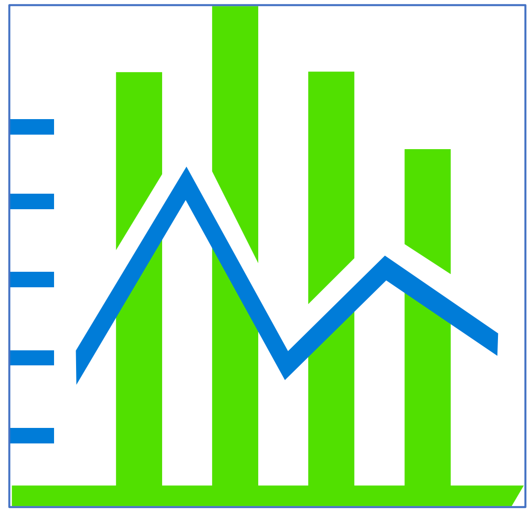
DEMAND VS. ENERGY, BLENDED RATES & YOUR BILL WHITE PAPER #18

Demand and energy affect your bill differently.

Measures that save one vs. the other are different.

Assigning a dollar value to savings depends on whether the reduction is more about energy, more about demand, or a blend. Oh, and what time of day the savings occur also matters.



Comparing terms 'energy' and 'demand'

Energy is used to do work
Lift buckets of sand up stairs all morning and you'll be ready for lunch. Fuel.

Demand is how *fast* the energy is used
Lift one pallet of sand buckets up the stairs over the morning and one person might be able to do it. Lift 100 pallets of sand buckets up the stairs in the same amount of time and you'll need more people or a gorilla. In our case, more energy in a short time means we need a bigger generator and bigger wires to carry the power.

- A way to thinking of demand charges is the size of generator you rented for the month, which is based on the highest rate of energy use you needed for the month.
- This image can also lead to demand charge reduction strategies. For example, if you find that your energy draw rate (demand) is very high for only for a short period of time, you can ask: Is there is a way to spread out the work over time? … because if there is, then my demand charges would be lower. And you would be right.
- By the way, the same 'demand' concepts apply to other utilities. High demand periods determine maximum size of water and gas pipes and cost of service as well.

Correlating energy and demand to utility cost of service

Conservation measures

Conservation includes familiar things at home like more efficient lights and HVAC equipment choices and setting back thermostats. Commercial and industrial facilities pursue these and many other items. Reducing electrical energy end use means less fuel the utility puts into the generators. Fuel expenses and maintenance are proportional to usage and are recovered in the energy charge. These costs go up and down depending upon end usage, so they go down when we conserve.

Demand reduction measures

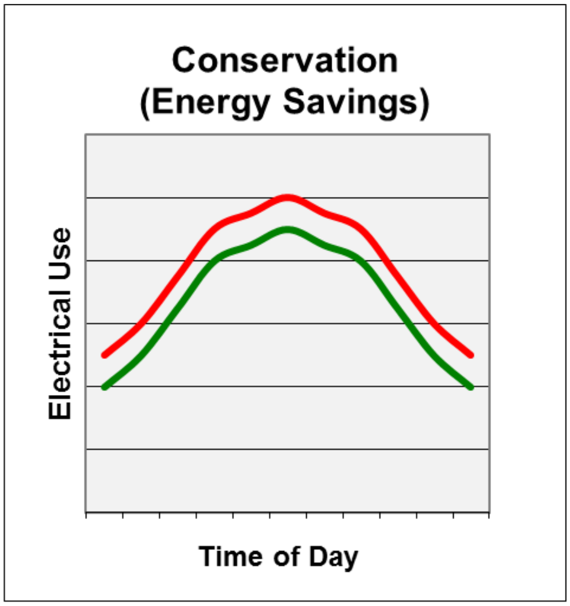
Demand reduction measures may or may not include equipment, but all have the goal of reducing energy delivery rate (demand) at times when the demand is highest. Our electrical generation system and infrastructure are fixed costs and are paid for by loans which are akin to a mortgage. All customers share in paying for fixed costs of the electrical system. Demand charges for residential customers are factored into the rates and this works because residential usage patterns are very similar. But usage patterns for commercial and industrial customers (C&I) vary widely.

To make this equitable, the 'mortgage' payment is apportioned to C&I customers based on demand. The higher the demand (peak loads), the higher the demand charges. Customers on a 'demand' rate have meters that record the highest kW for the billing period, which represents the greatest portion of our generation and transmission system that is dedicated to that customer. Demands are divided into on-peak and off-peak. On-peak demands requires us to use additional equipment that is there only for on-peak times, which is why on-peak demand charges are higher. Electricity cost goes up and down according to how much is used during the peak period – this means customer bill cost goes down when demand is reduced.

