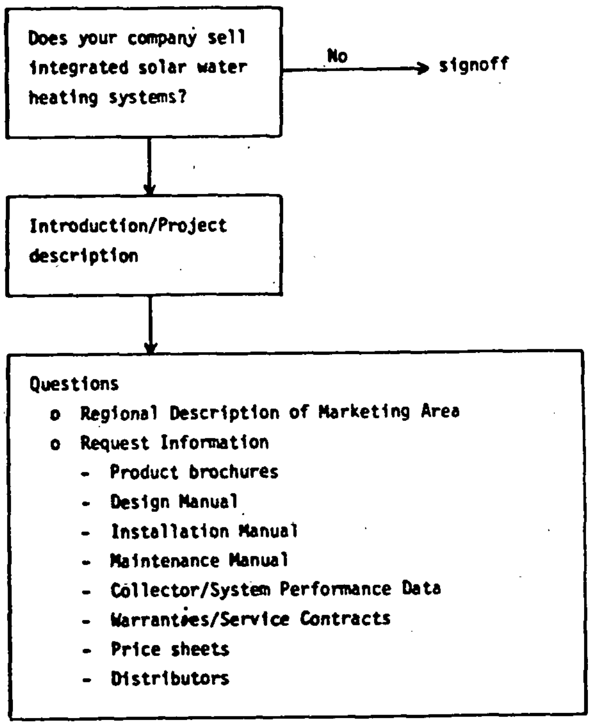
Using the master list of solar companies, a telephone survey was conducted to identify solar hot water systems and producers in order to collect the necessary information to perform the analyses and quality assessments. An outline of the procedure is shown in Figure 3.1.

A primary qualifier in the telephone interview was the initial question regarding the product sold differentiations between the component supplier from the systems suppliers. If the interviewee answered in the affirmative then a detailed questionnaire was discussed regarding the product, product documents and the supplier's organization. The interview terminated with a request for documentation.

Most firms were cooperative and over half supplied part or all of the documents requested.

FIGURE 3.1

SOLAR INDUSTRY SURVEY METHODOLOGY



3.1.3 Solar Hot Water Industry Survey Results

The four data bases mentioned earlier were used to construct a master list of solar companies from which the telephone and correspondence contacts were made. The complete list is included in Appendix I. A sample sheet from this master list is included as Table 3.1 The compilation shows that none of the lists are complete. In many cases a company appears on only one out of four lists.

TABLE 3.1

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine 12/79 Issue	SEIA SEM '79 Catalog	SERI	Integrated Systems Suppliers Contacted	Integrated Systems Suppliers Responded
Alabama						
Aircraftsman Millbrook	X					
Halstead & Mitchell Scottsboro	X	X			X	X
National Energy Systems Corp Birmingham				X		
Solar Energy of the South Mobile		X			X	
Solar Unlimited Huntsville	X	X	X	X	X	X
Arizona						
Arizona Engineering & Refrign Gilbert	X					
Arizona Solar Enterprises Scottsdale	X					
B&H Refrigeration Yuma			X			
Copper State Solar Products Inc Phoenix		X			X	X
Energex Mfg Corp Phoenix	X					
Goettl Air Conditioning Phoenix	X	X		X	X	

Table 3.2 summarizes the results of the survey. Two hundred and twenty-six companies (out of 364 possible) were contacted in the survey. Of those 226, 152 supplied complete integrated solar hot water systems. The difference accounted for companies that supplied only components (usually just collectors), and companies that had gone out of business (or did not answer).

TABLE 3.2

SURVEY RESULTS FOR SYSTEM MANUFACTURERS/INTEGRATORS

No. of System Suppliers	364
No. Contacted	226
No. of SHW System Suppliers - verbal acknowledgement	152
No. of SHW System Suppliers - documented proof	82

The product data base includes the 82 documented responses that were received as a result of the survey.

From the survey, marketing area demographics were determined. Table 3.3 illustrates that companies market and distribute primarily at a state, regional, and national level.

TABLE 3.3

MARKET AREA DEMOGRAPHICS

Market Area	Market Analysis (% of Sample)
City	2
County	5
Statewide	29
Regional	36
National	28

No. of Samples - 152

Figure 3.2 depicts the geographic distribution of 152 companies that supply integrated solar hot water systems (as determined from this survey). The Northeast; California, Florida, and Colorado represent the areas that are currently bases for major activity in the SDHW industry.

(See next page for
Figure 3.2)

FIGURE 3.2

INTEGRATED SYSTEM MANUFACTURERS/SUPPLIERS

From the telephone survey (152 contacts), it was also possible to determine the level at which the solar companies are providing product support including documentation. A summary of those results is given in Table 3.4. It was noted that approximately two-thirds of the suppliers provide design, installation and maintenance manuals. Over 10% do not provide product brochures.

TABLE 3.4

SHW SYSTEM DOCUMENTATION -- BASED ON TELEPHONE SURVEY*

Documentation	% of Contacts that can provide requested information (did not necessarily provide)
Product Brochure	89
Design Manual	60
Installation Manual	68
Maintenance Manual	63
Collector Data	89
Warranties	100
Service Contracts	40

*152 Contacts

3.2 INDUSTRY INFRASTRUCTURE

3.2.1 Supplier Characterization

Companies manufacturing solar water systems are representative of a broad range of companies from very small to multi-billion dollar enterprises. These companies have evolved in a variety of ways. Many of the smaller firms were initially organized as new ventures specifically for the development of solar components and systems. Another class of larger companies were spinoffs from similar activities; examples are, the conventional water heater companies and the HVAC dealers, distributors, and manufacturers. A smaller percentage of suppliers evolved from the raw materials companies that supply metals and glazing materials. Energy companies, high technology companies (e.g., aerospace firms), and large-scale mass production companies (e.g., the auto industry) are also included in the overall suppliers' list.

A very large percentage of the smaller firms on the solar system suppliers' lists which includes the 82 written respondents to the survey have annual sales under a million dollars per year. The 12 top "solar hot water industry leaders" list is dominated by large corporations.

A survey was conducted by the Planco corporation to identify the major solar hot water system manufacturers and that list includes the following companies: Grumman, Revere, Sunworks, State Industries, Lennox, Heliotherm, Daystar, Rheem/Ruud, Northrup, A. O. Smith, Reynolds Metals, and Mor-Flo. All 12 companies have sales in excess of $1 million per year and the list includes multi-billion dollar companies with sales exceeding a billion dollars per year.

Four of these companies, A.O. Smith, Rheem/Ruud, State Industries and Mor-Flo are major conventional hot water companies. Two of the companies are from the HVAC industries -- Lennox and Northrup. Two firms are raw materials suppliers -- Revere and Reynolds Metals. One company, Grumman, is a high technology aerospace firm.

Solar water heater production is heavily concentrated in five states -- California, New York, New Jersey, Florida and Arizona based on EIA report, <u>Solar Collection Manufacturing Activity, July-Dec., 1979</u>. Firms located in these five states produce over 75% of the collectors for solar water heating systems.

The EIA report also identifies the top 12 states that produce over 90% of the solar collectors for solar water heating systems. A listing of the 12 producer states is provided in Table 3.5. Based upon the sales trends shown in the EIA report, the top four states continue to enjoy significant increases in solar collector sales; whereas, Arizona, Colorado, and Texas are indicating a decrease in sales. Very likely, the impact of new state and federal legislation dealing with incentives could alter this picture in 1980.

The firms that are emerging as the industry leaders in solar water heating have access to a total capability to design, produce, and sell the solar water heater system. All 12 provide the product documentation listed in Table 3.4 with the exception of service contracts. Most of the firms on the top 12 list have access to engineering expertise in research and development as well as applications engineering. Therefore, it is not surprising that these firms would emerge as the industry leaders.

TABLE 3.5

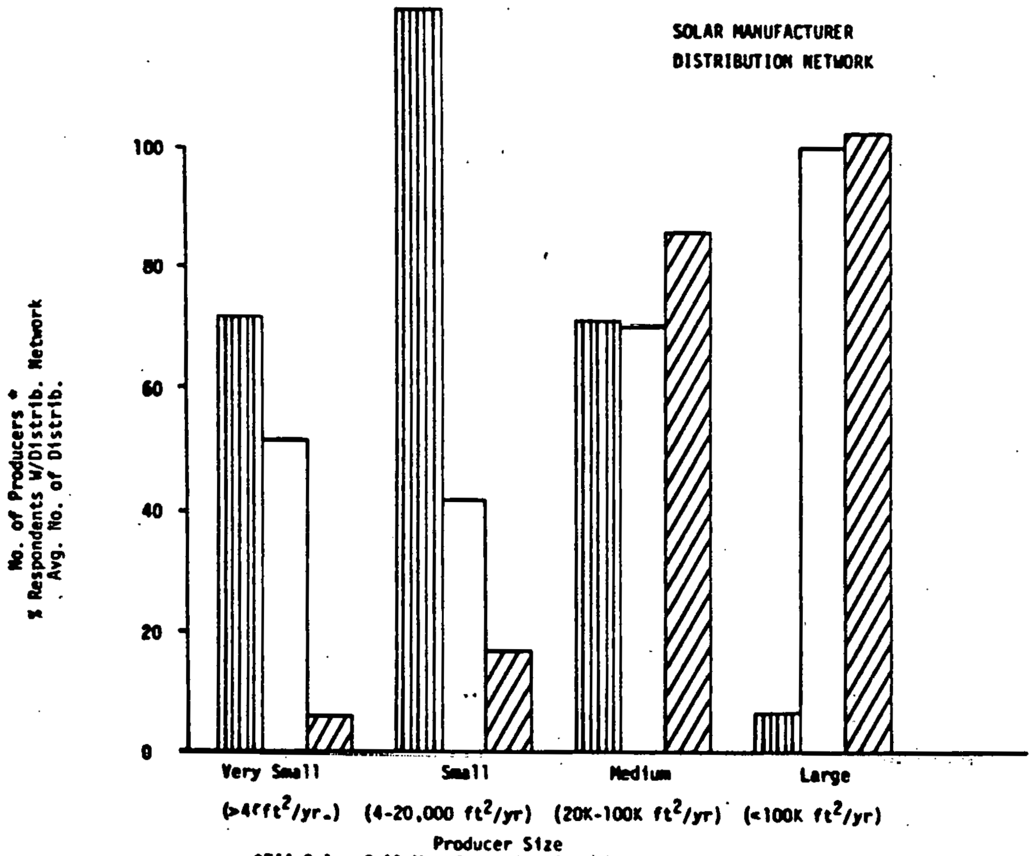
MAJOR HOT WATER SUPPLIERS BY STATE

		MFT^2	Trend
1.	California	390K	
2.	New York	380K	
3.	New Jersey	228K	
4.	Florida	160K	
5.	Arizona	99K	
6.	Ohio	55K	
7.	Tennessee	49K	
8.	Virginia	47K	
9.	Colorado	42K	
10.	Pennsylvania	40K	
11.	Texas	28K	

EIA Solar Collector Manufacturing Activity, February, 1979

Distribution plays a key role in the success of the industry leaders. All of the top 12 companies are currently distributing solar hot water systems nationally, through the 2-step or multi-step distribution network, and all have over 100 distributors scattered throughout the United States. Figure 3.3 is based upon the EIA Solar Collector Manufacturing Activity, dated February 1979. It should be noted that as solar collector volume increases, firms develop a distributing organization with large numbers of distributors; 62.7% of the manufacturers of solar collectors have distribution organizations and 70.8% of the total volume sold in the first half of 1979 was sold through a distribution network.

FIGURE 3.3



*EIA Solar Coll Manufacturing Activity, Feb. 1979

It is also noteworthy that all of the 12 major companies provide packaged solar hot water systems. These systems, based upon this survey, were found to be designed for consumer appeal. All the systems had adequate warranties on all the major components and have collector warranties of at least five years. System documentation was provided by these industry leaders including product brochures, design information, installation and maintenance information.

3.3 PRODUCT CHARACTERIZATION

This study has sought to analyze the products that are currently on the market. This section will provide the results of an extensive effort to analyze the product data base that was constructed, based on the 82 documented respondents. The following topical areas will be covered:

- o Generic descriptions of currently available systems
- o Product literature review that assesses the quality of the existing documentation
- o System packaging
- o Component/system warranties
- o Performance
- o Cost

3.3.1 Generic Descriptions

Solar water heaters have typically been classified according to the common generic types that are supplied by the industry. These same classifications were adopted by the National Bureau of Standards in their studies of solar hot water performance. The different generic classifications have evolved from the industry's recognition of the particular features suited to regional needs usually related to climatic or market conditions and optimized for consumer economics. From the respondents' literature, the majority of systems currently on the market can be arranged into six generic types. For purposes of this report the breadbox concept was not considered due to the very low sales, as illustrated in Table 3.6.

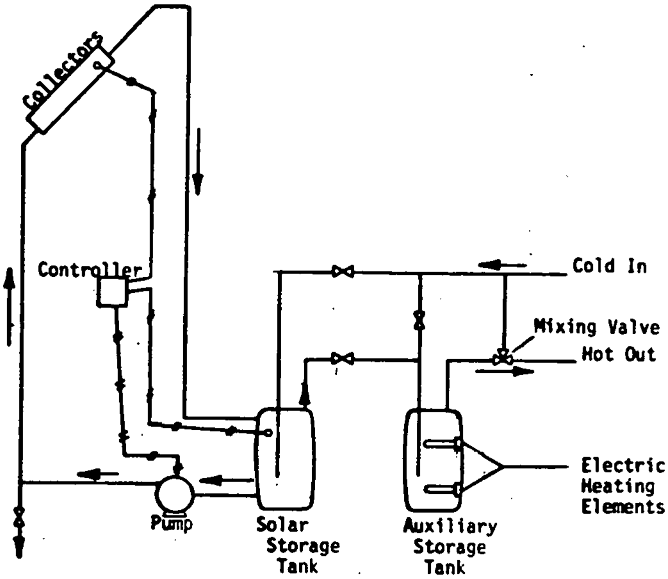
TABLE 3.6

GENERIC CLASS OF RESPONDENTS (82)

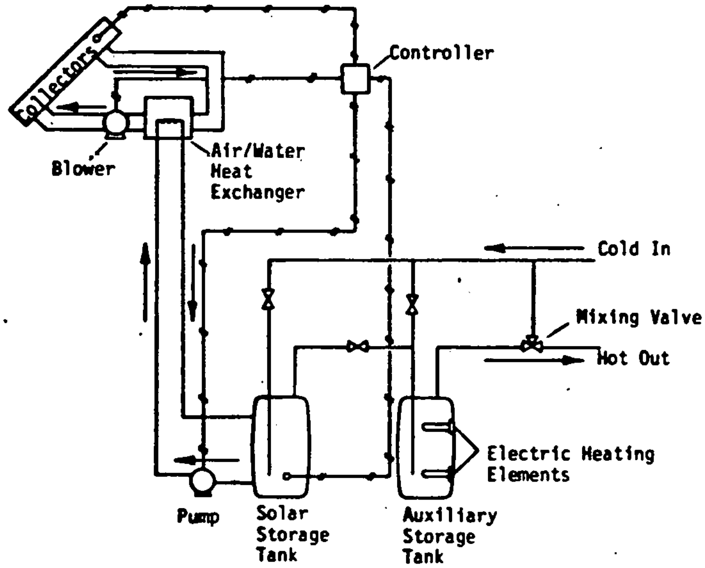
Generic Type	%	California Sales Since Start	California Sales 12 mo.
o Direct Recirculating	24		
o Direct Drainback	6	56	42
o Direct Draindown	22		
o Indirect (anti-freeze)	41	32	47
o Thermosyphon	5	10	10
o Air	2		
o Breadbox		2	1

3/2(a)

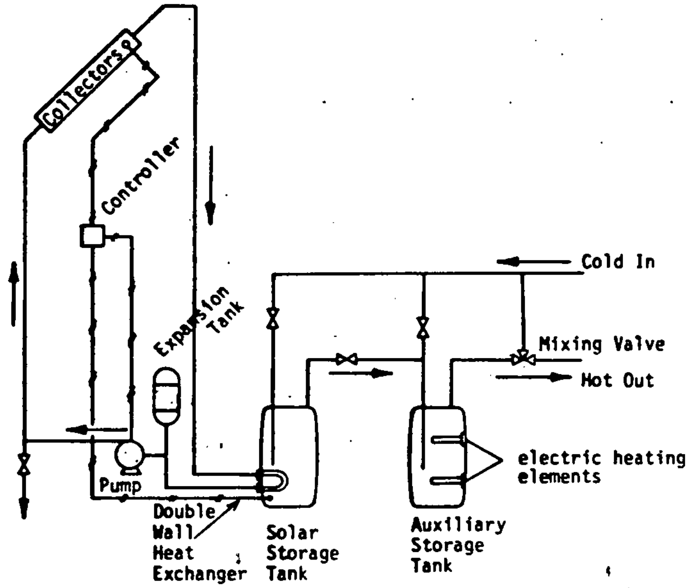
3-12a



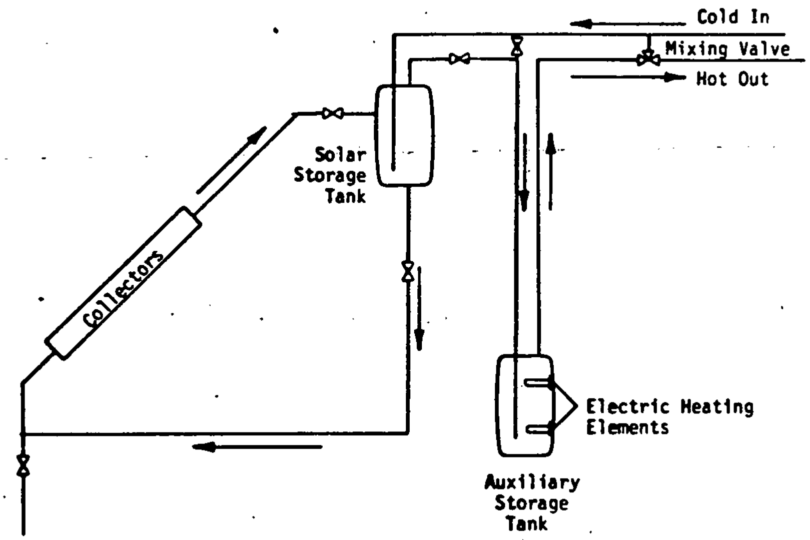
DIRECT, RECIRCULATION, TWO TANKS



INDIRECT, ACTIVE AIR SYSTEM, 2 TANKS



INDIRECT, ANTIFREEZE, 2 TANKS



THERMOSYPHON, DIRECT, TWO TANK

Companies typically offer at least two types of systems. The results of the generic classification of the respondents is summarized in Table 3.6 and compared to recently published data for Sacramento, California. (see page 3-11)

3.3.2 Product Literature Review

The product literature was reviewed for adequacy in several areas. A summary of those results is given in Table 3.7. Documentation was ranked from A(good),through N (extremely poor or not useful).

TABLE 3.7

PRODUCT LITERATURE REVIEW

	Quality of Documentation							
	A	B	C	N	IV	NV	NP	P
Collector Information	52%	28%	20%					
Component Information	22%	20%	12%	46%				
System Operation	20%	15%	8%	57%				
Collector Performance Equation					52%	26%	22%	
Warranty							43%	57%
Sizing							87%	13%

A - Good
B - Adequate
C - Poor
N - None or Extremely Poor

IV - Independently Validated
NV - Not Independently Validated or Nothing was said
NP - Information Not Provided
P - Information Provided

It is important to note that the documentation was either nonexistent or extremely poor for component information (46% of the cases) and for system operation (57% of the cases). Fifty-two percent of the sample provided systems using collectors that had been independently validated.

The literature was also reviewed to determine the degree of packaging that was being used in the industry. The majority of the respondents (71%) offered poorly packaged systems. It was noted in this survey that all major solar companies supplying integrated solar domestic water heating systems offer well packaged systems, though not necessarily optimum quality.

Fifty-seven percent of the respondents provided information on their warranties. The content of those warranties is summarized in Table 3.8. In most cases the collector had a 5-year limited warranty. Six out of 82 respondents offered a one-year full warranty on the system and installation. This low systems warranty is usually due to the division of responsibility between the supplier and installer.

TABLE 3.8

WARRANTIES

(82 Responses)

57% of Industry Responses Included Warranties (not HUD)

Warranty	No. of Respondents	Duration	Extent
System	6	1 yr	Full*
Collector	3 29 6	<5 yr 5 yr 10 yr	Limited Limited Limited
Storage/ Heat Exchanger	42	3-10 yr	Limited
Pump and Controls	42	12-18 mo	Limited
Installation	6	1 yr	Full

* Full warranty is considered to cover parts, labor, shipping and handling

The storage tank and heat exchanger warranties varied from 3 to 10 years and the manufacturers' warranties on pumps and controls was from 12 to 18 months.

3.3.3 Performance Analysis Based on the Product Literature

In the product/supplier survey, information on both collector and system performance was requested. There was no information in the respondents' literature on system performance (simply because in most cases systems performance data does not exist).

Collector performance is usually provided in the collector/system brochures. As was mentioned earlier, 52% of the respondents claimed independent validation of their collector performance.

In analyzing collector quality they were divided into the following categories:

- o Non selective, single glass
- o Selective, single glass
- o Non selective, double glass
- o Selective, double glass
- o Non selective, single (or double) plastic
- o Selective, single (or double) plastic
- o Selective, evacuated tube

From the respondents' literature, 75 collector performance equations were provided. These performance equations were divided into the seven categories and plotted for comparative purposes (Figures 3.5 through 3.10). A key to these figures is included in Appendix IV to identify collector manufacturers. Five representative systems (collectors) were chosen for performance/economic analysis (Chapter 4). The collector performance used in those systems are shown in Figures 3.5, 3.8 and 3.9. Several collectors were also tested at the Florida Solar Energy Center (May 1979).[1] The result (average of several collectors) of those tests is also shown for comparative purposes. It is interesting to note that performance varies considerably, even for collectors of identical construction as in the case of collectors with selective and non-selective absorbers with single glass covers. In both cases the efficiency has dropped to very low values, when the parameter T_i-T_a/I reaches the range of 0.4 to 0.5.

The reader is cautioned that performance curves are applicable for normal incidence only and inclusion of incidence angle modifiers could alter daily efficiencies. Also, as a few of the collectors have built-in manifolds, compensation for these loss factors

[1] "A Solar Collector Testing Program," Final Report on Grant EG-77-G-05-5561, Florida Solar Energy Center, 5/15/79.

could substantially alter comparative collector performances. The evacuated tube collector shown in Figures 3.5 and 3.8 is one example of a collector whose relative performance is penalized by the efficiency presentation as shown.

FIGURE 3.5

COLLECTOR EFFICIENCY FOR SELECTIVE, SINGLE GLASS COLLECTORS

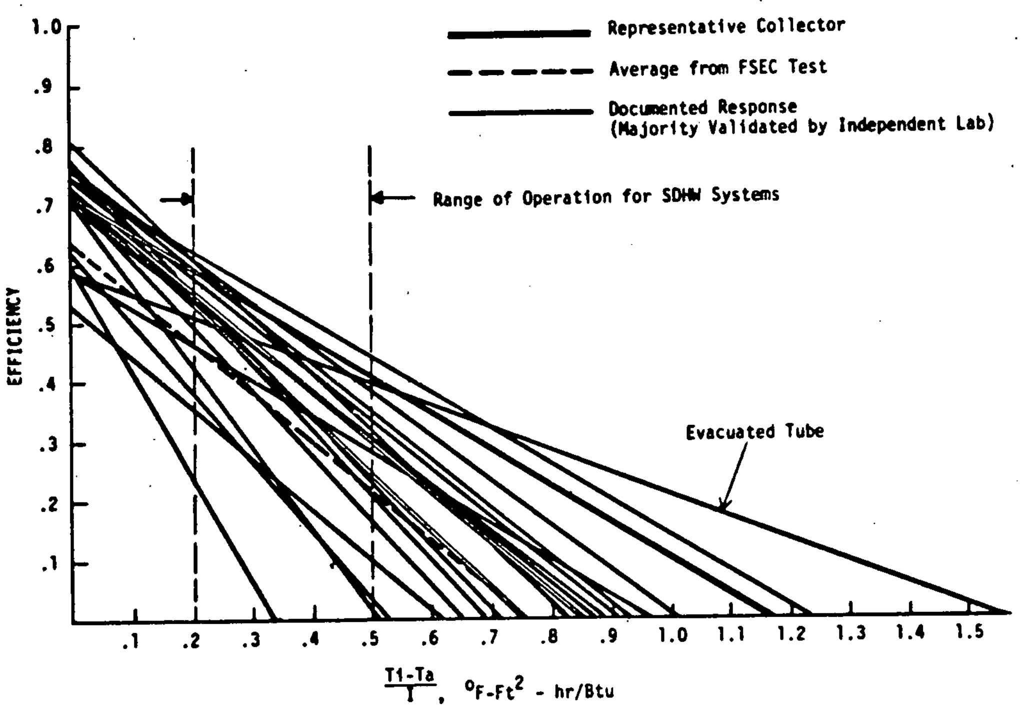


FIGURE 3.6

COLLECTOR EFFICIENCY FOR NON-SELECTIVE, DOUBLE GLASS COLLECTORS

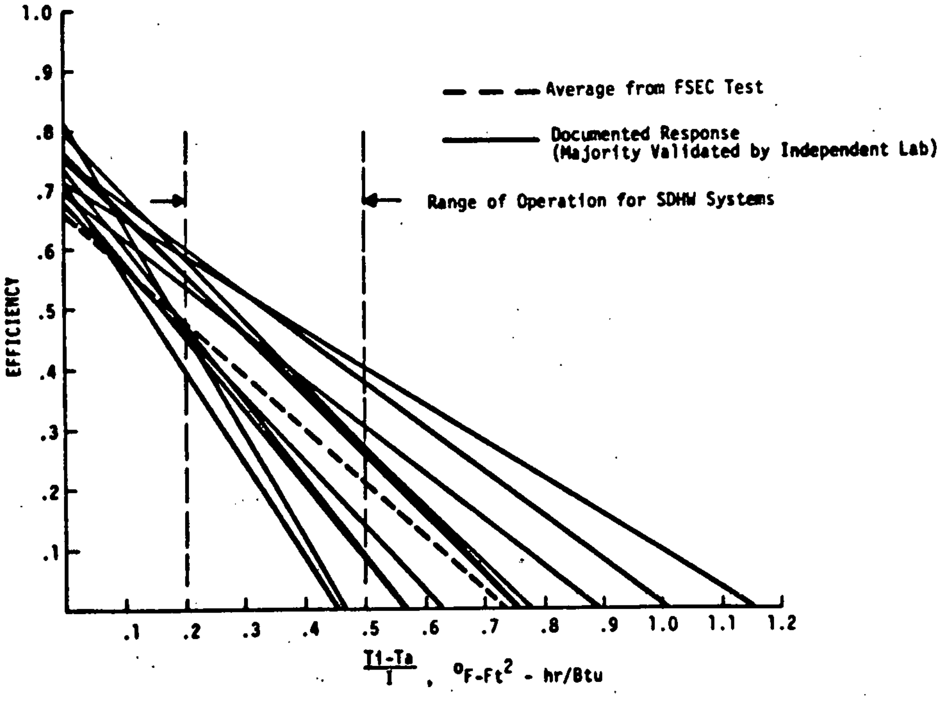


FIGURE 3.7

COLLECTOR EFFICIENCY FOR SELECTIVE, (SINGLE) PLASTIC COLLECTORS

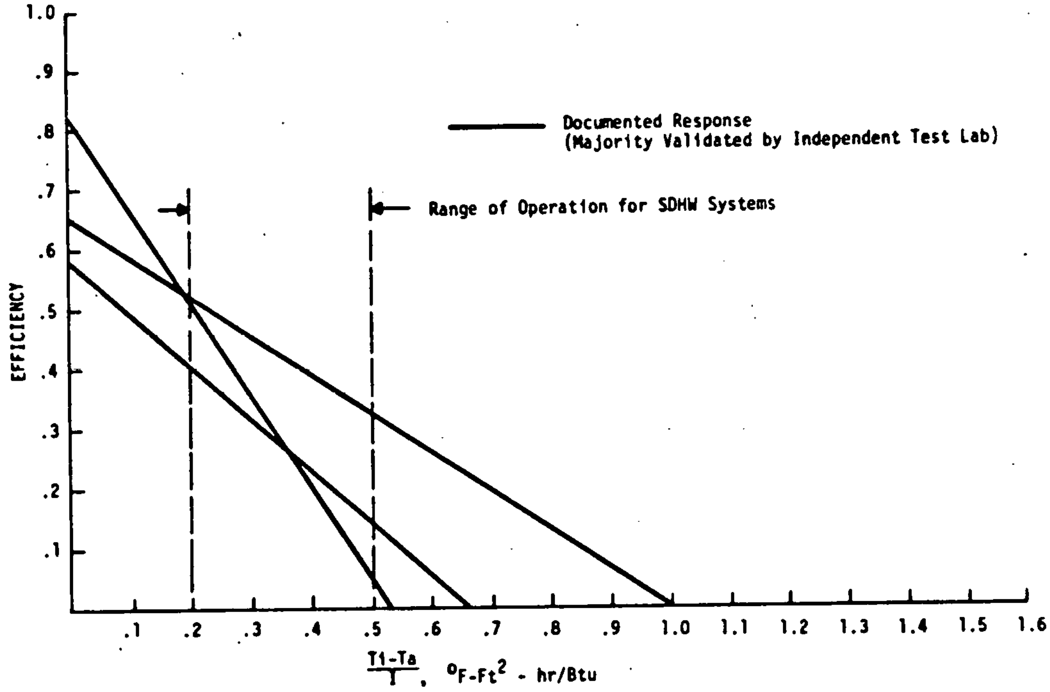


FIGURE 3.8

COLLECTOR EFFICIENCY FOR SELECTIVE, DOUBLE GLASS COLLECTORS

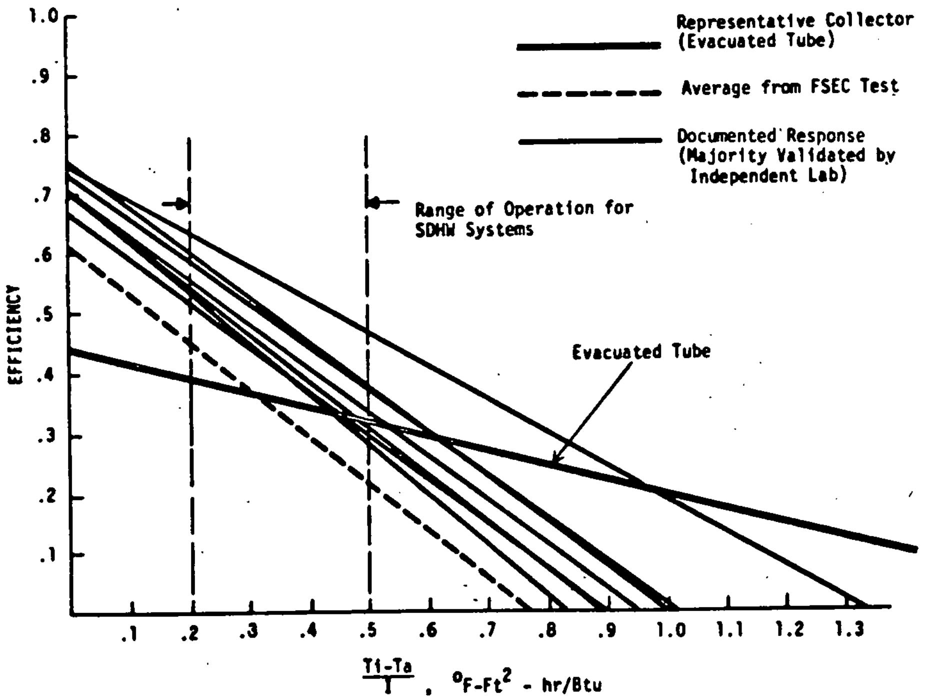


FIGURE 3.9

COLLECTOR EFFICIENCY FOR NON-SELECTIVE, SINGLE GLASS COLLECTORS

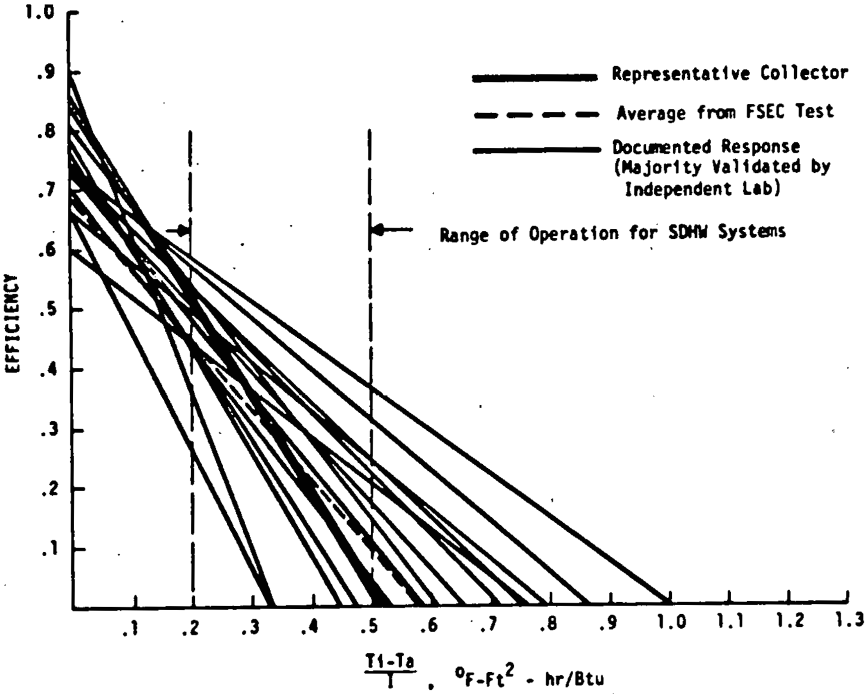
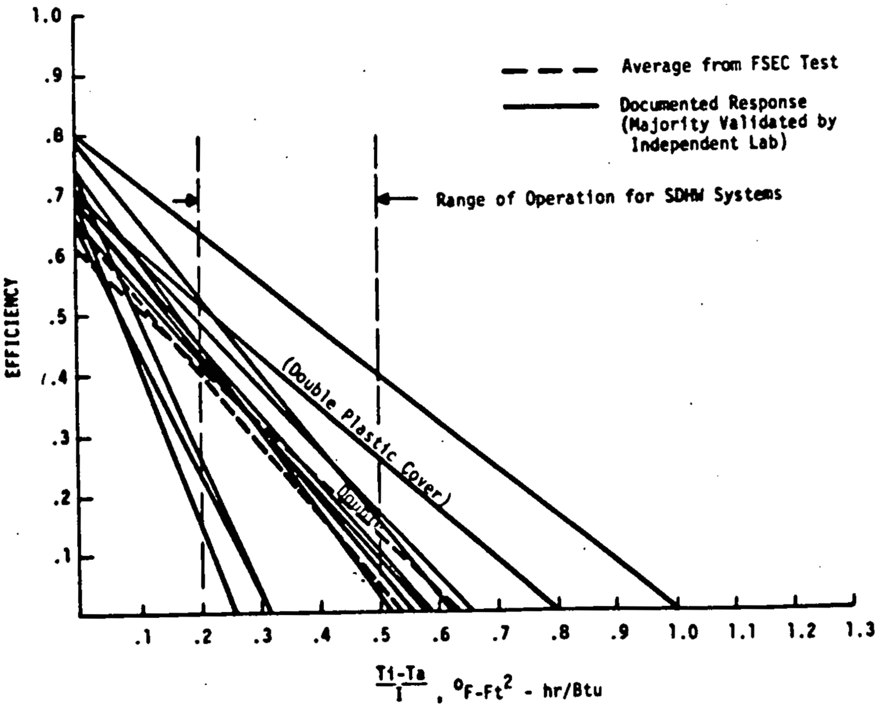


FIGURE 3.10

COLLECTOR EFFICIENCY FOR NON-SELECTIVE, (SINGLE) PLASTIC COLLECTORS

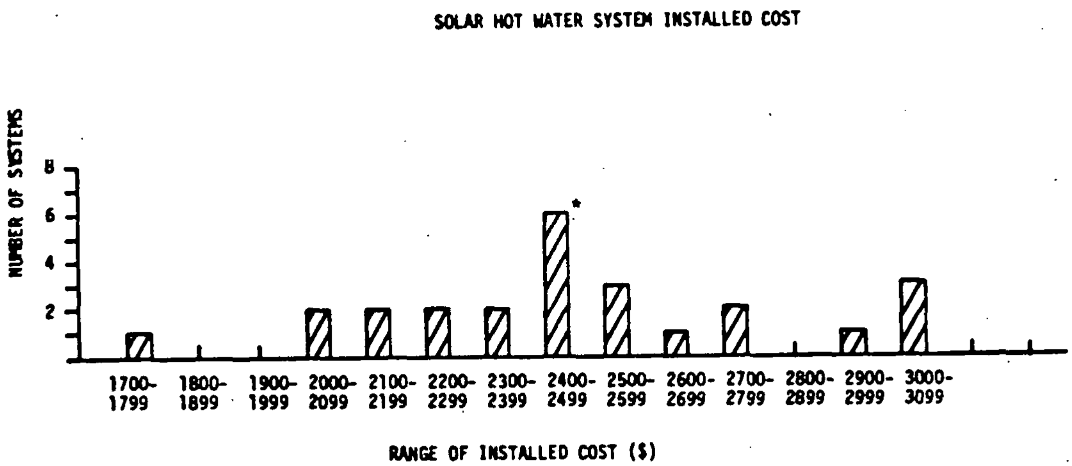


3.3.4 Cost Analysis Based on the Product Literature

In the process of conducting the solar hot water industry survey, only 25 of 82 respondents provided sufficient information to determine both collector and system capital and installation costs. Figure 3.11 shows that the range of installed costs for the 25 systems analyzed is from \$1700 to \$3100. The majority of systems had installed costs ranging from \$2000 to \$2800, with the largest number of systems having an installed cost of about \$2450. In a recent survey of solar domestic water heaters[2] for Arizona, the installation cost ranged from \$1399 to \$3523 with an average cost of \$2461. A complete breakdown of those costs is given in Table 3.9.

The costs were also validated with the Sacramento Solar Hot Water Installers Study (Nov. 79) and with personal interviews with solar water heater distributors. Those results are summarized in Table 3.10.

FIGURE 3.11



*NOTE: Validated with Sacramento and State of Arizona Studies
- \$2300 for Open Loop Systems
- \$2550 for Indirect Systems

[2]"Survey of Solar Domestic Water Heaters," Final Report, OEPAD Contract No. 448-78, ASERC Project No. RFP-78-7, Arizona Solar Energy Commission, 1979, by SERA.

TABLE 3.9

ANALYSIS OF CONSUMER PRICES
OF SOLAR DOMESTIC WATER HEATERS*

Lowest	Highest	
816.00	1373.00	Cost of equipment - 42.6 square feet of collector(s), 80 gallon (solar insulated) tank, pump, controls, miscellaneous pipes, wires, hardware, collector stand and/or mounting equipment.
210.00	430.00	Cost of installation.
286.00	960.00	Cost of marketing.
-0-	160.00	Set aside for warranty expense
87.00	600.00	Net Profit
$1399.00	$3523.00	Total (selling price to consumer)
	$2461.00	Average

*REFERENCE: Final Report, Survey of Solar Domestic Water Heaters, Economic and Market Analysis for Arizona by SERA

TABLE 3.10

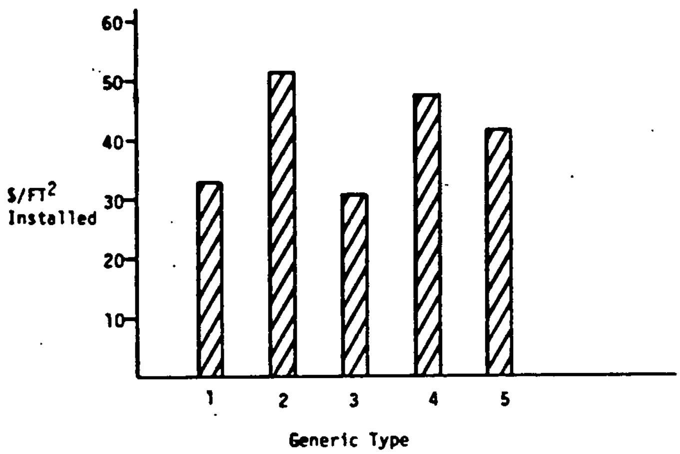
VALIDATION OF INSTALLED SYSTEM COST

	Sacramento Study*	Distributor Interview
Collectors	$730 to $1400/system	$716
Storage	$240 to $400	
Pump	$ 80 to $185	$848
Controls	$ 30 to $400	
Heat Exchanger	$100	
Average Cost	$1730	$1564
Installation Kit	$150 (estimated)	$142
Installation	$400	$600
	$2280	$2306

*Sacramento Solar Hot Water Installers, Nov. 1979

Based on the survey of costs for the 25 system suppliers in this study, the installed cost ranges from $31/ft^2 to $52/ft^2. Figure 3.12 shows this cost breakdown for the different generic types.

FIGURE 3.12 MEDIAN INSTALLED COST*



1 - Direct Recirculation

2 - Direct Draindown

3 - Direct Drainback

4 - Evacuated Tube Drainback

5 - Indirect Antifreeze

The large variation in system installed cost is primarily due to large differences in collector construction costs. This is shown in Figures 3.13 and 3.14. Figure 3.13 shows that collector costs range from $10 to $42 per square foot, with the majority of collectors falling between $16 and $24 per square foot.

FIGURE 3.13

DOCUMENTED COLLECTOR COSTS

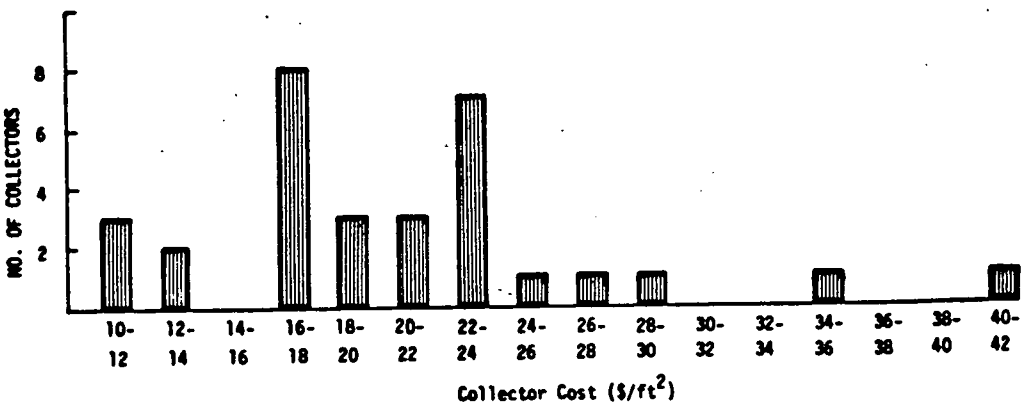
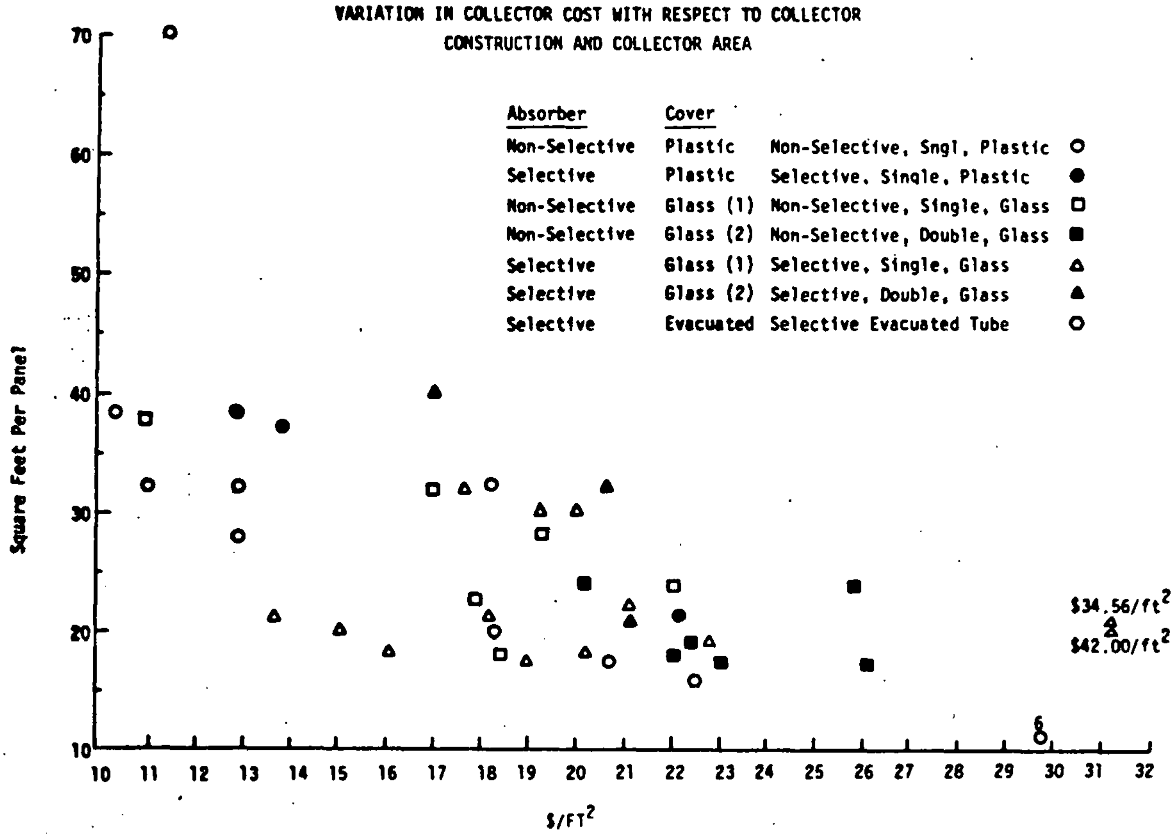


FIGURE 3.14

VARIATION IN COLLECTOR COST WITH RESPECT TO COLLECTOR CONSTRUCTION AND COLLECTOR AREA



A cost effectiveness factor was developed for collectors as a means of comparison.

