

Zero Emission Vehicles in the Community - Elementary

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Zero Emission Vehicles in the Community - Middle School

Objectives:

- Students will demonstrate a basic understanding of the difference between combustion engines and electric motors
- Students will understand the role of why combustion engines in contributing to air pollution and climate change
- Students will be able to list several types of ZEV in their community: e-bikes, scooters, cars, taxis, buses, garbage trucks, street sweepers
- Students will be able to articulate the benefits of electric vehicles: zero emission, quieter, better for community health, less maintenance

Materials:

Activity 1 - Green Propeller Vehicle

In Kit:

- Chassis
- 2 Axles
- 4 Wheels
- Motor
- Propeller
- 2 Wires (1 Black & 1 Red)
- Battery Holder
- Battery

Addition:

Student Instruction Guide

Activity 2 - Charging Station Design Challenge

In Kit:

- Vehicle
- Vehicle Card
- Backdrop Display
- Glue Dots
- LED
- Coin Cell Battery
- Coin Cell Battery Holder

In Addition:

Pass out Design Journals

Bring Markers & Scissors from general NYPA Education supplies.

Key Vocabulary:

Internal Combustion Engine: Combustion, also known as burning, is the basic chemical process of releasing energy from a fuel and air mixture. In an internal combustion engine (ICE), the ignition and combustion of the fuel occurs within the engine itself. The engine then partially converts the energy from the combustion to work. The engine consists of a fixed cylinder and a moving piston. The expanding combustion gases push the piston, which in turn rotates the crankshaft. Ultimately, through a system of gears in the powertrain, this motion drives the vehicle's wheels.

Electric Motor: An electrical machine that converts electrical energy into mechanical energy.

Zero Emission Vehicle: A vehicle that does not emit exhaust gases or other pollutants from the onboard power source

Design Thinking Process: It is an iterative process that teams use to redefine problems and create innovative solutions inclusive of an empathetic lens.

Teacher Tips:

Strategies to help struggling readers with vehicle task cards: Struggling readers will be focused on trying to decode the words on the card and lose the context of the information. The best way to support them is to offer a variety of connections with the information.

If educators notice a student struggling to read, they can offer to read with them, pointing out or highlighting the interesting information on the card. They should be sure to also ask them what they noticed or learned about the vehicle. This affords them a voice in understanding, and doesn't make your support about reading to them, but about connecting with them and the task at hand.

It is also great to allow struggling readers to connect and hear their peers around them - as they are the best models of engagement with information. Educators may want to invite a student nearby to share what they have learned or noticed about their vehicle based on the information provided. Since all of the cards are structured in the same manner, have them lay their cards side by side and discuss how their vehicles are similar and different. This gives an indirect opportunity for the struggling student to connect with information and mimic the modeling of information their peers shared. "Oh! Yes! I see that my vehicle has a rapid charge time of two hours too."

Struggling readers also benefit from having the end in mind while reading (all readers do). Pose the questions such as, "How does this ZEV impact the community? What will this vehicle need to be a part of the community?"

Strategies for spatial awareness and building of model

When educators ask students to visualize and build structures from a 2d format, it can be challenging for many. Strategies to support these learners include ideas such as:

- Lay out the materials provided in a well organized space - remove all distractions from the area.
- Match the tangible piece to it's representation on the page, physically lay them on top to see that they are "same, same" in shape and directionality in the way we lay them out
- Have students verbalize what they see in the picture before putting pieces together on the model - "I see that the battery pack has a red and black knob, on the bottom, I see a plus sign and a minus sign. I also see the shape of a battery cut into the bottom of the piece. "

Share out options: jigsaw with different vehicles, share whole group, watching air time

The “share” is the most important aspect of every learning experience. It is when students (of all ages) synthesize the knowledge they have learned and solidify the key points of understanding that they will walk away with at the end of the session with the educator. It is important that educators bring them full circle and let them connect and share out with each other - both about the content of what they learned and the process of the work they did today.

When sharing their charging stations, educators may choose to bring together small groups of students with various vehicles so that collectively there is a “community” of charging stations that hold similar and different components to meet the needs of their vehicles and their community.

If sharing as a whole group, it is great for students to share something new they learned (an Aha! moment) and a wonder they hope to explore further. Also, what did they enjoy about the process or experience today?

Be mindful of student airtime during whole group discussions. It is always important that we are diversifying the voices in the room and allowing those who would be otherwise quiet an opportunity to be heard, especially when a conversation could be moving quickly. Offer a time for everyone who wants to share, one comment or connection, before calling on the same student for a second share. Once everyone has been given ample opportunity to contribute at their comfort level with the discussion, then open the floor up for more discussion as time permits!

Lesson Steps:

Introduction & Transportation and Air Pollution Discussion - 15 minutes

1. Educators will introduce themselves and have students introduce themselves. **(slide 1)**
2. Educators will ask students **What is transportation? How do we use transportation? (slide 2)**
 - a. Students will respond with different types of vehicles and their purpose.
i.e. We use trucks to move goods across the country. We use airplanes to move people far distances quickly. We use buses to move people around the city.
3. Educators will ask students **What impact has the increased use of transportation had on the environment?** Students will respond that transportation has increased air pollution. **(slide 3- Photo Exhaust)**

- a. Air pollution is when chemicals or particles in the air that can harm the health of humans, animals, and plants. It also damages buildings. Pollutants in the air take many forms. They can be gases, solid particles, or liquid droplets.

Teacher Note:

- i. Pollution enters the Earth's atmosphere in many different ways. Most air pollution is created by people, taking the form of emissions from factories, vehicles, planes, or aerosol cans. Some types of air pollution, such as smoke from wildfires or ash from volcanoes, occur naturally. These are called natural sources. Air pollution is most common in large cities where emissions from many different sources are concentrated. This air pollution often appears as a cloud making the air murky. It is called smog. The word "smog" comes from combining the words "smoke" and "fog."
 - b. **Do we have any air pollution here? Do you know anyone affected by air pollution?** Air pollution affects people's health and breathing. People who are affected by air pollution may have asthma, lung cancer, and heart conditions.
 - c. Today we are going to talk about vehicles and transportation, and how they contribute to environmental pollution.
4. Educators will explain how most of the vehicles that we use today use a combustion engine. Ask students **how they think the Internal Combustion Engine in the presentation works? (Slide 4)**

Review the Internal Combustion Engine on the screen. Gasoline comes into one of the pistons, it is pushed up and a spark from the spark plug ignites the gasoline and pushes the piston back down, rotating the shaft at the bottom and the smoke or emissions from the combustion come out the other side of the motor. The emissions that come out are what causes air pollution. Even though we have made improvements, it will never go away.

