A.60954 U/BDS/FS/WPSC

Decision 83 03 033 MAR 16 1983

BEFORE THE PUBLIC UTILITIES COMMISSION OF THE STATE OF CALIFORNIA

Application of Sunwizard, Inc. for exemption from certain requirements of Decision Nos. 92251, 92501 and 92769 relating to eligibility of solar water heating equipment to be installed under the Solar Demonstration Financing Program of OII 42.	Application 60954 (Filed October 1, 1981)

OPINION ON SOLAR WATER HEATER ELIGIBILITY

Sunwizard manufactures a passive solar water heater simply consisting of a 120-gallon water heater tank with cylindrical glazing, standing alone vertically or supported horizontally, usually on the ground. No pump is used.

Sunwizard seeks OII 42 eligibility and recognition of its system's inherent freeze protection. It submitted the required SRCCa/ performance test results in November 1982. It also submitted data and calculations supporting its position that the SRCC test predicts relatively lower performance for the Sunwizard than it does for other system types.

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a/ Solar Rating and Certification Corporation Standard 200-82.

In this decision, the Commission finds Sunwizard's device best suited for low-temperature water heating, but eligible for the OII 42 program if multiple units are installed in two-bedroom and larger dwellings.

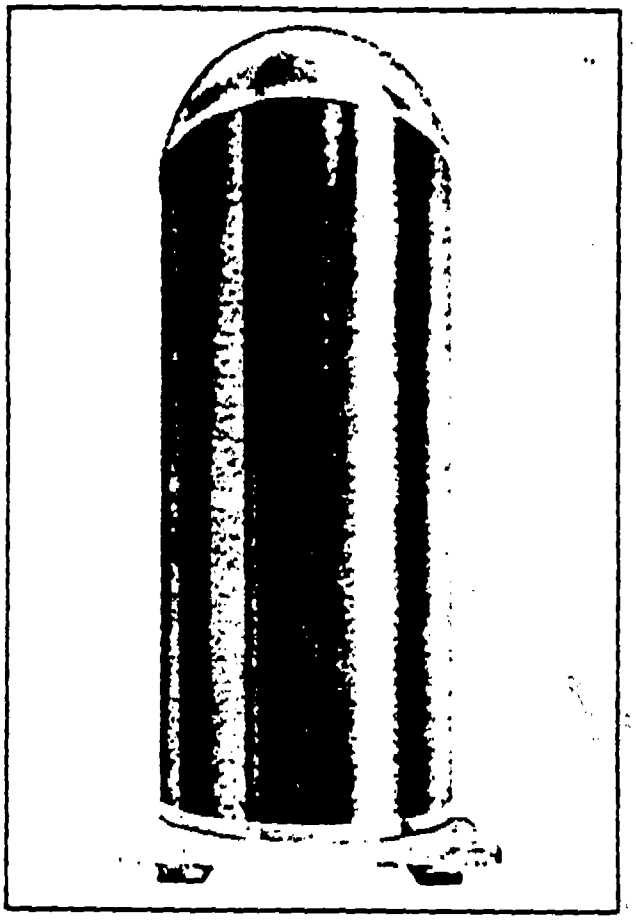
Program Background

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

Water flows through the Sunwizard tank under supply pressure whenever hot water is used. The tank absorbs direct and reflected sunlight from all directions, as shown in Figure 1. Sunwizard recommends painting adjacent walls and surfaces white for a distance of 10 feet to increase the solar output by 60% to 100% as shown in Figure 2. Tank insulation consists of a black surface

Figure 1



SPECIFICATIONS

SUNWIZARD Model 120V

(vertical) Solar Hot Water System
120 gallon glass-lined steel water tank
(U.L. listing No. E35410) with 2
sacrificial anodes

Absorber coating: absorptivity of 97%, emissivity of 7%; high purity nickel black selective surface

Optical efficiency: 85%

Heat loss coefficient: 0.4 BTU/ft^{2}hr°F

Glazing: acrylic cylinder with a hemispherical acrylic dome on top.

