# Legacy EV - Electric Vehicle Education

SEMA 2022 - Educational Seminars

**Summary**: Legacy EV will be providing electric vehicle (EV) training at SEMA 2022. If you are interested in attending any of the following sessions, please complete the survey (linked here). The training will be hosted in the SEMA Electrified Zone at SEMA Las Vegas, 2022.

## EV Overview

**Date:** Tuesday, 11/01/22 from 10am - 11:30am

While often regarded as a modern development in the automotive landscape, the history of electric vehicles can be traced back over 150 years. Their rise in popularity today mirrors many of the same reasons why they were first popular. Whether it's to save money at the pump, leverage the instant torque of an EV motor, or contribute positively to climate solutions, consumer trends are pointing towards an ever expanding EV presence in the automotive market.

In 2022, the transition to EV technology is no longer a question of if or when - but rather, how fast? Attendees will explore where this technology has been, where it is today, and where it will be in the future.

Participants will leave with an understanding of:

- How the market for electric vehicles is growing both nationally and globally.
- How EV system components compare with ICE system components.

## Electrical Theory

**Date:** Tuesday, 11/01/22 from 2pm - 3:30am

In order to understand how an EV works, it is important to first understand the fundamentals of electrical concepts. This includes basic electrical vocabulary, circuits, and components used in EVs.

Attendees will gain insight into several fundamental electrical concepts, their interrelationships, and their significance in the content of EV building. These notions will be compared to a system that is familiar to comprehend: water in a pipe that turns a waterwheel.

Participants will leave with an understanding of:

- How to use electrical concepts to calculate key EV performance parameters.
- Volts, amps, and watts and explain how each are measured.

- How to calculate wattage of a given electrical system.
- Ohm's law and explain how Ohms affects wattage.
- Circuits and the different applications of series and parallel circuits in an EV.
- Resistors, capacitors, inductors, transistors, diodes, contactors, and relays and explain what purpose they serve in an electrical circuit.

## HV Safety

**Date:** Wednesday, 11/02/22 from 10am - 11:30am

Building an electric vehicle is an exciting project. However, electrical systems can be incredibly dangerous. If not treated with care, respect and intelligence, they can result in costly damage to equipment, injury, and even death.

Attendees will be walked through many of the safety measures needed to work with specific types of electricity they will encounter throughout the build process.

Participants will leave with an understanding of:

- Fundamental best practices for avoiding electrical shock.
- Various categories of electricity that are encountered in an electric vehicle.
- The effects of varying levels of electricity on the body.
- How understanding Ohm's law can help prevent electrical shock.
- High Voltage safety standards that a vehicle must meet in order to be road safe and compliant for all regulations.
- Levels of PPE and tools required for an EV build.

## Motor Systems

**Date:** Wednesday, 11/02/22 from 2pm - 3:30am

There are a variety of motor technologies, brands, and models available for EV builds. Understanding what makes up a complete motor system is helpful in understanding how each motor type works. While there is not one commonly agreed upon definition of which components fit within a “motor system”, there are common patterns for which components work together to provide the required power to the wheels in an EV.

There are several types of motor technology available on the market. This technology is constantly evolving to create new and innovative categories of motors. Each motor technology has different benefits and drawbacks. Attendees will receive an overview of each technology before focusing on the working of a specific motor.

Participants will leave with an understanding of:

- Various EV motor technologies available on the market i.e. brushed DC, brushless DC, three phase AC, AC induction, axial flux, etc.
- Benefits and drawbacks on different motor technologies and generally understand their best use applications.
- Considerations and components required to determine optimal motor choice for an EV build.

## Battery and Charging Systems

**Date:** Thursday, 11/03/22 from 10am - 11:30am

A battery system includes more than simply the cells and modules that makeup a pack. It also needs management systems to monitor cell health and control discharge, cooling/heating systems to keep cells in a healthy temperature zone, and typically a box to house all the modules and cooling/management components.

A charging system also includes a variety of components ranging from an Onboard Charger, and EV Supply Equipment (EVSE), J1772 or CCS Plug, DC/DC Converter, and EV Charge Controller (EVCC), Fuses, Relays, and more. Attendees will leave with a basic understanding of how both battery and charging systems in an EV work as well as what benefits various technologies available in the market today offer to the overall performance of an EV.

Participants will leave with an understanding of:

- The considerations required to design a battery system for a motor.
- Charging components and their limitations.
- Processes needed to make traditional automotive components function in an EV.
- The various types of battery chemistries and configurations available on the market (i.e. cylindrical cell, prismatic cell, pouch cells and LFP, NMC, LiFePO4).
- The difference between an On Board Charger (OBC), an Electric Vehicle Charge Controller (EVCC), and Electric Vehicle Supply Equipment (EVSE).
- kW capacity of an EV charger affects charge time.
- How amp rating on various EVSE affects charge time.

## Mounting and Wiring

**Date:** Thursday, 11/03/22 from 2pm - 3:30am

Once the old ICE components have been removed from the vehicle, where do all th new EV components go? How will they fit together? Once mounting locations are planned for all the systems, now begins the task of placing components, running wires, and connecting each system together. Attendees will learn about the considerations they need to take into account before physically mounting the systems and connecting them. They will look at wiring diagrams and discuss how they translate into actual application on a vehicle. Additionally, they will explore best practices for wiring and connecting EV systems, as well as how to connect each system.

Participants will leave with an understanding of:

- Block diagrams to illustrate how the motor, battery, and charging systems work together to make a functional EV.
- Proper components and system mounting order for a variety of build configurations.
- Wiring a given high voltage battery system with battery management and EVCC given a wiring diagram.
- Commonly used wire plugs and connectors for EV builds.
- Best practices for connecting multiple EV systems in an EV.

## Programming an EV

**Date:** Friday, 11/04/22 from 10am - 11:30am

Due to the nature of an EV being an electronic system, it is likely far more programmable and customizable than the original combustion engine vehicle. For example, EVs have programmable torque curves, they can have different modes programmed and accessible in the cab by the flip of a switch, and they can even have programmable modes to allow for single pedal driving.

For seasoned builders with combustion engine experience, this may be the newest aspect of building an EV. Programming EVs will require having access to a properly specced computer, proper software, and the programming manual included with the VCU, BMS, and/or MCU system.

Participants will leave with an understanding of:

- How to properly test and find specifications for the final product of vehicle electrification.
- The required parameters that must be considered when programming various EV systems (i.e. max voltage, current, charge, discharge, etc)
- Ways in which EV systems can be programmed to meet specific needs of a build.
- Which components in an EV will require programming.
- Proper steps for commissioning, tuning, and testing an EV.

- Which vehicle features will require programming and understand how to adju them based on user experience.

## Fault Finding

**Date:** Friday, 11/04/22 from 2pm - 3:30am

Fault finding is one of the most valuable skill sets a technician can have. Given the virtually limitless number of potential errors in a system, a strong understanding of troubleshooting procedure is the key. Troubleshooting faults is a skill. Attendees will get expert insight on how to apply universal steps, strategies, and tools to troubleshoot electrical system faults.

Participants will leave with an understanding of:

- How to categorize common fault types encountered in an EV and list ways to avoid them.
- How digital multimeters are used to troubleshoot circuits.
- EV fault codes, their limitations, and how to fix their root causes.
- How senses can be used to troubleshoot and find fault