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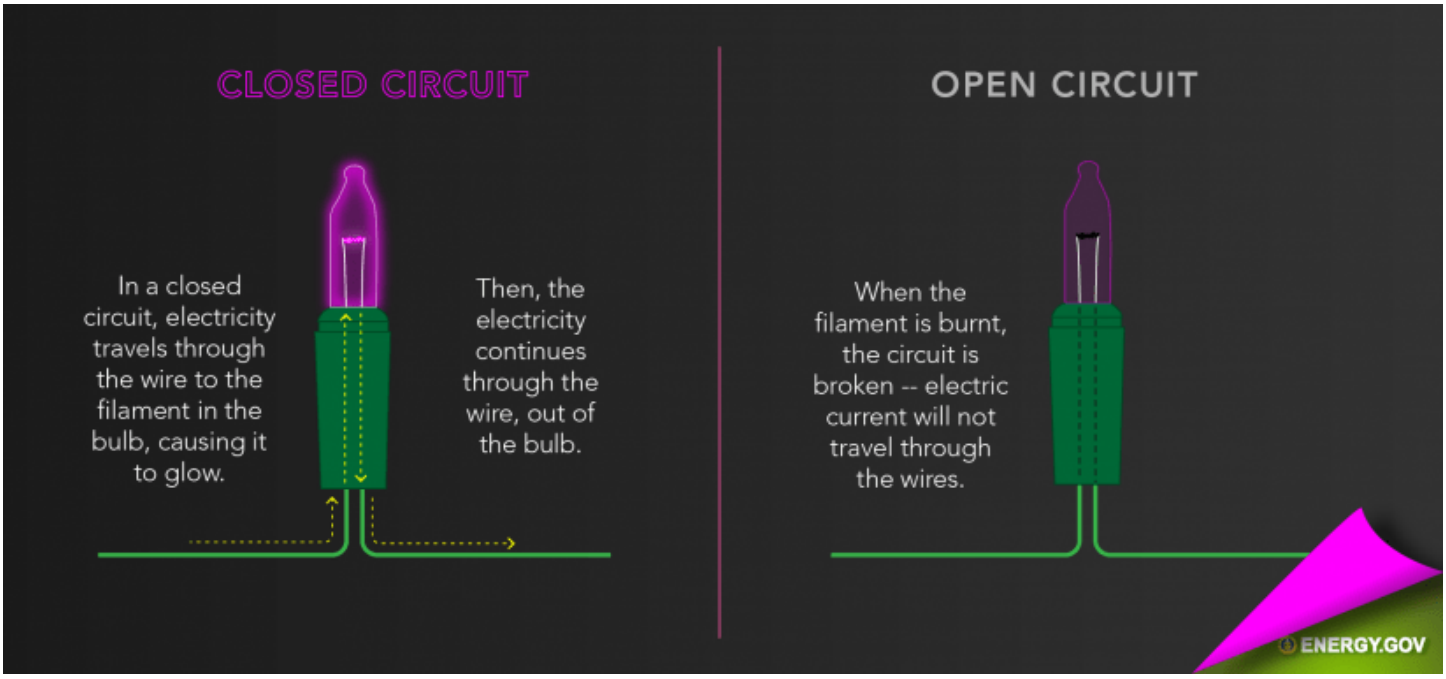
How holiday lights work

Information from the U.S. Department of Energy

Holiday lights are a great way to learn about the flow of electric current. In a simple circuit, including one in an incandescent light bulb, electricity travels through a closed circuit, passing over a filament, causing it to glow brightly. The more current that passes over a filament, the hotter it will get, the brighter it will burn, and the quicker it will burn out. If the circuit is broken, or open, no electricity will pass over the filament and it will not light. If the current is too great, the filament will melt, or blow out, causing the circuit to become open.



But we want more than one light to shine on our Christmas tree or along the roofs of our homes. If you want to connect multiple light bulbs to the same power source, there are two ways to do that: either attach the lights in series or in parallel.

Parallel vs. Series Lights

When lights are attached in series, the electricity passes from the power source to the first light, and then from light to light until it returns to the power source. In this setup, when a filament within any one bulb blows out, it creates an open circuit in the wiring. As we mentioned earlier, when a circuit is incomplete, or open, electricity fails to pass through any of the wire, causing all the lights to go out.