Absorber area: 35 square ft.

Aperture area: 40 square ft.

Height: 6 ft.

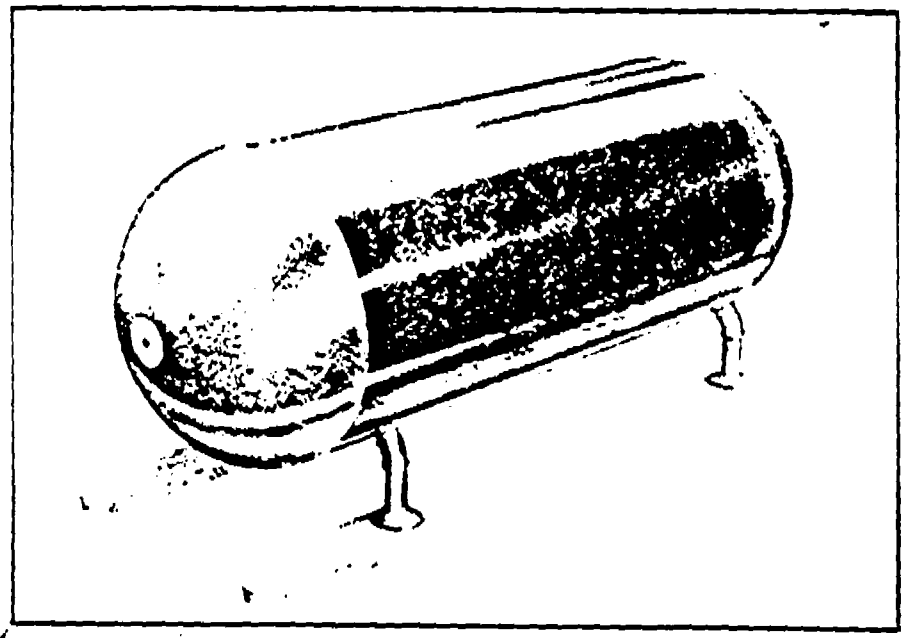
Diameter: 28 in.

Base: 30 in. x 30 in. redwood

Weight, empty: 300 lb.

Weight, full: 1300 lb.

Warranty: 10 years



SPECIFICATIONS

SUNWIZARD Model 120H

(horizontal) Solar Hot Water System
120 gallon glass-lined steel water tank
(U.L. listing No. E35410) with 2
sacrificial anodes

Absorber coating: absorptivity of 97%, emissivity of 7%, high purity nickel black selective surface

Optical efficiency: 85%

Heat loss coefficient: 0.4 BTU/ft^{2}hr°F

Glazing: acrylic cylinder with a hemispherical acrylic dome on each end

Absorber area: 38 square ft.

Aperture area: 47 square ft.

Height: 34 in.

Length: 80 in.

Diameter: 28 in.

