

# **Environmental Education Program:** Electric Vehicle Challenge

Grades 6-8



**2022-2023**

goHunterdon's Electric Vehicle Challenge explores the connection between transportation choice and impact on the environment.

### Program Delivery Changes for 2022-2023

Please note the following changes to the Electric Vehicle Challenge for this school year:

- The EV Challenge has been structured as an **8 month program for 2022-2023**. This will allow sufficient time for required prerequisite lessons prior to students designing and building their vehicles.
- **Electric Vehicle Challenge Prerequisite Lessons-** Prior to receiving EV Challenge build kits, **students will be required to have participated in prerequisite lessons as noted on page 6.**
- **“Lessons in a Box” Approach-** Lessons, online resources, and supplies for the Electric Vehicle Challenge will be delivered to schools for teachers to conduct lessons upon request via email. goHunterdon staff will not be available to teach lessons directly.
- **Teacher Workshop-** Attendance in a teacher workshop to be scheduled remotely in October will be **required** for all participating teachers. Workshop will include additional instructions on reserving lessons in a box and ordering build kits..
- **Facilitated Professional Learning Community-** gohunterdon staff will facilitate a professional learning community of participating teachers, provide trainings, and videos to support programming. **Participating teachers must agree to participate in the professional learning community to support other teachers.**
- **EV Challenge Countywide Race-** goHunterdon will conduct a countywide speed race for participating students in May 2023. goHunterdon will provide judging criteria and award certificates to teachers who wish to score student vehicles on engineering, design, craftsmanship, and use of upcycled materials.

These changes have been made to allow goHunterdon to continue to provide high quality programming to the maximum number of students in Hunterdon County and to ensure consistency with goHunterdon's mission.

For more information we invite you to contact **Margret Thompson, Sustainable Hunterdon Coordinator**, [mthompson@gohunterdon.org](mailto:mthompson@gohunterdon.org)





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## Electric Vehicle Challenge

*To successfully participate in the EV Challenge, teachers and students should anticipate an 8 month program schedule, starting in October.*



goHunterdon's Electric Vehicle Challenge program engages students to design, build, and race electrically powered model cars.

The EV Challenge is an environmental education program that aligns with STEAM curriculum (Science, Technology, Engineering, Arts, and Mathematics); bridging the gap between these important educational disciplines.

Following prerequisite lessons on the impact of transportation on the environment, students will work in **teams of 2-4 students** to transform a few components including a motor, wheels, axles, and a battery pack into a unique and functioning model race car. Beyond these materials, students may use anything they like to build their vehicle. The only two required materials that must be used are the battery pack and motor; everything else is fair game. Student vehicles may be evaluated by teachers on Engineering, Craftsmanship, and Use of Upcycled Materials. Scoring criteria is available upon request.



The EV Challenge Program may be incorporated into "in person" classroom curriculum, remote learning, or used as part of an after school club.

**EV Challenge Countywide Race will be conducted in May 2023.**

The lessons that follow teach students about electric vehicles, aerodynamics, gear ratios, and the alternative energy supplied by batteries, just like in a real electric vehicle. These lessons will guide them as they design and build their model cars. All lessons meet NJ Core Curriculum standards (details available on request).

goHunterdon facilitate the establishment of a professional learning community so teachers can support each other in implementing these lessons.

## Teacher Workshop- Mandatory

The introductory program workshop will provide teachers with practical information to allow them to help student teams to participate in the Electric Vehicle Challenge Program (EVC).



**Workshop will be offered remotely** this year and will offer an overview of the 2022-2023 EVC program, timelines for preparing students, and details and benefits of the lesson offerings. Teachers will receive a build kit to allow them to design and build a race car to familiarize themselves with the vehicle components and the design and build process.

Other topics discussed in the workshop will include prerequisite lessons, program rules and regulations, judging criteria, engineering design journal, vehicle Requirements, testing, and race day preparation.

**Participation is required for those teachers who want their students to participate in the program.**



## Prerequisite Lessons

The Electric Vehicle Challenge provides a hands on learning opportunity to teach students about the impact that transportation choice has on the environment as part of goHunterdon's broader environmental education program.

This year, teachers will be required to instruct 3 of the following 5 lessons prior to beginning the EV Challenge "design and build" lessons or receiving build kits.