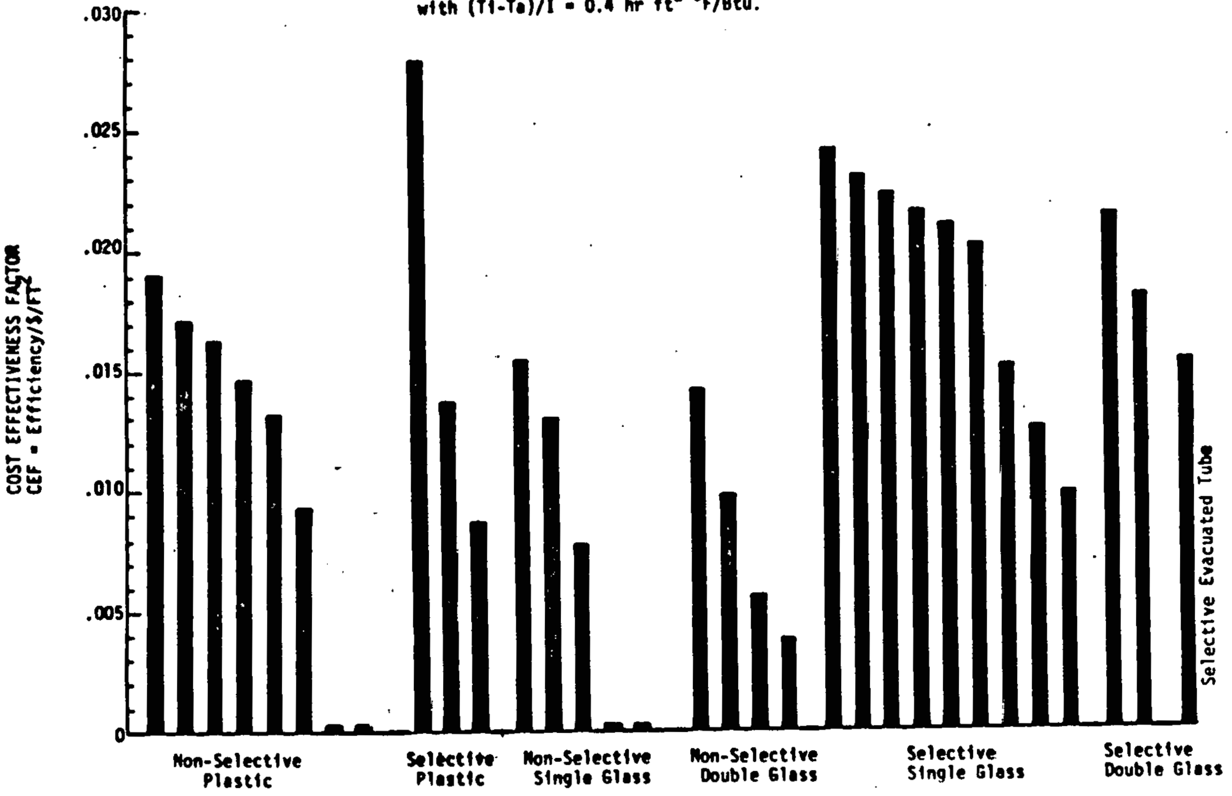
The cost effectiveness factor was defined as:

$$\text{CEF} = \frac{\text{Efficiency}}{\text{Collector Cost } (\$/\text{ft}^2)}$$

where, the efficiency corresponds to an instantaneous collector efficiency. With all of the collector costs sorted according to construction type, all of the collectors are compared in Figure 3.15 using the results of Section 3.3.3. It is especially informative to note that the cost effectiveness of several collectors is very marginal (and non-existent in four cases) for some collectors. It should also be noted that the CEF was calculated for collectors operating at T_i-T_a/I = 0.4 hr ft^2 ^{0}F/Btu which is a reasonable level of performance to expect from a collector used in a solar hot water application. It should further be pointed out that the utility of this bar chart has limiting constraints. The true measure of cost effectiveness is the annual system efficiency divided by the system installed cost and maintenance costs; including collector replacement if required before 20 years.

COST EFFECTIVENESS FACTOR (CEF) FOR VARIOUS SOLAR PANELS *

Note: CEF was computed based on an instantaneous efficiency with $(Ti-Ta)/I = 0.4$ hr ft^2 ^oF/Btu.



*Collector effectiveness based on daily EFF; life cycle maintenance not included.

FIGURE 3.15

3.4 PRODUCT QUALITY

The assessment of product quality represented a significant activity in the overall solar water heating study. It was important to determine the overall quality of the leading products being sold and to assess the needs of the industry required to upgrade the industry to full commercialization status.

Five studies were used to obtain the necessary data as well as site visits to the test facilities at the Wiley Laboratories and the Florida Solar Energy Center and visits to Denver area manufacturers, distributors and installations. The studies used were:

- o Solar Energy Industry Survey for SEIA
  Donovan, Hamester & Rathen, Inc., August 1979
- o Problem Identification of Solar Systems Used in HUD Demonstration Program; National Bureau of Standards, May 1979
- o Interim Report on Performance Data from the Residential Solar Demonstration Program, Franklin Research Center, Spring, 1980
- o DOE Demonstration Program Survey; Argonne National Laboratory, 1978-1979
- o Sacramento Area Solar Domestic Hot Water Heater Installers Study; California Energy Commission, November 1979

3.4.1 Results of the SEIA Industry Survey

Donovan, Hamester & Rathen were commissioned by the Solar Energy Industries Association to conduct a survey of the solar industry to identify problems encountered by the various industry groups in the development of space conditioning and hot water products. DHR relied on 171 telephone interviews of: collector and component manufacturers of solar systems, A&Es, installers, builders and dealers. Of the 171 interviews it was determined by DHR that 144 of the interviews were useful. The 144 included 83 collector and component manufacturers and 59 A&Es, installers, builders and dealers. Table 3.11 lists all interview categories.

Of the 83 manufacturers, 25 indicated that they felt no problems existed. Ten of the 59 A&Es, dealers, installers and builders also indicated they felt no problems existed. Fifteen of the 59 also weren't sure whether any problems existed. Therefore, problems were indicated

TABLE 3.11

SYSTEM/COMPONENT PROBLEMS* -- SEIA INDUSTRY SURVEY

Telephone Interviews	171
Usable Interviews	144
- Collector Manufacturers	66
- A&E, Installer, Builder	50
- Component Manufacturers	17
- Dealers	9

* Source: DHR Report, August 1979

by 58 of the 83 manufacturers and 34 of the 59 A&Es, installers, dealers and builders.

Most of the manufacturers indicated problems in only one area whereas the distribution side of the industry reported multiple problems in a ratio of almost two problems per interview.

The results of the survey are summarized in Table 3.12.

TABLE 3.12

SYSTEM/COMPONENT PROBLEMS -- SURVEY RESULTS

Problems Reported*	83 Manufacturers	59 A&Es
o Collectors	27	17
o Controls	14	16
o Insulation	4	5
o Installation	1	5
o Blowers	3	4
o Storage	17	7
o Energy Transport Subsystems	7	9
No Problems	25	10
Don't Know	--	15

* Final Report to Solar Energy Industry: DHR, August 1979

3.4.2 DOE Demonstration Program Study

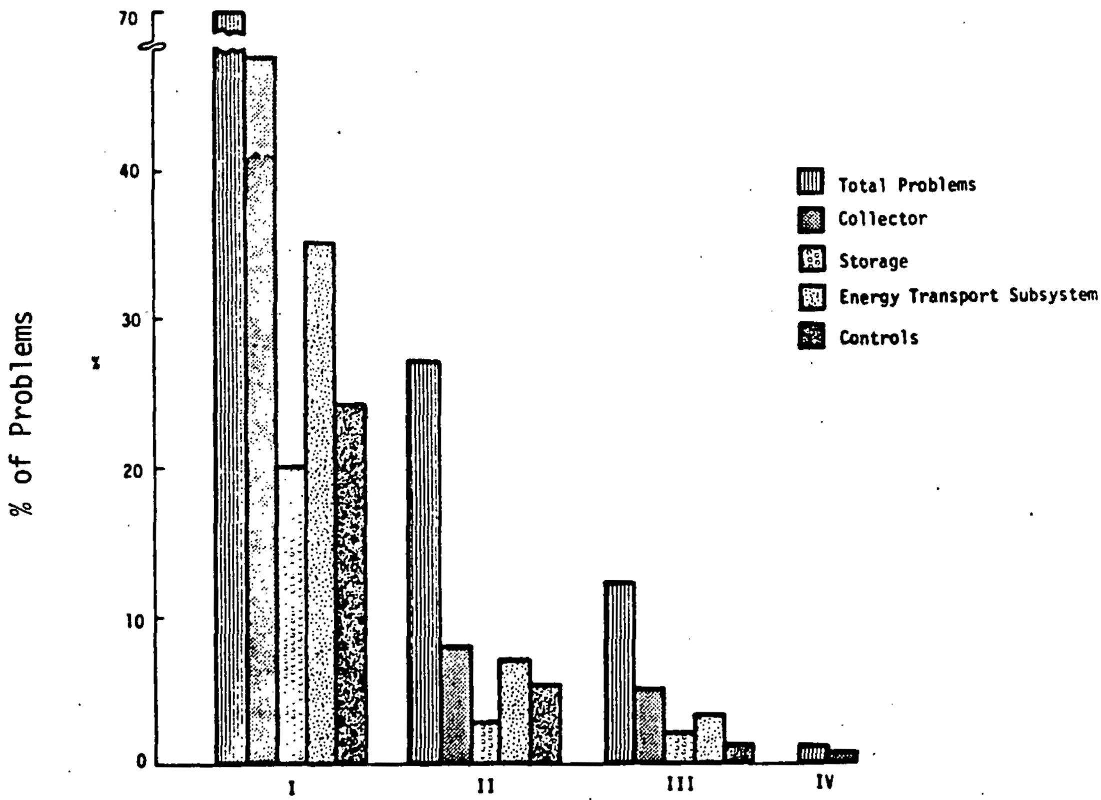
Argonne National Laboratory under contract to the Department of Energy conducted a survey of HUD residential space conditioning and hot water systems. Cycles 1 through 4 of that program were used in the survey. At the time of the survey, the project completions were as follows:

Cycle 1 -- 92 percent of 137 projects
Cycle 2 -- 88 percent of 1327 projects
Cycle 3 -- 82 percent of 3144 projects
Cycle 4 -- 25 percent of 6839 projects

Problems were categorized by collector, storage subsystem, control subsystem, energy transport subsystem, and auxiliary energy supply. Problems included both startup and operational difficulties. Multiple problems were encountered in some of the projects. Based on the complete data, percentage failures in each of the major failure categories are summarized in Figure 3.16. Data aggregates both hot water and space conditioning systems.

FIGURE 3.16

PROBLEM SUMMARY - MAJOR SUBSYSTEMS IN HUD DEMONSTRATION SITES*



*Letter Report to HUD, NBS, May 10, 1979.

NOTE: All problems include construction and operation with many of the operating problems occurring during start-up.

It is noteworthy that a continuous decline in failures in all categories occurred throughout the program. While the data might sugges that the problems in the systems are becoming negligible, it must be realized that many of these systems were recently completed at the time of the study and insufficient operating time was available to fully assess all of the problems. Nonetheless, many of the problems are diminishing as the manufacturers mature in the design, manufacture and installation.

These data are also useful in assessing the relative incidence of specific problems in each of the major subsystem categories. These data corroborate the results of the SEIA study performed by DHR. The most common problems are collectors, controls, and storage. Using aggregated data, energy transport could be considered the number 2 problem in the DHR study which would be in exact agreement with this HUD survey. It is noteworthy that the energy transport subsystem is applicable only to the space conditioning systems, would not be considered a problem in solar hot water systems, and therefore should be discounted for the purposes of this study.

Again, the reader is reminded that space conditioning systems and water heaters are all included and water heaters only would be expected to be less than these values.

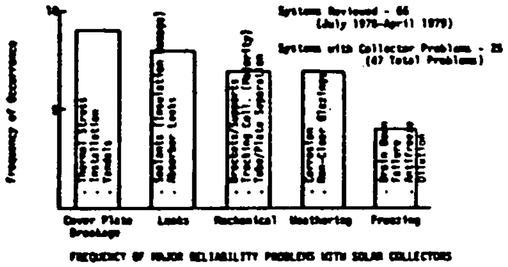
Later studies by the Franklin Institute on these same HUD demonstrations delineated operational problems for Cycles 1,2, and 3. In this analysis, collector problems in demonstration systems were reduced from 45% to 31% for Cycles 2 to 3. Storage problems decreased from 23% to 11%. Controls decreased from 34% to 16%.

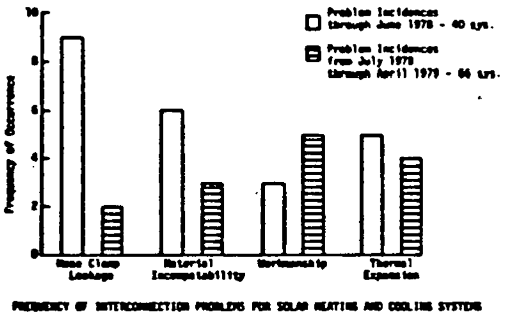
3.4.3 Component Failure Mechanisms

Argonne National Laboratory conducted a detailed study of problems which occurred in 40 commercial demonstration systems in a period through June of 1978 and 66 systems in commercial demonstration sites from July of 1978 through April of 1979. The purposes of this investigation were to identify major causes of failures, to establish failure trends and to identify corrective strategies.

3.4.3.1 <u>Collector Problems</u>: Collector problems were divided into two major categories -- those dealing with the collector module and those associated with the interconnect of the modules. In Figure 3.17 the results from 66 systems for the July 1978 through April 1979 survey are presented. There were a total of 47 collector problems in 25 systems.

<u>FIGURE 3.17</u>





Fourteen problems occurred in the interconnect system. Problems resulted from design, installation, mechanical failures and material failures. There was a uniform distribution of problems in many of the categories as shown in Figure 3.17. Most of the mechanical failures occurred in the tracking collectors as opposed to flat plate collectors.

3.4.3.2 <u>Collector Interconnects</u>: Argonne also performed a survey of the collector interconnect problems and identified the types of failures most likely to occur in each of three interconnect concepts including:

- o Rubber/elastomers
- o All metal interconnects
- o Metal/elastomer seals

Table 3.13 discusses five types of interconnect problems, including faulty hose connections, clamp failures, metallic connection failures, expansion joint problems and failure to provide adequate access to the interconnects.

TABLE 3.13

INTERCONNECT PROBLEMS

- o Hose Connections
  - loosening/leaks
  - overheating/material deteriorates
  - UV, ozone deteriorates
  - pipe cement leaks
  - inadequate tightening
  - swivel joint leaks
- o Clamps
  - compression set
  - loose crimp clamps
- o Metallic Connection
  - dielectric separation
    - . AL collectors/CU pipe
    - . steel/copper screw threads
  - CU solder joints
- o Expansion joints
  - inadequate allowance
  - improper alignment
- o Inadequate Access

Based on their survey of elastomers for collector interconnects, Argonne National Laboratory identified nine elastomer compounds as shown in Table 3.14 which are being used. Argonne rated each elastomer in ten design categories. As a result of this study, Argonne recommended four of the nine for use in interconnects.

3.4.3.3 Glazings: In conducting the survey of solar collectors, it was also necessary to assess the glazing materials used in

TABLE 3.14

Candidate Elastomers for Solar Heating Applications

COMPOUND (Chemical Name)	Water Resistance	Water Glycol Resistance	Sunlight Aging	Oxidation	Ozone Resistance	Temperature Aging	Low Temp Resistance	Compression Set	Abrasion Resistance	Tear Resistance	Remarks
1) EPDM Rubber (Ethylene Propylene-Diene Terpolymer	A	A	A	A	A	A	A	B	B	C	Recommended
2) Viton (Fluoroelastomer)	B	B	A	A	A	A	B	A	B	B	Recommended
3) Silicone (Polysiloxane Polymer)	A	A	A	A	A	A	A	C	C	C	Recommended
4) Hypalon (Chloro-Sulfonyl-Polyethylene)	B	B	A	A	A	B	B	C	A	C	Recommended
5) Neoprene (Chloroprene)	B	B	B	A	A	B	B	B	A	B	Acceptable
6) Butyl (Isobutylene Isoprene)	B	B	B	A	A	B	B	B	C	B	Acceptable
7) Natural Rubber (Polyisoprene)	B	B	NR	B	NR	C	B	B	A	B	Not Recommended
8) Nitrile (Buna N or Butadiene - Acrylonitrile)	B	C	NR	B	C	B	B	B	B	C	Not Recommended
9) Buna S (SBR Styrene-Butadiene)	B	B	C	C	NR	C	A	B	A	B	Not Recommended

RATING: A - Excellent
B - Good
C - Fair
NR - Not Recommended

collectors considering five different glazing materials -- glass, acrylic, polycarbonate, fiberglass and polyethylene. Each of these materials was examined for performance, operating temperature, lifetime and cost in dollars per square foot. This information was obtained from the Southwest Bulletin published by the New Mexico Solar Energy Association, September 1979 (Table 3.15).

In this study acrylic materials were shown to have the highest solar transmittance, and fiberglass, depending on its specific design, has the lowest solar transmittance. A good collector glazing must also inhibit IR transmittance and all of the glazing materials with the exception of the polyethylene sheeting have this desirable property.

Temperature of a glazing material is important particularly for the non-selective collectors where the glazing temperatures can become significantly high. It is usually desirable to have a glazing material which can tolerate operating temperatures in excess of 200°F. Again it is noteworthy that acrylics, fiberglass, and polyethylene receive an unfavorable rating in this category and therefore under stagnation conditions could exhibit some permanent damage.

TABLE 3.15

GLAZING MATERIAL PROPERTIES*

GLAZING MATERIAL PROPERTIES*

Material	Solar Transmittance	IR Transmittance	Operating Temp.	Life	Cost-$/ft^2
Glass	89	3	400+	20+	75-2 (1.5 typical)
Acrylic	92	N.A.	180-200	20	1-2
Polycarbonate	86	6	250-270	5-17	2.25-3.25
Fiberglass	78-90	6-10	160-200		.25-.5
Lascolite, Filon, Sunlight				4-7	
UV Resistant				7-13	
Tedlar Coated				13-20	
Polyethylene	85	70-80	140	<3	.01-.03

*Southwest Bulletin, N.M. Solar Energy Association, September, 1979.

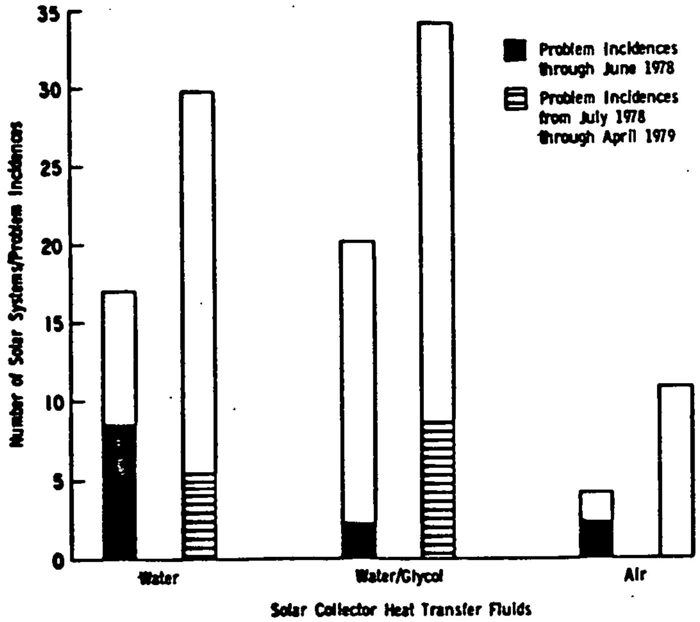
The lifetime of a collector should be in excess of 20 years and therefore the glazing should match this most important system parameter. Glass satisfactorily meets the lifetime requirement. Acrylic and tedlar coated fiberglass also have the potential of achieving this long-term requirement, but uncoated fiberglass and polyethylene will not.

And finally, a most important criterion to a manufacturer is the cost of the glazing. The most expensive glazing materials are the polycarbonates closely followed by acrylics and glass. The polyethylene and fiberglass glazings are much cheaper than any of the other three options, and the polyethylene is several orders of magnitude less expensive accounting for its application in a few instances.

Sixty-nine solar hot water system manufacturers were examined to determine the glazing materials in use; 55 are using glass glazings and 14 are using plastic glazings. Based on the information in Appendix II, it could be assumed that the 14 solar hot water systems utilizing plastic glazed collectors should be suspect and the consumer should be made aware of the potential shortened lifetime before purchasing the system.

3.4.3.4 Fluids: Argonne National Laboratory also examined the freezing problem in the 1978 and 1979 samples (Figure 3.18). It should be

FIGURE 3.18

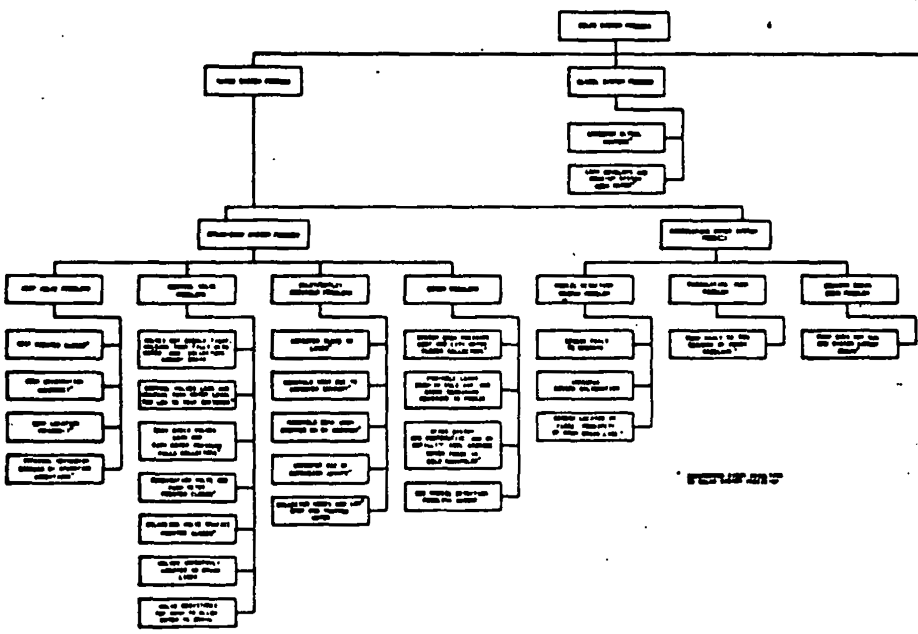


Incidences of Freezing Problems for
Solar Heating and Cooling Systems

noted that the draindown and drainback systems which utilize water for a collector coolant exhibited a higher percentage of problems in the earlier time frame and a significant drop in these problems occurred in the second sample indicating a diminishment of this catastrophic-type failure. The indirect or water glycol systems, on the other hand, continued to exhibit problems in the same ratio or perhaps slightly higher in the second sample -- indicating that these problems may not be completely understood. The air systems, on the other hand, found to have problems in the earlier time frame appear to have been solved completely.

It was interesting to note from the Argonne study that the water cooled (draindown and drainback) systems are much more susceptible to freezing problems which could occur from a variety of reasons as shown in Figure 3.19. It should be noted, however, that while the indirect systems have fewer failure mechanisms, these systems are plagued by potential failures in the glycol concentration ratio, loss of corrosion inhibitors, and increase in pH. These glycol systems have a significant potential for corrosion in the event of improper maintenance.

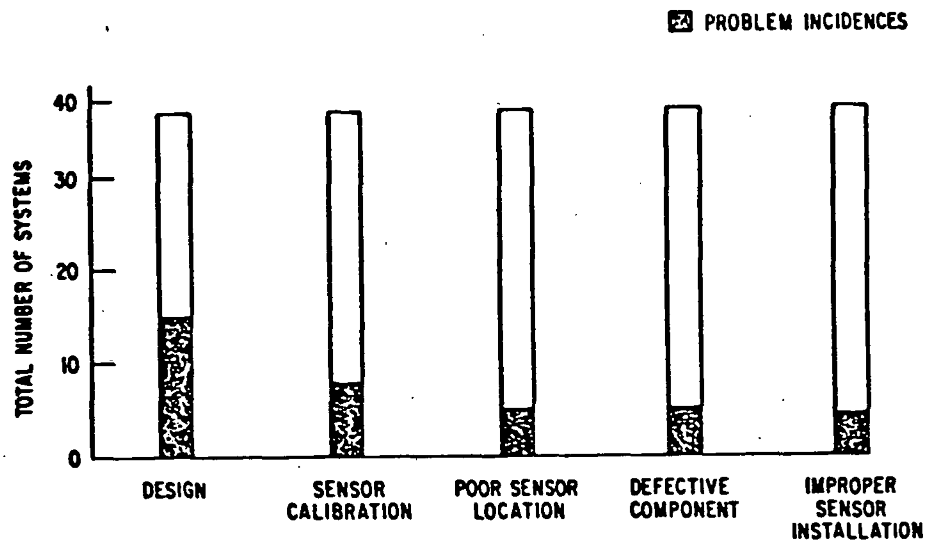
FIGURE 3.19



Component Problems Leading To Solar System Freeze-Ups

3.4.3.5 Controls: Turning next to the control systems (Figure 3.20) it is noted that three categories of problems can occur relating to the control system: design, sensors and defective components Design is the leading problem area in the control systems followed closely by sensor problems and finally defective components were identified as a less serious problem area. Table 3.16 translates these failures into specific impacts on the system which illustrates that control failures are most likely to impact system performance although the catastrophic collector damage can be as high as 8% in the event of a control failure.

FIGURE 3.20



Control-System Problem Incidences - To June '78

TABLE 3.16

Table 1. Listing of Control Problems and System Effects

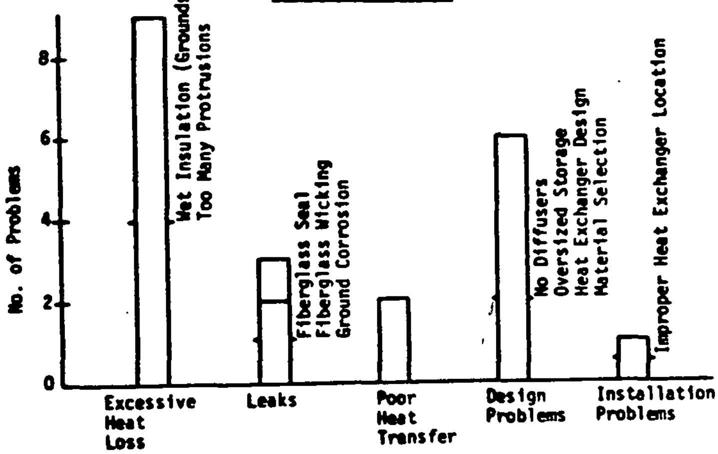
System Effect		Problem: Design	Calibration	Defective Component	Sensor Location	Improper Sensor Installation
Loss of Solar Energy	(30%)	1	4	3	3	0
Improper Operating Mode	(27%)	5	1	2	0	2
Loss of Auxiliary Energy	(16%)	4	1	0	1	0
Collector Damage	(8%)	2	0	0	1	0
Spurious Pump Operation	(8%)	2	1	0	0	0
Misc.	(11%)	2	1	1	0	0

In discussions with industry it was noted that controls have traditionally been a failure prone subsystem and it is not likely that the solar program will fare much better. Nonetheless, there are certain measures which can be adopted to alleviate the problem. These measures include:

- o improved design procedures making proper use of truth tables, reliability analysis and the development of better trouble-shooting guides
- o improved testing at the systems level under controlled conditions
- o improved factory quality control testing at the systems level including a better sensor calibration check
- o improved reliability testing under factory conditions to identify the superior system components
- o improved performance monitoring of installed systems to ensure the identification of system failures at an early point, particularly when it affects early failure of major subsystems
- o addition of glycol monitors to measure concentration and pH levels to notify the homeowner of impending glycol mix deficiencies

3.4.3.6 <u>Storage</u>: Storage problems were examined by collecting information on 21 storage problems identified in the demonstration sites (Figure 3.21). The predominant failure mechanism identified was loss of thermal insulation under buried tank conditions where ground water destroyed

FIGURE 3.21 STORAGE PROBLEMS



Frequency of Storage Problems*
in 21 Problems Investigated

* Design and Installation Manual for Thermal Energy Storage, ANL #79-15

the storage tank insulation. Design problems were identified as the second most significant storage tank failure. Leaks, poor heat transfer and installation problems were also noted in the Argonne study.

3.4.4 The Sacramento Solar Hot Water Installer Survey Report

The California Energy Commission conducted a survey of solar hot water installer service calls. This Sacramento report was published in November 1979 and identifies the frequency of service calls occurring in systems installed within the recent history.

In this report, service call histories were recorded at the three month, one year and two year intervals. It was noted from the data presented in this report that while many of the systems experienced some minor difficulties during the three month start up phase, the problems diminished rapidly thereafter. Problems listed in this survey indicated that many of the problems were fairly minor start up problems although one of the suppliers did experience some freezing problems. The problems which were identified included; air in the system, pump failure, sensor failures, freezing (one manufacturer only), leaks, and control failures. According to this report most of these problems were repaired and few problems were indicated beyond this initial three month shakedown period.

CHAPTER 4

COMPARISON OF THERMAL AND ECONOMIC PERFORMANCE FOR CONVENTIONAL AND SOLAR DOMESTIC WATER HEATERS

4.0 INTRODUCTION

This chapter presents the thermal and economic analysis of the two conventional and five solar domestic water heating systems considered in this study. The thermal results for Washington, D.C., and Phoenix, Arizona were obtained by simulating the system annual performance using TRNSYS. Due to the unavailability of TMY (Typical Meteorological Year) weather tapes for Denver, Colorado and Los Angeles, California during the course of this study, the thermal performance of each solar DHW system for each of these two cities was obtained by using F Chart. The economic performance of each system was determined with the use of the ECON computer program developed by SAI which performs life-cycle costing.

4.1 DESCRIPTION OF TEST ENVIRONMENTS AND SIMULATION MODELS

This section describes the environmental conditions, the hot water load, and the simulation models used in the study.

4.1.1 Environmental Conditions

The SAI modified TMY (Typical Meteorological Year) weather tapes were used to provide hourly weather data for Washington and Phoenix. These TMY weather data were developed by Sandia Laboratories under a DOE contract.

The monthly average water supply temperatures were used in each location and are presented in Table 4.1.

4.1.2 Load Description

In each of the conventional and solar DHW systems, the hot water daily use profile was based on a four person consumption of 300 liters

TABLE 4.1

MONTHLY AVERAGE WATER SUPPLY TEMPERATURES

City	Water Temperatures (°C) J	F	M	A	M	J	J	A	S	O	N	D
Washington	6	6	11	13	17	19	19	26	26	20	13	8
Phoenix	19	19	21	24	25	29	31	32	31	28	24	21
Los Angeles	5	7	12	13	15	20	21	24	23	19	14	5
Denver	3	3	5	9	12	16	20	19	18	13	8	4

(80 gallons). The hourly consumption was generated by using the Rand profile, which distributes the hourly hot water consumption as shown in Table 4.2 and Figure 4.1. A delivery temperature of 120°F (48.9°C) was assumed for all systems in all four cities. The hot water load is directly dependent on the temperature rise of the water from the main supply to delivery. The monthly and annual hot water loads for each of the four cities are given in Table 4.3.

TABLE 4.2

HOURLY PROFILE OF DOMESTIC HOT WATER CONSUMPTION

Time	Consumption (Liters)	Time	Consumption (Liters)
12-1 a.m.	6.4	12-1 p.m.	10.8
1-2 a.m.	0	1-2 p.m.	15.2
2-3 a.m.	0	2-3 p.m.	8.0
3-4 a.m.	0	3-4 p.m.	7.2
4-5 a.m.	0	4-5 p.m.	6.4
5-6 a.m.	0	5-6 p.m.	11.2
6-7 a.m.	4.4	6-7 p.m.	20.4
7-8 a.m.	14.0	7-8 p.m.	34.8
8-9 a.m.	21.6	8-9 p.m.	28.8
9-10 a.m.	25.6	9-10 p.m.	20.8
10-11 a.m.	20.8	10-11 p.m.	16.4
11-12 a.m.	13.6	11-12 p.m.	13.6

FIGURE 4.1

ASSUMED CONVENTIONAL AND SOLAR DEMAND PROFILES, DESCRIBED IN TERMS OF USE VS. TIME OF DAY

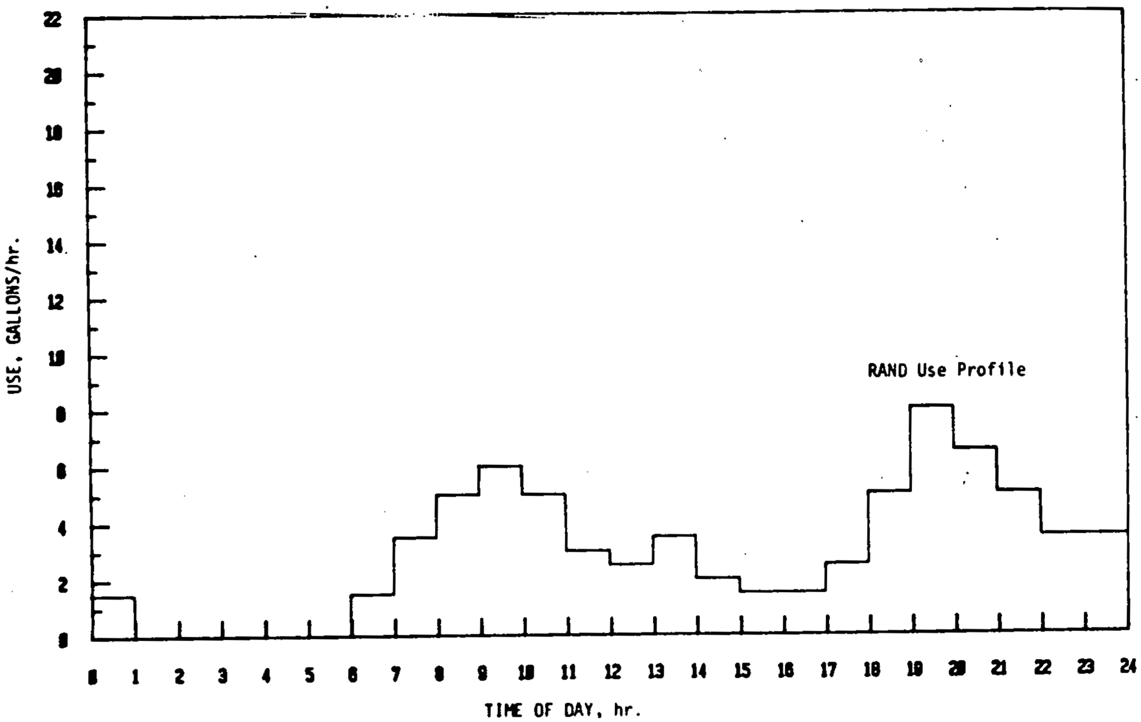


TABLE 4.3

MONTHLY AND ANNUAL HOT WATER LOAD (GJ)*

	CITY			
Month	Washington, D.C.	Phoenix	Denver	Los Angeles
J	1.67	1.17	1.79	1.71
F	1.51	1.05	1.62	1.48
M	1.48	1.09	1.71	1.44
A	1.35	0.94	1.51	1.38
M	1.24	0.93	1.44	1.32
J	1.13	0.75	1.24	1.09
J	1.17	0.70	1.13	1.09
A	0.89	0.66	1.17	0.97
S	0.86	0.68	1.17	1.00
O	1.13	0.82	1.40	1.17
N	1.35	0.94	1.55	1.32
D	1.59	1.09	1.75	1.71
Year	15.38	10.81	17.49	15.70

4.1.3 Simulation Models

As mentioned earlier in this chapter, TRNSYS was employed in simulating the thermal performance of each of the water heating systems in Washington and Phoenix and F Chart was used for Denver and Los Angeles. The TRNSYS simulation program was developed at the University of Wisconsin with support from the National Science Foundation (NSF), Energy Research and Development Administration (ERDA) and Department of Energy (DOE). The program consists of a central and algebraic solver, a library of component models, and front-end software which facilitates the building of system models and the interfacing with system forcing functions (Weather data, etc.). The technique is to iteratively solve the set of simultaneous equations which describe the system at discrete intervals of time, and thereby mimic the operation of the system on the computer. Output devices such as printers, summarizers, and histogram plotters allow the user to "probe" system dynamics by tracking key state variables and key energy flows.

The F Chart computer program is a state of the art method for estimating solar heating system performance which was also developed at the University of Wisconsin. It is based on the F Chart design method which is the result of an analysis of hundreds of detailed computer simulations of solar heating systems. Most of its solar radiation data were based on the SOLMET project of the National Oceanographic and Atmospheric Administration, funded by DOE. Since F Chart does not consider parasitic energy consumed by pumps and controllers, etc., calibration of F Chart results against TRNSYS results is necessary. In this study, the collector tilt angle was taken to be the same as the latitude.

The economic analysis is performed by using the ECON computer program developed at SAI from a DOE contract using life cycle costing method. The optimum collector size was determined by minimizing the present value of life cycle cost per unit energy displaced by solar.

4.2 SYSTEM DESCRIPTIONS

This study considers two types of conventional systems (gas and electric heaters) and five types of solar hot water systems (direct draindown , direct recirculation, direct drainback, evacuated tube and indirect). In the following paragraphs, each system is described in detail to provide a basic understanding of its operation.

4.2.1 Conventional Water Heaters

The conventional gas and electric heaters are schematically shown in Figures 4.2 and 4.3, respectively. Design and performance data was provided by Planco, Inc. The gas heater has a 40 gallon water storage tank of 50 3/8" height and 20 3/4" diameter and it has 3/4" fiberglass insulation (R-3). The burner efficiency is taken to be 68%. The electric heater has a storage tank of 52 gallon capacity (55 1/4" height and 21 3/4" diameter) and it has 1 3/4" fiberglass insulation (R-5.5). The electric heater element efficiency is assumed to be 98%. Storage losses were also considered in the analysis.

FIGURE 4.2 - SCHEMATIC OF GAS WATER HEATERS

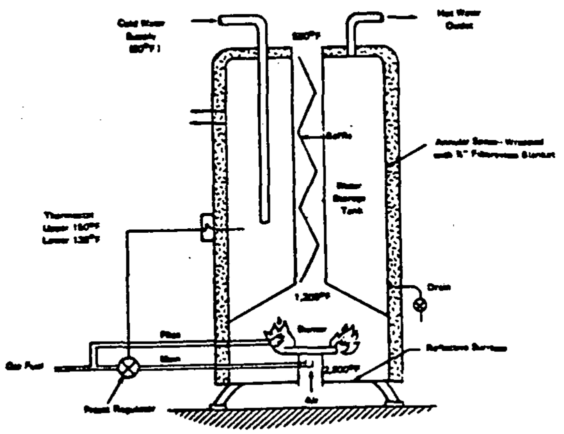
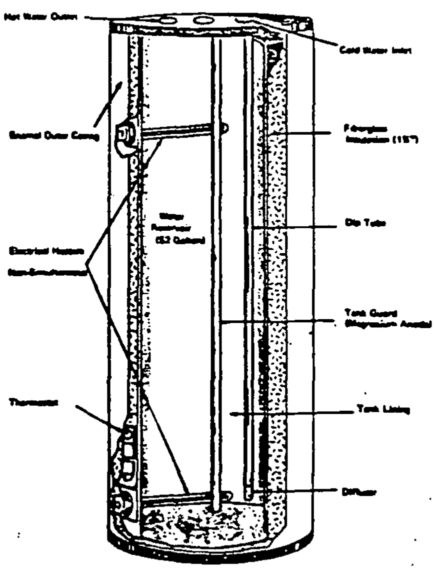


FIGURE 4.3 - SCHEMATIC OF ELECTRIC WATER HEATERS



4.2.2 Solar Water Heaters

The direct draindown, direct drainback, direct recirculation, indirect, and evacuated tube solar water heating systems considered in this study were schematically shown in Chapter 3, Figure 3.4. Representative commercial systems were selected from the solar hot water system suppliers list. These selections were made on the basis of quality and completeness of systems data.

TABLE 4.4

COLLECTOR PERFORMANCE CHARACTERISTICS*

	Collector Area/module (ft^2)	τ	α	F'	U_L Btu/hr-ft^2-^oF)
Draindown	17.94	.9	.95	.95	1.13
Indirect	17.06	.91	.95	.95	1.02
Drainback	16.99	.9	.9	.95	.70
Recirculation	29.2	.9	.9	.95	1.38
Evac. tube	16	.92	.86	NA	.25

*Information collected from product literature and telephone contacts with companies producing the systems.

The first four generic systems used flat plate solar collectors having collector characteristics as summarized in Table 4.4. The direct systems (draindown, drainback and recirculation) use a differential controller to actuate the collector pump according to the preset controller deadband temperatures (in Table 4.5).

TABLE 4.5

CONTROLLER DEADBAND TEMPERATURES

System Type	ΔT_1 (^oF)	ΔT_2 (^oF)
Draindown	9	3
Indirect	12	3
Drainback	17	3
Recirculation	9	3

The three direct systems use different methods of freezing protection. In the recirculation system, the collector loop pump recirculates water whenever the ambient temperature is less than 40^{o}F. In the draindown system, water in the collector and piping is discarded by drain valves whenever the collector pump is off. In the drainback system, water is drained from the collector to the storage tank when the collector loop pump is off.

The indirect system has two heat exchangers immersed in the storage tank. The effectiveness of the heat exchangers is 50%. For freeze protection, propylene glycol is used as the collector fluid. A proportional controller energizes the collector loop pump when the collector outlet exceeds the tank temperature by 12^{o}F and de-energizes it when this differential is less than 3^{o}F. In addition, the pump flow rate, until the maximum flow rate is reached, is directly proportional to this temperature differential. The pumping power is linearly increased from 76 to 98W with the temperature differential up to the maximum value of 98W.

Each of the above four systems has an 82 gallon storage tank (height to diameter ratio of 1.7) with three inches of fiberglass insulation (R-12).

In the evacuated tube system, the collector loop pump is on when the collector outlet temperature is greater than or equal to 180^{o}F, and fluid is circulated if the collector outlet exceeds the storage tank temperature by 10^{o}F. This system has a 42 gallon storage tank (34.5 inches high, 26 inch diameter) with three inches of fiberglass insulation (R-12).

All systems have a 40 gallon back up tank of 45 3/8" height and 21 3/4" diameter and three inch fiberglass insulation (R-12). The thermostat and auxiliary heating element are assumed to be located near the top of the back up tank to prevent the delivery temperature from dropping below 120^{o}F (43.3^{o}C). In performing TRNSYS simulations, each tank was assumed to have three stratified layers.

The pump and controller power consumption can reduce total energy savings and therefore becomes a significant factor in assessing system performance.

Energy consumption for each system is summarized in Table 4.6.

TABLE 4.6

PARASITIC ENERGY USAGE RATE FOR SOLAR HOT WATER SYSTEMS

SYSTEM	PUMPING POWER (W)	CONTROLLER POWER (W)	VALVE POWER (W)
Draindown	76	2	1.5
Indirect	76-98	2	---
Drainback	190	2	1.5
Recirculation	76	2	---
Evac. tube	241	2.3	---

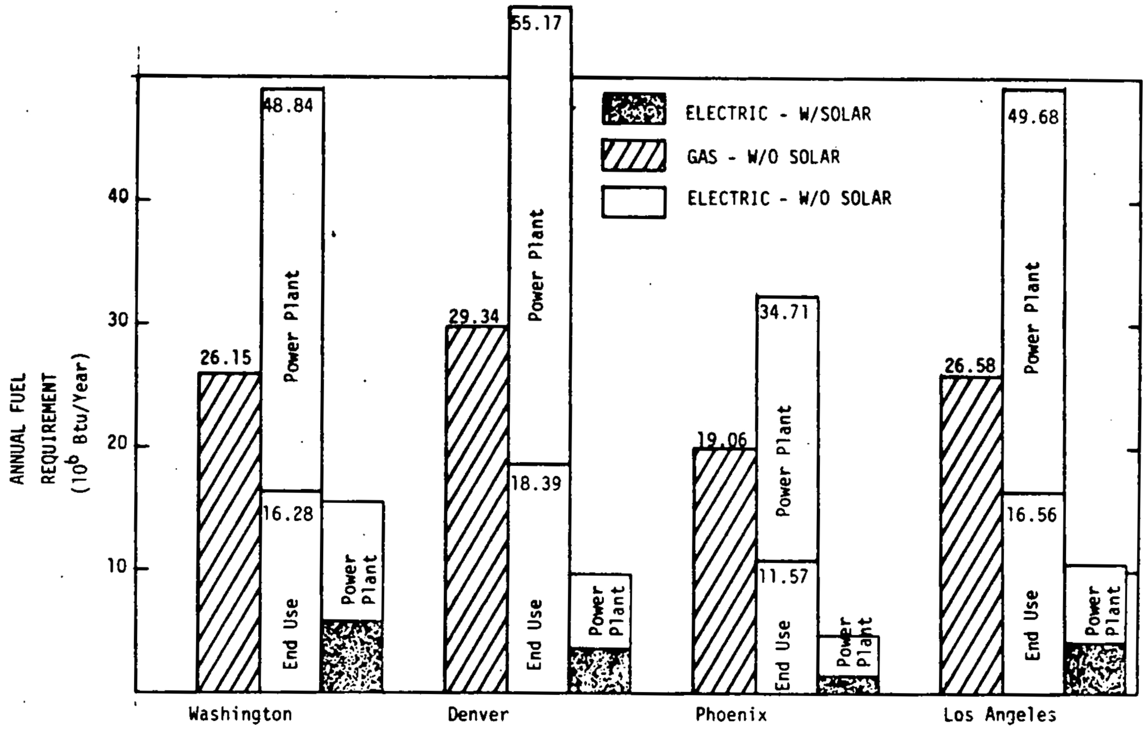
4.3 THERMAL ANALYSIS

The thermal performance of each solar hot water system was simulated for Washington and Phoenix using TRNSYS. For Denver and Los Angeles, the results were obtained using F Chart and were modified to account for parasitic energies. Thermal results were obtained for each system using one, two and three collectors. The life cycle cost of each system size (one, two and three collectors) was determined based on the auxiliary energy requirement, the economic factors described in the next section, and the system capital cost. Optimum size was obtained by minimizing the life cycle cost per unit of energy displaced. The thermal results presented in this section are for the optimum systems.

4.3.1 Fuel Requirements for Conventional Water Heaters

Annual fuel requirements for the conventional gas and electric water heaters in all four cities are presented in Figure 4.4. Electric resistance heating and electric parasitic losses are also computed at the power plant considering 33% conversion efficiencies in order to illustrate total energies saved.

FIGURE 4.4



CONVENTIONAL HOTWATER SYSTEMS

ANNUAL FUEL USAGE: GAS & ELECTRIC

4.3.2 Thermal Results for Solar Hot Water Systems

This section presents the thermal performance of the five solar domestic hot water systems considered in this study for Washington, Denver, Los Angeles, and Phoenix. Performance results include energy displaced with and without parasitic energies, thermal and system efficiencies, gross and net solar fractions, and system COP. Thermal efficiency is the solar energy delivered to the load divided by the solar insolation. System efficiency is thermal efficiency less the parasitic energy divided by total solar insolation incident on the collector. Gross solar fraction is the fraction of the thermal load met by solar. Net solar fraction is less than gross solar fraction by an amount equal to the parasitic energy divided by the thermal load. Subsequently, system COP is the solar energy delivered to the load divided by the operating energy (parasitic energy for pump, controller, etc.).

Monthly insolation values used in this analysis is tabulated in Table 4.7. Monthly and annual solar insolation for the four cities is compared. Note the low solar insolation for Washington, D.C. and nearly equal values for Phoenix and Denver.

TABLE 4.7

SOLAR INSOLATION

	Phoenix	Denver	Los Angeles	Wash. DC
Solar Insolation (GJ/M^2)				
January	0.56	0.61	0.49	0.30
February	0.60	0.61	0.52	0.35
March	0.76	0.75	0.67	0.46
April	0.82	0.72	0.67	0.50
May	0.84	0.73	0.65	0.55
June	0.78	0.72	0.62	0.56
July	0.76	0.75	0.71	0.56
August	0.77	0.75	0.70	0.57
September	0.77	0.75	0.63	0.50
October	0.75	0.74	0.60	0.46
November	0.60	0.58	0.51	0.33
December	0.53	0.55	0.47	0.26
Year	8.55	8.25	7.24	5.37

Thermal results were computed using these insolation values and are summarized for each generic type in each city using the format shown in Table 4.8. The remaining charts are included in Appendix V.