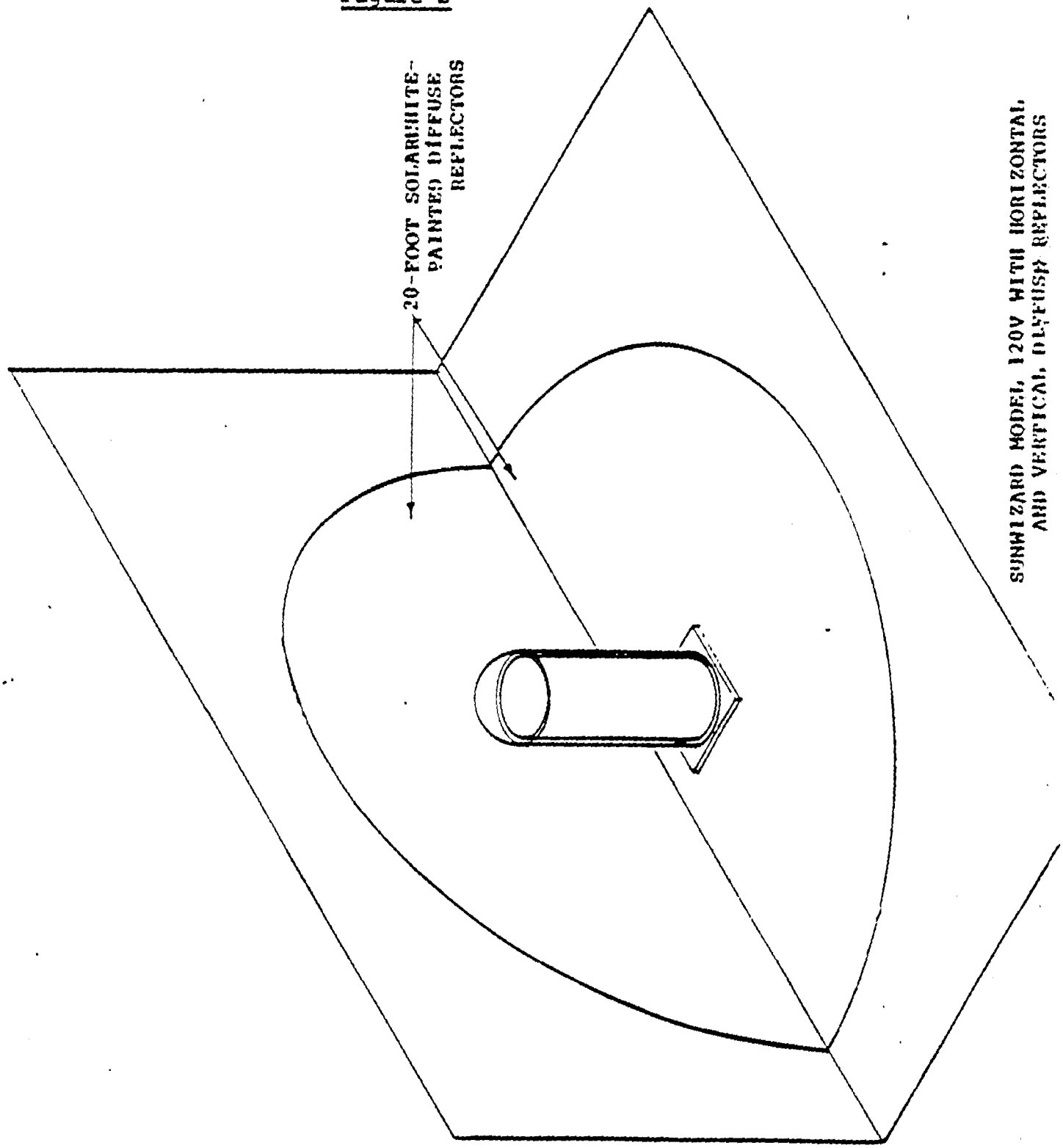
Base: two redwood 2 X 6 X 7 ft. runners

Weight, empty: 300 lb.

Weight, full: 1300 lb.

Warranty: 10 years

Figure 2


20-FOOT SOLARWHITE-PAINTED DIFFUSE REFLECTORS
SUNWIZARD MODEL 120V WITH HORIZONTAL AND VERTICAL DIFFUSE REFLECTORS

treatment to absorb and retain heat, and of curved plastic glazing mounted about an inch from the tank all around including the ends. The Sunwizard tank preheats water, and the user's backup water heater raises it to a final higher temperature if needed.

The Sunwizard is an integral collector-storage (ICS) device. The area receiving sunlight is limited to the outside of the storage tank. Its simplicity permits lower manufacturing cost, and eliminating moving parts improves reliability.

The disadvantage is that the collector area of a single unit cannot be increased without also increasing the amount of water being heated. When the tank is made larger, however, the added energy collected cannot produce water temperatures even as high as a smaller unit will.

