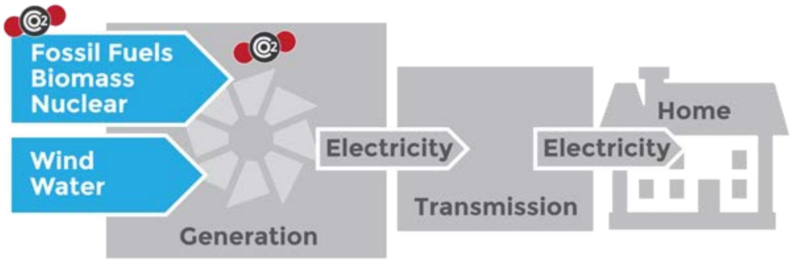
Household Electricity

Electricity is different from other forms of energy because it merely delivers the energy harnessed from other materials, the primary energy source, at the generating facility.

Move a magnet through a circle of copper wire, and you get electricity. Spin giant magnets in massive coils of wire, and you generate electricity to power cities.

Spinning those magnets requires energy—energy to turn a turbine that spins the magnets in the generator. That energy might come from fossil and nuclear fuels, wind, running water, or the sun.



FOSSIL FUELS | WATER | WIND | NUCLEAR ENERGY | BIOMASS | SOLAR

Fossil fuels—coal, oil, and natural gas—are the most common energy source used to make electricity: 64% in North America and 68% globally. These fuels boil water to make the steam that spins the turbines that generate electricity.[1] Coal is the number one fossil fuel for electric power, followed by natural gas. Very little electricity comes from other petroleum products.[2]

Fossil fuels all contain carbon, so burning them makes CO_2 and increases your carbon footprint. The amount of CO_2 produced when a fuel is burned depends on the carbon content of that fuel. The pounds of CO_2 emitted for each million Btu of energy from some fossil fuels are as follows:[3]

Anthracite coal	229 lb
Bituminous coal	206 lb
Subbituminous coal	214 lb
Lignite	215 lb
Natural gas	117 lb
Propane	139 lb
Gasoline	157 lb
Diesel and heating fuel	161 lb

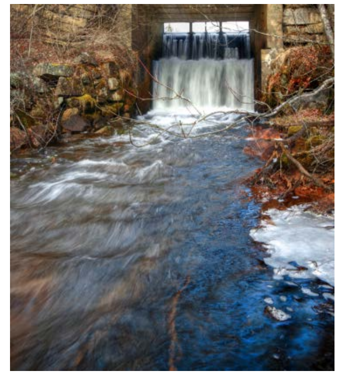
Why fossil fuels? Heat and pressure from being buried deep in the earth have concentrated the energy in fossil fuels, so they burn hotter and longer than the wood and other biomass from which they were formed. Fossil fuels are readily available and produce a stable and continuous flow of electricity—making them a reliable primary energy source.

[1] www.iea.org/publications/freepublications/publication/keyworld2014.pdf page 24 (accessed July 13, 2015).
[2] www.eia.gov/tools/faqs/faq.cfm?id=427&t=3 (accessed July 13, 2015).
[3] www.eia.gov/tools/faqs/faq.cfm?id=73&t=11 (accessed July 13, 2015).

ELECTRICITY

Energy Source

FOSSIL FUELS | **WATER** | WIND | NUCLEAR ENERGY | BIOMASS | SOLAR



Flowing water has spun turbines to generate electricity for over a century, either from dams or diversions. A change in elevation creates the flow and is the critical component to drawing energy from water to generate electricity—hydro. Using hydro to make electricity does not emit CO_2. Because a stable and continuous flow of water produces a stable and continuous flow of electricity, water is a reliable source of power.[1]

[1]green.blogs.nytimes.com/2009/10/30/report-argues-for-a-de-centralized-system-of-renewable-power-generation/?_r=0 (accessed July 13, 2015).