TABLE 4.8

THERMAL PERFORMANCE

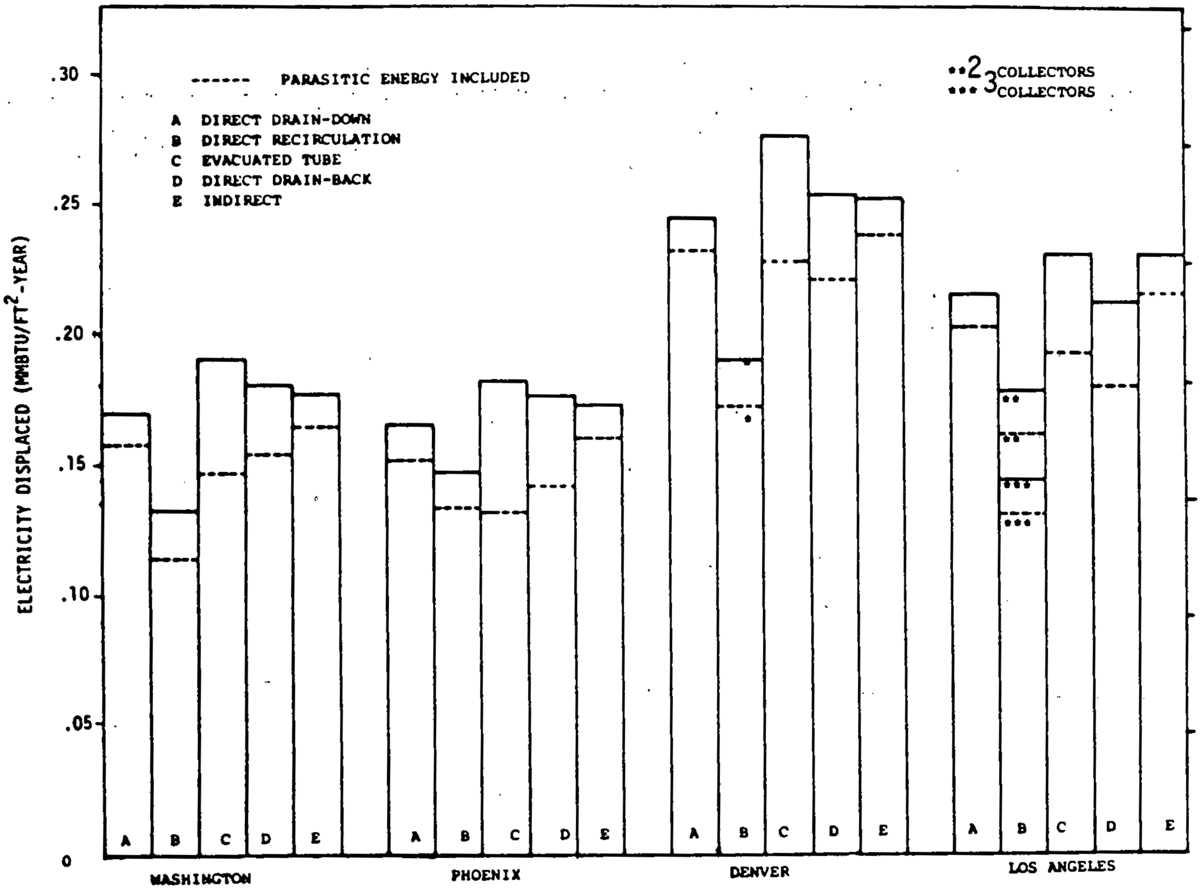
CITY: Washington, D.C.
SYSTEM: Direct drain-down (5 m^2)

Month	Electrical Energy Displaced (GJ) Parasitics not included	Electrical Energy Displaced (GJ) Parasitics included	Thermal Efficiency	System Efficiency	Solar Fraction (%) Gross	Solar Fraction (%) Net	System COP
J	.750	.701	.455	.425	44.9	42.0	15.8
F	.753	.704	.443	.414	49.8	46.7	15.4
M	1.001	.938	.417	.391	67.6	63.4	15.9
A	1.086	1.018	.418	.392	80.4	75.4	16.0
M	1.065	.990	.380	.354	85.9	79.8	14.2
J	1.070	.995	.369	.343	94.7	88.1	14.3
J	1.083	.998	.394	.363	92.6	85.3	12.7
A	.755	.683	.256	.232	84.8	76.7	10.5
S	.815	.755	.333	.308	94.8	87.8	13.6
O	.860	.802	.391	.365	76.1	71.0	14.8
N	.712	.660	.432	.400	52.7	48.9	14.6
D	.619	.574	.459	.425	38.9	36.1	13.8
Year	10.69	9.94	.391	.364	69.5	64.6	14.3

The results are compiled in the bar chart, Figure 4.5. Electrical energy displaced per unit area of collector is also presented.

FIGURE 4.5

COMPARISON OF THERMAL PERFORMANCE



Note: Collector performance differed for all systems with the indirect systems having the highest flat plate efficiency. This indirect system also uses a higher performance proportional controller. The indirect system was also the most expensive.

The evacuated tube system had the highest BTU displaced per square foot of collector area not considering parasitic energy. This is also true for thermal efficiency. When parasitics are included, the net energy displaced was similar for all but the recirculation system. This recirculation system performed less favorably in the colder environments of Washington, D.C. and Denver.

The indirect system benefited from better collector performance than the other three flat plate systems and also used a proportional controller. When a lower performing collector and a differential controller was substituted in the indirect system, the thermal performance of this indirect system was reduced 30% (as can be seen in Table 4.9).

TABLE 4.9

Sensitivity Tests for the Indirect System in Washington, D.C. with a Water Heating Load of 15.38 GJ/year

Controller Type	Collector Characteristics F'	α	T	U_L (kJ/m^2-Hr-^{o}C)	Auxiliary Heating (GJ)	Parasitic Energy (GJ)	Gross Solar Fraction (%)	Net Solar Fraction (%)
Proportional	.95	.95	.91	20.8	4.8	0.817	68.8	63.5
Differential	.95	.95	.91	20.8	5.8	1.313	62.3	53.8
Differential	.95	.90	.90	28.2	7.2	1.063	53.2	46.3

Comparing the thermal output for the four cities, a solar hot water system in Denver provided the best performance due to the larger water heating load (17.5 GJ per year) and high solar insolation (8.3 GJ/m^2 per year). The energy displaced per unit area of collector for each solar hot water system was about 60% higher in Denver than that in Washington, D.C.

Los Angeles demonstrated the second best city performance because it also had high insolation (7.2 GJ/m^2 per year) and a high water heating load (15.7 GJ per year).

Though Phoenix has the highest solar insolation (8.6 GJ/m^2 per year), it is not the best city for solar water heating in terms of energy displaced per unit collector area or system COP. This is due to the low water heating load (10.8 GJ/year) in Phoenix where city water temperatures are high.

The water heating load in Washington, D.C. is about the same as that in Los Angeles, but it has much less sunshine (only 5.4 GJ/m^2 per year) and has a lower annual temperature. Therefore, the thermal performance of a solar hot water system in Washington is poorer than that in Los Angeles.

Note that in Figure 4.5, the energy displaced per square foot of collector of the recirculation system in Los Angeles is comparatively lower than that in other cities. The explanation for this is that it uses three collectors compared to two collectors in the other three cities. The values of gross energy displaced by two and three collectors are 12.0 GJ and 14.7 GJ, respectively. Therefore, they are not linearly proportional to the collector areas. As a matter of fact, the system employing two collectors could have been chosen because the present values life-cycle costs for two and three collectors are very close.

System COP measures the solar energy delivered to the load per unit of operating energy. In general, the direct draindown and indirect systems had the highest annual COP because of good thermal efficiency and low parasitics. The thermal performance and system COP's are summarized in Table 4.10.

Difficulty was encountered during the calibration of F Chart results for the recirculation system in Denver. Since the calibration makes use of the TRNSYS simulation results in Washington, D.C. and Phoenix, the effect of recirculation in Denver could not be accurately determined.

In Phoenix, almost no recirculation of the recirculation system was necessary because the ambient temperature rarely falls below the 40°F recirculation set point. In Washington, recirculation does not lose much heat because the storage tank is cold and the recirculation system is still reasonable. However, the situation is somewhat different in Denver as the storage tank may be very warm at night when the ambient is freezing.

The effect of recirculation on the system performance in Denver could have been determined more accurately by using TRNSYS, but since a recirculation system is not a good selection for Denver, this exercise would not be worthwhile.

TABLE 4.10

ANNUAL SOLAR HOT WATER SYSTEM PERFORMANCE
GJ THERMAL/GJ PARASITIC

	Direct Recirc. ($63.6ft^2$)	Direct Drainback ($58.5ft^2$)	Direct Draindown ($58.5ft^2$)	Indirect ($55.8ft^2$)	Evac. Tube ($58ft^2$)
Denver	12.9/1.3	15.0/1.9	15.3/.8	15.0/.84	13.5/2.4
COP	16	6.5	19	17.8	5.6
Los Angeles	14.7/1.4	12.6/1.9	13.5/.8	13.7/.9	11.3/1.9
COP	10.5	14	16.9	15.2	5.9
Phoenix	10.0/.9	10.5/2.0	10.4/.8	10.3/.8	9.0/2.6
COP	10.3	4.5	13	13	3.8
Washington	9.1/1.2	10.9/1.7	10.7/.7	10.6/.8	9.3/2.1
COP	8	5.7	15	13	3.3

Annual Solar Fraction--%

Phoenix	85	78	88	88	69
Los Angeles	85	68	81	82	60
Denver	69	75	83	81	63.5
Washington	51	59	65	64	47

4.4 ECONOMIC ANALYSIS

The economic analysis of the domestic hot water systems can be analyzed on the basis of capital cost, monthly cash flow or life cycle cost. The most appropriate measure will differ for each buyer and his level of financial sophistication. The homeowner will often purchase on the basis of first cost and can be sold on the basis of monthly cash flow, but rarely will consider life cycle cost. It is usually the financial community that considers life cycle cost.

4.4.1 Relevant Cost Elements

In conducting these cost analyses the following system cost elements must be included:

- o System acquisition costs - initial investment costs including design, delivery, installation, value of system and tax credits (negative)
- o System repair and maintenance costs - cost of repairing or replacing system parts; exclusive of routine maintenance
- o Maintenance costs - cost of routine upkeep; maintenance, labor, and parts
- o Operating costs - cost of all funds used in operating the system; including primary and auxiliary equipment
- o Insurance costs - cost of insuring the system
- o Tax costs - federal/state income tax reductions due to interest paid

4.4.2 General Economic Factors

To calculate the above cost elements, a number of general economic factors must also be determined and/or assumed. The factors include the following general rates:

- o Annual discount
- o General inflation
- o Fuel inflation

In addition, there are several site/user specific factors:

- o Interest rate
- o Fuel cost
- o Federal/state income tax rate

Table 4.11 presents the economic factors which were used for all systems in all four cities.

TABLE 4.11

LIST OF ECONOMIC FACTORS
USED IN ANALYSIS

Factor	Value
General Inflation Rate	0.075
Maintenance Cost	5% annually
Downpayment	20%
Fuel Escalation Rate:	
Gas	12% annually
Electricity	10% annually
*Tax Credit:	
Current Tax Credit (Federal and State)	Differs by state
Proposed Tax Credit (Federal and State)	Differs by state
Market Discount Rate	8.5%
Interest Rate:	
Home Mortgage @ 30 years	11%
Low Interest Loans with reduced maturities (1/2 home mortgage @ 12 years assumed)	5.5%
Improvement Loan @ five years	22%

* Can be applied as an "instate tax credit" or as a "deferred tax credit."

<u>Deferred Tax Credit</u> -- tax credit recovered at the end of the first year

<u>Instant Tax Credit</u> -- tax credit at the same time when solar system is installed

Federal tax credits for installing solar heating and cooling systems are available, as well as state tax credits, in varying amounts. In this study the "current tax credit" (Federal and state) was assumed to be 30% of the initial investment. The proposed tax credit varies by state; the Federal credit is being increased to 40%; and state credit rates can be up to 30% additive to Federal rates (e.g., Colorado).

A concept of instant tax credits and deferred tax credits was introduced for this study. The instant tax credits reward the purchaser with the tax refund at the instant (year 0) the solar system is installed. In the deferred tax credit, tax credit is recovered at the end of the first year. Therefore, the instant tax credit can be applied to the downpayment and results in a smaller loan than the deferred tax credit method.

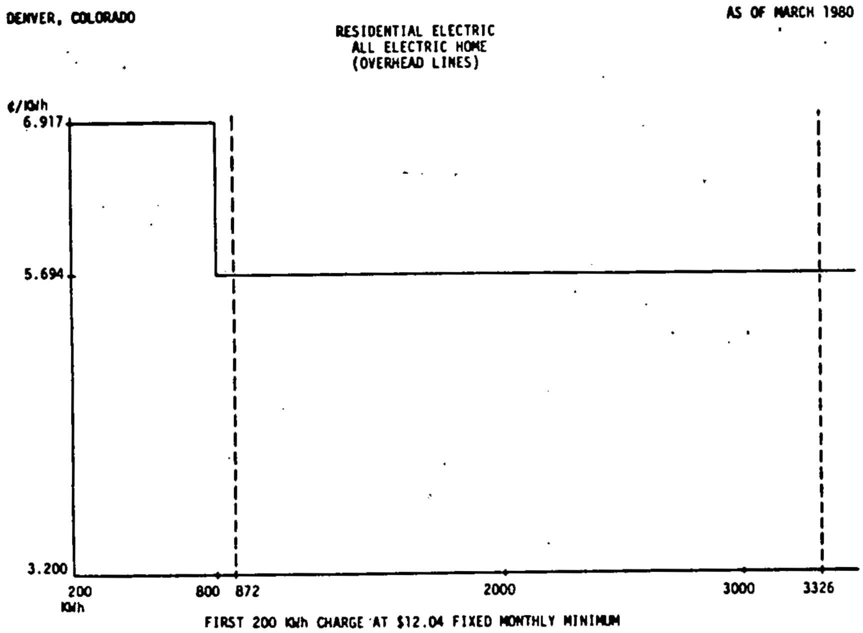
4.4.3 System Related Economic Parameters

There are two types of system related economic parameters. They are fuel costs and equipment/installation costs.

Based on the fuel rate schedules (presented in Figure 4.6) and the monthly heating and hot water load in each city, the yearly average fuel costs for gas and electricity were calculated. These are presented in Table 4.12. Fuel rates can differ widely within a utility region depending on urban proximity, utility line construction, season and other factors. A typical situation was used in this study. In certain cities flat rate structures are used for either gas or electric and these rates are not plotted.

FIGURE 4.6

SEASONAL GAS AND ELECTRIC RATE SCHEDULES FOR DENVER, LOS ANGELES, PHOENIX, AND WASHINGTON, D.C.



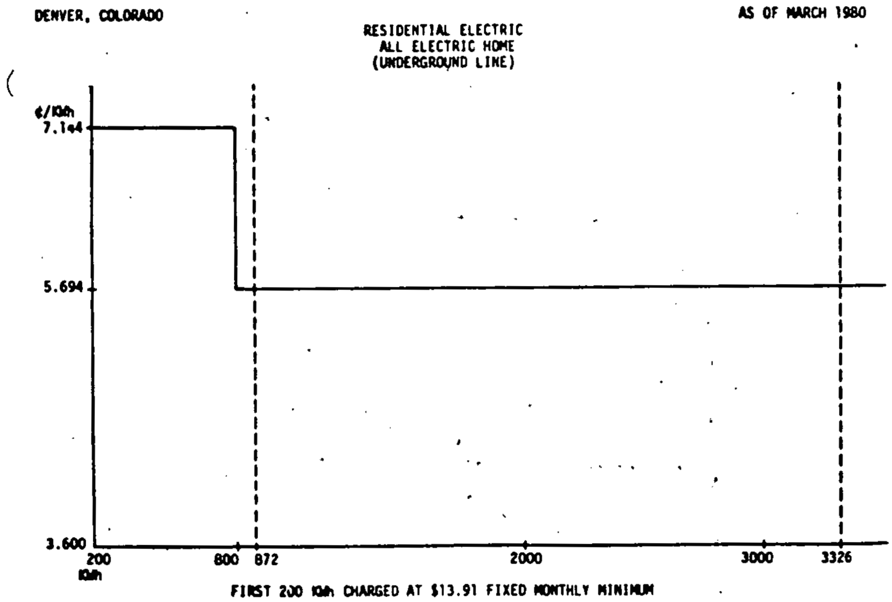
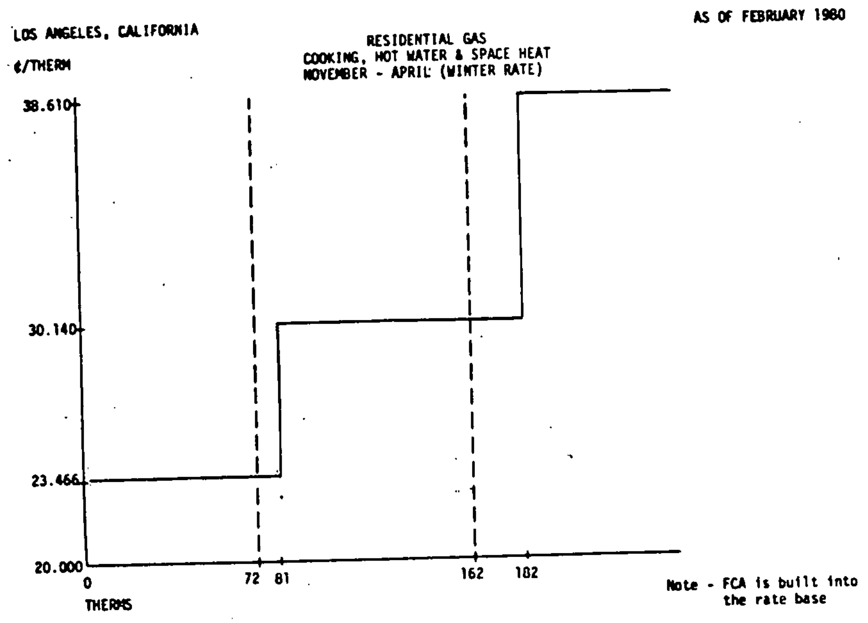


FIGURE 4.6
(continued)



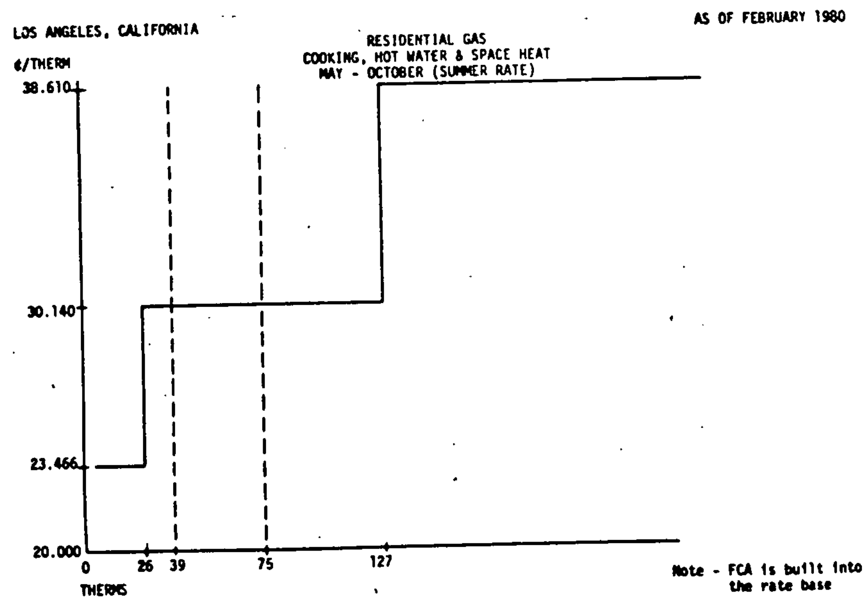
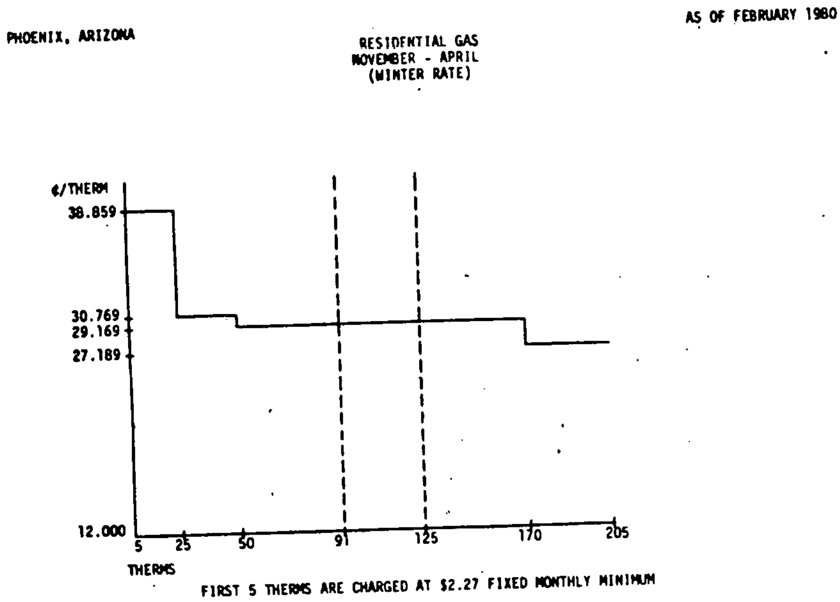


FIGURE 4.6
(continued)



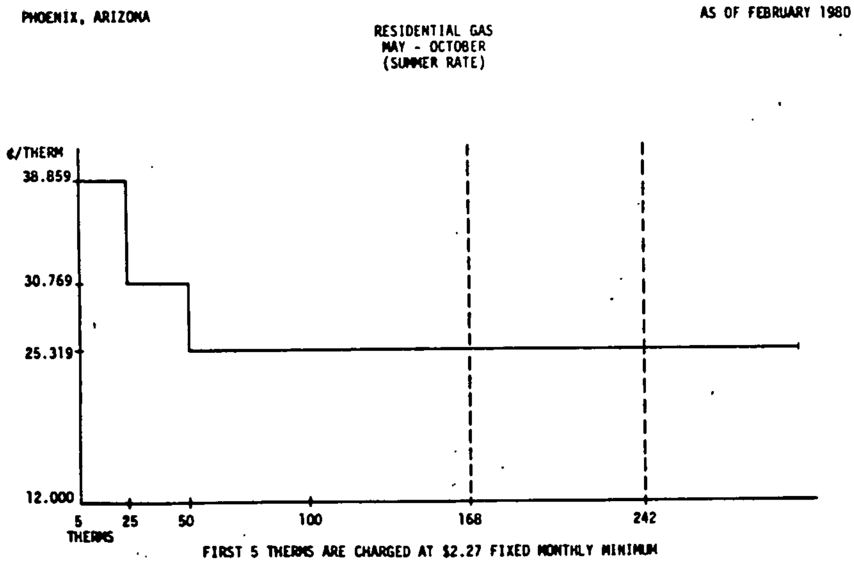
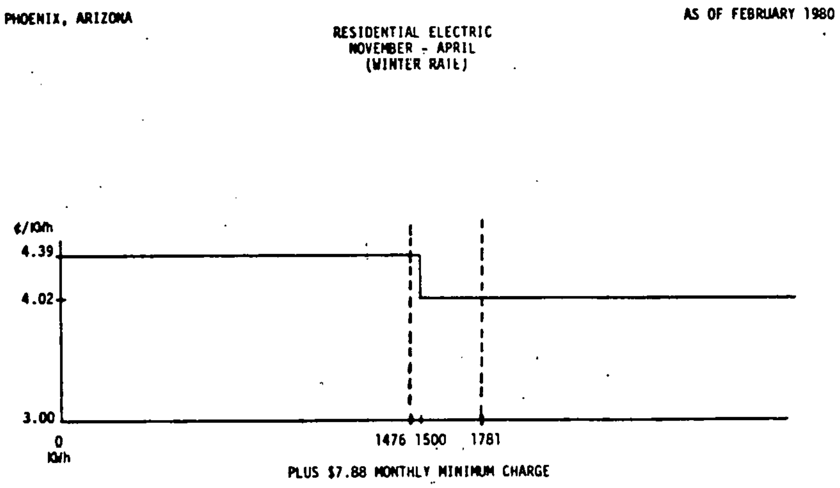
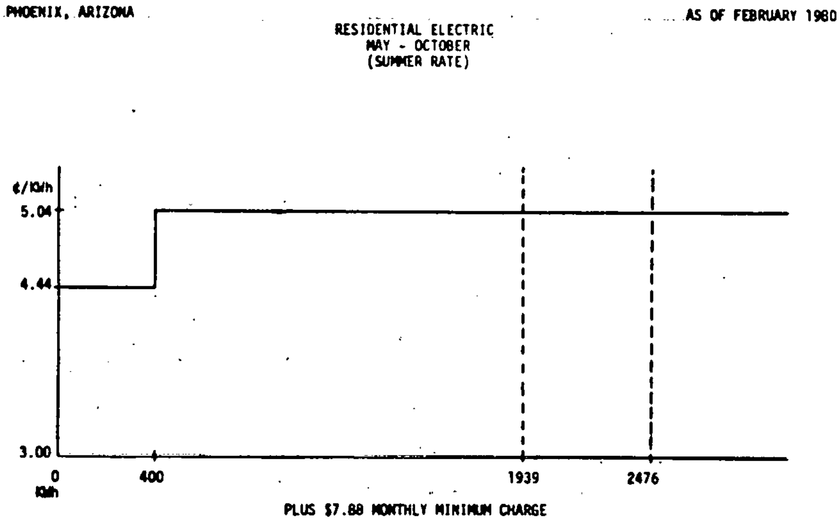
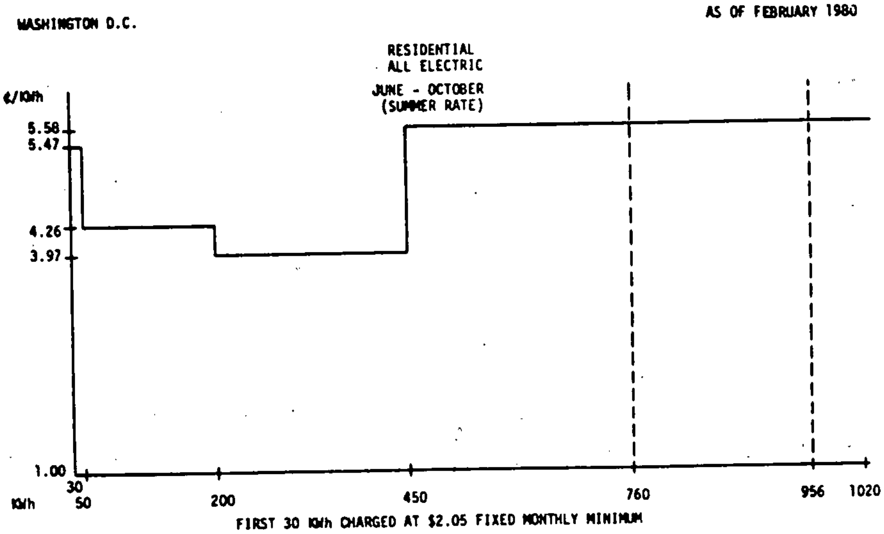


FIGURE 4.6
(continued)






WASHINGTON D.C.
AS OF FEBRUARY 1980
RESIDENTIAL
ALL ELECTRIC
JUNE - OCTOBER
(SUMMER RATE)
¢/KWh
5.58
5.47
4.26
3.97
1.00
KWh
30
50
200
450
760
956
1020
FIRST 30 KWh CHARGED AT $2.05 FIXED MONTHLY MINIMUM

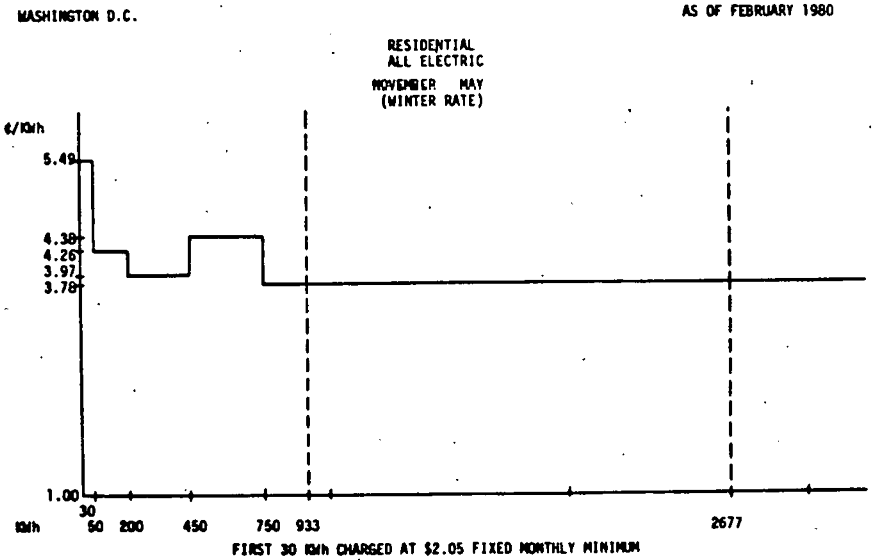

WASHINGTON D.C.
AS OF FEBRUARY 1980
RESIDENTIAL
ALL ELECTRIC
NOVEMBER MAY
(WINTER RATE)
¢/KWh
5.49
4.38
4.26
3.97
3.78
1.00
KWh
30
50
200
450
750
933
2677
FIRST 30 KWh CHARGED AT $2.05 FIXED MONTHLY MINIMUM

TABLE 4.12

1980 FUEL COST* ($/GJ)

City	Gas	Electricity
Washington, D.C.	3.45	12.12
Phoenix	2.61	12.18
Denver	2.33	15.98
Los Angeles	2.89	15.98

*Calculated from rate schedules presented in Figure 4.6.

The cost of generating electricity is very site specific depending on the fuel that is used. Table 4.13 summarizes the percentages of various fuel types that are used in electric generation for the four cities considered in the analysis. These data are also useful in determining the solar value of solar displaced imported fuels, e.g., electricity in Phoenix or Los Angeles has a higher usage of oil and gas than Denver or D.C. and therefore solar has a higher social value.

TABLE 4.13

FUEL BASIS FOR GENERATION OF ELECTRICITY IN FOUR CITIES

Fuel Type	% Generation by Fuel Type			
	Phoenix	L.A.	Denver	D.C.
Oil	10.0		0.1	14.7
Gas/Oil	48.4	37.7	11.3	
Gas		1.1	4.1	0.7
Coal	41.3	43.0	13.3	53.4
Coal/Oil				31.2
Coal/Gas			44.7	
Hydroelectric	0.2	18.3	13.9	
Nuclear			12.6	

The installation costs of the conventional and solar water heating systems are given in Table 4.14. No site specific labor cost was considered. All costs are in 1980 dollars.

TABLE 4.14

CONVENTIONAL AND SOLAR HOT WATER SYSTEM

CAPITAL COST

	System Cost ($)	Collector Cost ($/Collector)
Conventional Gas	240	-
Conventional Electricity	240	-
Draindown (3 collectors)	2450	440
Recirculation (2 collectors)	2775	550
Evacuated Tube (3 collectors)	2495	360
Drainback (3 collectors)	2488	376
Indirect (3 collectors)	3052	300

4.4.4 Economic Results

The monthly cash flow and present value analysis are presented in this subsection. Monthly cash flows were analyzed for each of the five solar water heating systems and conventional water heaters using different methods of financing. Costs are presented in present values discounted back to 1980. The cost in year 0 consisting of the downpayment and instant tax credit are not shown. A sample Table for Washington, D.C. is shown in Table 4.15 (all the Tables for each generic type in the four cities is included in Appendix VI.) For deferred tax credits, the cash flow in the first year is negative because it is assumed that the tax credit is recovered at the end of the first year and it is a negative cost. For a given type of loan, therefore, the higher the tax credit rate the larger the negative cost.

Without tax credits, the cash flows for deferred tax credit and instant tax credit are the same.

Comparing five year home improvement loans to twelve year low interest loans (Solar Bank perhaps -- for purposes of this study Solar Bank will be used to describe a low interest loan), it can be seen that after year 12, they have the same cash flow because the loan is already paid off and is no longer a constituent of the cash flow.

TABLE 4.15 ECONOMIC ANALYSIS:

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: WASHINGTON, D.C. SYSTEM: DIRECT DRAIN-DOWN

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 11%; 30 years
SOLAR BANK: 5.5%; 12 years

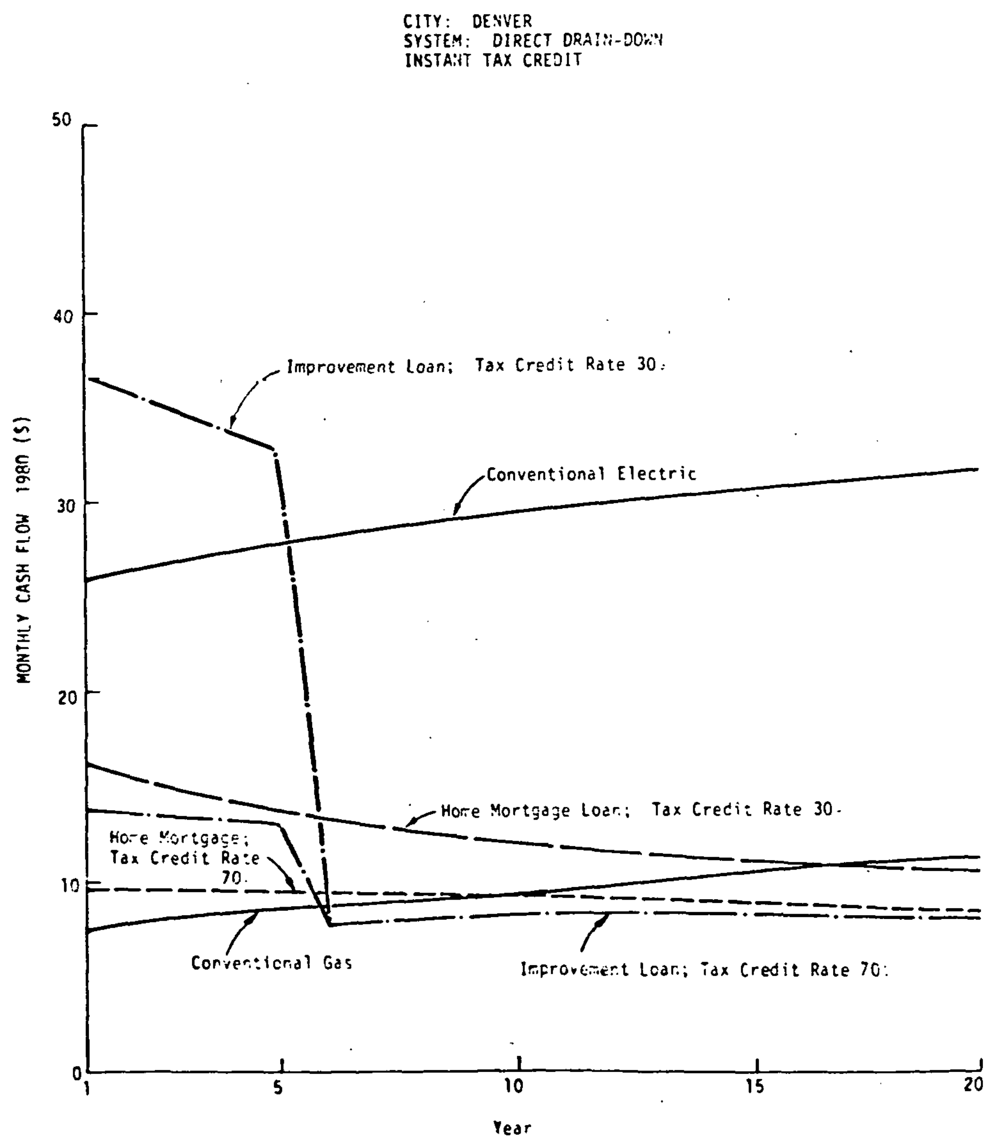
	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	LOW INTEREST LOAN	IMPROVEMENT LOAN	HOME MORTGAGE	LOW INTEREST LOAN	IMPROVEMENT LOAN	HOME MORTGAGE	LOW INTEREST LOAN
1	18.11	9.33	56.22	22.72	26.55	-10.05	-43.53	-59.41	-98.55	-131.85	-127.74
2	18.25	9.53	54.55	21.81	25.79	54.55	21.81	25.79	54.55	21.81	25.79
3	18.41	9.75	53.20	20.98	24.62	53.20	20.98	24.62	53.20	20.98	24.62
4	18.58	9.95	52.25	20.22	23.93	52.25	20.22	23.93	52.25	20.22	23.93
5	18.75	10.17	51.67	19.53	23.11	51.67	19.53	23.11	51.67	19.53	23.11
6	18.94	10.41	10.45	18.89	22.35	10.45	18.89	22.35	10.45	18.89	22.35
7	19.13	10.65	10.49	18.31	21.65	10.49	18.31	21.65	10.49	18.31	21.65
8	19.33	10.91	10.55	17.78	21.01	10.55	17.78	21.01	10.55	17.78	21.01
9	19.54	11.17	10.57	17.30	20.41	10.57	17.30	20.41	10.57	17.30	20.41
10	19.75	11.47	10.62	16.86	19.86	10.62	16.86	19.86	10.62	16.86	19.86
11	19.97	11.77	10.66	16.46	19.36	10.66	16.46	19.36	10.66	16.46	19.36
12	20.20	[illegible]	10.71	16.10	18.89	10.71	16.10	18.89	10.71	16.10	18.89
13	20.43	[illegible]	10.76	15.77	10.76	10.76	15.77	10.76	10.76	15.77	10.76
14	20.67	12.74	10.81	15.48	10.81	10.81	15.48	10.81	10.81	15.48	10.81
15	20.91	13.13	10.86	15.22	10.86	10.86	15.22	10.86	10.86	15.22	10.86
16	21.17	13.43	10.92	14.98	10.92	10.92	14.98	10.92	10.92	14.98	10.92
17	21.42	[illegible]	10.97	14.77	10.97	10.97	14.77	10.97	10.97	14.77	10.97
18	21.69	[illegible]	11.03	14.58	11.03	11.03	14.58	11.03	11.03	14.58	11.03
19	21.96	14.79	11.09	14.41	11.09	11.09	14.41	11.09	11.09	14.41	11.09
20	22.23	15.13	11.15	14.27	11.15	11.15	14.27	11.15	11.15	14.27	11.15

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
TAX CREDIT RECOVERED AT THE END OF FIRST YEAR

A comparison of the five solar hot water systems against conventional electric and gas water heaters indicates that the direct drainback evacuated tube systems provide the most energy per ft^2 in all of the four cities. When including parasitic losses all types, but the recirculating, have similar net energies displaced and economics.

A plot of monthly cash flow versus years is made in Figure 4.7 for conventional water heaters and the direct draindown solar hot water system in Denver using instant tax credit rates of 30% and 70%. These curves illustrate the heavier cash flow for the shorter term home improvement loans. Note that for an improvement loan, the cash flow of the solar system becomes less than that of the gas water heater after year five. A sudden decrease in cash flow from year five to year six is expected because the loan is paid off

FIGURE 4.7



after five years. For home mortgages with an instant tax credit rate of 30%, the monthly cost of the solar system always exceeds that of the gas water heater. With a 70% tax credit rate, the cash flow of the solar system is less than that of the gas water heater at year eight and after.

4.4.5 Sensitivity Study

The above results are for the base case economic factors described in subsection 4.4.1. However, if these economic factors change, then the economics of the solar and conventional water heaters will also change. This subsection presents the results of a sensitivity study on some of these factors.

Table 4.16 (included in Appendix VI) compares the monthly cash flow of a draindown solar hot water system with home mortgage interest rates of 16% against conventional gas and electric heaters in Denver using a deferred tax credit. Similarly, results for an instant tax credit are shown in Table 4.17 (included in Appendix VI). We see that increasing the interest rate from 11% to 16% has little influence on conventional water heaters (gas or electric) which are cheap to install (only $240). However, it increases the monthly cash flow of the solar hot water system in the first year by about 20% and in the twentieth year by about 10%.

Tables 4.18 and 4.19 (included in Appendix VI) compare the cash flows of a market discount rate of 8.5% to 0% discount rate. Note that with a zero discount rate the cash flow increases rapidly with time due to inflation.

(Please see following pages for Tables 4.16 through 4.19)

TABLE 4.16 ECONOMIC ANALYSIS SENSITIVITY STUDY:

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS
CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS

CITY: Denver SYSTEM: DRAIN DOWN

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 16% ; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	LOW INTEREST LOAN	IMPROVEMENT LOAN	HOME MORTGAGE	LOW INTEREST LOAN	IMPROVEMENT LOAN	HOME MORTGAGE	LOW INTEREST LOAN
1	26.60	7.84	53.96	25.17	24.58	-12.28	-41.08	-41.67	-100.61	-129.40	-129.99
2	26.86	7.92	52.24	23.84	23.50	52.24	23.84	23.50	52.24	23.84	23.50
3	27.13	8.01	50.88	22.65	22.51	50.88	22.65	22.51	50.88	22.65	22.51
4	27.38	8.12	49.90	21.51	21.58	49.90	21.51	21.58	49.90	21.51	21.58
5	27.65	8.25	49.29	20.48	20.73	49.29	20.48	20.73	49.29	20.48	20.73
6	27.93	8.38	21.66	19.54	19.94	21.66	19.54	19.94	21.66	19.54	19.94
7	28.22	8.53	15.01	18.67	19.20	15.01	18.67	19.20	15.01	18.67	19.20
8	28.52	8.70	15.22	17.87	18.52	15.22	17.87	18.52	15.22	17.87	18.52
9	28.84	8.88	15.39	17.14	17.89	15.39	17.14	17.89	15.39	17.14	17.89
10	29.16	9.07	15.54	16.48	17.31	15.54	16.48	17.31	15.54	16.48	17.31
11	29.49	9.27	15.65	15.86	16.77	15.65	15.86	16.77	15.65	15.86	16.77
12	29.84	9.48	15.74	15.31	16.27	15.74	15.31	16.27	15.74	15.31	16.27
13	30.19	9.71	15.73	14.79	15.73	15.73	14.79	15.73	15.73	14.79	15.73
14	30.55	9.95	10.42	14.33	13.97	10.42	14.33	13.97	10.42	14.33	13.97
15	30.92	10.21	10.35	13.90	13.55	10.35	13.90	13.55	10.35	13.90	13.55
16	31.30	10.47	10.29	13.52	13.17	10.29	13.52	13.17	10.29	13.52	13.17
17	31.69	10.75	10.25	13.17	12.82	10.25	13.17	12.82	10.25	13.17	12.82
18	32.08	11.04	10.21	12.85	12.50	10.21	12.85	12.50	10.21	12.85	12.50
19	32.49	11.34	10.17	12.57	12.20	10.17	12.57	12.20	10.17	12.57	12.20
20	32.90	11.66	10.15	12.31	11.94	10.15	12.31	11.94	10.15	12.31	11.94

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
TAX CREDIT RECOVERED AT THE END OF FIRST YEAR

TABLE 4.17 ECONOMIC ANALYSIS:

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: DENVER

SYSTEM: DIRECT DRAIN-DOWN

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 16 %; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	LOW INTEREST LOAN	IMPROVEMENT LOAN	HOME MORTGAGE	LOW INTEREST LOAN	IMPROVEMENT LOAN	HOME MORTGAGE	LOW INTEREST LOAN
	20.00	7.84									
1	26.80	7.92	55.40	25.17	24.36	56.75	18.73	18.57	13.70	10.16	10.00
2	27.13	8.01	52.24	23.84	23.50	55.06	17.91	17.69	13.54	9.99	9.95
3	27.38	8.12	50.60	22.65	22.51	54.61	17.15	17.07	13.36	9.84	9.85
4	27.65	8.25	49.95	21.51	21.56	54.20	16.45	16.56	13.20	9.71	9.72
5	27.93	8.38	49.29	20.40	20.75	53.81	15.81	15.97	13.18	9.58	9.61
6	28.22	8.53	0.03	19.54	19.94	0.03	15.22	15.47	0.03	9.47	9.52
7	28.52	8.70	0.04	18.67	19.20	0.04	14.68	15.02	0.04	9.37	9.45
8	28.84	8.88	0.05	17.87	18.52	0.05	14.19	14.59	0.05	9.27	9.36
9	29.16	9.07	0.06	17.14	17.89	0.06	13.74	14.20	0.06	9.19	9.28
10	29.49	9.27	0.06	16.48	17.31	0.06	13.32	13.84	0.06	9.12	9.22
11	29.84	9.48	0.08	15.86	16.77	0.08	12.94	13.51	0.08	9.05	9.16
12	30.19	9.71	0.09	15.31	16.27	0.09	12.60	13.20	0.09	8.99	9.11
13	30.55	9.95	0.10	14.79	0.10	0.10	12.28	0.10	0.10	8.94	0.10
14	30.92	10.21	0.11	14.33	0.11	0.11	12.00	0.11	0.11	8.89	0.11
15	31.30	10.47	0.13	13.90	0.13	0.13	11.74	0.13	0.13	8.85	0.13
16	31.69	10.75	0.15	13.52	0.15	0.15	11.50	0.15	0.15	8.82	0.15
17	32.08	11.04	0.16	13.17	0.16	0.16	11.29	0.16	0.16	8.79	0.16
18	32.49	11.34	0.18	12.85	0.18	0.18	11.10	0.18	0.18	8.77	0.18
19	32.90	11.66	0.20	12.57	0.20	0.20	10.95	0.20	0.20	8.75	0.20
20			0.22	12.31	0.22	0.22	10.76	0.22	0.22	8.73	0.22

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
INSTANT TAX CREDIT

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS
CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

DISCOUNT RATE 0

CITY: DENVER

SYSTEM: DIRECT DRAIN-DOWN

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 16 %; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	LOW INTEREST LOAN	IMPROVEMENT LOAN	HOME MORTGAGE	LOW INTEREST LOAN	IMPROVEMENT LOAN	HOME MORTGAGE	LOW INTEREST LOAN
	26.92	8.50									
1	31.04	9.32	58.54	27.31	26.44	39.85	20.32	19.78	14.93	11.02	10.91
2	34.64	10.23	61.48	28.04	27.42	41.97	21.03	20.67	15.94	11.76	11.68
3	37.93	11.25	64.97	28.74	28.48	44.45	21.90	21.64	17.08	12.57	12.52
4	41.56	12.39	69.13	29.89	29.62	47.37	22.79	22.68	18.36	13.45	13.43
5	45.54	13.67	74.08	30.78	30.85	50.82	23.76	23.80	19.81	14.40	14.41
6	49.92	15.10	13.10	31.35	32.18	13.10	24.83	25.02	13.10	15.44	15.48
7	54.74	16.69	14.22	33.02	33.61	14.22	25.97	26.34	14.22	16.57	16.64
8	60.04	18.46	15.44	34.30	35.15	15.44	27.23	27.76	15.44	17.80	17.91
9	65.67	20.48	16.77	35.70	36.82	16.77	28.60	29.30	16.77	19.14	19.28
10	72.27	22.71	18.22	37.22	38.63	18.22	30.04	30.97	18.22	20.59	20.77
11	79.32	25.21	19.79	38.83	40.58	19.79	31.72	32.78	19.79	22.18	22.39
12	87.07	28.01	21.50	40.64	42.68	21.50	33.49	34.74	21.50	23.90	24.15
13	95.59	31.14	23.36	42.67	23.36	23.36	35.43	23.36	23.36	25.78	23.36
14	104.96	34.64	25.39	44.33	25.39	25.39	37.54	25.39	25.39	27.82	25.39
15	115.27	38.56	27.60	47.20	27.60	27.60	39.35	27.60	27.60	30.05	27.60
16	126.61	42.95	30.00	49.79	30.00	30.00	42.37	30.00	30.00	32.47	30.00
17	139.07	47.86	32.62	53.62	32.62	32.62	45.12	32.62	32.62	35.12	32.62
18	152.78	53.35	35.47	55.72	35.47	35.47	48.12	35.47	35.47	38.00	35.47
19	167.86	59.50	38.57	59.11	38.57	38.57	51.41	38.57	38.57	41.14	38.57
20			41.95	62.83	41.95	41.95	55.00	41.95	41.95	44.56	41.95

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
INSTANT TAX CREDIT

TABLE 4.19 ECONOMIC ANALYSIS:

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

DISCOUNT RATE=0.085

CITY: DENVER

SYSTEM: DIRECT DRAIN-DOWN

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 16 %; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	LOW INTEREST LOAN	IMPROVEMENT LOAN	HOME MORTGAGE	LOW INTEREST LOAN	IMPROVEMENT LOAN	HOME MORTGAGE	LOW INTEREST LOAN
	20.66	7.84									
1	26.88	7.92	53.90	25.17	24.58	56.75	18.73	18.57	13.76	10.16	10.08
2	27.13	8.01	52.24	23.34	23.50	55.60	17.91	17.69	13.54	9.93	9.95
3	27.38	8.12	50.88	22.47	22.51	54.61	17.15	17.07	13.36	9.84	9.83
4	27.65	8.25	49.90	21.57	21.58	54.20	16.45	16.50	13.26	9.71	9.72
5	27.93	8.38	49.24	20.43	20.75	53.81	15.81	15.97	13.16	9.57	9.61
6	28.22	8.53	9.74	19.54	19.90	9.74	15.22	15.47	9.74	9.47	9.52
7	28.52	8.70	6.91	18.67	19.20	6.91	14.68	15.02	6.91	9.37	9.43
8	28.84	8.88	6.94	17.97	18.52	6.94	14.19	14.59	6.94	9.27	9.36
9	29.16	9.07	6.97	17.14	17.89	6.97	13.74	14.20	6.97	9.19	9.28
10	29.49	9.27	9.00	16.43	17.31	9.00	13.32	13.84	9.00	9.12	9.22
11	29.84	9.48	9.02	15.88	16.77	9.02	12.94	13.51	9.02	9.05	9.16
12	30.19	9.71	9.04	15.31	16.27	9.04	12.60	13.20	9.04	8.99	9.11
13	30.55	9.95	9.05	14.79	9.05	9.05	12.28	9.05	9.05	8.94	9.05
14	30.92	10.21	8.40	14.33	8.85	8.40	12.00	8.85	8.40	8.99	8.85
15	31.30	10.47	8.41	13.99	8.81	8.41	11.74	8.81	8.41	8.95	8.81
16	31.69	10.75	8.41	13.59	8.77	8.41	11.50	8.77	8.41	8.83	8.77
17	32.08	11.04	8.42	13.17	8.75	8.42	11.29	8.75	8.42	8.79	8.75
18	32.49	11.34	8.44	12.85	8.72	8.44	11.10	8.72	8.44	8.77	8.72
19	32.90	11.66	8.45	12.57	8.70	8.45	10.93	8.70	8.45	8.75	8.70
20			8.46	12.31	8.69	8.46	10.73	8.69	8.46	8.73	8.69

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
INSTANT TAX CREDIT

Table 4.20 gives the monthly cash flow, assuming that the conventional gas water heater is to be replaced in years eight and ten, and the electric water heater to be replaced in year twelve. The replacement only affects the cash flow in the years at which the water heater is replaced. It increases the cash flow of the electric water heater by about 50% in year twelve. For the gas water heater, replacement raises the cash flow by about three times in years eight and sixteen.