Reflecting Walls and Surfaces

Sunwizard stresses the value of providing large light painted adjacent surfaces to reflect added energy towards the tank. The ECB believes that when new such reflectors can increase the system's output, and they should be used where practical.

They would be subject to weathering, however, and dirt gathering on horizontal surfaces would impair their effectiveness. Repeated cleaning could remove the reflective paint itself. Reflectors are used in ICS systems now eligible, but they are much smaller and entirely enclosed to reduced heat loss.

For these reasons, the ECB recommends considering the Sunwizard on its performance as tested, without such reflectors, since they should not be considered permanent over a 10 to 20-year lifespan.

Freeze Protection

The Sunwizard, like other ICS solar water heaters consisting of only a tank, is not likely to freeze under conditions found in California's populated areas. Exposed water piping should be adequately insulated in any system.

Water Temperatures

Sunwizard's system is unique when compared to systems currently eligible for the OII 42 program, due to its simplicity, apparent low cost, and absorption of radiation from every direction. Other designs use enclosed or thermally insulated tanks which cost more and must be properly oriented towards the sun. By trapping concentrated beam radiation, however, other systems produce higher water temperatures.

Sunwizard's Technical Information Manual, in its Table 1, provides an example of its horizontal tank model installed in the Los Angeles area. The energy output is calculated under eight different conditions of shading and adjacent white surfaces. The average output is 11.6 million Btu per year when delivering 120 gallons of water per day. The average delivery temperature under the conditions given therefore must be only 90°F.

The table following Sunwizard's Table 1 gives "Spa Energy Savings." A high-volume, low-temperature application such as spa heating seems well-suited to the design and performance of the Sunwizard. Although the delivery temperature would increase if less water were used in some other application, such as domestic water heating, the total energy delivered would be less, because of greater heat losses resulting at the higher temperatures.

Sunwizard's manual advises customers that if they demand normal water temperatures from their backup tanks their savings will be much reduced. Sunwizard recommends adjusting the backup water heater to the lowest setting suitable for bathing, 110 degrees F if possible. Sunwizard assumes that if the water setting is hotter, to serve automatic washers, the user normally dilutes it with cold water for bathing. In that case less water flows through the Sunwizard to absorb any available solar energy. In other words, the "plant capacity factor" is reduced when the delivery temperature for all water is boosted to the highest temperature needed for any single end use.

Sunwizard states that "dishwashers have their own heating element." While true for some dishwashers, others now operating or to be installed during the next 10 to 20 years without that feature would apparently cause lower solar savings because they need water

typically at 140°F. to clean and sanitize dishes properly, as do laundry washers, for the hot cycle used especially for white and infants' laundry.

In the SRCC test described under Sizing, hot water is drawn from a backup heater set at 120°F. Although the Sunwizard cannot deliver its maximum output at this temperature setting, the ECB believes that 120°F. is the lowest acceptable temperature for domestic hot water under the OII 42 program, and we accept these test results as valid after the adjustment discussed below.

Solar Water Heater Testing

An equitable method of testing and rating the energy output of solar water heaters calls for a controlled input of solar energy radiation. An indoor lamp array can repeatably simulate the intensity and angle of solar radiation with repeatable air temperatures and wind speeds, without the random interference of clouds, haze or precipitation.

The Solar Rating and Certification Corporation provides a testing and rating service for solar equipment. Its directors represent government and industry, and have adopted test standards developed through the consensus process with input from all parties.

The ECB needs a uniform solar system test method to fairly evaulate all applicants for eligibility. The Branch helped develop the rating method used by SRCC, and has adopted it and required the results of it from all applicants since October 1981.

Sunwizard Testing

The processing of Sunwizard's application for eligibility in OII 42 has been delayed for more than a year now because the applicant asked exemption from the ECB's uniform method of evaluating OII 42 exemption requests; namely, the SRCC system test.