Energy Source

FOSSIL FUELS | WATER | **WIND** | NUCLEAR ENERGY | BIOMASS | SOLAR

Wind can also spin turbines, and this provides a good source of electricity when the wind is blowing (most efficiently between 25 and 35 mph[1] [40 and 55 kph]). But, the wind isn't always blowing; wind is a variable source of electricity. Electricity from wind does not emit CO_2.

[1]energybible.com/wind_energy/wind_speed.html (accessed July 13, 2015).

Energy Source

FOSSIL FUELS | WATER | WIND | **NUCLEAR ENERGY** | BIOMASS | SOLAR

Some power companies use the heat from nuclear fission to turn water into the steam that spins the turbines. This type of generation produces a stable and continuous flow of electricity.

Electricity generated from nuclear energy has no CO_2 emissions.

ELECTRICITY

Energy Source

FOSSIL FUELS | WATER | WIND | NUCLEAR ENERGY | **BIOMASS** | SOLAR

The heat from burning crop residue and wood waste can make steam to turn turbines (albeit at a smaller scale than fossil fuels). This type of generation produces a stable and continuous flow of electricity. Burning biomass creates CO_2. However, the consensus is that this CO_2 simply replaces the CO_2 recently removed from the atmosphere as part of the ongoing natural carbon cycle.

What is biomass? Organic nonfossil material of biological origin constituting a renewable energy source. Examples are wood, grass, corn stalks, etc.

Energy Source

FOSSIL FUELS | WATER | WIND | NUCLEAR ENERGY | BIOMASS | **SOLAR**

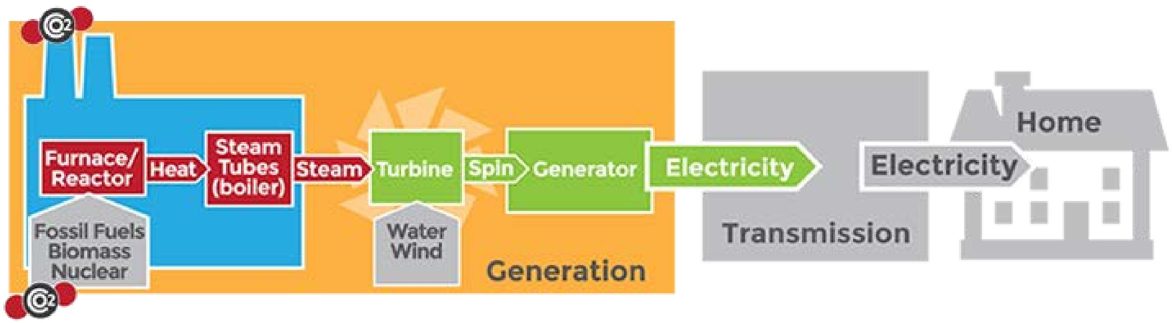
Solar energy makes electricity in two ways. Light-sensitive panels (containing photovoltaic cells) absorb sunlight, transforming it into electricity**.** For large-scale power generation, acres of mirrors concentrate sunlight on a solar-heated boiler in a solar tower that makes the steam to turn turbines. Electricity from solar does not produce CO_2 emissions.

Electricity from solar panels: Solar panels are perfect for low levels of off-the-grid electricity in remote situations.

Electricity Generation

Once the primary energy source arrives at the generating station, its energy is transformed into electricity in a generator—a machine consisting of powerful magnets that spin around heavy wires. The magnets induce electrons to move in the wires, creating electric current to send to customers.

Nearly all electricity manufactured for the U.S. power grid comes from generating stations that use turbines to spin the magnets. The energy source determines what spins the turbine—and its carbon footprint.



More on electricity generation in North Dakota: Spotlight on Energy

Electricity Generation

MAKING ELECTRICITY | CARBON FOOTPRINT

How Much Energy Is Used to Make Electricity?

In 2014, 39% of the energy consumed in the United States was transformed into electricity to power our homes, businesses, infrastructure, and so on.[1] (The other 61% was consumed to heat homes and businesses, for transportation, and for manufacturing.)

How Much Electricity Do We Make?

