A.82-11-39 U/BDS/FS/WPSC

ORIGINAL

Decision 83 06 047 JUN 15 1983

BEFORE THE PUBLIC UTILITIES COMMISSION OF THE STATE OF CALIFORNIA

Application of Solar Heat Corporation for eligibility in the California Public Utilities Commission's Solar Demonstration Financing Program.	Application 82-11-39 (Filed November 22, 1982)

OPINION ON SOLAR WATER HEATER ELIGIBILITY

Solar Heat Corporation (Solar Heat) is an importer of solar water heater components manufactured in France by Salva-Eclair. California Solar Conversion, Inc. then assembles and installs self-contained, modular, thermosyphon solar water heaters from these tanks and collectors. Solar Heat seeks eligibility under OII 42 for its device, the Salva 1200.1/ Solar Heat offers freeze protection described below which is comparable to other solar water heaters now eligible for installation under the OII 42 program up to 2,300 feet elevation.

In this decision, the Commission finds Solar Heat's device eligible when specified minimum sizing and installation conditions are met, and when specified warranty coverage is provided. Solar Heat offers a standard five-year parts-and-labor warranty.

1/ Also known as the Sol 120. Applicant is now replacing the Sol 120 tradename under which it applied.

Freeze Protection

All active systems approved by the utilities in California under the OII 42 program have been required to have a recognized means of freeze protection such as recirculation, automatic draining, or anti-freeze in the collectors. For passive innovative systems, adequate freeze protection has been confirmed on a case-by-case basis by the Energy Conservation Branch (ECB), before it recommended eligibility.

The flat-plate collectors normally used in thermosyphon systems such as this one are the components most often damaged by freezing. Each one found eligible to date has been required to have the only freeze protection method available for thermosyphon systems, an electric resistance heater in the collectors.2/ One manufacturer has also used a nonelectric, thermostatic draindown system which automatically drains the collectors, as is done in some non-thermosyphon systems.3/

2/ Limited to elevations of 2,300 feet or less because at higher elevations the electric anti-freeze would likely consume more energy than the electric pump in a comparably sized "conventional" solar system.

3/ Solar Edwards, D.83-03-031 in A.82-12-034.

Sizing

All solar water heaters eligible under the OII 42 program are subject to minimum collector area and solar-heated storage volume requirements. For solar water heaters which are connected to a separate conventional water heater, the minimum solar storage is 25 gallons of water per bedroom in single family dwellings (20 gallons per bedroom in multi-family dwellings). The minimum collector area for conventional flat-plate systems is determined from the OII 42 Sizing Chart Handbook.

For innovative systems of modular tank-collector units such as the Solar Heat system, the minimum number of units for OII 42 eligibility is determined by indivicual laboratory tests of energy output. Solar Heat has submitted the results of a solar water heater performance test known as SRCC-OG200. This test is a national standard, and certification based on it is a requirement for the California solar tax credit after 1982. The output of the Salva 1200 solar system in a California climate was calculated from the results of the SRCC-OG200 test as described in Appendix A. The minimum eligible system output of 101 therms per year for a three-bedroom dwelling is developed in Appendix B, based on adopted OII 42 criteria.

CORRECTION

THIS DOCUMENT

HAS BEEN REPHOTOGRAPHED

TO ASSURE LEGIBILITY

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Program Background

On September 16, 1980, we issued Decision (D.) 92251 establishing demonstration solar financing programs for Pacific Gas and Electric Company, San Diego Gas & Electric Company, Southern California Edison Company, and Southern California Gas Company. We subsequently modified this decision by D.92501, December 5, 1980, and D.92769, March 3, 1981. In these decisions, we specified a checklist of requirements for domestic solar water heaters. Solar water heaters must meet all sizing and checklist requirements to be eligible for the solar financing program effective March 1, 1981.

Description

The Salva 1200 consists of an insulated horizontal 42-gallon tank mounted above three flat, sloping, glass-covered seven-foot-by-one-foot collector panels. No electric pump is used because the water rises into the tank from the collectors below as the water is heated by the sun. The entire system is installed outdoors, typically on a roof. The local water supply is piped directly to the system, and from the system back down to the conventional water heater. As hot water is used from the conventional water heater in the dwelling, the hot water is made up by pre-heated water piped down from the Salva 1200.

Freeze Protection

All active systems approved by the utilities in California under the OII 42 program have been required to have a recognized means of freeze protection such as recirculation, automatic draining, or anti-freeze in the collectors. For passive innovative systems, adequate freeze protection has been confirmed on a case-by-case basis by the Energy Conservation Branch (ECB), before it recommended eligibility.