When lights are attached in parallel, each light is on its own circuit to the power source. If one filament burns out, it has no effect on the remaining lights, as they each continue to be in a closed circuit with the power source. Check out the difference.

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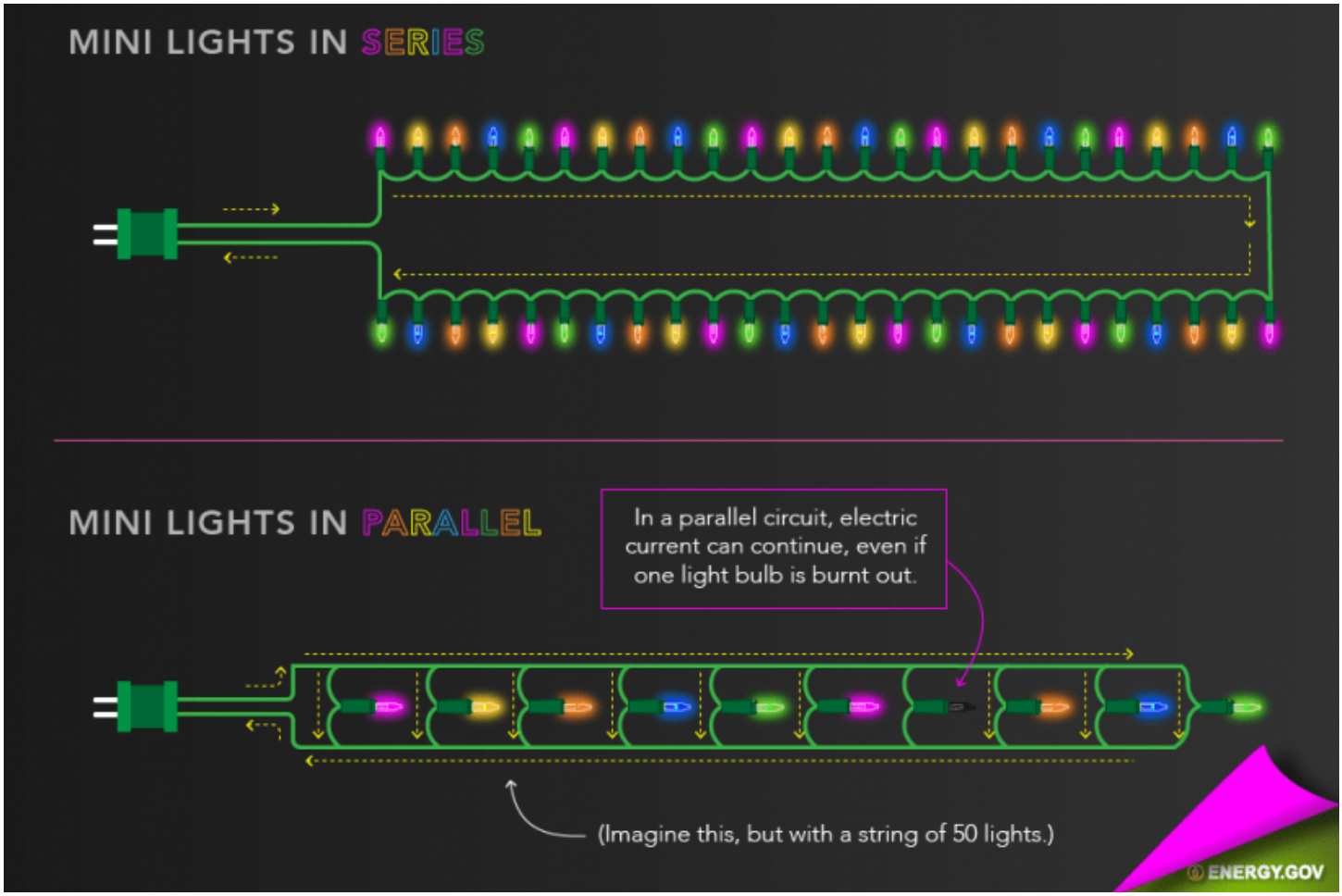
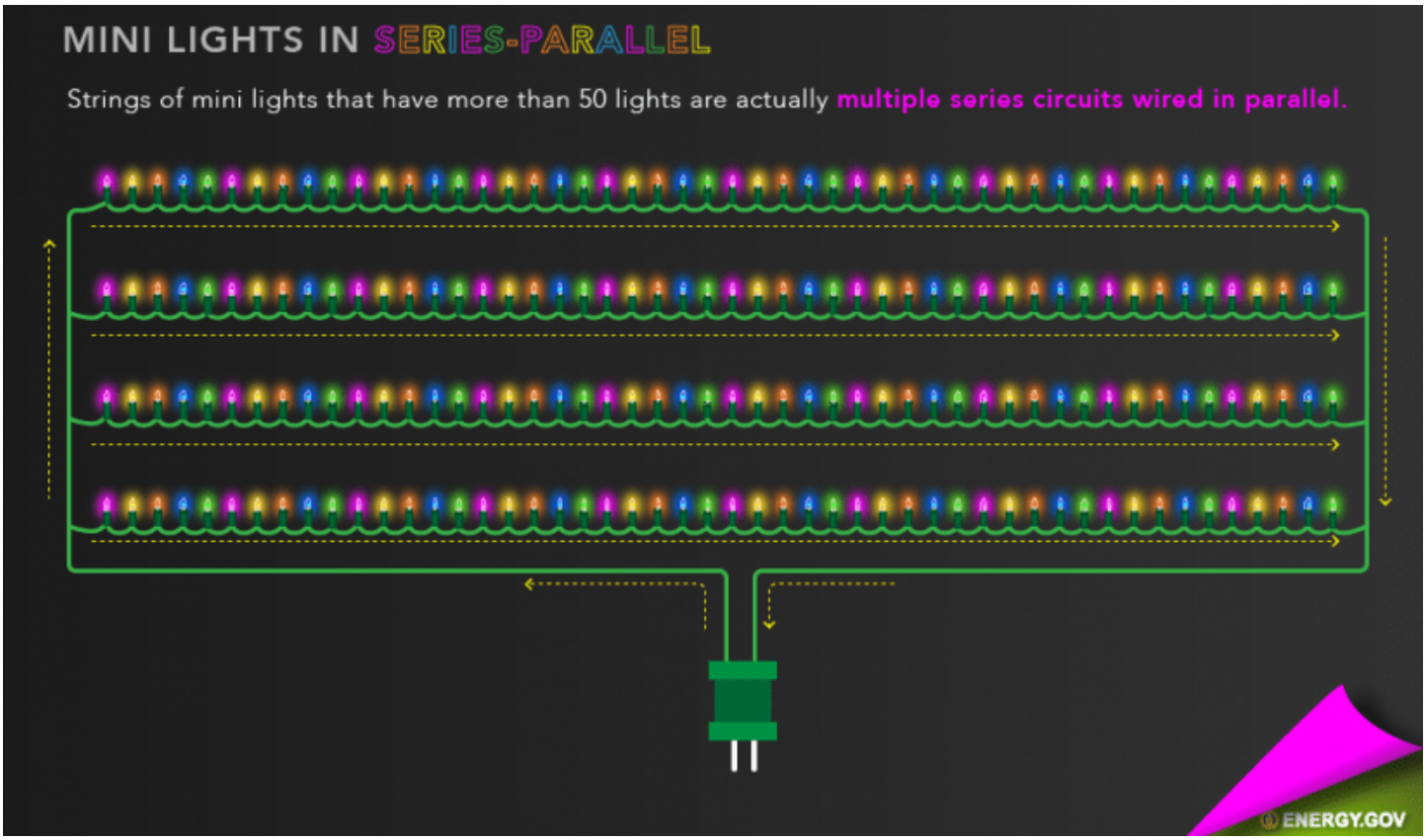


