Canadian Vehicle Manufacturers' Association
Association canadienne des constructeurs de véhicules

call2recycle
Leading the charge for recycling.

Understanding EV Batteries

Electric vehicles (EV) are entering the market as alternatives to traditional internal combustion engine (ICE) vehicles. Burning gasoline or diesel in passenger cars and trucks emits greenhouse gas (GHG) emissions and transitioning to EVs is an effective way to support GHG reductions.

Governments across Canada are looking for ways to increase the adoption of EVs through point-of-sale purchase incentives, ownership incentives (such as free parking, free tolls, use of HOV lanes), education of ownership benefits (such as reduced maintenance and fuelling cost), regulations, and infrastructure development. As the number of EVs on the road continues to rise, questions have been raised about the potential impact of EV batteries on the environment at end of life and the infrastructure needed to remanufacture, repurpose, and recycle them safely.

The Canadian Vehicle Manufacturers' Association (CVMA) has partnered with Call2Recycle (a leading battery recycling organization) to review current battery management practices with the aim of producing a white paper on EV battery management in fall 2021. As part of this initiative, we are consulting with stakeholders (government, industry, non-governmental organizations, vehicle and battery recyclers) to develop fact sheets on EVs and batteries.

This first fact sheet outlines the different types of EVs available in Canada, common types of batteries used in EVs and the number of EVs currently on the roads. Forthcoming fact sheets will explore battery recycling options, battery reuse and end of life management.

WHAT ARE ELECTRIC VEHICLES AND ARE THEY ALL THE SAME?

Hybrid electric vehicle (HEV): Hybrid electric vehicles are vehicles with an internal combustion engine and an electric motor/battery pack. The battery pack is not charged by an external source but rather through regenerative braking which captures energy that would otherwise be lost. They contain a relatively small battery (~70-90 kg) and the battery chemistry has traditionally been nickel metal hydride (NiMH).

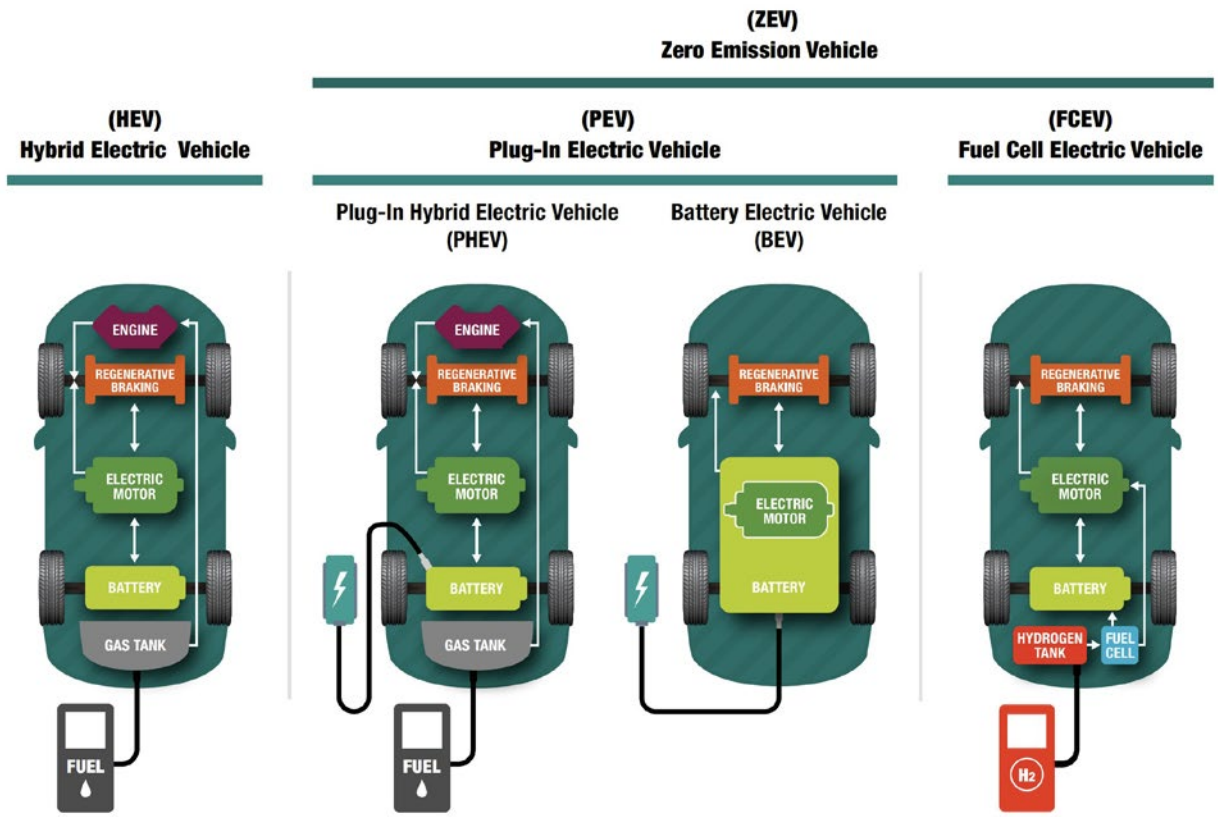
Plug-in hybrid vehicle (PHEV): Plug-in hybrid electric vehicles are vehicles with an internal combustion engine and an electric motor/battery pack that can be recharged from an external source as well as from regenerative braking. They typically run on electric power until the battery is drained and then the internal combustion engine takes over for propulsion. PHEVs produce zero tailpipe emissions when running on electric power. Common battery electric range for these vehicles is 40-60 km or higher. The battery is typically slightly larger than those found in an HEV and the chemistry is mainly lithium based or could be NiMH.