The flat-plate collectors normally used in thermosyphon systems such as this one are the components most often damaged by freezing. Each one found eligible to date has been required to have the only freeze protection method available for thermosyphon systems, an electric resistance heater in the collectors.2/ One manufacturer has also used a nonelectric, thermostatic draindown system which automatically drains the collectors, as is done in some non-thermosyphon systems.3/

2/ Limited to elevations of 2,300 feet or less because at higher elevations the electric anti-freeze would likely consume more energy than the electric pump in a comparably sized "conventional" solar system.

3/ Solar Edwards, D.83-03-031 in A.82-12-034.

Solar Heat offers no electric anti-freeze feature, although it does offer an electric backup heater immersed in the tank which does not contribute to freeze protection. Instead, a single thermostatic valve at the lowest point in the system begins to let water flow through the system automatically when the surrounding air temperature falls to a few degrees above freezing. The valve uses no electricity but depends on a solid metallic-compound actuater which lengthens or shortens according to its temperature.

As the valve opens, the near-freezing water in the collectors is forced out by line pressure to drain away, and replaced by water from the tank. The tank water is solar heated or is at least near the supply water temperature, which if not hot, is not near freezing. After water has flowed through the valve long enough to warm it a few degrees it closes. When the heat thus provided has dissipated, the cycle repeats itself.

Solar Heat did not provide test data or field performance data on this type of valve. Much water, as well as collected solar energy, could be wasted in parts of California by this device.

Therefore, the ECB concludes, and we adopt its recommendation, that Solar Heat's Salva 1200 systems as described in this application should be limited to locations where the elevation does not exceed 2,300 feet. Freeze protection methods are discussed further in Appendix C.

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For innovative systems of modular tank-collector units such as the Solar Heat system, the minimum number of units for OII 42 eligibility is determined by incivicual laboratory tests of energy output. Solar Heat has submitted the results of a solar water heater performance test known as SRCC-OG200. This test is a national standard, and certification based on it is a requirement for the California solar tax credit after 1982. The output of the Salva 1200 solar system in a California climate was calculated from the results of the SRCC-OG200 test as described in Appendix A. The minimum eligible system output of 101 therms per year for a three-bedroom dwelling is developed in Appendix B, based on adopted OII 42 criteria.

Using calculations based on the test data, the ECB concludes that an annual average output of 13,000 Btu per day should be adopted for each three-collector 42-gallon Salva 1200 unit which is properly installed in California under the OII 42 program. This output corresponds to 47.5 therms per unit per year. Therefore, two collectors (2.1 rounded) would be needed to meet the annual load of a three-bedroom home under OII 42. Table 1 summarizes the minimum eligible sizing for single-family homes. This sizing also provides more than 25 gallons of solar storage per bedroom in five of the six cases shown.

The ECB notes that the output of successive units is reduced when they are connected in series (the outlet of one leading to the inlet of the next), due to successively higher storage temperatures and standby heat losses. Therefore, we could require systems of more than one unit to be piped in parallel (the outlet of all units leading directly to the backup heater), because the test results are for only one unit (no units in series).

Two units in series, however, do produce slightly higher water temperatures. For this reason, plumbing arrangements of the minimum required number of units may be made with parallel pairs of a maximum of two Sol 120 units connected in series. The system plumbing as a whole must still provide an equal flow path length

through all collectors (Installation Checklist Item No. 21). A longer summer season of solar-only operation with suitably hot water available for use will then be possible with the backup water heater turned off for greater savings.

TABLE 1

Minimum Sizing of Solar Water Heater Systems
Using Solar Heat Salva 1200 Units 4/

Number of Bedrooms	OII 42 Minimum Output Therms/Yr.	Number of Units 5/	Use
1	33	0.7	1
2	68	1.4	1
3	101 6/	2.1	2
4	135	2.8	3
5	168	3.52	4
6	202	4.2	4
n over 6	33n	0.7n	

4/ As tested by SRCC with three collectors and 42 gallons storage per unit.
5/ A maximum of two (2) units to be installed in series.
6/ See Appendix B for derivations.

Ideally, the minimum sizing shown in Table 1 would depend on many factors such as the exact location within California. But we recognize that solar water heaters increasingly are marketed as modular appliances independent of small differences in climate, orientation, tilt, and so on. Less obvious or controllable factors such as the daily hot water use profile, installation quality, and weather variations affect solar system performance so strongly that actual savings from a given system can only be predicted within a reasonably broad range. For these reasons, and the fact that ratepayer benefits from the OII 42 program will stem from the average effect of all of the systems installed, we believe that all Solar Heat systems installed under OII 42 should be sized according to Table 1, provided the systems at least comply with the minimum guidelines for orientation and tilt which have been in effect for the California solar tax credit.

