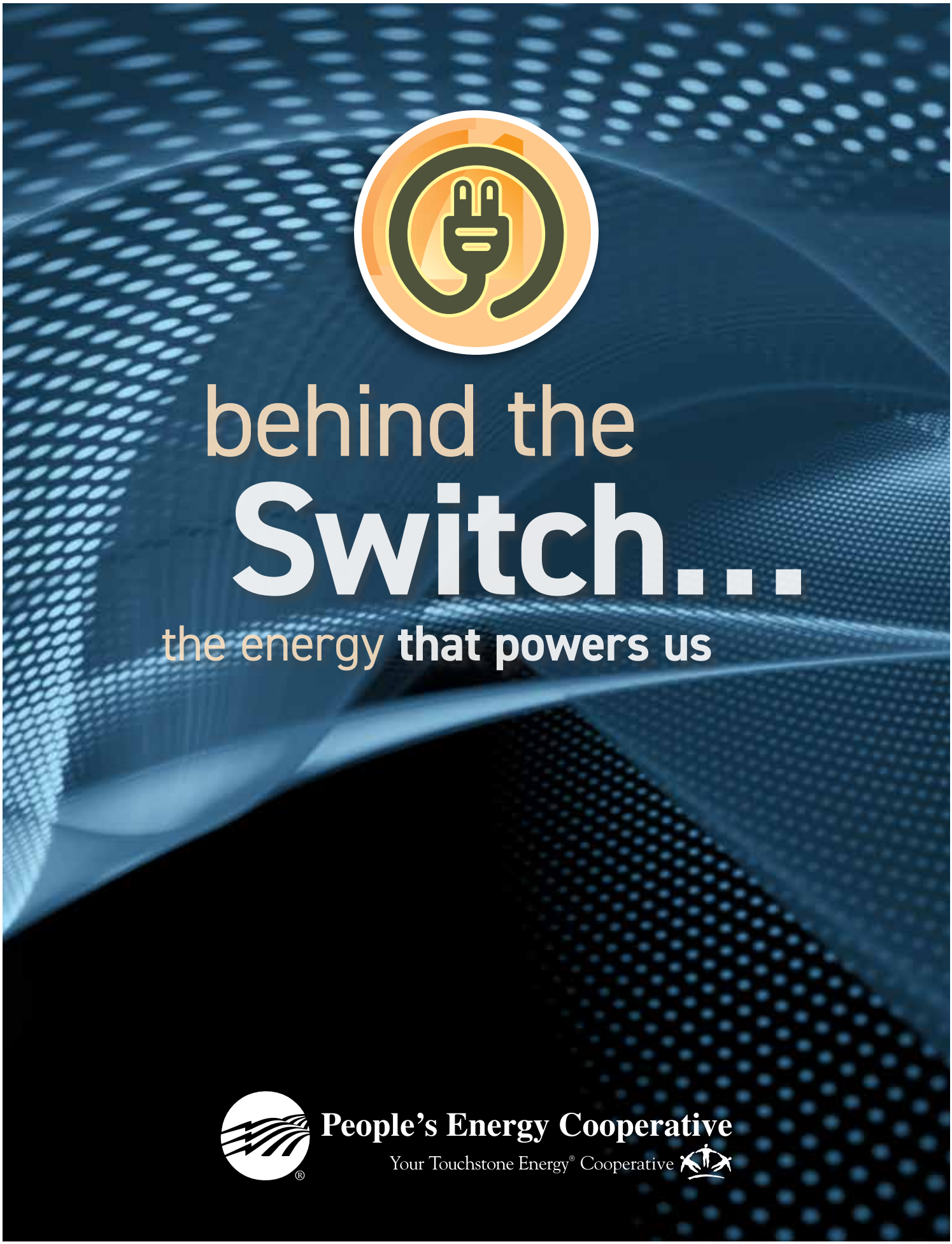

behind the
Switch...
the energy that powers us
People's Energy Cooperative
Your Touchstone Energy® Cooperative

# behind the Switch...

## Our Energy Sources

### EACH WITH THEIR OWN LIST OF BENEFITS AND CHALLENGES

Electricity. We all know what it is, right? Well, at least we recognize what it does for us.