Figures 4.8 through 4.11 present the present values of life cycle cost versus tax credit rate (deferred tax credit) for the draindown solar hot water system in Washington, Phoenix, Denver and Los Angeles, respectively. It can be seen that for all tax credit rates, home mortgage has the lowest life cycle cost and improvement loan has the highest. Even with a deferred tax credit rate of 70%, the solar system cannot compete with the conventional gas water heater.

FIGURE 4.8

DENVER
DRAINDOWN

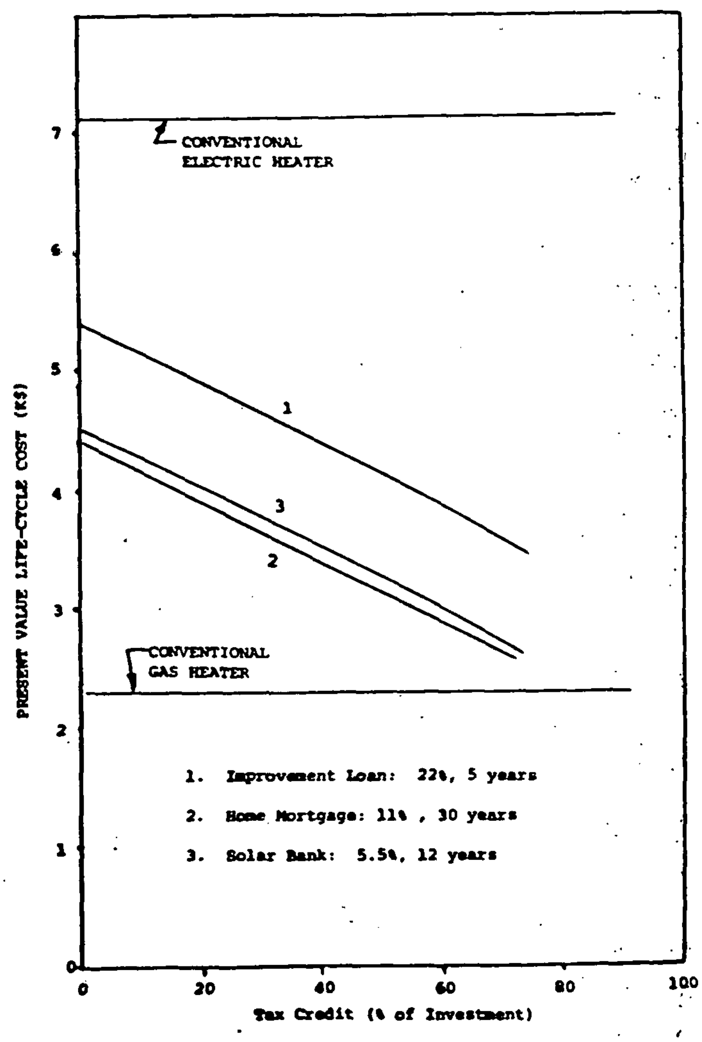


TABLE 4.20 ECONOMIC ANALYSIS:

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS

CITY: Denver **SYSTEM:** DRAIN DOWN

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 16% ; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM: WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	LOW INTEREST LOAN	IMPROVEMENT LOAN	HOME MORTGAGE	LOW INTEREST LOAN	IMPROVEMENT LOAN	HOME MORTGAGE	LOW INTEREST LOAN
1	26.66	7.84	53.96	25.17	24.58	-12.28	-41.08	-41.67	-100.61	-129.40	-129.99
2	26.88	7.92	52.24	23.84	23.50	52.24	23.84	23.50	52.24	23.84	23.50
3	27.13	8.01	50.88	22.63	22.51	50.88	22.63	22.51	50.88	22.63	22.51
4	27.38	8.12	49.90	21.51	21.58	49.90	21.51	21.58	49.90	21.51	21.58
5	27.65	8.25	49.29	20.48	20.73	49.29	20.48	20.73	49.29	20.48	20.73
6	27.93	8.38	21.66	19.54	19.94	21.66	19.54	19.94	21.66	19.54	19.94
7	28.22	8.53	15.01	18.67	19.20	15.01	18.67	19.20	15.01	18.67	19.20
8	28.52	27.27	15.22	17.87	18.52	15.22	17.87	18.52	15.22	17.87	18.52
9	28.84	8.88	15.39	17.14	17.89	15.39	17.14	17.89	15.39	17.14	17.89
10	29.16	9.07	15.54	16.48	17.31	15.54	16.48	17.31	15.54	16.48	17.31
11	29.49	9.27	15.65	15.86	16.77	15.65	15.86	16.77	15.65	15.86	16.77
12	47.73	9.48	15.74	15.31	16.27	15.74	15.31	16.27	15.74	15.31	16.27
13	30.19	9.71	15.73	14.79	15.73	15.73	14.79	15.73	15.73	14.79	15.73
14	30.55	9.95	10.42	14.33	13.97	10.42	14.33	13.97	10.42	14.33	13.97
15	30.92	10.21	10.35	13.90	13.55	10.35	13.90	13.55	10.35	13.90	13.55
16	31.30	27.72	10.29	13.52	13.17	10.29	13.52	13.17	10.29	13.52	13.17
17	31.69	10.75	10.25	13.17	12.82	10.25	13.17	12.82	10.25	13.17	12.82
18	32.08	11.04	10.21	12.85	12.50	10.21	12.85	12.50	10.21	12.85	12.50
19	32.49	11.34	10.17	12.57	12.20	10.17	12.57	12.20	10.17	12.57	12.20
20	32.90	11.66	10.15	12.31	11.94	10.15	12.31	11.94	10.15	12.31	11.94

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
TAX CREDIT RECOVERED AT THE END OF FIRST YEAR

FIGURE 4.9

LOS ANGELES DRAINDOWN

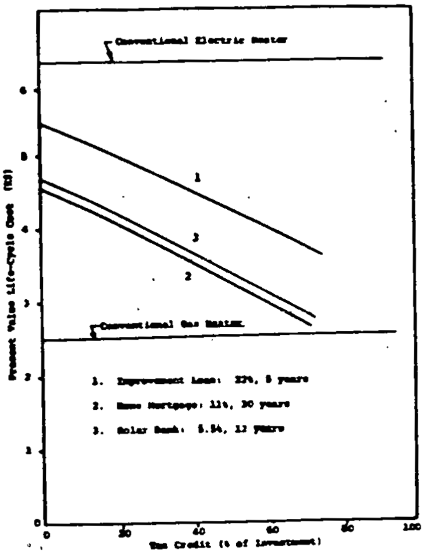


FIGURE 4.10

PHOENIX DRAINDOWN

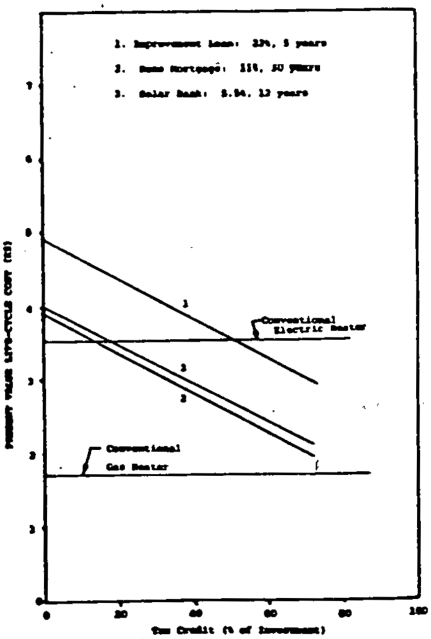
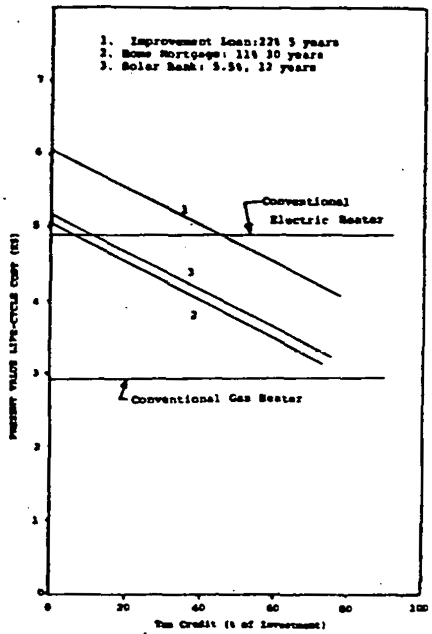


FIGURE 4.11

WASHINGTON, D.C. DRAINDOWN



In Washington the present value of life cycle cost of the solar water heater with home mortgage loan is equal to that of a conventional electric water heater when the tax credit rate is 5%. For solar bank and improvement loans, this occurs when their tax credit rates are 12% and 50%, respectively. In Phoenix, the solar system equalizes the conventional electric heater at tax credit rates of 12%, 20% and 55% for home mortgage, solar bank and improvement loan, respectively. In Denver or Los Angeles, the life cycle cost of the solar system is less than that of a conventional electric heater even without tax credit.

Figures 4.12 through 4.23 are plots of monthly average cost versus tax credit rate with instant tax credit against deferred tax credit. The monthly average cost is determined from the annual cost which is given by:

$$AC = \frac{LCC}{PVF} \quad \text{where } PVF = \frac{(1+d)^n - 1}{d(1+d)^n}$$

where: d = discount rate
n = period of economic analysis (10).

An instant tax credit is received at year 0 and, therefore, it needs a smaller loan than a deferred tax credit. These figures demonstrate the significant advantage of instant tax credit over deferred tax credit.

FIGURE 4.12

VARIATION OF DISCOUNTED AVERAGE MONTHLY COST WITH TAX CREDIT

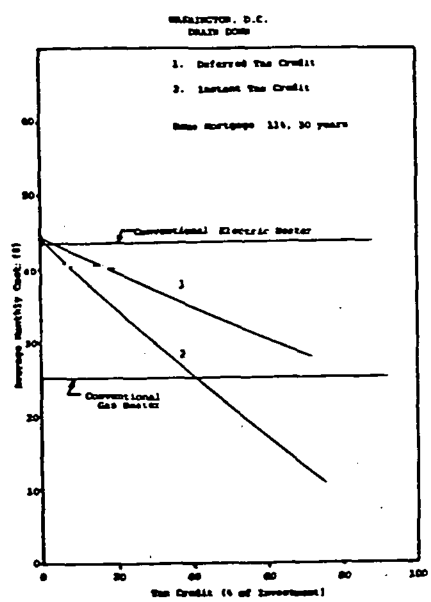


FIGURE 4.13
VARIATION OF DISCOUNTED AVERAGE MONTHLY COST WITH TAX CREDIT

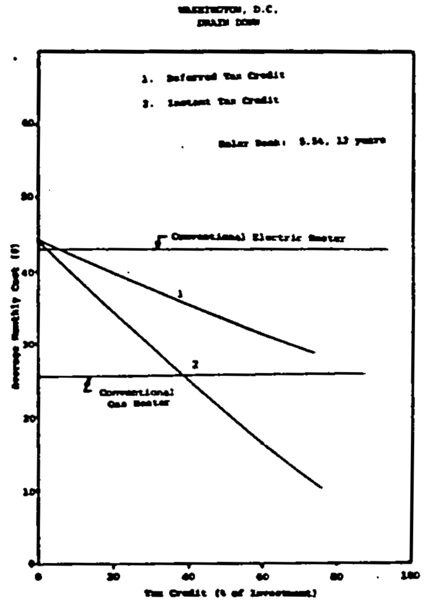


FIGURE 4.14
VARIATION OF DISCOUNTED AVERAGE MONTHLY COST WITH TAX CREDIT

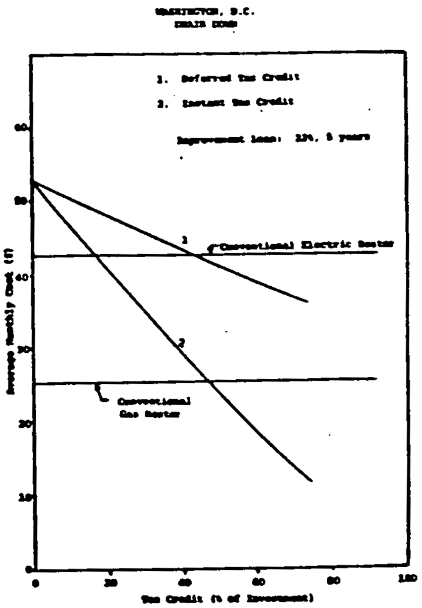


FIGURE 4.15

VARIATION OF DISCOUNTED AVERAGE MONTHLY COST WITH TAX CREDIT

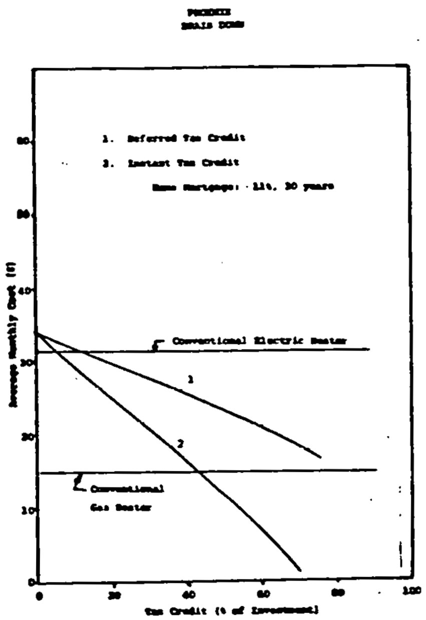


FIGURE 4.16

VARIATION OF DISCOUNTED AVERAGE MONTHLY COST WITH TAX CREDIT

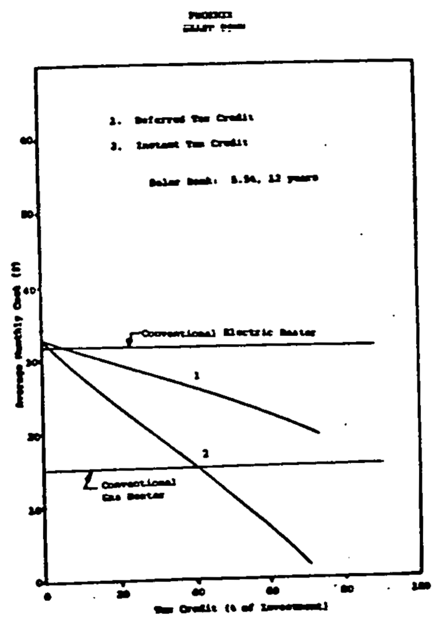


FIGURE 4.17

VARIATION OF DISCOUNTED AVERAGE MONTHLY COST WITH TAX CREDIT

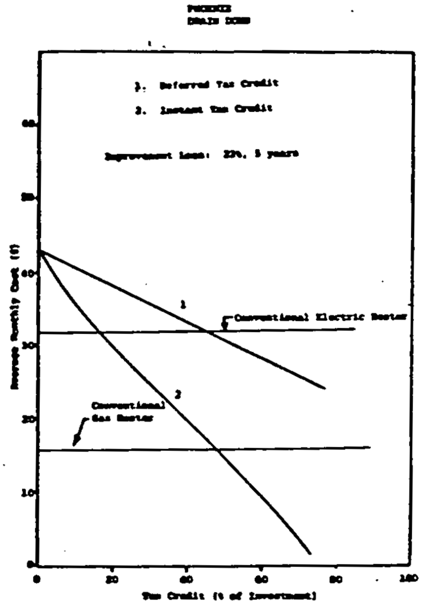


FIGURE 4.18

VARIATION OF DISCOUNTED AVERAGE MONTHLY COST WITH TAX CREDIT

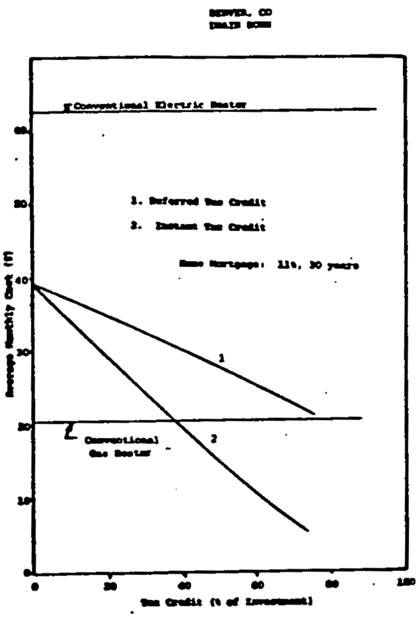


FIGURE 4.19
VARIATION OF DISCOUNTED AVERAGE MONTHLY COST WITH TAX CREDIT

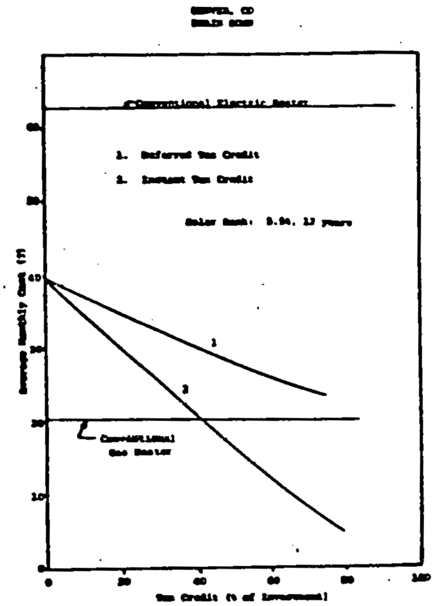


FIGURE 4.20
VARIATION OF DISCOUNTED AVERAGE MONTHLY COST WITH TAX CREDIT

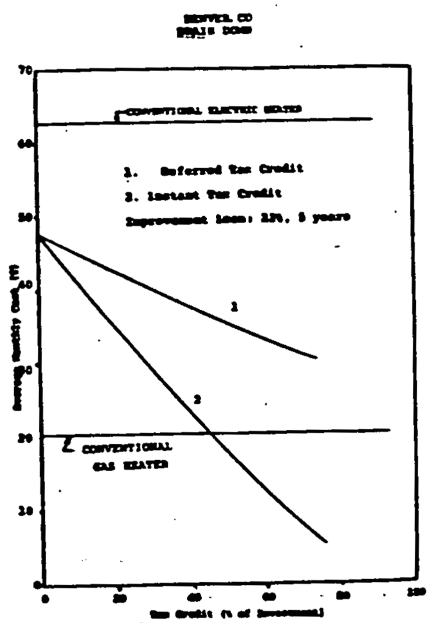


FIGURE 4.21

VARIATION OF DISCOUNTED AVERAGE MONTHLY COST WITH TAX CREDIT

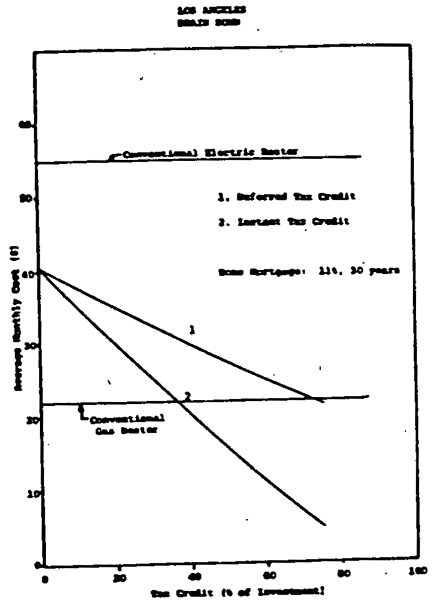


FIGURE 4.22

VARIATION OF DISCOUNTED AVERAGE MONTHLY COST WITH TAX CREDIT

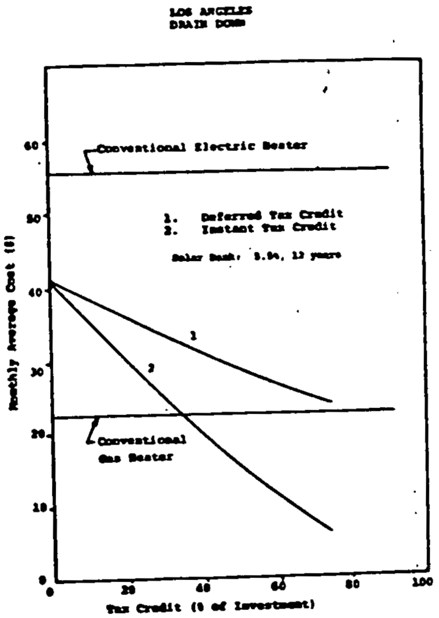
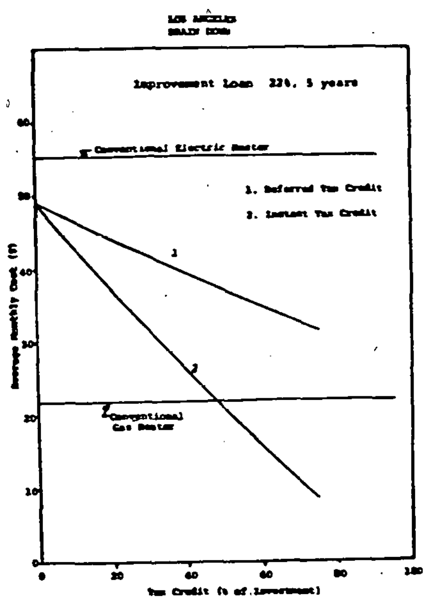


FIGURE 4.23

VARIATION OF DISCOUNTED AVERAGE MONTHLY COST WITH TAX CREDIT



For all four cities, with an instant tax credit rate of about 40%, the monthly average cost of the solar hot water system approaches that of the conventional gas water heater when home mortgage or solar bank is used. For improvement loans, this takes place when the tax credit rate is about 50%. An important conclusion which can be drawn is that with an instant tax credit rate of 40-50%, the monthly average cost of the solar hot water system equalizes the conventional gas water heater. Table 4.21 numerically compares the monthly average costs of the direct draindown solar hot water systems against conventional water heaters with a tax credit rate of 40% for all four cities. In addition, a comparison of the present values of life cycle cost of all the five solar hot water systems and the two conventional water heaters is made in Table 4.22 for Denver. Again, we see that with an instant tax credit rate of 40%, the draindown system using either home mortgage or solar bank approaches the life cycle cost of the conventional gas water heater.

TABLE 4.21

AVERAGE MONTHLY COST ($) WITH A TAX CREDIT RATE OF 40%

City	Conventional		Solar (Direct Draindown)					
			Deferred Tax Credit			Instant Tax Credit		
	Electric	Gas	Home Mortgage	Solar Bank	Improvement Loan	Home Mortgage	Solar Bank	Improvement Loan
Phoenix	31	15	26	25	33	16	15	20
Washington	43	25	34	36	43	25	25	29
Denver	63	20	30	30	38	19	21	23
Los Angeles	55	22	30	31	39	20	20	26

TABLE 4.22

PRESENT VALUE OF LIFE CYCLE COST ($)

System	Deferred Tax Credit			Instant Tax Credit		
	Home Mortgage	Solar Bank	Improvement Loan	Home Mortgage	Solar Bank	Improvement Loan
Conv. Electric	7140	-	-	7140	-	-
Conv. Gas	2310	-	-	2310	-	-
Draindown	3360	3470	4355	2318	2258	2700
Recirculation	4123	4217	5176	2997	2930	3408
Evacuated Tube	5292	5479	6508	4310	4311	4824
Drainback	4066	4180	5050	3043	2986	3420
Indirect	4106	4182	5226	2880	2803	3325

Figures 4.24 through 4.27 show how the present values of life cycle cost of the draindown solar hot water system are affected by interest rate. Similar plots of monthly average cost are made in Figures 4.28 through 4.31. It can be seen that interest rate has the largest impact on home mortgage loan. Its influence on improvement loan is the smallest. Also, it is interesting to see that when the interest rate is less than 14%, solar bank is better than improvement loan. When the interest rate is less than 17%, home mortgage is better than improvement loan. Furthermore, at an interest rate of 22% or larger, solar bank is preferred to a home mortgage loan. Although these curves suggest that the type of loan is important, in fact, these curves merely indicate the effects of the maturity dates; 30 years for home mortgage, 12 years for Solar Bank, and 5 years for home improvements.

FIGURE 2.4

VARIATION OF PRESENT VALUE LIFE CYCLE COST WITH INTEREST RATE

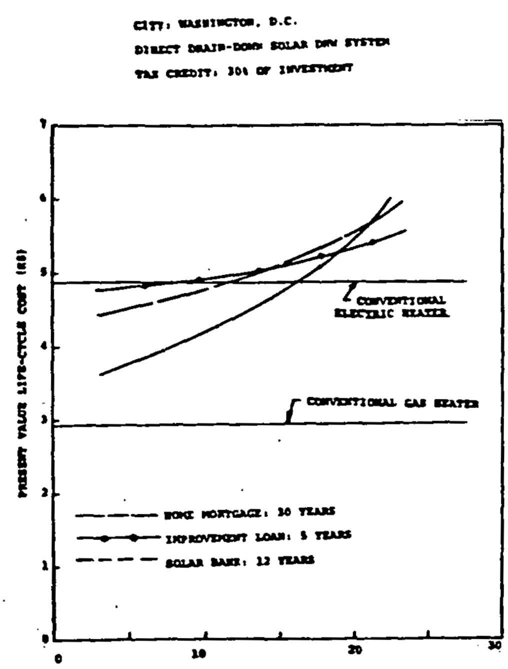


FIGURE 4.25

VARIATION OF PRESENT VALUE LIFE CYCLE COST WITH INTEREST RATE

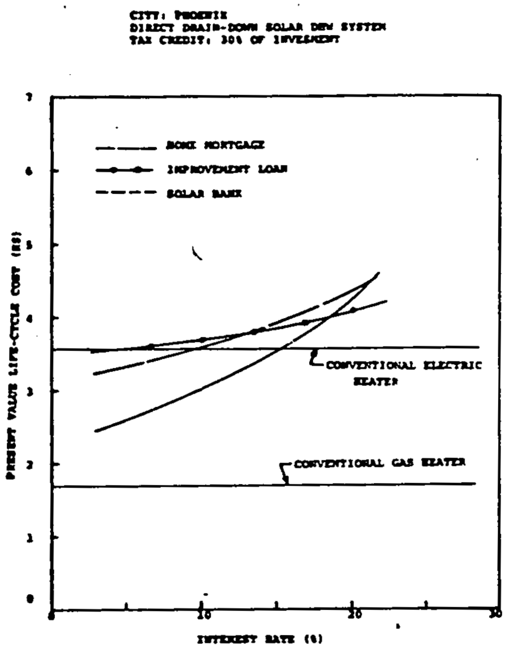


FIGURE 4.26

VARIATION OF PRESENT VALUE LIFE CYCLE COST WITH INTEREST RATE

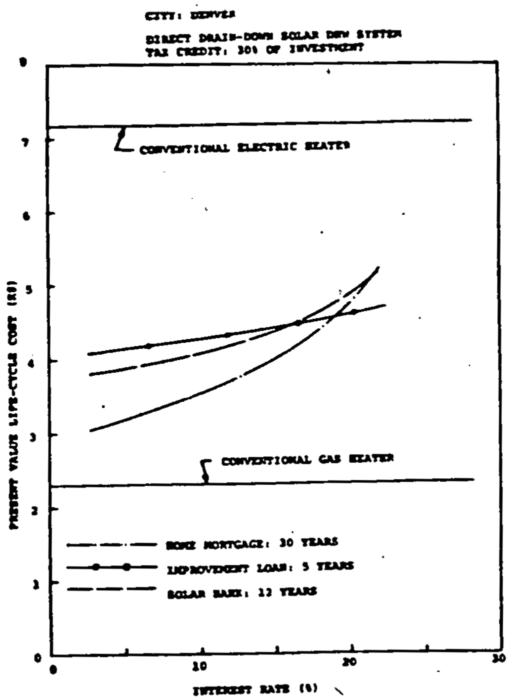


FIGURE 4.27

VARIATION OF PRESENT VALUE LIFE CYCLE COST WITH INTEREST RATE

CITY: LOS ANGELES
DIRECT DRAIN-DOWN SOLAR DHW SYSTEM
TAX CREDIT: 30% OF INVESTMENT

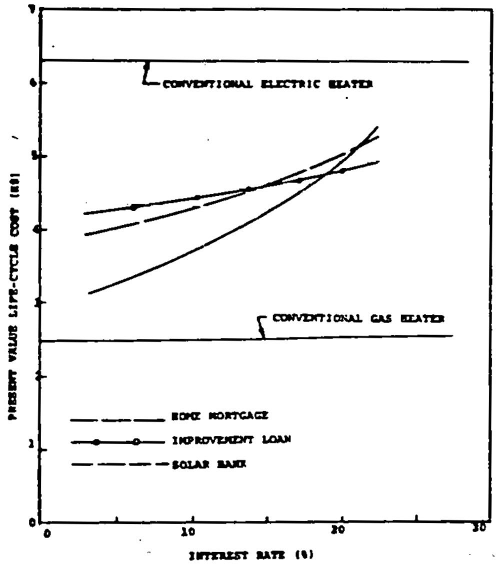


FIGURE 4.28

VARIATION OF MONTHLY AVERAGE COST (DISCOUNTED) WITH INTEREST RATE

CITY : WASHINGTON, D.C.
[illegible] SOLAR DHW SYSTEM
TAX CREDIT : 30% OF INVESTMENT

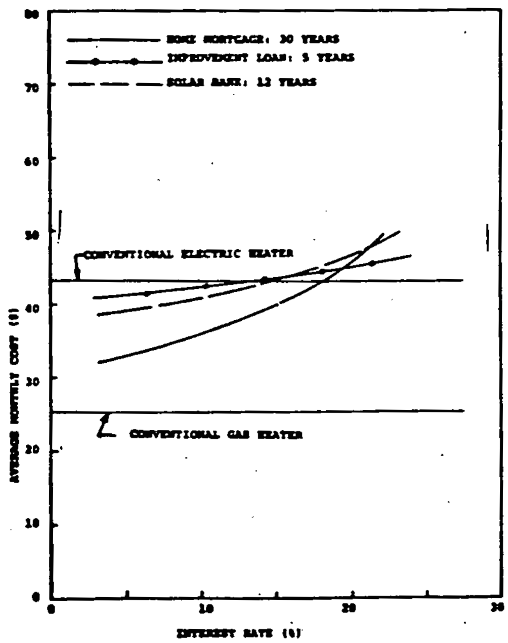


FIGURE 4.29

VARIATION OF MONTHLY AVERAGE COST (DISCOUNTED) WITH INTEREST RATE

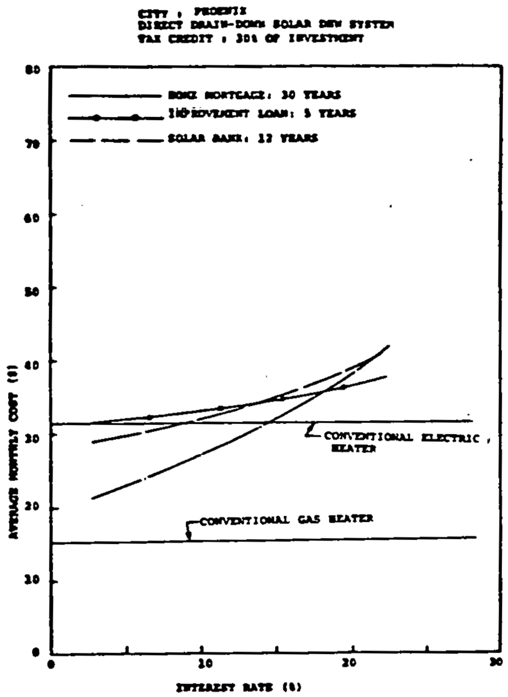


FIGURE 4.30

VARIATION OF MONTHLY AVERAGE COST (DISCOUNTED) WITH INTEREST RATE

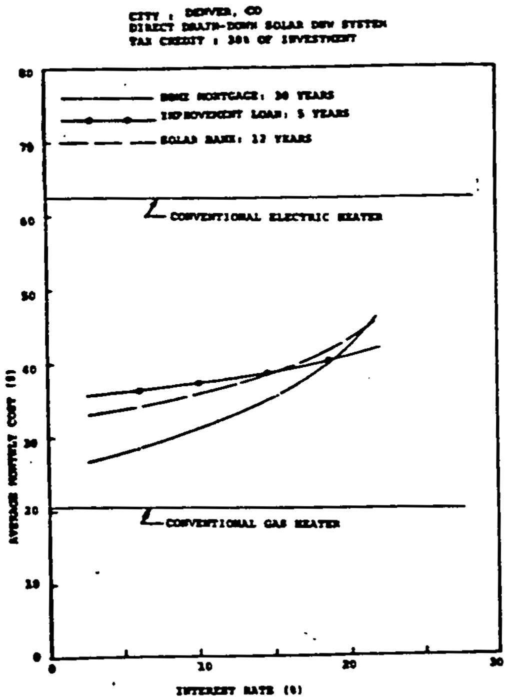
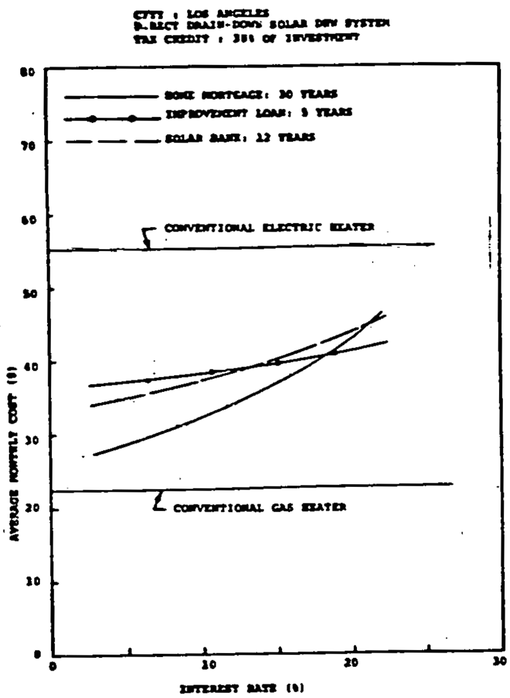


FIGURE 4.31

VARIATION OF MONTHLY AVERAGE COST (DISCOUNTED)

WITH INTEREST RATE



CHAPTER 5

A COMPARISON OF CONVENTIONAL AND SOLAR DOMESTIC WATER HEATING PRODUCTS AND INDUSTRIES

5.1 PRODUCT FEATURES

There are a variety of methods for heating water in the residence including the familiar electric or gas heater which provides an almost limitless supply of hot water in a large insulated tank. Other options are instantaneous heaters at the point-of-use, water heater heat pumps, and heat recovery units (HRU's). For purposes of this market comparison, only the conventional water heater is considered.

There are currently more than 4,000 different models, though these models usually differ only in fuel type and storage capacity. Gas and electric water heaters comprise the majority of all heaters that are sold (oil water heaters' annual sales were shown to be less than 50,000).

Solar water heaters are distinguished from conventional water heaters by the following additional equipment:

- solar collector(s)
- solar storage tank
- controller (electronic)
- control sensors
- pump
- tempering valve
- connecting plumbing

It is important that the consumer's basic needs are satisfied by a SHW system and the conventional product was used as a guide in making this assessment. Product features are summarized in Table 5.1 for both solar and conventional water heaters.

TABLE 5.1

COMPARISON OF PRODUCT FEATURES FOR SOLAR AND CONVENTIONAL RESIDENTIAL WATER HEATERS

	Solar		Electric		Gas	
	Median	Range	Median	Range[1]	Median	Range[2]
Specifications						
Capacity--Gallons	82	66- 120	52	20-66	40	30-50
Recovery--Gal/hr @ 90^{0} Rise		6- 11 (+Aux.)[3]		17-25		20-60
Input Rate, Btu/hr		4300-7900 (+Aux.)[4]		13-20,000		29-60,000
Efficiency, %		NA		78-81		48-52
Lifetime Efficiency Loss, %		5- 15		5-15		5-15
Life--years (water dependent)		10- 20[5]		8-11+		8-11
Warranty, years		1- 10[6]		5-10		5-10
Tank Liners	G L A S S Stone (cement)		G L A S S		G L A S S	

[1]Range for conventional electric heaters that are usually installed. Models are available in capacities up to 120 gallons. Btu/hr input and recovery rates will vary accordingly.

[2]Range for conventional gas heaters that are usually installed. Models are available in capacities up to 100 gallons. Btu/hr input and recovery rates will vary accordingly.

[3]With Aux., these features exceed conventional system performance.

[4]Maximum instantaneous solar input assuming clear day solar insolation of 300 Btu/ft^2 hr., 60 ft^2 of net collectors area, and a system efficiency range of 25 to 40.

[5]Assumes overtemp protection (few systems have this).

[6]Critical lifetime features compare favorably with conventional heating.

Solar storage capacities ranging from 66 to 120 gallons are typically recommended for residential applications (2 - 5 person loads). Electric and gas water heater storage capacities are usually less, ranging from 20-66 gallons (52 gallons median) and 30-50 gallons (40 gallon median), respectively. The larger storage capacity is usually required to compensate for the lower input rates and recoveries of electric water heaters.For solar water heaters to compensate (single tank systems), it is necessary to provide additional storage capacity that a sufficient volume of water is available for back-up capacity during inclement weather. Solar recovery and heat input rates (without auxiliary) are substantially lower than those for electric and gas water heaters, but with the back-up auxiliary unit, the total recovery rates will exceed a conventional unit.

Solar water heater efficiencies are estimated to be between 25 and 40 percent (solar and input only) as compared with electric and gas heaters that have overall efficiencies that range between 78-83 and 48-52, respectively. Of course the auxiliary supply of the solar system would correspond to the conventional water heater. The degradation in efficiency and life for these heaters is also an important consideration. The lifetime efficiency loss varies from 5 to 15 percent depending primarily on temperature/water hardness (scaling).

The lifetime and length of warranty for the various water heaters are also shown in Table 5.1. The lifetime of conventional heaters is determined by water hardness, temperature limits, amount of anode protection, and fuel. Gas water heaters suffer losses due to scaling and have a shorter life due to the combination of water hardness and high external combustion temperatures. The lifetime for solar water heaters can be much longer than conventional heaters since it operates at lower temperatures(two tank systems) and will have reduced external combustion. However, solar systems must provide temperature protection for glass lined tanks to insure protection and it is expected that some unnecessary failures may result.

Water heater warranties are usually for five to ten years but could be extended by increasing the length of the anode rod. Solar water heaters are comparably warranteed at the component level with the collector and storage tank receiving a five to ten year warranty. Controls have shorter warranties, usually 12 to 18 months, but these warranties correspond to industry practice for controls.

The conventional water heater is a well packaged simple device that receives virtually no maintenance during its lifetime but the solar system with minimal maintenance could survive it by 5-10 years.

5.2 PERFORMANCE, COST AND RELIABILITY

The three important factors that must be considered in analyzing solar and conventional domestic water heaters are performance, cost, and reliability. The energy delivered per dollar invested is the gauge that is used when comparing the cost effectiveness (performance/cost) of systems. This section compares the relative merits of the solar domestic water heaters in the framework of the conventional product.

5.2.1 Performance

The energy requirements for conventional gas and electric water heaters are summarized in Table 5.2 for each of the four cities considered in the analysis. Primary energy (which includes energy expended in generating and distributing) is compared with end use energy requirements.

TABLE 5.2

ANNUAL ENERGY REQUIREMENTS (MMBTU) FOR GAS AND ELECTRIC WATER HEATERS IN FOUR DIFFERENT CLIMATES

	Gas	Electric	
	(end use)	(end use)	(power plant)
Washington	26.2	16.3	48.8
Denver	29.3	18.4	55.2
Phoenix	19.1	11.6	34.7
Los Angeles	26.6	16.6	49.7

When comparing the solar system to the conventional water heaters,it is extremely important to consider the impact of the parasitics of the solar systems. If the solar COP is too low, it may offset the advantage (in terms of displaced energy) of having a solar system in the first place. The thermal energy displaced for a well designed system ranges from a low of 170,000 Btu/ft^2-year for Washington, D.C. and Phoenix to a high of 250,000 Btu/ft^2-year for Denver. For a hypothetical SDHW system in Denver using 60 ft^2 of net collector area the thermal energy displaced (excluding the effect of parasitics) ranges nationally from 10.2 MMBtu/year to 15.0 MMBtu/year. System COPs would range from a low of 3.5 to a high of 19.2. Table 5.3 summarizes the effect of parasitic energy on both end use and primary (power plant) energy requirements. The columns labeled high and low correspond to system COPs of 3.5 and 19.2, respectively.

TABLE 5.3

EFFECT OF PARASITIC ENERGY ON SOLAR SYSTEM PERFORMANCE

Thermal Energy Displaced (MMBtu/yr.)	Parasitic Energy (MMBtu/yr.		Primary Energy Requirement (MMBtu/yr.)	
	(high)	(low)	(high)	(low)
15.0	4.3	0.8	12.9	2.4
10.2	2.9	0.5	8.7	1.5

It should be noted that the primary energy requirement in Table 5.3 does not include the auxiliary energy required by the solar system. It is obvious from Table 5.3, that poor system design can substantially reduce the value of a system when considering the primary energy requirements. Minimizing parasitic energy consumption should be a goal in any SDHW system design.

5.2.2 Cost

The cost of solar when compared with conventional water heating can be presented in several ways. Typically, the cost effectiveness of one option versus another is presented in terms of life cycle cost or years to pay back the investment. But, consumer decisions are based on the monthly cost of owning and operating solar equipment when compared with the monthly cost of purchased conventional energy. That is an important consumer requirement and has been extensively documented in this study (along with present value life cycle costs).

The monthly cash flow (or average monthly cost) for a solar domestic water heater was defined as the ammortized cost of owning the solar system plus the cost of the back up fuel. After the system is paid for, the monthly cost equals the cost of the back up fuel. It was shown (Chapter 4) that for some financing scenarios, the average monthly cost for some of the solar systems analyzed will compete favorably with both gas and electricity.

Capital costs for solar water heaters are roughly ten times higher than costs for conventional water heaters. It is therefore necessary to find justification for solar water heaters in terms of both life cycle cost (for the viewpoint of banks and other lending institutions) and monthly cost (consumer viewpoint).

5.2.3 Reliability

The reliability of conventional gas and electric water heaters is unquestionably very good but, occasionally, problems will occur. A summary of failure mechanisms for gas and electric water heaters is given in Table 5.4. The failure rates of gas and electric water heaters due to the mechanisms listed in Table 5.4 are very low. As an example, tank leaks in gas water heaters occur 1 out of 100 the first year, 3 out of 100 the second year, and 5 out of 100 the third year.

TABLE 5.4

FAILURE MECHANISMS FOR GAS AND ELECTRIC WATER HEATERS

Failure Mechanisms

Gas Heater	Electric Heater
Thermocouple fails when improperly installed - lifetime of 2-4 years	Burnout caused by lime build-up (hard water) or dry-firing
Magnet or spring in gas safety control valve fails	
Necessity for thermostat recalibration	Necessity for thermostat recalibration
Anode rod erosion causes tank leaks/failure	Tank leaks caused by anode rod erosion: less common due to lower heat input
Clogging of orifice in pilot light	
Carbon build-up on burner	

The reliability of SDHW systems is not as good as that recorded for conventional water heaters, since several additional pieces of equipment are added in the design of solar water heaters. The necessity for providing freeze protection makes the solar water heater inherently more complex; thus reducing its reliability. Table 5.5 lists the additional equipment included in the solar water heating system (relative to a conventional water heater) and some of the associated reliability problems.

TABLE 5.5

RELIABILITY PROBLEMS ENCOUNTERED IN SOLAR DOMESTIC HOT WATER SYSTEMS

System Component	Associated Problem
Control Card	a) Minimal: electronics are usually very reliable b) Relays, if used, can be a significant problem in some controllers
Pump	a) Cycling can cause excessive wear b) Loss of prime due to poor design*
Tempering Valve	None
Control Sensors	a) Improper calibration b) Improper placement
Collector	a) Corrosion b) Scaling c) Freezing** d) Poor materials (glazing especially) selection
Plumbing	a) Leaks b) Freeze damage
Design	Poor thermal performance

* Controller is often blamed when this problem occurs.

** This can also be a control or plumbing problem.

Good performance and reliability also requires installations by trained installers. Some of the more serious omissions occuring in this survey included: failure to insulate pipes and to cover insulation with a UV retardant protective wrap, failure to dielectrically decouple to prevent lightning damage and failure to properly mount the collectors to the roof (clamped to roof rafters) and provide leak tight rc penetration methods.

