NB

Decision No. 53657

ORIGINAL

BEFORE THE PUBLIC UTILITIES COMMISSION OF THE STATE OF CALIFORNIA

In the Matter of the Application of)
CALIFORNIA ELECTRIC POWER COMPANY)
for authority to add a power-factor-) Application No. 37473
adjustment clause to its Rate)
Schedules A-1, A-2, A-3, P-2 and R.)

Donald J. Carman, for applicant.
California Manufacturers Association by Edwin Fleischmann; San Diego Gas & Electric Company by John H. Woy; Southwestern Portland Cement Company by Felix S. McGinnis; Pacific Coast Borax Company by E. D. Lemmon; Department of Defense and other executive agencies of the United States by Harold Gold and Clyde F. Carroll, interested parties.
L. S. Patterson, for the Commission staff.

O P I N I O N

Applicant's Request

California Electric Power Company, a public utility serving portions of the Counties of Mono, Inyo, Kern, San Bernardino and Riverside in the State of California and of the Counties of Nye and Esmeralda in the State of Nevada, filed the above-entitled application on November 8, 1955, requesting an order of the Commission approving a proposed power-factor-adjustment clause and authorizing the addition of such clause to the following rate schedules:

Schedule Number	Type of Service	Territory
A-1	General Service	Rate Zone C, excluding San Bernardino
A-2	General Service	Rate Zones N, R and S
A-3	General Service	Rate Zone M
P-2	Large Installation Power	Entire Territory, Excluding San Bernardino
R	Resale	Entire Territory Served

Proposed Power-Factor Clause

Applicant's proposed power-factor clause, as set forth in Exhibit No. 1, is:

> For any customer whose demand exceeds 250 kilowatts for three consecutive months, a reactive kilovolt-ampere demand meter will be installed as soon as practicable. Thereafter, until the billing demand has been less than 200 kw for 12 consecutive months, the billing charge will be adjusted each month for power factor, as indicated by the ratio of reactive kilovolt-amperes (kvar) to kilowatts (kw) as follows:
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> When the highest kva of reactive demand, measured over the demand interval as indicated above, exceeds 60 per cent of the highest measured kw demand for the same billing period, an additional charge will be made in the amount of 25 cents per kva of such excess reactive demand. When such reactive demand is less than 60 per cent of the kw demand, a discount will be allowed in the amount of 10 cents per kva of reactive demand by which the measured reactive demand is less than 60 per cent of the kw demand provided, however, that in no case shall the discount be applied to an amount of reactive kva demand greater than 1/5 of the kw demand.
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> Demands in kw and kvar shall be calculated to the nearest 1/10 (0.1) unit. A ratchet device will be installed in the reactive demand meter to prevent its reverse operation on leading power factor.

Public Hearing

After due notice, a public hearing was held on this application before Examiner M. W. Edwards on May 23, 1956 in San Bernardino. At the hearing applicant presented one exhibit and testimony by two witnesses in support of the application. Because of the technical nature of this proposal, the Commission staff, represented by an electrical engineer, had made a study of applicant's request prior to the hearing and presented the results of its study and recommendations through an exhibit and the testimony of an associate utilities engineer. Counsel for the United States Government and a representative of the California Manufacturers Association cross-examined the witnesses and presented statements of position for the Commission to consider in deciding this matter.

A technical analysis of the problem was included in the original application as Exhibit B; however, the engineer who had

prepared this original analysis had left the employ of the company and was not available to testify at the hearing. In preparing other witnesses to testify, applicant had made some additional tests and found it desirable to revise certain tables appearing in Exhibit B. These revised tables are set forth in Exhibit No. 1. Applicant made a motion to amend the application to conform to proof adduced at the hearing. Such motion is granted.

Power-Factor Problem

Most electrical power equipment has electromagnetic circuits and when excited with alternating current, a certain amount of current is required to magnetize and demagnetize the iron on each reversal of the direction of current flow which occurs twice each cycle. This current produces no work and is called the magnetizing current or reactive component. Thus, the total current is considered as consisting of two components, one the working or active current and the other that required to produce magnetic field or reactive current. The working current is in phase with the voltage and the magnetizing current lags 90 degrees behind the voltage.