With strings of holiday lights, engineers decided that the best option was to connect several series of lights together in parallel. In other words, holiday lights are both in series and in parallel. Let's see what this looks like:



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This way, when one series of bulbs becomes defective -- say, from a loose bulb -- it should have no effect on any of the other series of bulbs, since they are in parallel to the defective series. This is why sometimes only one portion of your lights will become defective, while others will remain functional. When additional strings of lights are attached to the end of a string, these lights are added in parallel to the original strand.

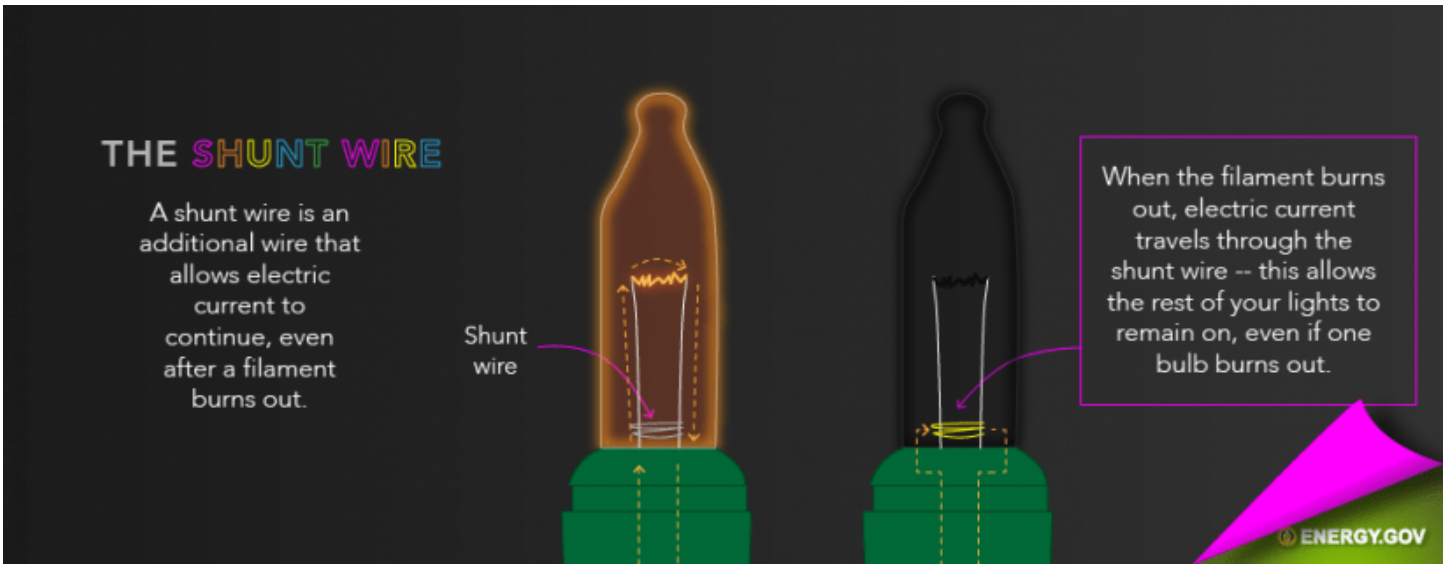
But what about when a bulb goes out in a series? It used to be that when one bulb went out, the entire series would go out. If this were the case, you would have to check each bulb individually to see which one was blown out. If multiple bulbs were blown out, this would become exceedingly difficult.

Enter the "shunt." What is a shunt, you ask? I will tell you!

Shunts And Fuses Save The Day

A shunt is any device that allows current to continue flowing through a circuit by creating a path of lower resistance than the original path. In incandescent holiday lights, shunts are small wires wrapped beneath the filament. Initially, they are coated with a substance that makes them an insulator. In other words, electricity cannot pass across the shunt as long as the filament exists, because the coating gives the shunt a higher resistance initially than the filament, and the electrical current avoids the shunt in order to find the path of least resistance through the filament.

If the filament burns out, however, the high temperature from the burnout will cause the substance coating the shunt to melt off, revealing the lower resistance wire beneath. Now the shunt has gone from an insulator to a conductor, and current passes along shunt, keeping the circuit closed, and the remaining lights burning. Check it out below.



Recently, as I was putting up lights, I tripped on a wire and the lights went out. The string of lights remained plugged in so I was stymied as to what happened. I unplugged, replugged … unplugged, replugged the string. Nothing. Then it came to me. "The fuse!" I said under my breath. I must have caused some sort of short circuit when I jolted the wire.

While shunts serve to remedy an open circuit, fuses work to prevent damage due to a short circuit or any other dramatic increase in current. A short circuit is the opposite of an open current. In other words, a short circuit is caused when electrical current finds an unintended path of lower resistance. At a steady voltage, this causes a spike in current, which can cause a variety of problems -- some mild (increased rate of incandescent bulb burnout) and some severe (system overheating and fires).