Solar water heating systems have other latent problems that had not surfaced and are not presently being adequately addressed. Some of these long-term latent problems that will probably not show up for several years (on a large scale) are:

- collector/system corrosion
- collector/system scaling, especially in hard water areas
- freezing damage to the collector
- tank failures from over-temperature protection

In systems that periodically reintroduce air into the piping systems (as in the direct, draindown system), corrosion has the potential of causing catastrophic failure. Some designers have attempted to avoid the problem by using a nitrogen purge, but for the large part most systems vent to the atmosphere when draining the collectors. Corrosion in glycol systems is also expected to be a significant problem. Monitoring the pH (acidity) of the glycol solution is extremely important. The acidity can change quickly causing a corrosive environment with subsequent complete failure. This condition could be avoided if a low cost pH monitor were developed.

Scaling problems are directly proportional to water hardness and temperature. Water hardness is a site specific problem. It is measured in terms of Mg/l of $CaCo_3$ as follows:

Water Condition	Hardness Number (Mg/l of $CaCO_3$)
Soft	1 - 60
Moderately Hard	61 - 120
Hard	121 - 180
Very Hard	181+

As an example of the problem that can exist, the average hardness for the four test cities is:

City	Hardness Number
Washington, D.C.	115
Denver	78
Phoenix	250
Los Angeles	110

The problem is also compounded by the decreasing solubility of $CaCO_3$ with higher temperatures.

Freezing and inadequate over temperature protection are also latent problems that can cause problems that would not show up for a long period of time. All these problems could be avoided through appropriate design measures.

5.3 SOLAR INDUSTRY ASSESSMENT

If the solar hot water industry is to compete with the conventional water heater technology, it is important that the industry groups not only provide a technically and economically competitive product to the marketplace, but it must provide that product with a delivery system which conforms to acceptable industry standards and within the regulatory framework which assures the protection of the consumer. Therefore, it is important to assess the framework of both industry groups and draw comparisons in their operating philosophies to identify any limitations which the solar industry has and must correct to achieve fully commercialized status. It is also important to examine the consumer protection mechanisms of the conventional industry and assume that the solar industry must operate within the established regulatory bounds. Finally, it will be important to determine those markets which the solar industry can impact and determine whether or not a suitable long term sales potential will exist.

5.3.1 Industry Infrastructure

5.3.1.1 Suppliers

In Chapter 2 it was noted that 95% of the conventional water heater market is serviced by six major companies. It can therefore be assumed that a solar industry can be achieved if a similar number of strong solar companies exist with the necessary delivery tools and strong solar products. In Chapter 3 it was noted that in the list of the twelve leading solar water heater suppliers, four of the six conventional water heater suppliers were included. Six of the eight remaining companies in the twelve "Solar Hot Water Suppliers" list included major firms in the United States with sales well into the millions and billions of dollars.

5.3.1.2 Characteristics of a Successful Company

It was noted in the Mitre Corporation report, dated January 1980, entitled "Characteristics of the Solar Heating and Cooling Equipment Industry," that the characteristics of an industry leader are that the product have: a brand name, proprietary design, existing distribution channels, and financial staying power. The four conventional water heater manufacturers and the HVAC manufacturer in the list of twelve leading manufacturers enjoy the brand name image based on their prior track record. The remaining seven firms on the list must, and are, developing the brand name status in the solar water heating industry by leveraging brand name status in other fields and/or extensive publicity.

5.3.1.3 Proprietary Designs

Proprietary designs are not common in the solar water heating industry. Many of the designs are quite straight forward and patents either do not exist or are not easily protected because of the diversity of options used to circumvent patent rights. Therefore, while the twelve current leaders have a strong position due to their early market entry it can be expected that as sales continue to grow, that other heavily capitalized firms and innovators will be able to achieve significant market penetration as this industry matures. As a result the twelve "leaders" list can be expected to undergo change.

5.3.1.4 Distribution

Over half of the firms interviewed are developing distribution networks with a third operating at a national level. Sixty-five percent are developing a state or regional distribution capability, and therefore this element of the commercialization process is proceeding at a rapid pace.

The four conventional water heater manufacturers and the single HVAC Company already have the mature distribution channels so vital to a successful commercial product. It has been necessary for the remaining seven of the twelve firms to develop similar distribution outlets. Significant progress is being made by these seven firms in the development of distribution channels and,as was noted, all of the twelve have over 100 distributors/dealers scattered throughout the United States and more specifically in the prime market regions for the solar water heater industry. These distribution outlets are continuing to expand as this industry matures.

The usual method by which the solar water heater manufacturers sell the product is through the two step distribution concept used by the conventional industry. The factory direct method has not been used extensively, primarily because of the need for a strong installer service organization.

5.3.1.5 Manufacture

The solar hot water industry leaders also have the complete organization necessary to design, manufacture, market, and deliver the product to the distributor. However, many of the smaller remaining firms (solar hot water system suppliers) are limited in one or more of these categories. This contributes to their limited success in selling and distributing the product.

5.3.1.6 Capitalization and Resources

Capital and manpower resources are a major impediment to the progress of many of the firms outside of the top twelve leaders. These firms tend to be under capitalized and manpower resource limited. This lack of capability is best illustrated by the quality of the training programs and support documentation including design manuals, installation service manuals, and product brochures.

5.3.2 Consumer Protection

The consumer of a conventional hot water product is almost always protected at the local level by one of five model plumbing codes. These codes are usually based upon standards developed by professional or government organizations which have been adopted for reasons of public health, safety or welfare. In comparison, the solar hot water product is currently very loosely regulated and many abuses are occurring and will continue until such codes and standards can be developed to protect the consumer. The most noteworthy solar standards used to regulate the solar hot water product is the HUD Minimum Property Standard. While the MPS addresses certain elements of the product quality and safety, it does not insure that the systems perform the claims of the manufacturer nor does it insure that the installer of the solar hot water system will adequately install the product. The industry would benefit substantially if installation standards were adopted. HUD has written "Installation Guidelines for SHW Systems."

Training is a very significant limitation in the industry. While many of the leading manufacturers have good training programs, the solar installer is usually not required to take the training program and many poor installations have resulted. The conventional industry uses a very simple training program and the licensed plumber is required as part of his state exam to exhibit a familiarity with proper hot water installation practices. Similar state requirements could be adopted for the solar hot water products.

5.4 SOLAR HOT WATER MARKET

The current solar hot water market has enormous market potential across the entire United States with the existing federal, and in many cases, state tax incentive programs. It has been shown in Chapter 4 that solar hot water will compete using monthly cash flow analysis in virtually every part of the United States against electric hot water competition. In those areas where state tax incentives are additive to the federal tax incentive of 40%, solar hot water will compete against gas heated hot water systems as well. This solar hot water option is particularly attractive in the new construction market.

Solar hot water usually becomes more economical as the size of the system increases due to the fixed costs associated with over 50% of the solar hot water systems. The addition of a single collector represents a 20-25% delta cost for the system. The return on investment for the additional collector can be as much as 2 to 2-1/2 times the return on investment of the first and second collectors in the system.

The large fixed costs of a solar hot water system will be disadvantageous in the smaller multi-family systems where the return on investment per square foot of collector is reduced due to the lower load factor on the entire system.

New construction will be the major market entry due to the very large inventory of gas water heaters in the existing housing stocks. It was shown in Chapter 2 that in the four major metropolitan areas studied only 10-20% of the housing stocks have electric water heaters, with the remainder of the residences using gas water heaters as a predominant choice. Based on the earlier analysis, it was shown that solar water heating is competitive economically with gas, only at tax incentive rates of 60-70%. At these higher tax incentive rates a positive cash flow is generated after the 9th or 10th year of the installation. This marginal cost advantage can be expected to be a significant barrier to the large scale substitution of solar water heating for gas water heating.

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APPENDIX I

SOLAR SYSTEMS SUPPLIERS LIST

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine 12/79 Issue	SEIA SEM '79 Catalog	SERI	Integrated Systems Suppliers Contacted	Integrated Systems Suppliers Responded
Hansberger Refrign & Electric Yuma	X			X	X	
J&J Solar Phoenix	X					
Natural Energy Resources Phoenix		X			X	
Navajo Air Industries Phoenix			X			
Solar Building Systems Inc Tempe	X					
Solar Dynamics of Arizona Lake Havasu City	X	X	X	X	X	X
Solar Energy Applications, Inc Phoenix	X		X			
Suncor Inc Tempe	X					
Sunpower Systems Corp Tempe	X	X	X	X	X	
Sunshine Unlimited Chandler	X	X	X	X	X	
Sunsource of Arizona Phoenix		X			X	

SOLAR SYSTEMS SUPPLIERS LIST

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine 12/79 Issue	SEIA SEM '79 Catalog	SERI	Integrated Systems Suppliers Contacted	Integrated Systems Suppliers Responded
Alabama						
Aircraftsman Millbrook	X					
Halstead & Mitchell Scottsboro	X	X			X	X
National Energy Systems Corp Birmingham				X		
Solar Energy of the South Mobile		X			X	
Solar Unlimited Huntsville	X	X	X	X	X	X
Arizona						
Arizona Engineering & Refrign Gilbert	X					
Arizona Solar Enterprises Scottsdale	X					
B&H Refrigeration Yuma			X			
Copper State Solar Products Inc Phoenix		X			X	X
Energex Mfg Corp Phoenix	X					
Goettl Air Conditioning Phoenix	X	X		X	X	

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine 12/79 Issue	SEIA SEM '79 Catalog	SERI	Integrated Systems Suppliers Contacted	Integrated Systems Suppliers Responded
Hale R Brokaw F.E. Carmel	X					
Buckmaster Industries Sunnymead	X	X			X	X
California Solar Systems Co Sunnyvale	X		X		X	
California Sun Energy Sunnymead		X			X	X
Custor Development Corp San Diego	X					
Colt Inc Rancho Mirage	X			X	X	
Conserdyne Corp Glendale	X	X	X	X	X	X
Elcam Inc/Sunspot Divn Santa Barbara	X		X	X	X	
Energy Absorption Systems Inc West Sacramento	X					
Energy Mgmt Corp of America Santa Monica		X	X			
Energy Systems Inc San Diego	X	X	X	X	X	
Era Del Sol Goleta	X					
Harness the Sun Cardiff-by-the-Sea	X					

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine 12/79 Issue	SEIA SEM '79 Catalog	SERI	Integrated Systems Suppliers Contacted	Integrated Systems Suppliers Responded
California						
Al Prototype El Cajon	X					
Acurex Aerotherm Mountain View	X					
Advanced Energy Technology Los Gatos	X	X	X	X	X	X
Alten Corp Mountain View	X	X	X		X	X
American Appliance Mfg Corp Santa Monica	X			X	X	
Alternative Energy Resources San Diego				X	X	X
American Home Solar Energy Systems Laguna Beach	X		X	X	X	
American Solar Industries Concord	X					
American Solar Systems Arrozo Grande	X					
American Sun Industries Newburg Park			X	X	X	
Approtech Solar Products S[illegible] Jose	X	X	X		X	
Beam Engineering Inc						

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine 12/79 Issue	SEIA SEM '79 Catalog	SERI	Integrated Systems Suppliers Contacted	Integrated Systems Suppliers Responded
Radco Products Inc Santa Maria	X	X			X	
Raypak Inc West Lake Village	X	X		X	X	X
Fred Rice Productions La Quinta	X	X				
Setsco (Solar Energy Thermal Systems Co) Concord	X					
Sol Power Industries Cupertino	X					
Sola Hart San Diego		X				
Sola Heat Los Angeles	X			X	X	
Solar Captivators Systems San Diego	X					
Solar Collectors of Santa Cruz Santa Cruz	X					
Solar Contact Systems Anaheim	X	X	X	X	X	
Solar Applications San Diego				X	X	
Solar Conversion Corp Long Beach	X					
Solar Energies of California Lakeside	X		X	X	X	

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine 12/79 Issue	SEIA SEM '79 Catalog	SERI	Integrated Systems Suppliers Contacted	Integrated Systems Suppliers Responded
Heliodyne Corp Richmond	X	X	X	X	X	
Helix Solar Systems LaPuente	X	X			X	
Insolarator San Diego	X					
International Solar Leasing Co San Diego	X	X				
Jacobs-Del Solar Systems Inc Pasadena	X	X				
J.G. Johnston Company Palmdale	X					
Kaiser Energy Engrg San Carlos	X					
Lordan/Solcoor Los Angeles	X					
Natural Heating Systems West Sacramento			X			
Pacific Solar Industries Inc Norwalk	X					
Piper Hydro Inc Anaheim	X	X		X	X	
Ra-Energy Systems L[illegible]side		X		X	X	X
Ra-Los Inc Campbell	X	X		X	X	X

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine 12/79 Issue	SEIA SEM '79 Catalog	SERI	Integrated Systems Suppliers	
					Contacted	Responded
Solargenics Inc Chatsworth	X	X	X		X	
Solardyne Inc San Diego			X			
Solahart International Sorrento Valley	X	X	X			
Solarmaster Porterville	X					
Solarnetics Corp El Cajon		X	X	X	X	
Solartec Corp San Diego				X	X	
Solarshingles Co Van Nuys	X					
Solartherm Mfg Corp Palm Springs	X				X	
Solarway Healdsburg	X					
Solen Enterprise Santa Barbara		X			X	
Solergy Inc San Francisco	X			X	X	
Solpower Cupertino	X	X			X	
Southwest Solar Corp Canoga Park	X					

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine 12/79 Issue	SEIA SEM '79 Catalog	SERI	Integrated Systems Suppliers Contacted	Integrated Systems Suppliers Responded
Solar Energy Engineering Santa Rosa	X		X			
Solar Energy Systems Inc Los Angeles	X		X			
Solar Energy Thermal Systems Co Concord				X	X	
Solar Enterprises Red Bluff	X	X				
Solar Hydro Systems Fullerton	X		X	X	X	
Solar King International Canoga Park	X	X		X	X	X
Solar Supply Inc San Diego			X			
Solar Systems Novato				X	X	
Solar Trend Industries Los Angeles		X			X	
Solar West Inc Fresno	X					
Solar II Enterprises Campbell		X			X	
Sol[illegible]eam Industries Inc A[illegible]mbra	X					
Sol[illegible]coa Inc						

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine 12/79 Issue	SEIA SEM '79 Catalog	SERI	Integrated Systems Suppliers Contacted	Integrated Systems Suppliers Responded
Sunwater Energy Products El Cajon				X	X	
Sunworks Healdsberg	X					
Swan Solar Canoga Park	X					
Technitrek Corp San Leandro	X	X		X	X	X
Thermics Cotati		X			X	
Vanguard Solar Systems Anaheim	X	X				
Western Energy Inc Palo Alto	X		X	X		
Western Solar Development Inc Vacaville	X	X			X	X
Yazaki Corp/LA Office Los Angeles	X					
Ying Mfg Corp Gardena	X	X		X	X	
ZZ Corp Las Alamitos	X					

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine 12/79 Issue	SEIA SEM '79 Catalog	SERI	Integrated Systems Suppliers Contacted	Integrated Systems Suppliers Responded
Stainless Steel Systems Julian				X	X	
Sun CO Solar Products Palm Springs	X					
Sun Energy International Concord				X	X	
Sun Energy Systems, Inc Covina				X	X	
Sun Power Systems Ltd Sunnyvale	X					
Sun of Man Solar Systems Bethel Island			X			
Sun Ray Solar Heaters San Diego	X	X			X	
Sun Water Inc Northridge	X					
Sunburst Solar Energy Inc Menlo Park	X	X	X	X	X	
Sundu Company Anaheim	X					
Sunglaze Olympic Valley	X					
Sunr[illegible] Solar Inc Re[illegible]a	X					
Sunspot Environmental Energy						

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine 12/79 Issue	SEIA SEM '79 Catalog	SERI	Integrated Systems Suppliers Contacted	Integrated Systems Suppliers Responded
Colorado						
American Heliothermal Corp Denver	X		X	X	X	
Alternative Heating Systems Boulder			X			
Colorado Sunworks Boulder			X	X	X	
Energy Dynamics Commerce City				X		
Entropy Ltd Boulder	X	X	X	X	X	X
Federal Energy Corp Denver				X	X	
Future Systems, Inc Lakewood			X			
Gramer Industries Inc Denver	X			X	X	X
House Warming Development Co Boulder			X			
Hyperion Boulder	X	X	X	X	X	X
Lamco Inc Colorado Springs	X	X			X	
Mountain Mechanical Sales Denver		X		X	X	

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine 12/79 Issue	SEIA SEM '79 Catalog	SERI	Integrated Systems Suppliers Contacted	Integrated Systems Suppliers Responded
Connecticut						
American Solar Heat Corp Danbury	X		X	X	X	X
Falbel Energy Systems Corp Stamford	X		X	X	X	
Groundstar Energy Corp Rowayton			X	X	X	
International Environmental Energy Hartford	X					
KEM Associates New Haven			X			
National Solar Corp Old Saybrook	X		X	X	X	X
Solar Craft Industries Windsor	X					
Solar Industries, Inc Plymouth				X	X	
Solar Kinetics Corp Hartford			X			
Solar Processes Inc Mystic	X					
Solar Products Mfg Corp Newington	X			X	X	X
Sta Corp/Solar Technology & Application Enfield	X					

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine 12/79 Issue	SEIA SEM '79 Catalog	SERI	Integrated Systems Suppliers Contacted	Integrated Systems Suppliers Responded
Novan Energy Inc Boulder	X	X		X	X	X
R.M. Products Denver	X	X		X	X	
Solar Control Corp Boulder			X			
Solar Development Inc Aurora	X					
Solar Energy Research Corp Longmont	X	X	X	X	X	X
Solar Specialties Inc Denver	X	X			X	X
Solar Technology Corp Denver	X	X	X	X	X	
Solaron Corp Denver	X	X	X	X	X	X
Sun-Heet Inc Englewood	X	X		X	X	
Sunlife Inc Boulder	X					
Telluride Solar Works Telluride	X					
T[illegible]state Sol-Aire Inc [illegible]ver	X	X				

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine 12/79 Issue	SEIA SEM '79 Catalog	SERI	Integrated Systems Suppliers Contacted	Integrated Systems Suppliers Responded
Aztec Solar Co Maitland	X		X			
Beutels Solar Heating Co Miami	X			X	X	
D.W. Browning Contracting Co Holly Hill	X		X	X	X	
Capital Solar Heating Inc Miami	X					
CBM Mfg Inc Ft Lauderdale			X			
Chemical Processors Inc St Petersburg	X			X	X	
CSI Solar Systems Division Clearwater	X	X	X	X		
Energy Conservation Equipment Corp Loxahatchee	X		X			
Flagala Corp Panama City	X					
Florida Solar Power Inc Tallahassee	X					
General Energy Devices Clearwater	X	X	X	X		
Gulf Thermal Corp Bradenton	X					

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine 12/79 Issue	SEIA SEM '79 Catalog	SERI	Integrated Systems Suppliers Contacted	Integrated Systems Suppliers Responded
Sun-Ray Solar Equipment Shelton	X			X		
Sunworks, Div of Enthane New Haven	X		X		X	X
Delaware						
Porter Energy Products Newark		X	X		X	X
Solar Energetics Inc Wilmington	X					
Florida						
All Sunpower Inc Miami	X	X	X	X	X	
American Solar Power Inc Tampa	X	X				
American Sun Corporation Miami	X					
American Sunsystems Inc Miami	X					
Apollo Solar Energy Corp Jacksonville	X		X			
Ast[illegible] Solar Corp W[illegible] Palm Beach	X					

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine 12/79 Issue	SEIA SEM '79 Catalog	SERI	Integrated Systems Suppliers Contacted	Integrated Systems Suppliers Responded
Solar Energy Products Inc Gainesville	X		X	X	X	X
Solar Energy Resources Corp Miami	X					
Solar Engineering & Mfg Co Inc Boca Raton	X					
Solar Fin Systems St Augustine	X	X			X	
Solar Heater Manufacturers Lake Worth	X		X			
Solar Heating Systems Clearwater	X					
Solar Industries of Florida Jacksonville	X					
Solar Innovations Lakeland		X	X		X	
Solar Products Inc/Sun-Tank Miami	X				X	
Solar Servants Ft Myers Beach		X			X	
Solar Water Heaters of Newport Newport Richez	X					
Solar-Eze Products Inc Ft Lauderdale	X	X				

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine 12/79 Issue	SEIA SEM '79 Catalog	SERI	Integrated Systems Suppliers Contacted	Integrated Systems Suppliers Responded
Heliokon Industries Jacksonville			X			
Horizon Enterprises, Inc Homestead	X	X	X	X	X	X
Largo Solar Systems Inc Plantation	X	X	X	X	X	X
OEM Products Inc/Solarmatic Tampa	X	X			X	X
Raleigh Solar Systems/ Raleigh Mfg Co Miami			X			
W R Robbins & Son Miami	X			X	X	X
Rox International Sarasota	X					
Semco Solar Products Corp Ft Lauderdale	X	X	X	X	X	
JGR Simmons Construction Co Ormond Beach	X					
Solar Development Inc Riviera Beach	X	X	X	X	X	X
Solar Dynamics Inc Hialeah	X			X	X	
Solar Energy Components Inc Cocoa	X					

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine 12/79 Issue	SEIA SEM '79 Catalog	SERI	Integrated Systems Suppliers Contacted	Integrated Systems Suppliers Responded
Georgia						
ILI, Inc Atlanta		X			X	
Independent Living Inc Norcross	X		X			
Kaz Solar Systems Inc Rome	X					
National Solar Company Atlanta	X					
National Solar Supply Atlanta	X					
Rheem Mfg Co Atlanta				X		
Solar Energy Systems of Georgia Atlanta				X	X	
Southeastern Solar Systems, Inc Atlanta	X	X		X	X	X
Sunplate Inc Thomaston	X					
United States Solar Industries Atlanta	X					
Wallace Co Gainsville	X					

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine 12/79 Issue	SEIA SEM '79 Catalog	SERI	Integrated Systems Suppliers Contacted	Integrated Systems Suppliers Responded
Solarcell Corp Ft Lauderdale	X					
Solarkit of Florida Tampa	X			X	X	
Southern Lighting/Universall 100 Products Orlando	X					
Sun Dance Inc Miami Lakes	X		X	X	X	X
Sun Harvesters Inc Ocala	X			X	X	
Sunking Ft Lauderdale		X			X	
Systems Technology Inc Shalimar	X	X	X	X	X	
U.S. Solar Corp Hampton	X	X	X	X	X	
Union CRRCTNL Inst (FL St Agencies only) Raiford	X					
Unit Electric Control Inc/Sol Ray Divn Maitland	X			X	X	
Wilc [illegible]orp Oc[illegible]	X					

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine	SEIA	SERI	Integrated Systems Suppliers	
		12/79 Issue	SEM '79 Catalog		Contacted	Responded
S S Solar Inc River Forest	X	X	X		X	
A O Smith Corp Kankakee	X	X	X	X	X	X
Solar Dynamics Corp Northfield	X					
Solarflame Systems LeRoy		X			X	X
Sunduit Inc Virden	X	X			X	X
<u>Indiana</u>						
BDP Company Indianapolis	X		X			
Energy Management Engineering Evansville				X	X	
International Solar Technologies Plainfield	X					
Solar Shelter Engrg Co Inc Muncie				X	X	
<u>Iowa</u>						
Engineers Ltd Dubuque	X					

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine 12/79 Issue	SEIA SEM '79 Catalog	SERI	Integrated Systems Suppliers Contacted	Integrated Systems Suppliers Responded
Hawaii						
Haleakala Solar Resource Inc Honolulu	X					
Solar Energy Corp of America Honolulu	X					
Solar Enterprises Hawaii Honolulu	X					
Solaray Corp Honolulu	X					
Idaho						
Energy Alternatives, Inc Moscow	X		X		X	
Solar Development, Inc., Northwest Pocatello		X			X	X
Illinois						
Chicago Solar Corp Chicago	X					
Illini Insulation & Sun Effingham	X	X			X	
Rheem Water Heater Div/ Ci[illegible] nvestors Chicago	X		X		X	X

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine 12/79 Issue	SEIA SEM '79 Catalog	SERI	Integrated Systems Suppliers Contacted	Integrated Systems Suppliers Responded
Mid-Western Solar Systems Paducah	X	X			X	
Louisiana						
Sun-Pac Inc Alexandria	X	X			X	
Maine						
Aidco Maine Corp ORRS Island	X					
Dumont Industries Monmouth	X	X	X	X	X	X
Shape Symmetry & Sun Inc Biddeford			X	X	X	
Solarkinetics Bridgton	X					
Maryland						
Futuristic Solar Systems Temple Hills	X	X			X	
General Solar Corp Rockville		X				
KTA Products Div/NPD Energy Sys Rockville	X					
Payne Inc Anapolis	X					

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine 12/79 Issue	SEIA SEM '79 Catalog	SERI	Integrated Systems Suppliers Contacted	Integrated Systems Suppliers Responded
Lennox Industries Marshtown			X			
Plelad Industries, Inc West Branch	X					
R O Sullivan & Son Cedar Rapids	X	X				
Solar Aire Division, Sunsaver Corp North Liberty			X			
Solar Electric Inc. West Branch	X					
Kansas						
Alternate Energy Sources Inc Salina	X	X			X	
Energy Alternatives Wichita				X	X	
Salina Solar Products Inc Salina	X					
Solar Farm Industries Stockton	X	X			X	
Kentucky						
Kent[illegible] Solar Fr[illegible]furt				X	X	

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine 12/79 Issue	SEIA SEM '79 Catalog	SERI	Integrated Systems Suppliers Contacted	Integrated Systems Suppliers Responded
Diz-Sol Inc Marlboro	X					
Elbart Mfg Co Millbury	X			X	X	X
Energy Distribution Inc Duxbury		X			X	
Solafern Ltd Bourne	X	X		X	X	X
Solar Aqua Heater Corp Weymouth	X					
Solar Heat Corp Arlington	X					
Solar Thermal Systems/Div Exxon Burlington	X	X		X	X	
Solarmaster Systems Inc Farmingham	X					
Solectro-Thermo Inc Dracut	X					
Sun Systems Inc Boston	X		X			
Sunsav Inc Lawrence	X	X			X	
Terra-Light Inc Billerica	X	X		X	X	

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine 12/79 Issue	SEIA SEM '79 Catalog	SERI	Integrated Systems Suppliers Contacted	Integrated Systems Suppliers Responded
Polestar Corp Columbia	X					
Solar Comfort Systems/ Div Solar Sys Bethesda	X					
Solar Energy Systems Products Emmitsburg	X					
Solartherm Silver Spring	X	X	X	X	X	
Thomason Solar Homes Inc Ft Washington	X	X				
N H Yates Co, Inc Cockeysville	X		X	X	X	X
Massachusetts						
Acorn Structures Inc Concord	X		X	X	X	X
Columbia Chase Solar Energy Div Holbrook	X	X	X	X	X	X
JT Corey Inc West Boston	X					
Daystar Corp Burlington			X			
Dixon Energy Systems Inc Hadley	X		X	X	X	X

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine 12/79 Issue	SEIA SEM '79 Catalog	SERI	Integrated Systems Suppliers Contacted	Integrated Systems Suppliers Responded
Northern Solar Power Co Moorhead			X			
Solar Enterprises Inc Fridley	X	X				
Solargizer International Inc Bloomington	X	X			X	X
Solergy Co Minneapolis	X					
Sunsource Systems Co Burnsville	X					
Missouri						
Cessna Solar Systems Inc Kansas City	X					
Sun Time Solar Corp Kansas City	X	X				
Weather-Made Systems Inc Springfield	X	X	X	X	X	
Montana						
Energy Solutions Inc Stevensville	X	X	X	X	X	
Sun Wise Inc Great Falls		X			X	

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine	SEIA	SERI	Integrated Systems Suppliers	
		12/79 Issue	SEM '79 Catalog		Contacted	Responded
Michigan						
Champion Homebuilders Co Dryden			X	X	X	
Electric Motor Repair & Service Lake Leelanau	X					
Kawneer Architectural Products Niles	X					
Refrigeration Research/Solar Research Brighton	X	X	X	X	X	
Sol-Lector Inc Grand Rapids	X					
Solarator Birmingham	X		X	X	X	
Solartran Corp Escanaba	X					
Sunrise Energy Products Inc Pellsion	X		X			
Tranter Inc Lansing	X					
Minnesota						
Ilse Engrg Inc Du[illegible]h			X			
National Energy Corp [illegible]			X	X	X	

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine 12/79 Issue	SEIA SEM '79 Catalog	SERI	Integrated Systems Suppliers Contacted	Integrated Systems Suppliers Responded
Granite State Solar Industries Dover	X					
Kalwall Corp Manchester		X			X	
SunHouse Inc Nashua		X			X	
New Jersey						
Calmac Mfg Corp Englewood	X					
Creighton Solar Concepts Lawrenceville	X		X	X	X	
Edwards Engrg Corp Pompton Plains				X	X	
Ener*G Systems Westfield	X					
Multi Research Corp/Solarad Div Keyport		X	X	X	X	
Rainaire Products Laramie			X			
Solar and Geophysical Engrg Sparta	X					
Solar-En Corp Denville		X			X	X

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine 12/79 Issue	SEIA SEM '79 Catalog	SERI	Integrated Systems Suppliers Contacted	Integrated Systems Suppliers Responded
Sunset Solar Construction Stevensville	X					
Nebraska						
SMC Energy Co Omaha		X			X	
Solar Americ Inc Omaha	X					
Solar Inc Mead	X					
Valmont Energy Systems Valley	X	X			X	
Nevada						
Richdel Inc Carson City		X	X			
Southwest Ener-Tech Inc Las Vegas	X					
Sundog Solar Reno	X					
New Hampshire						
Conte[illegible]ary Systems Inc Wal[illegible]	X	X		X	X	

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine 12/79 Issue	SEIA SEM '79 Catalog	SERI	Integrated Systems Suppliers Contacted	Integrated Systems Suppliers Responded
American Solar Products Las Cruces		X				
K-Line Corp Albuquerque	X			X		
S W Energy Options Silver City		X			X	
Southwest-Standard Albuquerque	X			X	X	
Zone Works Industries Albuquerque	X	X				
New York						
A.C.M. Industries Cliffton Park				X		
Advance Cooler Mfg Corp Cliffton Park	X	X			X	
Alternate Energy Industries New York		X			X	X
Bio-Energy Systems Spring Glen	X	X			X	X
Carrier Air Conditioning Corp Syracuse	X		X			
Catalano & Sons Inc Brooklyn	X					
Eastern Sun-Tech Industries Rockville Center	X					

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine 12/79 Issue	SEIA SEM '79 Catalog	SERI	Integrated Systems Suppliers Contacted	Integrated Systems Suppliers Responded
Solar Energy Systems Inc Burlington	X					
Solar Htg of New Jersey Paramus				X		
Solar Industries Farmingdale		X			X	X
Solar Living Inc Netcong	X	X	X	X	X	X
Solarlife Riverton	X					
Solenco Corp Flanders		X			X	
Sunassist Monroeville	X					
Sunrise Solar Systems Montvale		X				
Sunworks Div/Sunselector Corp Somerville		X				
W&W Solar Systems Inc Linden	X					
New Mexico						
Albuquerque Western Solar Industries Albuquerque	X		X			

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine 12/79 Issue	SEIA SEM '79 Catalog	SERI	Integrated Systems Suppliers Contacted	Integrated Systems Suppliers Responded
Standard Solar Collectors Inc Brooklyn	X	X			X	
Sulzer Bros Inc New York	X					
Sun Chance Hurleyville	X					
Sun Tech Solar Industries Chester			X	X	X	
Sunmaster Corp Corning	X		X	X	X	X
Sunray Solar Heat Inc Brooklyn	X			X	X	
Technodyne Associates New York	X					
Total Energy Solar Prod Mfr Install Inc Patchogue	X					
North Carolina						
Air Comfort Solar Co Raleigh	X	X	X		X	X
Carolina Solar Equipment Co Salisbury			X	X	X	
Energy Control Systems Raleigh	X					

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine 12/79 Issue	SEIA SEM '79 Catalog	SERI	Integrated Systems Suppliers Contacted	Integrated Systems Suppliers Responded
Energy Design Inc Schenectday			X			
Grumman Corp/Energy Sys Div Ronkonkoma	X	X	X	X	X	X
Hitachi Chemical Co America Ltd New York	X					
Meromit Piping Heating Corp Forest Hills				X	X	
Nortec Solar Industries Inc Ogdensburg	X					
Northeastern Solar Energy Corp Great Neck				X	X	
Prima Industries Inc Deer Park	X		X	X	X	
Revere Solar & Architectural Prod Rome	X	X	X	X	X	
Solar Energy Products Hopewell Junction		X			X	
Solar Energy Systems Scarsdale		X				
Solarom of North America Westbury		X	X		X	
Sole [illegible]olar Energy Systems Sc[illegible]sdale				X	X	

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine	SEIA		Integrated Systems Suppliers	
		12/79 Issue	SEM '79 Catalog	SERI	Contacted	Responded
Rom-Air Solar Systems Avon Lake		X			X	
SJC Corp/Div Frigiking-Tuppar Elyria		X			X	X
Solar Central Mechanicsburg	X					
Solar Energy Products Company Avon Lake	X		X	X	X	X
Solar Heat Corp Euclid		X				
Solar Home Systems Inc Chesterland	X	X	X		X	
Solar Sun Inc Cincinnati	X			X	X	
Solar 1/Div Stellar-Industries Inc Mentor	X					
Solartec Inc Salem	X					
Solarvak Inc Dayton	X					
Stolle Corp Sidney	X					

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine 12/79 Issue	SEIA SEM '79 Catalog	SERI	Integrated Systems Suppliers Contacted	Integrated Systems Suppliers Responded
Jensen Solar Inc Goldsboro	X					
Solar Development & Mfg Raleigh	X					
Solar Technology International Statesville		X				
Surry Solar Services Mount Airy				X	X	
Whiteline Inc Asheville	X					
Ohio						
Alpha Solarco Cincinnati	X	X	X	X	X	
Gem Mfg Corp/Solar Usage Now Bascom	X					
Libbey-Owens-Ford Co/Solar Energy Toledo	X					
Mor-Flo Industries Inc Cleveland	X	X	X	X	X	X
Owens Illinois Inc Toledo	X					
Ralo Solar Enterprises New Carlisle	X					

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine 12/79 Issue	SEIA SEM '79 Catalog	SERI	Integrated Systems Suppliers Contacted	Integrated Systems Suppliers Responded
A.B.C. Solar Corp Barto			X			
Amicks SOlar Heating Middletown	X	X			X	X
General Electric Co Philadelphia	X	X			X	X
Heliotherm Inc Lenni	X		X	X	X	X
Overly Mfg Co Greensburg	X					
PAolino Engrg Clifton Hgts	X					
PPG Industries Inc Pittsburgh			X			
Practical Solar Heating Bethlehem	X		X	X	X	
Solar Energy Associates Hellertown	X					
Solar Heat Co Greenville	X	X	X		X	
Solar Shelter Engrg Co Kutztown	X		X			

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine 12/79 Issue	SEIA SEM '79 Catalog	SERI	Integrated Systems Suppliers Contacted	Integrated Systems Suppliers Responded
Oklahoma						
Cimarron Solar Industries Oklahoma City	X		X	X	X	
McKim Solar Energy Systems Inc Tulsa	X			X		
Westinghouse Electric Corp/Air Conditioning Div Norman				X	X	
Oregon						
W C Brown & Associates Portland		X			X	
Kastek Corp Portland	X					
Scientifico Cottage Grove			X			
Solarkits Philomath	X					
SunLife Solar Products Inc Clackamas			X			
Pennsylvania						
Amet[illegible] Inc Iv[illegible]nd	X	X	X		X	X

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine 12/79 Issue	SEIA SEM '79 Catalog	SERI	Integrated Systems Suppliers Contacted	Integrated Systems Suppliers Responded
South Carolina						
General Solargenic Corp John's Island	X					
Tennessee						
Energy Converters Inc Chattanooga	X		X	X	X	X
Energy Design Corp Memphis	X	X			X	X
W. L. Jackson Mfg Co Chattanooga	X		X	X	X	X
State Industries Inc Ashland City	X		X	X	X	X
Sun Harvester Corp Knoxville				X	X	
Texas						
Ace Solar Systems Mission	X					
Alternative Energy Resources Inc El Paso	X	X	X	X	X	X
American Solar King Corp Waco	X	X	X	X	X	X

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine 12/79 Issue	SEIA SEM '79 Catalog	SERI	Integrated Systems Suppliers Contacted	Integrated Systems Suppliers Responded
Solara Inc Levittown		X				
SunGod Solar Heat New Britain	X					
Sundevelopment York	X			X	X	
Sunearth Solar Products Corp Harleysville	X	X	X	X	X	X
Sunwall Inc/Sunway Pittsburgh	X					
Puerto Rico						
Solar Devices Inc San Juan	X					
Rhode Island						
Amtrol Inc West Warwick				X		
Solar Homes Inc/Suntrol Providence	X			X	X	
Suntree Solar Co Woonsocket	X	X			X	X
Vulca[illegible]lar Industries, Inc Paw[illegible]ket	X		X	X	X	X

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine 12/79 Issue	SEIA SEM '79 Catalog	SERI	Integrated Systems Suppliers Contacted	Integrated Systems Suppliers Responded
Sun-a-matic Mineral Wells				X	X	
Utah						
Griep Heating Salt Lake City	X					
Vermont						
Earth Services Inc Pawlet	X			X	X	
Solar Alternative Inc Battleboro	X	X	X			
Virginia						
Clarks Products & Services Bluemont	X					
Dunham-Bush Inc Harrisonburg	X	X				
Helios Corp Charlottesville	X			X		
Intertechnology/Solar Corp Warrenton	X	X	X	X	X	
Pioneer Energy Products Forest			X	X		

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine 12/79 Issue	SEIA SEM '79 Catalog	SERI	Integrated Systems Suppliers Contacted	Integrated Systems Suppliers Responded
Butler Venta-matic Corp Mineral Wells	X					
Cole Solar Systems Inc Austin	X	X	X	X	X	X
Heliosystems Dallas	X	X	X	X	X	
Lennox Industries Inc Dallas	X	X		X	X	X
Northrup Inc Dallas	X		X	X	X	X
Pres Clancey & Associates San ANtonio				X	X	
Solar Enterprises Inc Arlington	X			X	X	
Solar Kinetics Inc Dallas	X					
Solar Systems Inc Tyler	X					
Solartech Systems Corp Lubbock	X		X	X		
Solus Inc Houston	X					
Sout[illegible]st Standard El [illegible]aso	X					

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine 12/79 Issue	SEIA SEM '79 Catalog	SERI	Integrated Systems Suppliers Contacted	Integrated Systems Suppliers Responded
Wisconsin						
B E Solar Systems Inc Janesville	X					
Northwest Solar Inc Onalaska	X					
Research Products Corp Madison	X	X		X	X	
SunStone Solar Energy Equipment Sheboygan	X	X	X	X	X	X
Wefcol Solar Div Whitewater	X	X				
Wissota Solar Chippewa Falls		X	X		X	
Wyoming						
Park Energy Co Jackson	X	X			X	
Washington D C						
Natural Energy Corporation			X			
Solar Comfort Division, Solar Systems Inc			X			

Company/Location	National Solar Heating & Cooling Information Center	Solar Energy Magazine 12/79 Issue	SEIA SEM '79 Catalog	SERI	Integrated Systems Suppliers Contacted	Integrated Systems Suppliers Responded
Reynolds Metals Company Richmond	X				X	X
Solar American Co Inc Williamsburg	X		X			
Solar One Ltd Virginia Beach	X	X	X			
Solar Water Panels Inc Petersburg	X		X			
Virginia Solar Components Inc Rustburg	X	X	X	X	X	X
Westinghouse Electric Corp/Solar Co Falls Church	X	X				
Washington						
E&K Service Co Bothell	X	X	X	X	X	X
Energy Production Systems Inc Everett	X					
Practical Solar Systems Kent		X			X	
West Virginia						
Sola[illegible]uipment Distributors Inc/ Di[illegible] Yago Systems Design Barboursville		X	X		X	

APPENDIX II

SOLAR WATER HEATER SYSTEM SUPPLIERS

FROM SAMPLE SURVEY

SOLAR WATER HEATER SYSTEM SUPPLIERS
FROM SAMPLE SURVEY

1. Acorn Structures
2. Advanced Energy Technology, Inc.
3. Air Comfort, Inc.
4. Alten Corp.
5. Alternate Energy Industries
6. Alternative Energy Resources
7. American Solar Heat Corp
8. American Solar King Corp
9. Ametek
10. Amicks
11. Beam Engineering, Inc.
12. Bio-Energy Systems, Inc.
13. Buckmaster Industries
14. California Sun Energy
15. Cole Solar Systems, Inc.
16. Columbia Chase Solar Energy
17. Conserdyne Corp
18. Copper State Solar Products
19. Dixon Energy Systems, Inc.
20. Dumont Industries
21. E&K Service Co.
22. Elbart Co.
23. Energy Converters, Inc.
24. Energy Design Corp.
25. Energy Systems, Inc.
26. Entropy Ltd.
27. General Electric
28. Grumman
29. Halstead & MItchell
30. Heliotherm
31. Horizon
32. Hyperion
33. W. L. Jackson Mfg. Co., Inc.
34. Largo Solar Systems, Inc.
35. Lennox
36. Mor-Flo Industries, Inc.
37. National Solar Corp.
38. Northrup Energy
39. Novan Energy, Inc.
40. OEM Products, Inc.
41. Porter Energy Products
42. RA Energy Systems, Inc.
43. Ramada Energy Systems, Inc.
44. Raypak, Inc.
45. Reynolds Metals Co.
46. Rheem
47. W. R. Robbins
48. SJC Corp
49. Semco Corp.
50. A. O. Smith
51. Solafern (Fern Engineering)
52. Solar Development, Inc., Pocatello
53. Solar Development, Inc., Riviera E h,
54. Solar Dynamics of Arizona

--. Solar-En Corp.

