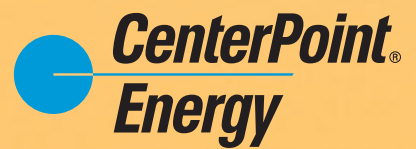


Electric Service

Reliability and power quality
at CenterPoint Energy



Always There.®



Electricity is critical to the livelihood of almost everyone and essential for companies to conduct business as usual. That's why CenterPoint Energy strives to maintain a safe and reliable electric delivery system.

Why do we care?

At CenterPoint Energy we understand that our customers demand both reliable and high-quality electric service. Dependable electricity is essential to the bottom line of industrial and commercial businesses, as well as a necessity for the productivity and comfort of our residential customers. As a result, CenterPoint Energy strives to make reliable power delivery a top priority.

In this report, we will explain the origin of reliability and power quality events. In addition, we'll explain how the electric delivery system works, as well as what to expect from your CenterPoint Energy delivery service in terms of reliability and power quality.

We will also identify possible solutions that may help relieve undesired events.



What is going on here?

Are you experiencing problems with your appliances or equipment, or have you noticed any of these occurrences?

What is a power surge?

The term “power surge” has no official definition and, as such, is not recommended terminology. What many customers refer to as “power surges” are in fact either momentary interruptions, voltage sags or voltage transients. IEEE Standard 1100 (Emerald Book) contains the technical definitions of power quality terms and is an excellent source of information on power quality.

Residential customers

- Upon coming home, you see your digital clocks flashing.
- The ground-fault circuit-interrupter (GFCI) receptacle in your bathroom keeps tripping for no apparent reason.
- You have experienced frequent failures of home entertainment equipment, which you suspect to be caused by “power surges.”
- The incandescent light bulbs in your home seem to require replacement more often than what you consider normal.
- Every time your air conditioner turns on, the lights flicker.

Industrial and commercial customers:

- The chillers at your facility frequently trip off-line.
- The variable frequency drives (VFD) in your facility trip off-line at the same time every day.
- The motors in your plant trip off-line when there is a “power blip.”
- The uninterruptible power supply (UPS) for your computer has frequently been beeping and switching to battery.
- What you consider to be excessively frequent power interruptions are impairing production.

If so, then you’re not alone. Many of the more than two million customers that receive electric delivery service from CenterPoint Energy have similar concerns. Why is this? Well, events like these are possibly the result of either reliability or power quality related issues. These occurrences may be caused by conditions originating from the utility system, from within your home or facility, or even from the affected equipment itself.