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Fuses are important safety features for many electrical appliances, but most of us don't even know that they're there. In holiday lights, the fuse can be found near the part of the strand that plugs into the wall, often called the male end of the wire. Normally, the fuse is accessible through a small plastic door in the plug that can be opened and closed for replacing the fuse.

As the electrical current within a wire increases, the wire can heat up, at times causing melting or even fires. To prevent this, fuses were introduced as so-called “sacrificial devices” (so very selfless of them!). When the current increases past a safe level, instead of the wire melting or your Christmas tree catching fire, the fuse safely opens the circuit, averting many disastrous scenarios.

Fuses are typically small sections of replaceable wire, rated to a maximum current level. Because they are more delicate than the rest of the wiring, a fuse will burn out before overcurrent has an opportunity to overheat other portions of the light strand. When a fuse breaks, the circuit becomes incomplete and current cannot flow through the remainder of the circuit.

So What About My New Led Holiday Lights?

LED holiday light strands are becoming more popular. They’re sturdier, last longer and consume 70 percent less energy than conventional incandescent light strands. It only costs $0.27 to light a 6-foot tree for 12 hours a day for 40 days with LEDs compared to $10 for incandescent lights. On top of that, they are significantly less likely to burn out or break compared to their incandescent forerunners. Why is this?

While incandescent light technology is relatively straightforward (a heated filament glows much like any ember in a fire), the mechanics of LED lights are much more sophisticated. It requires a bit of insight into particle physics to understand, but I’ll give you the quick version: A diode consists of something called a p-n junction -- two semiconductor materials next to each other, one with a positive charge (p) and one with a negative charge (n). When current is applied to the system, electrons from the negative side move toward the positive side. On the positive side, particles called “electron holes” move toward the negative side. When an electron and an electron hole collide, a small amount of energy is released as a photon. The result is the visible light we see in an LED.

LEDs are wired in series-parallel just like the traditional bulbs we described above. Unlike incandescent lights, however, LEDs do not typically make use of shunts. When incandescent light bulbs fail, the missing filament causes an open circuit -- a drastic increase in resistance too high for the current to pass across. On the other hand, when an LED fails, it typically short circuits, creating a path of lesser resistance. This essentially takes the place of a shunt, making shunts unnecessary for LEDs.

Article by Daniel Wood

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Power Summit presentations available on NDEE website

The 2022 Power Summit, sponsored by NDEE and NPPD, was held in Lincoln on Oct. 6, 2022. The Power Summit provides those in the power generating industry and those responsible for the implementation of the associated environmental regulations with an opportunity to exchange information related to power production, environmental policies, programs, and issues in Nebraska.

A primary objective of the Summit is to enhance the dialogue that has been established between the power industry and the associated regulatory agencies.

The agenda for the summit and presentations that were made that day are available on NDEE's website. NDEE and NPPD would like to thank all presenters for their time and efforts in supporting the Power Summit.