In 2014, the United States generated about 4093 billion kWh (kilowatt-hours) of electricity.[2] About 67% of the electricity generated was from fossil fuels (coal, natural gas, and petroleum). Nuclear power provided 19%. Hydropower provided 6%, and other renewables made up 7%.

[1] www.eia.gov/totalenergy/data/monthly/pdf/flow/css_2014_energy.pdf (accessed July 13, 2015).

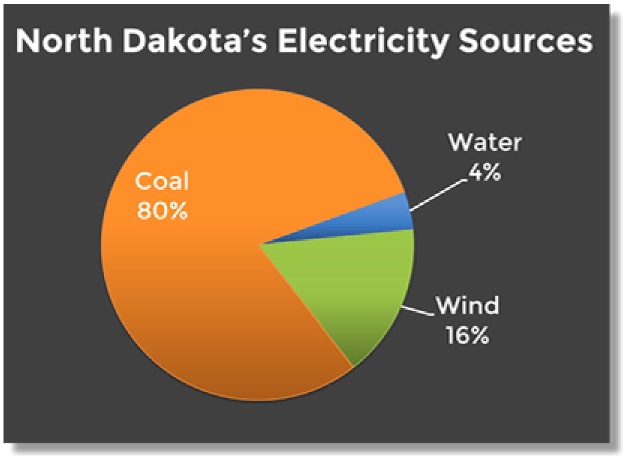
[2] www.eia.gov/tools/faqs/faq.cfm?id=427&t=3 (accessed July 13, 2015).

Electricity Generation

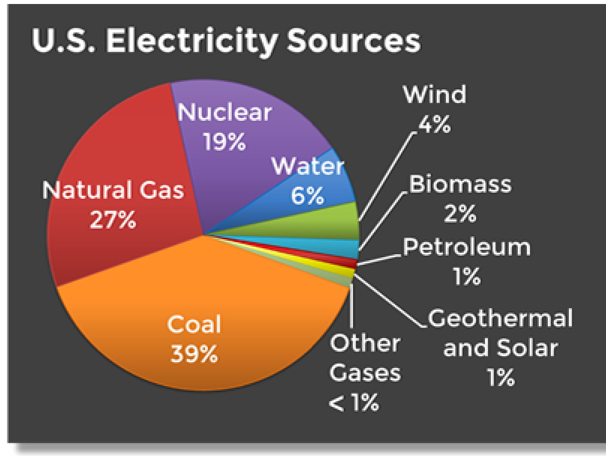
MAKING ELECTRICITY | CARBON FOOTPRINT

Electricity's Carbon Footprint Happens at the Power Plant.

When fossil fuels burn, the carbon in the fuel combines with oxygen in the air to form carbon dioxide—part of our carbon footprint.



In North Dakota, 80% of the electricity comes from burning one fossil fuel—lignite.



Nationwide, about 67% of electricity comes from burning fossil fuels that contribute to our carbon footprint.

Operating hydroelectric and wind farm, other renewable (geothermal and solar), and nuclear generating stations does not increase our carbon footprint. Generating electricity by burning biomass also produces carbon dioxide, but biomass is part of the natural carbon cycle and does not contribute to our carbon footprint.

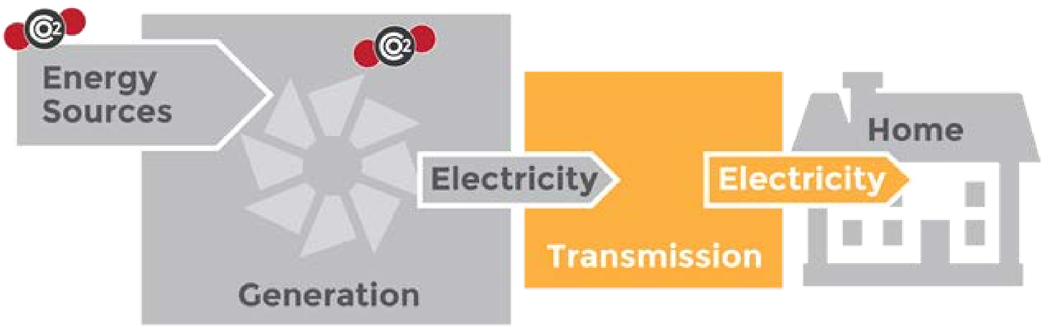
According the U.S. Environmental Protection Agency's carbon calculator, the carbon footprint of electricity for most of North Dakota is 1.5 lb of CO_2 per kWh.