When the alternations of the current coincide in time with those of the impressed voltage the current and voltage are said to be "in phase" and the power factor is 100 per cent or 1.0 or unity. When the alternations of the current wave fall behind those of the voltage the current is said to be "lagging" and a lagging power factor is produced. When the alternations of the current wave precede those of the voltage the current is said to be "leading" and a leading power factor is produced. Lagging power factor results from the utilization of most power equipment, except synchronous motors. Leading power factor results when circuits contain electrostatic capacity or capacitance. Lagging power factor can be corrected by installing fixed capacitors or using synchronous condensors or motors. Also the

capacitance of long transmission lines tends to correct for the lagging power factor of customers' load.

Applicant's Position

Applicant is in the position of having to supply both the active component and the reactive component of customers' loads. Up to the year 1952, the lagging power factors of customers' loads were not of serious effect because the capacitance of applicant's several long transmission lines largely offset the effects of these loads. Since 1952, because of load growth, the applicant has found it necessary to add static capacitors to its system. In 1954 applicant added 24,450 kva of capacitors to its system. For 1955 and 1956 applicant has budgeted an additional 23,715 kva of capacitors.

With low-power-factor loading a utility's generating transmission and distribution system is subjected to increased losses and poor voltage regulation, and generators, transformers and lines have their useful capacities reduced, thereby restricting the revenue-producing load which the system is able to carry. Because many of these capacitor installations had to be made for the purpose of correcting the poor-power-factor conditions created solely by individual customers, applicant represents that there now is need for a power-factor clause not only to induce present customers to correct or improve their power factors but also to encourage future customers to utilize high-power-factor equipment.

Applicant's basic position is that the proposed power-factor clause will eliminate certain inequities resulting from the lack of a power-factor-adjustment clause in the five schedules enumerated. Applicant states that power-factor discrimination now exists on its system because no compensation is given to those customers whose equipment is operated at a power factor in excess of the class average power factor and no penalty is imposed on those customers who operate at a power factor less than average without

limitation. Applicant is not seeking a rate increase as the present level of rates covers all costs, including capacitor installation costs, which have been in the past distributed equally among all customers regardless of the individual reactive power requirements. The application of the proposed clause might result in somewhat higher charges for some customers and somewhat lower charges for other customers. The over-all result might be a revenue increase which applicant considers to be insignificant after allowing for the added cost of reactive power metering installations.

Basis of Proposed Charges

For the purpose of determining the level of the discount allowance of 10 cents per kva when the measured reactive demand is less than 60 per cent of the kw demand, applicant assumed a capital cost of $7.50 per kva of capacitor and a monthly fixed charge at the rate of 1½ per cent or at the rate of 15 per cent for annual fixed charge. This computes to 9.37 cents per kva per month which applicant rounded to 10 cents. For the penalty rate of 25 cents per kva applicant assumed a capital cost of $10 per kva to the customer and a monthly fixed charge at the rate of nearly 2 per cent on the basis of an annual rate of 23 per cent. This computes to 19.17 cents per kva per month which applicant increased to 25 cents to induce the customer to install his own capacitors rather than to pay the penalty and allow the applicant to install the capacitors or furnish the reactive current. The various components of these annual fixed charge rates are:

	Company's Estimated Costs	Customers' Estimated Costs
Return	6%	11%
Depreciation	3	5
Taxes: Income	3	3
Other	2	2
Operation and Maintenance	1	2
Total	15	23

The staff assumed a cost of $12 per kva for capacitors and using a 1½ per cent monthly fixed charge rate derived a rate of 15 cents per kva per month as a more equitable rate to use as a discount figure. Also, the staff assumed this same rate as more equitable than the 25-cent penalty rate for low-power factor. Applicant's witness admitted that present-day costs for capacitors are greater than the average costs used in the study and that unswitched capacitor installations currently are in the range of 14 to 17 cents per kva per month and switched capacitors currently are in the range of 15 to 17 cents.

The record indicates that three other large utilities[1] in the state have power-factor clauses that allow discounts or provide penalties based on kvar. Edison's rates are 20 cents per kvar for discounts or penalties. San Diego's rate is 10 cents per kvar and SMUD's rate is 25 cents per kvar for penalties, neither one allowing any discount for power factors above the pivot point.

Pivot Point

The pivot point proposed by applicant was 85.75 per cent power-factor lagging and its clause is so designed as to provide discounts above 85.75 per cent up to 93 per cent power factor and penalties below 85.75 per cent power factor. Edison uses 70.70 per cent power factor as the pivot point, San Diego uses 80 per cent and SMUD uses 85.75 per cent. Applicant justified its use of 85.75 per cent as the pivot point on the basis that this is the approximate present average power factor of the customers that would be affected by the proposed clause based on its sample tests.