Monitoring

Solar Heat solar systems should be evaluated in the monitoring program now beginning for all other solar water heaters which are installed under the OII 42 program, if they can be accommodated in the sample group.

Warranty

Solar Heat offers its standard warranty against defects in material or workmanship for five years. We believe that to be eligible for ratepayer-funded assistance, Solar Heat and all of its installers should advise potential customers of eventual reduced performance due to poor water quality conditions wherever that is the case, as it is in much of Southern California. Solar Heat and its installers should then be willing to assist such customers at no charge for five years in maintaining the original level of solar energy production.

Any reference by Solar Heat to this order in its correspondence, marketing literature, or media advertising must contain the following full text of this Disclaimer of Product Endorsement:

> "The California Public Utilities Commission in no way encorses, recommends, or warrants the durability, suitability, or the reliability, or the short- or long-term energy savings performance of this or any other brand of system or component for domestic water heating or any other application".

While this disclaimer is applicable to any system under our demonstration program, we must be certain that this order is not viewed by the public as an implied endorsement.

We believe that public hearings would serve no useful purpose. This application should be granted ex parte to the extent provided in the following order.

Findings of Fact

1. Solar Heat solar water heaters do not have the freeze protection from thermal mass or automatic draining found in passive solar water heaters which are eligible for installation above 2,300 feet elevation in the OII 42 program.

2. A 3-collector model 3C2 Salva 1200 Solar Heat system was certified by SRCC and produced 13,000 Btu per day in the standard laboratory test sequence after adjustment for California conditions.

3. Solar energy collection in all nonpumped thermosyphon systems, including Solar Heat's, relies on internal flow passages which are free from significant deposits of water-borne material.

4. Conventional water heater losses may be reduced by appropriate valves or circuit breakers.

5. Solar Heat systems with water tanks are roof-mounted.

6. Solar Heat's warranty complies with the state solar tax credit requirements.

7. Solar Heat's warranty exempts earthquake damage (acts of God) but not nail or freeze damage.

Conclusions of Law

"Solar Heat" refers to Solar Heat Corporation and/or its installers:

1. Solar Heat's nonelectric freeze protection using a thermostatic drain valve on each Salva 1200 solar water heater should be permitted only in locations below 2,300 feet elevation.

2. Solar Heat's standard five-year warranty covers system repair or replacement due to damage by freezing wherever installed.

3. Solar Heat installations should not be eligible for OII 42 rebates unless they meet the minimum sizing of Table 1.

4. Solar Heat should install valves for flushing purposes on all systems in accordance with the Inspection Checklist. If the accumulation of hard water deposits in the system causes a serious loss of system efficiency, Solar Heat should assist customers in flushing and removing water borne deposits from the system. No charge will be made for such service during the first five years.

5. Solar Heat should not install its units on any roof that is not capable of supporting the added weight. Solar Heat should secure all necessary building permits for any installation.

6. Solar Heat should assure that in no case is a residence converted from gas water heating to electric water heating.

7. Solar Heat should instruct customers to turn off pilot lights on gas backup water heaters during summer months.

8. Solar Heat should instruct customers to turn off electric backup water heaters during summer months.

9. Solar Heat should recommend installation of time clocks on all electric backup water heaters.

O R D E R

IT IS ORDERED that:

1. Solar Heat installations contracted after January 29, 1980 are eligible for OII 42 rebates when installed in compliance with the preceding Conclusions on dwellings occupied before January 29, 1980.

2. Except as granted and provided herein, Solar Heat and its contractors shall adhere to all other currently effective requirements set forth in D.92251, 92501, and 92769 and subsequent orders in this proceeding.

This order is effective today.

Dated JUN 15 1983, at San Francisco, California.

LEONARD M. GRIMES, JR.
President
VICTOR CALVO
PRISCILLA C. GREW
DONALD VIAL
WILLIAM T. BAGLEY
Commissioners

I CERTIFY THAT THIS DECISION WAS APPROVED BY THE ABOVE COMMISSIONERS TODAY.

Joseph E. Bodovitz, Executive Director

Method Used to Process the Salva 1200 Solar Water Heater Test Results

The minimum number of Salva 1200 units per bedroom served follows from the results of Solar Heat's SRCC-OG200 test by comparing those results against the 101-therm minimum criterion for a three-bedroom dwelling. However, the test conditions reflect national average values, not California values, for available solar radiation and other variables. Therefore, the following method was used to determine the annual solar output under California conditions from the SRCC-OG200 test output.

