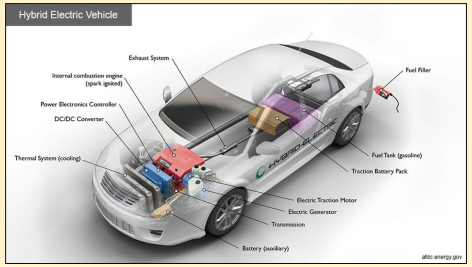
WELCOME TO ELECTRIC VEHICLE FREQUENTLY ASKED QUESTIONS (EVFAQS) - ANSWERED

Class Session #1
About The Class, About Me, About What You'd Like to Know & FAQs About the EVs Themselves



Damond Osterhus, SGL

CLASS SESSION #1 -The Class & EV's Themselves

TODAY'S AGENDA

About The Class

- Purpose
- Preliminary Class Session Content
- Bibliography

"None of us is as smart as all of us"

A Little About Me

- What I Drive Now
- My Car Use Scenario
- My EV Driving Experiences

A Little About You

- Completing the Name Tent:
  - What Name You would like to be called
  - The Year, Make, & Model of the Car You Drive Now

Answers To FAQs About The EV's Themselves

ABOUT THE CLASS

Purpose/Aim/Mission:

To provide you with the facts about the differences in owning & driving a gas car and the different EVs.

4 each 1½ Hour Class Sessions

≈ 1 hrs. 20min class room presentations & discussions (P&Ds)

No Hosted Cars & Coffee Get Together 😭

Class Session #1, Answer FAQs About the EV's Themselves

Presentation & Discussion Topic Plan

What is an ICE vehicle? What Is An EV?

What is a Hybrid EV, Plug-in Hybrid EV, Battery EV? How Do They Differ From an ICE vehicle?

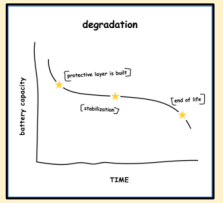
What is the Cost Difference for Maintenance between a BEV & ICE?

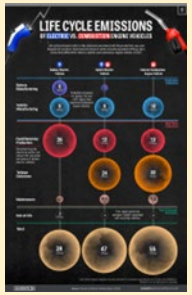
FAQs About:

EV Batteries. How Long Do They Last? What's degradation?

Tires? Do they wear out fast(er)?

EV's Overall Environmentally Cleanliness as compared to ICE vehicles?





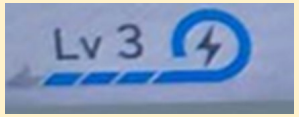
ABOUT THE CLASS SESSIONS continued

Class Session #2, Answer FAQs About Charging, At Home and Not At Home

Presentation & Discussion Topic Plan

EV External Charging: What are Level I, Level II, and Level III Charging?

What is Internal Regeneration Charging (and One Pedal driving) all about?



How long do EV batteries take to charge?

Level I, 120VAC @ 12amps - AT HOME Daily Charging Scenario; Time to Charge & Cost to Fuel Up								
VEHICLE	ENERGY USED		CHARGE TIME* @ 1kW/hr	VARIABLE COST RATE		COST	PER 100 MILES**	FIXED 1-TIME COST
RAV4 PHEV	10.7	kWh	10hr 42min	$0.13	per kWh	$1.39	$4.63	Cost of a Level I EVSE - $100-200; Normally provided for PHEVs. Sometimes provided with BEV
NIRO BEV	8.8		8hr 48min			$1.14	$3.80	
TESLA Model 3 BEV	7.9		7hr 54min			$1.03	$3.42	
Audi A3 MHEV-32mpg	0.94	gal	No At Home Fueling	$3.00	per gal	$2.82	$9.38	None
RAV4 HEV-39mpg	0.77					$2.31	$8.33	
RAV4 ICE-28mpg	1.07					$3.21	$11.61	
* Level I At Home Charging Time. Except for the time to plug in and unplug ≈1 min total, charging is done unattended, usually overnight.								
** ($0.13 ÷ mi/kWh) X 100; ($3.00 ÷ mpg) X 100								

How much does it cost to fuel up compared to gas ICEV?

