Energy Rate Structures: Unit Pricing and Understanding Your Bill

An Online Continuing Education Course for Engineers

Course Number: BS-1017

Credit: 1 Hour / 1 PDH / 1 CPD

Energy Rate Structures: Unit Pricing and Understanding Your Bill

Mark Knarr, P.E., CEM, LEED AP BD+C, PMP, CCEA, GPCP

Introduction

An industrial facility may have multiple utility bills for each commodity that it uses, such as electricity, gas, and water. For each utility, there is a unique pricing arrangement that underpins monthly billing. Knowing the types of energy that a facility uses, and their respective rate structures are crucial to understanding energy costs and implementing an energy management program.

If energy managers understand what they are paying for energy, and how the rate structure controls the bill, then they can implement different strategies to reduce energy costs at their sites. In fact, with enough prudence, energy managers could even move to a different rate structure that is more cost effective for their site.

The target audience for this course is an energy manager who oversees operations at non-residential sites: that is, sites with industrial facilities or campuses with multiple facilities.

Electricity is the focus of this course because electrical billing tends to be the most complex of all utilities. This complexity is due to **demand charges**, which tend to be unique to electricity. Nevertheless, many pricing and billing approaches for electricity can easily extend to other utilities, such as natural gas, water, and steam.

In the USA, contracts between energy suppliers and their customers vary greatly from each other, even within the same state. Definitions vary regarding seasons, on- and off-peak hours, and so forth. As such, this course may not address every nuance in energy pricing or unique billing terms between you and your provider. Rather, this course is intended to teach the more general conventions in pricing and billing as a starting point to understand the less intuitive line items on your energy bill.

Consumption vs. Demand

The very first step in gaining a clear understanding of electricity rate structures and your bill can distinguish **consumption** versus **demand**. These two quantities are the cornerstones of any electric bill.

Let's use a car's odometer and speedometer as a simple analogy, as shown in Figure 1.

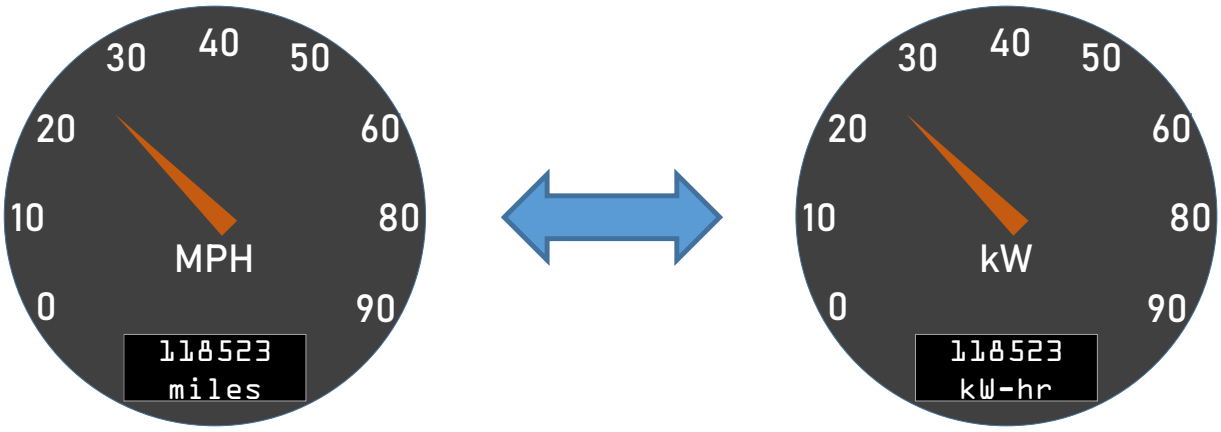


Figure 1. Analogy between [distance & speed] vs. [consumption & demand]

The odometer measures the distance traveled, with the units of measurement being miles. Analogously, your electric meter measures the energy consumed, with the units of measurement being kilowatt-hours (kW-hr). This is **consumption**.

