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ORIGINAL

Decision 82 09 018 SEP 8 1982

BEFORE THE PUBLIC UTILITIES COMMISSION OF THE STATE OF CALIFORNIA

Application of Cornell Energy, Inc.) for exemption from certain sizing and checklist requirements of Decision Nos. 92251, 92501 and 92769.	Application 82-03-112 (Filed March 30, 1982)

OPINION ON SOLAR WATER HEATER ELIGIBILITY

Cornell Energy, Inc. (Cornell) manufactures domestic solar water heater systems composed of one or more of its Cornell 360 collector-storage devices. These systems have not been eligible under the Commission's OII 42 program because no method was available until recently to estimate the energy savings produced by them. Cornell requests that the Commission find its Cornell 360 systems eligible. Cornell also requests that it be exempted from Checklist Item B.7.c. requiring freeze protection, arguing that all Cornell systems are inherently freeze-proof.

By this decision, the Commission finds Cornell systems eligible under the sizing and other conditions specified. The Commission also recognizes Cornell's adequate freeze protection under the conditions specified.

Applicant's Background

Cornell has manufactured the same basic unit in Tucson, Arizona since 1980. It consists of a 32-gallon horizontal tank within an insulated fiberglass box. The tank absorbs heat from sunlight passing through an outer glass cover and two inner plastic covers of 18 sq. ft. gross area. Normally several units are connected as a pre-heater so that incoming water flows from one unit to the next, and from the last into the customer's existing conventional water heater. No electrical pumps are used.

Cornell has sold over 1,000 of these units, primarily in the Southwest. An installation was tested in the Northeast through the winter of 1982-83 without freezing. Based on this experience, Cornell has extended its 20-year Warranty to cover freezing down to minus 10 degrees F.

Cornell hopes to increase its California sales under the OII 42 program, and expects that its dealers will continue to price the systems competitively depending on system size (the number of Cornell 360 units).

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.

Cornell formally filed its application on March 30, 1982. It was docketed as No. 82-03-112. On June 3, 1982, the performance test results were provided, enabling the Energy Conservation Branch (ECB) staff to begin sizing calculations.

In the following sections, Cornell's request is discussed and the minimum eligible system sizing is developed.

Freeze Protection

Cornell requests an:

"exemption or staff waiver from the requirements reflected in the (Installation) Checklist as revised and adopted June 2, 1981:

(The) Checklist (states at) Appendix B, (paragraph) 7.c.:

Has the contractor certified that: The system complies with program freeze protection requirements or has obtained a staff waiver?"

The intent of this item is to recognize that a single freeze could cause such extensive damage to some solar water heater components that it would significantly reduce their effectiveness. Throughout the state of California a number of periods of freezing weather are assumed to occur during the expected 20-year life of OII 42 solar systems.

Cornell's rationale for requesting an exemption is that its unit will not freeze in air temperatures as low as minus 10 degrees F. This claim is based on three pieces of evidence which the ECB accepts; namely, conservative engineering calculations; the use of a low heat loss surface coating not considered in the calculations; and lastly Cornell's statement that in about 1,000 installations no Cornell 360 has ever frozen.

The ECB interprets Item B.7.c. to be a performance specification, not a prescriptive one. Specific freeze protection methods such as use of antifreeze heat transfer fluid are needed with some systems, notably those using flat-plate collectors. But for an integral collector-storage (ICS) unit, such as the Cornell 360, the collectors store heat internally, and are usually insulated well enough to prevent freezing even after several consecutive freezing days with little sun.

Because the Cornell system meets the performance standard, no exemption to this requirement is necessary. However, the installer must strictly comply with Cornell's installation instructions in order for the owner to qualify under the OII 42 program. Those instructions clearly state that insulation must completely cover all outdooor piping, fittings and valve bodies, because even small gaps will greatly increase nighttime heat loss, thereby reducing efficiency as well as the protection against frozen pipes.

Sizing

All solar water heaters eligible under the OII 42 program are subject to minimum collector area and solar-heated storage volume requirements. For ICS devices such as Cornell's, which are connected to a separate conventional water heater, the minimum solar storage is 25 gallons per bedroom in single family dwellings (20 gallons per bedroom in multi-family dwellings).

The minimum collector area is determined on a case-by-case basis depending on test results. The annual solar energy output can be estimated from the test data. The minimum solar

output for eligibility is 101 therms per year for a three-bedroom dwelling. (This figure is developed, for reference, in Appendix B, based on adopted OII 42 criteria.)

Cornell has submitted the results of a solar water heater performance test known as SRCC-OG200. This test was recently developed as a national standard, and the certification obtainable following this test was recently adopted by the California Energy Commission (CEC) as a requirement for the California solar tax credit after 1982. The output of the Cornell solar system in therms per year can be calculated from the results of the SRCC-OG200 test in a manner described in Appendix A to this decision.

Although the ECB used these results for sizing, we note that certification by the Solar Rating and Certification Corporation (SRCC) has been delayed. Until this Commission receives the SRCC certification sheet, the OII 42 eligibility granted by this decision must be restricted to systems installed before 1983. The applicant should submit the evidence of certification to the ECB, which in turn will inform participating utilities of the extension of OII 42 eligibility into 1983.