5. Educator will explain how there are other ways we can make vehicles, people and goods move.
 - a. Electricity vehicles were first introduced by Thomas Edison in the late 1800s. He used an electric motor to create mechanical energy. Electric vehicles have evolved so much since then and are now more important than ever. **(Slide 5)**
6. **Educators will show/play the video** of how electric vehicles work today. **(Slide 6)**
 - a. (Video: 1:31 min) Here is an explanation of how electric vehicles work today. Electric vehicles (aka EV) motors are completely powered by a battery. EVs have a different type of motor than a combustion engine. EV motors use a magnetic field that forces the shaft to rotate distributing power to the wheels creating mechanical energy. Notice how many fewer parts there are in this whole vehicle. (17 parts in EV and over 300 in a combustion engine)

Since these vehicles are only using battery power and a magnetic field there are no emissions, no air pollution, and little to no maintenance. This is why we call them Zero Emission Vehicles.

Vehicles that use electric motors get electrical power from a rechargeable DC battery to an inverter which converts it into AC power and controls the speed, then send the AC electricity to the magnets in the motor which creates a magnetic field and spins a shaft that is then connected to the wheels.

7. **How are electric vehicles a benefit to our environment?** Since these vehicles are only using battery power and a magnetic field there are no emissions, no air pollution, and little to no maintenance. This is why we call them Zero Emission Vehicles. **(Slide 7)**

Activity 1 - Green Propeller Vehicle - 15 minutes

**** Review Safety Slide (Slide 8) prior to handing out any materials.**

Once done, Hand out ZEV activity 1 kits and student guides.

Activity 1 for ZEV:

Students will build their zero emission vehicle. Follow along with the student guide for creating the circuit that will propel the vehicle. **(Slide 9)**

8. For early finishers or if time allows: Educators will challenge students to make their vehicle go backwards or faster. Switching the polarity by switching where the red wire and black wire connect to: connect wires from red knob on motor to black knob on battery and black knob on motor to red knob on battery. See what happens, decide which way goes faster and why.
9. When all students have completed the build and have tested it, ask them to put their work to the side. Remind students that the green vehicle is a model of a ZEV because it uses mechanical energy created by the propeller to move the vehicle.

Share & Closing - 15 minutes

(Slide 10, transition to reflection)

10. Ask students to compare and contrast internal combustion vehicles with zero emission vehicles. To inspire students, ask them about the negative effects they currently experience with combustion vehicles noise, pollution, paying for gas, and maintenance. **(Slide 11)**

[Teacher Note] If time permits, play “Would You Rather” game. Explain and play “Would You Rather” with students, read off the questions to students, have them move to one side of the room or raise one of their hands. (Slide 12)

Discussion - 5 minutes

11. **How would our community change if all of our transportation was zero emissions?**
There would be no gas stations and there would be charging stations everywhere. The neighborhood would be quieter, cleaner. So if we need to consider these changes to our community, how will we manage to keep ZEV charged and on the go? **(Slide 13)**

This leads us to our second activity today - **(Slide 14, transition)**

Charging Zero Emissions Vehicles

12. Educator will describe: To use an electric vehicle, the battery has to be charged. There needs to be stored energy in the battery when driving. When the battery becomes depleted, it needs to be recharged. Just like we do with our cell phones or laptops.
When charging ZEV at home, plugging the vehicle into a regular outlet works, but it can take a long time, because the battery is about 400 times bigger than the one in your phone. NYPA is working on building a network of rapid chargers around New York State so that you can quickly charge your vehicle from anywhere while you are on the go. **(Slide 15)**

[Teacher Note] Tell students that they will simulate charging their vehicle by putting an LED on the vehicle and building a circuit on the cardboard display

13. Review the safety slide with students **(Slide 16)**
- Do not put electrical components in your mouth.
 - Always have a load in the circuit.
 - Never run a path directly from the battery, back to the battery.
 - If anything gets hot, call over the teacher.
14. Educator will handout and introduce activity 2: You are going to use the design thinking process to build the best possible solution for your vehicle charging station. In the activity bag there is a vehicle and a story card about the people who drive that vehicle. Take out your story card and read the card to yourself. **(Slide 17)**

Activity 2 - Charging Station - 20 minutes

15. Educators will give students a moment to read their card, then using the guiding questions in slide 18, facilitate the conversation. **(Slide 18)**

[Teacher Note] Based on the group dynamics and skill level you may want to have them fill out the journal, turn and talk with a neighbor, or work through them as a group.

16. Educators will ask them to brainstorm at least 4 different ideas about what their charging station will look like and need to include based on the guiding questions and task card. Tell students to select their best brainstorm that meets the needs of people in their task card story. **(Slide 19)**
17. Students will draw out a final sketch with the details of their charging station. Students need to plan their final design before they build it, so that they can build the most successful solution. They should include where the circuits are going to go, the setting around the charger, the type of power source, where the people will be and any other details they think are necessary. **(Slide 20)**
18. Follow along with instruction in the prototype section of the student guide. **(Slide 21)**
 - a. Base of the cardboard should overlap making a 3D structure. Place glue dots in between cardboard so that the base is secure.
 - b. To simulate the charging station we will place an LED light and half the circuit on the vehicle.
 - c. The other half of the circuit and the power source will be built on the charging station
 - *** When the vehicle comes into the charging station it will line up the two circuits, close the circuit and simulate charging.
 - d. If the LED does not light up, Remember the positive + side of the LED has to be touching the positive + side of the battery which can get confusing here.
 - *** For an easy fix flip around the wires coming out of the battery into the Maker Tape.
 - e. Students will then respond to the test of their design, think about real world applications and reflect on their learning in their student guide. **(Slide 22)**