The method used to estimate performance under conditions which differ from the test conditions ideally should have national consensus. Such a consensus is now in its early stages. Since a usable method may not be available before the OII 42 program is over, the ECB staff, with informal review from the solar community, recommends an objective approach of its own, to clear the docket of applications and to aid the achievement of the OII 42 program market penetration goals.

Of the many conditions chosen for the SRCC-OG200 test, three vary significantly for systems installed in California. These are the incident solar energy, the volume and timing of hot water drawn per day, and the effect of overnight heat losses on the net solar energy delivered by the system.

Incident Solar Energy

An increase in incident solar energy will increase the solar energy delivered by the system. The increase can reasonably be estimated to be in the ratio of the California annual average value to the test value, or (1700/1500), in Btus per sq. ft. per day.

Hot Water Usage

The effect of varying the second factor, the amount and timing of hot water drawn per day, is difficult to quantify. However, the direction of the effect is clear. Reducing the volume from approximately 100 gallons per day during the test, to 60 gallons per day for a three-bedroom dwelling under OII 42

conditions, will reduce the net solar energy delivered.a/ (Shifting the timing of usage from evening towards morning also reduces the energy delivered. However, we do not differ with the test assumption of equal draws at morning, noon and late afternoon.)

If we quantify this reduction factor for lower water use at a value of (1500/1700), it would simplify the analysis by just offsetting the increase due to greater solar insolation. The value chosen depends on the extent of analysis, quality of test data, and on the values assumed for other variables. In the absence of a recognized method to calculate this factor, ECB staff believes that (1500/1700) is a reasonable one. Therefore, the output under OII 42 conditions of radiation and water usage are assumed to be unchanged from the SRCC-OG200 value.

Overnight Heat Losses

The importance of this factor in the net solar energy delivered by a solar system is recognized in the SRCC-OG200 test process. A separate 16-hour temperature decay test is conducted to determine the rate of heat loss under the known test conditions. But the actual amount of energy lost in any given locality or installation depends on the annual average nighttime temperature. Therefore no night heat losses are deducted from the SRCC-OG200 energy output as reported.

The method of determining the actual loss, using local temperatures and SRCC heat loss rate data, will eventually have national agreement, as with the other factors which modify the SRCC test result. A reasonable engineering estimate of that loss is recommended by the ECB staff for use in the OII 42 program until another method is developed and recognized.

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a/ The "net solar energy delivered" (in Btus for example) should be distinguished from the "solar fraction" (in %). While net solar Btus would fall along with gallons of daily load, the solar fraction would likely increase because it is the ratio of net usable Btus to total Btus. (The total Btus fall nearly 50% from 100 gal./day to 60 gal./day, while net Btus might only fall 20%.

The ECB recommends using two items of test data to make this estimate. One is the temperature difference between the solar heated water remaining in the solar system after the standard test day, and the annual average overnight temperature in California population centers, as the factor affecting the overnight heat loss. The second item is the rate of heat loss.

These two data items, combined with an exponential heat loss model, produce for the Salva 1200 an overnight heat loss of 13% of the net solar energy delivered under the SRCC rating as reported.

APPENDIX B
Page 1 of 3

OII 42 Program Assumptions

Solar Water Preheater Systems with Gas Auxiliary Energy
Conventional Gas Water Heater

Line	Item	Amount
1	Single Family Daily Hot Water Usage	20 Gallons Per Bedroom
2	Three-Bedroom Dwelling Usage	60 Gallons per Day
3	Energy to Raise Water 70 degrees F	128 th/yr
	Conventional Water Heater Efficiencies	
4	After Combustion and Flue Losses	53%
5	After Jacket Losses	80%
6	Net Efficiency (4 times 5)	42%
	Before Solar Conventional Energy Usage	
7	(3 over 6)	300 th/yr
	60% Savings of Conventional Energy	
8	(7 times 60%)	180 th/yr
	Maximum Metered Usage With Solar	
9	(7 less 8)	120 th/yr
10	Energy From Auxiliary With Solar (9 times 6)	51 th/yr
11	Minimum Net Energy From Solar (3 less 10)	77 th/yr
12	Solar System Piping Efficiency	95%
13	Net Solar Plumbing Efficiency (12 times 5)	76%
	Gross Solar Energy Output Required	
14	(11 over 13)	101 th/yr

OII 42 Program Assumptions

Solar Water Preheater Systems with Gas Auxiliary Energy
High-Efficiency Gas Water Heater

