# POWER FACTOR CHARGE

WHO PAYS IT  Larger commercial and industrial customers

PURPOSE To collect costs of serving reactive load and to encourage customers to install power factor correction.

WHY CHARGE FOR POWER FACTOR

- Industry creates the vast majority of the reactive (generally lagging ie inductive) load from more and larger motors, more fluorescent lighting, transformer type welders, x ray units, arc furnaces, etc.
- Residential load is primarily resistive (true power or KVA) with nearly no reactive power (KVAR).  The few motors in a home (furnace, dryer, garbage grinder, etc) are very small (fractional horsepower) compared to those in industry (often up to hundreds of horsepower).  Residences are shifting to fluorescent lighting but this is inconsequential compared to the thousands used in industry and commercial. Residential meters do not detect reactive load.
- The utility must install larger equipment often with extra cooling capacity.  This increases cost to all consumers.
- Utilities install power factor correction capacitors in the switchyards and substations to reduce the effects of reactive load on “upstream equipment”. This increases cost to all consumers.
- Reactive load will affect system voltage.  Capacitors and special voltage regulating transformers are installed to deal with this – at increased consumer cost.
- Bonneville Power and other suppliers to City Light charge City Light for power factor. Installing power factor correction capacitors reduces this cost for all consumers.

Currently City Light

- charges $0.0014 (0.14 cents) for each kilowatt of reactive power  (Kw Hr R) where the customer has a power factor of 0.97 lagging or more (.97 to .85).
- is not obligated to serve customers whose power factor is 0.85 or worse.  This is a common utility practice.
- Although the metering installed to measure reactive power will detect a leading power factor, City Light does not let them indicate leading power factor.  There is no charge for leading power factor and no rebate either.
- Pays Bonneville (BPA) about $25,000 per year in power factor charges.  This indicates that the power factor of the City Light system is very good and they have effective power factor correction installed to keep the overall system at near unity.

The attached charts show the effect of power factor and the costs to the consumer.
Suggested order of reading the charts in the attached Excel file
PF .85  --  PF .97  --  cost .85  --  cost  .97  ---

PROPOSAL

- Charge on an increasing basis for Power Factor.
- Charge $0.0004667 (.047 cents) per each Kw Hr R for increment 0.01 PF less than one for lagging power factor.
- Pay for leading power factor at the request of the customer. Few customers will be able to achieve a leading power factor.

Suggested order of reading the charts in the attached Excel file
Prop rate – prop cost

REASONS TO INCREASE THE CHARGE

- recoup the expenses of equipment needed to serve the reactive load (generally lagging).
- Increasing the charge proportional to worsening power factor places the cost on those who are the larger contributors.
- Encourage industrial and commercial operators to purchase equipment with a better power factor rating
- Encourage industrial and commercial operators to install power factor correction
- City Light is concerned that increasing the charge will hurt the smaller industrial / commercial business owner who is not able to afford the high cost components and changes to their equipment. City Light reported that their corrective capacitors in the substations were correcting the system at a favorable cost to these building owners. NOTE this statement is copied also in "reasons not to change" The issue can support either argument depending on perspective.

REASONS TO NOT INCREASE THE CHARGE

- Cost of Industrial product will increase resulting in increased consumer cost.
- Power factor is presently charged for reactive Kw Hrs. Adding a charge for worsening power factor is double charging
- Will require re programming of computers to allow for an increasing rate per increment of power factor
- Customer dissatisfaction
- Seattle City Light representatives reported they did not see any need to change the rate, they are breaking even
- City Light is concerned that increasing the charge will hurt the smaller industrial / commercial business owner who is not able to afford the high cost components and changes to their equipment. City Light reported that their corrective capacitors in the substations were correcting the system at a favorable cost to these building owners.

# LEADING POWER FACTOR PAYMENT

This may be done in one of two ways

- Remove the ratchet allow the meter to turn backwards in the case of a leading power factor. This will result in the leading power canceling out an equivalent amount of lagging power reducing the bill. This is similar to turning a car odometer backwards.
- Refund .047 cents x 50% for each increment of 0.01 PF leading. This may require modification of the meter to allow separate recording of leading and lagging power factors.

This is shown in attached Excel file chart “prop ch 3”.

PAYING FOR A LEADING POWER FACTOR

- Will encourage installation of power factor correction capacitors.
- will still be a reactive load for the transformer serving the customer (in the case where there is no inductive load in off hours) however it would serve to balance overall substation and system wide power factor.
- SAFETY ISSUE the tendancy will be to leave the capacitors connected in off hours and get a rebate. Linemen servicing equipment will have to contend with energized capacitors inside a building they have no access to. This will take some study by City Light engineering to protect linemen from arc flash (resulting from shorting energized capacitors) and or possible electrocution.
- may be a wasted effort, because there will be so few customers who can actually become a leading power factor load.
- City Light will need to remove the ratchet mechanism from each meter to allow recording of leading power factor. Labor has been estimated at one hour per meter.

# RECOMMENDATION

Leave the existing charge in place.
Let customers who are able to achieve a leading power factor request the change to their meter at their cost.
Defer the leading power factor rebate until the next rate change.

# BACKGROUND INFORMATION

This is included to explain the terms and concepts.
Three types of loads on Alternating Current electrical circuits are shown below.

| TYPE OF LOAD | POWER TERM | POWER FACTOR TERM | COMMONLY ENCOUNTERED |
|---|---|---|---|
| RESISTIVE | True Power Kw or KVA | Unity Power Factor | Heaters, incandescent light bulbs and as the work output of motors (shaft Horsepower) |
| INDUCTIVE | Reactive Power KVAR (inductive) | Lagging Power Factor | Generally occurs where the equipment consists of many windings: transformers, motor windings, fluorescent lighting ballasts. |
| CAPACITIVE | Reactive Power KVAR (capacitive) | Leading Power Factor | Single phase motors to cause a phase shift which results in a rotating magnetic field which makes the motor turn. Also commonly seen as a method to correct for inductive loads. |

- Inductance and capacitance oppose each other. If the power resulting from each is equal they cancel each other out and the net effect is zero reactive power (KVAR).
- Where capacitive power is greater than inductive power the net reactive load (KVAR) is capacitive and the power factor is leading.
- The reverse case (inductance greater than capacitance) results in a lagging power factor. This is the most common case in utility systems and most electrical systems.
- Power is measured in terms of True power KVA (resistive load only) and Reactive Power (KVAR).
- Power Factor is calculated using vector analysis and trig. Power Factor is also termed cosine theta which is the source of the numerical value ie .97 etc.
- for a Power Factor of 0.8 the ratio of KVA to KVAR (KVA divided by KVAR) is 1.25
- Inductive Reactive Power (lagging) is often termed magnetizing energy, does no real work, and creates unwanted heat in alternators, motors, transformers and other distribution equipment.

Utilities use several methods to bill for reactive load

- Demand charge adjusted for power factor. Measured demand (Kw) is multiplied by power factor standard and dividing by average power factor
- Demand charge adjusted for power factor. Measured demand (Kw) is increased by one percent for each .01 by which average power factor is less than standard.
- Power factor rate per KVAR Hr Power factor is charged at a rate per KVAR Hr where the power factor is below standard. This method is used by a minority of utilities. Seattle City Light and Puget Sound Energy are two.

To summarize

- the utility has to generate both types of power (True and Reactive).
- true power is what all power meters measure and what consumers pay for.
- Reactive power takes a special meter
- the Reactive Power portion is just wasted overhead.  No work can be done with it.