ELECTRICITY

Transmission

Electricity flows from generating facilities through a network of power lines, transformers, and routing centers called the electrical grid. Electricity from all sources is mixed together or pooled on the grid for transport to our homes. During this process, resistance in the lines causes about 6% of the electricity to be lost (line loss) as heat between the generating station and the customer.[1]

[1]www.eia.gov/tools/faqs/faq.cfm?id=105&t=3 (accessed July 13, 2015).

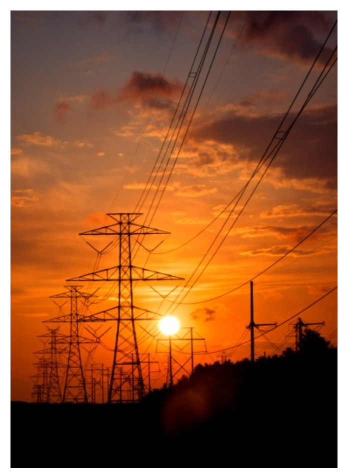


More on the electric grid: www.eia.gov/energy_in_brief/article/power_grid.cfm

More on storage options: www.eia.gov/todayinenergy/detail.cfm?id=6910#

Transmission

THE GRID | ALTERNATIVES | LINE LOSS | STORAGE



Instant Energy from the Grid
Electricity (also known as electrical energy) is a flow of charges or charged particles (electrons) traveling about 186,000 miles per second (light speed). It must be used as soon as it is generated. That means that at every moment, electricity supply has to match the amount of electricity being used.

Matching Electricity Generation to Demand
Because of electricity's instantaneous nature, generating just the right amount to meet demand is a guessing game. Grid managers estimate the minimum daily electricity demand (called base load) and the maximum extra demand (when customers are likely to use more electricity, called peak load). Using banks of computer screens connected to remote sensors throughout the grid, they monitor and actively manage electricity generation at baseload and peaking plants. Baseload plants meet the consistent and predictable demands for electricity. Peaking plants can quickly come online to meet the extra demand during higher-use periods. This is part of load management.

(continued next page)

ELECTRICITY

Transmission

THE GRID | ALTERNATIVES | LINE LOSS | STORAGE

Power companies use other management strategies to meet peak demand such as working with commercial customers to reduce demand during peak times and having voluntary programs for regulating electricity to residential consumers. At times of very high demand, utilities even make requests to the public to reduce electricity use.

What are baseload plants? Whenever possible, electricity providers depend on reliable and least expensive energy sources to meet baseload demand and save more expensive options to tackle the peak. Because the peak demand can vary over hours as well as seasons, some of the peak load capacity needs to come from generators that can power up to manufacture electricity very quickly. Nuclear energy, coal, and water have historically been the dependable sources to cover the baseload demand. Low-efficiency steam-driven units, gas turbines, diesels, or pumped-storage hydroelectric equipment stand ready to meet peak demand for your home's electricity under today's supply system.

What is regulating electricity to residential consumers? Two examples are off-peak and interruptible-power programs. Off-peak refers to times when demand for electricity is low (typically late evening through early morning). Electric water and space heaters on an off-peak program use electricity during off-peak hours to generate enough hot water and stored space heat for an entire day. This can be accomplished with either high storage capacity or dual-fuel systems (backup heating source).