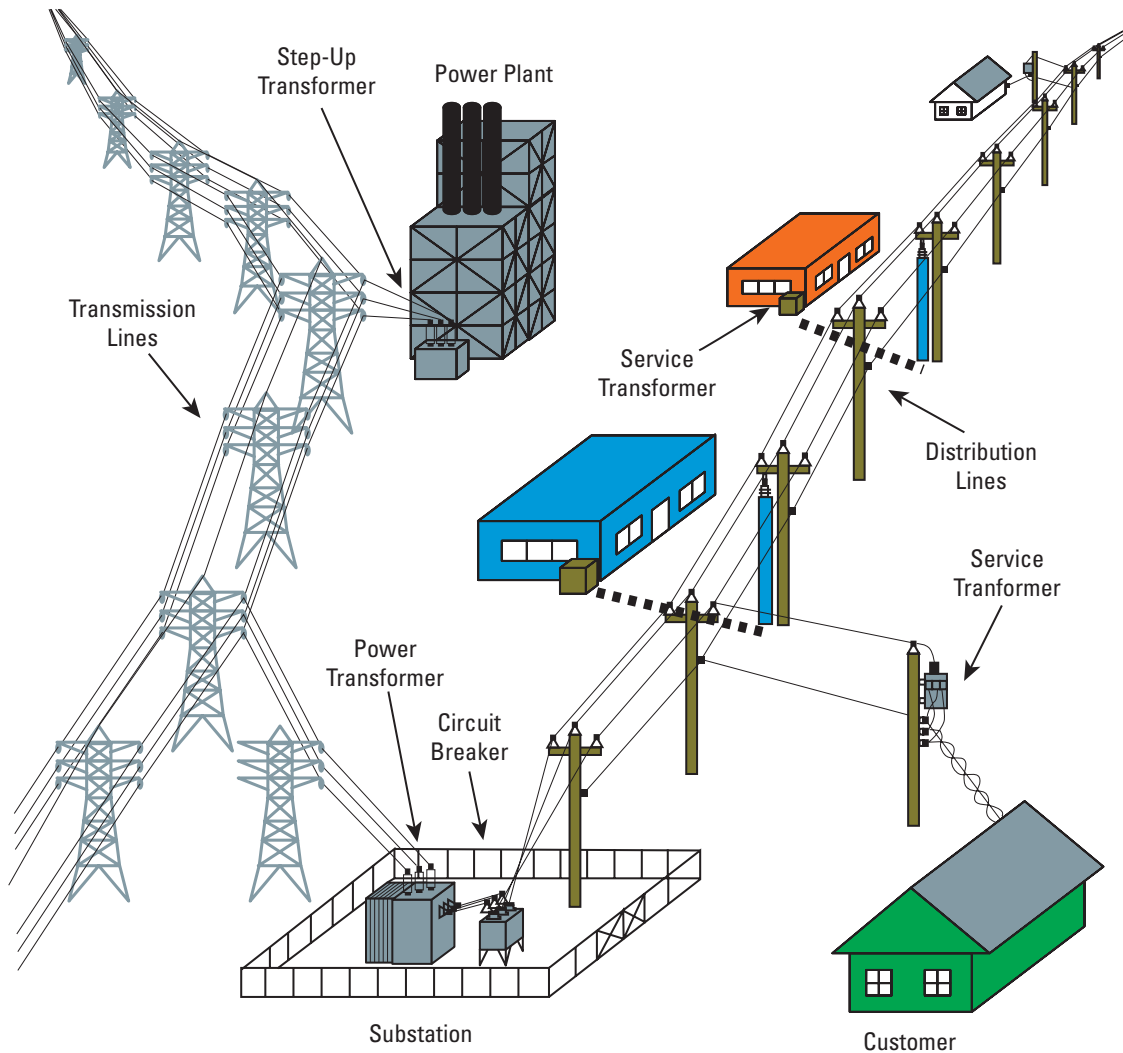
In order to determine the most appropriate solutions to your reliability and power quality problems, it is best to first understand how electrical power is delivered from the utility system to your appliances or equipment.

How does CenterPoint Energy deliver electricity?

The electricity delivered to your home or business is typically generated in large centralized power plants as illustrated in the figure below. Power then travels over long distances via high voltage transmission lines, which are interconnected in a grid or network configuration. From the transmission system, power travels to distribution substations. From these substations, distribution lines, operating at lower voltage levels, disperse the power throughout cities and neighborhoods. For safety reasons, each distribution line is protected by a circuit breaker in the substation.



Figure 1





What is reliability and power quality exactly?

- **RELIABILITY** refers to the continuity of electric delivery as described by the number and duration of power outages.
- **POWER QUALITY** describes the characteristics of power fluctuations, such as momentary interruptions, voltage sags or swells, flickering lights, transients, harmonic distortion and electrical noise.

CenterPoint Energy maintains more than 3,700 miles of transmission lines and 49,900 miles of overhead and underground distribution lines. With the advent of electricity deregulation in Texas in 2002, wholesale electric power companies and retail electric providers are allowed to deliver electricity over CenterPoint Energy's power lines.

CenterPoint Energy delivers electricity to more than two million customers in a 5,000-square-mile area including Houston, the nation's fourth largest city.

The power then travels from the distribution line through a service transformer located in close proximity to your home or business. Electricity enters the facility either through overhead or underground service entrance conductors (wires) which connect to the meter. CenterPoint Energy reads this meter on a monthly basis and reports the information gathered to your retail energy provider. Typically, ownership and responsibility of the service entrance conductors are transferred from CenterPoint Energy to the customer near the meter. The location where this transfer of ownership takes place is referred to as the point of service.

