Engineering
Tech Tips

United States Department of Agriculture
Forest Service
Technology & Development Program

December 2000

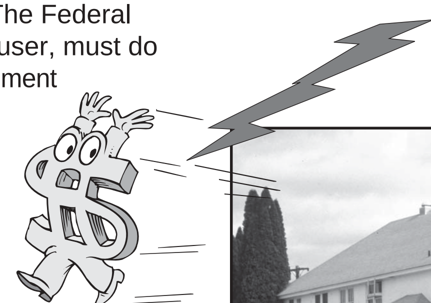
7100 0071-2373–MTDC

Saving Money by Understanding Demand Charges on Your Electric Bill

Dave Dieziger, Project Leader

This Tech Tip explains demand charges, how they are calculated, why we need to monitor them, and what we can do to lower them. Demand-related charges usually represent 30 to 70 percent of most commercial customers' electric bills. Electrical demand in some parts of the Nation stretched the capabilities of electrical gener-ating and transmission systems during the summer of 1999, causing brownouts and blackouts.

The Department of Energy studied the events of the summer of 1999 and concluded that the problem will probably get worse before it gets better. The Federal Government, the Nation's largest energy user, must do its part to help. The Federal Energy Management Program's special issue on Power Outages (July 2000) has a letter from the Secretary of Energy and a Plan of Action instructing all government agencies to develop indi-vidual load reduction plans. This provides guidance and useful suggestions for reducing electrical demand and developing load reduction plans. The letter can be found at the web site: *http://www.eren.doe.gov/femp*.



What Are Demand Charges?

Demand is a measure of the rate at which energy is con-sumed. The demand an electric company must supply varies with the time of day, day of the week, and the time of year. Peak demand seldom occurs for more than a few hours or fractions of hours each month or year, but electric companies must maintain sufficient generating and transmission capacity to supply the peak demand. Demand charges represent the high costs that electric companies pay for generating and transmission capacity that sits idle most of the time. Demand charges are based on the amount of energy consumed in a specified period of time known as a demand interval. Demand intervals are usually 15 or 30 minutes.

To calculate a customer's demand, the electric company takes the demand interval with the highest energy con-sumption in kilowatt hours (kWh) and divides by the length of the demand interval in hours. Mathematically, this is expressed as kilowatt hours per hour. The hours cancel, leaving kilowatts, the units of power or demand. The Missoula Technology and Development Center's (MTDC) electric bill shows the high cost of energy consumed during the peak demand interval (figure 1). The total of all charges on MTDC's monthly electric bill based on kilowatt hours is 3.3 cents per kilowatt hour. All costs based on kilowatts total $7.37 per kilowatt. The demand interval is 15 minutes.

Figure 1—The MTDC offices were built in the late 1800's or early 1900's. The main building has about 10,265 square feet of floor space.

Suppose you use a 100-watt light bulb during MTDC's 15-minute peak demand interval. The demand charge will be:

For additional Information contact: *Dave Dieziger, Project Leader; USDA Forest Service, MTDC; 5785 Hwy. 10 West; Missoula, MT 59808–9361. Phone: 406–329–3904; Fax: 406–329–3719; E-mail: ddieziger@fs.fed.us*

($7.37/kW)(100 W)(kW/1000 W) = $0.74

The energy charge for using a 100-watt light bulb during any 15-minute period of the month is:

($0.033/kWh)(100 W)(kW/1000W)(15 min)
(1 hour/60 min) = $0.00083

It costs just as much to operate a 100-watt light bulb during the 15-minute peak demand interval as it does to operate the same 100-watt light bulb for 223 hours any other time during the month. The 223 hours equals 1 month of use at 10 hours per day and 22 days per month.

Calculating the cost per kilowatt hour during the peak demand interval further illustrates the high cost of demand charges. The cost of operating a 100-watt light during the 15-minute peak demand interval is $0.74.

$/kWh = $0.74/(100 W)(kW/1000 W)(15 min)
(1 hr/60 min) = $29.60/kWh

Compare a cost of $29.60 per kilowatt hour to MTDC's rate schedule, just 3.3 cents per kilowatt hour. The Center is in the Northwest, which has some of the lowest electric rates in the country.