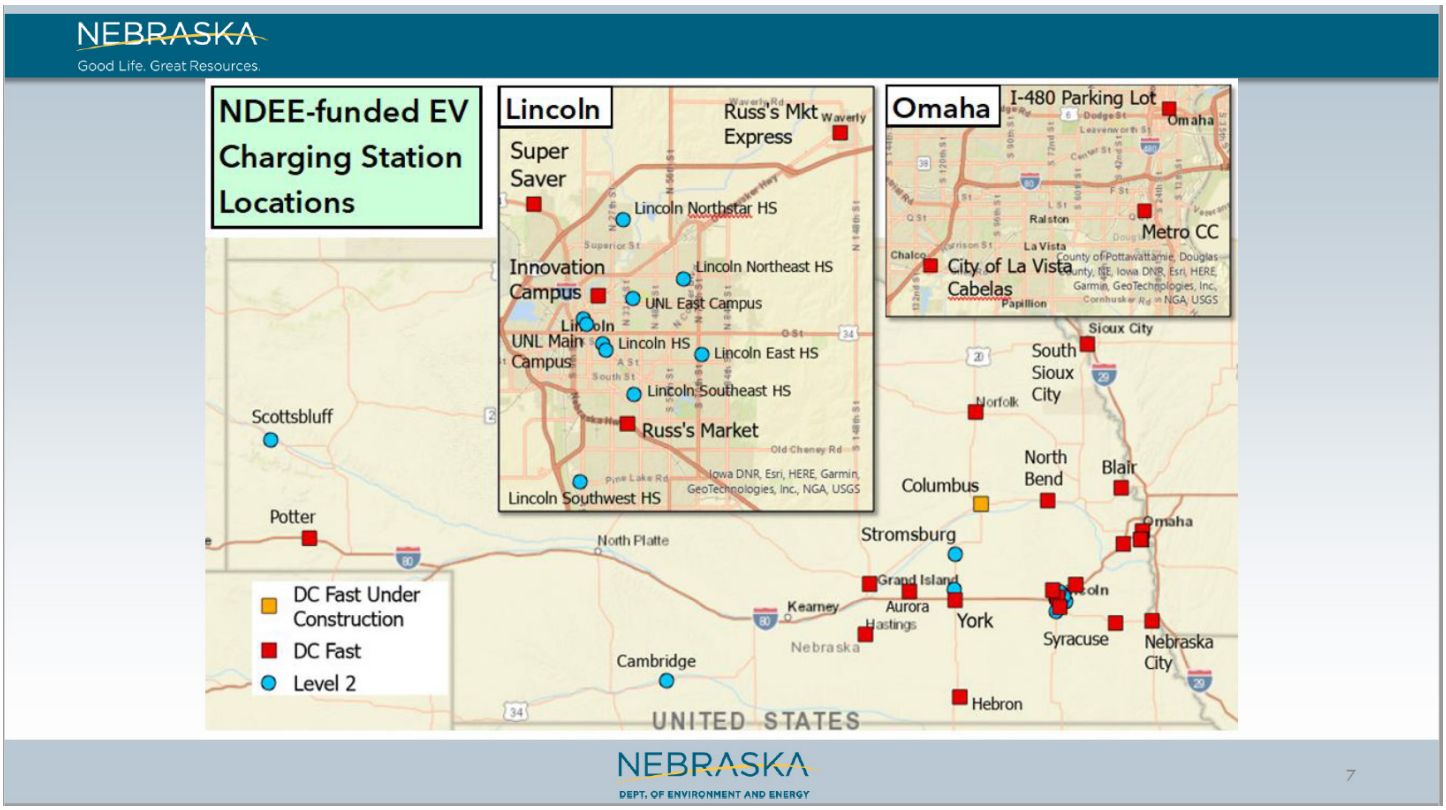

Photo from NDEE

Pictured is a slide from NDEE Deputy Director Kara Valentine's presentation at the 2022 Power Summit. Slides from her presentation and others are availble on NDEE's website.

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EPA announces approval of Nebraska's expanded E30 Demonstration Project

Governor Pete Ricketts announced Oct. 20 that the U.S. Environmental Protection Agency (EPA) has approved the continuation of groundbreaking research being done in Nebraska on E30 fuel. Results of the State's initial pilot program, launched in 2019, showed that E30 is safe and reliable fuel for use in conventional vehicles. Under current EPA guidelines, only flex fuel vehicles (FFVs) can use ethanol blends higher than E15. Through its second phase of research, the State intends to underscore its initial findings in order to support regulatory change to make E30 accessible to all drivers.

Photo by Amanda Woita, NDEE

The Environmental Protectoin Agency approved the continuation of Nebraska's research on E30 fuel. E30 fuel is an ethanol blend, and the State of Nebraska's previous study showed it is safe and efficient to use in non-flex fuel vehicles.

In June 2019, the State of Nebraska began its study on the use of locally sourced E30 biofuel in conventional vehicles. State teammates outfitted 50 State-owned vehicles with onboard tracking systems to capture data on vehicle performance. They monitored those vehicles for an entire year. Data was submitted to engineers at the University of Nebraska-Lincoln (UNL) for analysis.

In 2021, UNL's Engineering Department released its analysis of data from the first phase of the demonstration. It clearly showed that E30, a blend of gasoline and 30% ethanol, is safe and efficient to use in non-FFVs. Read the report here. This peer-reviewed research was the first scientific demonstration of its kind.