In an interruptible-power program, the electric supplier places an electric control device in the home for the specific appliance(s). During peak demand periods, the electric provider sends a signal to the control device to shut the appliance(s) off for a period of time. Example of such appliances include central air conditioners, water heaters, and electric boilers or baseboard heaters. Customers might be compensated for the possibility of inconvenience by receiving a rebate or paying a lower rate on their monthly electricity bill.

Transmission

THE GRID | **ALTERNATIVES** | LINE LOSS | STORAGE

How do intermittent supplies fit into the grid?

The intermittent availability of wind and solar increase the complexity of the electricity grid's load balancing act. Grid controllers must continually make adjustments to the system in order to accept the electricity from intermittent power sources like wind and solar. This includes reducing electricity generation from existing baseload plants. Reengineering the grid will be a critical step in order to achieve a shift to diversified electricity sources like wind and solar.

ELECTRICITY

Transmission

THE GRID | ALTERNATIVES | LINE LOSS | STORAGE

Line loss happens because of the resistance to electron flow inherent in the metal wire. Silver has the least resistance, followed by copper, but both are too expensive to string across the continent. In addition, these lines must endure temperature extremes, wind, storms, and the weight of ice. As a result, transmission lines are generally steel or aluminum. Research into other materials to reduce line loss is under way. At very large voltage, direct current, or DC, lines experience less line loss than alternating current, or AC, lines, which offsets the cost of additional equipment needed to convert between AC and DC at both ends of the line. Two large DC lines carry electricity generated by North Dakota power plants into eastern Minnesota.

Transmission

THE GRID | ALTERNATIVES | LINE LOSS | STORAGE

Storing Electricity

The ability to store electricity would help balance supply and demand on the grid and to accommodate the electricity from intermittent sources like solar and wind.

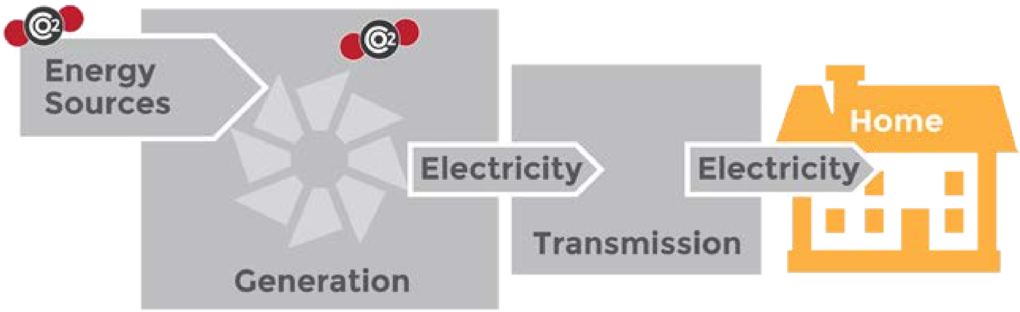
Unfortunately, we have a long way to go before stored electricity makes a significant contribution to the electric grid. Electricity "storage" options represent about 2% of the total generating capacity of our system, and nearly all of it involves hydropower.

For example: During periods of low demand, power producers use electricity to pump water uphill to fill reservoirs at hydro plants and then use the flow of water to generate electricity at times of higher demand. Other technologies being tested or investigated include compressed air, thermal storage, and batteries.

"Storing" electricity involves converting electrical energy into another form of energy until it is needed, at which time it is transformed back to electricity. For example, charging a battery "stores" electricity as chemical energy. When you use the battery in a device, it is converted back to electricity.

Nearly all homes in North Dakota have electricity. In 2013, the average monthly residential electric use was 1205 kWh, which ranks North Dakota fifth in the nation (Behind Louisiana, Tennessee, Mississippi, and Alabama).