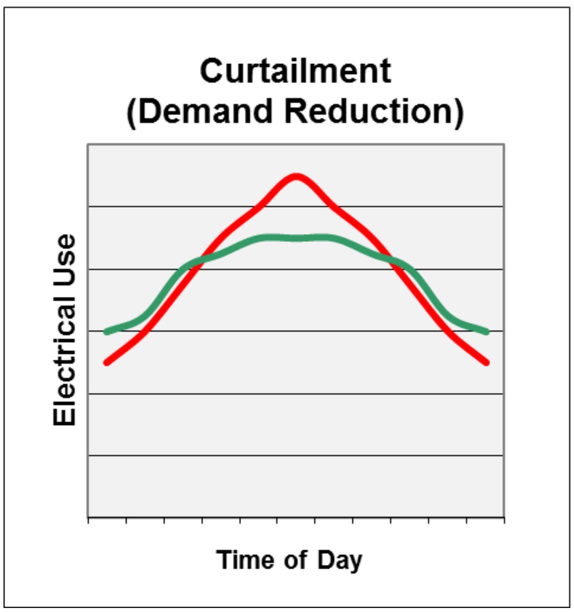
> Important note on demand savings. The concept of 'rented generator' is 'renting it by the month'. For demand reduction to save money it must occur at the peak time (to lower the metered max) and must be consistent. Missing even one day will negate savings. Automatic solutions are strongly encouraged for reliable results.

Conservation and demand effects on load shape

See **Figure 1** and notes.



Conservation measures 'use less' for the same task and the effect on usage patterns are intuitive: assuming a steady use and a more efficient device, the new curve has the same shape, only slightly lower.



Curtailment is about reducing a peak, usually because of cost during that period. Assuming the same amount of work exists, curtailment amounts to making up the missed work before and after the peak time. In this scenario, the new curve is lower during the peak period but higher on the shoulders of it.

Figure 1. Characteristic load shapes for conservation and curtailment

Your electric bill is in pieces

For most commercial and industrial customers, the electricity bill is in pieces. There may be a dozen pieces to the bill, but the main ones are energy and demand, each divided by time of use called 'on peak' and 'off peak'. Both energy and demand cost more 'on peak'. Reasons for higher peak cost are related to the fact that peak equipment run time per year is short compared to base load equipment. The 'mortgage' expense for the peaking equipment is added to the base equipment which is also running. Also, fuel used during peak times is higher for each unit of electricity created – this is because base load equipment justifies higher efficiency since it runs all the time, vs peaking equipment that only runs occasionally.

All this may sound like a boring lesson in the utility business, but it can help you as you strategize how to manage utility cost. Knowing what things create lower or higher cost of service for a utility gives insight for what will reduce or increase your electric bill – namely trying to use the lower cost product and avoiding using the higher cost product if you can. Of course, energy is a tool for business, and you have a job to do. There will always be peak usage - for example people will always eat lunch at lunchtime, and air conditioners run in hot weather. But within many businesses, we find there is some amount of adjustability that can be made in operations that results in a lower energy bill while still getting the job done.

Divide and conquer

Electricity bills are in pieces so applying savings strategies unique to each piece makes sense. **Table 1** gives a few examples that illustrate the different paths for savings.

Table 1 is only intended to illustrate that ways to reduce energy cost are different than ways to reduce demand costs – to coax customers away from one-size-fits-all approaches.

Other topics related to utility cost management either mentioned briefly or outside the scope of this paper:

- Operations and maintenance to make the most of what you already have.
- Accessing your usage and demand data on the customer portal, and ways to use it.
- Common themes for smart energy cost management.
- Automatic controls to optimize equipment operation.
- Strategies for demand limiting.
- Use of blended rates.
- Load factor as an indicator of electric cost effectiveness.
- Power factor correction.
- Energy audits to utilize outside expertise for a list of measures specific to your facility.
- Smart choices that can 'build in' added efficiency and demand control while planning for a large project and when replacing worn equipment.

Table 1: Example Ways to Reduce Specific Pieces of the Electric Bill

This shows contrast of ways to approach for energy cost reduction and demand cost reduction, as a way of thinking. On/off peak considerations excluded. Power factor correction excluded.

Note on overlap: The items illustrate that measures aimed at energy are different than demand, but there is some overlap for many measures. For example:

- High efficiency air conditioning reduces demand on the hot days… and saves energy all year.
- High efficiency lighting saves energy all year…which includes peak periods.