The speedometer measures your instantaneous speed – that is, the rate of distance per unit time, measured in miles per hour (mph). Analogously, your electric meter approximates the instantaneous power – that is, the rate of energy per unit time, measured in kilowatts (kW). This is **demand**, also known as *a load*.

In short,

- Consumption measures energy in units of kW-hr.
- Demand measures power in units of kW.

Figure 2 below illustrates this difference even further. Demand is plotted as a function of time days. Two consecutive, 30-day billing periods are shown as blue and orange in the figure. The area under each curve is the consumption in that period, which is equal for both: 19,800 kW-hrs. However, their demand profiles are quite different. The blue profile has only one distinct peak of 35 kW. The orange profile, on the other hand, had two distinct peaks, with the higher one at 50 kW and the lower one at 30 kW.

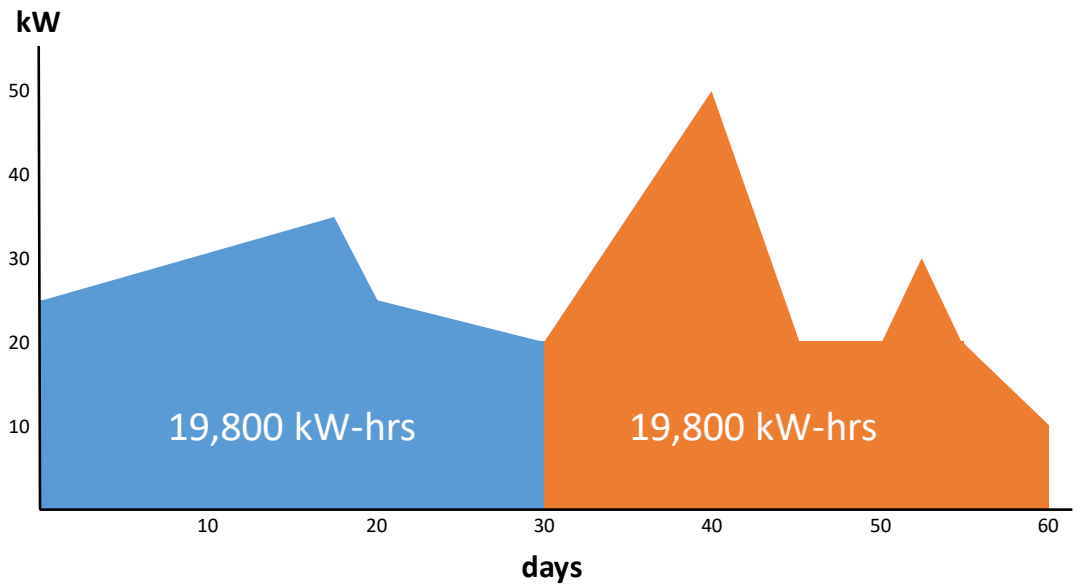


Figure 2. Although two billing periods may have the same consumption, their demand profiles can be starkly different.

The point of Figure 2 is to show that there's more to billing than just kilowatt-hours. Utility companies are not only interested in *how much energy* you use, but also in *the rate that you use it*. So, despite the blue and orange periods having identical consumption, the higher demand in the orange period will incur more negative billing effects…as we'll see later in this course.

Up to this point, we've explained consumption vs. demand in the context of electrical energy. What about natural gas (NG)?

Like electricity, NG consumption is also cumulatively recorded on a meter. Gas meters record volumetric consumption in cubic feet (ft^3) or cubic meters (m^3), which can be converted to energy in British thermal units (BTU's) using standard factors for NG, such as 1,000 BTU/ft^3.

However, *demand* – for billing – tends to be exclusively electrical. That is, NG suppliers don't normally charge customers based upon peak gas flows measured in ft^3 per second or m^3 per minute.

Flat And Block Rates

Flat rate is straightforward: the utility charges a single price per unit to the customer during the billing month. This flat rate can apply to either consumption or demand. For example, the utility may charge a flat rate of 7¢ per kW-hr, $21 per kW, or 20¢ per cubic meter of NG.