*Having a readily available and dependable source of electricity is essential to modern living, our comfort and safety, our livelihoods, and the economy.*

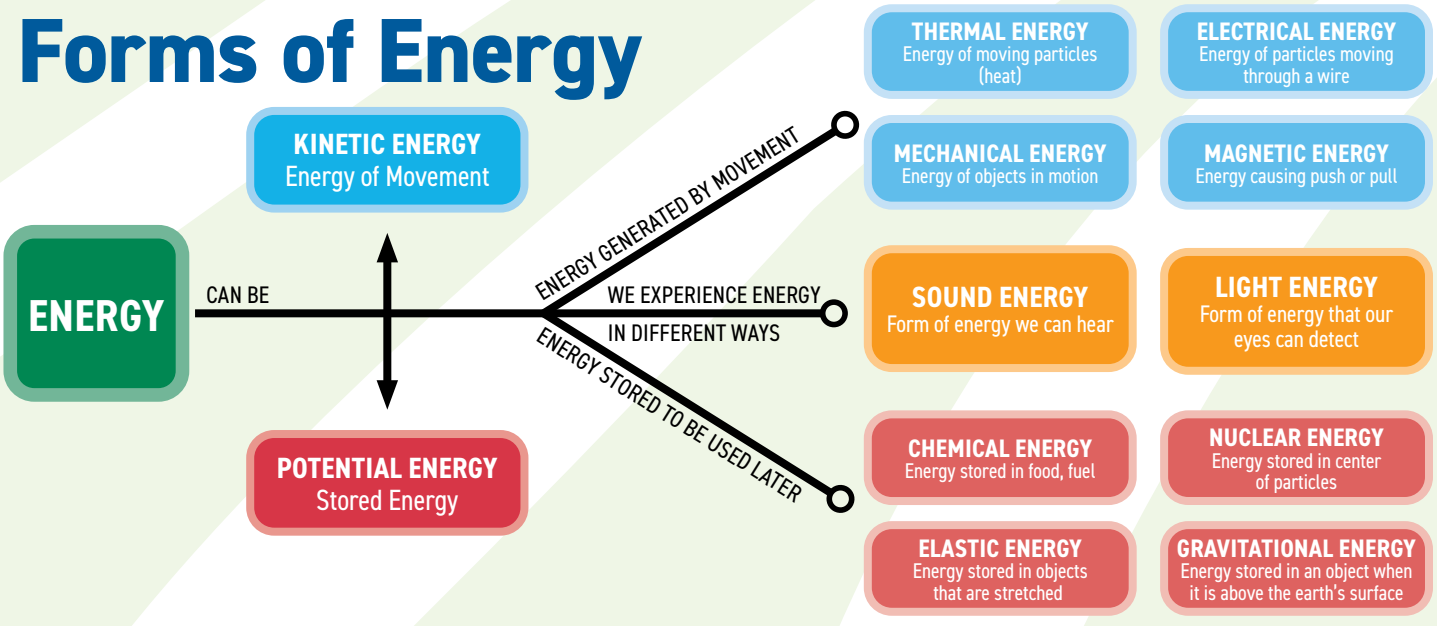
*But, do you know what it takes to generate and deliver electricity to your home and place of work? Let's start with the basics of what energy is.*

WHAT IS ENERGY? 'Energy' is a term used very broadly. The term is often used casually or in public policy discussions as a reference to a wide variety of fuel types. These can be carbon based fuels like coal, petroleum, and natural gas or renewable sources such as sun, wind, geothermal, hydropower, and biomass. Renewables are often referred to being "green" because of their smaller carbon footprint. Nuclear energy leaves no carbon footprint by using an atomic reaction to release a large amount of heat that is then used in the production of electricity.

Scientifically, energy can be categorized as either *potential* or *kinetic*. Potential energy is energy stored in an object. Kinetic energy is working energy. Basically, potential energy is the fuel for kinetic energy to do work. Both potential and kinetic energy play a role in generating electricity.

WHAT IS ELECTRIC ENERGY? Electricity is produced *(generated)* by processes that utilize a non-renewable (i.e. coal) or renewable source *(i.e. wind)* to power a machine or reaction that creates a flow of charged particles called electrons. Electrons are negatively charged particles of matter. Electric current *(electricity)* results when the electrons move in a wire or other conducting material from a negatively charged point to a positively charged point.

## Forms of Energy



# the energy that powers us

## COAL

A major fuel source used to generate electricity in our region is coal. Since coal-fired power plants cost millions of dollars to build and are designed to have a generating life that spans several decades, much of the Upper Midwest remains predominantly dependent on coal because it is an affordable source of fuel that can generate hundreds of megawatts (MW) of reliable electricity at one plant. Over the years, coal plants have undergone significant environmental updates to reduce emissions. In fact, substantial investments in large-scale technology improvements have vastly reduced their environmental impact. Our power supplier, Dairyland Power Cooperative (DPC), currently generates 37% of its power using coal.