Sharing & Closing -15 minutes

19. Allow students to clean up and then share their story and the charging station they created. Other students can give positive comments & compliments. **(Slide 23)**
20. Share with students NYPA and Evolve's plan for vehicle charging around NYS. **(Slide 24)**

Vehicle charging does not happen instantly; it takes some time to fill up the battery with a full charge. Around New York State Evolve NY and NYPA are building a network of 800 fast charging stations. In these stations you will pull up, plug in your vehicle and wait 15 - 30 minutes to charge then move on with your day! These charging stations are built at places like rest stops or outside of shopping malls, hotels, and parking garages. Here is a map of current charging stations in the state. **(Slide 25)**

21. Students will be asked how the infrastructure and culture of the state will have to change based on using more zero emission vehicles? (**Slide 26**)

22. Today you were NYPA designers, planners, and environmentalists, thinking about how Zero Emission Vehicles can solve some of our climate change problems. As more and more citizens of New York State buy Zero Emission Vehicles, we need your great minds and kind hearts to build a culture where everyone makes eco-friendly decisions to populate a healthier state. How can you go home and make an impact now and what problems do you want to work on with NYPA to solve in the future?

We really enjoyed being with you today, if you have questions, we can answer them as we wrap up our time together today.

21. Share with students NYPA and Evolve's plan for vehicle charging around NYS. **(Slide 24)**

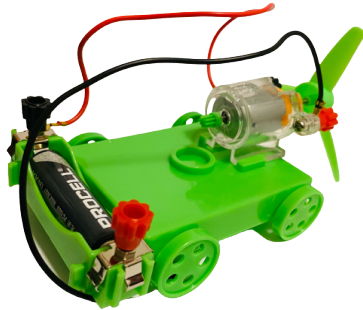
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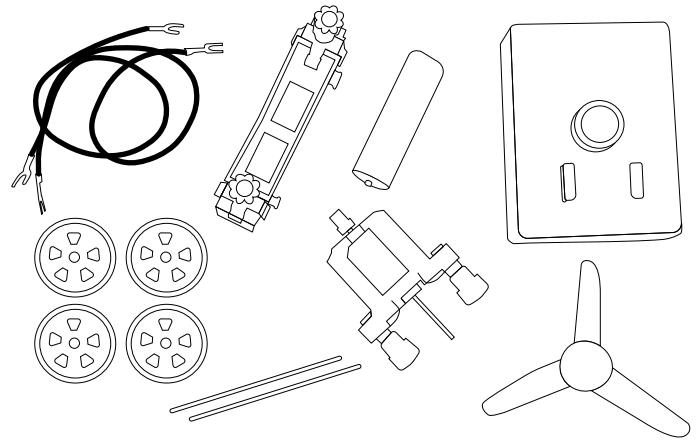
24. Today you were NYPA designers, planners, and environmentalists, thinking about how Zero Emission Vehicles can solve some of our climate change problems. As more and more citizens of New York State buy Zero Emission Vehicles, we need your great minds and kind hearts to build a culture where everyone makes eco-friendly decisions to sustain a healthier state. How can you go home and make an impact now and what problems do you want to work on with NYPA to solve in the future?

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Zero Emissions Vehicle (ZEV) Elementary & Middle School ACTIVITY 1

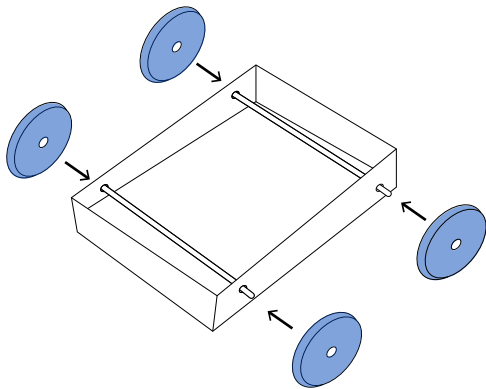


MATERIALS



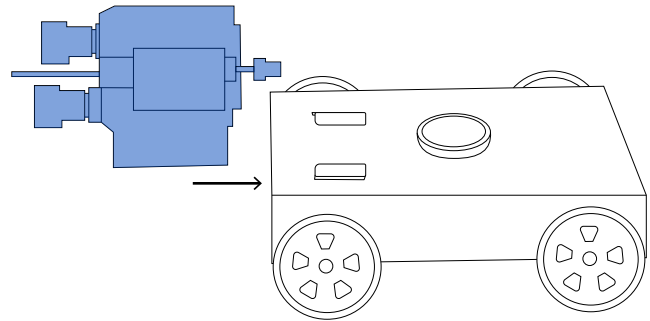
Insert the AA battery into the battery holder.

1



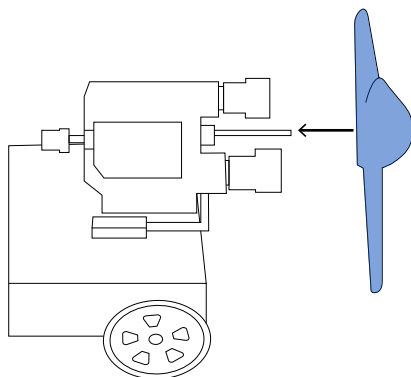
Slide each axle through a hole on the chassis and put a wheel on the end of each axle.

2



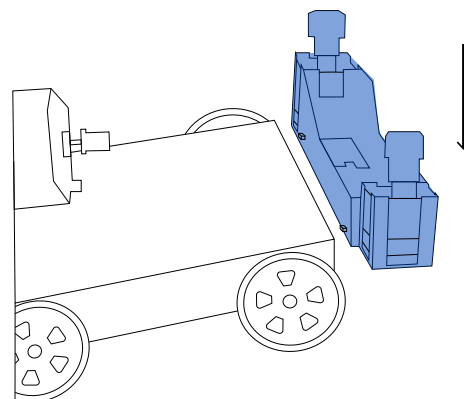
Slide the motor under the grooves on top of the chassis until it clicks.