1 Southern California Edison Company (referred to as Edison), San Diego Gas & Electric Company (referred to as San Diego), Sacramento Municipal Utility District (referred to as SMUD).

Power-Factor Range

Applicant proposed a maximum power factor of 93 per cent on which to base discounts and did not desire to go as high as 100 per cent because of the effect it might have on system stability at light load. In view of the capacity effect of its several long transmission lines and the age of its hydro units, one of applicant's witnesses could foresee operating difficulties if customers were encouraged to install capacitors to improve their peak-load power factor to a point greater than 93 per cent. It was proposed that the applicant's experience of operating under a power-factor clause with a 93 per cent upper limit could be submitted to the Commission for periodic review so that increase to a higher upper limit could be authorized later if study indicated such action to be desirable.

No limit or stopper point was suggested for the minimum point other than zero power factor. No lower limit appears necessary as an extremely low power factor would be an unusual situation and there would be sufficient economic gain under either a 15- or 25-cent per kvar penalty to warrant correction up to 80 or 85 per cent power factor.

Minimum Load Size

Applicant suggested 250 kw as the minimum load which will be affected by the proposed power-factor clause. The reason given for not going to a lower load was that the cost of the special reactive current meter was such that the power factor savings to applicant would not offset the cost of the metering equipment. The staff did not take exception to this point but showed that for certain other utilities in the State this minimum point was as low as 100 kw in San Diego and 50 hp in Needles.

Revenue Effects

Applicant's study showed that if no customers correct their power factor, its gross revenue would increase by $1,723.50 per month

and that if all customers over 250 kw in size correct to 93 per cent power factor its gross revenues would decrease by $1,648.60 per month. To arrive at net figures a monthly cost of $220.50 for 42 special metering installations should be deducted. Hence the net revenue effect of applicant's proposal would fall in the range of $1,503 gain to $1,869.10 decrease. The staff pointed out that the net decrease would be less than shown above if applicant would evaluate the system loss saving and saving in system capacity resulting from customers' correcting their own power factors.

Staff Recommendations

After analyzing the application and studying the matter, the staff made the following recommendations:

a. The power-factor-adjustment clause should not be used at this time to compensate the applicant for providing kvar facilities, as allowances for these facilities have already been made in the basic design of the tariffs;

b. A power-factor-adjustment clause is highly desirable to eliminate inequities in billings between high and low power-factor customers;

c. Class average power factor should be used as the pivot point;

d. Penalties, as well as discounts, should be based on the cost to the applicant of installing power-factor-corrective equipment.

e. Discounts should be applied for power factors up to the practical limit for the installation of capacitors.

The staff also recommended a revision of the power-factor clause to read as follows:

> For any customer whose demand exceeds 250 kw for three consecutive months, a reactive kilovolt-ampere demand meter will be installed as soon as practicable. Thereafter, until the billing demand has been less than 200 kw for 12 consecutive months, the billing charge will be adjusted each month for power factor, as follows:
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> > The monthly charges will be decreased by 9 cents for each kilowatt of measured maximum demand and increased by 15 cents for

each kilovar of reactive demand. In no case will the kilovars used for the adjustment be less than 40 per cent of the number of kw. Additional charges computed as above will, in no case, be less than 75 per cent of the maximum of such additional charges established in the preceding 11 months.

Demands in kw and reactive demand in kvar shall be calculated to the nearest one tenth (0.1 unit). A ratchet device will be installed in the reactive demand meter to prevent its reverse operation on leading power factor.

The staff's position was that the discount and penalty amounts should be approximately equal and should be based on the applicant's costs. The staff did not desire a penalty charge so high as to encourage customers to install unswitched capacitors which, at light loading periods, could conceivably cause portions of the utility system to operate at leading power factor, creating serious operating problems.

Position of California Manufacturers Association

The California Manufacturers Association did not oppose a power-factor clause in a rate schedule if it properly reflects the costs to the utility of correcting the power factor to the average of the other classes of customers. The Association pointed out that more information is needed to determine the exact effects of the proposal by the applicant and of the recommendation of the staff, but did not desire to put the applicant to large expense for additional tests. The additional data desired by the Association relates to the diversity of reactive demands, whereas applicant's proposal is to base the power factor on the maximum kw and kvar demands without regard to their relative time of occurrence in any one month.

