Electric power rates are structured to compensate the electric power supplier for energy (kilowatt-hours) consumed and for the electric power supplier's capital investment, upkeep, and replacement cost of power lines, transformers, power generating stations, and other equipment needed to supply electric energy to the customer's premises. For year-round and relatively uniform customer loads such as residential, the two charge factors are lumped together in the energy (kilowatt-hour) rate structure. For intermittent or seasonal loads such as irrigation, some electric power suppliers impose two charges—the regular energy or kilowatt-hour charge and either a hook-up or demand charge to cover fixed costs. Rate structures used by electric power suppliers vary; no two are identical.

**Demand charges**

The hook-up or demand charge is usually structured as either a specific charge per connected horsepower or a stated charge per measured kilowatt of demand. When the demand charge is based on connected horsepower, the nameplate rating of the motor is usually used to determine the monthly or seasonal demand charge. When the demand charge is based on measured kilowatts of demand, a special watthour meter, figure 1, is used. These meters measure kilowatt-hours on one register or set of dials and record maximum kilowatts of demand on another register or set of dials. The kilowatt demand for each billing cycle, as recorded by the demand meter, is the highest average use of power for any 15- or 30-minute period during the billing cycle. The time period used varies with different power suppliers—check with individual power suppliers for the time period they utilize.

Some power suppliers bill for the demand charge each billing cycle—others make an annual billing, usually based on the average of the two highest monthly demand recordings. The meter reader resets the demand meter to zero each time the meter is read.

**Controlling demand**

Since the demand charge for each billing cycle is based on the highest average kilowatt demand recorded during either a 15- or 30-minute period, an irrigator should manage the system to consistently keep demand as steady as possible. With motor irrigation systems, the greatest kilowatt demand usually occurs when starting the system and/or filling the pipelines. A typical pump curve, figure 2, shows why this is true.

The horsepower demand for a centrifugal pump is lowest at shutoff and increases as discharge is increased. To keep the kilowatt demand (which is directly proportional to motor horsepower used) as low as possible when starting the system, centrifugal pumps should be primed and started with the discharge valve nearly closed. Never let a pump run for over a minute or two with the discharge control valve in the closed position as it may damage the pump.

To know what the pump is doing, install a pressure gauge in the discharge line on the pump side of the discharge control valve near enough to be seen when adjusting the valve. As soon as the pump is slightly over operating pressure as indicated on the gauge, start opening the valve slowly to about one-quarter turn. Do not let the pump pressure drop below normal system operating pressure. If a rattle is heard in the pump, close the valve down slightly until the noise disappears. A similar rattle in the valve cannot always be avoided.

Pipelines and laterals should always be filled at a flow velocity of less than 2 feet per second, or approximately one-third of design pumping capacity. This low flow velocity allows air to escape, minimizing chances for excessive hydraulic shock or water hammer that can occur if lines are filled too rapidly. When the system is full of water and up to operating pressure, the discharge valve should be fully opened. So doing helps to seal drain valves and couplings. With centrifugal pumps, this startup procedure also helps prevent cavitation in the pump.

Centrifugal pumps which are used as boosters should not be started until the primary pump has completely filled the pipelines. If the primary pump cannot fill the system without the help of the booster, start the booster with a partially-opened discharge control valve so that it pumps about one-third of its capacity at startup.

![Figure 1: Kilowatt demand is measured with a watthour meter having two registers—one to measure energy or kilowatt-hours, the other to measure demand or kilowatts. The kilowatt register is reset to zero each time the meter is read.](image)

![Figure 2: Horsepower increases as pump discharge increases. When discharge rate is less than filling of line or allowed to exceed normal operating discharge, the pump operates somewhere to the right of the crossover on the horsepower and kilowatt power curves, requiring additional horsepower and substantially higher demand.](image)
Some turbines have their highest horsepower demand at shut-off as shown on their respective pump curves. These should always be started with the discharge control valve partially open, allowing startup at approximately one-third of design flow.

Net benefits
Following this procedure every time lines are filled ensures that the kilowatt demand does not exceed the normal operating demand requirement for the system. The result will be the minimum demand possible for the system and, in turn, a reduced monthly or annual demand charge.

Using a watthour meter for measuring power

The watthour meter can be used to determine the horsepower output of an electric motor. The typical watthour meter, figure 3, incorporates a small revolving disc with a black or red mark painted on the perimeter to aid in counting disc revolutions. There is also a Kh factor printed on the faceplate, usually in the lower right-hand corner. On this example, the Kh factor is 28.8.

To make a horsepower measurement of an irrigation pump motor, first turn off auxiliary motors so only the irrigation pump motor is on the circuit. With the motor running under normal operating conditions, record the time in seconds required for ten revolutions of the rotating disc. Utilize the painted mark on the disc edge to aid in counting. To increase accuracy, repeat this step several times and average the readings. Locate the Kh factor on the faceplate. Use the following equation to determine the watt demands:

\[ kW = \frac{3.6 \times 10 \text{ disc revolutions}}{\text{seconds}} \times \text{Kh (meter constant)} \]

Example: Ten meter disc revolutions required an average of 19 seconds and the Kh factor is 28.8.

\[ kW = \frac{3.6 \times 10}{19} \times 28.8 \]

\[ = 54.6\ kW \]

To convert the kW measurement to horsepower, use the following equation:

\[ hp = kW \times 1.34 \]

\[ = 54.6 \times 1.34 \]

\[ = 73.2\ hp \]

The nameplate on the motor used in this example reads 75 hp.

Some watthour meter installations will have a current transformer installed ahead of the meter, which changes the above procedure. Current transformers are devices used to channel only a small portion of the current through the meter. The current transformer, a cylindrical device through which one service conductor passes, may be located on a power pole or in a box along with the watthour meter. It will have a ratio number stamped on it—usually 50:5, 100:5, 150:5, 200:5, 400:5, 800:5, or 1600:5—denoting multiplier factors of 10, 20, 30, 40, 80, 160, or 320. If a current transformer is installed, there may or may not be a notice on the faceplate indicating the multiplier factor. Check with the electric power supplier to verify if a current transformer is used and to obtain the proper multiplier.

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