When you try to save money, you should focus most of your efforts on the most expensive items. The same approach should be used when trying to lower utility bills. The first step is to analyze your utility bills and understand exactly what you are paying for. Unfortunately, electric bills are often complicated and confusing. Demand and consumption charges sometimes vary with the time of day, day of the week, and the seasons. Some utilities have "ratchet" charges where the highest demand or consumption that occurs in one year will determine demand or energy charges for the next year. Even so, it is usually possible to summarize your bill into a demand charge (dollars per kilowatt) and an energy charge (dollars per kilowatt hour). The best place to start is the local electric company.

Communications With Your Local Electric Company

It is the author's experience that the utility bills for most Forest Service facilities are sent directly to the National Finance Center where they are paid. Your local electric company is the best place to get copies of previous bills that will help you understand your rate structure. Electric companies often have representatives who work with commercial customers. They can help you understand what you are paying for, develop an individual facility plan for emergency load reduction, and develop strategies for shaving peak demand. Utilities can also help fund energy conservation projects. For example, the Bonneville Power Administration (BPA) works with other Federal agencies in the Pacific Northwest to save energy and lower peak demand, reducing monthly electric bills. The BPA can provide technical assistance and funding to help projects happen. The BPA cannot make a profit and is reimbursed only for actual costs. Reimbursement is usually by monthly payments through the local electric company. In most cases the payments are less than the savings the improvements generate. For more information about the BPA's program, contact Marla McCombie at: *mlmccombie@bpa.gov.*

If the utility is unable to supply the demand, they may be forced into a brownout (where the utility reduces the voltage), or the utility may use rolling blackouts (cutting all power to some customers for a period of time). As the Nation's largest electric power consumers, U.S. Government facilities must have individual facility plans for electric load reduction that can be put into action at the electric company's request. This plan lists loads that can be deferred for short periods, such as copy machines, hall lighting, air conditioning compressors, and similar devices.

If you were billed just for consumption, you would have no monetary incentive to reduce your peak demand. Because you are charged for demand, it is extremely helpful to know the monthly peak demands for a typical year, your demand profile for the day your peak demand occurred each month, and if possible, the daily peak demands for the entire year. The daily demand profile is a plot of your electrical demand for each hour of the day. This information is helpful in determining when, how long, how much, and how many times each month you will have to employ a strategy to reduce peak usage. With the advances in remote meter reading, your electric company may be able to provide this information for you or to set up a system that will allow you access to this information over the Internet. If not, you will have to install a device on the electric company's meter and coordinate the installation with them. Daily and monthly profiles with a sharp peak offer more opportunities for shaving peak usage (figure 2). Demand plots that are more of a rectangle with little or no peak offer few opportunities for shaving peak usage (figure 3) because demand must be reduced longer for the same savings. This makes some peak-usage-shaving strategies (such as supplying some of the facility's loads with a standby generator) impractical.

To Simplify the Electricity Bill...

The average cost per kilowatt hour has been traditionally used to estimate costs. This cost is calculated by dividing the total annual electric bill by the total annual kilowatt hours. This average will accurately reflect costs only when the following conditions are met:

- **The load being evaluated is operating at 100-percent capacity for the entire time the building is occupied.**
- **The facility's energy consumption is negligible when it is unoccupied.**
- **The rate charged per kilowatt and kilowatt hour does not vary with consumption, demand, or season.**

These conditions are unlikely to apply to Forest Service facilities.

If you are evaluating a load that is not on continuously when the building is occupied, the impact on the facility's demand will probably be the same as if the load were on continuously. The impact on consumption will be proportional to how long the load is on. This causes demand charges to be higher than average for the energy consumed. The actual cost per hilowatt hour consumed by the load is higher than the average cost per kilowatt hour.

Any night or weekend, energy consumption (off peak) will cause the average cost per kilowatt hour to be lower than the actual cost during peak periods on workdays, because the demand charge for energy consumed off the peak is low or nonexistent.

If you are evaluating the cost of energy consumed at night, such as security lights, you should use only the cost per kilowatt hour from the utility's rate schedule. The average cost per kilowatt hour will include a demand charge. Peak demand almost never occurs at night, on weekends, or on holidays.

Estimating costs using the average annual cost per kilowatt hour will not give accurate results when the load is seasonal and the rates vary with the seasons. For example, air conditioning may be used only during the summer, so it is important to use the summer rates.