## RENEWABLES

As coal supplies decrease and environmental regulations on CO2 have increased, and generation and transmission organizations (G&T's) such as DPC, are diversifying fuel sources to include more renewables. DPC utilizes hydropower, wind, solar, and biomass generation from facilities in Iowa, Illinois, Minnesota, South Daktoa, and Wisconsin. The challenges with renewable energy such as solar and wind are that the sun sets each day, the wind doesn't always blow, and and cost-effective, utility-scale batteries that enable us to store renewable energy when it's generated, but not needed by the grid are not yet widely available.

## NATURAL GAS

A good back-up to intermittent renewable sources of energy are natural gas-powered plants that have a smaller carbon footprint than coal and can be powered-up and shut-down more easily than a coal-fired plant. DPC currently generates 39% of its power using natural gas facilities.

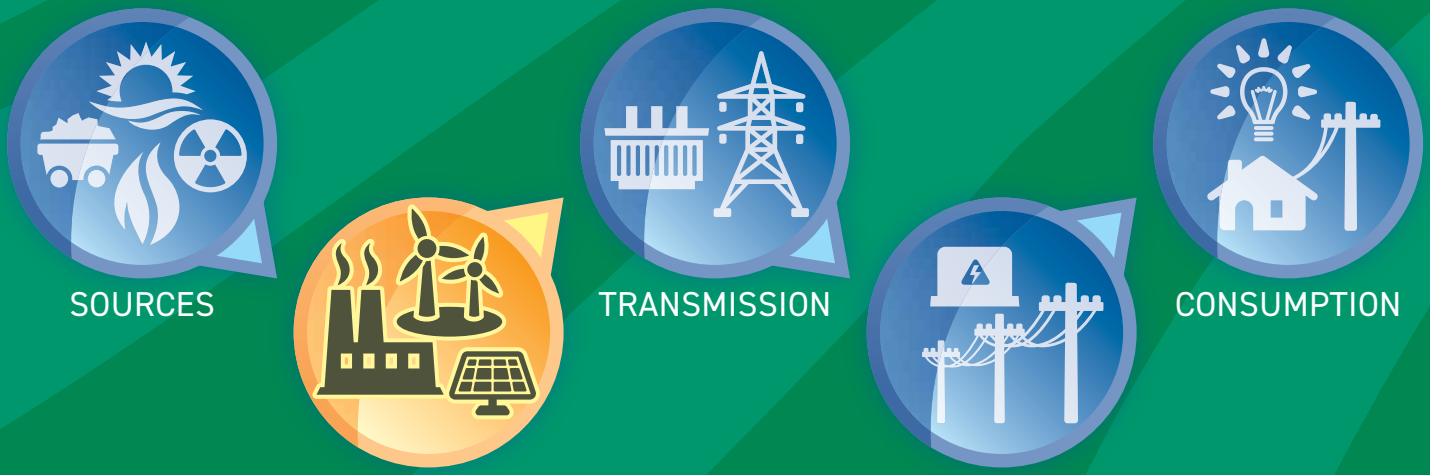
## NUCLEAR

While nuclear plants produce a large amount of electricity and no CO2 emissions, the used uranium is radioactive waste and finding safe storage sites is difficult. Because there is no adequate solution to the long-term storage of nuclear waste, the Minnesota legislature placed a moratorium on building nuclear plants in 1994 with MN State Statute 216B.243 Subdivision 3b. The Minnesota Rural Electric Association is leading an effort to repeal this moratorium to help the state secure a long term carbon-free energy future.

# behind the Switch...

## Electricity Generation

### THE PROCESSES THAT WORK TO PROVIDE YOU WITH POWER




Electricity is generated by processes *that utilize a fuel (i.e. coal) or renewable energy source (i.e. wind) to power a machine or reaction that creates a flow of charged particles called electrons.*

Each fuel source requires a different process to convert the potential energy into electricity. When done on a large scale, we refer to the generating facility as a power plant.

Solar and wind sources are helping augment the production of base load electricity. However, their output is not consistent enough to replace traditional base load facilities (i.e. coal-fired plants) which ensure an ample, reliable, and cost-effective supply of electricity. Power plants are huge investments and designed to have a service life that is decades long. This is the main reason there are "all requirements" contracts in place between the generation and transmission component of the utility industry and the local, distribution side.