From the meter, or point of service, power flows along conductors to the main panel which contains the main breaker. The main breaker's duty is to provide protection for the entire facility. In homes, the main panel may also contain additional circuit breakers which provide protection for each individual branch circuit. These branch circuits deliver power for lights, appliances and electric outlets within the residence.

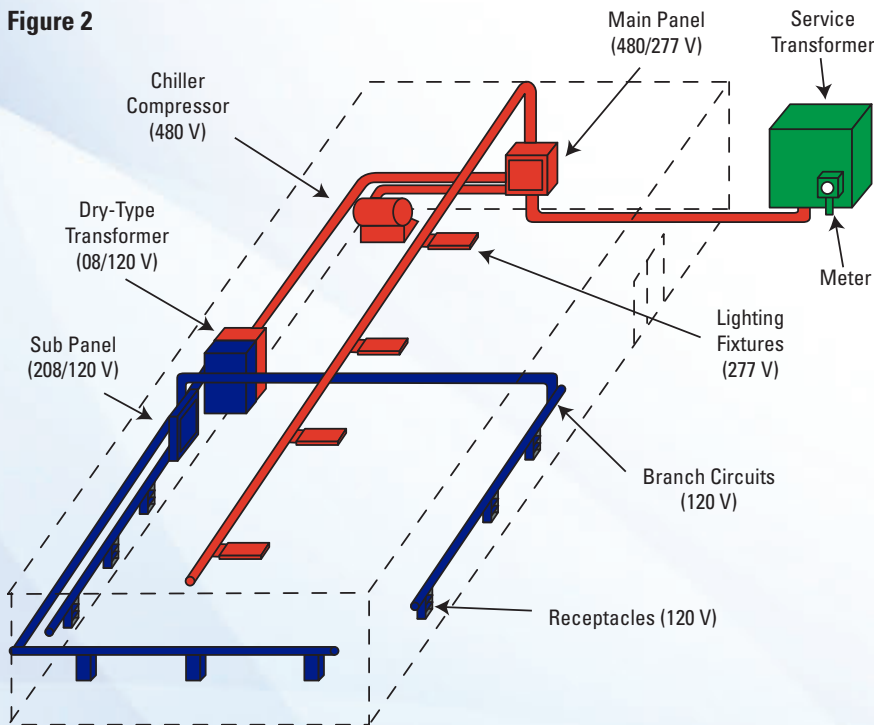
In industrial or commercial facilities (see fig. 2 on page 5), the main panel may also be the point of origin for circuits providing heating, ventilation, and air conditioning, as well as lighting. Furthermore, the main panel may supply feeder circuits for sub panels and dry-type transformers. The dry-type transformers step the voltage down to lower levels for branch circuits, which supply convenience receptacles throughout the facility.



The following figure helps illustrate the paths traveled within a commercial facility.

In figures 1 and 2, you can see the long and complex path electricity takes from the centralized generating plant all the way to an appliance, piece of equipment or receptacle. Unfortunately, due to the length of this path, numerous opportunities exist for events to happen, which can interrupt the flow of power or degrade its quality as it travels to a particular destination.

Figure 2



What are sensitive loads?

In general, modern equipment and appliances have incorporated electronics and microprocessors, which improve performance capability but are also more sensitive to common power quality and reliability problems. Examples of sensitive loads include:

- Digital computers
- Variable frequency motor drives
- Programmable logic controllers
- Computer numerical control (CNC) equipment
- Automated systems and processes
- Consumer electronics
- Digital clocks



Before examining reliability and power quality in detail, we should discuss CenterPoint Energy's responsibility for electric service delivery. As an investor owned utility, CenterPoint Energy is regulated by the Public Utility Commission of Texas (PUC). In an effort to ensure quality electric service at an affordable rate, the PUC requires CenterPoint Energy to adhere to its Tariff for Retail Delivery Service as well as Chapter 25 of the Substantive Rules.