If the cost per kilowatt or kilowatt hour varies with demand or consumption, the unit cost of the load that triggers higher rates can be tremendous, because the new rates can be applied to the portion of the bill over the triggering amount, to the entire bill, or to all bills for the next year. In any of these cases, using the average cost per kilowatt hour for the previous year will drastically underestimate the actual costs.

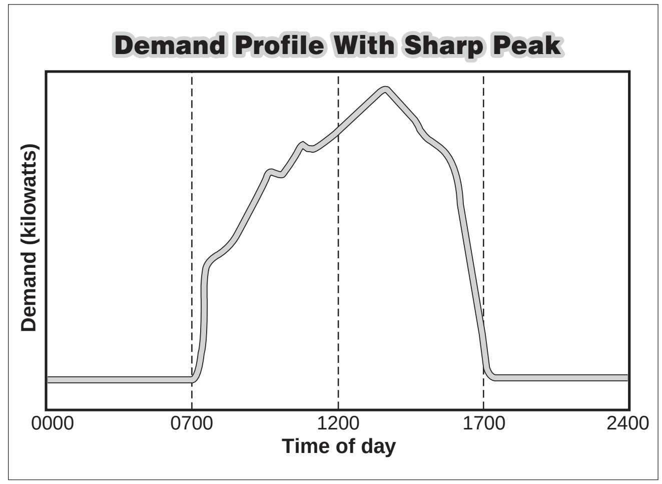


Figure 2—A demand profile with a sharp peak. Demand just has to be reduced during the early afternoon to achieve demand savings.

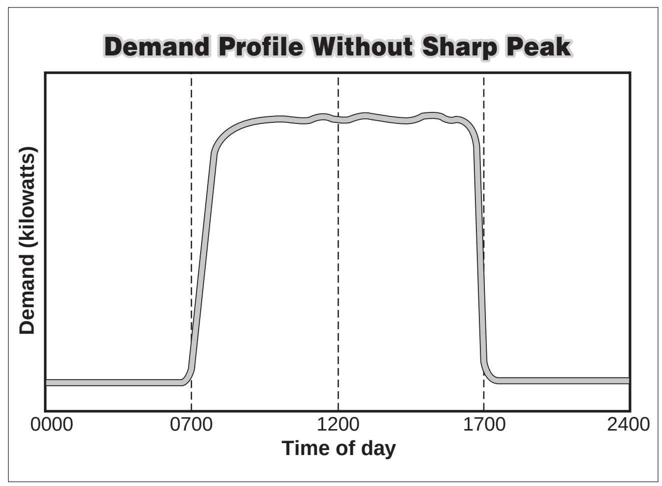


Figure 3—A demand profile without a sharp peak. Demand must be reduced over the entire workday to achieve demand savings.

Reducing Peak Demand

Install More Efficient Equipment—Upgrading an older lighting system can reduce peak demand and energy consumption. In addition, modern lighting (figure 4) can improve productivity and reduce heat produced by the lights. Lighting retrofits should be done before, or when air conditioning units are downsized, because a modern lighting system will reduce cooling requirements. Articles on lighting and refrigeration can be found on MTDC's home page, available on the Forest Service and Bureau of Land Management's internal computer network at: *http://fsweb.mtdc.wo.fs.fed.us.*

Figure 4—Light fixtures with energy-efficient T8 fluorescent lamps and electronic ballasts save energy and reduce peak demand.

Downsize Equipment—Air-conditioning systems are probably the most common example of oversized equipment causing high demand charges**.** An oversized system may not consume much more energy than one closely sized to the load, but it will demand more electricity when it operates. An appropriately-sized system will operate longer, but it will save money by using less electricity at any given time.

Reschedule Loads—When possible, perform energy-intensive operations when your facility's demand is low. If your facility uses a well or electric pump for irrigation, irrigate at night or early in the morning instead of during the day (figure 5). A timer that runs the sprinklers at night (figure 6) will reduce demand charges and evaporation losses. Reducing evaporation losses saves water and the energy used to pump it. If your facility has an electric hot water heater, a timer can be installed to prevent the heating elements from coming on during the day. Most water heaters have enough storage capacity to provide sufficient hot water for rest rooms and other

Figure 5—Sprinklers supplied by a well or pump using an electric motor increase electrical demand charges when they are used during the day.