### GENERATION AND TRANSMISSION COMPANIES

People's Energy Cooperative is a member-owner of the Dairyland Power Cooperative *(DPC)* system of electric cooperatives, based in La Crosse, Wisconsin. DPC is a generation and transmission company that owns and operates several power plants, providing electricity to its 24 member electric distribution cooperatives and several municipalities in Wisconsin, Minnesota, Iowa and Illinois. As we shared earlier, 37 percent of the power DPC generates is from coal-fired plants.

Like most distribution utilities, we have an all-requirements contract with DPC that states we agree to purchase all our power from them for the life of the contract. These contracts are usually over 40 years long due to the enormous capital investment required to build utility-scale electric generation sources.

DPC is part of MISO, the Midcontinent Independent System Operator, which allows DPC to sell excess generation for a profit or purchase power supply when it is more economical than generating their own power.

# the energy that powers us

## Power Plants

NATURAL GAS PLANTS are similar to coal-fired plants, however, they use the expanding gas pressure caused by burning natural gas to turn the turbine directly without using steam. With a heat recovery steam generator *(HRSG)* attached to a natural gas plant *(combined cycle)*, the waste heat from the turbine is used to generate steam that turns an additional turbine for more output.

NUCLEAR PLANTS use a controlled atomic reaction to split atoms of uranium. This releases a great amount of heat that boils water to make steam which drives turbine-powered generators like a coal-fired plant.

COAL-FIRED plants burn coal to heat pipes full of cold water to create steam *(~1000° F)* that flows at high-pressure *(1,000 to 3,500 psi)* through pipes to a large wheel-type device called a turbine. The turbine converts the thermal energy of the steam into mechanical energy by utilizing the high-pressure of the steam to spin the tightly-packed blades of the turbine at about 3,600 revolutions per minute.

A shaft links the turbine to a generator which uses the kinetic energy from the turbine to spin magnets around a coil that converts the mechanical energy into magnetic energy that generates alternating current *(AC)* electricity. AC is electric current that reverses direction, usually many times per second. This makes it possible to transmit electricity across greater distances, as compared to direct current *(DC)* electricity.

## Wind Turbines

Wind turbines create electricity by utilizing wind to turn propeller-like blades around a rotor. The rotor is connected to a main shaft, which spins magnets in a generator to produce electricity similar to the generators in power plants, but on a much smaller scale.

## Solar Arrays

Solar arrays use panels of photovoltaic cells that convert the sun's radiation into electricity by allowing photons *(particles of light)* to knock electrons free from atoms, generating a flow of DC electricity.

Each photovoltaic cell is basically a sandwich made up of two slices of semi-conducting material that is usually silicon. Typically, the top layer contains phosphorous which adds extra electrons, with a negative charge, to that layer. The bottom layer contains boron, which results in fewer electrons and creates a positive charge. This creates an electric field at the junction between the silicon layers. When a photon of sunlight knocks an electron free, the electric field will push that electron out of the silicon junction. Metal conductive plates on the side of the cell collect those electrons and transfer them to wires as DC electricity. A converter changes the DC electricity to AC electricity that is then usable by the electric grid.

# behind the Switch...

## Transmission

### MOVING AND TRANSFORMING HIGH VOLTAGES INTO USABLE POWER

Once electricity has been generated, *the next step in powering your home or business is transmitting electricity from the generation source to the Cooperative's distribution system through high voltage conductors, more commonly known as power lines.*

To transmit electricity over long distances, it first must go through a transformer that "steps-up" (increases) the voltage so that, for example, power generated in Alma, Wisconsin, can reach Stewartville, Minnesota, and beyond. Transformers got their name because they transform electricity from one voltage to another. They can increase or decrease voltages.

Like water pressure in a pipe, voltage is the force at which electricity is flowing through the power line. The amount of electric force carried through a high-voltage transmission line is measured in kilovolts *(kV)* which is equal to 1,000 volts. Typically, the higher the voltage the larger the structures that carry the lines. See the small diagram on page 7 for examples of typical transmission line structures and the voltages they support.

While there are several designs of transmission structures, they are self-supporting and designed to resist all forces due to conductor loads, unbalanced conductors, wind from any direction and the build-up of ice. However, on occasion, tornados and extensive ice storms have damaged transmission facilities and disrupted electric service to large geographic areas.

Transmission lines are upgraded and new lines built as demand for electricity continues to grow. Therefore, the transmission system must be sized properly so that it has enough capacity, or carrying power, to meet the demand. They are located according to where the power is generated and the population centers to which it is eventually delivered. This could be distances of hundreds of miles.