The second phase of the E30 demonstration will begin in the fall 2022 and include up to 825 State vehicles. While further demonstrating the safety and reliability of E30, the State will also significantly reduce its fuel costs and carbon footprint through the program.

"Promoting higher ethanol blends should be a centerpiece of our national strategy to lower gas prices," said Gov. Ricketts. "Ethanol saves drivers money at the pump, is better for the environment, and creates opportunities for farm families in America's Heartland. Nebraska has already demonstrated that E30 can be used in regular vehicles without reducing performance or requiring extra maintenance. With our expanded study, we'll be in an even stronger position to advocate regulatory change to make E30 accessible to everyone."

One of the key findings from the first phase of the E30 demonstration is the positive environmental impact of allowing statewide E30 consumption. According to the Nebraska Ethanol Board, if only 10% of the 1.7 million registered non-FFVs in Nebraska used E30 instead of E10, ethanol consumption would increase by 18.5 million gallons per year and carbon emissions would decrease by 64,000 tons per year.

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"This marks another significant milestone for the nation's ethanol industry and another significant step in reducing gasoline's aromatic content," said Reid Wagner, Executive Director of the Nebraska Ethanol Board. "We have demonstrated that higher ethanol blends release fewer harmful emissions, have no detrimental impact on vehicles, and save consumers money. We hope to see other states follow Nebraska's lead by demonstrating the use of E30 in their state fleets."

Wagner said the State plans to work with industry partners and the EPA to continue the E30 demonstration for at least two years.

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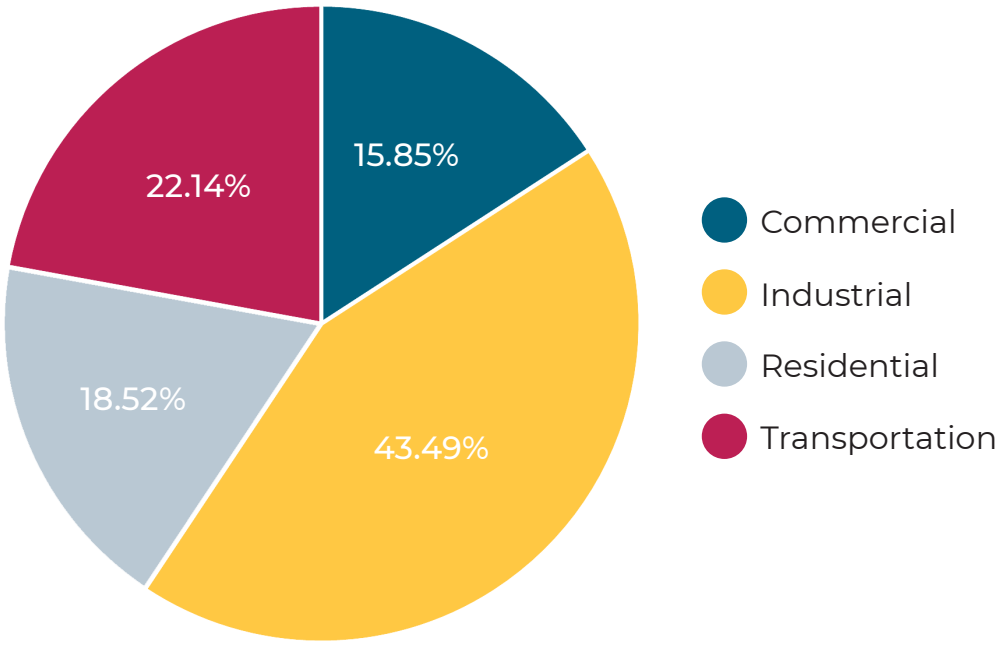
Nebraska by Numbers