Figure 6—A timer for controlling irrigation sprinklers. If water is supplied by a well or electric pump, irrigating early in the morning or at night instead of during the middle of the day will lower peak electrical demand, reducing the electric bill.

miscellaneous uses during a normal workday. If more hot water is needed, increase the water temperature and install a water heater blanket. Increasing the water temperature and heating at night will increase energy consumption a small amount, but energy consumed at night is comparatively inexpensive. Preventing an electric water heater from coming on during peak demand periods will eliminate the water heater's demand charge.

Thermal Storage—An example of thermal storage is making ice at night when energy is cheaper. During the day when demand is high, the air-conditioning compressor could be turned off and ice could provide the cooling. If you do not need to reduce your demand for more than an hour or so, it may be possible to use the thermal storage of the building itself. Thermostats can be set toward the bottom of the comfort zone instead of the top (at 72 °F instead of 78 °F, for example). The lower temperature allows the air-conditioning compressor to be turned off or its output to be reduced for short periods without raising the temperature enough to bother a building's occupants. According to the American Society of Heating, Refrigeration, and Air-Conditioning Engineers, most people will not notice 1-hour periods when a building is hotter than normal. Thermal storage increases energy consumption, but the additional energy consumed is inexpensive compared to energy that is not consumed during peak demand.

Duty Cycling—When demand is high it may be possible to limit the operating time of equipment that consumes a lot of energy or to install a device that prevents two or three pieces of equipment from operating at the same time. For example, MTDC's six air-conditioning compressors (figure 7) could be placed on a system that allows only three or four units to operate at any one time. Energy consumption and occupant comfort will not be affected unless there is an extremely high cooling load. Preventing all of these units from operating at any one time will significantly reduce the demand charge. Only the compressor and its cooling fan will be interrupted. The building's air handlers will continue to circulate air and ensure a healthy environment. If this modification causes the building to become too hot during the afternoon, the thermostats could be set at a lower temperature. This will keep the building's temperature from exceeding the comfort zone during short periods of high cooling load. As a part of an emergency load-reduction plan, the air-conditioning units could be cycled manually every one-half hour with switches located at each unit.

Dispatchable Load Shedding—Some electric companies will install equipment that allows them to interrupt nonessential loads at your facility for a specified amount of time in exchange for lower rates. The power company pays for the equipment. The consumer works with the electric company to determine which loads can be interrupted and for how long.

Alternate Power Sources—You may be able to use alternate power sources. If your facility has a standby or emergency generator, the generator (figure 8) may be able to supply a portion of your facility's load when demand is peaking. Other examples are using an engine to power an irrigation pump, air conditioning compressor, or