Battery electric vehicle (BEV): Battery electric vehicles are vehicles powered solely by an electric motor/battery pack that can be recharged from an external source as well as from regenerative braking. BEVs produce zero tailpipe emissions. They typically have a range greater than 200 km. As a result, the battery packs are much larger weighing between 200-1200 kg. The chemistry of these batteries in North America are all lithium based.

Fuel cell electric vehicles (FCEV): Fuel cell electric vehicles are also powered solely by an electric motor like a BEV but instead of recharging a battery from an external source they generate their own electricity. FCEVs store hydrogen gas in an onboard tank that the fuel cell combines with oxygen from the air to produce electricity. The electricity from the fuel cell then powers an electric motor, which powers the vehicle just like a BEV. And like BEVs, there is no GHG emissions. Unlike BEVs or PHEVs, however, there is no need to plug-in FCEVs, since their fuel cells are recharged by refilling the hydrogen. The batteries in these vehicles support regenerative braking, receive some charging from the fuel cell, are similar in size to HEVs and PHEVs and tend to be lithium based.

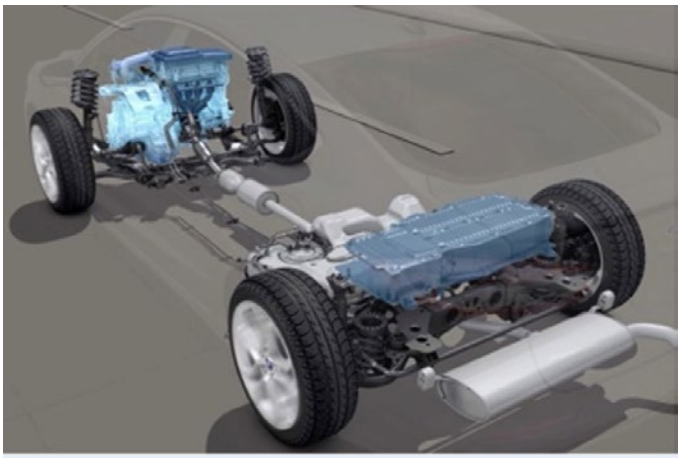
Although HEV, PHEV, BEV and FCEV are often grouped together, HEVs or hybrids that cannot be recharged from an external source are not included in zero emission vehicle (ZEV) mandates such as those in Quebec, British Columbia or California, although they do contribute to lower vehicle GHG emissions. In addition PHEV, BEV, and FCEV are using predominantly lithium battery chemistries whereas typically HEV use nickel metal hydride technology which means the opportunity for reuse and the technology used for recycling are significantly different.