Sunwizard contends that the SRCC system test produces little diffuse radiation such as that normally received by tank surfaces outdoors.

The ECB agrees with Sunwizard that the SRCC test radiation is almost entirely from the direction of the lamp (beam radiation), whereas outdoor radiation is only about two-thirds in beam form, directly from the sun, and one-third from all other parts of the sky (diffuse radiation).

From an energy standpoint, however, the ECB disagrees with Sunwizard. Its test results are comparable with others regardless of the low level of diffuse radiation used in the indoor test. The level of beam radiation is correspondingly increased in the test, and the lamps produce the total rated specific energy of 1,500 Btus per day.

Sunwizard also maintains that weak radiation available to it outdoors around sunrise and sunset is significant, and is absorbed by its system. That radiation is not simulated at all during the test. Other systems do not absorb energy at such low levels due to their optical and thermal threshold losses. The indoor and outdoor rating therefore would be the same for most systems, but would be greater outdoors for the Sunwizard.

The unique characteristics of the Sunwizard justify increasing its test output rating due to such low-intensity, off-angle radiation not simulated during the test. Sunwizard calculates that 12% more energy should be presented, and the ECB recommends giving Sunwizard credit for most of that, since the very weakest radiation will not be absorbed by a warm tank. We do not disagree and will adopt a 10% increase in the test output underlying Sunwizard's minimum eligible sizing for OII 42.

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 nonflat-plate, nonpumped (passive and innovative) systems such as the Sunwizard, the minimum number of systems needed to serve a dwelling for OII 42 eligibility may be more than one. That number is determined by the individual laboratory tests of energy output.

Sunwizard submitted the results of the required SRCC test for its horizontal, 120-gallon Model 120H. This test is a national standard, and certification based on it is required for the California solar tax credit and for OII 42 eligibility. The output of the 120H in a California climate was calculated from the results of that test as described in Appendix A.

The minimum eligible annual output of 101 therms per installation for a three-bedroom dwelling is developed in Appendix B, based on adopted OII 42 criteria.

The applicant's calculations indicate a 3% reduction in annual energy if the Model 120V (vertical tank) is used instead of a 120H (horizontal tank). Since this difference rounds to 0.0 Sunwizard units (systems), the ECB recommends that the sizing of Table 1 be applicable to either 120-gallon model. Sunwizard tanks of 55 gallon capacity should not be eligible because no test results were submitted.

Using calculations based on the test data, the ECB concludes that an annual average output of 8,000 Btu per day should be adopted for each Sunwizard unit installed under the OII 42 program. Units should be installed, as tested, without

TABLE 1

Minimum Sizing of Sunwizard Solar Water Heater Systems
Using 120H or 120V Collector Units

Number of Bedrooms	OII 42 Minimum Output Therms/Yr	Number of Collectors 29 Th/Yr Per Unit	Number of Collectors Minimum Eligible
1	33	1.1	1
2	68	2.3	2
3	101 a/	3.5	4
4	135	4.7	5
5	168	5.8	6
n over 5	33n	1.14 n	-

a/ See Appendix B for derivations.

b/ Multiple collectors to be installed in parallel for eligibility.

NOTES: Reflecting surfaces are not required for OII 42 eligibility.

Units must not be shaded at any time during the day or year.

Preferred orientation of the longitudinal axis of the 120H is North-South. Orientation is not an eligibility requirement if aesthetics dictate otherwise.

shading, but reflectors are not required either. This rating corresponds to 29 therms per unit per year. Therefore, four units would be needed, as shown in Table 1, to meet the annual load of a three-bedroom home under the OII 42 program.

The ECB notes that the output of successive ICS units is reduced when they are connected in series (the outlet of one leading to the inlet of the next). Therefore, multiple Sunwizard units need to be installed in parallel (the outlet of all units leading to the backup water heater). Piping connections must comply with the Installation Checklist Item No. 21 regarding an equal flow path length through all collectors.