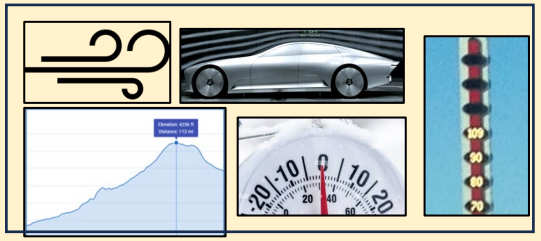
VEHICLE	LEVEL II AT HOME COST PER 100 MILES	LEVEL III DCFC NOT AT HOME COST PER 100 MILES	
		Minimum	Maximum
NIRO BEV - 3.4 mi/kWh	$3.80	$15.05	$19.75
TESLA M3 BEV - 3.8 mi/kWh	$3.42	$10.53	$17.57
RAV4 PHEV - 2.4 mi/kWh & 38mpg	$4.64	$8.80	
Audi A3 MHEV -32 mpg	$9.38	$9.38	
RAV4 HEV - 39 mpg	$8.33	$7.69	
RAV4 ICE -28 mpg	$11.61	$10.71	

ABOUT THE CLASS Sessions continued

Class Session #3, Range, Charging Infrastructure, and Trip Planning – Locally & Long Distance, Nov 20th

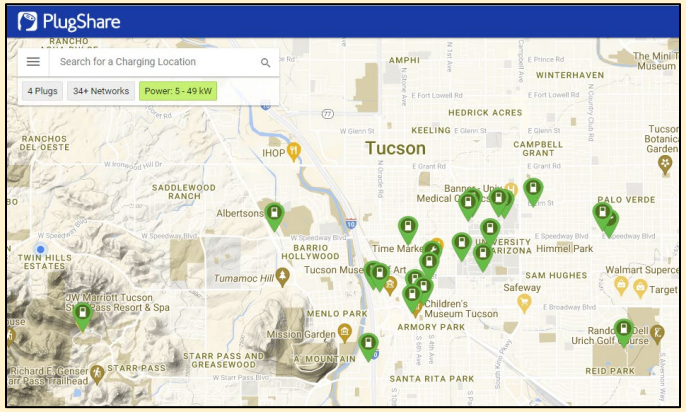
Presentation & Discussion Topic Plan

Range: How many miles can one get on a charge? What affects range?



Charging Infrastructure: What is happening to improve charging locations, and reliability?

Trip Planning-Locally & Long Distance: How <u>can</u> one do it?



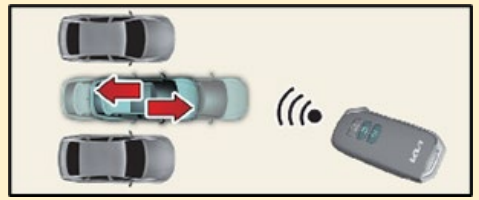
ABOUT THE CLASS Sessions continued

Class Session #4, Buying An EV FAQs; Dec 4th

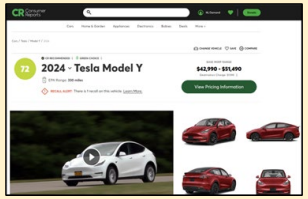
Preliminary Presentation & Discussion Topic Plan

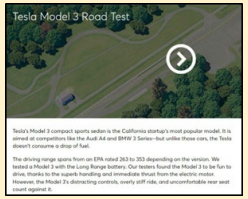
Which One Is Right For Me?

What unique EV features might I like to have?



What tools can I use to check out an EV?



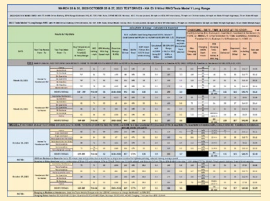


How can I test drive an EV before buying?

TURO

ABOUT THE CLASS continued

What are the reference sources used in this class?