A VISUAL COMPARISON OF EV CONFIGURATIONS



Source: Call2Recycle; adapted from www.thedriven.io

PICTURES OF DIFFERENT EV BATTERIES



HEV

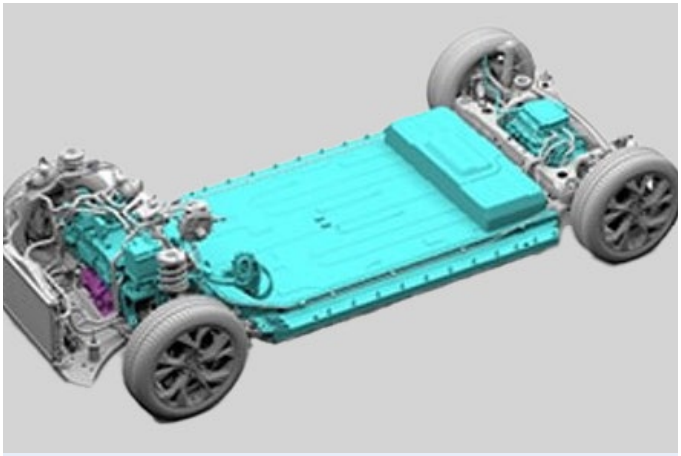
2020 Ford Fusion HEV

Source: www.ford.ca

PHEV

2021 Jeep® Wrangler 4xe

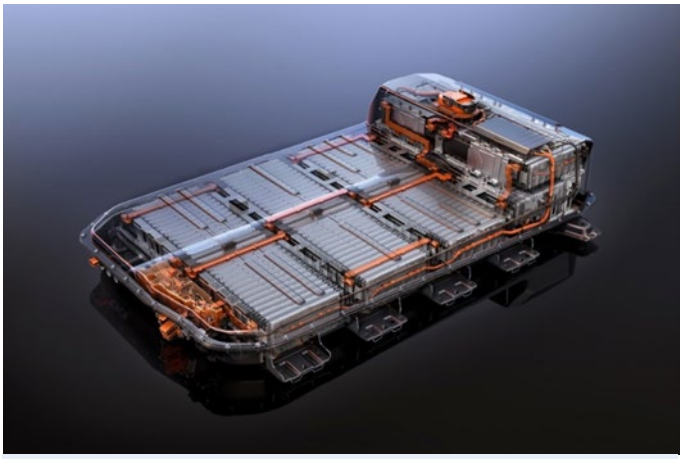
"Jeep is a registered trademark of FCA US LLC."