As an electric generation and transmission *(G&T)* cooperative, our power provider, Dairyland Power Cooperative, owns and operates a network of 69 and 161 kVa lines as well as a share of some 345 kVa transmission assets in. assets in the states of Minnesota, Wisconsin, Iowa, and Illinois. Assets include more than 3,720 miles of transmission lines. Note that a 69 kV transmission line costs over $200,000 per mile of line to build which is why placement is strategic and proper maintenance is critical.

Managing the transmission portion of Dairyland's operations requires planning with other utilities, normally as part of a regional transmission organization *(RTO)*. Dairyland is an active member of the Midcontinent Independent System Operator, Inc. *(MISO)* and works to ensure that cooperative perspectives are included in decisions regarding the management of the vast electrical grid. See the box out on page 7 to learn more about MISO.

One cause of transmission line related outages is trees or tree branches falling onto the power line during severe weather such as high wind and ice storms. This is one of the critical reasons it is so important for electric utilities to invest in the maintenance or removal of trees in the right-of-way.

# the energy that powers us

GENERATION | TRANSMISSION | DISTRIBUTION | CONSUMPTION

The voltage of transmission lines varies according to the grid system to which they belong. Nevertheless, the voltage is too high to be used by the end-user. To reduce the voltage to a level that can be used by the consumer, the electricity must be sent through transformers in a substation.

Distribution substations are the point of inter-connection between the G&T system, like Dairyland, and an electric distribution system such as People's Energy Cooperative. DPC maintains about 40 transmission substations across their entire system.

For safety reasons, substations are secured with fencing and security systems and may only be entered by qualified utility personnel wearing required personal protective equipment. They contain a complex variety of sensitive equipment and high voltage electricity. Equipment includes conductors, transformers, capacitor banks, circuit switches, lightning arrestors, fuses and circuit breakers, rectifiers and relays. All play a role in providing safe and reliable electricity.

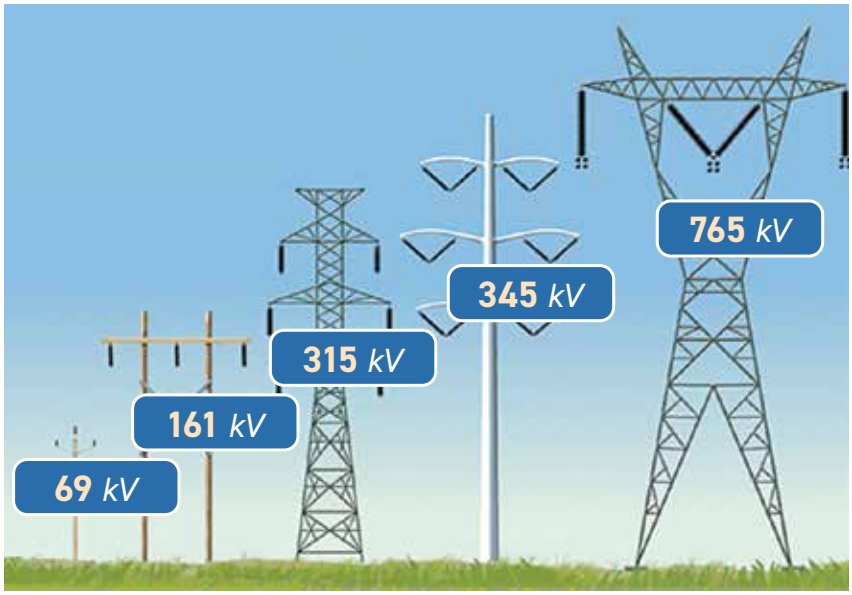
When a power outage occurs on a transmission line, the flow of electricity can often be re-routed across another transmission line into the substation. The configuration of these circuits is a key factor in restoring electric service to a broad area of the distribution cooperative.

## MISO

*The Midcontinent Independent System Operator (MISO) is a regional transmission organization (RTO) that provides a platform for matching the supply and demand of electric energy enabling G&Ts like Dairyland to purchase and sell power based on their needs and the needs of other MISO members. They are charged with ensuring the reliable delivery of electricity, at the lowest cost, across 15 U.S. States and the Canadian province of Manitoba and assuring consumers of market transparency.*

**Visit www.misoenergy.org for more info.**

## TYPICAL TRANSMISSION LINE VOLTAGES



# behind the Switch...

## Distribution

### THE FINAL LINK IN DELIVERING ELECTRICITY TO WHERE YOU NEED IT

Electricity is moved from the substation to your electric meter through People's Energy Cooperative, your electric distribution cooperative. *As a distribution cooperative, we distribute electricity from the generation and transmission company's (G&T) transmission substations to our member-owners. We accomplish this through our network of 29 substations, 2,906 miles of distribution power lines, and countless pieces of electrical equipment, including:*

#### SUBSTATIONS

Distribution substations transfer power from the transmission system to the distribution system by transforming voltages from high to low or the reverse using transformers. A distribution substation is typically fed by two transmission lines and can isolate faults in either the transmission or distribution system to help minimize outages. It can also be a point of voltage regulation.