What is CenterPoint Energy's responsibility regarding reliability and power quality?

In terms of reliability and power quality, two sections in Chapter 5 of the PUC-approved CenterPoint Energy tariff are especially important:

- **Section 5.2.1** (Liability Between Company and Retail Customers) states CenterPoint Energy will make reasonable provisions to supply steady and continuous delivery service, but does not guarantee against fluctuations or interruptions.
- **Section 5.5.3** (Equipment Sensitive to Voltage and Waveforms) states customers with equipment that may be adversely impacted by voltage fluctuations are responsible for installing the necessary protective equipment to limit the affect of those events.

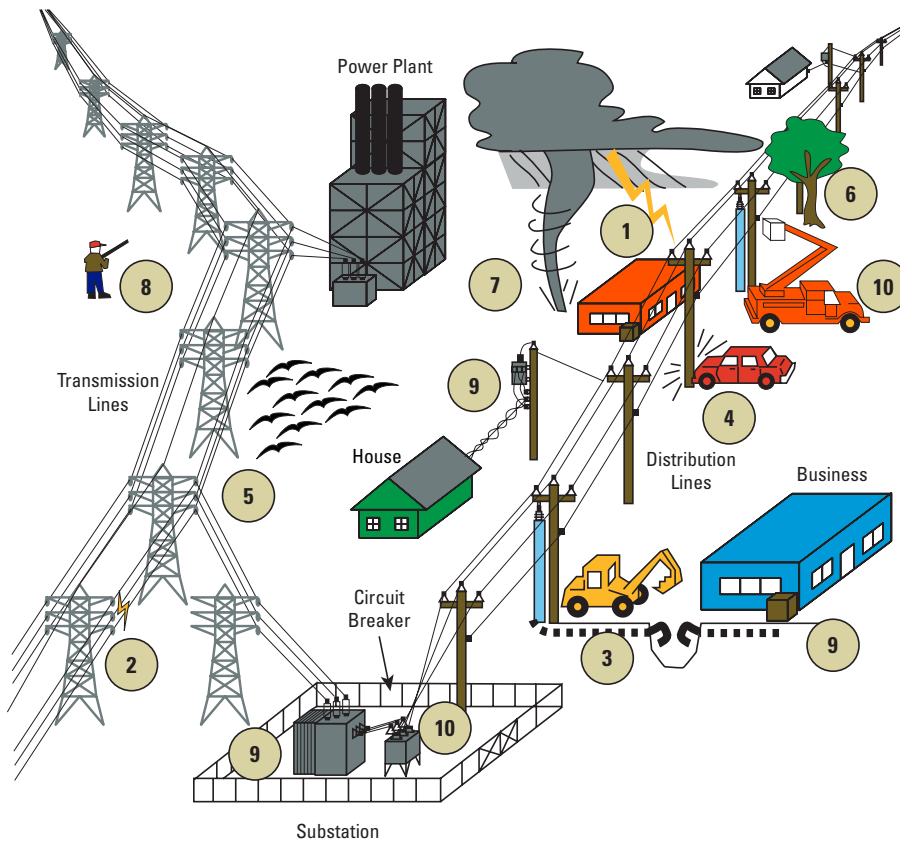
Section 5.2.1 requires CenterPoint Energy to make reasonable efforts to provide reliable service, while Section 5.5.3 states it is the customer's responsibility to install protective equipment for sensitive loads. In addition to the tariff , the PUC has two specific Substantive Rules addressing reliability and power quality:

- **Substantive Rule 25.51** (Power Quality) covers such issues as voltage and frequency variations, harmonics, power quality monitoring and voltage surveys. This rule requires CenterPoint Energy to provide steady-state supply voltage in compliance with the American National Standards Institute (ANSI) Standard C84.1.
- **Substantive Rule 25.52** (Reliability and Continuity of Service) is similar to Section 5.2.1 of the PUC-approved CenterPoint Energy tariff . It states CenterPoint Energy will make reasonable efforts to maintain electric delivery service. In the event of an interruption, CenterPoint Energy shall reestablish service as quickly as possible.