Example 1: A utility charges a flat rate of 20¢ per cubic meter of gas. During the billing month, a facility uses 11,000 cubic meters. The consumption/energy charge is simple multiplication:

$$11{,}000\ m^3 \cdot \$0.20/m^3 = \$2{,}200$$

Another common form of energy pricing is **block rates**, also known as tiered or step rates. Under block rate schedules, the price per unit changes at different levels of consumption or demand.

Block rates can either be declining or inverted, as shown in Figure 3.

- *Declining* means that the cost goes down with each incremental block. Declining block rates are implemented when the marginal cost of providing electricity goes down. Utilities tend to use these rates when they want to win business from large energy consumers.
- *Inverted* means that the cost goes up with each incremental block. Inverted block rates are implemented when the cost of building new facilities and infrastructure to provide energy is significantly higher than the cost of old facilities. Utilities tend to use these rates to discourage consumers from overconsuming.

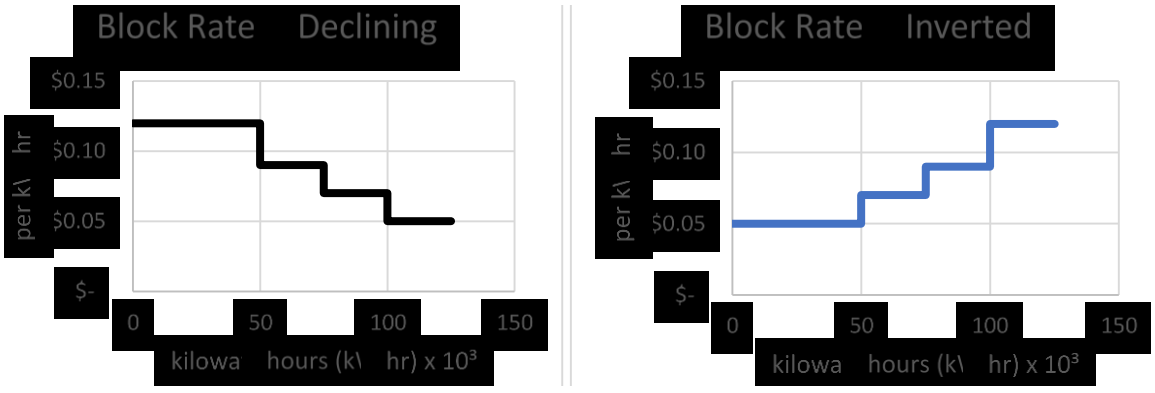


Figure 3. Declining and inverted block rates

Example 2: Inverted, fixed block schedule. A public utility charges a customer using the following block schedule:

- The first 50,000 kW-hr are charged at 5¢ per kW-hr.
- All remaining kW-hr are charged at 7¢ per kW-hr.

If a facility uses 40,000 kW-hr in a billing month, then their consumption is entirely in the 5¢ block. The cost would be

$$40{,}000 \text{ kW-hr} \cdot \$0.05 \text{ / kW-hr} = \$2{,}000.$$

Example 3: Inverted, fixed block schedule. Using the same schedule as in Example 2, another facility uses 80,000 kW-hr in a billing month. Hence, 50,000 kW-hr are in the 5¢ block; and the remaining 30,000 kW-hr are in the 7¢ block. The cost would be

$$50{,}000 \text{ kW-hr} \cdot \$0.05 \text{ / kW-hr} + (80{,}000 - 50{,}000) \text{ kW-hr} \cdot \$0.07 \text{ / kW-hr} = \$4{,}600$$

Example 4: Declining, fixed block schedule. Re-run Example #3 but swap the block rates to make a declining block schedule:

- The first 50,000 kW-hr are charged at ~~5¢~~ 7¢ per kW-hr.
- All remaining kW-hr are charged at ~~7¢~~ 5¢ per kW-hr.