Based on these test data and calculations, the ECB recommends that an annual average output per day of 8,900 Btu be adopted for each Cornell 360 ICS unit which is properly installed in California under the OII 42 program. This output corresponds to 32.5 therms per unit per year. Therefore, three collectors (3.1 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 provides more than the minimum 25 gallons of solar storage per bedroom.

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, we could restrict the sizing requirements for multiple units to a maximum of two units in series since the test results are for two units in series. Additional pairs then would need to be in parallel (the outlet of all pairs leading to the same manifold).

But three units in series produce slightly higher water temperatures. For this reason, plumbing arrangements of the minimum required number of units may be made with a maximum of three Cornell 360 ICS units connected in series. The necessary parallel connections made thereafter must comply with the Installation Checklist Item No. 21 regarding an equal flow path

length through all collectors. A longer summer season of solar-only operation with the backup water heater turned off will then be possible while still making suitably hot water available for use.

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

Monitoring

Cornell 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.

TABLE 1

Minimum Sizing of Cornell Solar Water Heater Systems
Using Cornell 360 Collector Units

Number of Bedrooms	OII 42 Minimum Output Therms/Yr.	Number of Collectors (Sq. Ft.) b/
1	33	1 (18)
2	68	2 (36)
3	101 a/	3 (54)
4	135	4 (72)
n over 4	33n	n (18n)

a/ See Appendix B for derivations.

b/ A maximum of three (3) collectors to be installed in series.

ECB recommends that Cornell be allowed to participate in the Demonstration Solar Financing Program based on the following conditions (as used below, Cornell refers to Cornell and/or its installers):

a. Cornell's warranty will cover system repair or replacement due to damage by freezing wherever installed.

b. Cornell will assure that in no case is a residence converted from gas water heating to electric water heating.

c. Cornell will instruct customers to turn off pilot lights on gas backup water heaters during summer months.

d. Cornell will instruct customers to turn off electric backup water heaters during summer months.

e. Cornell will recommend installation of time clocks on all electric backup water heaters.

Cornell and its installers will meet the minimum quality and sizing criteria as contained in D.92251, 92501, and 92769 and all subsequent decisions and will meet the current standards of the California Energy Commission's Solar Energy Tax Credit Guidelines when installing Cornell systems. Cornell and its installers will size systems according to the Table on Page 9.

Any reference by Cornell 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 of Fact

1. Cornell manufactures an integral collector-storage (ICS) solar water heater sold as the Cornell 360.

2. ICS solar systems are not eligible in the OII 42 program without a showing of quantifiable energy savings.

3. Cornell submitted results of the SRCC-OG200 systems test without certification.

4. SRCC-OG200 results may be converted to estimate system performance under California conditions.

5. Overnight heat losses significantly decrease net solar energy delivered by a system.

6. ECB staff estimates that one Cornell 360 ICS unit will deliver 8,900 Btus per day on an annual average basis or 32.5 therms per year under California conditions.

7. Little increase in delivered solar energy is gained by connecting more than three (3) units in series.

8. ICS collectors are inherently freeze-protected under most California conditions.

9. Cornell offers a standard 20-year warranty covering damage due to freezing at temperatures as low as minus 10 degrees F.

10. The expense of a public hearing is not justified for this application.

Conclusions of Law

1. Cornell 360 solar water heater systems should be eligible to participate in the OII 42 demonstration solar water heater program under the following conditions.

2. Cornell 360 solar water heaters should be installed according to manufacturer's instructions in order to meet the program freeze protection requirements.

3. Cornell 360 solar water heaters should be sized according to Table 1.

4. OII 42 eligibility should be restricted to systems installed before 1983 until SRCC certification is received by the ECB.

5. This application should be processed ex parte.

6. The following order should be effective the date of signature in order to allow participation in the solar financiing program and competition with other solar manufacturers at the earliest time.

O R D E R

1. Cornell solar water heating systems of multiple Cornell 360 integral collector-storage units are eligible to participate in the OII 42 Demonstration Solar Financing Program under the sizing and freeze protection conditions summarized in the Conclusions of Law, provided that these systems are installed in strict compliance with the manufacturer's installation instructions and specifications.

2. The ECB is authorized upon receipt of SRCC certification to extend the OII 42 eligibility granted by this decision to Cornell systems installed after 1982.

3. Except as granted and provided, Cornell and its installers shall adhere to all other currently effective requirements set forth in D.92251, 92501 and 92769 or subsequent orders in this proceeding including the Disclaimer of Product Endorsement.

This order is effective today.

Dated SEP 8 1982, at San Francisco, California.

JOHN E. BRYSON
President
RICHARD D. GRAVELLE
LEONARD M. GRIMES, JR.
VICTOR CALVO
PRISCILLA C. GREW
Commissioners

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

Joseph E. Bodovitz, Executive Director

Method Used to Process the Cornell Solar Water Heater Test Results

The minimum number of Cornell 360 units per bedroom served follows from the results of Cornell's SRCC-OG200 test by comparing them 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 annual solar output under California conditions was determined from the SRCC-OG200 results by using the following method.

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 ICS 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 for ICS systems. 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 any data used, and on the assumptions made. 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/ 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%.

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. The rate used in this analysis should be greater than the rate determined in the SRCC test because the test value was measured under conditions of zero wind.

These two data items, combined with an exponential heat loss model, produce for Cornell an overnight heat loss of 11% of the net solar energy delivered under the SRCC rating as reported.

OII 42 Program Assumptions

Solar Water Preheater Systems With Gas 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	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

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

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