3



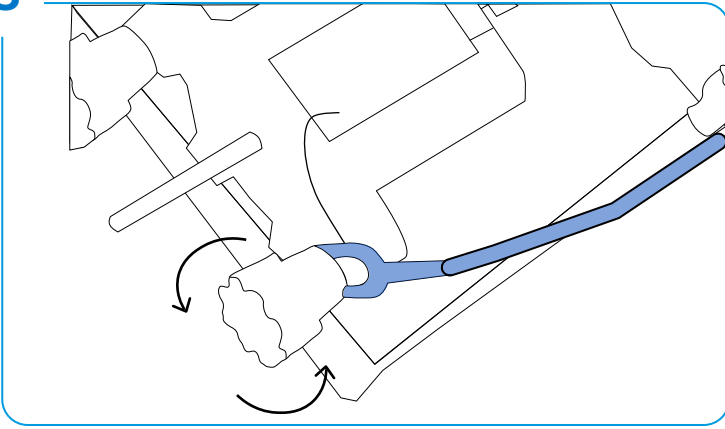
Put the propeller on the end of the shaft coming out the motor.

4



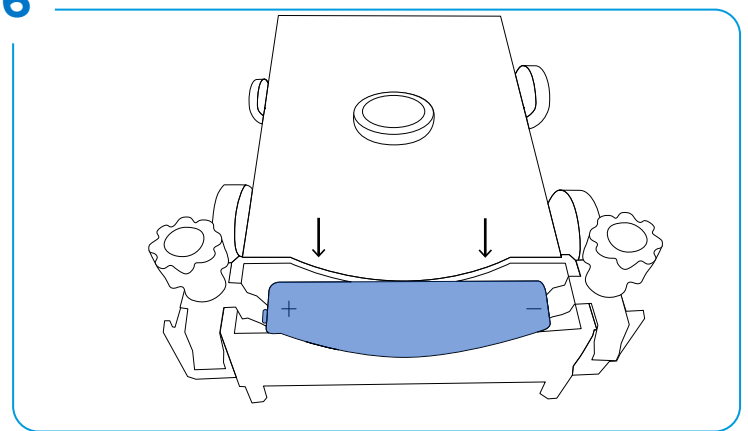
Slide the battery holder down onto the tabs on the back of the car.

5



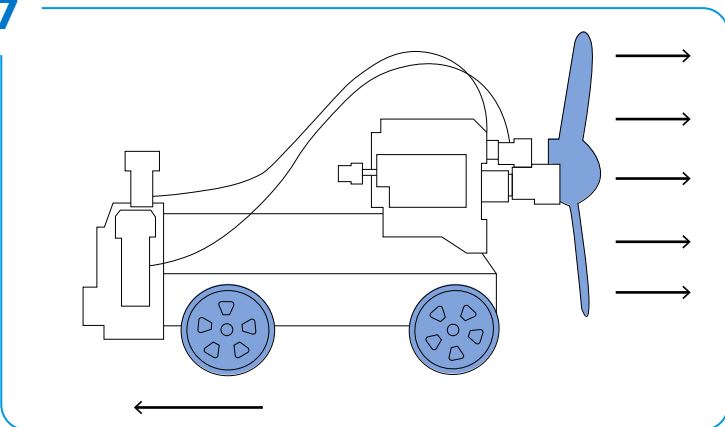
- Untwist all of the red and black knobs, just a little bit.
- Slide the fork from the end wire underneath each knob.
- Tighten the red and black knobs to hold the wire in place.

6



Place the battery in the holder. The propellor should start spinning.

7



Ready to zoom away!

Which way is the propeller spinning?

Which way is the car moving?

Can you switch it? What happens?

SAFETY

Do not put any of the pieces in your mouth, teeth are not tools.

Do not use your body weight to push the wheels on the axles.

Watch your fingers and hand by the propeller. You do not want to hurt your hand or break the propeller.

Short circuits are dangerous and occur when energy does not move through a load. In this vehicle the load is the motor that moves the fan. Make sure the motor is always part of this circuit.

Combustion Engine Vehicles



Zero Emission Vehicles



Uses heat from burning gasoline to move a piston, crankshaft and system of gears to move the vehicle.



Gasoline comes from fossil fuels which can only be extracted from certain places under the earth, then it is processed and transported to a gas station.



When the gasoline is burned in the combustion engine, emissions of harmful chemicals are released into our air causing air pollution.



Produces emissions such as carbon dioxide and methane that contribute to air pollution and health issues.



12% - 30% of the energy from gasoline is turned into power at the wheels.



Cars speed and power are controlled by the physical moving pistons and gearbox inside the engine.



Uses stored electrical energy from the battery onboard to create an electromagnetic field in the motor that spins a shaft to move the vehicle. Electrical Energy comes from the electrical grid.



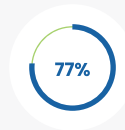
The batteries in electric vehicles can be charged from renewable resources like solar panels, wind turbines, hydropower plants



When the electrical energy from the battery is used there are zero emissions released.
Provide quiet, smooth operation and stronger acceleration.



Produce no greenhouse gas emissions.
Can drive just as far or farther on a full charge as a full tank of gas.



77% of the electrical energy from the grid is turned into power at the wheels.



Cars speed and power are controlled by the software onboard the car. For example it can go backwards as fast as it can go forward.

