How Power Plants Work

What is electricity?

- Charge is one of the fundamental characteristics of matter
- Particles like protons and electrons have a certain charge associated with them
- Whenever charge builds up in a particular location, there are associated fields and potentials that are created
- Since protons are several orders of magnitude heavier than electrons, we are interested in the movement of electrons
- In semiconductor physics, engineers use the movement of both electrons and the absence of electrons, known as holes, to model structures
- Basically, electricity is the phenomenon associate with the
- presence and flow of electric charge

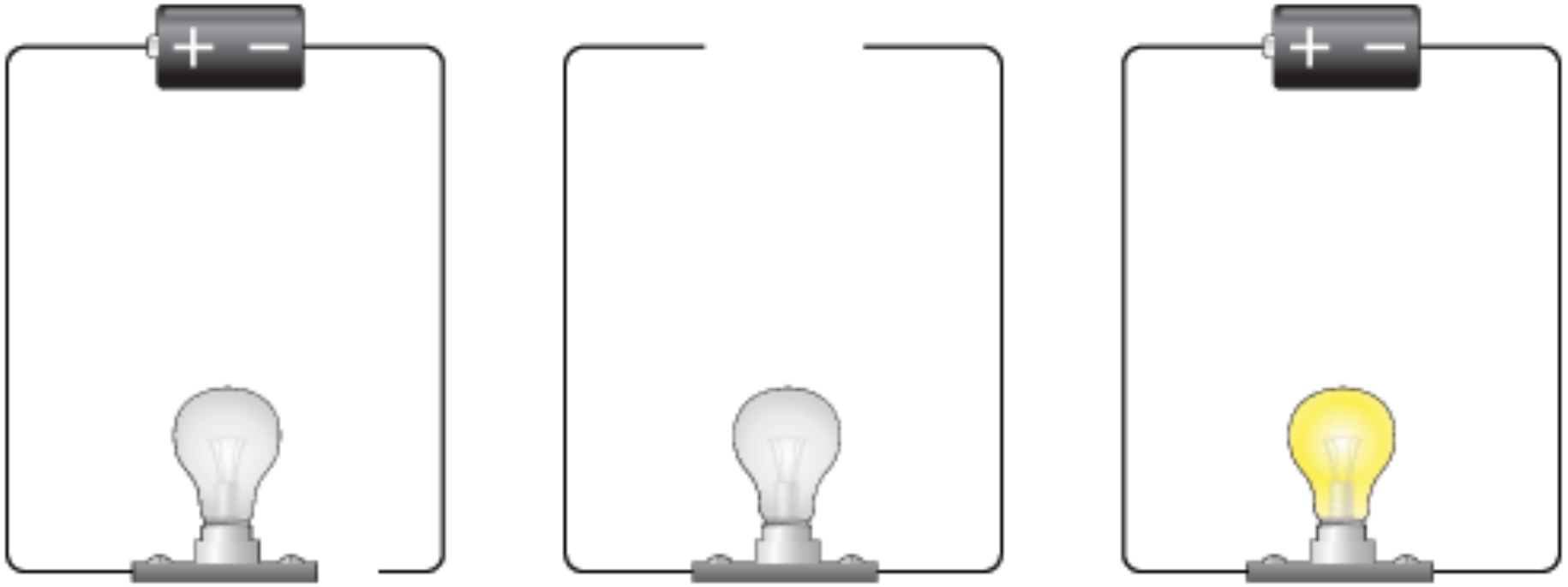
What are some sources of electricity?

- **Lightning.** Electrostatic discharge between electrically charged regions between clouds, or a cloud and the Earth's surface
- **Batteries**. Converts electrochemical energy into electrical energy
- **Solar Panels.** Generates electrons (and holes) upon exposure to light via the photoelectric effect
- **Piezoelectric Materials**. Crystals that generate electrons in response to applied mechanical stress
- **Generators.** Generates electricity by rotating a magnetic rotor inside conducting stator windings

Where do we get electricity from?

- Power plants (coal, natural gas, nuclear), hydro-dams, wind turbines, solar panels
- Which provides the most electricity for us?
  - Coal
  - Natural Gas
  - Nuclear
  - Hydro
  - Everything else

What does a circuit look like?



Source: BBC

Basic theory describing electricity.