56. Solar Energy Products Co., Avon Lake, Ohio

57. Solar Energy Products, Inc., Gainesville, FL

58. Solar Energy Research Corp.

59. Solar Flame Systems

60. Solar Industries, Inc.

61. Solar King International

62. Solar Living, Inc.

63. Solar Products Mfg. Corp.

64. Solar Specialties, Inc.

65. Solar Unlimited, Inc.

66. Solargizer

67. Solaron Corp.

68. Southeastern Solar Systems, Inc.

69. State Industries

70. Sun Dance

71. Sunduit, Inc.

72. Sunearth Solar Products Corp.

73. Sunmaster Corp.

74. Sunstone Solar Energy Equipment

75. Suntree Solar Co.

76. Sunworks

77. Technitrek Corp.

78. United Materials

79. Virginia Solar Components

80. Vulcan Solar Industries, Inc.

81. Western Solar Development, Inc.

82. N. H. Yates & Co., Inc.

APPENDIX III

GENERIC CLASSIFICATION OF RESPONDENTS

GENERIC CLASSIFICATION OF RESPONDENTS

82 Respondents

Company/Location	Direct Recirculation	Direct Draindown	Direct Drainback	Indirect Antifreeze, etc.	Direct Thermosyphon	Air System
Advanced Energy Technology Los Gatos, CA	X			X		
Air Comfort, Inc. Raleigh, NC				X		
Alten Corp Mountain View, CA	X					
Alternate Energy Industries New York, NY				X		
American Solar Heat Corp Danbury, Conn				X		
American Solar King Corp Waco, TX				X		
Ametek Ivyland, PA			X	X		
Amicks Solar Heating Middletown, PA		X				
Beam Engineering Sunnyvale, CA	X					
Bio-Energy Systems, Inc Storrs, Conn				X		
California Sun Energy Sunnymead, CA				X		
Cole Solar Systems Austin, TX	X			X		
Columbia Chase Solar Energy Holbrook, Mass			X	X		
Conserdyne Glendale, CA				X		
Copper State Solar Products Phoenix, Ariz		X		X		

GENERIC CLASSIFICATION OF RESPONDENTS

82 Respondents

Company/Location	Direct Recirculation	Direct Draindown	Direct Drainback	Indirect Antifreeze, etc.	Direct Thermosyphon	Air System
Dixon Energy Systems Hadley MA			X	X		
Dumont Industries Monmouth, MA				X		
E&K Service Co Bothell, Wash	X					
Elbart Co Millbury, Mass		X				
Energy Converters Chattanooga, TN		X				
Energy Systems, Inc. San DIego, CA	X	X				
Entropy Ltd Boulder, CO	Heat pipe solar water heater					
Grumman Energy Systems, Inc. Ronkonkoma, NY				X		
Halstead & Mitchell Scottsboro, AL				X		
Heliotherm, Inc. Lenni, PA	X					
Horizon Homestead, FL	X					
Hyperion, Inc Boulder, CO				X		
W L Jackson Chattanooga, TN				X		
Largo Solar Systems Plantation, FL					X	
Mor-Flo Cleveland, Ohio		X		X		

GENERIC CLASSIFICATION OF RESPONDENTS

82 Respondents

Company/Location	Direct Recirculation	Direct Draindown	Direct Drainback	Indirect Antifreeze, etc.	Direct Thermosyphon	Air System
Northrup Energy Hutchins, TX				X	X	
Novan Energy Boulder, CO		X		X		
OEM Products, Inc. Dover, FL		X				
Ra-Energy Systems, Inc. Lakeside, CA	X					
Raypak, Inc. Westlake Village, CA	X	X				
Rheem Chicago, IL		X				
W R Robbins & Son Miami, FL	X					
SJC Corp Elyria, Ohio		X				
Semco Corp Ft Lauderdale, FL	X				X	
A O Smith Kankakee, Il				X		
Solafern Bourne, MASS				X		
Solar Development, Inc Pocatello, Idaho			X			
Solar Development Inc Riviera Beach, FL	X	X		X		
Solar Dynamics of Arizona Lake Havasu City, AZ		X		X		

GENERIC CLASSIFICATION OF RESPONDENTS

82 Respondents

Company/Location	Direct Recirculation	Direct Draindown	Direct Drainback	Indirect Antifreeze, etc.	Direct Thermosyphon	Air System
Solar-En Corp Denville, NJ				X		
Solar Energy Products Avon Lake, Ohio				X		
Solar Energy Products, Inc. Gainesville, FL	X	X		X		
Solar Energy Research Corp Longmont, CO	X					
Solar Industries Farmingdale, NJ	X					
Solar King International Canoga Park, CA	X	X				
Solar Living, Inc Netcong, NJ		X				
Solar Products Mfg Cromwell, CT				X		
Solar Unlimited, Inc. Huntsville, AL				X		
Solargizer International, Inc. Minneapolis, MN				X		
Solaron Denver, CO						X
Sunduit, Inc. Virgin, IL				X		
Sunearth Solar Harleysville, PA				X		
Sunmaster Corning, NY	Evacuated tube, drainback SDHW Heater					

GENERIC CLASSIFICATION OF RESPONDENTS

82 Respondents*

Company/Location	Direct Recirculation	Direct Draindown	Direct Drainback	Indirect Antifreeze, etc.	Direct Thermosyphon	Air System
Sunstone Baraboo, WI						X
Suntree Solar Woonsocket, RI			X	X		
Sunworks Somerville, NJ	X	X		X		
Technitrek Corp San Leandro, CA					X	
United Materials, Inc. Denver, CO	X					
Virginia Solar Components Rustburg, VA	X	X		X		
Western Solar Vacaville, CA	X	X				
N H Yates & Co., Inc Silver Spring, MD				X		
TOTALS	21	19	5	37	4	2
% of Total Generic Types	25.61	23.17	6.10	45.12	4.88	2.44

The following respondents either did not provide sufficient information to make a determination, or the company does not supply solar domestic hot water heating systems:

Acorn Structures
Concord, Mass

Alternate Energy Resources
El Paso, Texas

Buckmaster Industries
Sunnymead, CA

Energy Design Corp
Memphis, TN

General Electric Space Division
Philadelphia, PA

Lennox
Dallas, TX

National Solar Corp
Old Saybrook CT

Porter Energy Products
Newark, Delaware

Ramada Energy Systems, Inc.
Tempe, Arizona

*82 Respondents of 226 contacted and 364 listed

Reynolds Metals Co
Richmond, VA

Solarflame Systems
LeRoy, IL

Solar Specialties
Golden, CO

Southeastern Solar Systems, Inc
Atlanta, GA

State Industries
Ashland City, TN & Henderson, Nevada

Sun Dance, Inc
Miami Lakes, FL

Vulcan Solar Industries, Inc
Smithfield, RI

APPENDIX IV

SOLAR HOT WATER SYSTEM SUPPLIERS - SYSTEM COLLECTOR PERFORMANCE

LIST OF COMPANIES

Non-Selective, Double Glass

Company	Intercepts η	Intercepts $Ti\text{-}Ta/_I$	Slope
National Solar Corp.	.8048	.467	-1.724
N.H. Yates & Co.	.787	.753	-1.045
Libby-Owens-Ford	.78	.757	-1.03
Halstead & Mitchell	.765	.776	- .986
Dixon Energy Systems	.75	1.02	- .738
Raypak, Inc.	.73	.57	-1.28
SJC Corp	.71	1.15	- .617
Dumont Industries	.706	.455	-1.55
Ramada Energy Systems, Inc.	.7	.565	-1.24
Beam Engineering	.69	.885	- .78
Energy Systems, Inc.	.67	.63	-1.063
FSEC Test (mean of several collectors tested)	.650	.731	- .889

SOLAR HOT WATER SYSTEM SUPPLIERS -

SYSTEM COLLECTOR PERFORMANCE

Non-Selective, Single Glass

Company	Intercepts η	Intercepts $Ti-Ta/_I$	Slope
Northrup	.9	.333	-2.7
N.H. Yates & Co.	.852	.518	-1.64
Libby-Owens-Ford	.85	.51	-1.7
N.H. Yates & Co.	.833	.507	-1.644
Solar Industries	.805	.61	-1.32
Ramada Energy Systems, Inc.	.78	.445	-1.75
United Materials	.75	.872	- .86
Southeastern Solar Systems, Inc.	.75	.477	-1.57
Copper State Solar Products	.74	.718	-1.03
Ra Energy	.738	.583	-1.265
SJC Corp.	.73	1.019	.7167
Solaron Corp	.72	.758	- .95
Solar Energy Products Corp.	.72	.655	-1.10
Solar King International	.7	.54	-1.3
FSEC Test (mean of several collectors tested)	.683	.580	-1.18
Beam Engineering	.68	.791	- .86
W.R. Robbins & Son Roofing Co.	.653	.322	-2.026
Energy Systems, Inc.	.60	.78	- .769

LIST OF COMPANIES

Selective, Single Glass (continued)

Company	Intercepts η	Intercepts $T_i - T_a / I$	Slope
General Electric Co.	.58	1.568	-.37
Solafern (Fern Engineering)	.585	.965	-.606
Solaron Corp.	.522	.617	-.846

LIST OF COMPANIES

Selective, Single Glass

Company	Intercepts η	Intercepts $T_i - T_a / I$	Slope
Libby-Owens-Ford	.805	.83	-.970
N.H. Yates & Co.	.792	.849	-.933
N.H. Yates & Co.	.775	.831	-.933
N.H. Yates & Co.	.764	.711	-1.074
Ametek	.76	1.01	-.75
Virginia Solar Components	.76	.691	-1.10
N.H. Yates & Co.	.747	.696	-1.074
Lennox	.747	.938	-.796
Cole Solar Systems, Inc.	.74	.925	-.80
Solar King International	.74	1.23	-.6
Solaron Corp.	.73	.9125	-.8
Solar-En Corp	.729	.859	-.849
A. O. Smith	.718	.846	-.849
Novan	.727	.759	-.958
Solar-En Corp	.718	.846	-.849
Solar Development Inc.--Northwest	.714	.642	-1.113
Grumman	.710	.87	-.818
Energy Systems, Inc.	.7	.897	-.78
Western Solar Development	.70	.509	-1.376
FSEC Test (mean of several collectors tested)	.631	.755	-.836
California Sun Energy	.618	.523	-1.181
Sun Dance	.588	.336	-1.750

LIST OF COMPANIES

Selective, Plastic

Company	Intercepts η	Intercepts $T_i - T_a/I$	Slope
Heliotherm, Inc.	.8157	.523	-1.56
Western Solar Development, Inc.	.648	.985	-.658
Grumman	.576	.66	-.873

LIST OF COMPANIES

Selective, Double Glass

Company	Intercepts η	Intercepts $Ti-Ta/_I$	Slope
Libby-Owens-Ford	.755	1.0	-.755
Beam Engineering	.75	1.34	-.56
N.H. Yates & Co.	.735	1.099	-.699
Solar-En Corp.	.705	.950	-.742
Cole Solar Systems, Inc.	.7	.833	-.84
Solar-En Corp	.667	.899	-.742
FSEC Test (mean of several collectors tested)	.609	.778	-.783

LIST OF COMPANIES

Selective, Evacuated Tube

Company	Intercepts η	Intercepts $Ti\text{-}Ta/_I$	Slope
Sunmaster Corp	.438	1.752	-.250

LIST OF COMPANIES

Non-Selective, Plastic

Company	Intercepts η	Intercepts $T_i - T_a/_I$	Slope
Solar Energy Research Corp.	.80	1.026	- .78
Mor-Flo	.78	.62	-1.25
Technitrek Corp.	.738	.520	-1.42
Columbia Chase Solar Energy	.730	.318	-2.297
Solar Unlimited Inc.	.705	.653	-1.080
Sunearth Solar Products	.7	.8	- .875
Acorn	.69	.585	-1.18
Advanced Energy Technology	.682	.554	-1.23
Horizon Enterprises	.680	.257	-2.647
Solarqizer International, Inc.	.659	.564	-1.168
FSEC Test (double cover collectors tested)	.641	.525	-1.22
Western Solar Development, Inc.	.641	.319	-2.01
FSEC Test (single cover collectors tested)	.605	.635	- .952

APPENDIX V

PERFORMANCE RESULTS

CITY: Denver
SYSTEM: Direct recirculation (5.422 m^2)

Month	Electrical Energy Displaced (GJ) Parasitics not included	Parasitics included	Thermal Efficiency	System Efficiency	Solar Fraction (%) Gross	Net	System COP
J	1.359	1.189	.411	.359	75.9	66.4	8.0
F	1.353	1.204	.409	.364	83.5	74.3	9.1
M	1.549	1.409	.381	.346	90.6	82.4	11.1
A	1.361	1.270	.349	.325	90.1	84.1	15.0
M	1.313	1.223	.332	.309	91.2	84.9	14.6
J	1.192	1.101	.305	.282	96.1	88.8	13.1
J	1.098	1.008	.270	.248	97.2	89.2	12.2
A	1.143	1.052	.381	.259	97.7	89.9	12.6
S	1.117	1.040	.275	.256	95.4	88.9	14.8
O	1.267	1.176	.316	.293	90.5	84.0	13.9
N	1.344	1.173	.427	.373	76.8	67.0	7.9
D	1.216	1.045	.407	.350	69.5	59.7	7.1
Year	15.11	13.75	.337	.308	86.4	78.6	11.1

CITY: Denver
SYSTEM: Direct drain-down (5 m^2)

Month	Electrical Energy Displaced (GJ) Parasitics not included	Parasitics included	Thermal Efficiency	System Efficiency	Solar Fraction (%) Gross	Net	System COP
J	1.296	1.235	.425	.405	72.4	69	21.2
F	1.307	1.247	.428	.409	80.7	77	21.8
M	1.524	1.454	.406	.388	89.1	85	21.8
A	1.398	1.329	.388	.369	92.6	88	20.3
M	1.372	1.282	.376	.351	95.3	89	15.2
J	1.24	1.166	.344	.324	100.	94	16.8
J	1.13	1.085	.301	.289	100.	96	25.1
A	1.17	1.123	.312	.300	100.	96	24.9
S	1.17	1.112	.312	.285	100.	95	20.2
O	1.316	1.246	.356	.337	94.	89	18.8
N	1.161	1.101	.400	.380	74.9	71	19.4
D	1.153	1.103	.419	.401	65.9	63	23.1
Year	15.32	14.52	.371	.351	87.6	83	19.2

CITY: Denver
SYSTEM: Evacuated tube (3.9 m^2)

Month	Electrical Energy Displaced (GJ) Parasitics not included	Electrical Energy Displaced (GJ) Parasitics included	Thermal Efficiency	System Efficiency	Solar Fraction (%) Gross	Solar Fraction (%) Net	System COP
J	.988	.832	.415	.350	55.2	46.5	6.3
F	1.015	.849	.427	.357	62.6	52.4	6.1
M	1.220	1.024	.417	.350	71.3	59.9	5.2
A	1.166	.950	.415	.338	77.2	62.9	5.4
M	1.178	.932	.413	.327	81.8	64.7	4.8
J	1.111	.875	.396	.312	89.6	70.6	4.7
J	1.074	.848	.367	.290	95.0	75.0	4.8
A	1.106	.880	.378	.301	94.5	75.2	4.9
S	1.078	.872	.369	.298	92.1	74.5	5.2
O	1.117	.921	.387	.319	79.8	65.8	5.7
N	.918	.752	.405	.332	59.2	48.5	5.5
D	.874	.728	.407	.339	49.9	41.6	6.0
Year	13.49	11.11	.419	.345	77.1	63.5	5.7

CITY: Denver
SYSTEM: Direct recirculation ($5.427m^2$)

Month	Electrical Energy Displaced (GJ) Parasitics not included	Solar Fraction (%) Gross	Solar Fraction (%) Net
J	.915	51.1	41.6
F	.922	56.9	47.7
M	1.091	63.8	55.6
A	1.361	90.1	84.1
M	1.313	91.2	84.9
J	1.192	96.1	88.8
J	1.098	97.2	89.2
A	1.143	97.7	89.9
S	1.117	95.4	88.9
O	0.931	66.5	60.0
N	1.134	64.8	55.0
D	.842	48.1	38.3

CITY: Denver
SYSTEM: Indirect (4.752 m^2)

Month	Electrical Energy Displaced (GJ)		Thermal Efficiency	System Efficiency	Solar Fraction (%)		System COP
	Parasitics not included	Parasitics included			Gross	Net	
J	1.278	1.217	.441	.420	71.4	68	20.9
F	1.307	1.216	.451	.420	80.7	76	14.4
M	1.522	1.436	.427	.403	89.0	84	17.7
A	1.401	1.314	.409	.384	92.8	87	16.1
M	1.369	1.282	.395	.370	95.1	89	15.7
J	1.24	1.166	.362	.341	100.	94	16.8
J	1.13	1.062	.317	.298	100.	94	16.6
A	1.17	1.100	.328	.309	100.	94	16.7
S	1.17	1.100	.328	.309	100.	94	16.7
O	1.316	1.246	.374	.354	94.	89	18.8
N	1.155	1.085	.419	.394	74.5	70	16.5
D	1.145	1.085	.438	.415	65.4	62	19.1
Year	15.01	14.17	.383	.361	85.8	81	17.8

CITY: Denver
SYSTEM: Direct drain-back (4.736 m^2)

Month	Electrical Energy Displaced (GJ) Parasitics not included	Electrical Energy Displaced (GJ) Parasitics included	Thermal Efficiency	System Efficiency	Solar Fraction (%) Gross	Solar Fraction (%) Net	System COP
J	1.217	1.092	.421	.378	68	61	9.7
F	1.241	1.102	.430	.381	76.6	68	8.9
M	1.370	1.300	.385	.366	80.1	76	9.6
A	1.376	1.208	.404	.354	91.1	80	8.2
M	1.381	1.181	.400	.342	95.9	82	6.9
J	1.24	1.042	.364	.306	100.	84	6.3
J	1.13	.949	.318	.267	100.	84	6.2
A	1.17	.995	.329	.280	100.	85	6.7
S	1.17	.995	.329	.280	100.	85	6.7
O	1.298	1.148	.370	.328	92.7	82	8.7
N	1.107	.976	.403	.355	71.4	63	8.5
D	1.083	.963	.416	.370	61.9	55	9.0
Year	15.04	13.12	.385	.336	86	75	7.8

CITY: Los Angeles
SYSTEM: Direct recirculation (8.133 m^2)

Month	Electrical Energy Displaced (GJ) Parasitics not included	Parasitics included	Thermal Efficiency	System Efficiency	Solar Fraction (%) Gross	Net	System COP
J	1.454	1.283	.365	.322	85	75	8.5
F	1.391	1.243	.329	.294	94	84	9.4
M	1.424	1.282	.261	.235	98.9	89	10.0
A	1.347	1.256	.247	.231	97.6	91	14.8
M	1.239	1.148	.235	.217	93.9	87	13.6
J	1.082	.992	.215	.197	99.3	91	12.0
J	1.09	.992	.189	.172	100.	92	11.1
A	0.97	.883	.171	.155	100.	91	11.1
S	1.00	.91	.195	.177	100.	91	11.1
O	1.123	1.018	.23	.209	96	87	10.7
N	1.175	1.003	.283	.242	89	76	6.8
D	1.419	1.248	.371	.327	83	73	8.3
Year	14.71	13.345	.250	.227	93.7	85	10.7

CITY: Los Angeles
SYSTEM: Direct drain-down ($5m^2$)

Month	Electrical Energy Displaced (GJ) Parasitics not included	Parasitics included	Thermal Efficiency	System Efficiency	Solar Fraction (%) Gross	Net	System COP
J	1.214	1.154	.496	.471	71.0	67.5	20.2
F	1.215	1.154	.467	.444	82.1	78	20.2
M	1.344	1.196	.401	.380	93.3	88.4	9.1
A	1.325	1.261	.396	.377	96.0	91.4	20.7
M	1.250	1.160	.385	.357	94.7	87.9	13.4
J	1.050	.959	.339	.310	96.3	88.0	11.5
J	1.090	1.010	.307	.285	100.	92.7	13.6
A	.97	.89	.277	.254	100.	91.8	12.1
S	.983	.897	.312	.290	98.3	91.3	11.4
O	1.062	.992	.354	.331	90.8	84.8	15.2
N	1.031	.972	.404	.381	78.1	73.6	17.5
D	1.158	1.108	.493	.472	67.7	64.8	22.2
Year	13.5	12.72	.373	.352	86	81	17.3

CITY: Los Angeles
SYSTEM: Direct drain-back (4.736 m^2)

Month	Electrical Energy Displaced (GJ)		Thermal Efficiency	System Efficiency	Solar Fraction (%)		System COP
	Parasitics not included	Parasitics included			Gross	Net	
J	1.052	.922	.453	.397	61.5	53.9	8.1
F	1.079	.938	.438	.381	72.9	63.4	7.7
M	1.212	1.063	.382	.335	84.2	73.8	8.1
A	1.231	1.061	.388	.334	89.2	76.9	7.2
M	1.172	.972	.381	.316	88.8	73.6	5.9
J	1.016	.816	.346	.278	93.2	74.9	5.1
J	1.09	.888	.324	.264	100.	81.5	5.4
A	.97	.795	.293	.240	100.	82.0	5.5
S	.976	.772	.327	.265	97.6	79.1	4.5
O	1.031	.832	.363	.293	88.1	71.1	5.2
N	.916	.787	.379	.326	69.4	59.6	7.1
D	1.002	.882	.450	.396	58.6	51.6	8.4
Year	12.55	10.676	.366	.311	80	68	6.7

CITY: Los Angeles
SYSTEM: Evacuated Tube (3.9 m^2)

Month	Electrical Energy Displaced (GJ) Parasitics not included	Electrical Energy Displaced (GJ) Parasitics included	Thermal Efficiency	System Efficiency	Solar Fraction (%) Gross	Solar Fraction (%) Net	System COP
J	.858	.711	.449	.372	50.2	41.6	5.8
F	.881	.736	.434	.363	59.5	49.7	6.1
M	1.043	.857	.400	.328	72.4	59.5	5.6
A	1.056	.860	.404	.329	76.5	62.3	5.4
M	1.014	.788	.400	.311	76.8	59.7	4.5
J	.932	.671	.385	.278	85.5	61.6	3.6
J	1.003	.767	.362	.277	92.0	70.4	4.3
A	.925	.698	.338	.256	95.4	72.0	4.1
S	.857	.566	.349	.230	85.7	66.1	2.9
O	.855	.679	.365	.290	73.1	58.0	4.9
N	.779	.623	.392	.313	59.0	47.2	5.0
D	.816	.679	.445	.370	47.7	39.7	6.0
Year	11.29	9.40	.400	.333	71.9	59.87	6.0

CITY: Phoenix
SYSTEM: Direct Draindown ($5m^2$)

Month	Electrical Energy Displaced (GJ) Parasitics not included	Parasitics included	Thermal Efficiency	System Efficiency	Solar Fraction (%) Gross	Net	System COP
J	.992	.962	.405	.393	84.8	82.2	33.1
F	.980	.920	.356	.335	93.3	87.6	16.3
M	1.080	1.013	.323	.303	99.0	92.9	16.1
A	.94	.848	.251	.226	100.	90.2	10.2
M	.93	.846	.218	.198	100.	91.0	11.1
J	.75	.666	.186	.165	100.	88.8	8.9
J	.70	.622	.190	.169	100.	88.6	9.0
A	.66	.585	.178	.158	100.	88.6	8.8
S	.68	.609	.193	.172	100.	89.6	9.6
O	.82	.756	.246	.226	100.	92.3	12.8
N	.94	.860	.319	.212	100.	91.5	11.8
D	.93	.875	.389	.366	85.3	80.3	16.9
Year	10.40	9.56	.259	.238	96.2	88.4	12.3

CITY: Los Angeles
SYSTEM: Indirect (4.752 m^2)

Month	Electrical Energy Displaced (GJ) Parasitics not included	Electrical Energy Displaced (GJ) Parasitics included	Thermal Efficiency	System Efficiency	Solar Fraction (%) Gross	Solar Fraction (%) Net	System COP
J	1.206	1.146	.518	.492	70.5	67	20.1
F	1.215	1.145	.492	.464	82.1	77.4	17.4
M	1.346	1.267	.423	.398	93.5	88	17.0
A	1.336	1.256	.420	.394	96.8	91	16.7
M	1.237	1.156	.400	.374	93.7	87.6	15.3
J	1.028	.958	.349	.325	94.3	87.9	14.7
J	1.09	1.025	.323	.304	100.	94	16.8
A	.97	.902	.292	.271	100.	93	14.3
S	.98	.896	.327	.304	98	91.0	11.1
O	1.06	.99	.372	.347	90.6	84.6	15.1
N	1.038	.968	.428	.399	78.6	73.3	14.8
D	1.161	1.101	.520	.493	67.9	64.4	19.4
Year	13.72	12.87	.399	.374	87.4	82	16.1

CITY: Phoenix
SYSTEM: Evacuated Tube (3.903 m^2)

Month	Electrical Energy Displaced (GJ) Parasitics not included	Parasitics included	Thermal Efficiency	System Efficiency	Solar Fraction (%) Gross	Net	System COP
J	.943	.766	.493	.401	80.6	65.5	5.4
F	.902	.720	.420	.336	85.9	68.6	5.0
M	.989	.774	.379	.297	90.7	71.0	4.6
A	.88	.651	.301	.223	93.6	69.3	3.8
M	.93	.66	.279	.198	100.	71.0	3.4
J	.75	.493	.238	.157	100.	65.7	2.8
J	.70	.461	.244	.161	100.	65.9	2.9
A	.66	.416	.229	.144	100.	63.0	2.7
S	.68	.455	.248	.166	100.	66.9	3.0
O	.807	.596	.310	.229	98.4	72.7	3.8
N	.866	.678	.376	.295	92.1	72.1	4.6
D	.888	.717	.484	.391	81.5	65.8	5.2
Year	9.05	6.47	.289	.206	92.4	68.5	3.5

CITY: Phoenix
SYSTEM: Direct recirculation (5.42 m^2)

Month	Electrical Energy Displaced (GJ) Parasitics not included	Electrical Energy Displaced (GJ) Parasitics included	Thermal Efficiency	System Efficiency	Solar Fraction (%) Gross	Solar Fraction (%) Net	System COP
J	.875	.793	.329	.298	74.8	67.8	10.7
F	.924	.849	.310	.285	88.0	80.9	12.3
M	1.060	.992	.292	.273	97.2	91.0	15.6
A	.807	.735	.199	.181	85.9	78.2	11.2
M	.93	.846	.201	.182	100.	91.0	11.1
J	.75	.668	.171	.153	100.	89.1	9.1
J	.70	.623	.176	.156	100.	89.0	9.1
A	.66	.586	.164	.146	100.	88.8	8.9
S	.68	.609	.178	.160	100.	89.6	9.6
O	.82	.756	.226	.209	100.	92.3	12.8
N	.934	.876	.292	.274	99.4	93.8	16.1
D	.784	.692	.303	.267	71.9	63.5	8.5
Year	10.04	9.139	.230	.210	92.8	84.5	11.1

CITY: Phoenix
SYSTEM: Indirect (4.752 m^2)

Month	Electrical Energy Displaced (GJ)		Thermal Efficiency	System Efficiency	Solar Fraction (%)		System COP
	Parasitics not included	Parasitics included			Gross	Net	
J	.979	.912	.420	.392	83.7	77.9	14.6
F	.975	.908	.373	.347	92.8	86.5	14.5
M	1.063	.991	.334	.312	97.5	90.9	14.8
A	.914	.847	.257	.238	92.2	90.1	13.6
M	.93	.857	.229	.211	100.	92.2	12.7
J	.75	.686	.196	.179	100.	91.5	11.7
J	.70	.640	.200	.183	100.	91.4	11.7
A	.66	.602	.188	.171	100.	91.2	11.4
S	.68	.624	.203	.187	100.	81.8	12.1
O	.82	.758	.258	.239	100.	92.4	13.2
N	.936	.873	.334	.311	99.6	92.9	14.6
D	.911	.849	.401	.374	83.6	77.9	14.7
Year	10.31	9.54	.270	.250	95.4	88.3	13.4

CITY: Phoenix
SYSTEM: Direct drain-back (4.734 m^2)

Month	Electrical Energy Displaced (GJ) Parasitics not included	Parasitics included	Thermal Efficiency	System Efficiency	Solar Fraction (%) Gross	Net	System COP
J	1.04	.896	.448	.386	88.8	76.6	7.2
F	.902	.756	.346	.290	85.9	72.0	6.2
M	1.09	.925	.344	.292	100.	84.9	6.6
A	.94	.765	.265	.216	100.	81.4	5.4
M	.93	.720	.230	.179	100.	77.4	4.4
J	.75	.54[illegible]	.196	.142	100.	72.1	3.6
J	.70	.506	.183	.132	100.	72.3	3.6
A	.66	.473	.190	.136	100.	71.7	3.5
S	.68	.504	.194	.144	100.	74.1	3.9
O	.82	.661	.259	.209	100.	80.6	5.2
N	.94	.797	.336	.285	100.	84.9	6.6
D	.96	.830	.423	.367	88.1	76.1	7.4
Year	10.51	8.463	.276	.222	97.2	78.3	5.31

CITY: Washington, D.C.
SYSTEM: Direct recirculation (5.422 m^2)

Month	Electrical Energy Displaced (GJ) Parasitics not included	Parasitics included	Thermal Efficiency	System Efficiency	Solar Fraction (%) Gross	Net	System COP
J	.446	.267	.249	.149	26.7	16.0	2.5
F	.474	.307	.257	.166	31.4	20.3	2.8
M	.743	.605	.285	.232	50.2	40.9	5.4
A	.973	.891	.345	.316	72.1	66.0	11.9
M	1.013	.940	.334	.310	81.7	75.8	12.7
J	1.041	.967	.331	.307	92.1	85.6	14.1
J	1.054	.971	.353	.326	90.1	83.0	12.7
A	.871	.801	.272	.250	97.9	90.0	12.4
S	.787	.728	.296	.274	91.5	84.7	13.3
O	.784	.717	.329	.301	69.4	63.5	11.7
N	.527	.428	.295	.239	39.0	31.7	5.3
D	.362	.194	.247	.133	22.8	12.2	2.0
Year	9.074	7.816	.305	.263	59.0	50.8	7.2

CITY: Washington, D.C.
SYSTEM: Direct drain-down (5 m^2)

Month	Electrical Energy Displaced (GJ) Parasitics not included	Electrical Energy Displaced (GJ) Parasitics included	Thermal Efficiency	System Efficiency	Solar Fraction (%) Gross	Solar Fraction (%) Net	System COP
J	.750	.701	.455	.425	44.9	42.0	15.8
F	.753	.704	.443	.414	49.8	46.7	15.4
M	1.001	.938	.417	.391	67.6	63.4	15.9
A	1.086	1.018	.418	.392	80.4	75.4	16.0
M	1.065	.990	.380	.354	85.9	79.8	14.2
J	1.070	.995	.369	.343	94.7	88.1	14.3
J	1.083	.998	.394	.363	92.6	85.3	12.7
A	.755	.683	.256	.232	84.8	76.7	10.5
S	.815	.755	.333	.308	94.8	87.8	13.6
O	.860	.802	.391	.365	76.1	71.0	14.8
N	.712	.660	.432	.400	52.7	48.9	14.6
D	.619	.574	.459	.425	38.9	36.1	13.8
Year	10.69	9.94	.391	.364	69.5	64.6	14.3

CITY: Washington, D.C.
SYSTEM: Indirect (4.752 m^2)

Month	Electrical Energy Displaced (GJ) Parasitics not included	Electrical Energy Displaced (GJ) Parasitics included	Thermal Efficiency	System Efficiency	Solar Fraction (%) Gross	Solar Fraction (%) Net	System COP
J	.777	.722	.495	.460	46.5	43.2	13.1
F	.739	.685	.457	.424	48.9	45.3	13.9
M	.987	.917	.433	.402	66.7	62.0	14.1
A	1.071	.996	.433	.403	79.3	73.7	14.3
M	1.060	.977	.398	.367	85.5	78.8	12.8
J	1.062	.982	.385	.356	94.0	86.9	13.3
J	1.079	.990	.413	.379	92.2	84.6	12.1
A	.881	.807	.314	.288	99.0	90.7	12.0
S	.805	.740	.346	.318	93.6	86.0	12.4
O	.856	.792	.409	.379	75.8	70.1	13.3
N	.708	.651	.451	.415	52.4	48.2	12.4
D	.604	.556	.471	.433	38.0	35.0	12.6
Year	10.631	9.81	.408	.377	69.1	63.8	12.9

CITY: Washington, D.C.
SYSTEM: Evacuated tube (3.9 m^2)

Month	Electrical Energy Displaced (GJ) Parasitics not included	Parasitics included	Thermal Efficiency	System Efficiency	Solar Fraction (%) Gross	Net	System COP
J	.656	.514	.510	.400	39.3	30.8	4.6
F	.661	.520	.514	.404	43.8	34.4	4.7
M	.874	.695	.467	.371	59.1	47.0	4.9
A	.911	.718	.449	.354	67.5	53.2	4.7
M	.909	.697	.416	.319	73.3	56.2	4.3
J	.939	.722	.415	.319	83.1	63.9	4.3
J	.874	.657	.407	.306	74.7	56.2	4.0
A	.883	.671	.384	.292	99.2	75.4	4.2
S	.729	.547	.381	.286	84.8	63.6	4.0
O	.769	.599	.448	.349	68.1	53.0	4.5
N	.615	.468	.478	.364	45.6	34.7	4.2
D	.531	.402	.504	.382	33.4	25.3	4.1
Year	9.298	7.160	.435	.335	60.5	46.5	4.3

APPENDIX VI

ECONOMIC RESULTS

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: Denver

SYSTEM: DRAIN DOWN

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 11%; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
1	26.26	7.45	53.96	20.46	24.56	-12.28	-45.78	-41.07	-100.61	-134.11	-129.94
2	26.52	7.56	52.24	19.53	23.50	52.24	19.53	23.50	52.24	19.53	23.50
3	26.80	7.66	50.88	18.66	22.51	50.88	18.66	22.51	50.88	18.66	22.51
4	27.08	7.82	49.90	17.87	21.58	49.90	17.87	21.58	49.90	17.87	21.58
5	27.37	7.97	49.29	17.14	20.73	49.29	17.14	20.73	49.29	17.14	20.73
6	27.66	8.13	8.03	16.48	19.94	8.03	16.48	19.94	8.03	16.48	19.94
7	27.94	8.30	8.04	15.86	19.20	8.04	15.86	19.20	8.04	15.86	19.20
8	28.31	8.48	8.05	15.30	18.52	8.05	15.30	18.52	8.05	15.30	18.52
9	28.66	8.68	8.06	14.78	17.89	8.06	14.78	17.89	8.06	14.78	17.89
10	29.00	8.88	8.06	14.31	17.31	8.06	14.31	17.31	8.06	14.31	17.31
11	29.35	9.10	8.08	13.87	16.77	8.08	13.87	16.77	8.08	13.87	16.77
12	29.68	9.33	8.09	13.48	16.27	8.09	13.48	16.27	8.09	13.48	16.27
13	30.05	9.57	8.10	13.12	8.10	8.10	13.12	8.10	8.10	13.12	8.10
14	30.42	9.82	8.11	12.78	8.11	8.11	12.78	8.11	8.11	12.78	8.11
15	30.80	10.09	8.13	12.48	8.13	8.13	12.48	8.13	8.13	12.48	8.13
16	31.19	10.36	8.15	12.21	8.15	8.15	12.21	8.15	8.15	12.21	8.15
17	31.59	10.65	8.16	11.96	8.16	8.16	11.96	8.16	8.16	11.96	8.16
18	31.99	10.95	8.18	11.73	8.18	8.18	11.73	8.18	8.18	11.73	8.18
19	32.40	11.26	8.20	11.53	8.20	8.20	11.53	8.20	8.20	11.53	8.20
20	32.82	11.58	8.22	11.34	8.22	8.22	11.34	8.22	8.22	11.34	8.22

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
TAX CREDIT RECOVERED AT THE END OF FIRST YEAR

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: DENVER

SYSTEM: DIRECT RECIRCULATION

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 11%; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
1	26.20	7.45	60.16	23.92	28.37	-11.50	-47.74	-43.29	-107.05	-143.28	-138.83
2	26.52	7.56	56.52	22.93	27.23	56.52	22.93	27.23	56.52	22.93	27.23
3	26.80	7.66	56.08	22.03	26.18	56.08	22.03	26.18	56.08	22.03	26.18
4	27.08	7.82	55.64	21.19	25.21	55.64	21.19	25.21	55.64	21.19	25.21
5	27.37	7.97	55.20	20.43	24.31	55.20	20.43	24.31	55.20	20.43	24.31
6	27.68	8.13	10.60	19.73	23.48	10.60	19.73	23.48	10.60	19.73	23.48
7	27.99	8.30	10.63	19.10	22.71	10.63	19.10	22.71	10.63	19.10	22.71
8	28.31	8.48	10.67	18.51	22.00	10.67	18.51	22.00	10.67	18.51	22.00
9	28.64	8.68	10.71	17.98	21.35	10.71	17.98	21.35	10.71	17.98	21.35
10	28.98	8.88	10.74	17.50	20.74	10.74	17.50	20.74	10.74	17.50	20.74
11	29.33	9.10	10.78	17.06	20.19	10.78	17.06	20.19	10.78	17.06	20.19
12	29.68	9.33	10.82	16.66	19.67	10.82	16.66	19.67	10.82	16.66	19.67
13	30.05	9.57	10.87	16.29	10.87	10.87	16.29	10.87	10.87	16.29	10.87
14	30.42	9.82	10.91	15.96	10.91	10.91	15.96	10.91	10.91	15.96	10.91
15	30.80	10.09	10.96	15.67	10.96	10.96	15.67	10.96	10.96	15.67	10.96
16	31.19	10.36	11.01	15.40	11.01	11.01	15.40	11.01	11.01	15.40	11.01
17	31.59	10.65	11.05	15.16	11.05	11.05	15.16	11.05	11.05	15.16	11.05
18	31.99	10.95	11.11	14.95	11.11	11.11	14.95	11.11	11.11	14.95	11.11
19	32.40	11.26	11.16	14.76	11.16	11.16	14.76	11.16	11.16	14.76	11.16
20	32.82	11.58	11.21	14.59	11.21	11.21	14.59	11.21	11.21	14.59	11.21

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
TAX CREDIT RECOVERED AT THE END OF FIRST YEAR

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: DENVER

SYSTEM: EVACUATED TUBE

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 11%; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
1	26.26	7.45	67.91	29.05	33.82	-8.94	-47.80	-45.02	-111.39	-150.25	-145.48
2	26.52	7.56	65.98	28.03	32.65	65.98	28.03	32.65	65.98	28.03	32.65
3	26.80	7.68	64.48	27.11	31.56	64.48	27.11	31.56	64.48	27.11	31.56
4	27.08	7.82	63.42	26.26	30.57	63.42	26.26	30.57	63.42	26.26	30.57
5	27.37	7.97	62.78	25.50	29.66	62.78	25.50	29.66	62.78	25.50	29.66
6	27.66	8.13	15.00	24.80	28.81	15.00	24.80	28.81	15.00	24.80	28.81
7	27.94	8.30	15.09	24.16	28.04	15.09	24.16	28.04	15.09	24.16	28.04
8	28.31	8.48	15.18	23.59	27.33	15.18	23.59	27.33	15.18	23.59	27.33
9	28.60	8.68	15.27	23.07	26.68	15.27	23.07	26.68	15.27	23.07	26.68
10	28.96	8.88	15.36	22.61	26.09	15.36	22.61	26.09	15.36	22.61	26.09
11	29.33	9.10	15.46	22.19	25.54	15.46	22.19	25.54	15.46	22.19	25.54
12	29.68	9.33	15.56	21.81	25.04	15.56	21.81	25.04	15.56	21.81	25.04
13	30.05	9.57	15.66	21.47	15.66	15.66	21.47	15.66	15.66	21.47	15.66
14	30.42	9.82	15.76	21.18	15.76	15.76	21.18	15.76	15.76	21.18	15.76
15	30.80	10.09	15.87	20.92	15.87	15.87	20.92	15.87	15.87	20.92	15.87
16	31.19	10.36	15.97	20.69	15.97	15.97	20.69	15.97	15.97	20.69	15.97
17	31.59	10.65	16.08	20.49	16.08	16.08	20.49	16.08	16.08	20.49	16.08
18	31.99	10.95	16.20	20.32	16.20	16.20	20.32	16.20	16.20	20.32	16.20
19	32.40	11.26	16.31	20.17	16.31	16.31	20.17	16.31	16.31	20.17	16.31
20	32.82	11.58	16.43	20.05	16.43	16.43	20.05	16.43	16.43	20.05	16.43

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
TAX CREDIT RECOVERED AT THE END OF FIRST YEAR

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS
CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: DENVER SYSTEM: DRAIN-BACK

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 11%; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
1	26.26	7.45	55.79	22.89	26.93	-9.26	-42.15	-38.11	-95.99	-128.88	-124.84
2	26.52	7.56	54.13	22.01	25.92	54.13	22.01	25.92	54.13	22.01	25.92
3	26.80	7.68	52.84	21.20	24.98	52.84	21.20	24.98	52.84	21.20	24.98
4	27.08	7.82	51.91	20.47	24.11	51.91	20.47	24.11	51.91	20.47	24.11
5	27.37	7.97	51.35	19.79	23.31	51.35	19.79	23.31	51.35	19.79	23.31
6	27.68	8.13	10.89	19.18	22.58	10.89	19.18	22.58	10.89	19.18	22.58
7	27.99	8.30	10.93	18.61	21.90	10.93	18.61	21.90	10.93	18.61	21.90
8	28.31	8.48	10.98	18.10	21.27	10.98	18.10	21.27	10.98	18.10	21.27
9	28.64	8.68	11.03	17.64	20.69	11.03	17.64	20.69	11.03	17.64	20.69
10	28.98	8.88	11.09	17.22	20.16	11.09	17.22	20.16	11.09	17.22	20.16
11	29.33	9.10	11.14	16.84	19.68	11.14	16.84	19.68	11.14	16.84	19.68
12	29.68	9.33	11.20	16.49	19.23	11.20	16.49	19.23	11.20	16.49	19.23
13	30.05	9.57	11.26	16.18	11.26	11.26	16.18	11.26	11.26	16.18	11.26
14	30.42	9.82	11.31	15.90	11.31	11.31	15.90	11.31	11.31	15.90	11.31
15	30.80	10.09	11.38	15.65	11.38	11.38	15.65	11.38	11.38	15.65	11.38
16	31.19	10.36	11.44	15.43	11.44	11.44	15.43	11.44	11.44	15.43	11.44
17	31.59	10.65	11.50	15.23	11.50	11.50	15.23	11.50	11.50	15.23	11.50
18	31.99	10.95	11.57	15.06	11.57	11.57	15.06	11.57	11.57	15.06	11.57
19	32.40	11.26	11.64	14.90	11.64	11.64	14.90	11.64	11.64	14.90	11.64
20	32.82	11.58	11.71	14.77	11.71	11.71	14.77	11.71	11.71	14.77	11.71

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
TAX CREDIT RECOVERED AT THE END OF FIRST YEAR

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: DENVER

SYSTEM: INDIRECT

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 11%; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
1	26.26	7.45	64.12	24.65	29.50	-13.92	-53.39	-48.54	-117.98	-157.44	-152.60
2	26.52	7.56	62.09	23.56	28.24	62.09	23.56	28.24	62.09	23.56	28.24
3	26.80	7.66	60.51	22.55	27.07	60.51	22.55	27.07	60.51	22.55	27.07
4	27.08	7.82	59.35	21.62	26.00	59.35	21.62	26.00	59.35	21.62	26.00
5	27.37	7.97	58.64	20.77	25.00	58.64	20.77	25.00	58.64	20.77	25.00
6	27.66	8.13	10.05	19.99	24.07	10.05	19.99	24.07	10.05	19.99	24.07
7	27.99	8.30	10.06	19.28	23.22	10.06	19.28	23.22	10.06	19.28	23.22
8	28.31	8.48	10.08	18.62	22.42	10.08	18.62	22.42	10.08	18.62	22.42
9	28.64	8.68	10.10	18.02	21.69	10.10	18.02	21.69	10.10	18.02	21.69
10	28.98	8.88	10.12	17.47	21.01	10.12	17.47	21.01	10.12	17.47	21.01
11	29.33	9.10	10.14	16.97	20.38	10.14	16.97	20.38	10.14	16.97	20.38
12	29.68	9.33	10.16	16.51	19.80	10.16	16.51	19.80	10.16	16.51	19.80
13	30.05	9.57	10.19	16.09	10.19	10.19	16.09	10.19	10.19	16.09	10.19
14	30.42	9.82	10.21	15.71	10.21	10.21	15.71	10.21	10.21	15.71	10.21
15	30.80	10.09	10.24	15.37	10.24	10.24	15.37	10.24	10.24	15.37	10.24
16	31.19	10.36	10.27	15.05	10.27	10.27	15.05	10.27	10.27	15.05	10.27
17	31.59	10.65	10.30	14.77	10.30	10.30	14.77	10.30	10.30	14.77	10.30
18	31.99	10.95	10.33	14.51	10.33	10.33	14.51	10.33	10.33	14.51	10.33
19	32.40	11.26	10.36	14.28	10.36	10.36	14.28	10.36	10.36	14.28	10.36
20	32.82	11.58	10.40	14.07	10.40	10.40	14.07	10.40	10.40	14.07	10.40

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
TAX CREDIT RECOVERED AT THE END OF FIRST YEAR

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: DENVER

SYSTEM: DIRECT DRAIN-DOWN

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 11%; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
1	26.20	7.45	55.96	20.46	24.56	36.73	15.60	18.37	13.76	9.57	10.08
2	26.52	7.56	52.24	19.55	23.50	35.66	15.21	17.69	13.54	9.45	9.95
3	26.80	7.66	50.86	18.06	22.51	34.81	14.67	17.07	13.36	9.35	9.83
4	27.08	7.82	49.90	17.67	21.56	34.20	14.18	16.50	13.26	9.25	9.72
5	27.37	7.97	49.29	17.14	20.73	33.81	13.73	15.97	13.18	9.17	9.61
6	27.66	8.13	8.03	16.48	19.94	8.03	13.31	15.47	8.03	9.09	9.52
7	27.99	8.30	8.04	15.88	19.20	8.04	12.93	15.02	8.04	9.02	9.43
8	28.31	8.48	8.05	15.30	18.52	8.05	12.58	14.59	8.05	8.95	9.36
9	28.64	8.68	8.06	14.78	17.89	8.06	12.26	14.20	8.06	8.90	9.28
10	28.98	8.88	8.06	14.31	17.31	8.06	11.97	13.84	8.06	8.85	9.22
11	29.33	9.10	8.08	13.87	16.77	8.08	11.70	13.51	8.08	8.80	9.16
12	29.68	9.33	8.09	13.48	16.27	8.09	11.46	13.20	8.09	8.76	9.11
13	30.05	9.57	8.10	13.12	8.10	8.10	11.23	8.10	8.10	8.73	8.10
14	30.42	9.82	8.11	12.78	8.11	8.11	11.03	8.11	8.11	8.70	8.11
15	30.80	10.09	8.13	12.48	8.13	8.13	10.85	8.13	8.13	8.67	8.13
16	31.19	10.36	8.15	12.21	8.15	8.15	10.69	8.15	8.15	8.65	8.15
17	31.59	10.65	8.16	11.96	8.16	8.16	10.54	8.16	8.16	8.64	8.16
18	31.99	10.95	8.18	11.73	8.18	8.18	10.40	8.18	8.18	8.63	8.18
19	32.40	11.26	8.20	11.53	8.20	8.20	10.28	8.20	8.20	8.62	8.20
20	32.82	11.58	8.22	11.34	8.22	8.22	10.17	8.22	8.22	8.61	8.22

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
INSTANT TAX CREDIT

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: DENVER SYSTEM: DIRECT RECIRCULATION

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 11%; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
1	26.26	7.45	60.16	23.92	28.37	41.52	18.87	21.65	16.67	12.14	12.69
2	26.52	7.56	58.52	22.95	27.25	40.38	18.26	20.95	16.46	12.04	12.58
3	26.80	7.68	56.86	22.03	26.18	39.49	17.71	20.30	16.30	11.95	12.47
4	27.08	7.82	55.64	21.19	25.21	38.65	17.20	19.71	16.20	11.87	12.37
5	27.37	7.97	55.20	20.43	24.31	38.46	16.73	19.16	16.15	11.80	12.29
6	27.68	8.13	10.60	19.73	23.48	10.60	16.31	18.65	10.60	11.74	12.21
7	27.99	8.30	10.63	19.10	22.71	10.63	15.92	18.18	10.63	11.69	12.14
8	28.31	8.48	10.67	18.51	22.00	10.67	15.57	17.75	10.67	11.65	12.09
9	28.64	8.68	10.71	17.98	21.35	10.71	15.25	17.36	10.71	11.62	12.04
10	28.98	8.88	10.74	17.50	20.74	10.74	14.96	16.99	10.74	11.59	11.99
11	29.33	9.10	10.78	17.06	20.19	10.78	14.70	16.66	10.78	11.57	11.96
12	29.68	9.33	10.82	16.66	19.67	10.82	14.47	16.35	10.82	11.55	11.93
13	30.05	9.57	10.87	16.29	10.87	10.87	14.26	10.87	10.87	11.55	10.87
14	30.42	9.82	10.91	15.96	10.91	10.91	14.07	10.91	10.91	11.54	10.91
15	30.80	10.09	10.96	15.67	10.96	10.96	13.90	10.96	10.96	11.55	10.96
16	31.19	10.36	11.01	15.40	11.01	11.01	13.75	11.01	11.01	11.55	11.01
17	31.59	10.65	11.05	15.16	11.05	11.05	13.62	11.05	11.05	11.57	11.05
18	31.99	10.95	11.11	14.95	11.11	11.11	13.51	11.11	11.11	11.59	11.11
19	32.40	11.26	11.16	14.76	11.16	11.16	13.41	11.16	11.16	11.61	11.16
20	32.82	11.58	11.21	14.59	11.21	11.21	13.32	11.21	11.21	11.63	11.21

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
INSTANT TAX CREDIT

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: DENVER

SYSTEM: EVACUATED TUBE

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 11%; 30 years
SOLAR BANK: 5.5%; 12 years

YEAR	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
1	26.26	7.45	67.90	29.05	33.82	47.92	23.05	26.61	21.27	16.41	17.01
2	26.52	7.56	65.96	28.63	32.64	46.74	23.02	25.91	21.09	16.35	16.92
3	26.80	7.68	64.48	27.11	31.56	45.83	22.47	25.26	20.97	16.30	16.86
4	27.08	7.82	63.41	26.26	30.57	45.20	21.98	24.67	20.91	16.26	16.80
5	27.37	7.97	62.78	25.44	29.65	44.65	21.55	24.13	20.90	16.24	16.76
6	27.68	8.13	15.00	24.80	28.81	15.00	21.12	23.65	15.00	16.23	16.73
7	27.99	8.30	15.09	24.16	28.04	15.09	20.76	23.18	15.09	16.22	16.71
8	28.31	8.48	15.18	23.59	27.35	15.18	20.43	22.77	15.18	16.23	16.70
9	28.64	8.68	15.27	23.07	26.68	15.27	20.14	22.40	15.27	16.24	16.69
10	28.98	8.88	15.36	22.60	26.08	15.36	19.89	22.06	15.36	16.27	16.70
11	29.33	9.10	15.46	22.18	25.54	15.46	19.66	21.76	15.46	16.30	16.72
12	29.68	9.33	15.55	21.81	25.04	15.55	19.46	21.48	15.55	16.34	16.74
13	30.05	9.57	15.65	21.47	15.65	15.65	19.24	15.65	15.65	16.38	15.65
14	30.42	9.82	15.76	21.17	15.76	15.76	19.14	15.76	15.76	16.43	15.76
15	30.80	10.09	15.86	20.91	15.86	15.86	19.02	15.86	15.86	16.49	15.86
16	31.19	10.36	15.97	20.68	15.97	15.97	18.92	15.97	15.97	16.56	15.97
17	31.59	10.65	16.08	20.48	16.08	16.08	18.83	16.08	16.08	16.63	16.08
18	31.99	10.95	16.19	20.31	16.19	16.19	18.77	16.19	16.19	16.71	16.19
19	32.40	11.26	16.31	20.17	16.31	16.31	18.72	16.31	16.31	16.79	16.31
20	32.82	11.58	16.43	20.05	16.43	16.43	18.69	16.43	16.43	16.88	16.43

