

# Modeling an Electricity Delivery System

# TCIPG

TRUSTWORTHY CYBER INFRASTRUCTURE FOR THE POWER GRID

*Build a model of an electricity distribution system using some or all of the items in the kit. Use the coin battery as a power source and design a circuit that powers LED's in a community of three or four houses.*

**Investigate possible circuit combinations.** Use the prototyping breadboard with the coin battery to experiment with various LED colors and combinations.

Using a breadboard is an easy way to experiment with circuits. They come in many sizes. This breadboard has two strips and each strip has fifty connected tie points.

**Put the coin battery in the battery holder** so you can see the side with the writing and + symbol. Connect the battery to the breadboard by connecting the prong near the tab on the battery to the red strip (positive) and the other to the blue strip (negative or ground).



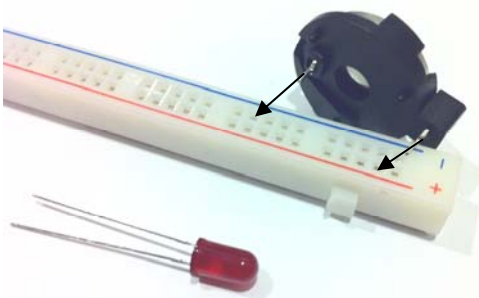
## In the kit

- 1 coin battery (CR2032)
- 1 coin battery holder
- 1 two-strip 100 pt breadboard
- LED's
  - 5 red
  - 5 green
  - 5 yellow
  - 3 blue
  - 3 orange
- 4 house blueprint pages
- 18" red wire, ends stripped
- 18" black wire, ends stripped
- 12" aluminum tape

## Other supplies

- Clear tape
- Scissors

**Connect an LED** by pushing the anode (longer leg) into a tie on the red (+) strip and the other leg (the cathode) into the blue (-) strip. If all your connections are tight, you should see the LED light.



How many LED's can you power at one time? How many of each color?

What happens when you mix colors? Which colors can be wired into the same circuit? Does the order matter?

Which combinations of LED's cause some bulbs not to light? Which LED's stay on and which go out?

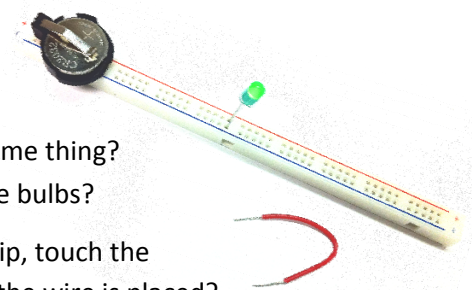
**What causes the power in your neighborhood to go out?** Sometimes a tree or a squirrel creates an easy route to the ground and causes a **short circuit** to the power system. Create a short circuit on your breadboard.

Make one bulb light and then add a shorting wire by pushing one end in the + strip and one end in the - strip. Why does the light go off? Where is the current going? Why is it called a **short circuit**?

Make several bulbs light and then add a shorting wire. Do all of the bulbs do the same thing? Does it matter if the shorting wire is before the bulbs, in between bulbs, or after the bulbs?

Make several bulbs light and then push one end of the wire into a tie on the red strip, touch the other end to the cathode of a bulb. Does it matter which bulb you touch or where the wire is placed?

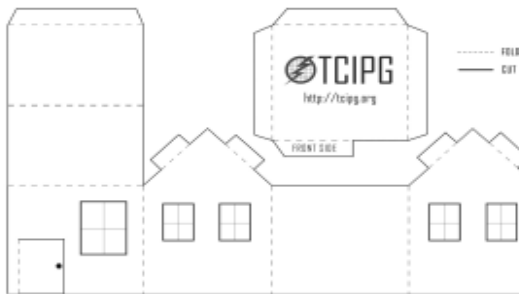
Whenever one path in a circuit has less resistance, a short circuit occurs. How can this explain how LED's of one color cause others to not light?