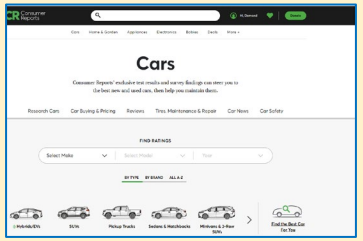



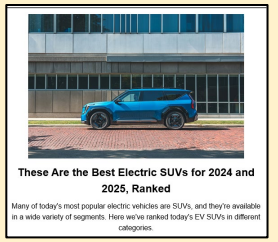
EV Driving & Owning Experiences

Mine, and

My friends & former students who own EVs

On-line Websites, such as:





Consumer Reports (www.ConsumerReports.org)

Detailed EV reviews and Road Test Results reports + Guides

Car & Driver caranddriver@newsletter.caranddriver.com

Primarily EV reviews

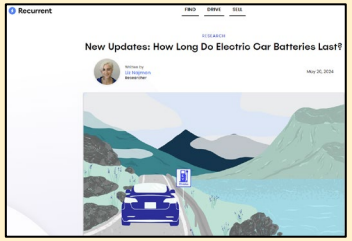
Motor Trend www.motortrend.com/features/ev-battery-life

EV reviews, and articles on EV owning & driving issues

Mach-e Vlog https://machevlog.com/videos/

Actual recorded long distance drives and charging “adventures”

On-Line Research Articles



RecurrentAuto.com www.RecurrentAuto.com/research

Maintains a 30,000+ database on EV battery status fed by EV owners

Monthly reports to owners on the status of their EV’s batteries

Publish research articles & guides on all aspects of EV ownership & operation

Daily Email Reports on EVs, Solar/Wind Power, Grid, Batteries, etc

The electrek team daily report; https://electrek.co/about/

Cleantechnica News of the day: https://cleantechnica.com/

ABOUT THE CLASS SESSIONS
Any Questions or Clarifications or Comments

Feel free to ask questions, request clarifications, comment,

Anytime in class - just raise hand

or after class, send me an email, text, or even call me:

damondlosterhus@verizon.net

520.449-1893 (cell)

I will respond to you individually, and

as appropriate, to all registrants

A LITTLE ABOUT ME

FAQs

Do I own an EV?

No, not yet; but I do want to.

Why not yet?

- The **state of the charging infrastructure for non-Tesla EVs**. It's improving by the month 😀
- Waiting for the **Porsche 718 Boxster EV** with J3400/NACS charging port, coming out in 2025?

What Do I Drive?



2013 Porsche Boxster (Primary), 2017 Porsche 911, my wife's 2019 Subaru Outback

My Annual Vehicle Use Scenario *(the one that also applies to an EV I would buy)*

Local driving (includes to Phoenix, Green Valley, Tubac): **≈ 5,000 miles a year**

Long Distance: Tucson to Henderson/Las Vegas NV & back **≈ 5 ea 1000 mile trips @ ≈ 5,000 miles a year**

My Electric Vehicle Driving Experiences (since Summer 2021)

≈ 6,800 test drive miles , 11 different EVs; 85 Charging Attempts at Tesla/non-Tesla chargers, & At Home

Porsche Taycan 4S, Ford Mustang Mach-e, Tesla Model 3 & Y, Hyundai IONIQ 5, Kia EV6, Cadillac Lyriq, Nissan Ariya, Honda CR-V hybrid, F-150 Lightning, & Mitsubishi Outlander PHEV

Why the EV test drives?

To see if I could "**Get there (Henderson/Las Vegas) from Here (Tucson)"** [Long Distance Use Scenario]

When it is **over 105F** at **Interstate speeds (80mph**), **from 80% to 10% SOC without any anxiety**

Also, to **Check out Features, Controls & Displays, Comfort, etc (class curriculum development)**

ANSWERS TO FAQs ABOUT THE EVs THEMSELVES

What is an ICE vehicle?

What Is An EV? [my definition]

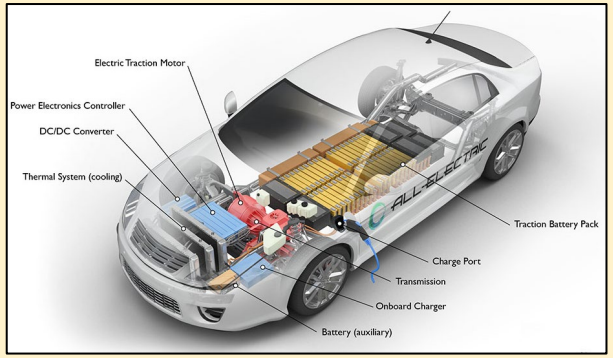
What is a Hybrid EV (HEV), Plug-in Hybrid EV (PHEV), Battery EV (BEV)?