- Kirchoff's Current Law: All currents into a node sum to zero
- Kirchoff's Voltage Law: All voltages in a loop sum to zero
- Ohm's Law: V = IR
- Electric power in a circuit: P = IV = V2=R = I 2R
  - Voltage is measured in volts (V)
  - Current is measured in amperes (A)
  - Resistance is measured in ohms (Ω)

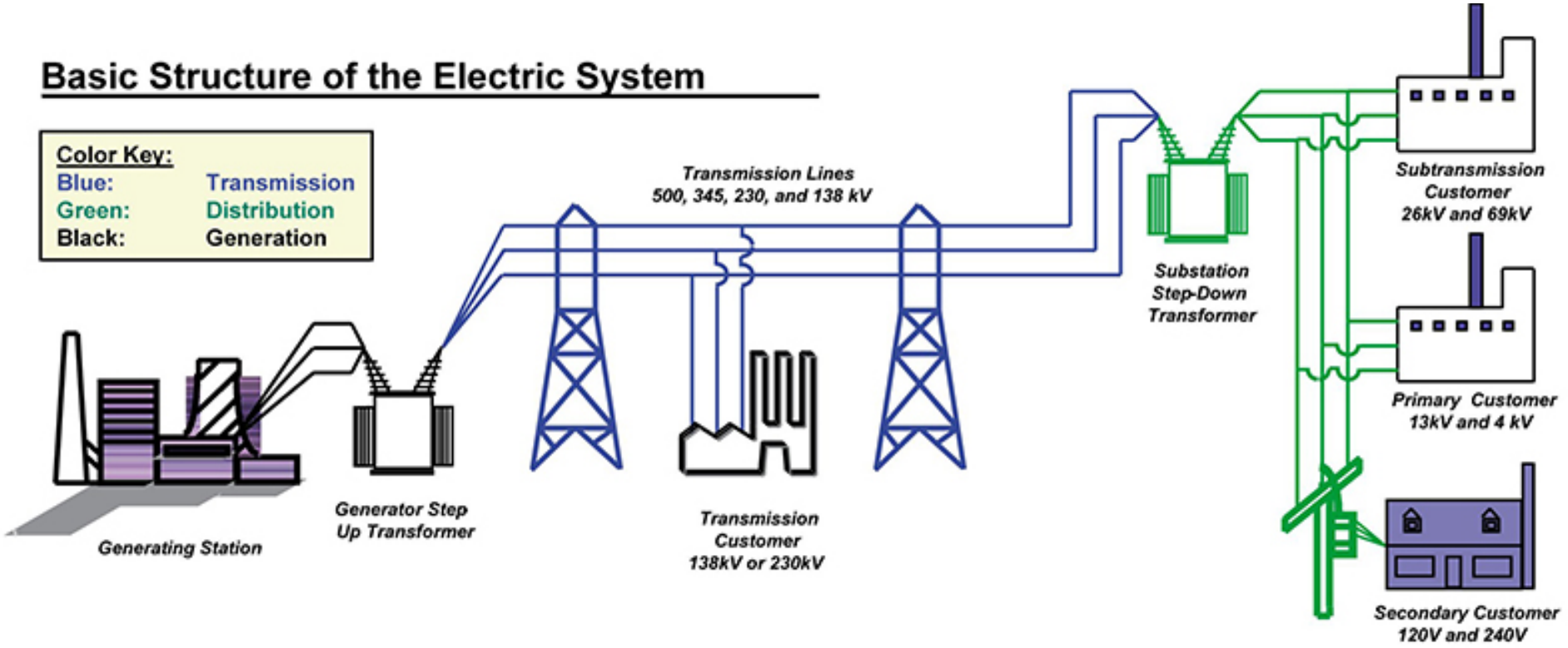
Alternating current vs. Direct current

- AC power is like an ocean wave
- DC power is like a river current

Comparison of AC vs DC

AC	DC
• Easier to transform between voltages • Cheaper, simpler, and more reliable than DC • Fewer voltage losses during transmission • Used for motors in refrigerators and washer/dryers	• First to be installed in urban areas • More expensive, more intricate, and less reliable than AC • More voltage losses during transmission • Used for computers and other electronic devices