NYS CHARGING STATION PLAN

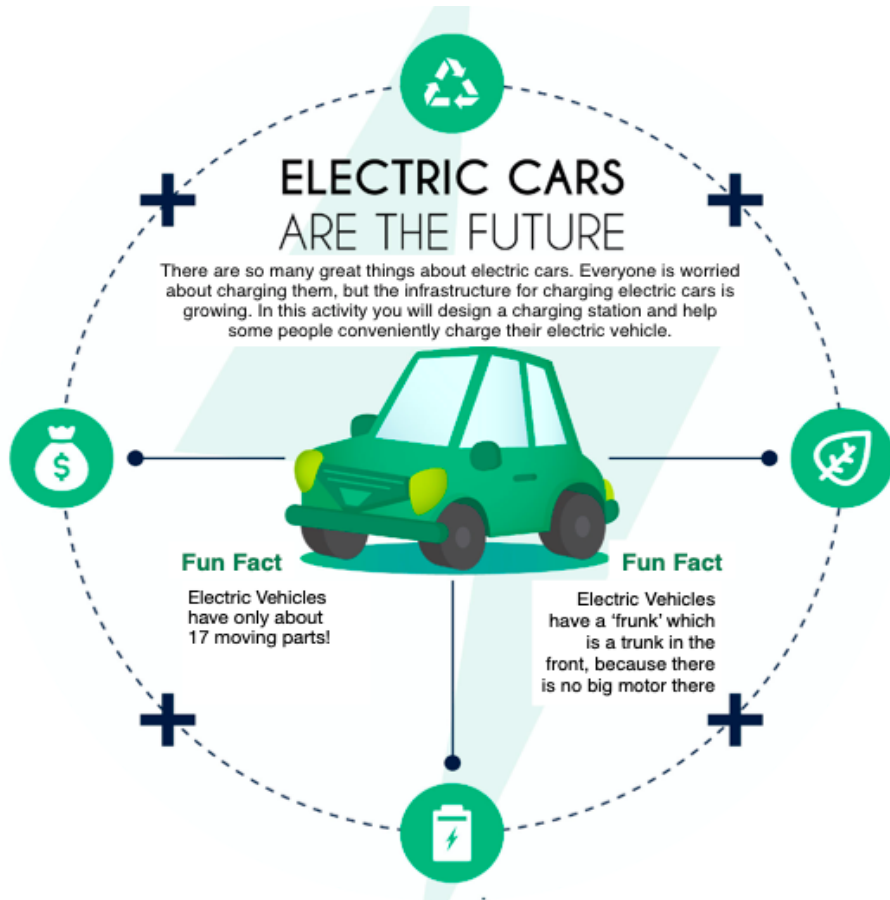
| Drive with Confidence

- ⚡ **800 Evolve charging station** every 50 miles throughout the state by 2025
- ⚡ Charging will take between **15 and 30 minutes**
- ⚡ **A full charge** will cost less than a full tank of gas
- ⚡ All New York City buses will be **electric by 2025**
- ⚡ Electric Vehicle **model communities** are showing up all over the state



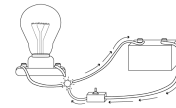
NY Power Authority

Zero Emission Vehicle Charging Station Design Thinking Journal



Safety

Coin Cell batteries should not be piled or stored in a way that they could accidentally pile onto each other. Piled coin cell batteries could cause a short circuit.



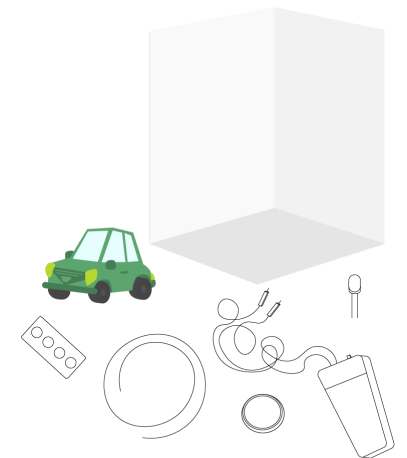
Short Circuits are very dangerous. They happen when electricity flows without passing through a load such as an LED or fan.

Coin Cell batteries are amazing, but if eaten by humans or animals can become lethal. Never put any electric components in your mouth.



Materials:


- Vehicle
- Vehicle Information Card
- Maker Tape
- Backdrop Display
- Glue Dots
- LED
- Coin Cell Battery
- Coin Cell Battery holder



Design Challenge:

You will build the circuit and scene for the vehicle charging station on the display. Unfortunately we cannot actually charge our vehicles, we are just creating a model. However, you will signify charging by placing an LED and half the circuit on the vehicle and placing the other half of the circuit and power source on the display. When the vehicle drives into the charging station, the two half circuits will meet up and the LED light will turn on signifying that the vehicle is charging.

Read the scenario for the vehicle in your design kit.

4X4 OFF ROAD VEHICLE	VEHICLE USAGE DATA
	Weight of Vehicle: 4000 lb.
	Number of Passengers: Max number 4 (2 adults, 2 children)
	Full Charge Battery Range: 230 miles
	Time Needed to Fully Charge Battery: Standard Charger: 12 hours Rapid Charger: 2 hours

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Guiding questions to get help you get started:

- What is important for the person charging the vehicle?
- What else would be nearby the charging station?
- Where would the charging station be located?
- What type of power source would work for this type of charging station?
- What type of charger will the charging station use? Rapid or Standard? Why?

Brainstorm:

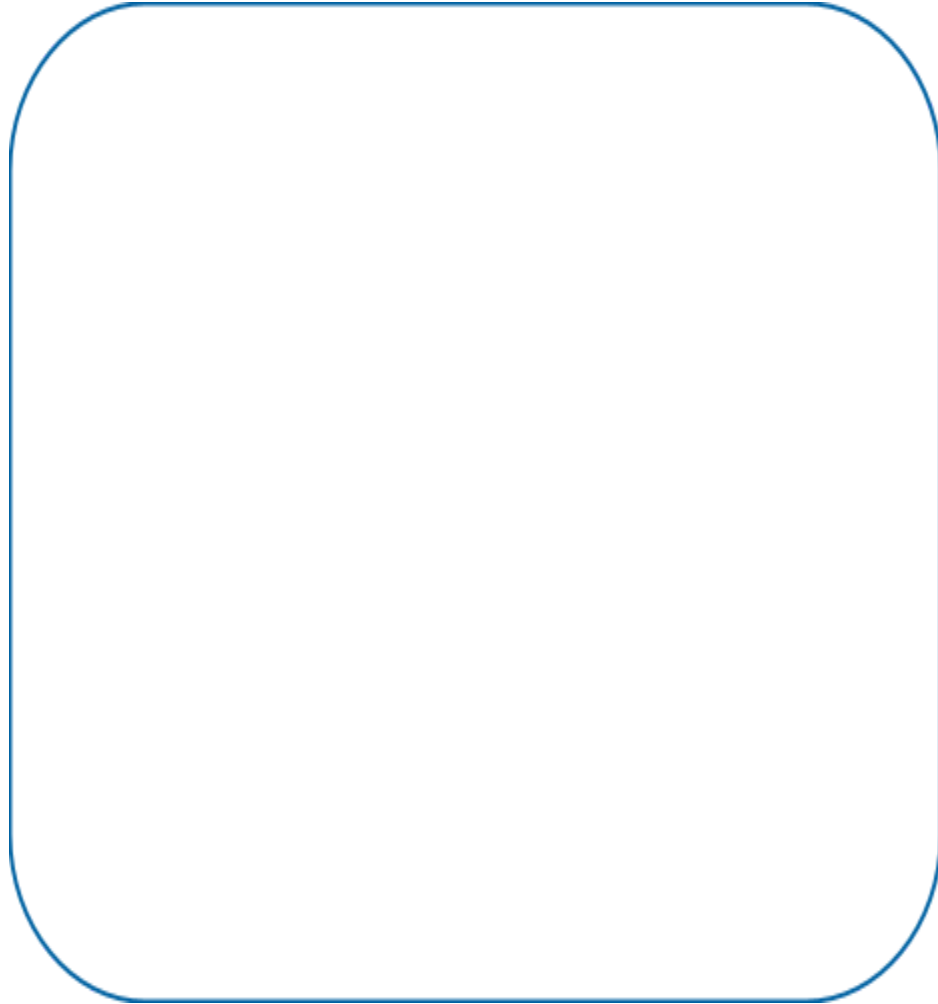
Brainstorm ideas for what the charging station will look like. Include all of the things that are necessary to meet the person's needs and create enough power for the vehicle.

IDEA 1	IDEA 2
IDEA 3	IDEA 4

Choose what you want your charging station to look like.

Sketch

Draw the details of what you are going to create for the charging station for this person, scenario, location and vehicle. Remember to include the answers to the guiding questions.

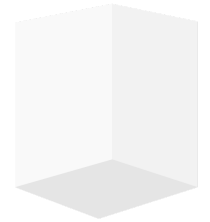


Prototype

Build your charging station

You will build a circuit that will open and close when it connects to the charging station. When the vehicle is in the charging station, and the two half circuits meet, the circuit will be closed.

1. Pop open your cardboard display and use glue dots to keep it open.



2. Separate the legs of the LED and sit it on top of the vehicle.

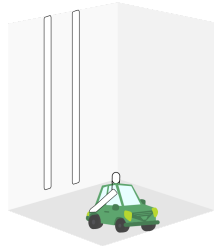


3. Cut and attach two strips of Maker Tape to the vehicle that go from each of the LED legs to the bumper of the vehicle. Make sure the two strips of Maker Tape do not touch each other.

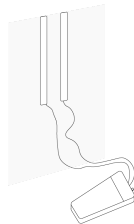


- Depending on where you want your charging station on your display, run two long strips of Maker Tape from the points where the Maker Tape on the bumper of the vehicle will connect with the display.

- Run the long strips of Maker Tape all the way to the back of the display, do not tape down the ends of the Maker Tape.

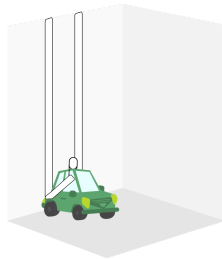


- Slide open the battery holder, place the coin cell battery in one of the compartments.



- Connect the metal tips of the wires of the battery holder to the end strips of the Maker Tape.

- Test to see if the LED light on the vehicle works. If not, switch the polarity, or switch the wires of the coin cell battery.



Add details to the setting of your charging station on the display that gives context to the story. Look back at the guiding questions and make sure you show all of the answers to them in the details of your model.

Testing

- What will the people be doing while the battery is charging?
- What convenience does it provide for people in the story?
- How does this charging station benefit the overall health of the community?

Real World Application

- How could this be implemented in the real world?
- What would people have to learn in order to do this?
- How would the community be a different type of place if every vehicle was a zero emission vehicle?

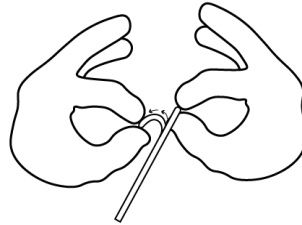
Reflecting

- What did you learn during this project?
- What did you learn about yourself during this project?
- What career do you think you can have when there are a lot of zero emission vehicles in our world?

Expert tips and tricks

Peeling Maker Tape:

- When peeling paper off of the Maker Tape, use your thumb to roll the Maker Tape back towards the paper and catch the sticky side on your finger.
- Remove the paper slowly and leave some of the paper in place while you are securing it to the project - If not, it could stick to itself!
- Make sure none of the Maker Tape lines are crossing over and touching each other.