How Do They Differ from an ICEV

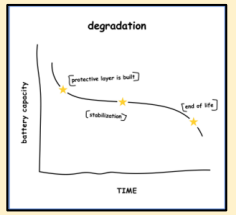
- Maintenance Cost BEV & ICE vehicles?

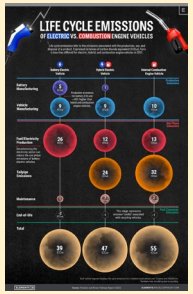
FAQs About:

- EV Batteries. How Long Do They Last?
- What's degradation?
- Tires? Do they wear out fast(er)?
- EV's Overall Environmentally
  - Cleanliness as compared to ICE vehicles over their lifetimes ≈16 yrs?



	HYBRID ELECTRIC VEHICLES (HEV)	PLUG-IN HYBRID ELECTRIC VEHICLES (PHEV)	BATTERY ELECTRIC VEHICLES (BEV)	MILD HYBRID (MHEV)
	 2024 Toyota Prius	 2024 Toyota Prius Prime	 2024 Kia Niro EV	 2024 Mazda CX90
Drive Powered By	ICE Electric Motor	ICE Electric Motor	Electric Motor Only	ICE 48VDC Starter-Generator (Assist Only)
Replenshible Energy Sources	Gasoline Only	Gasoline Electrical Energy - Battery	Electrical Energy - Battery Only	Gasoline Only
Energy Storage	Gas Tank NiMH Battery	Gas Tank Lithium Ion Battery	Lithium Ion Battery Only	Gas Tank Lithium Ion Battery
Battery Size*	1.3 kilowatt hours (kWh)	8.8 kilowatt hours (kWh)	66.4 kilowatt hours (kWh)	0.5-1 kilowatt hour (kWh)
Curb Weight	3,097 to 3,340 lbs	3,461 to 3,571 lbs	3,721 lbs	4,709 to 4,899 lbs
Efficiency	57 mpg; city and highway	48 mpg - gas only 3.4 miles/kWh - Electric Only (114 MPGe)**	3.5 miles/kWh (113 MPGe)**	25 mpg, city & highway
Reliability	Good	Fair (complexity)	Good	Good.
"Greenness"	2.6 tons of CO2 annually	1.0 tons of CO2 annually	Zero tons of CO2 Annually	5.9 tons of CO2 Annually





ANSWERS TO FAQs ABOUT THE EVs THEMSELVES

What is an Internal Combustion Engine (ICE) Vehicle?

Internal Combustion Engine (ICE) Vehicles

Not to be confused with Immigration and Customs Enforcement !