Bill Piece	What Drives the Cost	Example Things to Lower Cost
Energy	Variable costs like fuel and maintenance. More usage means higher cost	• Maintenance activities such as heat exchanger cleaning, control calibration. • Automatic controls that strive for 'enough but just enough', setbacks, scheduled operation, occupancy sensors, ventilation control, use of daylight. • Higher efficiency equipment and lighting. • Load-following modifications like variable speed drives, variable flow kitchen hoods.
Demand	Fixed costs like generation size and infrastructure. Higher demand, especially peak demand, means higher cost	• Demand management controls such as load limiting and staging for large electrical machines or heaters. • Higher efficiency equipment that runs during peak times, especially cooling equipment • Load shifting to off peak, which can include battery charging and thermal ice storage • Fuel switching to allow something using electricity to be eliminated as a load on the grid. This could be standby generation, batteries, absorption cooling, evaporative cooling. • Temporarily doing without and riding through short periods like an hour or two, in response to curtailment signals; can include dimming lights, half speed on a pool pump, half ventilation. For cooling, the load not seen during the peak time will either be picked up before or after the event and can include over-cooling. These must be carefully evaluated to prevent impact to business which would be false economy but can be effective if the period is short enough.

Use of blended rates to convert energy/demand reductions to dollar savings

The details of savings measures will be in energy and/or demand units but must end up as dollars to help the business financially. The term 'blended rate' is a commonly used method to convert electricity savings to dollar savings. It is a calculation of total dollars for a month or year, divided by the total kWh used in the year. But wait: the bill is in pieces, so how can an overall number be accurate? Good question. *In many cases blended rates give reasonable valuation, but if misused can result in understating or overstating savings.*

Blended rates are commonly used because it is easy, and work fine in many cases. With rates in pieces, identifying the precise dollar savings can be very complex and time consuming because it requires identifying savings in corresponding pieces. For example, a blended rate dollar conversion would use annual kWh per year saved, where a precise dollar conversion would break down the savings into bits, like:

- kWh saved on peak
- kWh saved off peak
- kW saved on peak and if persistent
- kW saved off peak and if persistent

The granularity of calculations increases greatly. Generalized methods like degree-days, bin weather, efficiency ratio / percent reduction are not compatible with dollar conversion by rate pieces – to the business owner seeking numbers with this precision, this means many vendors won't offer a savings value, and consultant costs go up because detailed hourly modeling is takes more time.

What to do?

- Option: Always use blended rates. This will cause large errors in some cases
- Option: Always use granular modeling. This will weaken the business case by spending some of the savings for precision.
- Option: Balance. Ask yourself whether blended rates can be used. Reduce analysis costs, accept minor errors along with other assumptions made in calculations, and guard against the big pothole errors.

Table 2 shows some basic flags to help you decide. Large errors are bad whether savings are over-stated or under-stated, although the ones that really hurt are over-stated savings.

Table 2: General ECM Characteristics for Using Blended Rates

- "ECM" stands for Energy Conservation Measure, an improvement made to the facility. ECM can be equipment replacement, operational change, maintenance change, control setting change, etc.
- This table is for standard electric rates that have on/off peak energy and on/off peak demand components. ECMs for savings under special rates are not generalized, such as interruptible rates, seasonal rates, totalized rates, block rates.
- Demand charges are based on highest average 15-minute demand. Savings from demand measures rely on the ECM being persistent throughout the billing period and occurring at the peak time so the overall facility demand sees the reduction.
- Not all ECM cases that save money are covered in this table. Examples: thermal ice storage or moving some load to off peak (load shifting), changing equipment from electric heat to natural gas heat (fuel switching), power factor correction, evaporative cooling.
- Blended rates are fine for electric rates based on energy use only, with no distinction of time-of-use, i.e. no demand rate, and energy is energy regardless of when it is used.
- "Significant" is something like a 7 year payback instead of the 3 years expected.

Blended Rates Usually Reasonable for Dollar Savings	Blended Rates A Bit Low for Dollar Savings, De-Rate or Special Model, Judgment Call	Blended Rates Significantly Over-State Dollar Savings	Blended Rates Significantly Under-State Dollar Savings
ECM *reduces energy and demand proportionally and steadily* across on-peak and off-peak time periods. Examples: • Indoor lighting • More efficient copier • More efficient pool pump motor • More efficient HVAC fan wheel • More efficient air compressor that runs all the time	ECM reduces energy throughout the year but does not lower peak billing demand. Examples: • Variable speed drive (VSD) applications for heating/cooling (HVAC) equipment • Occupancy sensor controls • DDC optimizing routines	ECM *affects primarily off peak hours.* Examples: • Parking lot lighting • Ghost load reductions (curbing energy use at night) • Set-back controls ECM is *primarily about demand but is not consistent or is not coincident with on-peak demand.* Example: • Solar PV without batteries has minimal benefit to demand charges due to a cloudy day and bulk of annual savings is off peak energy	ECM is *primarily about demand, reduces demand consistently, and occurs coincident with on peak billable demand so it lowers it.* Examples: • Load limiting or other load-spreading changes (same work, spread out) • Load leveling with batteries