BEV

2021 Ford Mach-E Extended Range

Source: www.ford.ca



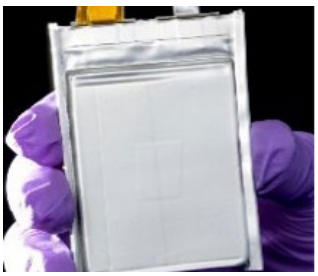
BEV

2017 Chevrolet Bolt

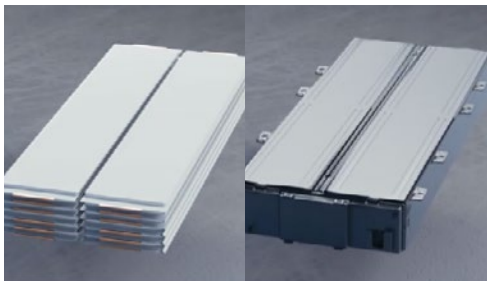
Source: https://media.gm.com

UNDERSTANDING EV BATTERY TERMINOLOGY

- **A battery cell** is one single rechargeable pouch, cylinder or unit within a battery module.
- **A battery module** is a group of cells fitted together as a unit, wired and ready for connection into a larger configuration.
- **A battery pack** is a set of modules wired together and performing as one large entity via battery management software. Battery packs can be composed of many modules (typically 3-16) and weigh hundreds of kilograms and occupy a significant portion of the vehicle.
- For this fact sheet, the term **EV battery** means the same as the description of a battery pack.



Lithium ion cell



Module

Pack

Source: https://media.gm.com

Different configurations of cells, modules, and battery packs allow automotive manufacturers to create unique vehicle designs that address differences in size and weight, provide additional power, or extend vehicle range. Although the battery pack configurations may vary between vehicles this level of differentiation does not create barriers to recycling. All battery recyclers that specialize in recycling lithium batteries can accept and process all of these batteries found in EVs, just as they can process different consumer-based lithium batteries found in cell phones or computers.

VEHICLE SALES AND THE POPULARITY OF ELECTRIC VEHICLES

Table 1 shows all new vehicle registrations by vehicle type over the last 10 years. Electric vehicle registrations have grown significantly over the last decade since sales began yet still only represent 6.1% of total new vehicle sales in 2020. If only zero emission vehicle sales are considered, then the percentage drops to approximately 3.5% of total vehicle sales. Industry has brought more than 40 EV models to market and predicts there will be over 130 EV models by 2023[1] with some vehicle manufacturers committing to convert their entire light duty product offering to EVs by 2035. That does not mean that all vehicles on the road in 2035 will be EVs, but that all new light duty vehicle sales by these manufacturers will be electrified.

Vehicles typically remain on the road for an average of 12-14 years. As a result, few EVs have been in the market long enough to be naturally retiring out of use. Vehicles can remain on the market much longer than the average or due to unforeseen circumstances may exit the market (e.g. vehicle crashes) earlier than anticipated. The information below gives some indication that the number of lithium-based batteries from BEV, PHEV and FCEV being retired from vehicle use will remain small over the next several years.

[1] IHS Markit, EV model forecast

Table 1: Vehicle sales in Canada over the last 10 years by type

	Statistics Canada Data									
Fuel Type	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
BEV	215	646	1,602	2,839	4,151	4,990	8,921	22,544	35,523	39,036
PHEV	303	1,343	1,548	2,533	2,737	7,019	11,405	21,111	20,642	15,317
HEV	10,106	20,938	20,695	19,791	17,309	21,722	22,832	25,355	38,390	41,453
FCEV*						4	0	4	85	24
GASOLINE	1,548,815	1,582,476	1,662,103	1,723,164	1,776,345	1,815,693	1,925,026	1,838,455	1,776,571	1,384,928
DIESEL	63,849	68,902	74,342	88,204	85,635	71,217	65,406	70,855	59,089	64,769
OTHER FUELS						2	7	238	145	34
ALL VEHICLES	1,623,288	1,674,305	1,760,290	1,836,531	1,886,177	1,920,647	2,033,597	1,978,562	1,930,445	1,545,561
EV % Of Registrations	0.7%	1.4%	1.4%	1.4%	1.3%	1.8%	2.1%	3.5%	4.9%	6.2%

Source: https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=2010002101 - Table 20-10-0021-01 New motor vehicle registrations
Source For FCEV*: IHS

NEXT STEPS

Additional information on electric vehicles and their batteries will be published over the coming months. Expected topics to be covered are:

- **Battery recycling options**
- **Battery reuse**
- **How EV batteries circulate to end of life management**

If you wish to be added to our distribution list or receive information on this project, please direct any inquiries to **ProjectEVbattery@cvma.ca.**