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, 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 Sunwizard systems installed under OII 42 should be sized according to Table 1.

Monitoring

Sunwizard 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 it is possible for the statistical sample to include them. Sunwizard should be able to provide a list to the utilities on request, of the addresses of systems installed to meet the OII 42 requirements, to facilitate such monitoring.

Warranty

Sunwizard currently warrants its water heater to be free from defects in materials and workmanship and from any malfunction or failure to perform, under normal use and service, for ten years. The unit will be repaired or replaced by Sunwizard, Inc. without charge for parts, labor or transportation if any defect including damage by freezing occurs during that period, provided Sunwizard is still in business.

Sunwizard should provide at no charge the CalSEAL one-year bonded warranty to purchasers seeking OII 42 eligibility. It is available to contractors through the CalSEAL program, an industry organization in Sacramento.

Tax Credit Eligibility

Sunwizard provided documentation from SRCC that its equipment was tested and certified as of November 1982, which is one of the requirements for California solar tax credit eligibility.

Provision of the CalSEAL label will indicate that the entire installation also meets the requirements for the tax credit.

Disclaimer

Any reference by Sunwizard 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 endorses, 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

1. Sunwizard markets a 120-gallon passive solar water heater with cylindrical plastic glazing which is not automatically eligible in the OII 42 program.

2. Sunwizard applied for eligibility and exemption from freeze protection requirements in November 1981.

3. The ECB required Sunwizard to provide results from the solar water heater indoor test required for the state solar tax credit and provided by all other innovative system manufacturers who applied after October 1981.

4. Sunwizard provided the test results with technical material to support its position that the indoor test produces a lower output from the Sunwizard than an outdoor test.

5. Repeatable radiation levels are needed for a fair comparison of solar water heater performance.

6. Present test methods use direct beam radiation.

7. Test methods using controlled diffuse radiation have not been developed.

8. The cylindrical Sunwizard collects more diffuse radiation than do ICS devices and collectors with flat glazing.

9. The diffuse energy in outdoor radiation is included in the total beam energy of the indoor test.

10. The total rated solar energy of 1,500 Btu per day is presented in the SRCC indoor test.

11. The Sunwizard absorbs low intensity radiation not absorbed by other systems and not provided in the SRCC test.

12. The Sunwizard has less collector area per gallon of water stored than any system eligible under OII 42.

13. The effective area of any collector is increased by locating it near light-colored surfaces to reflect beam and diffuse radiation.

14. The Sunwizard has less storage tank insulation than any system eligible under OII 42.

15. Sunwizard provides a ten-year warranty.

16. Sunwizard units are used with conventional water heaters.

17. The Sunwizard produces relatively low temperature water.

18. Sunwizard's 55-gallon system test results were not submitted.

Conclusions

1. A single consensus test rating is the most fair and reasonable means of comparing solar systems.

2. No single test can equitably contrast every characteristic of every innovative solar water heater.

3. The unique characteristics of the Sunwizard justify increasing its test output by 10% due to low-intensity, off angle radiation not simulated during the test.

4. Sunwizard's test results are comparable to others' test results because the same amount of energy is presented in beam form and reflectors are not needed to collect it.

5. Sunwizard's freeze protection is adequate.

6. Sunwizard systems should be eligible only when the user agrees to maintain a backup water heater setting of 120 degrees F. or less.

7. Sunwizard systems should be sized according to Table 1.

8. Sunwizard's 55-gallon systems should not be eligible.

9. Sunwizard should not install its units on any roof that is not capable of supporting the added weight. Sunwizard and its dealers should secure all necessary building permits for any installation.

10. Sunwizard should assure that in no case is a residence converted from gas water heating to electric water heating.

11. Sunwizard systems should be included in the monitoring program sample.

12. Sunwizard should provide the locations of all systems installed to OII 42 requirements to any participating utility on request.