Position of the United States Government

Counsel for the government expressed a desire for a reasonable power-factor clause, but stated that the penalty and bonus should be on an equal basis. He foresaw unreasonable penalty charges

in some cases due to using indicating instruments, and recommended that the kvar demand for each customer be determined by computing the monthly ratio of the kilovar-hours to the kilowatt-hours and applying this factor to the customers' maximum kw demand. He suggested that the Commission only issue an interim decision, effective upon installation of suitable metering equipment by the applicant, and that data be compiled over a period of at least six months before deciding upon a proper pivot point to incorporate in the power-factor clause in the final decision.

Findings and Conclusions

After considering the record in this matter it is the Commission's finding and conclusion that a power-factor clause should be authorized for Schedules Nos. A-1, A-2, A-3, P-2 and R, but that the evidence is not conclusive as to the proper level of the charges and the method of metering. One main point of difference between the staff and the applicant was whether or not the customer should be induced to install the capacitors up to 85 per cent power-factor correction, by assessing a high penalty charge. The charge of 25 cents per kva proposed by applicant would exceed applicant's cost of installing capacitors by 8 to 11 cents per kva. The Commission's conclusion on this point is that the penalty charged should approximate the applicant's cost of installing capacitors which ranges from 14 to 17 cents per kva. Moreover, on this same point, the Commission concludes that from an operating standpoint on the particular system of applicant, it would be preferable for capacitors to be installed which would be under control of the utility. In view of these conclusions, a high penalty rate that might encourage customers to install capacitors, particularly nonswitched capacitors, or which would return to the utility greater revenues than required to correct the low power factor, will not be authorized. A uniform rate of

15 cents per kvar, credit or penalty, will be authorized. Such a uniform rate also has the advantage that the over-all revenue changes will be held to a minimum.

Credit for power-factor correction will not go beyond the level of approximately 93 per cent as proposed by the applicant and 85.75 per cent will be adopted as the pivot point. The applicant's proposed method of using indicating meters will be adopted. However, it is suggested that also the monthly kilovar-hours be measured. Since the California Manufacturers Association and the United States Government both have made suggestions indicating that more power-factor information should be available, the order will provide for submission of a report covering applicant's first year of operation under the power-factor clause herein ordered.

The Commission finds that the increases in rates and charges authorized herein are justified and that present rates, in so far as they differ from those herein prescribed, for the future are unjust and unreasonable.

O R D E R

California Electric Power Company having applied to this Commission for authority to add a power-factor clause to certain of its rate schedules, a public hearing having been held, the matter having been submitted and now being ready for decision; therefore,

IT IS HEREBY ORDERED that applicant is authorized to insert a power-factor clause in rate Schedules A-1, A-2, A-3, P-2 and R subject to the following conditions:

1. A uniform charge or discount of 15 cents per kva of reactive demand in lieu of the 25-cent charge and 10-cent discount as proposed by applicant;

2. The wording and other conditions of the clause shall substantially conform to that which the staff has proposed in Exhibit No. 2, or to the

alternative wording read into the record by the staff witness which was patterned after the applicant's proposal, whichever in applicant's judgment is the most appropriate;

3. Revised rate tariffs with such clause as is chosen by applicant shall be filed in quadruplicate with this Commission after the effective date of this order, in conformity with General Order No. 96, and after not less than five days' notice to the Commission and to the public to make said revised rates with power-factor clauses effective for service rendered on and after October 1, 1956;

4. Within 90 days after a full year's operation under the power-factor clause herein ordered applicant shall submit a report and serve copies of such report upon all parties of record herein setting forth power-factor data obtained during that year. The report should be in sufficient detail to permit an examination of the following items:

   a. Relation of pivot point to class power factor;

   b. Appropriateness of 93 per cent as the basis for maximum power-factor discount;

   c. Relation on a sampling basis of customers' non-simultaneous power factor, peak kw power factor and average power factor;

   d. Effect of computing power-factor adjustment on basis of kilovar-hours and kilowatt-hours in lieu of indicating meter basis.

   Such report shall contain applicant's comments as to the appropriateness of the existing clause in view of the data collected and recommendations for any changes.

The effective date of this order shall be twenty days after the date hereof.

Dated at Los Angeles, California, this 29th day of August, 1956.

President

Commissioners