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
INSTANT TAX CREDIT

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: DENVER

SYSTEM: DIRECT DRAIN-BACK

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 11%; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
1	26.26	7.45	55.79	22.89	26.45	38.87	18.31	20.83	10.31	12.20	12.70
2	26.52	7.56	54.13	22.01	25.42	37.85	17.77	20.21	10.14	12.12	12.61
3	26.80	7.68	52.64	21.20	24.98	37.00	17.28	19.64	10.01	12.06	12.53
4	27.06	7.82	51.91	20.47	24.11	36.49	16.84	19.12	15.93	12.00	12.46
5	27.37	7.97	50.35	19.79	23.51	36.16	16.43	18.63	15.90	11.96	12.40
6	27.68	8.13	10.69	19.18	22.56	10.69	16.07	18.19	10.69	11.92	12.35
7	27.99	8.30	10.93	18.61	21.90	10.93	15.73	17.79	10.93	11.89	12.30
8	28.31	8.48	10.98	18.10	21.27	10.98	15.43	17.41	10.98	11.87	12.27
9	28.64	8.68	11.03	17.64	20.69	11.03	15.16	17.07	11.03	11.86	12.24
10	28.98	8.88	11.09	17.22	20.16	11.09	14.92	16.76	11.09	11.85	12.22
11	29.33	9.10	11.14	16.84	19.68	11.14	14.70	16.48	11.14	11.85	12.21
12	29.68	9.33	11.20	16.49	19.23	11.20	14.51	16.22	11.20	11.86	12.20
13	30.05	9.57	11.26	16.18	11.26	11.26	14.33	11.26	11.26	11.87	11.26
14	30.42	9.82	11.31	15.90	11.31	11.31	14.18	11.31	11.31	11.89	11.31
15	30.80	10.09	11.38	15.65	11.38	11.38	14.05	11.38	11.38	11.91	11.38
16	31.19	10.36	11.44	15.43	11.44	11.44	13.93	11.44	11.44	11.94	11.44
17	31.59	10.65	11.50	15.23	11.50	11.50	13.83	11.50	11.50	11.97	11.50
18	31.99	10.95	11.57	15.06	11.57	11.57	13.75	11.57	11.57	12.01	11.57
19	32.40	11.26	11.64	14.90	11.64	11.64	13.68	11.64	11.64	12.05	11.64
20	32.82	11.58	11.71	14.77	11.71	11.71	13.62	11.71	11.71	12.09	11.71

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
INSTANT TAX CREDIT

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: DENVER SYSTEM: INDIRECT

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 11%; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
1	26.26	7.45	64.12	24.05	29.50	45.82	19.15	22.18	10.75	11.62	12.43
2	26.52	7.56	62.09	23.56	28.24	42.56	18.47	21.40	10.51	11.69	12.28
3	26.80	7.66	60.51	22.55	27.07	41.57	17.85	20.67	10.32	11.57	12.14
4	27.08	7.82	59.35	21.62	26.06	40.85	17.27	20.00	10.19	11.47	12.02
5	27.37	7.97	58.04	20.77	25.00	40.41	16.75	19.39	10.11	11.37	11.90
6	27.68	8.15	10.05	19.44	24.07	10.05	16.26	18.81	10.05	11.29	11.80
7	27.99	8.30	10.06	19.28	23.22	10.06	15.82	18.28	10.06	11.21	11.71
8	28.31	8.48	10.08	18.62	22.42	10.08	15.42	17.79	10.08	11.15	11.62
9	28.64	8.68	10.10	18.02	21.69	10.10	15.05	17.34	10.10	11.09	11.55
10	28.98	8.88	10.12	17.47	21.01	10.12	14.72	16.93	10.12	11.04	11.48
11	29.33	9.10	10.14	16.97	20.36	10.14	14.41	16.54	10.14	10.99	11.42
12	29.68	9.33	10.16	16.51	19.60	10.16	14.13	16.18	10.16	10.96	11.37
13	30.05	9.57	10.19	16.09	10.19	10.19	13.88	10.19	10.19	10.92	10.19
14	30.42	9.82	10.21	15.71	10.21	10.21	13.65	10.21	10.21	10.90	10.21
15	30.80	10.09	10.24	15.37	10.24	10.24	13.44	10.24	10.24	10.88	10.24
16	31.19	10.36	10.27	15.05	10.27	10.27	13.26	10.27	10.27	10.87	10.27
17	31.59	10.65	10.30	14.77	10.30	10.30	13.09	10.30	10.30	10.86	10.30
18	31.99	10.95	10.33	14.51	10.33	10.33	12.94	10.33	10.33	10.85	10.33
19	32.40	11.26	10.36	14.28	10.36	10.36	12.81	10.36	10.36	10.85	10.36
20	32.82	11.58	10.40	14.07	10.40	10.40	12.69	10.40	10.40	10.85	10.40

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
INSTANT TAX CREDIT

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS
CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS

CITY: Denver

SYSTEM: DRAIN DOWN

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 16%; 30 years
SOLAR BANK: 5.5%; 12 years

YEAR	CONVENTIONAL SYSTEMS: ELECTRIC	CONVENTIONAL SYSTEMS: GAS	SOLAR SYSTEM, WITHOUT CREDITS: IMPROVEMENT LOAN	WITHOUT CREDITS: HOME MORTGAGE	WITHOUT CREDITS: SOLAR BANK	WITH CURRENT CREDITS: IMPROVEMENT LOAN	WITH CURRENT CREDITS: HOME MORTGAGE	WITH CURRENT CREDITS: SOLAR BANK	WITH PROPOSED CREDITS: IMPROVEMENT LOAN	WITH PROPOSED CREDITS: HOME MORTGAGE	WITH PROPOSED CREDITS: SOLAR BANK
1	26.66	7.84	53.96	[illegible]	24.58	-12.28	-41.08	-41.67	-100.61	-129.40	-129.99
2	26.88	7.92	52.24	[illegible]	23.50	52.24	23.84	23.50	52.24	23.84	23.50
3	27.13	8.01	50.88	[illegible]	22.51	50.88	22.65	22.51	50.88	22.65	22.51
4	27.38	8.12	49.90	21.51	21.58	49.90	21.51	21.58	49.90	21.51	21.58
5	27.65	8.25	49.29	[illegible]	20.73	49.29	20.48	20.73	49.29	20.48	20.73
6	27.93	8.38	21.66	19.54	19.94	21.66	19.54	19.94	21.66	19.54	19.94
7	28.22	8.53	15.01	[illegible]	19.20	15.01	18.67	19.20	15.01	18.67	19.20
8	28.52	8.70	15.22	[illegible]	18.52	15.22	17.67	18.52	15.22	17.67	18.52
9	28.84	8.88	15.39	17.14	17.89	15.39	17.14	17.89	15.39	17.14	17.89
10	29.16	9.07	15.54	[illegible]	17.31	15.54	16.48	17.31	15.54	16.48	17.31
11	29.49	9.27	15.65	[illegible]	16.77	15.65	15.66	16.77	15.65	15.66	16.77
12	29.84	9.48	15.74	[illegible]	16.27	15.74	15.31	16.27	15.74	15.31	16.27
13	30.19	9.71	15.73	[illegible]	15.73	15.73	14.79	15.73	15.73	14.79	15.73
14	30.55	9.95	10.42	[illegible]	13.97	10.42	14.33	13.97	10.42	14.33	13.97
15	30.92	10.21	10.35	[illegible]	13.55	10.35	13.90	13.55	10.35	13.90	13.55
16	31.30	10.47	10.29	[illegible]	13.17	10.29	13.52	13.17	10.29	13.52	13.17
17	31.69	10.75	10.25	[illegible]	12.82	10.25	13.17	12.82	10.25	13.17	12.82
18	32.08	11.04	10.21	[illegible]	12.50	10.21	12.85	12.50	10.21	12.85	12.50
19	32.49	11.34	10.17	[illegible]	12.20	10.17	12.57	12.20	10.17	12.57	12.20
20	32.90	11.66	10.15	[illegible]	11.94	10.15	12.31	11.94	10.15	12.31	11.94

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
TAX CREDIT RECOVERED AT THE END OF FIRST YEAR

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS
CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: DENVER

SYSTEM: DIRECT DRAIN-DOWN

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 16 %; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
	26.66	7.84									
1	26.88	7.92	55.96	25.17	24.58	36.73	18.73	18.57	13.70	10.16	10.08
2	27.13	8.01	52.24	23.84	23.50	35.68	17.91	17.89	13.54	9.99	9.95
3	27.38	8.12	50.66	22.65	22.51	34.81	17.15	17.07	13.36	9.84	9.85
4	27.65	8.25	49.95	21.51	21.56	34.20	16.45	16.50	13.20	9.71	9.72
5	27.93	8.38	49.29	20.40	20.75	33.41	15.81	15.97	13.18	9.58	9.61
6	28.22	8.53	8.03	19.54	19.94	8.03	15.22	15.47	8.03	9.47	9.52
7	28.52	8.70	8.04	18.67	19.20	8.04	14.68	15.02	8.04	9.37	9.43
8	28.84	8.88	8.05	17.87	18.52	8.05	14.19	14.59	8.05	9.27	9.36
9	29.16	9.07	8.06	17.14	17.84	8.06	13.74	14.20	8.06	9.19	9.28
10	29.49	9.27	8.06	16.48	17.31	8.06	13.32	13.84	8.06	9.12	9.22
11	29.84	9.48	8.08	15.86	16.77	8.08	12.94	13.51	8.08	9.05	9.16
12	30.19	9.71	8.09	15.31	16.27	8.09	12.60	13.20	8.09	8.99	9.11
13	30.55	9.95	8.10	14.79	8.10	8.10	12.28	8.10	8.10	8.94	8.10
14	30.92	10.21	8.11	14.33	8.11	8.11	12.00	8.11	8.11	8.89	8.11
15	31.30	10.47	8.13	13.90	8.13	8.13	11.74	8.13	8.13	8.85	8.13
16	31.69	10.75	8.15	13.52	8.15	8.15	11.50	8.15	8.15	8.82	8.15
17	32.08	11.04	8.16	13.17	8.16	8.16	11.29	8.16	8.16	8.79	8.16
18	32.49	11.34	8.18	12.85	8.18	8.18	11.10	8.18	8.18	8.77	8.18
19	32.90	11.66	8.20	12.57	8.20	8.20	10.93	8.20	8.20	8.75	8.20
20			8.22	12.31	8.22	8.22	10.76	8.22	8.22	8.73	8.22

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
INSTANT TAX CREDIT

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS
CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

DISCOUNT RATE 0

CITY: DENVER

SYSTEM: DIRECT DRAIN-DOWN

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 16 %; 30 years
SOLAR BANK: 5.5%; 12 years

YEAR	CONVENTIONAL SYSTEMS: ELECTRIC	CONVENTIONAL SYSTEMS: GAS	SOLAR SYSTEM WITHOUT CREDITS: IMPROVEMENT LOAN	SOLAR SYSTEM WITHOUT CREDITS: HOME MORTGAGE	SOLAR SYSTEM WITHOUT CREDITS: SOLAR BANK	WITH CURRENT CREDITS: IMPROVEMENT LOAN	WITH CURRENT CREDITS: HOME MORTGAGE	WITH CURRENT CREDITS: SOLAR BANK	WITH PROPOSED CREDITS: IMPROVEMENT LOAN	WITH PROPOSED CREDITS: HOME MORTGAGE	WITH PROPOSED CREDITS: SOLAR BANK
	28.42	8.50									
1	31.64	9.32	58.54	27.39	26.44	39.85	20.33	19.78	14.93	11.07	10.91
2	34.64	10.23	61.48	28.06	27.42	41.97	21.03	20.67	15.94	11.76	11.68
3	37.93	11.25	64.97	28.83	28.48	44.45	21.90	21.64	17.08	12.57	12.52
4	41.56	12.34	69.13	29.80	29.62	47.37	22.79	22.68	18.36	13.45	13.43
5	45.54	13.67	74.08	30.78	30.85	50.82	23.76	23.80	19.81	14.40	14.41
6	49.92	15.10	13.10	31.85	32.18	13.10	24.82	25.02	13.10	15.44	15.48
7	54.74	16.69	14.22	33.02	33.61	14.22	25.97	26.34	14.22	16.57	16.64
8	60.04	18.46	15.44	34.30	35.15	15.44	27.23	27.76	15.44	17.80	17.91
9	65.87	20.48	16.77	35.70	36.82	16.77	28.60	29.30	16.77	19.14	19.28
10	72.27	22.71	18.22	37.22	38.63	18.22	30.09	30.97	18.22	20.59	20.77
11	79.32	25.21	19.79	38.83	40.58	19.79	31.72	32.78	19.79	22.13	22.39
12	87.07	28.01	21.50	40.63	42.68	21.50	33.49	34.74	21.50	23.90	24.15
13	95.59	31.14	23.36	42.67	23.36	23.36	35.42	23.36	23.36	25.78	23.36
14	104.96	34.64	25.39	44.33	25.39	25.39	37.54	25.39	25.39	27.82	25.39
15	115.27	38.56	27.60	47.20	27.60	27.60	39.85	27.60	27.60	30.05	27.60
16	126.61	42.95	30.00	49.79	30.00	30.00	42.37	30.00	30.00	32.47	30.00
17	139.07	47.86	32.62	52.62	32.62	32.62	45.12	32.62	32.62	35.12	32.62
18	152.78	53.35	35.47	55.72	35.47	35.47	48.12	35.47	35.47	38.00	35.47
19	167.86	59.50	38.57	59.11	38.57	38.57	51.41	38.57	38.57	41.14	38.57
20			41.95	62.33	41.95	41.95	55.99	41.95	41.95	44.56	41.95

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
INSTANT TAX CREDIT

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

DISCOUNT RATE=0.08

CITY: DENVER

SYSTEM: DIRECT DRAIN-DOWN

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 16 %; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM: WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
	26.66	7.84									
1	26.88	7.92	53.96	25.17	24.56	56.73	18.73	18.37	13.76	10.16	10.08
2	27.13	8.01	52.24	23.34	23.50	55.60	17.91	17.64	13.54	9.93	9.95
3	27.38	8.12	50.88	22.63	22.51	54.81	17.15	17.07	13.36	9.84	9.83
4	27.65	8.25	49.90	21.51	21.56	54.20	16.45	16.50	13.26	9.71	9.72
5	27.93	8.38	49.24	20.43	20.75	53.81	15.81	15.97	13.18	9.59	9.61
6	28.22	8.53	9.74	19.54	19.98	9.74	15.22	15.47	9.74	9.47	9.52
7	28.52	8.70	8.91	18.67	19.20	8.91	14.63	15.02	8.91	9.37	9.43
8	28.84	8.88	8.94	17.87	18.52	8.94	14.13	14.59	8.94	9.27	9.36
9	29.16	9.07	8.97	17.14	17.89	8.97	13.74	14.20	8.97	9.19	9.28
10	29.49	9.27	9.00	16.43	17.31	9.00	13.33	13.84	9.00	9.12	9.22
11	29.84	9.48	9.02	15.86	16.77	9.02	12.94	13.51	9.02	9.05	9.16
12	30.19	9.71	9.04	15.31	16.27	9.04	12.60	13.20	9.04	8.99	9.11
13	30.55	9.95	9.05	14.79	9.05	9.05	12.28	9.05	9.05	8.94	9.05
14	30.92	10.21	8.40	14.33	8.65	8.40	12.00	8.85	8.40	8.89	8.85
15	31.30	10.47	8.41	13.90	8.61	8.41	11.74	8.81	8.41	8.85	8.81
16	31.69	10.75	8.41	13.53	8.77	8.41	11.50	8.77	8.41	8.82	8.77
17	32.08	11.04	8.42	13.17	8.75	8.42	11.29	8.75	8.42	8.79	8.75
18	32.49	11.34	8.44	12.85	8.72	8.44	11.10	8.72	8.44	8.77	8.72
19	32.90	11.66	8.45	12.57	8.70	8.45	10.93	8.70	8.45	8.75	8.70
20			8.46	12.31	8.69	8.46	10.73	8.69	8.46	8.73	8.69

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
INSTANT TAX CREDIT

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS
CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS

CITY: Denver

SYSTEM: DRAIN DOWN

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 16% ; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
1	26.66	7.84	53.96	25.17	24.58	-12.28	-41.08	-41.67	-100.61	-129.40	-129.99
2	26.88	7.92	52.24	23.84	23.50	52.24	23.84	23.50	52.24	23.84	23.50
3	27.13	8.01	50.86	22.63	22.51	50.88	22.65	22.51	50.88	22.65	22.51
4	27.38	8.12	49.90	21.51	21.58	49.90	21.51	21.58	49.90	21.51	21.58
5	27.65	8.25	49.29	20.43	20.73	49.29	20.48	20.73	49.29	20.48	20.73
6	27.93	8.38	21.66	19.54	19.94	21.66	19.54	19.94	21.66	19.54	19.94
7	28.22	8.53	15.01	18.67	19.20	15.01	18.67	19.20	15.01	18.67	19.20
8	28.52	27.27	15.22	17.87	18.52	15.22	17.87	18.52	15.22	17.87	18.52
9	28.84	8.88	15.39	17.14	17.89	15.39	17.14	17.89	15.39	17.14	17.89
10	29.16	9.07	15.54	16.48	17.31	15.54	16.46	17.31	15.54	16.48	17.31
11	29.49	9.27	15.65	15.86	16.77	15.65	15.86	16.77	15.65	15.86	16.77
12	47.73	9.48	15.74	15.31	16.27	15.74	15.31	16.27	15.74	15.31	16.27
13	30.19	9.71	15.73	14.79	15.73	15.73	14.79	15.73	15.73	14.79	15.73
14	30.55	9.95	10.42	14.33	13.97	10.42	14.33	13.97	10.42	14.33	13.97
15	30.92	10.21	10.35	13.90	13.55	10.35	13.90	13.55	10.35	13.90	13.55
16	31.30	27.72	10.29	13.52	13.17	10.29	13.52	13.17	10.29	13.52	13.17
17	31.69	10.75	10.25	13.17	12.82	10.25	13.17	12.82	10.25	13.17	12.82
18	32.08	11.04	10.21	12.85	12.50	10.21	12.85	12.50	10.21	12.85	12.50
19	32.49	11.34	10.17	12.57	12.20	10.17	12.57	12.20	10.17	12.57	12.20
20	32.90	11.66	10.15	12.31	11.94	10.15	12.31	11.94	10.15	12.31	11.94

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
TAX CREDIT RECOVERED AT THE END OF FIRST YEAR

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: LOS ANGELES SYSTEM: DIRECT DRAIN-DOWN

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 11%; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
1	25.19	[illegible]	54.45	20.95	25.00	-11.80	-45.29	-41.18	-100.12	-133.62	-129.51
2	25.40	[illegible]	52.73	20.02	23.99	52.73	20.02	23.99	52.73	20.02	23.99
3	25.63	[illegible]	51.58	19.16	23.01	51.58	19.16	23.01	51.58	19.16	23.01
4	25.67	[illegible]	50.41	18.38	22.09	50.41	18.38	22.09	50.41	18.38	22.09
5	24.12	9.55	49.80	17.66	21.24	49.80	17.66	21.24	49.80	17.66	21.24
6	24.38	[illegible]	8.55	17.00	20.46	8.55	17.00	20.46	8.55	17.00	20.46
7	24.65	[illegible]	8.57	16.39	19.73	8.57	16.39	19.73	8.57	16.39	19.73
8	24.92	[illegible]	8.58	15.83	19.06	8.58	15.83	19.06	8.58	15.83	19.06
9	25.20	[illegible]	8.60	15.32	18.44	8.60	15.32	18.44	8.60	15.32	18.44
10	25.50	[illegible]	8.61	14.86	17.86	8.61	14.86	17.86	8.61	14.86	17.86
11	25.80	[illegible]	8.63	14.43	17.33	8.63	14.43	17.33	8.63	14.43	17.33
12	26.10	10.95	8.65	14.04	16.83	8.65	14.04	16.83	8.65	14.04	16.83
13	26.42	[illegible]	8.67	13.69	8.67	8.67	13.69	8.67	8.67	13.69	8.67
14	26.74	10.59	8.70	13.37	8.70	8.70	13.37	8.70	8.70	13.37	8.70
15	27.07	[illegible]	8.72	13.07	8.72	8.72	13.07	8.72	8.72	13.07	8.72
16	27.41	[illegible]	8.74	12.81	8.74	8.74	12.81	8.74	8.74	12.81	8.74
17	27.75	11.59	8.77	12.56	8.77	8.77	12.56	8.77	8.77	12.56	8.77
18	28.10	[illegible]	8.80	12.35	8.80	8.80	12.35	8.80	8.80	12.35	8.80
19	28.46	[illegible]	8.82	12.15	8.82	8.82	12.15	8.82	8.82	12.15	8.82
20	28.83	12.51	8.85	11.97	8.85	8.85	11.97	8.85	8.85	11.97	8.85

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
TAX CREDIT RECOVERED AT THE END OF FIRST YEAR

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: LOS ANGELES

SYSTEM: DIRECT RECIRCULATION

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 11%; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
1	23.19	[illegible]	67.43	24.78	30.02	-16.90	-59.55	-54.31	-129.35	-171.99	-106.76
2	23.40	[illegible]	65.21	23.57	28.63	65.21	23.57	28.63	65.21	23.57	28.63
3	23.65	[illegible]	63.47	22.46	27.35	63.47	22.46	27.35	63.47	22.46	27.35
4	23.87	[illegible]	62.20	21.43	26.15	62.20	21.43	26.15	62.20	21.43	26.15
5	24.12	[illegible]	61.40	20.48	25.05	61.40	20.48	25.05	61.40	20.48	25.05
6	24.38	[illegible]	8.86	19.61	24.02	8.86	19.61	24.02	8.86	19.61	24.02
7	24.65	[illegible]	8.85	18.81	23.07	8.85	18.81	23.07	8.85	18.81	23.07
8	24.92	[illegible]	8.85	18.08	22.18	8.85	18.08	22.18	8.85	18.08	22.18
9	25.20	[illegible]	8.84	17.40	21.36	8.84	17.40	21.36	8.84	17.40	21.36
10	25.50	[illegible]	8.83	16.78	20.60	8.83	16.78	20.60	8.83	16.78	20.60
11	25.80	[illegible]	8.82	16.21	19.89	8.82	16.21	19.89	8.82	16.21	19.89
12	26.10	[illegible]	8.82	15.68	19.23	8.82	15.68	19.23	8.82	15.68	19.23
13	26.42	[illegible]	8.81	15.20	8.81	8.81	15.20	8.81	8.82	15.20	8.81
14	26.74	[illegible]	8.81	14.76	8.81	8.81	14.76	8.81	8.81	14.76	8.81
15	27.07	[illegible]	8.81	14.35	8.81	8.81	14.35	8.81	8.81	14.35	8.81
16	27.41	[illegible]	8.81	13.98	8.81	8.81	13.98	8.81	8.81	13.98	8.81
17	27.75	[illegible]	8.81	13.64	8.81	8.81	13.64	8.81	8.81	13.64	8.81
18	28.10	[illegible]	8.81	13.33	8.81	8.81	13.33	8.81	8.81	13.33	8.81
19	28.46	[illegible]	8.82	13.05	8.82	8.82	13.05	8.82	8.81	13.05	8.81
20	28.83	[illegible]	8.82	12.79	8.82	8.82	12.79	8.82	8.82	12.79	8.82

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
TAX CREDIT RECOVERED AT THE END OF FIRST YEAR

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: LOS ANGELES

SYSTEM: EVACUATED TUBE

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 11%; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
1	25.19	[illegible]	67.24	26.59	33.16	-9.00	-48.46	-43.09	-112.06	-150.91	-140.14
2	25.40	[illegible]	65.31	27.36	31.97	65.31	27.36	31.97	65.31	27.36	31.97
3	25.63	[illegible]	63.80	26.45	30.88	63.80	26.45	30.88	63.80	26.45	30.88
4	25.67	[illegible]	62.73	25.58	29.88	62.73	25.58	29.88	62.73	25.58	29.88
5	24.12	[illegible]	62.08	24.80	28.96	62.08	24.80	28.96	62.08	24.80	28.96
6	24.38	[illegible]	14.30	24.09	28.11	14.30	24.09	28.11	14.30	24.09	28.11
7	24.65	[illegible]	14.37	23.45	27.32	14.37	23.45	27.32	14.37	23.45	27.32
8	24.92	[illegible]	14.45	22.88	26.60	14.45	22.88	26.60	14.45	22.88	26.60
9	25.20	[illegible]	14.53	22.35	25.94	14.53	22.35	25.94	14.53	22.35	25.94
10	25.50	[illegible]	14.61	21.88	25.34	14.61	21.88	25.34	14.61	21.88	25.34
11	25.80	[illegible]	14.70	21.43	24.78	14.70	21.43	24.78	14.70	21.43	24.78
12	26.10	[illegible]	14.79	21.04	24.27	14.79	21.04	24.27	14.79	21.04	24.27
13	26.42	[illegible]	14.88	20.69	14.88	14.88	20.69	14.88	14.88	20.69	14.88
14	26.74	[illegible]	14.97	20.39	14.97	14.97	20.39	14.97	14.97	20.39	14.97
15	27.07	[illegible]	15.06	20.11	15.06	15.06	20.11	15.06	15.06	20.11	15.06
16	27.41	[illegible]	15.16	19.87	15.16	15.16	19.87	15.16	15.16	19.87	15.16
17	27.75	[illegible]	15.26	19.66	15.26	15.26	19.66	15.26	15.26	19.66	15.26
18	28.10	[illegible]	15.36	19.48	15.36	15.36	19.48	15.36	15.36	19.48	15.36
19	28.46	[illegible]	15.47	19.32	15.47	15.47	19.32	15.47	15.47	19.32	15.47
20	28.83	[illegible]	15.57	19.19	15.57	15.57	19.19	15.57	15.57	19.19	15.57

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
TAX CREDIT RECOVERED AT THE END OF FIRST YEAR

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: LOS ANGELES

SYSTEM: DIRECT DRAIN-BACK

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 11%; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
1	23.19	[illegible]	56.39	23.50	27.54	-6.65	-41.54	-37.51	-95.38	-120.27	-124.23
2	23.40	[illegible]	54.75	22.63	26.53	54.75	22.63	26.53	54.75	22.63	26.53
3	23.65	[illegible]	53.47	21.83	25.60	53.47	21.83	25.60	53.47	21.83	25.60
4	23.67	[illegible]	52.55	21.10	24.74	52.55	21.10	24.74	52.55	21.10	24.74
5	24.12	[illegible]	52.00	20.43	23.95	52.00	20.43	23.95	52.00	20.43	23.95
6	24.38	[illegible]	11.54	19.83	23.23	11.54	19.83	23.23	11.54	19.83	23.23
7	24.65	[illegible]	11.59	19.27	22.56	11.59	19.27	22.56	11.59	19.27	22.56
8	24.92	[illegible]	11.65	18.77	21.94	11.65	18.77	21.94	11.65	18.77	21.94
9	25.20	[illegible]	11.71	18.32	21.37	11.71	18.32	21.37	11.71	18.32	21.37
10	25.50	[illegible]	11.77	17.90	20.85	11.77	17.90	20.85	11.77	17.90	20.85
11	25.80	[illegible]	11.84	17.53	20.37	11.84	17.53	20.37	11.84	17.53	20.37
12	26.10	10.95	11.90	17.20	19.93	11.90	17.20	19.93	11.90	17.20	19.93
13	26.42	[illegible]	11.97	16.90	11.97	11.97	16.90	11.97	11.97	16.90	11.97
14	26.74	[illegible]	12.04	16.63	12.04	12.04	16.63	12.04	12.04	16.63	12.04
15	27.07	[illegible]	12.11	16.39	12.11	12.11	16.39	12.11	12.11	16.39	12.11
16	27.41	[illegible]	12.19	16.17	12.19	12.19	16.17	12.19	12.19	16.17	12.19
17	27.75	[illegible]	12.26	15.99	12.26	12.26	15.99	12.26	12.26	15.99	12.26
18	28.10	[illegible]	12.34	15.82	12.34	12.34	15.82	12.34	12.34	15.82	12.34
19	28.46	[illegible]	12.42	15.68	12.42	12.42	15.68	12.42	12.42	15.68	12.42
20	28.83	[illegible]	12.50	15.56	12.50	12.50	15.56	12.50	12.50	15.56	12.50

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
TAX CREDIT RECOVERED AT THE END OF FIRST YEAR

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS
CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: LOS ANGELES SYSTEM: INDIRECT

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 11%; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
1	25.19	[illegible]	63.54	24.08	28.92	-14.50	-53.96	-49.12	-116.55	-158.02	-153.17
2	25.40	[illegible]	61.51	22.98	27.66	61.51	22.98	27.66	61.51	22.98	27.66
3	25.65	[illegible]	59.92	21.96	26.49	59.92	21.96	26.49	59.92	21.96	26.49
4	25.61	[illegible]	58.76	21.03	25.40	58.76	21.03	25.40	58.76	21.03	25.40
5	24.12	[illegible]	58.04	20.17	24.39	58.04	20.17	24.39	58.04	20.17	24.39
6	24.38	[illegible]	9.43	19.38	23.46	9.43	19.38	23.46	9.43	19.38	23.46
7	24.65	[illegible]	9.44	18.66	22.59	9.44	18.66	22.59	9.44	18.66	22.59
8	24.92	[illegible]	9.45	17.99	21.79	9.45	17.99	21.79	9.45	17.99	21.79
9	25.20	[illegible]	9.46	17.38	21.05	9.46	17.38	21.05	9.46	17.38	21.05
10	25.50	[illegible]	9.47	16.82	20.36	9.47	16.82	20.36	9.47	16.82	20.36
11	25.80	[illegible]	9.48	16.31	19.72	9.48	16.31	19.72	9.48	16.31	19.72
12	26.10	[illegible]	9.49	15.85	19.13	9.49	15.85	19.13	9.49	15.85	19.13
13	26.42	[illegible]	9.51	15.42	9.51	9.51	15.42	9.51	9.51	15.42	9.51
14	26.74	[illegible]	9.53	15.03	9.53	9.53	15.03	9.53	9.53	15.03	9.53
15	27.07	[illegible]	9.54	14.67	9.54	9.54	14.67	9.54	9.54	14.67	9.54
16	27.41	[illegible]	9.56	14.35	9.56	9.56	14.35	9.56	9.56	14.35	9.56
17	27.75	[illegible]	9.58	14.05	9.58	9.58	14.05	9.58	9.58	14.05	9.58
18	28.10	[illegible]	9.60	13.79	9.60	9.60	13.79	9.60	9.60	13.79	9.60
19	28.46	[illegible]	9.63	13.54	9.63	9.63	13.54	9.63	9.63	13.54	9.63
20	28.83	[illegible]	9.65	13.33	9.65	9.65	13.33	9.65	9.05	13.33	9.05

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
TAX CREDIT RECOVERED AT THE END OF FIRST YEAR

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: LOS ANGELES

SYSTEM:DIRECT DRAIN-DOWN

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 11%; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
1	23.19	[illegible]	54.45	20.95	25.66	57.22	16.28	18.85	14.24	10.06	10.57
2	23.40	[illegible]	52.73	20.02	23.99	56.15	15.70	18.19	14.04	9.95	10.44
3	23.63	[illegible]	51.58	19.10	23.01	55.51	15.17	17.57	13.88	9.85	10.33
4	23.87	[illegible]	50.41	18.38	22.09	54.70	14.68	17.00	13.76	9.76	10.22
5	24.12	[illegible]	49.80	17.66	21.24	54.33	14.24	16.48	13.70	9.68	10.13
6	24.38	[illegible]	8.55	17.00	20.46	8.55	13.83	15.99	8.55	9.61	10.04
7	24.65	[illegible]	8.57	16.39	19.73	8.57	13.46	15.54	8.57	9.54	9.96
8	24.92	[illegible]	8.58	15.83	19.06	8.58	13.11	15.13	8.58	9.49	9.89
9	25.20	[illegible]	8.60	15.32	18.44	8.60	12.80	14.75	8.60	9.44	9.83
10	25.50	[illegible]	8.61	14.86	17.86	8.61	12.52	14.39	8.61	9.40	9.77
11	25.80	[illegible]	8.63	14.43	17.33	8.63	12.26	14.07	8.63	9.36	9.72
12	26.10	[illegible]	8.65	14.04	16.83	8.65	12.02	13.70	8.65	9.33	9.68
13	26.42	[illegible]	8.67	13.69	8.67	8.67	11.81	8.67	8.67	9.30	8.67
14	26.74	[illegible]	8.70	13.37	8.70	8.70	11.61	8.70	8.70	9.28	8.70
15	27.07	[illegible]	8.72	13.07	8.72	8.72	11.44	8.72	8.72	9.26	8.72
16	27.41	[illegible]	8.74	12.81	8.74	8.74	11.28	8.74	8.74	9.25	8.74
17	27.75	[illegible]	8.77	12.56	8.77	8.77	11.14	8.77	8.77	9.24	8.77
18	28.10	[illegible]	8.80	12.35	8.80	8.80	11.01	8.80	8.80	9.24	8.80
19	28.46	[illegible]	8.82	12.15	8.82	8.82	10.90	8.82	8.82	9.24	8.82
20	28.83	[illegible]	8.85	11.97	8.85	8.85	10.80	8.85	8.85	9.24	8.85

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
INSTANT TAX CREDIT

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: LOS ANGELES SYSTEM: DIRECT RECIRCULATION

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 11%; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
1	25.19	9.[illegible]	67.43	24.78	30.02	45.49	18.84	22.11	16.24	10.91	11.57
2	25.40	9.9[illegible]	65.21	23.57	28.65	44.19	18.08	21.24	15.95	10.75	11.38
3	25.65	9.22	65.47	22.46	27.35	43.01	17.37	20.43	15.72	10.60	11.21
4	25.67	9.[illegible]	62.20	21.43	26.15	42.21	16.73	19.68	15.55	10.46	11.05
5	24.12	9.55	61.40	20.48	25.05	41.71	16.13	18.98	15.44	10.33	10.90
6	24.38	9.72	8.86	19.61	24.02	8.86	15.58	18.34	8.86	10.21	10.76
7	24.65	9.9[illegible]	8.85	18.81	23.07	8.85	15.08	17.74	8.85	10.10	10.63
8	24.92	9.12	8.85	18.08	22.18	8.85	14.61	17.18	8.85	10.00	10.51
9	25.20	9.24	8.84	17.40	21.36	8.84	14.19	16.67	8.84	9.91	10.40
10	25.50	9.5[illegible]	8.83	16.78	20.60	8.83	13.80	16.19	8.83	9.82	10.30
11	25.80	9.20	8.82	16.21	19.89	8.82	13.44	15.74	8.82	9.75	10.21
12	26.10	10.95	8.82	15.68	19.25	8.82	13.11	15.33	8.82	9.68	10.12
13	26.42	10.2[illegible]	8.81	15.20	8.81	8.81	12.80	8.81	8.81	9.61	8.81
14	26.74	10.5[illegible]	8.81	14.76	8.81	8.81	12.53	8.81	8.81	9.56	8.81
15	27.07	10.[illegible]	8.81	14.35	8.81	8.81	12.27	8.81	8.81	9.50	8.81
16	27.41	11.1[illegible]	8.81	13.98	8.81	8.81	12.04	8.81	8.81	9.46	8.81
17	27.75	11.5[illegible]	8.81	13.64	8.81	8.81	11.83	8.81	8.81	9.41	8.81
18	28.10	11.[illegible]	8.81	13.33	8.81	8.81	11.64	8.81	8.81	9.38	8.81
19	28.46	12.14	8.82	13.05	8.82	8.82	11.46	8.82	8.82	9.34	8.82
20	28.83	12.51	8.82	12.79	8.82	8.82	11.30	8.82	8.82	9.32	8.82

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
INSTANT TAX CREDIT

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: LOS ANGELES

SYSTEM: EVACUATED TUBE

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 11%; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
1	25.19	[illegible]	67.22	27.56	33.13	47.25	22.95	25.95	20.58	15.73	10.32
2	25.40	[illegible]	65.29	27.34	31.95	46.05	22.33	25.21	20.40	15.66	10.25
3	25.63	[illegible]	63.78	26.40	30.80	45.13	21.77	24.56	20.27	15.60	10.16
4	25.67	[illegible]	[illegible]	25.55	29.86	44.49	21.27	23.90	20.20	15.55	10.09
5	24.12	[illegible]	62.00	24.77	[illegible]	44.11	20.81	23.41	20.18	15.52	10.04
6	24.38	[illegible]	14.27	24.06	[illegible]	14.27	20.39	22.90	14.27	15.50	10.00
7	24.65	[illegible]	14.35	23.42	27.50	14.35	20.02	22.44	14.35	15.48	15.97
8	24.92	[illegible]	14.43	22.84	26.58	14.43	19.68	22.02	14.43	15.48	15.94
9	25.20	[illegible]	14.51	22.31	25.92	14.51	19.36	21.64	14.51	15.48	15.95
10	25.50	[illegible]	14.59	21.85	25.31	14.59	19.11	21.29	14.59	15.49	15.95
11	25.80	[illegible]	14.67	21.40	24.76	14.67	18.88	20.96	14.67	15.51	15.93
12	26.10	10.95	14.76	21.01	24.25	14.76	18.67	20.64	14.76	15.54	15.95
13	26.42	[illegible]	14.85	20.67	14.85	14.85	18.49	14.85	14.85	15.58	14.85
14	26.74	[illegible]	14.94	20.36	14.94	14.94	18.33	14.94	14.94	15.62	14.94
15	27.07	[illegible]	15.04	20.09	15.04	15.04	18.19	15.04	15.04	15.67	15.04
16	27.41	[illegible]	15.13	19.84	15.13	15.13	18.08	15.13	15.13	15.72	15.13
17	27.75	[illegible]	15.23	19.63	15.23	15.23	17.98	15.23	15.23	15.78	15.23
18	28.10	[illegible]	15.33	19.45	15.33	15.33	17.91	15.33	15.33	15.85	15.33
19	28.46	[illegible]	15.43	19.29	15.44	15.44	17.85	15.44	15.44	15.92	15.44
20	28.83	[illegible]	15.54	19.16	15.54	15.54	17.81	15.54	15.54	15.99	15.54

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
INSTANT TAX CREDIT

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: LOS ANGELES

SYSTEM: DIRECT DRAIN-BACK

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 11%; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
1	23.19	[illegible]	50.39	23.50	27.50	39.46	18.92	21.44	16.92	12.81	13.31
2	23.40	[illegible]	54.75	22.63	26.53	38.46	18.39	20.83	16.75	12.74	13.23
3	23.63	[illegible]	53.47	21.83	25.60	37.88	17.91	20.27	16.64	12.68	13.15
4	23.87	[illegible]	52.55	21.10	24.74	37.15	17.47	19.75	16.57	12.64	13.09
5	24.12	[illegible]	52.00	20.43	23.95	36.80	17.06	19.28	16.55	12.60	13.04
6	24.38	[illegible]	11.54	19.83	23.23	11.54	16.72	18.84	11.54	12.57	13.00
7	24.65	[illegible]	11.59	19.27	22.56	11.59	16.39	18.45	11.59	12.55	12.96
8	24.92	[illegible]	11.65	18.77	21.90	11.65	16.10	18.08	11.65	12.54	12.94
9	25.20	[illegible]	11.71	18.32	21.37	11.71	15.84	17.75	11.71	12.54	12.92
10	25.50	[illegible]	11.77	17.90	20.85	11.77	15.61	17.45	11.77	12.54	12.91
11	25.80	[illegible]	11.84	17.53	20.37	11.84	15.40	17.17	11.84	12.55	12.91
12	26.10	[illegible]	11.90	17.20	19.93	11.90	15.21	16.92	11.90	12.57	12.91
13	26.42	[illegible]	11.97	16.90	11.97	11.97	15.05	11.97	11.97	12.59	11.97
14	26.74	[illegible]	12.04	16.63	12.04	12.04	14.91	12.04	12.04	12.61	12.04
15	27.07	[illegible]	12.11	16.39	12.11	12.11	14.78	12.11	12.11	12.65	12.11
16	27.41	[illegible]	12.19	16.17	12.19	12.19	14.66	12.19	12.19	12.68	12.19
17	27.75	[illegible]	12.26	15.99	12.26	12.26	14.59	12.26	12.26	12.73	12.26
18	28.10	[illegible]	12.34	15.82	12.34	12.34	14.52	12.34	12.34	12.77	12.34
19	28.46	[illegible]	12.42	15.68	12.42	12.42	14.46	12.42	12.42	12.82	12.42
20	28.83	[illegible]	12.50	15.56	12.50	12.50	14.41	12.50	12.50	12.88	12.50

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
INSTANT TAX CREDIT

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: LOS ANGELES SYSTEM: INDIRECT

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 11%; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
1	23.19	[illegible]	63.54	24.08	28.42	43.25	18.58	21.61	16.18	11.25	11.85
2	23.40	[illegible]	61.51	22.98	27.66	41.96	17.69	20.82	15.95	11.11	11.70
3	23.65	[illegible]	59.42	21.96	26.49	40.48	17.26	20.08	15.73	10.99	11.55
4	23.67	[illegible]	56.76	21.05	25.40	40.20	16.67	19.41	15.59	10.87	11.42
5	24.12	[illegible]	54.04	20.17	24.39	39.81	16.14	18.78	15.50	10.77	11.30
6	24.38	[illegible]	9.43	19.38	23.40	9.43	15.65	18.20	9.43	10.68	11.19
7	24.65	[illegible]	9.44	18.66	22.59	9.44	15.26	17.66	9.44	10.59	11.06
8	24.92	[illegible]	9.45	17.99	21.79	9.45	14.79	17.16	9.45	10.52	10.99
9	25.20	[illegible]	9.46	17.38	21.05	9.46	14.41	16.70	9.46	10.45	10.91
10	25.50	[illegible]	9.47	16.82	20.36	9.47	14.07	16.28	9.47	10.39	10.85
11	25.80	[illegible]	9.48	16.31	19.72	9.48	13.75	15.88	9.48	10.34	10.76
12	26.10	[illegible]	9.49	15.85	19.13	9.49	13.46	15.52	9.49	10.29	10.70
13	26.42	[illegible]	9.51	15.42	9.51	9.51	13.20	9.51	9.51	10.25	9.51
14	26.74	[illegible]	9.53	15.03	9.53	9.53	12.96	9.53	9.53	10.21	9.53
15	27.07	[illegible]	9.54	14.67	9.54	9.54	12.75	9.54	9.54	10.18	9.54
16	27.41	[illegible]	9.56	14.35	9.56	9.56	12.55	9.56	9.56	10.16	9.56
17	27.75	[illegible]	9.58	14.05	9.58	9.58	12.38	9.58	9.58	10.14	9.58
18	28.10	[illegible]	9.60	13.79	9.60	9.60	12.22	9.60	9.60	10.13	9.60
19	28.46	[illegible]	9.63	13.54	9.63	9.63	12.08	9.63	9.63	10.12	9.63
20	28.83	[illegible]	9.65	13.33	9.65	9.65	11.95	9.65	9.65	10.11	9.65

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
INSTANT TAX CREDIT

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: WASHINGTON, D.C. SYSTEM: DIRECT DRAIN-DOWN

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 11%; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM: WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
1	18.11	9.33	56.22	22.12	26.65	56.99	18.05	20.02	16.01	11.83	12.34
2	18.25	9.52	54.55	21.61	25.74	57.44	17.50	19.46	15.85	11.74	12.24
3	18.41	9.75	55.26	20.98	24.82	57.15	16.99	19.39	15.69	11.67	12.15
4	18.58	9.94	52.25	20.22	23.95	56.55	16.55	18.85	15.61	11.60	12.07
5	18.75	10.17	51.67	19.55	23.11	56.20	16.11	18.35	15.57	11.55	12.00
6	18.94	10.41	10.45	18.89	22.35	10.45	15.72	17.89	10.45	11.50	11.94
7	19.15	10.65	10.49	18.31	21.65	10.49	15.38	17.47	10.49	11.47	11.88
8	19.35	10.91	10.53	17.78	21.01	10.53	15.06	17.06	10.53	11.44	11.84
9	19.54	11.17	10.57	17.30	20.41	10.57	14.76	16.72	10.57	11.41	11.80
10	19.75	11.47	10.62	16.86	19.86	10.62	14.52	16.34	10.62	11.40	11.77
11	19.97	11.77	10.66	16.46	19.36	10.66	14.29	16.10	10.66	11.39	11.75
12	20.20	12.07	10.71	16.10	18.89	10.71	14.08	15.82	10.71	11.38	11.73
13	20.43	12.42	10.76	15.77	10.76	10.76	13.89	10.76	10.76	11.39	10.76
14	20.67	12.76	10.81	15.48	10.81	10.81	13.73	10.81	10.81	11.39	10.81
15	20.91	13.12	10.86	15.22	10.86	10.86	13.58	10.86	10.86	11.41	10.86
16	21.17	13.43	10.92	14.98	10.92	10.92	13.46	10.92	10.92	11.42	10.92
17	21.42	13.83	10.97	14.77	10.97	10.97	13.34	10.97	10.97	11.45	10.97
18	21.69	14.38	11.03	14.56	11.03	11.03	13.25	11.03	11.03	11.47	11.03
19	21.96	14.79	11.09	14.41	11.09	11.09	13.17	11.09	11.09	11.50	11.09
20	22.23	15.17	11.15	14.27	11.15	11.15	13.10	11.15	11.15	11.54	11.15

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
INSTANT TAX CREDIT

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: WASHINGTON, D.C. SYSTEM: DIRECT RECIRCULATION

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 11%; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
1	18.11	9.[illegible]	71.02	26.57	33.61	49.08	22.43	25.70	19.84	14.51	15.16
2	18.25	9.5[illegible]	6[illegible]	27.21	32.27	47.75	21.72	24.88	19.60	14.39	15.02
3	18.41	9.75	67.17	26.15	31.04	46.70	21.07	24.12	19.42	14.29	14.90
4	18.56	9.[illegible]	65.96	25.17	29.90	45.95	20.47	23.42	19.30	14.20	14.79
5	18.75	10.17	65.20	24.28	28.84	45.50	19.93	22.78	19.24	14.12	14.69
6	18.94	10.41	12.71	23.46	27.87	12.71	19.43	22.19	12.71	14.06	14.61
7	19.13	10.[illegible]	12.76	22.71	26.97	12.76	18.96	21.64	12.76	14.00	14.53
8	19.33	10.91	12.80	22.05	26.14	12.80	18.57	21.14	12.80	13.95	14.47
9	19.54	11.17	12.85	21.41	25.37	12.85	18.20	20.67	12.85	13.92	14.41
10	19.75	11.47	12.89	20.84	24.06	12.89	17.86	20.25	12.89	13.89	14.37
11	19.97	11.77	12.94	20.35	24.01	12.94	17.56	19.86	12.94	13.87	14.33
12	20.20	12.[illegible]	13.00	19.86	23.41	13.00	17.29	19.50	13.00	13.85	14.30
13	20.43	12.4[illegible]	13.05	19.43	13.05	13.05	17.04	13.05	13.05	13.85	13.05
14	20.67	12.7[illegible]	13.11	19.05	13.11	13.11	16.82	13.11	13.11	13.85	13.11
15	20.91	13.1[illegible]	13.16	18.71	13.16	13.16	16.63	13.16	13.16	13.86	13.16
16	21.17	13.4[illegible]	13.22	18.40	13.22	13.22	16.46	13.22	13.22	13.87	13.22
17	21.42	13.[illegible]	13.29	18.12	13.29	13.29	16.31	13.29	13.29	13.89	13.29
18	21.69	14.[illegible]	13.35	17.87	13.35	13.35	16.17	13.35	13.35	13.91	13.35
19	21.96	14.7[illegible]	13.4[illegible]	17.65	13.41	13.41	16.06	13.41	13.41	13.94	13.41
20	22.23	15.1[illegible]	13.48	17.45	13.48	13.48	15.97	13.48	13.48	13.98	13.48

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
INSTANT TAX CREDIT

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: WASHINGTON, D.C. SYSTEM: EVACUATED TUBE