$$50{,}000 \text{ kW-hr} \cdot \$0.07 \text{ / kW-hr} + (80{,}000 - 50{,}000) \text{ kW-hr} \cdot \$0.05 \text{ / kW-hr} = \$5{,}000$$

Block sizes can be fixed or variable, also referred to as adjustable. Fixed blocks will remain the same every month. Variable block sizes depending on the peak demand for the month; for example, 400 kW-hr per kW of peak demand. Block sizes are usually applied to the total monthly values (total energy consumption, or monthly peak demand). However, in some cases, especially for gas rates, the block sizes are defined as daily values.

Variable block pricing is seen in energy charges for electricity rates. These rates are sometimes referred to as "hours of use." Variable block sizes are typically defined as a certain number of kilowatt-hours per kilowatt of peak demand.

Example 5: Variable block pricing. The first 200 kW-hr per kW of peak demand are charged at 7¢ per kW-hr, and all remaining consumption is charged at 4¢ per kW-hr. Calculate the energy charge using the following scenario:

- Facility's monthly peak demand is 550 kW.
- Total energy usage for the month is 160,000 kW-hr.

To compute the size of the first block of energy, multiply the peak demand times the block size in the rate to find the block size.

$$550 \text{ kW} \cdot 200 \text{ kW-hr / kW} = 110{,}000 \text{ kW-hr}$$

Now calculate the energy charge for the first block by multiplying the energy in the first block times its corresponding block rate.

$$110{,}000 \text{ kW-hr} \cdot \$0.07 \text{ / kW-hr} = \$7{,}700$$

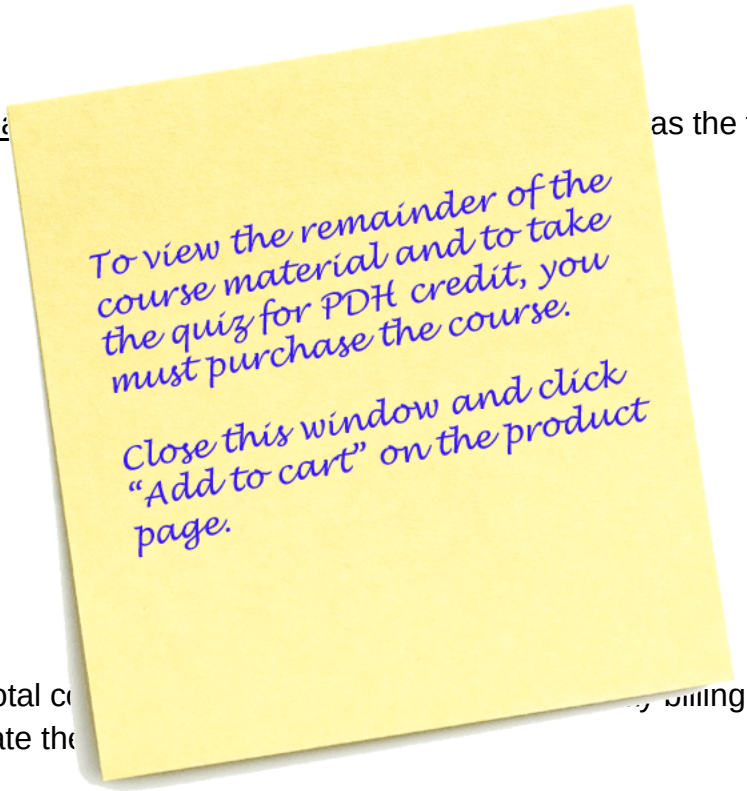
Multiply the remaining kW-hr times 4¢ per kW-hr.

$$(160{,}000 - 110{,}000) \text{ kW-hr} \cdot \$.04 \text{ / kW-hr} = \$2{,}000$$

Add the two block costs together to get the energy charge.

$$\$7{,}700 + \$2{,}000 = \$9{,}700$$

Example 6: Da as the following block



The customer's total c billing period. How would you calculate th