#### OVERHEAD & UNDERGROUND PRIMARY LINES

For decades, overhead power lines were the only lines constructed. However, improved technology has made underground power lines feasible to install. Physical terrain, soil type, rights-of-way stipulations and requirements of end-users are all factors that impact whether an overhead or underground power line is constructed. As aging power lines are rebuilt, they may be changed from overhead to underground for reliability purposes since underground lines are less susceptible to extreme weather. However, underground is more costly to install *($52,000 per mile of line versus $45,000 for overhead single-phase)* and is not immune to Mother Nature because they can still be affected by lightning strikes.

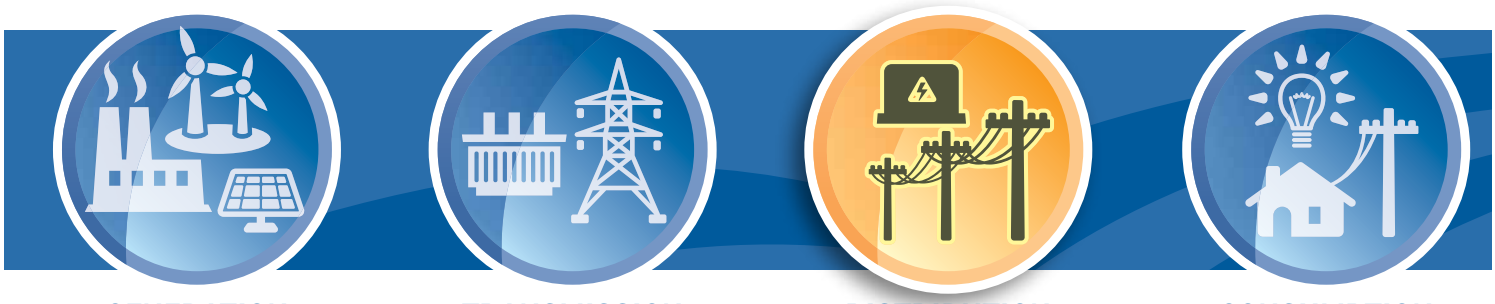
Currently, about 2,070 miles of the Cooperative's system are overhead lines and approximately 840 miles are underground. This network of primary 'feeder' lines are fed from substations and carry electricity in a circuit that serves many members in a specific geographic area. Our crews are trained to work on both overhead and underground power lines.

#### THREE-PHASE AND SINGLE-PHASE SERVICE

Our cooperative operates three-phase and single-phase service depending on the needs of the members on the line. Electrical service is transmitted in the form of alternating current whose magnitude and direction reverse cyclically (60 times per second – 60Hz). A single-phase power line has current flowing through only one wire and one return path, called a neutral line, that completes the circuit. Three-phase service is three single phase lines which are out of phase by one third of a cycle so that the individual voltages peak one after another in sequence. Single-phase is typical for homes while large power users, such as farmers and industry, use three-phase service.

**Just as it is necessary to keep a safe distance away from overhead power lines, it is just as dangerous to accidently cut into an underground line. Call 811 to have the location of underground facilities flagged before you dig or excavate.**

# the energy that powers us



GENERATION TRANSMISSION DISTRIBUTION CONSUMPTION

**DISTRIBUTION EQUIPMENT:**
Distribution power lines require transformers, regulators, switches, fuses and oil circuit reclosers to operate effectively. Transformers, regulators and switches are equipment critical to keeping voltages within specified tolerance levels. Transformers increase or decrease voltages. Regulators keep voltages within the prescribed range to ensure that the proper voltage is supplied to consumers. Switches are used to redirect or cut-off power flows for load balancing when demand is high or to avoid disrupting service.

Fuses and circuit reclosers are essential to the safe operation of the system. Fuses protect transformers from current surges and overloads by opening when they occur. Circuit reclosers are circuit breakers equipped with a mechanism that can automatically close the breaker after it has been opened due to a fault. They are used to detect and interrupt momentary faults.