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 11%; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
1	18.11	[illegible]	67.24	28.58	33.15	47.25	22.97	25.95	20.60	15.75	16.34
2	18.25	[illegible]	65.31	27.30	31.97	46.07	22.35	25.24	20.42	15.68	16.25
3	18.41	9.75	63.80	26.43	30.88	45.15	21.79	24.58	20.29	15.62	16.16
4	18.58	[illegible]	62.72	25.57	29.88	44.51	21.29	23.98	20.22	15.57	16.11
5	18.75	10.17	62.06	24.79	28.95	44.13	20.83	23.43	20.20	15.54	16.06
6	18.94	10.41	14.29	24.09	28.10	14.29	20.41	22.92	14.29	15.52	16.02
7	19.15	[illegible]	14.37	23.44	27.32	14.37	20.04	22.46	14.37	15.50	15.99
8	19.35	[illegible]	14.45	22.86	26.60	14.45	19.71	22.04	14.45	15.50	15.97
9	19.54	[illegible]	14.53	22.33	25.94	14.53	19.41	21.66	14.53	15.50	15.96
10	19.75	11.47	14.61	21.85	25.34	14.61	19.14	21.31	14.01	15.52	15.95
11	19.97	11.77	14.70	21.42	24.78	14.70	18.90	21.00	14.70	15.54	15.96
12	20.20	[illegible]	14.78	21.04	24.27	14.78	18.69	20.71	14.78	15.57	15.97
13	20.43	[illegible]	14.87	20.69	14.87	14.87	18.51	14.87	14.87	15.60	14.87
14	20.67	[illegible]	14.97	20.38	14.97	14.97	18.35	14.97	14.97	15.64	14.97
15	20.91	[illegible]	15.06	20.11	15.06	15.06	18.22	15.06	15.06	15.69	15.06
16	21.17	[illegible]	15.16	19.87	15.16	15.16	18.10	15.16	15.16	15.75	15.16
17	21.42	[illegible]	15.26	19.66	15.26	15.26	18.01	15.26	15.26	15.81	15.26
18	21.69	[illegible]	15.36	19.48	15.36	15.36	17.93	15.36	15.36	15.87	15.36
19	21.96	[illegible]	15.46	19.32	15.46	15.46	17.87	15.46	15.46	15.94	15.46
20	22.23	[illegible]	15.57	19.19	15.57	15.57	17.83	15.57	15.57	16.02	15.57

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
INSTANT TAX CREDIT

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: WASHINGTON, D.C. SYSTEM: DIRECT DRAIN-BACK

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 11%; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
1	18.11	[illegible]	56.50	23.66	27.04	59.56	19.02	21.54	17.02	12.91	13.41
2	18.25	[illegible]	54.85	22.75	26.35	58.57	18.49	20.93	16.86	12.84	13.33
3	18.41	[illegible]	53.57	21.93	25.71	57.79	18.01	20.37	16.74	12.79	13.26
4	18.56	[illegible]	52.65	21.21	24.85	57.23	17.56	19.86	16.67	12.74	13.20
5	18.75	10.17	52.10	20.54	24.06	56.91	17.18	19.38	16.65	12.71	13.15
6	18.94	10.41	11.65	19.94	23.34	11.65	16.83	18.95	11.65	12.68	13.11
7	19.13	[illegible]	11.70	19.38	22.67	11.70	16.50	18.50	11.70	12.66	13.07
8	19.33	10.91	11.76	18.88	22.05	11.76	16.21	18.19	11.76	12.65	13.05
9	19.54	[illegible]	11.83	18.43	21.49	11.83	15.95	17.86	11.83	12.65	13.03
10	19.75	11.47	11.89	18.02	20.97	11.89	15.72	17.56	11.89	12.66	13.02
11	19.97	11.77	11.96	17.65	20.49	11.96	15.51	17.29	11.96	12.67	13.02
12	20.20	[illegible]	12.02	17.32	20.05	12.02	15.33	17.04	12.02	12.68	13.03
13	20.43	[illegible]	12.09	17.02	12.09	12.09	15.17	12.09	12.09	12.71	12.09
14	20.67	12.76	12.16	16.75	12.16	12.16	15.03	12.16	12.16	12.74	12.16
15	20.91	13.12	12.24	16.51	12.24	12.24	14.91	12.24	12.24	12.77	12.24
16	21.17	[illegible]	12.31	16.30	12.31	12.31	14.80	12.31	12.31	12.81	12.31
17	21.42	[illegible]	12.39	16.11	12.39	12.39	14.72	12.39	12.39	12.85	12.39
18	21.69	[illegible]	12.47	15.95	12.47	12.47	14.64	12.47	12.47	12.90	12.47
19	21.96	[illegible]	12.55	15.81	12.55	12.55	14.59	12.55	12.55	12.95	12.55
20	22.23	[illegible]	12.63	15.69	12.63	12.63	14.54	12.63	12.63	13.01	12.63

CURRENT TAX CREDITS: 30% CF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
INSTANT TAX CREDIT

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: WASHINGTON, D.C. SYSTEM: INDIRECT

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 11%; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
1	18.11	[illegible]	65.51	26.04	30.89	45.21	20.54	23.57	18.14	13.21	13.82
2	18.25	[illegible]	63.51	24.97	29.65	43.97	19.88	22.81	17.92	13.10	13.69
3	18.41	[illegible]	61.94	23.96	28.50	43.00	19.20	22.10	17.75	13.00	13.57
4	18.58	[illegible]	60.80	23.07	27.45	42.30	18.72	21.45	17.64	12.92	13.47
5	18.75	[illegible]	60.11	22.24	26.47	41.88	18.21	20.85	17.58	12.84	13.37
6	18.94	[illegible]	11.54	21.48	25.56	11.54	17.75	20.30	11.54	12.78	13.29
7	19.13	[illegible]	11.57	20.79	24.73	11.57	17.33	19.79	11.57	12.72	13.22
8	19.33	[illegible]	11.61	20.15	23.95	11.61	16.95	19.33	11.61	12.68	13.15
9	19.54	[illegible]	11.65	19.57	23.24	11.65	16.60	18.90	11.65	12.64	13.10
10	19.75	[illegible]	11.69	19.05	22.58	11.69	16.29	18.50	11.69	12.61	13.05
11	19.97	[illegible]	11.74	18.57	21.96	11.74	16.00	18.14	11.74	12.59	13.02
12	20.20	[illegible]	11.78	18.13	21.42	11.78	15.75	17.80	11.78	12.57	12.96
13	20.43	[illegible]	11.83	17.73	11.83	11.83	15.52	11.83	11.83	12.56	11.83
14	20.67	[illegible]	11.87	17.36	11.87	11.87	15.31	11.87	11.87	12.56	11.87
15	20.91	[illegible]	11.92	17.05	11.92	11.92	15.13	11.92	11.92	12.57	11.92
16	21.17	[illegible]	11.98	16.76	11.98	11.98	14.97	11.98	11.98	12.57	11.98
17	21.42	[illegible]	12.03	16.50	12.03	12.03	14.82	12.03	12.03	12.59	12.03
18	21.69	[illegible]	12.08	16.27	12.08	12.08	14.70	12.08	12.08	12.61	12.08
19	21.96	[illegible]	12.14	16.06	12.14	12.14	14.59	12.14	12.14	12.63	12.14
20	22.23	[illegible]	12.20	15.88	12.20	12.20	14.50	12.20	12.20	12.66	12.20

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
INSTANT TAX CREDIT

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: PHOENIX SYSTEM: DIRECT DRAIN-DOWN

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 11%; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
1	13.34	5.34	51.99	18.49	22.60	-14.26	-47.75	-45.64	-102.58	-136.08	-131.97
2	13.42	5.32	50.24	17.52	21.50	50.24	17.52	21.50	50.24	17.52	21.50
3	13.52	5.34	48.85	16.63	20.48	48.85	16.63	20.48	48.85	16.63	20.48
4	13.61	6.02	47.84	15.81	19.53	47.84	15.81	19.53	47.84	15.81	19.53
5	13.72	6.17	47.20	15.06	18.64	47.20	15.06	18.64	47.20	15.06	18.64
6	13.84	6.27	5.92	14.36	17.82	5.92	14.36	17.82	5.92	14.36	17.82
7	13.90	6.37	5.89	13.72	17.06	5.89	13.72	17.06	5.89	13.72	17.06
8	14.00	6.59	5.87	13.12	16.35	5.87	13.12	16.35	5.87	13.12	16.35
9	14.22	6.63	5.85	12.58	15.69	5.85	12.58	15.69	5.85	12.58	15.69
10	14.36	6.77	5.83	12.07	15.08	5.83	12.07	15.08	5.83	12.07	15.08
11	14.50	6.92	5.81	11.61	14.50	5.81	11.61	14.50	5.81	11.61	14.50
12	14.65	7.09	5.79	11.18	13.97	5.79	11.18	13.97	5.79	11.18	13.97
13	14.81	7.25	5.77	10.79	5.77	5.77	10.79	5.77	5.77	10.79	5.77
14	14.97	7.42	5.75	10.42	5.75	5.75	10.42	5.75	5.75	10.42	5.75
15	15.14	7.61	5.74	10.09	5.74	5.74	10.09	5.74	5.74	10.09	5.74
16	15.31	7.81	5.72	9.78	5.72	5.72	9.78	5.72	5.72	9.78	5.72
17	15.49	8.01	5.70	9.50	5.70	5.70	9.50	5.70	5.70	9.50	5.70
18	15.67	8.22	5.69	9.24	5.69	5.69	9.24	5.69	5.69	9.24	5.69
19	15.86	8.45	5.67	9.00	5.67	5.67	9.00	5.67	5.67	9.00	5.67
20	16.05	[illegible]	5.66	8.78	5.66	5.66	8.78	5.66	5.66	8.78	5.66

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
TAX CREDIT RECOVERED AT THE END OF FIRST YEAR

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS
CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: PHOENIX

SYSTEM: DIRECT RECIRCULATION

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 11%; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
1	13.34	5.[illegible]	56.56	20.32	24.77	-15.10	-51.34	-46.09	-110.64	-146.88	-142.43
2	13.42	5.[illegible]	54.67	19.28	23.58	54.67	19.28	23.58	54.67	19.28	23.58
3	13.52	5.[illegible]	53.18	18.33	22.48	53.18	18.33	22.48	53.18	18.33	22.48
4	13.61	6.9[illegible]	52.09	17.44	21.46	52.09	17.44	21.46	52.09	17.44	21.46
5	13.72	6.17	51.40	16.63	20.51	51.40	16.63	20.51	51.40	16.63	20.51
6	13.84	6.27	6.75	15.88	19.62	6.75	15.88	19.62	6.75	15.88	19.62
7	13.90	6.3[illegible]	6.73	15.19	18.80	6.73	15.19	18.80	6.73	15.19	18.80
8	14.08	6.59	6.71	14.55	18.04	6.71	14.55	18.04	6.71	14.55	18.04
9	14.22	6.6[illegible]	6.69	13.97	17.33	6.69	13.97	17.33	6.69	13.97	17.3
10	14.36	6.77	6.67	13.43	16.67	6.67	13.43	16.67	6.67	13.43	16.67
11	14.50	6.9[illegible]	6.66	12.93	16.06	6.66	12.93	16.06	6.66	12.93	16.06
12	14.65	7.0[illegible]	6.64	12.47	15.49	6.64	12.47	15.49	6.64	12.47	15.49
13	14.81	7.25	6.62	12.05	6.62	6.62	12.05	6.62	6.62	12.05	6.6
14	14.97	7.4[illegible]	6.61	11.66	6.61	6.61	11.66	6.61	6.61	11.66	6.6
15	15.14	7.61	6.60	11.31	6.60	6.60	11.31	6.60	6.60	11.31	6.6
16	15.31	7.8[illegible]	6.58	10.98	6.58	6.58	10.98	6.58	6.58	10.98	6.5
17	15.49	8.0[illegible]	6.57	10.68	6.57	6.57	10.68	6.57	6.57	10.68	6.5
18	15.67	8.2[illegible]	6.56	10.40	6.56	6.56	10.40	6.56	6.56	10.40	6.5
19	15.86	8.45	6.55	10.15	6.55	6.55	10.15	6.55	6.55	10.15	6.5
20	16.05	[illegible]	6.54	9.92	6.54	6.54	9.92	6.54	6.54	9.92	6.5

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
TAX CREDIT RECOVERED AT THE END OF FIRST YEAR

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: PHOENIX

SYSTEM: EVACUATED TUBE

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 11%; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
1	13.34	5.[illegible]	62.51	23.45	28.22	-14.53	-53.59	-46.62	-116.99	-155.85	-151.00
2	13.42	5.[illegible]	60.51	22.36	26.97	60.51	22.36	26.97	60.51	22.36	26.97
3	13.52	5.[illegible]	58.73	21.30	25.81	58.73	21.30	25.81	58.73	21.30	25.81
4	13.61	6.9[illegible]	57.58	20.45	24.74	57.58	20.45	24.74	57.58	20.45	24.74
5	13.72	6.17	56.87	19.58	23.74	56.87	19.58	23.74	56.87	19.58	23.74
6	13.84	6.27	9.01	18.80	22.82	9.01	18.80	22.82	9.01	18.80	22.82
7	13.96	6.3[illegible]	9.01	18.09	21.96	9.01	18.09	21.96	9.01	18.09	21.96
8	14.08	6.59	9.02	17.43	21.17	9.02	17.43	21.17	9.02	17.43	21.17
9	14.22	6.[illegible]	9.02	16.83	20.44	9.02	16.83	20.44	9.02	16.83	20.44
10	14.36	6.77	9.03	16.27	19.75	9.03	16.27	19.75	9.03	16.27	19.75
11	14.50	6.9[illegible]	9.04	15.76	19.12	9.04	15.76	19.12	9.04	15.76	19.12
12	14.65	7.0[illegible]	9.05	15.30	18.54	9.05	15.30	18.54	9.05	15.30	18.54
13	14.81	7.25	9.06	14.88	9.06	9.06	14.88	9.06	9.06	14.88	9.06
14	14.97	7.43	9.07	14.49	9.07	9.07	14.49	9.07	9.07	14.49	9.07
15	15.14	7.61	9.08	14.13	9.08	9.08	14.13	9.08	9.08	14.13	9.08
16	15.31	7.8[illegible]	9.10	13.81	9.10	9.10	13.81	9.10	9.10	13.81	9.10
17	15.49	8.0[illegible]	9.11	13.51	9.11	9.11	13.51	9.11	9.11	13.51	9.11
18	15.67	8.[illegible]	9.13	13.25	9.13	9.13	13.25	9.13	9.13	13.25	9.13
19	15.86	8.45	9.15	13.00	9.15	9.15	13.00	9.15	9.15	13.00	9.15
20	16.05	8.[illegible]	9.17	12.79	9.17	9.17	12.79	9.17	9.17	12.79	9.17

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
TAX CREDIT RECOVERED AT THE END OF FIRST YEAR

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: PHOENIX

SYSTEM: DIRECT DRAIN-BACK

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 11%; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
1	15.34	5.[illegible]	52.20	19.30	23.34	-12.65	-45.74	-41.70	-99.58	-132.47	-128.43
2	15.42	5.3[illegible]	50.49	18.37	22.27	50.49	18.37	22.27	50.49	18.37	22.27
3	15.52	5.3[illegible]	49.15	17.51	21.29	49.15	17.51	21.29	49.15	17.51	21.29
4	15.61	[illegible]	48.17	16.72	20.37	48.17	16.72	20.37	48.17	16.72	20.37
5	15.72	[illegible]	47.56	16.00	19.52	47.56	16.00	19.52	47.56	16.00	19.52
6	15.84	[illegible]	7.04	15.33	18.73	7.04	15.33	18.73	7.04	15.33	18.73
7	15.96	[illegible]	7.03	14.72	18.00	7.03	14.72	18.00	7.03	14.72	18.00
8	14.08	[illegible]	7.03	14.15	17.32	7.03	14.15	17.32	7.03	14.15	17.32
9	14.22	[illegible]	7.03	13.63	16.69	7.03	13.63	16.69	7.03	13.63	16.69
10	14.36	[illegible]	7.02	13.15	16.10	7.02	13.15	16.10	7.02	13.15	16.10
11	14.50	[illegible]	7.02	12.72	15.56	7.02	12.72	15.56	7.02	12.72	15.56
12	14.65	[illegible]	7.02	12.31	15.05	7.02	12.31	15.05	7.02	12.31	15.05
13	14.81	7.25	7.02	11.95	7.02	7.02	11.95	7.02	7.02	11.95	7.02
14	14.97	7.4[illegible]	7.02	11.61	7.02	7.02	11.61	7.02	7.02	11.61	7.02
15	15.14	[illegible]	7.02	11.30	7.02	7.02	11.30	7.02	7.02	11.30	7.02
16	15.31	[illegible]	7.03	11.02	7.03	7.03	11.02	7.03	7.03	11.02	7.03
17	15.49	[illegible]	7.03	10.76	7.03	7.03	10.76	7.03	7.03	10.76	7.03
18	15.67	[illegible]	7.04	10.52	7.04	7.04	10.52	7.04	7.04	10.52	7.04
19	15.86	[illegible]	7.04	10.31	7.04	7.04	10.31	7.04	7.04	10.31	7.04
20	16.05	[illegible]	7.05	10.11	7.05	7.05	10.11	7.05	7.05	10.11	7.05

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
TAX CREDIT RECOVERED AT THE END OF FIRST YEAR

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS
CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: PHOENIX SYSTEM: INDIRECT

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 11%; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
1	15.54	5.[illegible]	61.03	21.57	26.41	-17.01	-56.48	-51.65	-121.07	-160.53	-155.69
2	15.42	5.[illegible]	58.96	20.43	25.11	58.96	20.43	25.11	58.96	20.43	25.11
3	15.52	5.[illegible]	57.55	19.38	23.90	57.55	19.38	23.90	57.55	19.38	23.90
4	15.61	[illegible]	56.14	18.41	22.78	56.14	18.41	22.78	56.14	18.41	22.78
5	15.72	[illegible]	55.58	17.51	21.74	55.58	17.51	21.74	55.58	17.51	21.74
6	15.84	[illegible]	0.74	16.69	20.77	0.74	16.69	20.77	0.74	16.69	20.77
7	15.90	[illegible]	0.71	15.93	19.86	0.71	15.93	19.86	0.71	15.93	19.86
8	14.00	[illegible]	0.68	15.22	19.02	0.68	15.22	19.02	0.68	15.22	19.02
9	14.22	[illegible]	0.65	14.58	18.24	0.65	14.58	18.24	0.65	14.58	18.24
10	14.36	[illegible]	0.62	13.98	17.52	0.62	13.98	17.52	0.62	13.98	17.52
11	14.50	[illegible]	0.60	13.43	16.84	0.60	13.43	16.84	0.60	13.43	16.84
12	14.65	7.[illegible]	0.57	12.92	16.21	0.57	12.92	16.21	0.57	12.92	16.21
13	14.81	7.25	0.55	12.45	0.55	0.55	12.45	0.55	0.55	12.45	0.55
14	14.97	7.4[illegible]	0.52	12.02	0.52	0.52	12.02	0.52	0.52	12.02	0.52
15	15.14	7.[illegible]	0.50	11.62	0.50	0.50	11.62	0.50	0.50	11.62	0.50
16	15.31	7.[illegible]	0.47	11.26	0.47	0.47	11.26	0.47	0.47	11.26	0.47
17	15.49	[illegible]	0.45	10.92	0.45	0.45	10.92	0.45	0.45	10.92	0.45
18	15.67	[illegible]	0.43	10.61	0.43	0.43	10.61	0.43	0.43	10.61	0.43
19	15.86	[illegible]	0.41	10.33	0.41	0.41	10.33	0.41	0.41	10.33	0.41
20	16.05	[illegible]	0.39	10.06	0.39	0.39	10.06	0.39	0.39	10.06	0.39

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
TAX CREDIT RECOVERED AT THE END OF FIRST YEAR

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: PHOENIX SYSTEM: DIRECT DRAIN-DOWN

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 11%; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
1	13.34	5.[illegible]	51.99	18.49	22.00	54.76	13.82	16.39	11.78	7.60	8.11
2	13.42	5.[illegible]	50.24	17.52	21.50	53.05	13.21	15.69	11.54	7.45	7.95
3	13.52	5.[illegible]	48.65	16.65	20.48	52.78	12.64	15.04	11.35	7.32	7.80
4	13.61	6.[illegible]	47.84	15.81	19.53	52.14	12.12	14.44	11.20	7.20	7.66
5	13.72	6.[illegible]	47.26	15.00	18.04	51.75	11.64	13.88	11.10	7.08	7.53
6	13.84	6.[illegible]	5.92	14.50	17.82	5.92	11.19	13.36	5.92	6.97	7.41
7	13.90	6.[illegible]	5.89	13.72	17.06	5.89	10.78	12.87	5.89	6.87	7.29
8	14.00	6.59	5.87	13.12	16.35	5.87	10.40	12.42	5.87	6.78	7.18
9	14.22	6.[illegible]	5.85	12.58	15.69	5.85	10.05	12.00	5.85	6.69	7.08
10	14.36	6.[illegible]	5.83	12.07	15.08	5.83	9.73	11.61	5.83	6.61	6.99
11	14.50	6.[illegible]	5.81	11.61	14.50	5.81	9.43	11.24	5.81	6.54	6.90
12	14.65	7.[illegible]	5.79	11.10	13.97	5.79	9.16	10.90	5.79	6.46	6.81
13	14.81	7.25	5.77	10.79	5.77	5.77	8.91	5.77	5.77	6.40	5.77
14	14.97	7.43	5.75	10.42	5.75	5.75	8.67	5.75	5.75	6.34	5.75
15	15.14	7.61	5.74	10.09	5.74	5.74	8.46	5.74	5.74	6.28	5.74
16	15.31	7.[illegible]	5.72	9.76	5.72	5.72	8.26	5.72	5.72	6.23	5.72
17	15.49	8.[illegible]	5.70	9.50	5.70	5.70	8.08	5.70	5.70	6.18	5.70
18	15.67	8.[illegible]	5.69	9.24	5.69	5.69	7.91	5.69	5.69	6.13	5.69
19	15.86	8.45	5.67	9.00	5.67	5.67	7.75	5.67	5.67	6.09	5.67
20	16.05	8.[illegible]	5.66	8.78	5.66	5.66	7.61	5.66	5.66	6.05	5.66

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
INSTANT TAX CREDIT

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: PHOENIX

SYSTEM: DIRECT RECIRCULATION

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 11%; 30 years
SOLAR BANK: 5.5%; 12 years

YEAR	CONVENTIONAL SYSTEMS: ELECTRIC	CONVENTIONAL SYSTEMS: GAS	SOLAR SYSTEM, WITHOUT CREDITS: IMPROVEMENT LOAN	WITHOUT CREDITS: HOME MORTGAGE	WITHOUT CREDITS: SOLAR BANK	WITH CURRENT CREDITS: IMPROVEMENT LOAN	WITH CURRENT CREDITS: HOME MORTGAGE	WITH CURRENT CREDITS: SOLAR BANK	WITH PROPOSED CREDITS: IMPROVEMENT LOAN	WITH PROPOSED CREDITS: HOME MORTGAGE	WITH PROPOSED CREDITS: SOLAR BANK
1	13.34	5.3[illegible]	56.56	20.52	24.77	57.92	15.27	18.05	13.07	8.54	9.10
2	13.42	5.[illegible]	54.67	19.26	23.56	56.75	14.61	17.36	12.81	8.39	8.93
3	13.52	5.[illegible]	53.18	18.33	22.46	55.79	14.01	16.66	12.61	8.25	8.77
4	13.61	6.0[illegible]	52.09	17.44	21.46	55.10	13.45	15.96	12.45	8.12	8.62
5	13.72	6.17	51.40	16.65	20.51	54.66	12.93	15.35	12.35	8.00	8.48
6	13.84	6.27	6.75	15.88	19.62	6.75	12.45	14.80	6.75	7.89	8.36
7	13.96	6.3[illegible]	6.73	15.19	18.80	6.73	12.02	14.28	6.73	7.78	8.24
8	14.08	6.59	6.71	14.55	18.04	6.71	11.61	13.79	6.71	7.69	8.12
9	14.22	6.[illegible]	6.69	13.97	17.33	6.69	11.24	13.34	6.69	7.60	8.02
10	14.36	6.77	6.67	13.43	16.67	6.67	10.89	12.92	6.67	7.52	7.92
11	14.50	6.[illegible]	6.66	12.93	16.06	6.66	10.58	12.53	6.66	7.44	7.83
12	14.65	7.[illegible]	6.64	12.47	15.49	6.64	10.26	12.17	6.64	7.37	7.75
13	14.81	7.25	6.62	12.05	6.62	6.62	10.01	6.62	6.62	7.30	6.62
14	14.97	7.43	6.61	11.66	6.61	6.61	9.77	6.61	6.61	7.24	6.61
15	15.14	7.[illegible]	6.60	11.31	6.60	6.60	9.54	6.60	6.61	7.18	6.60
16	15.31	7.[illegible]	6.58	10.98	6.58	6.58	9.33	6.60	6.60	7.13	6.60
17	15.49	8.[illegible]	6.57	10.68	6.57	6.57	9.14	6.58	6.58	7.08	6.58
18	15.67	8.[illegible]	6.56	10.40	6.56	6.56	8.96	6.57	6.57	7.04	6.57
19	15.86	8.45	6.55	10.15	6.55	6.55	8.80	6.56	6.56	7.00	6.56
20	16.05	8.[illegible]	6.54	9.92	6.54	6.54	8.65	6.55	6.55	6.96	6.55

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
INSTANT TAX CREDIT

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: PHOENIX

SYSTEM: EVACUATED TUBE

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 11%; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
1	15.34	5.[illegible]	62.31	23.45	26.22	42.32	18.04	21.02	15.67	10.82	11.41
2	15.42	5.[illegible]	60.31	22.36	26.97	41.07	17.55	20.24	15.42	10.68	11.25
3	15.52	5.[illegible]	58.73	21.30	25.81	40.09	16.75	19.51	15.22	10.55	11.11
4	15.61	6.[illegible]	57.59	21.43	24.74	39.57	16.15	18.84	15.08	10.44	10.97
5	15.72	6.17	56.87	19.56	23.74	38.92	15.62	18.22	14.99	10.33	10.85
6	15.84	6.27	9.01	16.80	22.82	9.01	15.13	17.64	9.01	10.24	10.74
7	15.90	6.[illegible]	9.01	16.59	21.97	9.01	14.69	17.11	9.01	10.15	10.63
8	14.00	6.59	9.02	17.43	21.17	9.02	14.28	16.62	9.02	10.07	10.54
9	14.22	6.[illegible]	9.02	16.83	20.44	9.02	13.90	16.16	9.02	10.00	10.45
10	14.36	6.77	9.03	16.27	19.76	9.03	13.56	15.73	9.03	9.94	10.37
11	14.50	6.[illegible]	9.04	15.77	19.12	9.04	13.24	15.34	9.04	9.88	10.30
12	14.65	7.[illegible]	9.05	15.56	18.54	9.05	12.90	14.98	9.05	9.83	10.23
13	14.81	7.25	9.06	14.88	9.06	9.06	12.70	9.06	9.06	9.79	9.06
14	14.97	7.4[illegible]	9.07	14.49	9.07	9.07	12.46	9.07	9.07	9.75	9.07
15	15.14	7.61	9.08	14.13	9.08	9.08	12.24	9.08	9.08	9.72	9.08
16	15.31	7.[illegible]	9.10	13.81	9.10	9.10	12.04	9.10	9.10	9.69	9.10
17	15.49	8.[illegible]	9.11	13.52	9.11	9.11	11.86	9.11	9.11	9.66	9.11
18	15.67	8.[illegible]	9.13	13.25	9.13	9.13	11.70	9.13	9.13	9.64	9.13
19	15.86	8.45	9.15	13.01	9.15	9.15	11.56	9.15	9.15	9.63	9.15
20	16.05	8.[illegible]	9.17	12.74	9.17	9.17	11.43	9.17	9.17	9.62	9.17

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
INSTANT TAX CREDIT

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: PHOENIX

SYSTEM: DIRECT DRAIN-BACK

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 11%; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
1	15.34	5.[illegible]	52.20	19.30	23.34	35.28	14.72	17.24	12.72	8.61	9.11
2	15.42	5.[illegible]	50.49	18.37	22.21	34.21	14.13	16.57	12.50	8.48	8.97
3	15.52	5.[illegible]	49.15	17.51	21.29	33.37	13.59	15.95	12.32	8.37	8.84
4	15.61	[illegible]	48.17	16.72	20.37	32.75	13.10	15.38	12.19	8.26	8.72
5	15.72	[illegible]	47.50	16.00	19.52	32.37	12.64	14.84	12.11	8.16	8.60
6	15.84	[illegible]	7.04	15.33	18.73	7.04	12.22	14.35	7.04	8.08	8.50
7	15.90	[illegible]	7.03	14.72	18.00	7.03	11.84	13.89	7.03	7.99	8.40
8	14.08	[illegible]	7.03	14.15	17.32	7.03	11.48	13.46	7.03	7.92	8.32
9	14.22	[illegible]	7.03	13.63	16.69	7.03	11.15	13.06	7.03	7.85	8.25
10	14.36	[illegible]	7.02	13.15	16.10	7.02	10.86	12.70	7.02	7.79	8.16
11	14.50	[illegible]	7.02	12.72	15.56	7.02	10.58	12.36	7.02	7.73	8.09
12	14.65	7.[illegible]	7.02	12.31	15.05	7.02	10.33	12.04	7.02	7.68	8.03
13	14.81	7.25	7.02	11.95	7.02	7.02	10.10	7.02	7.02	7.64	7.02
14	14.97	7.[illegible]	7.02	11.61	7.02	7.02	9.89	7.02	7.02	7.60	7.02
15	15.14	7.[illegible]	7.02	11.30	7.02	7.02	9.70	7.02	7.02	7.56	7.02
16	15.31	7.[illegible]	7.03	11.02	7.03	7.03	9.52	7.03	7.03	7.53	7.03
17	15.49	[illegible]	7.03	10.76	7.03	7.03	9.36	7.03	7.03	7.50	7.03
18	15.67	[illegible]	7.04	10.52	7.04	7.04	9.21	7.04	7.04	7.47	7.04
19	15.86	[illegible]	7.04	10.31	7.04	7.04	9.06	7.04	7.04	7.45	7.04
20	16.05	[illegible]	7.05	10.11	7.05	7.05	8.96	7.05	7.05	7.43	7.05

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
INSTANT TAX CREDIT

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: PHOENIX SYSTEM: INDIRECT

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 11%; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
1	13.34	[illegible]	61.03	21.57	26.41	40.73	16.07	19.09	13.67	8.73	9.34
2	13.42	[illegible]	58.96	20.45	25.11	39.45	15.34	18.27	13.38	8.56	9.15
3	13.52	[illegible]	57.33	19.38	23.90	38.40	14.67	17.50	13.15	8.40	8.97
4	13.61	[illegible]	56.14	18.41	22.78	37.64	14.05	16.79	12.97	8.25	8.80
5	13.72	[illegible]	55.38	17.51	21.74	37.15	13.48	16.12	12.85	8.11	8.64
6	13.84	[illegible]	6.74	16.69	20.77	6.74	12.96	15.51	6.74	7.98	8.49
7	13.96	[illegible]	6.71	15.95	19.86	6.71	12.47	14.93	6.71	7.86	8.35
8	14.08	[illegible]	6.68	15.22	19.02	6.68	12.02	14.40	6.68	7.75	8.22
9	14.22	[illegible]	6.65	14.58	18.24	6.65	11.60	13.90	6.65	7.64	8.10
10	14.36	[illegible]	6.62	13.98	17.52	6.62	11.22	13.43	6.62	7.54	7.99
11	14.50	[illegible]	6.60	13.43	16.84	6.60	10.87	13.00	6.60	7.45	7.88
12	14.65	[illegible]	6.57	12.92	16.21	6.57	10.54	12.59	6.57	7.37	7.78
13	14.81	7.25	6.55	12.45	6.55	6.55	10.24	6.55	6.55	7.28	6.55
14	14.97	[illegible]	6.52	12.02	6.52	6.52	9.96	6.52	6.52	7.21	6.52
15	15.14	[illegible]	6.50	11.62	6.50	6.50	9.70	6.50	6.50	7.14	6.50
16	15.31	[illegible]	6.47	11.26	6.47	6.47	9.46	6.47	6.47	7.07	6.47
17	15.49	[illegible]	6.45	10.92	6.45	6.45	9.25	6.45	6.45	7.01	6.45
18	15.67	[illegible]	6.43	10.61	6.43	6.43	9.04	6.43	6.43	6.95	6.43
19	15.86	[illegible]	6.41	10.33	6.41	6.41	8.86	6.41	6.41	6.90	6.41
20	16.05	[illegible]	6.39	10.08	6.39	6.39	8.68	6.39	6.39	6.85	6.39

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
INSTANT TAX CREDIT

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: WASHINGTON, D.C. SYSTEM: DIRECT DRAIN-DOWN

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 11%; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
1	18.11	9.[illegible]	56.22	22.72	26.55	-10.03	-43.53	-39.41	-98.35	-131.85	-127.74
2	18.25	9.5[illegible]	54.55	21.81	25.79	54.55	21.81	25.79	54.55	21.81	25.79
3	18.41	9.75	53.20	20.98	24.62	53.20	20.98	24.62	53.20	20.98	24.62
4	18.56	9.[illegible]	52.25	20.22	23.93	52.25	20.22	23.93	52.25	20.22	23.93
5	18.75	10.17	51.67	19.53	23.11	51.67	19.53	23.11	51.67	19.53	23.11
6	18.94	10.41	10.45	18.89	22.35	10.45	18.89	22.35	10.45	18.89	22.35
7	19.13	10.[illegible]	10.49	18.31	21.65	10.49	18.31	21.65	10.49	18.31	21.65
8	19.33	10.[illegible]	10.55	17.78	21.01	10.55	17.78	21.01	10.55	17.78	21.01
9	19.54	11.1[illegible]	10.57	17.30	20.41	10.57	17.30	20.41	10.57	17.30	20.41
10	19.75	11.47	10.62	16.86	19.86	10.62	16.86	19.86	10.62	16.86	19.86
11	19.97	11.77	10.66	16.46	19.36	10.66	16.46	19.36	10.66	16.46	19.36
12	20.20	12.[illegible]	10.71	16.10	18.89	10.71	16.10	18.89	10.71	16.10	18.89
13	20.43	12.4[illegible]	10.76	15.77	10.76	10.76	15.77	10.76	10.76	15.77	10.76
14	20.67	12.7[illegible]	10.81	15.48	10.81	10.81	15.48	10.81	10.81	15.48	10.81
15	20.91	13.1[illegible]	10.86	15.22	10.86	10.86	15.22	10.86	10.86	15.22	10.86
16	21.17	13.4[illegible]	10.92	14.98	10.92	10.92	14.98	10.92	10.92	14.98	10.92
17	21.42	13.[illegible]	10.97	14.77	10.97	10.97	14.77	10.97	10.97	14.77	10.97
18	21.69	14.[illegible]	11.03	14.58	11.03	11.03	14.58	11.03	11.03	14.58	11.03
19	21.96	14.7[illegible]	11.09	14.41	11.09	11.09	14.41	11.09	11.09	14.41	11.09
20	22.23	15.1[illegible]	11.15	14.27	11.15	11.15	14.27	11.15	11.15	14.27	11.15

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
TAX CREDIT RECOVERED AT THE END OF FIRST YEAR

COMPARISON OF MON''LY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS
CONSIDERING CURRE AND FUTURE FINANCING SCENARIOS.

CITY: WASHINGTON, D . SYSTEM: DIRECT R IRCULATION

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 11%; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
1	18.11	9.33	71.02	28.37	33.61	-13.31	-55.96	-50.72	-125.75	-108.40	-163.16
2	18.25	9.52	68.86	27.21	32.27	68.86	27.21	32.27	68.86	27.21	32.27
3	18.41	9.75	67.17	26.15	31.04	67.17	26.15	31.04	67.17	26.15	31.04
4	18.58	9.93	65.94	25.17	29.90	65.94	25.17	29.90	65.94	25.17	29.90
5	18.75	10.17	65.20	24.28	28.84	65.20	24.28	28.84	65.20	24.28	28.84
6	18.94	10.41	12.71	23.46	27.87	12.71	23.46	27.87	12.71	23.46	27.87
7	19.13	10.65	12.76	22.71	26.97	12.76	22.71	26.97	12.76	22.71	26.97
8	19.33	10.91	12.80	22.03	26.14	12.80	22.03	26.14	12.80	22.03	26.14
9	19.54	11.18	12.85	21.41	25.37	12.85	21.41	25.37	12.85	21.41	25.37
10	19.75	11.47	12.89	20.84	24.66	12.89	20.84	24.66	12.89	20.84	24.66
11	19.97	11.77	12.94	20.33	24.01	12.94	20.33	24.01	12.94	20.33	24.01
12	20.20	12.09	13.00	19.86	23.41	13.00	19.86	23.41	13.00	19.86	23.41
13	20.43	12.42	13.05	19.43	13.05	13.05	19.43	13.05	13.05	19.43	13.05
14	20.67	12.76	13.11	19.05	13.11	13.11	19.05	13.11	13.11	19.05	13.11
15	20.91	13.12	13.16	18.71	13.16	13.16	18.71	13.16	13.16	18.71	13.16
16	21.17	13.49	13.22	18.40	13.22	13.22	18.40	13.22	13.22	18.40	13.22
17	21.42	13.88	13.29	18.12	13.29	13.29	18.12	13.29	13.29	18.12	13.29
18	21.69	14.28	13.35	17.87	13.35	13.35	17.87	13.35	13.35	17.87	13.35
19	21.96	14.70	13.41	17.65	13.41	13.41	17.65	13.41	13.41	17.65	13.41
20	22.23	15.12	13.48	17.45	13.48	13.48	17.45	13.48	13.48	17.45	13.48

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
TAX CREDIT RECOVERED AT THE END OF FIRST YEAR

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: WASHINGTON, D.C. SYSTEM: EVACUATED TUBE

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 11%; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
1	18.11	9.[illegible]	67.21	28.50	33.15	-9.63	-48.49	-45.72	-112.09	-150.95	-140.16
2	18.25	9.[illegible]	65.28	27.33	31.94	65.28	27.33	31.94	65.28	27.33	31.44
3	18.41	9.75	63.77	26.40	30.65	63.77	26.40	30.65	63.77	26.40	30.65
4	18.56	9.[illegible]	62.69	25.54	29.65	62.69	25.54	29.85	62.69	25.54	29.65
5	18.75	10.1[illegible]	62.05	24.76	28.92	62.05	24.76	28.92	62.05	24.76	28.92
6	18.94	10.41	14.26	24.06	28.07	14.26	24.06	28.07	14.26	24.06	28.07
7	19.13	10.[illegible]	14.34	23.41	27.29	14.34	23.41	27.29	14.34	23.41	27.29
8	19.33	10.[illegible]1	14.42	22.83	26.57	14.42	22.83	26.57	14.42	22.83	26.57
9	19.54	11.1[illegible]	14.50	22.30	25.91	14.50	22.30	25.91	14.50	22.30	25.91
10	19.75	11.4[illegible]	14.58	21.82	25.30	14.58	21.82	25.30	14.58	21.82	25.30
11	19.97	11.77	14.66	21.39	24.75	14.66	21.39	24.75	14.66	21.39	24.75
12	20.20	12.[illegible]	14.75	21.00	24.24	14.75	21.00	24.24	14.75	21.00	24.24
13	20.43	12.4[illegible]	14.84	20.66	14.84	14.84	20.66	14.84	14.84	20.66	14.84
14	20.67	12.7[illegible]	14.93	20.35	14.93	14.93	20.35	14.93	14.93	20.35	14.93
15	20.91	13.1[illegible]	15.03	20.08	15.03	15.03	20.08	15.03	15.03	20.08	15.03
16	21.17	13.4[illegible]	15.12	19.83	15.12	15.12	19.83	15.12	15.12	19.83	15.12
17	21.42	13.[illegible]	15.22	19.62	15.22	15.22	19.62	15.22	15.22	19.62	15.22
18	21.69	14.[illegible]	15.32	19.44	15.32	15.32	19.44	15.32	15.32	19.44	15.32
19	21.96	14.7[illegible]	15.43	19.28	15.43	15.43	19.28	15.43	15.43	19.28	15.43
20	22.23	15.1[illegible]	15.53	19.15	15.55	15.55	19.15	15.55	15.55	19.15	15.55

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
TAX CREDIT RECOVERED AT THE END OF FIRST YEAR

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: WASHINGTON, D.C. SYSTEM: DIRECT DRAIN-BACK

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 11%; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
1	18.11	[illegible]	56.50	23.60	27.04	-8.55	-41.44	-37.40	-95.28	-128.17	-124.15
2	18.25	[illegible]	54.65	22.73	26.63	54.65	22.73	26.63	54.65	22.73	26.63
3	18.41	[illegible]	53.57	21.93	25.71	53.57	21.93	25.71	53.57	21.93	25.71
4	18.56	[illegible]	52.65	21.21	24.85	52.65	21.21	24.85	52.65	21.21	24.85
5	18.75	[illegible]	52.10	20.54	24.06	52.10	20.54	24.06	52.10	20.54	24.06
6	18.94	10.41	11.65	19.94	23.34	11.65	19.94	23.34	11.65	19.94	23.34
7	19.13	[illegible]	11.70	19.38	22.67	11.70	19.38	22.67	11.70	19.38	22.67
8	19.33	10.91	11.76	18.88	22.05	11.76	18.88	22.05	11.76	18.88	22.05
9	19.54	[illegible]	11.83	18.43	21.49	11.83	18.43	21.49	11.83	18.43	21.49
10	19.75	11.47	11.89	18.02	20.97	11.89	18.02	20.97	11.89	18.02	20.97
11	19.97	11.77	11.96	17.65	20.49	11.96	17.65	20.49	11.96	17.65	20.49
12	20.20	[illegible]	12.02	17.32	20.05	12.02	17.32	20.05	12.02	17.32	20.05
13	20.43	[illegible]	12.09	17.02	12.09	12.09	17.02	12.09	12.09	17.02	12.09
14	20.67	[illegible]	12.16	16.75	12.16	12.16	16.75	12.16	12.16	16.75	12.16
15	20.91	[illegible]	12.24	16.51	12.24	12.24	16.51	12.24	12.24	16.51	12.24
16	21.17	[illegible]	12.31	16.30	12.31	12.31	16.30	12.31	12.31	16.30	12.31
17	21.42	[illegible]	12.39	16.11	12.39	12.39	16.11	12.39	12.39	16.11	12.39
18	21.69	[illegible]	12.47	15.95	12.47	12.47	15.95	12.47	12.47	15.95	12.47
19	21.96	[illegible]	12.55	15.81	12.55	12.55	15.81	12.55	12.55	15.81	12.55
20	22.23	[illegible]	12.63	15.69	12.63	12.63	15.69	12.63	12.63	15.69	12.63

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
TAX CREDIT RECOVERED AT THE END OF FIRST YEAR

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

CITY: WASHINGTON, D.C. SYSTEM: INDIRECT

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 11%; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
1	18.11	[illegible]	65.51	26.04	30.69	-12.53	-52.00	-47.15	-116.59	-156.05	-151.21
2	18.25	9.53	63.51	24.97	29.65	63.51	24.97	29.65	63.51	24.97	29.65
3	18.41	9.75	61.94	23.98	28.50	61.94	23.98	28.50	61.94	23.98	28.50
4	18.58	9.93	60.80	23.07	27.45	60.80	23.07	27.45	60.80	23.07	27.45
5	18.75	10.17	60.11	22.24	26.47	60.11	22.24	26.47	60.11	22.24	26.47
6	18.94	10.41	11.54	21.48	25.56	11.54	21.48	25.56	11.54	21.48	25.56
7	19.13	10.65	11.57	20.79	24.73	11.57	20.79	24.73	11.57	20.79	24.73
8	19.33	10.91	11.61	20.15	23.95	11.61	20.15	23.95	11.61	20.15	23.95
9	19.54	11.17	11.65	19.57	23.24	11.65	19.57	23.24	11.65	19.57	23.24
10	19.75	11.47	11.69	19.05	22.58	11.69	19.05	22.58	11.69	19.05	22.58
11	19.97	11.77	11.74	18.57	21.98	11.74	18.57	21.98	11.74	18.57	21.98
12	20.20	[illegible]	11.78	18.13	21.42	11.78	18.13	21.42	11.78	18.13	21.42
13	20.43	12.43	11.83	17.73	11.83	11.83	17.73	11.83	11.83	17.73	11.83
14	20.67	12.74	11.87	17.38	11.87	11.87	17.38	11.87	11.87	17.38	11.87
15	20.91	13.13	11.92	17.05	11.92	11.92	17.05	11.92	11.92	17.05	11.92
16	21.17	13.43	11.98	16.76	11.98	11.98	16.76	11.98	11.98	16.76	11.98
17	21.42	[illegible]	12.03	16.50	12.03	12.03	16.50	12.03	12.03	16.50	12.03
18	21.69	[illegible]	12.08	16.27	12.08	12.08	16.27	12.08	12.08	16.27	12.08
19	21.96	14.79	12.14	16.06	12.14	12.14	16.06	12.14	12.14	16.06	12.14
20	22.23	15.13	12.20	15.88	12.20	12.20	15.88	12.20	12.20	15.88	12.20

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
TAX CREDIT RECOVERED AT THE END OF FIRST YEAR

COMPARISON OF MONTHLY CASH FLOW FOR CONVENTIONAL AND SOLAR DHW HEATERS CONSIDERING CURRENT AND FUTURE FINANCING SCENARIOS.

DISCOUNT RATE 0

CITY: DENVER

SYSTEM: DIRECT DRAIN-DOWN

IMPROVEMENT LOAN: 22%; 5 years
HOME MORTGAGE: 16 %; 30 years
SOLAR BANK: 5.5%; 12 years

	CONVENTIONAL SYSTEMS		SOLAR SYSTEM								
			WITHOUT CREDITS			WITH CURRENT CREDITS			WITH PROPOSED CREDITS		
YEAR	ELECTRIC	GAS	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK	IMPROVEMENT LOAN	HOME MORTGAGE	SOLAR BANK
	28.92	8.50									
1	31.64	9.32	58.54	27.39	26.44	39.85	20.32	19.78	14.93	11.02	10.91
2	34.64	10.23	61.48	28.05	27.42	41.97	21.03	20.67	15.94	11.76	11.68
3	37.93	11.25	64.97	28.89	28.48	44.45	21.90	21.64	17.08	12.57	12.52
4	41.56	12.39	69.13	29.80	29.62	47.37	22.79	22.68	18.36	13.45	13.43
5	45.54	13.67	74.08	30.78	30.85	50.82	23.76	23.80	19.81	14.40	14.41
6	49.92	15.10	13.10	31.85	32.18	13.10	24.82	25.02	13.10	15.44	15.48
7	54.74	16.69	14.22	33.02	33.61	14.22	25.97	26.34	14.22	16.57	16.64
8	60.04	18.46	15.44	34.30	35.15	15.44	27.23	27.76	15.44	17.80	17.91
9	65.87	20.46	16.77	35.70	36.82	16.77	28.60	29.30	16.77	19.14	19.28
10	72.27	22.71	18.22	37.22	38.63	18.22	30.09	30.97	18.22	20.59	20.77
11	79.32	25.21	19.79	38.88	40.58	19.79	31.72	32.78	19.79	22.18	22.39
12	87.07	28.01	21.50	40.68	42.68	21.50	33.49	34.74	21.50	23.90	24.15
13	95.59	31.14	23.36	42.67	23.36	23.36	35.43	23.36	23.36	25.78	23.36
14	104.96	34.64	25.39	44.83	25.39	25.39	37.54	25.39	25.39	27.82	25.39
15	115.27	38.56	27.60	47.20	27.60	27.60	39.85	27.60	27.60	30.05	27.60
16	126.61	42.95	30.00	49.79	30.00	30.00	42.37	30.00	30.00	32.47	30.00
17	139.07	47.86	32.62	52.63	32.62	32.62	45.12	32.62	32.62	35.12	32.62
18	152.78	53.35	35.47	55.72	35.47	35.47	48.12	35.47	35.47	38.00	35.47
19	167.86	59.50	38.57	59.11	38.57	38.57	51.41	38.57	38.57	41.14	38.57
20			41.95	62.83	41.95	41.95	55.00	41.95	41.95	44.56	41.95

CURRENT TAX CREDITS: 30% OF INVESTMENT
PROPOSED TAX CREDITS: 70% OF INVESTMENT
INSTANT TAX CREDIT