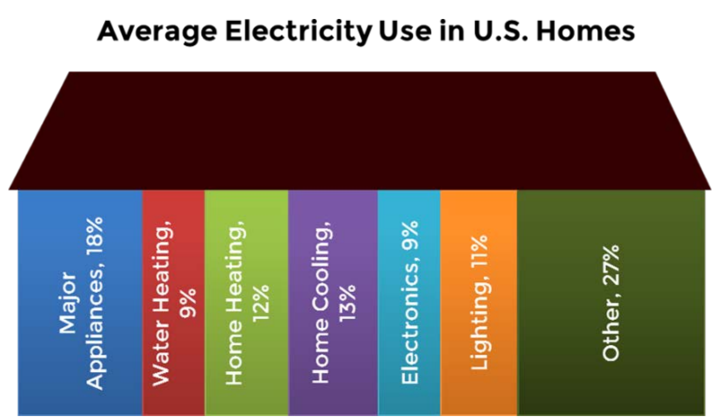
About 80% of this electricity has a carbon footprint.



Additional links: www.nrdc.org/energy/renewables/ndakota.asp

U.S.	REGION

How do we use electricity? This is the average distribution for homes across the United States.



Major Appliances, 18%. This includes refrigeration, clothes dryer, cooking, dishwasher, freezer, and clothes washer, in descending order of electrical consumption.

Water Heating, 9%. In our region, a third of the households depend on electricity to power their water heater.

Home Heating, 12%. In addition to electric heaters, this includes furnace fans and boiler circulation pumps for nonelectrical systems, which represent 25% of this category (3% of the total pie). In our region, electricity is a minor provider of room heat.

Home Cooling, 13%.

Electronics, 9%. Examples: computers, TVs, and battery chargers.

Lighting, 11%.

Other, 27% Examples: dehumidifiers, kitchen and bathroom electronics, game consoles, small electronic devices, heating elements, and external power adaptors.

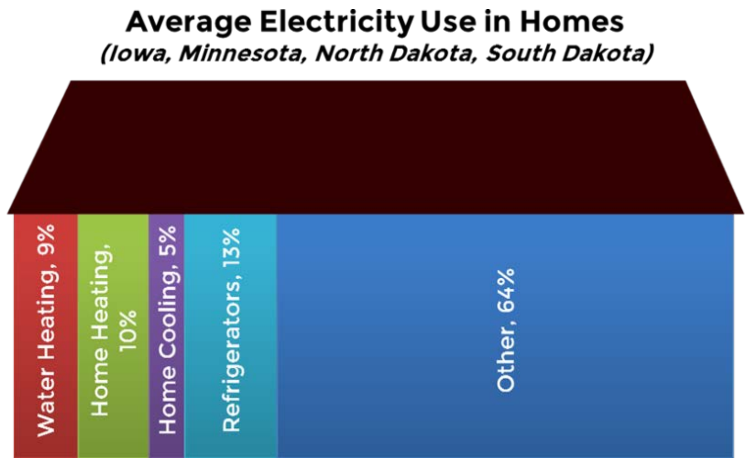
Source: www.eia.gov/tools/faqs/faq.cfm?id=96&t=3 (accessed July 13, 2015).

ELECTRICITY

Home

U.S. | REGION

How do we use electricity? This is the average distribution for homes in the four-state region of Iowa, Minnesota, North Dakota, and South Dakota.



Home Heating, 10%. This includes furnace fans and boiler circulation pumps for non-electrical systems. In our region, electricity is a minor provider of room heat—15% of homes use electricity as the primary source for space heating.

Water Heating, 9%. In our region, a third of the households depends on electricity to power their water heater.

Home Cooling, 5%.

Refrigerators, 13%.

Other, 64%. Includes major appliances (clothes dryer, cooking, dishwasher, freezer, and clothes washer), lighting, electronics (examples: computers, TVs, and battery chargers), and small appliances/devices (dehumidifiers, kitchen and bathroom electronics, game consoles, small electronic devices, heating elements, and external power adaptors.

About two-thirds of homes in our region use electricity for drying clothes and cooking food.

Source: www.eia.gov/consumption/residential/data/2009/index.cfm?view=consumption#end-use-by-fuel (accessed July 13, 2015).

Household Energy / Electricity / Home Fuels / Gasoline / Carbon Calculator

Last updated 12/14/2015

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