The EV Challenge prerequisite lessons are listed below and included in this catalog:

- **Drive It Green**
- **Transportation and the Environment**
- **Electric Vehicles and Climate Change**
- **Busting Myths About Electric Vehicles**
- **Green Marketing**

All teachers are also encouraged to coordinate with goHunterdon to arrange to have an electric vehicle visit the school.

## Suggested Program Schedule

The following schedule includes all of the **prerequisite lessons**. Three (3) of the five (5) lessons are required prior to starting the EV Challenge “design and build” lessons. The “design and build” lessons should be taught in the order presented so that students learn all concepts needed for students to create a successful vehicle. The amount of time needed for construction and testing of students’ creations will vary, and more time may be needed than is included here. The following time line may be used to help plan your program year.

Week 1	October	<b>Drive It Green</b>
Week 2	October	<b>Electric Vehicles and Climate Change</b>
Week 3	November	<b>Busting Electric Vehicle Myths</b>
Week 4	November/December	<b>Transportation and the Environment</b>
Week 5	December	<b>Green Marketing ***</b>
Week 6	December/January	<b>Electric Vehicle Visit</b>
Week 7	January	Introduction and Basics of Design
Week 8	January	Battery Power
Week 9	February	Aerodynamics
Weeks 10 and 11	February/March	Introduction to Gears
Week 12	March	Prototypes
Weeks 13 and 14	March/April	Construction and Testing
Week 15	April/May	At the Race Line
Week 16	May	Final Prep for races

**\*\*\* teachers may order EV kits**

# PREREQUISITE LESSONS

## Drive it Green

### Learning Objectives

Students will be able to:

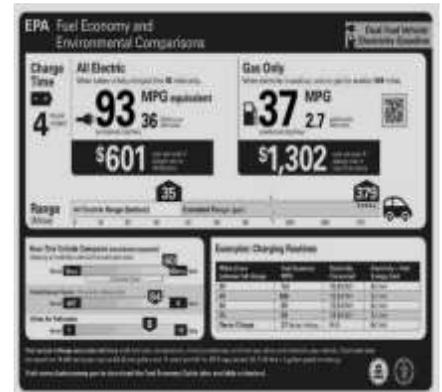
- Discuss fuel efficiency and what it means for the environment
- Understand how transportation choices impact the environment
- Understand the types of fuel that can power motor vehicles

### Overview

Students start out the lesson by looking at a list of seven (7) reasons that a person might consider when purchasing a vehicle (color, style, brand name, etc.)

Students are then directed to select a vehicle (sports car, sedan, pick-up truck, etc.) that they will utilize for the remainder of the class period. Students select their vehicle prior to being given any further information about the activity. Only after the student teams have selected their vehicles are they provided with a “window sticker” which will give them additional information, such as gas mileage, EPA ratings, etc.

Students repeat the activity with a second vehicle which is more fuel efficient or which runs on alternate fuels such as a hybrid vehicle. They compare information from both vehicle choices and discuss alternative fuels and more sustainable forms of transportation.



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Remote Delivery: Lesson in a Box with supplies

# Transportation and the Environment: Energy, Fuels and Emissions

## Learning Objectives:

After this lesson, students should be able to:

- Understand the sources of energy used to power vehicles.
- Understand the difference between fossil fuels and renewable/advanced fuels
- Explain why advanced fuels have lower emissions

## Overview

In this lesson students delve into the different ways that vehicles can be powered and how each works:

Gasoline/Diesel

Hybrid electric

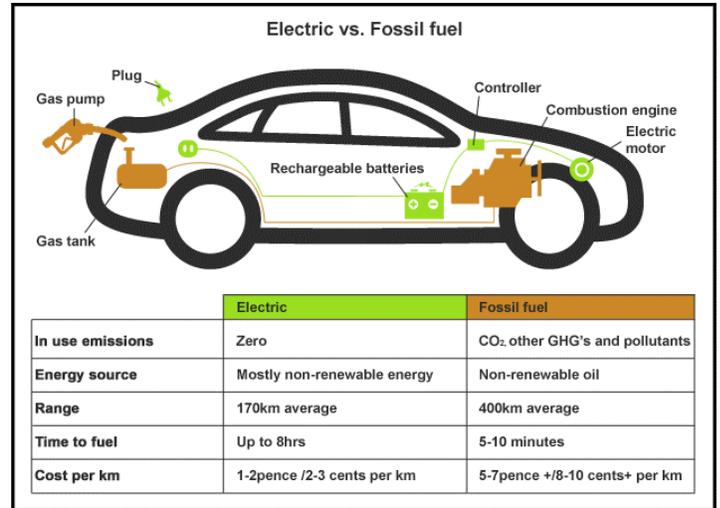
Battery electric

Biodiesel

Compressed natural gas/propane

Hydrogen fuel cell

Students will then have the opportunity to apply what they have learned by designing their own eco-friendly transportation vehicle of the future. Design criteria will include New Jersey's goal to have 100% clean energy by 2050 as well as to appeal to consumers of the future.




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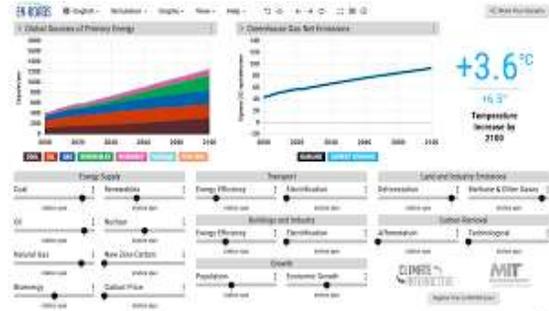
Remote Delivery: Lesson in a Box with all necessary supplies

# Electric Vehicles and Climate Change

## Learning Objectives

After this activity, students should be able to:

- Identify how climate change is affected by greenhouse gases.
- Use a digital interactive graph to predict climate change outcomes.
- Evaluate how electrification of transportation will impact climate change.
- Write an evidence based statement supporting an environmental policy.



## Overview

Digital tools can help us to visualize and predict outcomes. The En-ROADS simulator tool allows us to see how changes in the use of greenhouse gas emitting technologies change the overall warming of the planet. Students will gain a better understanding of climate change with a video from National Geographic with Bill Nye. Then, students will use the En-ROADS simulator tool to change transportation to electrification to evaluate the change in predicted temperature. Students will write a statement to make an evidence based recommendation about electrification of transportation.

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Remote Delivery: Lesson in a Box with all necessary supplies

## Busting Electric Vehicle Myths

### Learning Objectives

After this activity, students should be able to:

- Research using digital tools, print and video sources to comprehend an issue.
- Use speaking and listening strategies to engage in discourse using technical vocabulary of the subject accurately.
- Evaluate arguments using facts from trusted sources.



### Overview

There are many myths about why electric vehicle adoption is not a good idea. Students will use video, web, and print sources to research some of these myths and find out how they are false.

Students will role play explaining why an electric vehicle myth is not true through an interactive game structure. In the process, they will learn about how to advocate for positive change through combatting disinformation.

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Remote Delivery: Lesson in a Box with all necessary supplies

## Green Marketing

### Learning Objectives

After this activity, students should be able to:

- Write an advertisement for a hybrid vehicle.
- Use a full range of strategies to comprehend technical writing, newspapers, magazines, etc.
- Write in the content areas using the technical vocabulary of the subject accurately.
- Learn the principles of comparative analysis.



### Overview

Part of successful engineering invention and innovation is exploring the factors that determine success or failure in the competitive marketplace. This includes knowing your product, your competition and your potential customers. Successful engineers have strong written and oral communication skills suitable for a range of audiences. Even though engineers themselves may not create the advertising, they must clearly explain to the advertisers the product benefits.

Students will learn basic marketing concepts and use professional marketing techniques to compose an advertisement for a hybrid vehicle. In the process, they will learn about hybrid vehicle technology and why it is good for the environment.

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Remote Delivery: Lesson in a box with all necessary supplies.

## Electric Vehicle Visit

Learning Objectives:

- Students will identify the parts of an electric vehicle and how they are different from internal combustion engine cars.
- Students will develop questions to enhance their understanding of electric vehicles.



Overview:

Students have been learning about different types of cars including electric vehicles. Students will develop questions to ask and identify answers to as they get to know an electric vehicle in person.