What should I expect?

Most power outages and disturbances can be attributed to factors beyond the control of a utility. CenterPoint Energy's system is exposed to environmental influences and normal operational conditions, which can create both power quality and reliability disturbances. Common sources of disturbances include the following and are illustrated in the figure below:

- | | |
|---------------------------------|-------------------------------|
| 1. Lightning | 6. Trees and vegetation |
| 2. Insulator flashovers | 7. Strong winds |
| 3. Dig-ins on underground lines | 8. Vandalism |
| 4. Automobile collisions | 9. Equipment failures |
| 5. Birds and other wildlife | 10. Switching and maintenance |



The tap water analogy

The electricity supplied along power lines is much like the water coming out of your faucet. It is perfectly safe for normal use; however, it does contain minor impurities. Should you desire entirely pure water, then filtering out these impurities is left up to you. Electricity works in the same manner. Even though CenterPoint Energy is dedicated to providing reliable and high quality electric service, it is not possible to provide a perfect power supply that is steady and continuous without occasional interruptions or fluctuations. Items to obtain "pure" electricity will be discussed later.



Reliability indexes

The most widely used reliability indexes are SAIFI, CAIDI and SAIDI.

- **SAIFI stands for System Average Interruption Frequency Index and is defined to be the average number of outages for the system over a specified time period.**
- **CAIDI stands for Customer Average Interruption Duration Index and is defined to be the average duration of a single outage event.**
- **SAIDI stands for the System Average Interruption Duration Index and is defined to be the average outage duration for the system over a specified time period.**

Also, the indexes are mathematically related as follows:

$$\text{SAIDI} = (\text{SAIFI}) \times (\text{CAIDI})$$

Average reliability

CenterPoint Energy maintains statistics of outage frequencies and durations for each distribution circuit and for the electric system as a whole. While there is some variation from year to year, the average figures that customers may experience are as follows:

Duration of sustained outages = 3 hours per year

Number of sustained outages = 2 per year

Average power quality

As for power quality events, CenterPoint Energy also maintains statistics of momentary outage frequencies for each distribution circuit and for the system as a whole. While there is some variation from year to year, the average figure that customers may experience is as follows:

Number of momentary outages = 10 per year

Besides momentary outages, instantaneous voltage sags are the most common type of utility-related power quality event that adversely affects our customers. While CenterPoint Energy does not keep statistics on voltage sags, it did participate in a national power quality survey that accurately reflects what typical customers can experience:

Number of sags below 90 percent of nominal voltage = 70 per year

Of these 70 sags, 23 will dip below 70 percent of nominal voltage, which is generally considered the threshold for causing motors and other sensitive equipment to drop off-line.

Bulk power vs. premium power

Bulk power is a term used to describe the electricity delivered by the utility system in a well-established manner allowing for satisfactory performance of conventional lighting and motor loads. Utility systems providing bulk power are designed to minimize costs while maintaining reasonable levels of reliability. As a result, bulk power is often referred to as “utility-grade” power and is described in the tap water analogy on page 7. Bulk power also refers to the power supplied inside customer-owned facilities, which contains internally created power quality disturbances and problems. In fact, studies done by the Electric Power Research Institute (EPRI) indicate that four out of five power quality problems are due to faulty wiring and grounding inside customer-owned facilities.

In contrast, **premium power** is used to describe the electricity delivered to sensitive electronic loads requiring higher reliability and power quality than conventional loads. Premium power can be customized to match the operating requirements of the equipment in question and is commonly referred to as “computer-grade” power. Ideally, premium power will consist of continuous, regulated voltage free from disturbances.

In general, CenterPoint Energy cannot provide premium power. In order to obtain this level of service, customers must enhance or upgrade their existing electrical facilities by installing power conditioners and applying other power quality solutions specifically selected to meet their requirements.