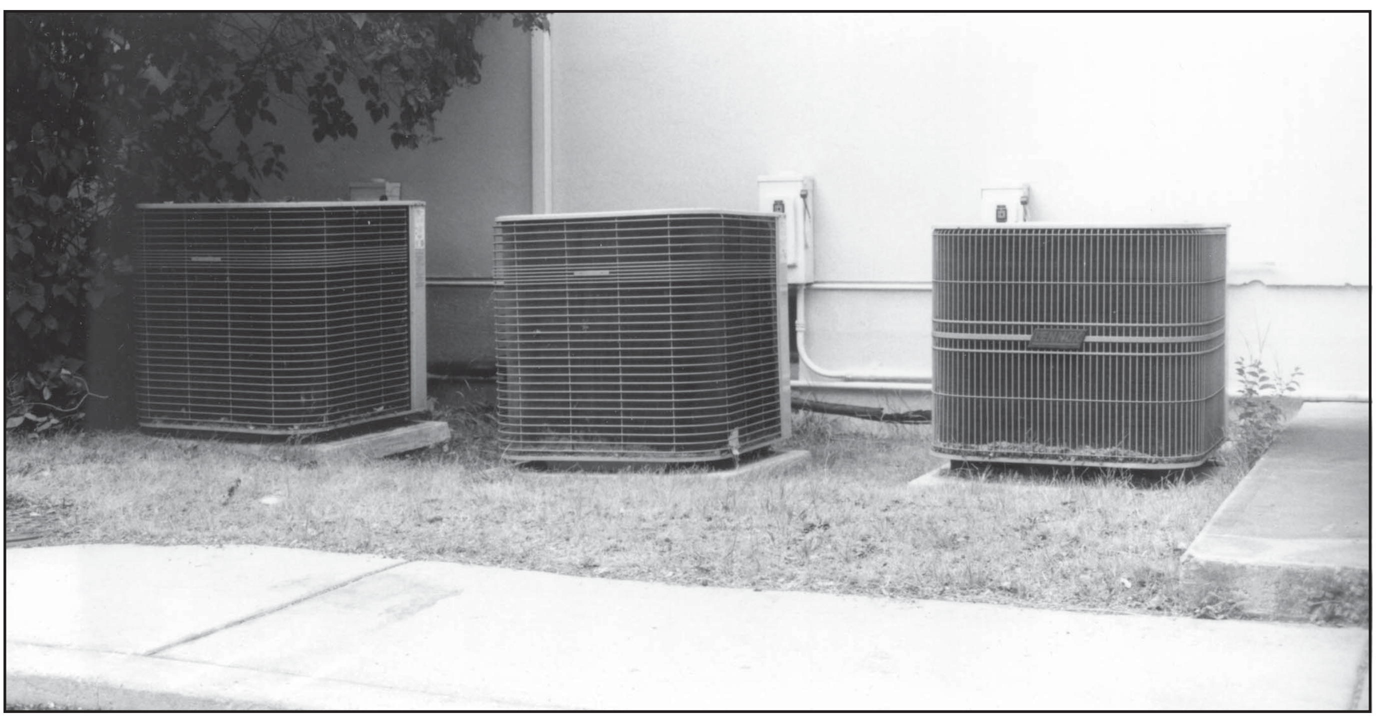


Figure 7—Three of MTDC's six air-conditioning compressors. Installing a controller that would prevent all the compressors from operating at the same time would lower MTDC's peak electrical demand.

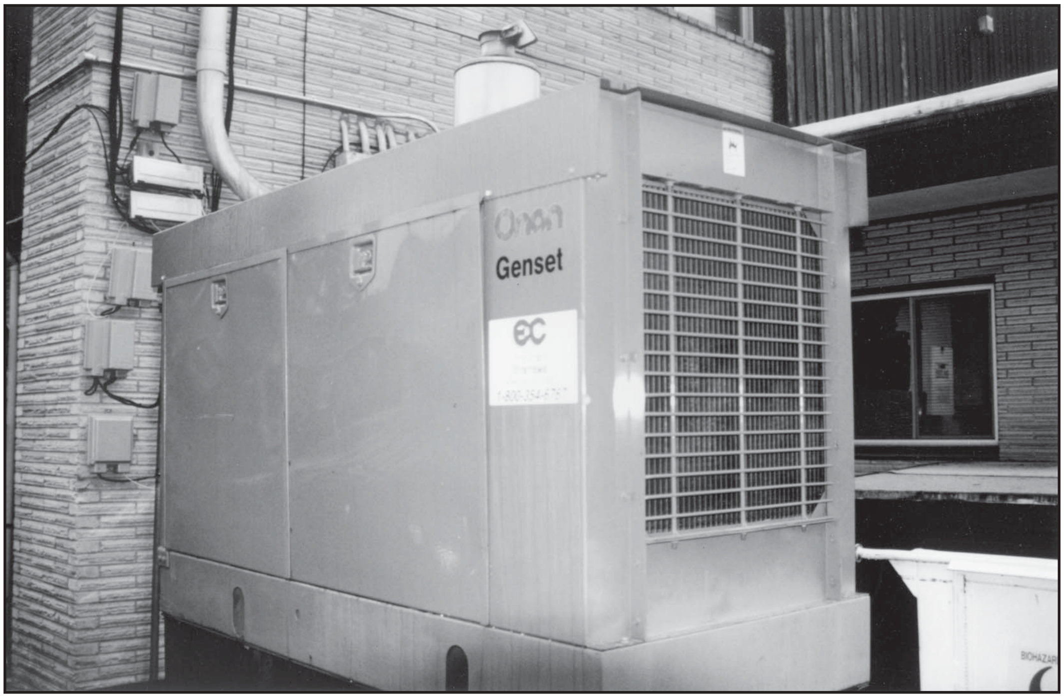


Figure 8—A generator that could be used to shave peak electrical demand.

electric arc welder when demand is peaking. When available, natural gas is the most desirable fuel. It costs less per British thermal unit than gasoline or diesel fuel and produces fewer pollutants. Because of the high costs of operating an internal combustion engine, it is not practical to supply a portion of your facility's load with a generator unless demand needs to be reduced just a few times each month.