## MORE ABOUT LED'S

Light emitting diodes or LED's create light when electrons are pushed through two different semiconductor materials. The two materials are layered together so that electrons can only flow in one direction. The moving electrons release photons that we see as colored light. The color of the LED light depends on the type of semiconductor. Some colors require more power than others.

LED's don't create heat so they are more efficient light sources and they last longer than traditional light bulbs. LED lighting is becoming more common. They are used to light supermarket freezer sections, streetlights and traffic lights, automobile taillights, and have recently been installed to light the giant signs in Time Square in New York City.



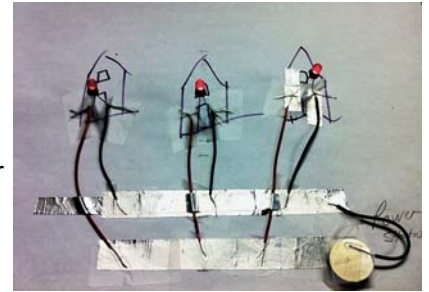
## ASSEMBLE THE HOUSE

- Cut out each house.
- Fold on the dotted lines
- Cut out the windows and cut and fold the opening for each door.
- Tape or glue the tab on the side of each house to the inside of the front.
- Fold the roof.
- Insert the base so that the logo is on the bottom.
- Use the tabs to attach the base to the house.
- Run the wires or conductive tape into the base of the house.
- Use the tabs to attach the roof to the house.
- Use your model electric grid to light your houses.
- Use what you've learned about LED's and circuits to light the insides of your houses with as many lights as possible. Which color combinations work best?



Use the breadboard to plan the circuit for powering your community of houses.

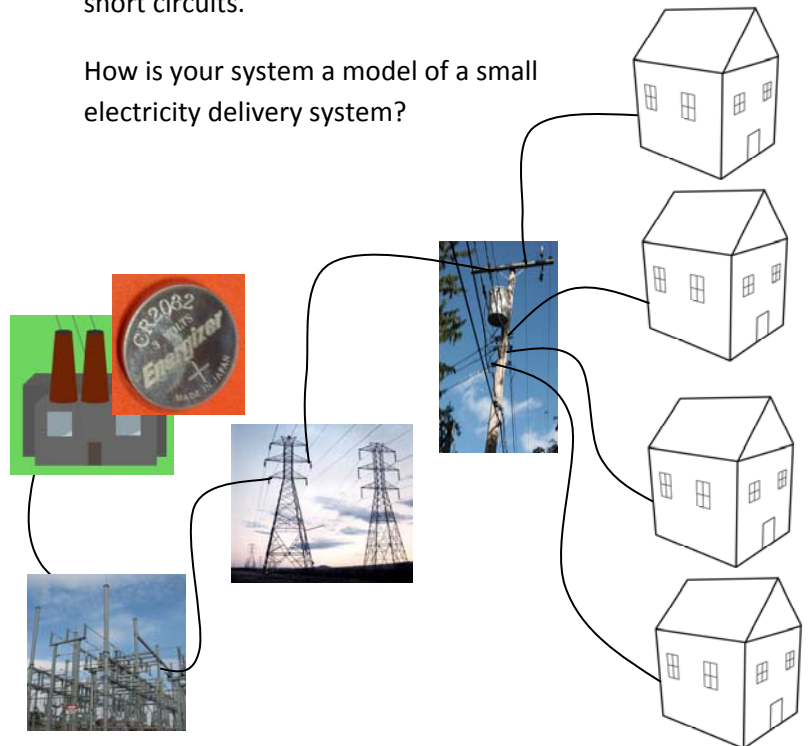
Then build a system that supplies power to every house in your community. Use the conductive tape and/or the wire in your kit to connect the parts of the system. Add foil, paper clips or other conductors if you need them.



Add more houses or connect two or more kits together.

Design your system to power the most lights without any short circuits.

How is your system a model of a small electricity delivery system?



Power travels from a generator at a power plant through a system of substations and transmission lines to neighborhoods and businesses.

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