13. This order should be effective immediately in order to permit Sunwizard to compete at the earliest possible time.

O R D E R

IT IS ORDERED that:

1. Sunwizard installations are eligible for OII 42 rebates when installed in compliance with all preceding Conclusions regardless of the date of installation.

2. Except as granted and provided herein, Sunwizard 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 MAR 16 1983, at San Francisco, California.

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

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

Joseph E. Bodovitz, Executive Director

APPENDIX A

Method Used to Process the Sunwizard Solar Water Heater Test Results

The minimum number of 120-gallon units to be installed per bedroom follows from the results of Sunwizard's SRCC-OG200 test by comparing the results against the 101-therm minimum criterion for a three-bedroom dwelling (Appendix B). The SRCC-OG200 test conditions do not reflect California values for available solar radiation and other variables. Therefore, the annual solar output under California conditions was determined by modifying the results as follows:

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, is applying its own approach uniformly to all applicants.

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 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. Theoretically it is less than this ratio.

Hot Water Usage

The effect of varying the second factor, the amount and timing of hot water drawn per day, is more difficult to quantify; however, the direction of this effect is clear. Reducing the volume from approximately 95 gallons per day during the test, to 60 gallons per day (for a three-bedroom dwelling under OII 42),

will reduce the net solar energy delivered.a/ (Shifting the timing of usage from evening towards morning also reduces the energy delivered, but 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 necessary accuracy depends on the number of other factors considered and on the quality of related data used. In the absence of a recognized method to calculate this factor, ECB staff believes that (1500/1700) is a reasonable value. Therefore, the output under OII 42 conditions of radiation and water usage is unchanged from the SRCC-OG200 value.

Overnight Heat Losses

All solar systems having outdoor storage tanks lose heat overnight. This group of principally passive (nonpumped) systems includes thermosyphon systems (tanks with flat-plate collectors) and ICS systems (integral collector-storage units having only a tank). The importance of this factor in the net solar energy delivered by a solar system is recognized in the SRCC-OG200 test process by a separate 16-hour temperature decay test conducted to determine the rate of heat loss under known test conditions. The amount of energy actually lost in any given location depends on the annual average nighttime temperature. Therefore no night heat losses are deducted from the SRCC-OG200 energy output as reported.

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a/ For persons familiar with the development of the OII 42 eligibility criteria, this "net solar energy delivered" (in Btus for example) should be distinguished from the "solar fraction" (in %). While net solar Btus would fall in this case, 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%.)

APPENDIX A

The method of determining the amount of energy lost due to overnight temperature decay, using local temperatures and SRCC heat loss rate data, will eventually be part of a consensus standard to modify the SRCC test result. An engineering estimate of that loss is described here.

Two items of test data are used. One is the temperature of the solar heated water remaining in the solar system after the standard test day. The difference between this temperature and the annual average overnight temperature in California population centers, is used as the factor driving the overnight heat loss.

The second item is the rate of heat loss. The two rates used in this analysis reflect overnight conditions of zero wind during the three days of solar simulation and a known wind during the separate heat loss test.

These two data items are combined with an exponential heat loss model to produce an overnight heat loss which is deducted from the SRCC rating as reported.

APPENDIX B
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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

APPENDIX B
Page 2 of 3

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
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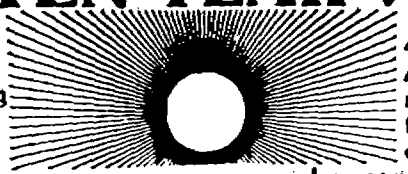
OII 42 Program Assumptions

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

SUNWIZARD SOLAR HOT WATER SYSTEM
FULL TEN YEAR WARRANTY



1. Scope of Coverage

This warranty applies to the new **Sunwizard** water heater purchased by a retail buyer, as a whole including all its parts, and extends to the first retail buyer and all **subsequent owners.**

2. Full Ten-Year Warranty

The **Sunwizard** is warranted to be free from defects in material and workmanship and from any malfunction, or failure to perform, under normal use and service, for ten years from the date of delivery to the purchaser.