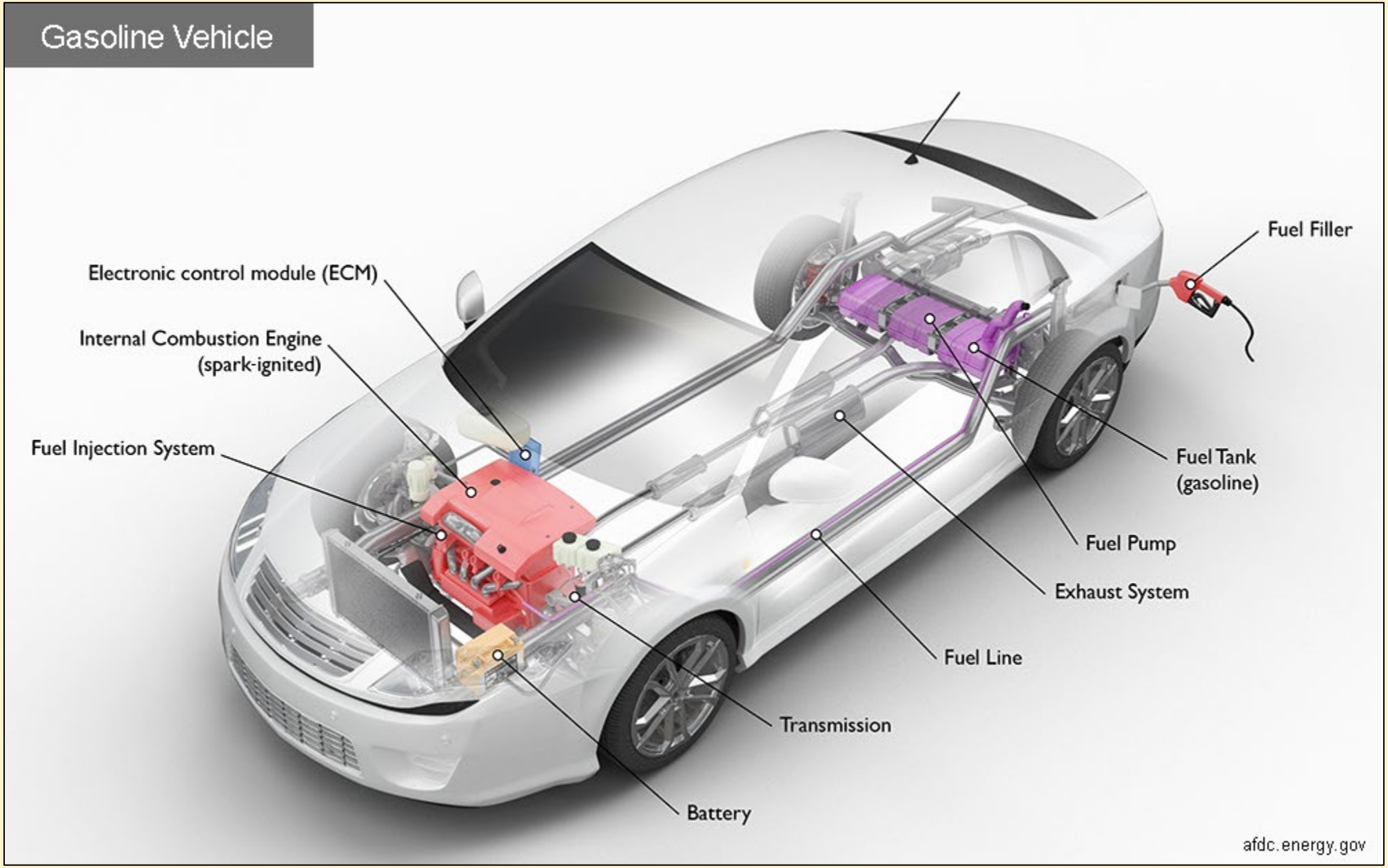
Vehicles using fuels such as:

- gasoline/kerosene
- diesel/bio-diesel
- propane
- liquified natural gas (LNG),
- Burning wood chips (methane),
- jet fuel
- alcohol

Which is burned internally in the engine to provide energy to move the vehicle

Note: A Stanley Steamer is not an ICE vehicle since it burns its fuel externally to heat the water in its boiler. 😳

What is an Internal Combustion Engine (ICE) Vehicle? cont'd



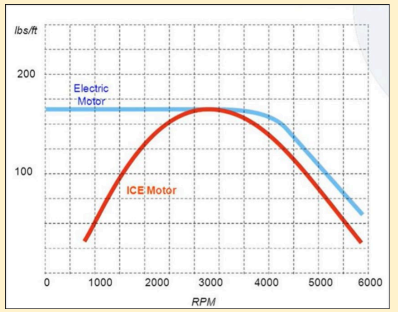
What is an Electric Vehicle (EV)?

A vehicle that **uses an electric motor, some or all of the time to move or help move** the vehicle.

What's so special about electric motors?