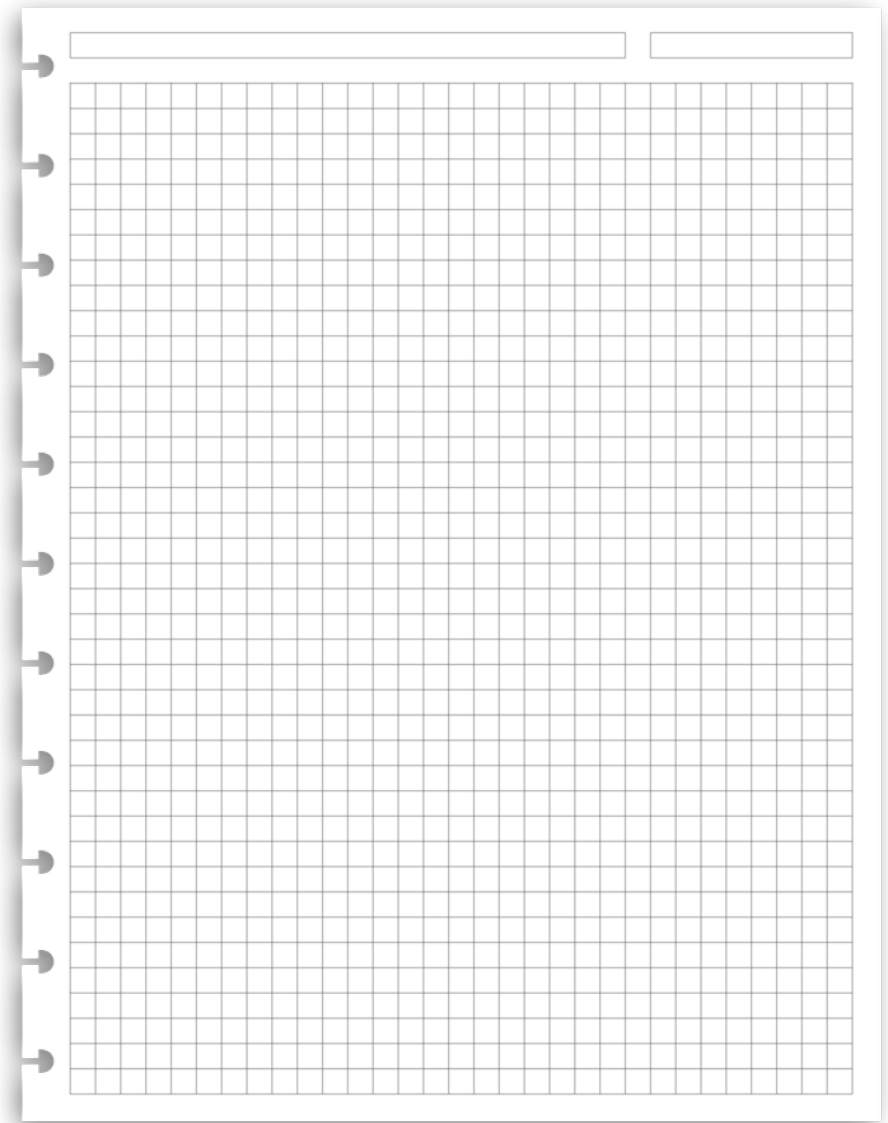


Continue Exploring and Learning about the NYPA!

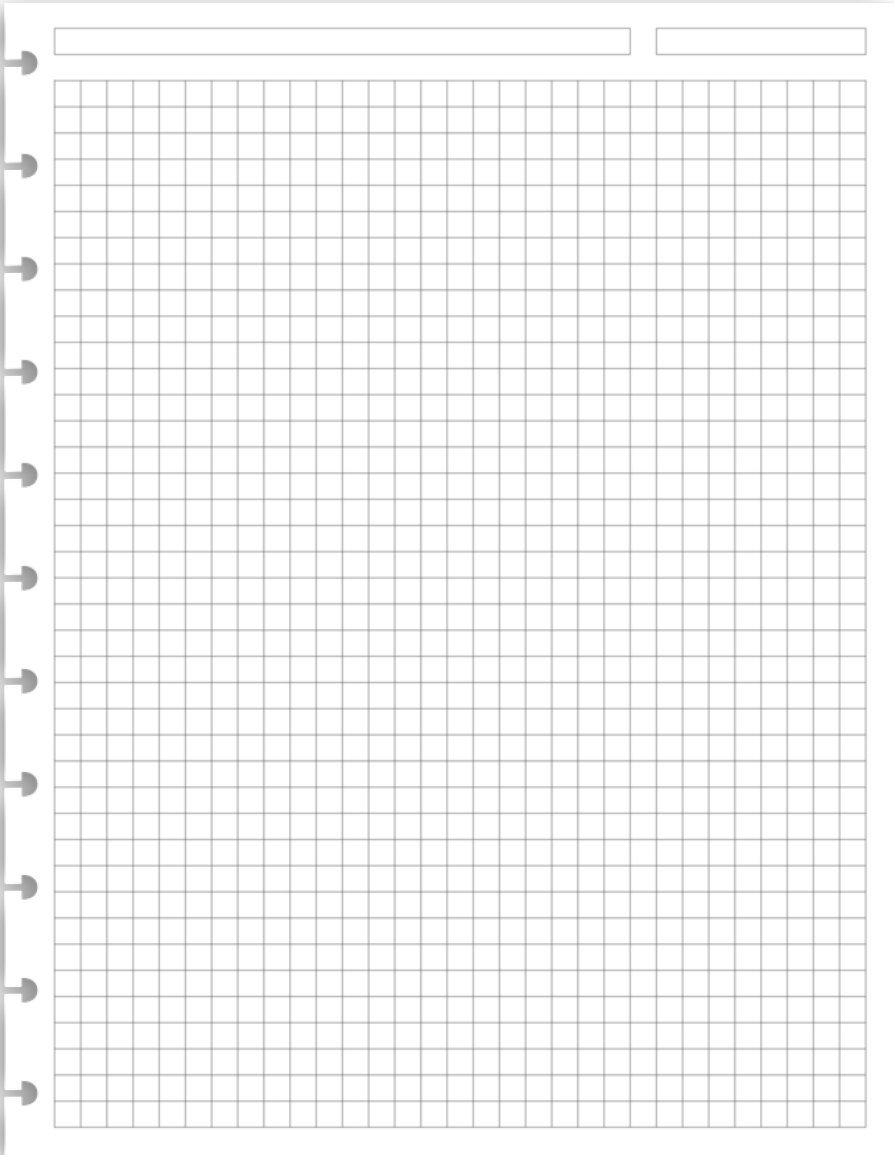
- Explore all that NYPA is doing to move NY forward in the world of energy- <https://www.nypa.gov>
- NYPA: Leading the way in EV infrastructure <https://evolveny.nypa.gov>


Electric vehicles should be a realistic option in every region of New York State and drivers should know they can charge up quickly and get to their destinations on time."