Basic Structure of the Electric System



Source: U of Idaho

Basic structure of a power plant

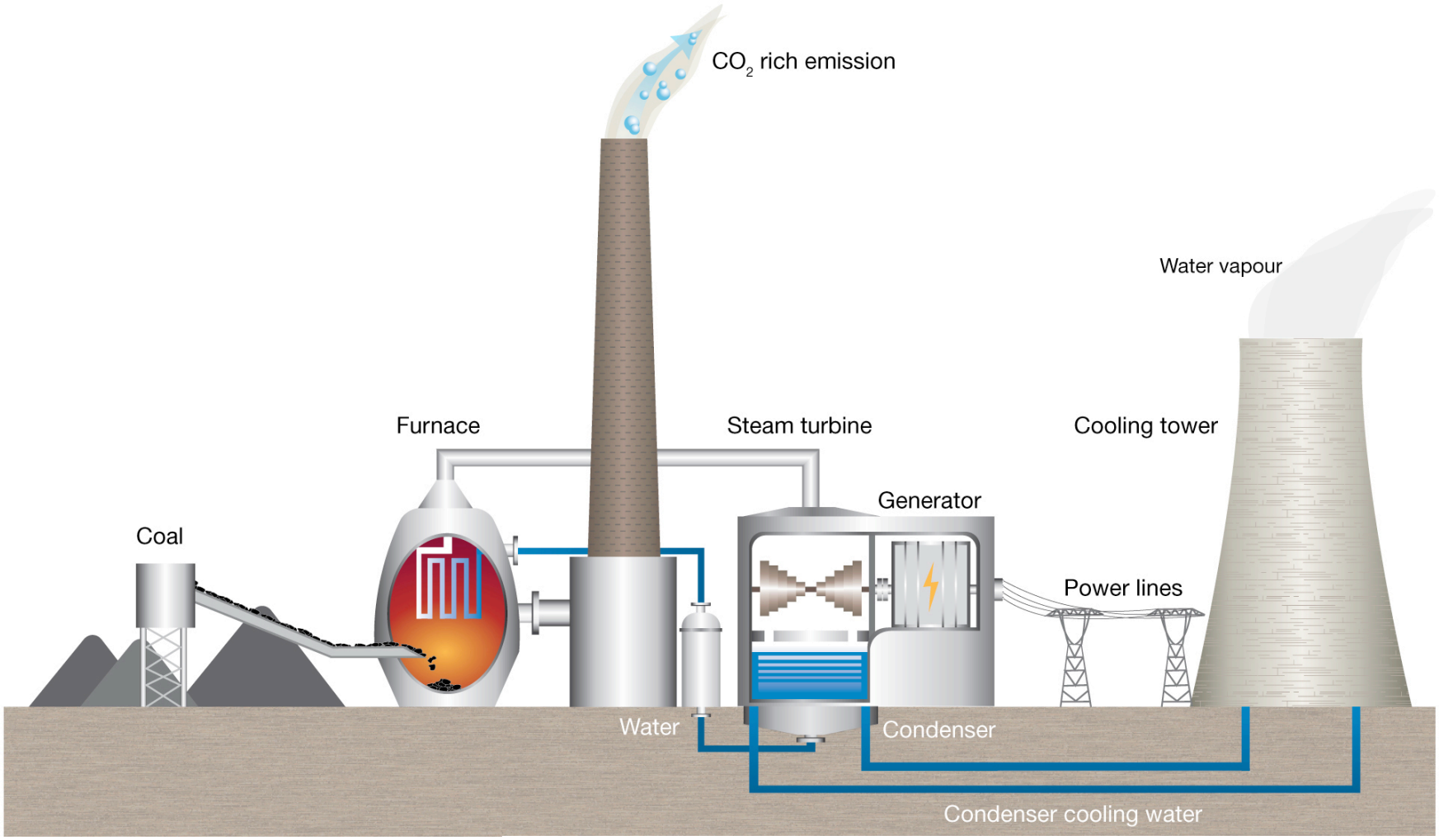


Figure Source: CO2CRC

Power plant process (wet side)

1. Bring in the fuel
2. Process the fuel
3. Burn the fuel
4. Heat steam in the boiler, creating higher pressure steam
5. Power the turbine
6. Condense the steam using cool water to remove waste heat
7. Dispose of by-products (carbon dioxide, ash, etc.)

Power at your house process (dry side)

1. Transform the generator output
2. Transmit the energy to your house
3. Step down the voltage for distribution
4. Turn on your lightbulb