Line	Item	Amount
1	Single Family Daily Hot Water Usage	20 Gallons Per Bedroom
2	Three-Bedroom Dwelling Usage	60 Gallons per Day
3	Energy to Raise Water 70 degrees F	128 th/yr
	Conventional Water Heater Efficiencies	
4	After Combustion and Flue Losses	75%
5	After Jacket Losses	80%
6	Net Efficiency (4 times 5)	60%
	Before Solar Conventional Energy Usage	
7	(3 over 6)	213 th/yr
	60% Savings of Conventional Energy	
8	(7 times 60%)	128 th/yr
	Maximum Metered Usage With Solar	
9	(7 less 8)	85 th/yr
10	Energy From Auxiliary With Solar (9 times 6)	51 th/yr
11	Minimum Net Energy From Solar (3 less 10)	77 th/yr
12	Solar System Piping Efficiency	95%
13	Net Solar Plumbing Efficiency (12 times 5)	76%
	Gross Solar Energy Output Required	
14	(11 over 13)	101 th/yr

APPENDIX B
Page 3 of 3

OII 42 Program Assumptions

Solar Water Preheater Systems with Electric Auxiliary Energy

Line	Item	Amount
1	Single Family Daily Hot Water Usage	20 Gallons Per Bedroom
2	Three-Bedroom Dwelling Usage	60 Gallons per Day
3	Energy to Raise Water 70 degrees F	3750 kWh/yr = 128 th/yr
	Conventional Water Heater Efficiencies	
4	After Combustion and Flue Losses	100%
5	After Jacket Losses	80%
6	Net Efficiency (4 times 5)	80%
	Before Solar Conventional Energy Usage	
7	(3 over 6)	4687 kWh/yr = 160 th/yr
	60% Savings of Conventional Energy	
8	(7 times 60%)	2813 kWh/yr = 96 th/yr
	Maximum Metered Usage With Solar	
9	(7 less 8)	1874 kWh/yr = 64 th/yr
10	Energy From Auxiliary With Solar (9 times 6)	1499 kWh/yr = 51 th/yr
11	Minimum Net Energy From Solar (3 less 10)	2251 kWh/yr = 77 th/yr
12	Solar System Piping Efficiency	95%
13	Net Solar Plumbing Efficiency (12 times 5)	76%
	Gross Solar Energy Output Required	
14	(11 over 13)	2962 kWh/yr = 101 th/yr

Use of Heat to Prevent Freezing in Solar Systems

Water confined in an exposed solar collector may cause damage to it by freezing and expanding if the air temperature falls much below 45 deg. F. (depending on wind and cloud cover). Water will freeze occasionally in all parts of California.

Typically the flat-plate components of active and of thermosyphon systems require freeze protection because they contain little heat when solar radiation is not available. ICS systems typically do not require freeze protection because of their large thermal mass.

Freeze protection for piping leading to and from solar systems is not discussed in individual solar decisions for two reasons. Piping is relatively inexpensive in comparison to the collector components of a solar system, and secondly, because good plumbing practice for all water piping calls for insulation as heavy as the local climate warrants.

The water in solar collectors should be drained to prevent damage, but for practical or economic reasons, the user may only try to prevent freezing. In that case, antifreeze liquid or gas may be used, in so-called closed loop systems, where the potable water supply does not flow directly through the collectors.

Another method is to provide heat to the collectors. It is used in those designs where potable water is always present throughout the system. In mild climates, the long-term performance of these systems will not greatly reduced. There are now at least three methods to heat collectors.

A common one is to simply start the system electric pump, in an active system, to circulate warm water from the indoor storage tank. Another is to turn on electric heaters in the collectors themselves. The Commission has limited use of both of these in OII 42 to climates defined by a maximum elevation for installation. A third method is now being used, chiefly in thermosyphon systems.

In that method a valve is activated by thermal contraction when the temperature drops into the freezing range of water. It opens to permit water to move through the system under line pressure, as if a hot water tap were opened in the dwelling. The coldest water is forced out first, over the valve actuator followed by water which warms the coldest parts of the system, including the valve. The valve actuator expands and closes, and when the heat provided by the water has dissipated, the cycle repeats itself. In very cold weather, the valve may remain open.

While this method relies only on water pressure for reliability, it is from an energy standpoint, no different from the recirculation method used in active systems, or the electric anti-freeze used in thermosyphon systems.

All three methods rely on heat to keep ice from forming. Therefore, their use of resources and effect on net energy production is the same on a statewide average. The conditions of exposure are the same, because all three methods are equally eligible regardless of insolation, water supply temperature, climate, or dwelling size. The recirculation method actually is limited to 1,000 feet elevation, not 2,300 feet, but only because it is less efficient. Electricity is used both to collect heat and to recirculate some of it, before dissipating that heat, but ice forms no more easily because the recirculation method is used.