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Remote Delivery: Lesson in a Box with all necessary supplies

# DESIGN AND BUILD LESSONS

## Basics of Design & Building Your Model Car Lesson

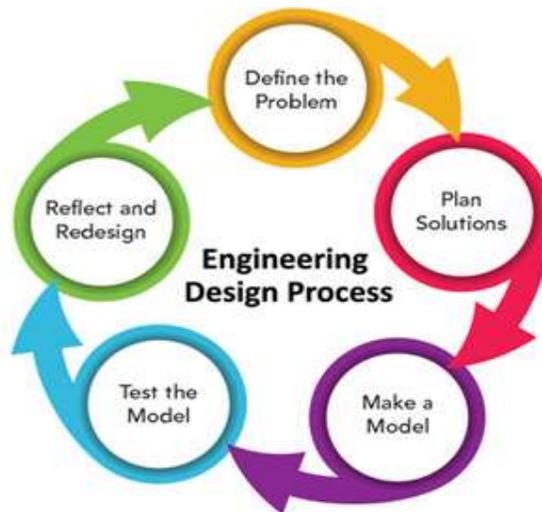
### Learning Goals/Essential Questions

- What are the basic design strategies?
- What are the best materials for strength vs. weight?
- How does the structure of my vehicle impact its durability?



### Overview

Using the continuous feedback loop seen below, students will learn the steps necessary to successfully build a working model electric vehicle.



This information will be extremely important as students move through the stages of building their Electric Vehicle Challenge cars and developing not only a working vehicle but one that might win the races.

Following the informative lesson, students will participate in a building exercise that will engage them in the building and design of shapes that could help them improve the overall strength of their vehicles without sacrificing added weight.

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**Remote Delivery:** Lesson in a Box supplies for hands on building activity

# Battery Power! Lesson

## Learning Goals/Essential Questions

- How does a battery work?
- Do different batteries produce different amounts of electricity?
- What happens when more than one battery is used in series?



## Overview

Do different batteries really impact electric power output that much? Find out with this lesson that is designed to test that exact question. We will review the basics when it comes to batteries; how they work, how much electricity different batteries produce, and what happens when they are connected in series.

Utilizing test batteries and multi-meters students will investigate the electrical output of different batteries. By taking measurements using different batteries the students will get to see the importance of the power of their battery packs during the races.

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**Remote Delivery:** Lesson in a Box with multi-meters and test batteries.

# Aerodynamics Lesson

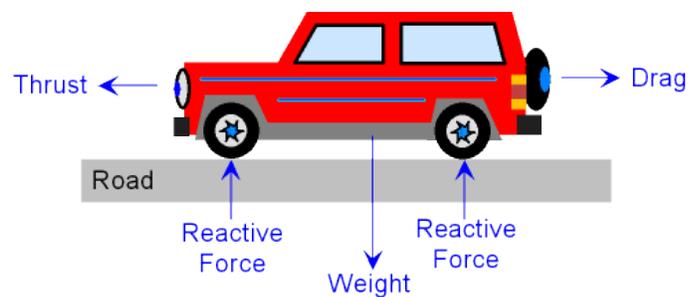
## Learning Goals/Essential Questions:

- What is Aerodynamics? How does it impact my vehicle?
- How can I make aerodynamics work for me?



## Overview

How does the aerodynamics, or shape, of an object moving through the air increase or decrease the friction (drag) on that object? In this lesson we explore the four (4) forces of aerodynamics: Lift (or Reaction), Weight, Thrust, and Drag. We will discuss these different forces and describe how each of them works with or against a vehicle.



For the experimental portion of this lesson students will be asked to design, using foam pieces, different shaped objects that will be put into a homemade wind tunnel to test how they interact with the air. Students will place their shapes into the wind tunnel and record the amount of time it takes to cross the finish line.



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**Remote Delivery:** Lesson in a Box and wind tunnel.

# Introduction to Gears & Gear Ratio Lesson

## Learning Goals/Essential Questions

- What is a gear and how does it work?
- How do you determine a gear ratio?
- What is torque vs. speed and how do they impact the way gears operate?

## Overview

What is a gear? How does it work? How does the size of the gear and different gear arrangements impact the overall performance of the gears?

In this lesson we answer all of these questions and more. Students will be introduced to gears, and gear ratios. Students will also learn about torque and speed and how to determine if the gear ratio that they are using is utilizing either of these.

The second part of the lesson, after the students are familiarized with gear ratios, focuses on how to incorporate these concepts into their Junior Electric Vehicle Challenge vehicles. During this portion of the lesson we will discuss how wheel size directly impacts the gear ratio needed to move the vehicle and how to best find the proper ratio to use.