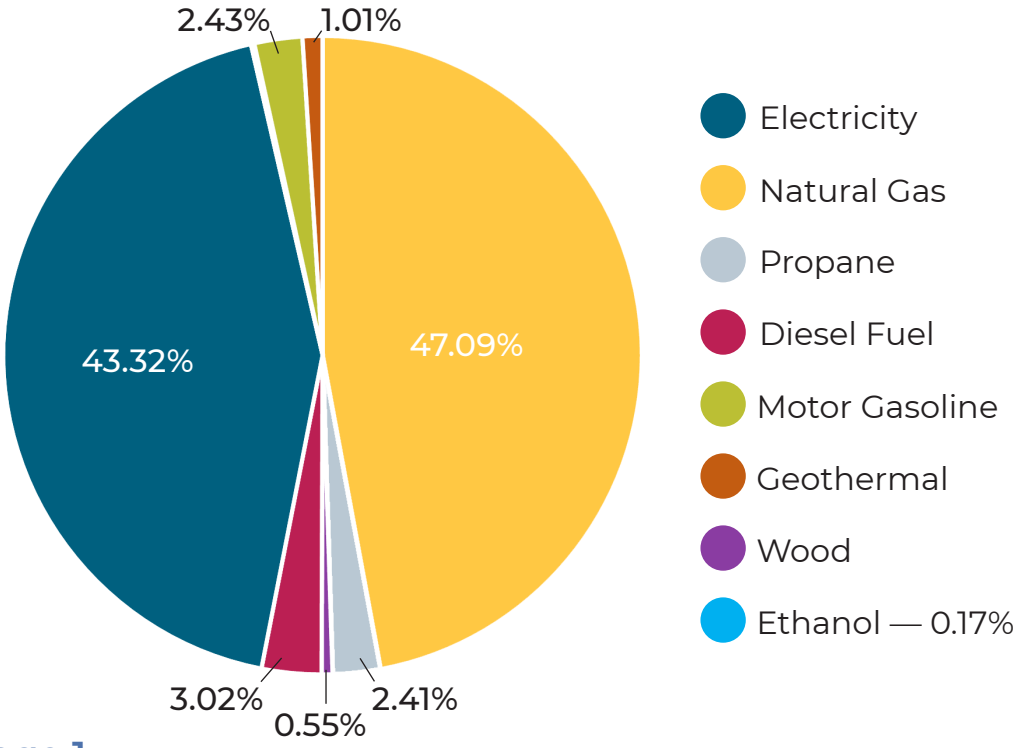
This edition of Nebraska by Numbers focuses on total energy consumption in Nebraska by sector (commercial, industrial, residential and transportation), and takes a closer look at the fuel types consumed by the commercial sector in 2020. See future editions of the Nebraska Energy Quarterly to view similar pie charts for the industrial, residential, and transportation sectors.

Information used to create these graphs comes from The Nebraska Department of Environment and Energy and the Energy Information Administration.

Total energy Consumption by sector, 2020



Net energy consumption by fuel type Commercial Sector, 2020



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Cut gas costs this holiday traveling season with three easy tips

Information from the U.S. Department of Energy

It is just before Christmas and people are hitting the road to visit friends and relatives. To help save money on fuel after spending so much on gifts, here are some easy tips for driving more efficiently, which is not only safer, but less expensive and better for the environment.

Photo by Jantine Doornbos on Unsplash

Holidays may mean more driving. To save on gas costs, the U.S. Department of Energy offers tips like cleaning out your trunk before leaving home, among other recommendations.

1) Slow your roll: Aggressive driving, such as speeding and rapidly accelerating or braking, wastes gas and can lower your mileage by 5% to 33%. While the speed for optimal fuel economy ranges with each vehicle, gas mileage usually decreases rapidly at speeds above 50 miles per hour (mph). In fact, every 5 mph you drive over 50 mph is like paying an additional 24 cents per gallon for gas, depending on the price for gas in your area. To find out how much speedy driving is costing you, check out this new speed penalty tool.

2) Clean out your trunk: Of course it is unavoidable that you are going to be hauling gifts and possibly other people with you, but before heading out, lose the extra unneeded weight in your car. Extra weight can cost you in lost fuel efficiency—fuel economy decreases by up to 2% for every extra 100 pounds in your vehicle, and the extra weight generally affects smaller vehicles more than larger ones. Besides, this will help make room for the things you need for the trip.

3) Avoid needless idling: It can be tempting to keep your car on and idling as you wait in a parking lot or the driveway, but you can save money and reduce pollution by just turning the engine off when parked. Idling can use a quarter to a half gallon of fuel per hour, depending on the vehicle's size and whether the air conditioner is being used. Burning that extra fuel can really add up over time if you're not careful!

The cost savings above assume gasoline price of $3.19 per gallon. For more fuel-efficient driving tips or to customize these savings based on the price for gasoline in your area, visit fueleconomy.gov.

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