CenterPoint Energy’s tariff states it is the customer’s responsibility to install the necessary protective equipment to limit the adverse effects to equipment from voltage fluctuations, waveform distortion and single-phasing events. The concepts of bulk power and premium power help provide an explanation of the responsibilities and obligations for both the utility and its customers.



CenterPoint Energy’s Tariff for Retail Delivery Service states while reasonable provisions are made to deliver continuous and steady service, there is no guarantee against interruptions or fluctuations. In fact, bulk power not only contains reliability-related events such as sustained outages of service but also contains commonly occurring power quality events such as flicker, momentary interruptions, voltage sags, swells, transients, harmonic distortion and electrical noise.



As a consumer of electricity, what are you responsible for?

Most power quality problems are due to a lack of compatibility between customer-owned equipment and the power supply. This includes not only outages and fluctuations emanating from the utility system but also power quality disturbances and problems created inside customer- owned electrical facilities. Therefore, both CenterPoint Energy and its customers have a critical role to play in resolving power quality problems.

As noted before, customer-owned electrical facilities can be the source of a significant percentage of power quality problems. In accordance with the CenterPoint Energy tariff, customers have the responsibility to install necessary protective equipment to limit the adverse affect of power quality problems. In fact, existing codes and standards provide a wealth of information on how to improve the performance of customer-owned electrical facilities. If a customer desires “pure” power, or a higher quality of service than CenterPoint Energy is able to supply, it is his/her responsibility to supply that level of service.

Items to improve or better endure your current situation

Protective equipment able to enhance electric service is readily available in the power quality market place. Examples of these devices and methods are as follows:

- Transient voltage surge suppressor (TVSS)
- Constant voltage (ferroresonant) transformer
- Magnetic synthesizer
- Dip proofing inverter
- Lightning protection system
- Dynamic sag corrector
- Static VAR compensator
- High-speed transfer switch
- Battery UPS
- Rotary UPS
- Proper maintenance of electrical facilities
- Dedicated branch circuit

Who can help?

CenterPoint Energy strongly recommends that the services of a professional engineer or qualified power quality consultant be utilized to evaluate various solution options based upon safety, performance and economic pay-back criteria.

An excellent source of information to improve the power quality of customer-owned facilities is the set of standards created by the Institute of Electrical and Electronics Engineers (IEEE). The IEEE is a nonprofit, technical professional organization with over 360,000 members that creates consensus standards for industrial and commercial power systems. Among the various IEEE publications, which may help improve power quality-related issues are:

- **Standard 1100 (Emerald Book)** – IEEE Recommended Practice for Powering and Grounding Electronic Equipment
- **Standard 446 (Orange Book)** – IEEE Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications
- **Standard 493 (Gold Book)** – IEEE Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems
- **Standard 519** – IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems



According to EPRI, poor power quality and reliability are estimated to be costing the United States economy billions of dollars per year. In response, the power quality equipment and services market offers a myriad of solutions. However, it is imperative that the power quality problem be clearly defined in order to make the best decision when evaluating the possible solution options. The services of a professional engineer or qualified consultant can provide the knowledge and experience necessary to insure success.



Always There.®

CenterPoint Energy's commitment to improving reliability and power quality

Reliable electricity is critical to the daily life of almost everyone. From the lights in their homes to the computers at their offices or the large equipment within their plants, a safe and reliable supply of power is essential. Many factors play a role in maintaining the safe and reliable operation of the electric transmission and distribution network.

CenterPoint Energy prides itself with traditions of quality and commitment – traditions we have developed during more than 130 years of energy delivery service. In addition to honoring these traditions, we are excited about establishing new traditions of service and operational excellence by providing our customers with electric delivery service that is characterized by both high reliability and power quality. Therefore, CenterPoint Energy employees are always there to maintain the reliability and power quality of the electrical delivery system as well as quickly restore power after outages.

Furthermore, CenterPoint Energy hopes to help customers understand their retail electrical service. Should you desire to discuss reliability and power quality in greater detail than what is covered in this brochure, please contact **Customer Service at 713-207-2222** for answers on the spot.

CenterPoint Energy. Always There.



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