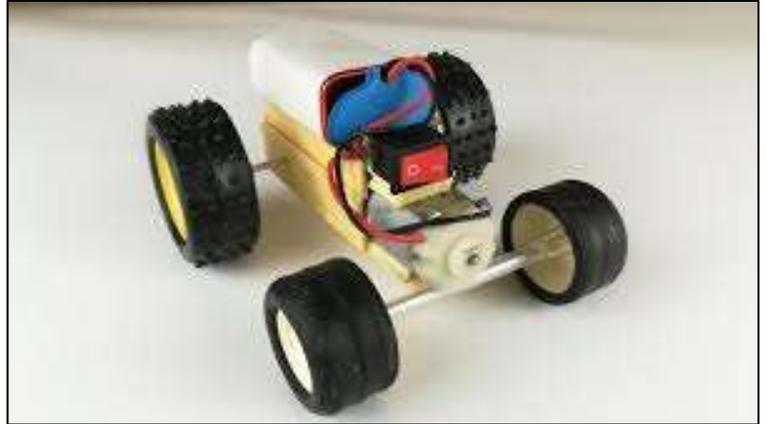
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**Remote Delivery:** Lesson in a Box supplies with testing gears and worksheets

## Prototypes Lesson

### Learning Goals/Essential Questions:

- What do the different gear ratios mean for car design?
- How do you decide what gear ratio to use?



### Overview

As a follow-up to the Introduction to Gears lesson, students are provided with an opportunity to test different gear ratios. Utilizing equipment supplied by goHunterdon the students will build and test a working prototype and will have the opportunity to see how gear choices impact their car.

This workshop is designed for the students to design and build a working prototype which will help them in refining their actual design. Documenting the Engineering Design Process with their ideas and iterations becomes important and will be discussed.

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**Remote Delivery:** Lesson in a Box with prototype supplies.

## Construction and Testing Lesson

### Learning Goals/Essential Questions:

- How do I apply what I have learned to create a successful electric vehicle?
- What materials should I use?
- How will I decide what works and what doesn't for my electric vehicle?



### Overview

The prior lessons lead up to this one where students use everything they have learned so far to construct their Electric Vehicle Challenge vehicles. This is where it all comes together! Students will document their design ideas for the vehicle's chassis, axles and wheels, gear setup, body/shell, and materials they will use. Then students will construct, test, document, and modify their vehicle using the engineering design process. Consideration of strength of materials, the effects of friction and weight, and aerodynamics will all be needed to successfully build their electric vehicles. The Electric Vehicle Challenge vehicles have two design requirements that must be incorporated: 1) the motor and battery pack provided by goHunterdon must be used and 2) the vehicle must hold a standard soda can as a passenger which can be easily removed without affecting the structure of the vehicle.

It is likely that this lesson will occur over a few weeks as students build their vehicles and goHunterdon staff provide check ins and support during the build and test process.



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Remote Delivery: Lesson in a Box with supplies and virtual mentoring sessions.

## At the Race Line Lesson

### Learning Goals/Essential Questions:



Why do we attach our cars to a race line?

What is the race line and what does it do?

How do I attach and detach my vehicle easily from the race line?

### Overview

Race line attachment is a consistent challenge for students on race day. Student vehicles must attach (and remain attached or they are disqualified from that race) to a 60# fishing wire that stretches the length of the track. This lesson will help your students feel more confident and understand what they need to do prior to race day.

Utilizing simply designed balloon powered cars with different race line attachments students will have the opportunity to experiment with different set-ups to find one that would work well with the design of their vehicle.



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Remote Delivery: Lesson in a Box with race line supplies.

## What to Expect on Race Day Information Session

Grade(s): 6-8



### Information Session Goals:

- Making students comfortable with what will be happening on Race Day.
- Providing opportunities for last minute fixes, and tweaks to vehicles.

### Overview

This workshop will be tailored to the specific needs of the race at your school. The lesson will provide your students' with specific information about what to expect on race day, what to do and how the event works. The main goal of this lesson is to make sure your students and their vehicles are ready to race on Race Day.

This may include answering last minute questions, soldering/wire connections, vehicle inspection to provide useful tips for students, and test race line for students to test their vehicles.



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**Remote Delivery:** Virtual presentation and check in.