A. Repairs. If a defect or malfunction including freeze damage occurs, the **Sunwizard** will be repaired or replaced within a reasonable time, without charge for parts, labor, or transportation within the United States of America. The warranty will be extended in duration by the period of nonfunctioning.

B. Refund Option. If a defect cannot be repaired after a reasonable number of attempts, the buyer may elect a refund rather than a replacement. The item to be replaced must be made available in exchange for the replacement or refund. A replacement will have a new warranty dating from its delivery to the purchaser.

3. Exclusions

A. Conditions resulting from a defect in a component which is not part of the **Sunwizard.**

B. Conditions resulting from not providing a temperature/pressure relief valve, or from any other violation of requisite local codes and ordinances

C. Conditions resulting from any misuse, abuse, negligence, accident (including fire, flood, earthquake, vandalism, severe sandblasting), disassembly, or alteration.

D. Conditions resulting from operation with any fluid besides potable water. Conditions that may occur in the normal operation of the **Sunwizard** shall not be invoked to reduce or defeat this warranty's coverage.

4. Other Rights and Remedies

A. Consequential and Incidental Damages. The manufacturer shall be liable for (1) Consequential damages to the **Sunwizard** from improperly functioning component, and (2) Incidental expenses incurred to repair or replace, as necessary, any component injured by a breach of warranty. This warranty confers specific rights to the retail purchaser to consequential and incidental damages, and there may be specific rights varying from state to state.

B. No Other Express Warranties. Unless otherwise explicitly agreed in writing, these are the only warranties on the **Sunwizard**, and no other obligation or liability is assumed or authorized to be assumed by anyone else.

C. Implied Warranties. This warranty confers specific legal rights, and there may be other rights varying from state to state, including, in California, implied warranties of merchantability and, in certain instances of fitness for a particular purpose.

D. Right to Arbitration. Any dispute between the retail purchaser and the manufacturer of the **Sunwizard** may, at the option of the purchaser, be resolved in California according to the rules of the American Arbitration Association.

E. Right to Indemnity. The manufacturer will fully indemnity a licensed contractor who installs the **Sunwizard** and gives a written warranty as required by the California solar tax credit regulations, in the amount of any liability to the buyer for a breach that is also a breach of the manufacturer's warranty.

5. Endorsement

This **Sunwizard** and its accompanying warranty complies with the tax credit regulations of the California Energy Commission.

6. Claims

For any warranty claims, contact Sunwizard, Inc., 1424 W. 259th St., Harbor City, CA 90710. (213) 539 8590

Serial # _____

Date of Sale _____

Contractors Initial Installation Date _____

Contractor _____

SUNWIZARD, INC.
1424 West 259th St.
Harbor City, California 90710
(213) 539-8590

13. The effective area of any collector is increased by locating it near light-colored surfaces to reflect beam and diffuse radiation.

14. The Sunwizard has less storage tank insulation than any system eligible under OII 42.

15. Sunwizard provides a ten-year warranty.

16. Sunwizard units are used with conventional water heaters.

17. The Sunwizard produces relatively low temperature water.

18. Sunwizard's 55-gallon system test results were not submitted.

Conclusions

1. A single consensus test rating is the most fair and reasonable means of comparing solar systems.

2. No single test can equitably contrast every characteristic of every innovative solar water heater.

3. The unique characteristics of the Sunwizard justify increasing its test output by 10% due to low-intensity, off angle radiation not simulated during the test.

4. Sunwizard's test results are comparable to others' test results because the same amount of energy is presented in beam form and reflectors are not needed to collect it.

5. Sunwizard's freeze protection is adequate.

6. Sunwizard systems should be eligible only when the user agrees to maintain a backup water heater setting of 120 degrees F. or less.