High-Demand, Low-Consumption Loads

Infrequently used high-demand loads are often ignored. They should not be. For example, assume MTDC has a 10kW electric resistance space heater that is used 4 hours per month. Also assume MTDC's demand is otherwise constant and using this heater causes the monthly peak to be 10 kW higher. Using MTDC's low electric rates, the demand charge is: (10 kW)($7.36/kW) = $73.60 per month. The energy charge is: (10kW)(4 hr)($0.033/kWh) = $1.32 per month. Even though the heater consumes a small amount of electricity, the cost of operating this load for 6 months is substantial.

Converting to another heat source or rescheduling operations in this facility to another time so the load does not contribute to peak demand will save $73.60 per month. Another exercise that further illustrates how expensive high-demand, low-consumption loads can be is to calculate the average cost per kilowatt hour:

($73.60 + $1.32)/(10 kW)(4 hr) = $1.87/kWh

Compare a cost of $1.87 per kilowatt hour to the average energy charge of 3.3 cents per kilowatt hour from MTDC's rate schedule.

Portable Electric Heaters

Portable electric heaters are a fire hazard and are very expensive for the amount of heat they generate. For example, the monthly demand charge for a single 1,500-watt electric heater at MTDC is: (1,500 W)(1 kW/1,000 W)($7.37/kW) = $11.06/month. This figure is based on some of the nation's lowest electric rates and does not include any energy consumption. It would be safer and less expensive to ban portable electric heaters, raise the temperature of the building a few degrees, and make everyone more comfortable.

Figure 9—Photovoltaic cells on the roof of a Forest Service building. Photovoltaic cells produce power during the daytime when the peak demand for electricity usually occurs.

Renewable Energy Sources

Photovoltaic cells (figure 9) produce electricity during the day when peak demand usually occurs. Because photovoltaic power will be available during peak demand periods, economic analysis of their benefits should not be based on the average cost of electricity, but on the cost during peak demand periods. Otherwise, the savings will be underestimated and the payback period will be overestimated.

Conclusions

Lowering your electric bill involves more than just saving energy. You must understand the role that demand charges play in your electricity bill, and do your best to reduce them.

About the Author

Dave Dieziger came to MTDC from the Northern Region Fleet Management staff in 1999. He has a bachelor's degree in mechanical engineering from the University of Idaho and is a licensed Professional Engineer. Other experience includes American Society of Mechanical Engineers certification as a boiler inspector, energy conservation work for the Navy, enlisted service in the Navy, and work as a city fireman.

Library Card

Dieziger, Dave. 2000. Saving money by understanding demand charges on your electric bill. Tech Tip 0071-2373. Missoula, MT: U.S. Department of Agriculture, Forest Service, Missoula Technology and Development Center. 8 p.

Explains electric demand charges and describes ways to save money by reducing demand charges. Demand charges are based on peak amounts of energy used in a given time period, known as demand intervals. Demand charges are usually 30 to 70 percent of the total electricity bill. Demand charges can be reduced by scheduling some activities (such as irrigation that requires electric pumps) at night rather than during high-demand periods. Federal facilities must have load-reduction plans that will allow them to reduce their electrical demand temporarily when an electric utility asks them to do so, based on a July 2000 letter from the Secretary of Energy. Internet links to additional information are included.

Keywords: costs, energy conservation, energy consumption, facilities, scheduling

Additional single copies of this document may be ordered from:

USDA Forest Service, MTDC
5785 Hwy. 10 West
Missoula, MT 59808–9361
Phone: 406–329–3978
Fax: 406–329–3719
E-mail: *wo_mtdc_pubs@fs.fed.us*

For further technical information, contact Dave Dieziger at MTDC.

Phone: 406–329–3904
Fax: 406–329–3719
E-mail: *ddieziger@fs.fed.us*

An electronic copy of this report is available on the Internet at:

http://fsweb.mtdc.wo.fs.fed.us/cgi-bin/enter.pl?link=pubs/htmlpubs/htm00712373/