Have you ever had your lights blink about three times before the power went out? That was due to the proper functioning of a circuit recloser. This mechanism is used on overhead power lines to identify faults. The cause of many faults may be temporary occurrences, such as a squirrel or a tree limb blowing into the line. As the recloser senses the fault it automatically opens the circuit, shutting off the flow of electricity. It then automatically tries to reset its breaker. It will try this process three times before the power remains off and requires the dispatch of a repair crew. This device improves our continuity of service and reduces labor costs by automatically restoring power to the line following a momentary fault which you'll experience as a blink. Many blinks are caused by trees blowing into a line, which is why trimming trees and clearing rights-of-way are so important in reducing blinking lights and power outages.

**DISTRIBUTING DISTRIBUTED GENERATION:**
As the role of renewable energy steadily increases, we face new challenges. Distribution systems were designed to distribute electricity, not receive it. Distributed generation *(DG)* facilities are small stand-alone power producers *(i.e. member-owned solar arrays and wind turbines)*, which are located within a utility's service territory. By law, utilities must accept and pay retail rates for excess power generated by a member's DG system that is under 40kW. Interconnecting with DG systems requires special equipment and contractual arrangements with the power producer to ensure it doesn't harm the system and the lineworkers who build and maintain it.

# behind the Switch...

## Electricity Consumption

### FEEDING YOUR HOME OR BUSINESS SERVICE LOCATION

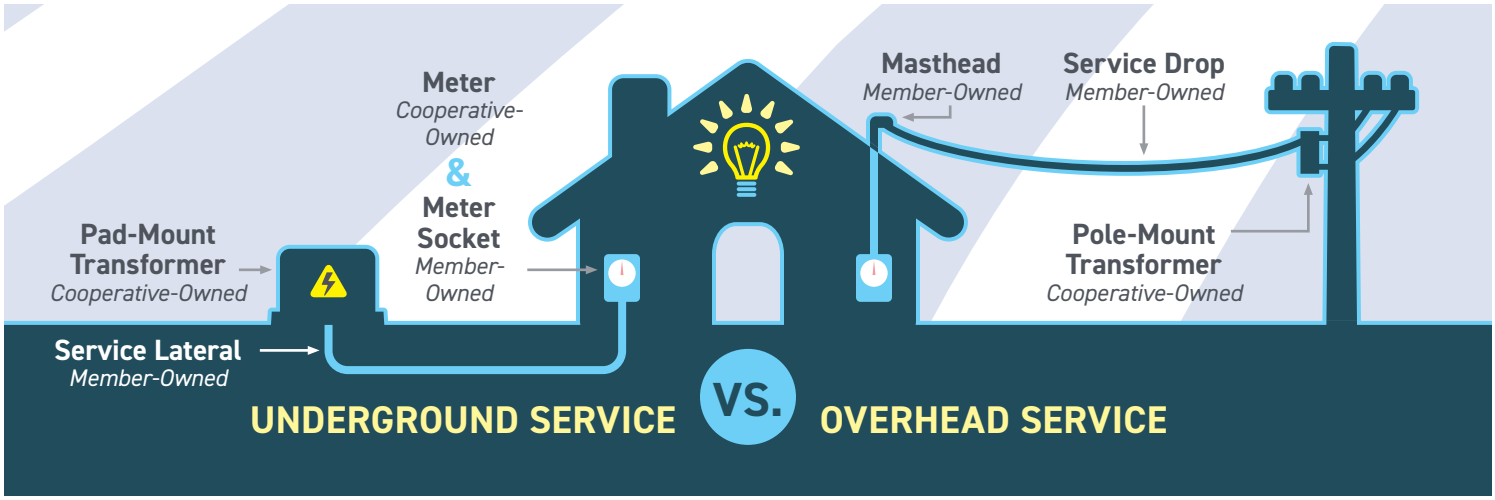
*The final step in the distribution process is feeding your service location from the distribution system so you can consume electricity. This is accomplished through a service transformer, secondary power lines and the point of connection, shown in the illustration below.*

A SERVICE TRANSFORMER may be on a power pole or mounted on a pad mount and may serve one or several members. Either way, it decreases *(or 'steps down')* the voltage from the distribution line to a voltage that can be used by appliances and equipment. It then distributes electricity through the secondary power lines.