- Gil C. Quiniones, NYPA President & CEO




Notes and Design Space



4x4 Off Road Vehicle	Vehicle Usage Data
	Weight of Vehicle: 4400 lb.
	Number of Passengers: Max number 4 (2 adults, 2 children)
	Full Charge Battery Range: 230 miles
	Time Needed to Fully Charge Battery: Standard Charger - 12 hours Rapid Charger - 2 hours


Every weekend a group of cousins love off-roading in their electric SUV either on trails in the woods or on the beach. Although they might not be driving long distances, power consumption is high due to the terrain they are navigating and with the equipment they need to carry for hiking and camping on their adventures. They want to recharge in the middle of their outdoor adventure so they can keep going.

How might you design a charging station that is environmentally friendly and convenient for their needs?

Electric School Bus	Vehicle Usage Data
	Weight of Vehicle: 24,387 pounds
	Number of Passengers: 112 students
	Full Charge Battery Range: 230 miles
	Time Needed to Fully Charge Battery: Standard Charger - 14 hours Rapid Charger - 4 hours


School buses drive their specific routes through their neighborhoods everyday, they not travel many miles. School bus drivers spend a lot of time starting and stopping along their route in order to load and unload students traveling to and from school. Whether it is hot or cold outside, it is always a comfortable temperature on the bus and this requires a lot of power. After they drive their route, they go back to their depot to recharge their bus with the rest of the fleet until the next day. The school bus depot is a big open, uncovered lot. The manager of the depot is looking to find solutions to create shade as well as how to best charge the 75 electric school buses.

How might you design a charging station that is environmentally friendly and convenient for their needs?

Electric Camper Van	Vehicle Usage Data
	Weight of Vehicle: 2,300 lbs
	Number of Passengers: up to 7
	Full Charge Battery Range: 373 miles
	Time Needed to Fully Charge Battery: Standard Charger - 14 hours Rapid Charger - 2 hours


Seven friends are going on a road trip across New York State to experience all 180 state parks from the shores of Long Island to Niagara Falls. They expect to travel about 1400 miles on their journey. The friends will need to consider that sometimes they will be doing a long drive through rural parts of New York without stopping. They also will be carrying all the things they need for hiking and camping.

How might you design a charging station that is environmentally friendly and convenient for their needs?

Electric State Vehicle	Vehicle Usage Data
	Weight of Vehicle: 2,700 lbs
	Number of Passengers: 4
	Full Charge Battery Range: 114 miles
	Time Needed to Fully Charge Battery: Standard Charger - 5 hours Rapid Charger - 1 hour


This vehicle is driven as a work vehicle for an employee of the state of NY. It is driven to and from job sites all around the region. At times it carries one employee, yet other days it may carry up to 4 employees as they commute to meetings around the state together. These NYS employees may drive 3 or more hours to get to a job site and then 3 or more hours back to the state office. During meetings they usually park in parking lots of office buildings. What is interesting about this vehicle is that it is also equipped with wifi capacity so that the employees can use their vehicle as a workstation "on the go".

How might you design a charging station that is environmentally friendly and convenient for their needs?

Community Police Vehicle	Vehicle Usage Data
	Weight of Vehicle: 4,561 lbs
	Number of Passengers: 5
	Full Charge Battery Range: 387 to 520 miles
	Time Needed to Fully Charge Battery: Standard Charger - 12 hours Rapid Charger - 2 hours

The electric police car is out and about helping the community throughout the day and night. Each electric police car is on a shift during two 8 hour windows of a 24 hour day (8am-4pm, 4pm-12am, 12am- 8am). As the police are out in the community, it is important they have access to quick communication with the first responders on their team. The police have a lot of electronic components and a computer on board the car. When the car is not on it's shift, it is back in the underground station garage with the remainder of the fleet.

How might you design a charging station that is environmentally friendly and convenient for their needs?

Family Car Adapted	Vehicle Usage Data
	Weight of Vehicle: 3,020 lbs
	Number of Passengers: 3 + 1 driver who uses a wheelchair
	Full Charge Battery Range: 250 miles
	Time Needed to Fully Charge Battery: Standard Charger: 12 hours Rapid Charger: 4 hours

This car belongs to a family of 4 that lives in an apartment complex in a vibrant neighborhood. This car has been adapted for a member of their family who utilizes a wheelchair and loves to drive. The car is used for short trips, day to day driving, to run errands, pick up food, and to see friends across town. Most trips taken are less than 30 minutes and average no more than 15 miles. When the car is not in use it is parked outside of the apartment complex in a handicap spot.

How might you design a charging station that is environmentally friendly and convenient for their needs?

**REV Electric
Ambulance**

Vehicle Usage Data



Weight of Vehicle: 10,300 lbs


Number of Passengers: 2 EMT workers, 1 passenger, 1 family member with patient

Full Charge Battery Range: 170 miles

Time Needed to Fully Charge Battery:
Standard Charger - 18 hours
Rapid Charger - 4 hours

This ambulance is parked the majority of the day right outside the local hospital with its two EMTs. When a call comes in the EMTs are zig zagging around town and then returning to the hospital to deliver patients and replenish its supplies. They do a lot of short trips, where they keep the engine running to power all the electronic components in the cabin. It is important to maintain a comfortable temperature in the cabin and a smooth ride for the patients when enroute.

How might you design a charging station that is environmentally friendly and convenient for their needs?

Electric Sports Vehicle	Vehicle Usage Data
	Weight of Vehicle: 4,300 lbs
	Number of Passengers: 2
	Full Charge Battery Range: 230 miles
	Time Needed to Fully Charge Battery: Standard Charger - 12 hours Rapid Charger - 2 hours

The driver of this beautiful, sleek sports car loves to go really fast and take long highway day trips enjoying the endless roads within the state of New York. The driver pins charging stations on their map so that they can enjoy their time on the road without worrying about where they will charge next. This driver prefers to not spend a lot of time waiting at the charging stations as they like to be on the go and moving, enjoying their day out.

How might you design a charging station that is environmentally friendly and convenient for their needs?