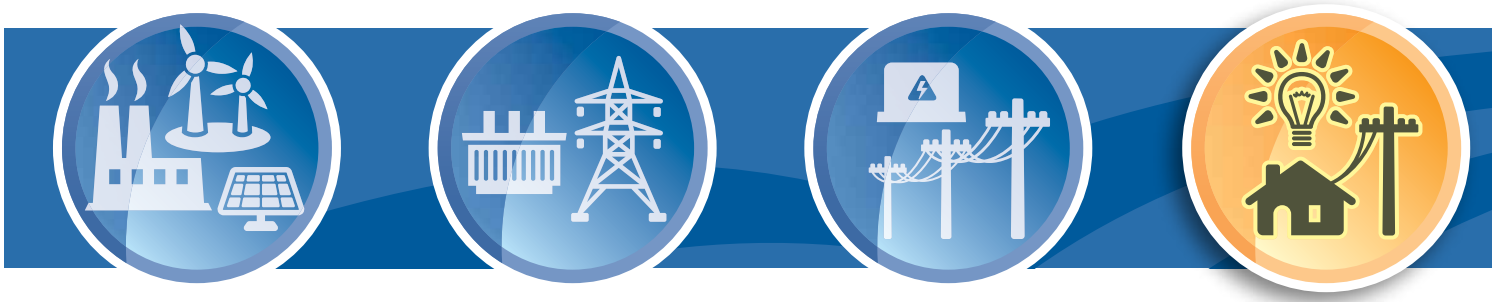
THE SECONDARY POWER LINE delivers electricity from the transformer to the connection point of a home or business. This line can be overhead or underground. It is referred to as the "service drop" for overhead lines and the "service lateral" for underground lines. In most cases, these lines are owned by the member.

THE CONNECTION, OR SERVICE POINT, is where the secondary line is connected to a home or business. In the case of overhead lines, the service drop typically connects to the building at the top of a vertical pipe called a masthead. It's important to note where this is when you are performing projects that require you to work near this area so you, or equipment such as a ladder, do not contact the power line.

Underground service typically feeds up from the ground to the meter through a galvanized pipe. It's important to know the location of the underground lines feeding the connection point so you don't accidentally dig into them. Always call 811 to have underground utilities located and marked. It's important to note that locators will only locate services owned by utilities. It is the property owner's responsibility to know if other electrical or telecommunication lines have been extended to other locations on the property.



# the energy that powers us



**GENERATION** **TRANSMISSION** **DISTRIBUTION** **CONSUMPTION**

ELECTRIC METER: The electric meter is the last point in the Cooperative's distribution system and it reports the amount of electricity consumed. Our automated metering system can also measure demand. Unlike the consumption of electricity which is measured in kilowatt hours *(kWh)* for energy consumed over time, demand is the measure of capacity or how much energy in killowatts *(kW)* is consumed at one time. Understanding demand is important because the Cooperative must ensure we have the proper equipment in place to support the demand requirements of our members.

Demand also impacts the Cooperative's cost of power. Part of our cost for power is based on the highest level of demand our system requires from the generation and transmission companies *(G&Ts)*. This is one of the reasons why we issue peak energy alerts and offer load management programs. Our hope is that we can reduce demand during peak times by having members:

- SHIFT HIGH USAGE ACTIVITIES *to different times of the day when there is less demand;*
- UTILIZE A NON-ELECTRIC *heat source during winter;*
- ALLOW THE COOPERATIVE *to manage air conditioner, water heater, heating loads;*
- GENERATE THEIR OWN POWER *in the case of some farmers or commercial accounts;*
- SCHEDULE YOUR ELECTRIC VEHICLE CHARGING *to occur overnight when demand and wholesale electric prices are low.*

'If you want to better understand your consumption patterns, you can monitor and analyze it through SmartHub. SmartHub is a web-based application that enables you to analyze your energy use, manage your account information, pay your bill and receive notifications from the Cooperative on your computer or smart phone.

ELECTRIC SERVICE PANEL: After the meter, there are typically three service conductor wires that feed a residential service panel: two hot feeder wires and a neutral wire that bonds to the grounding system of the home or structure.

It's important to know where your service panel is and make sure it is easily accessible. If you call in to report an outage and there are no other outages reported in your area, one of the first things we do is ask you to check your electric service panel. We do this before we send a crew to evaluate the situation because a blown fuse or tripped breaker is often the cause of power issues.

If we need to dispatch a crew, we send one that is closest to the outage to limit the amount of time it takes to restore power. Our lineworkers are on call 24 hours a day, seven days a week to ensure power is restored as safely as possible. Most outages in 2022 were caused by equipment failures (22%), trees (19%), public accidents (15%), power supplier (13%), and weather (12%).

*If you have any additional questions for you home or business, feel free to contact the Cooperative.*

# People's Energy Cooperative

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