TORQUE (acceleration force) – **fully available at 0 rpm**

ICE motors require high rpm for full torque



And They Are Fun To Drive!!!
Particularly BEVs
😊

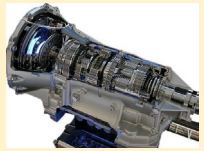
Low # of Moving Parts

Electric Motors have only **1 moving part** – the rotor

Electric Motor drives have **≈20 parts**

ICE Motors have over 200 moving parts

plus several hundred transmission parts

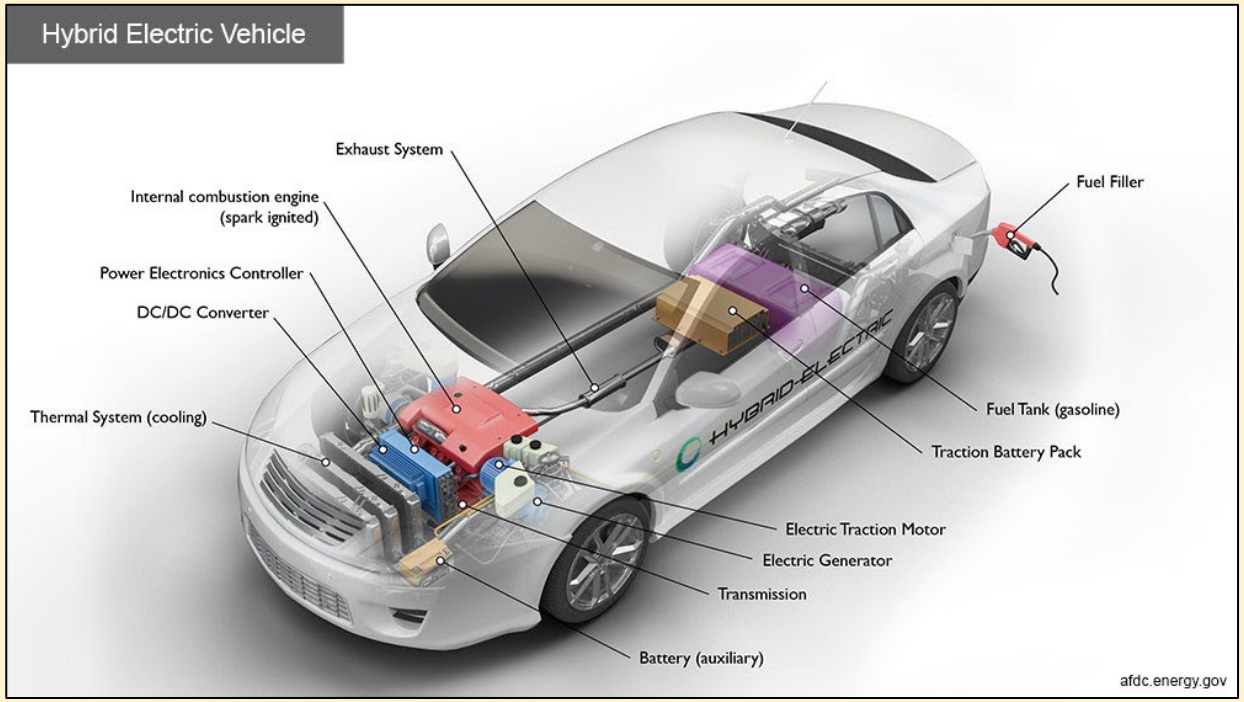


Low Weight: Electric Motor Drive = 200 - 250 lbs; ICE Motor + Transmission ≈ 400+ lbs

What Are the Different EV Types? How Do They Differ? Cont'd

What is a Hybrid Vehicle (HEV)?

- **Teams an EV electric motor with a gasoline engine.**
  - Both can drive the vehicle, but not at the same time.
  - Engine-electric motor drive the wheels via a coupling.
- **100% gasoline fueled**.
- **Doesn't need the EV battery to be charged externally**
  - The battery is charged via regenerative braking
  - Electric motor is turned into a generator
  - And the gas engine's alternator.
- **The EV battery is small**
- **Electric drive does so only at low speeds & short range**
- **The gasoline engine drive kicks in for higher speeds when climbing hills, & when the EV battery needs charging.**



PROS
- Excellent Gas Mileage
- Lower emissions than ICE vehicle
- No need to plug in
- Fuel up at any gas station
- Quiet at low speed
- Regenerative braking

CONS
- Cost more than ICE vehicle
- Heavier; stops longer
- Sometimes use CVT; noisier
- Maintain 2 systems; ICE & EV
- Less powerful engine design
  - Atkinson cycle engine

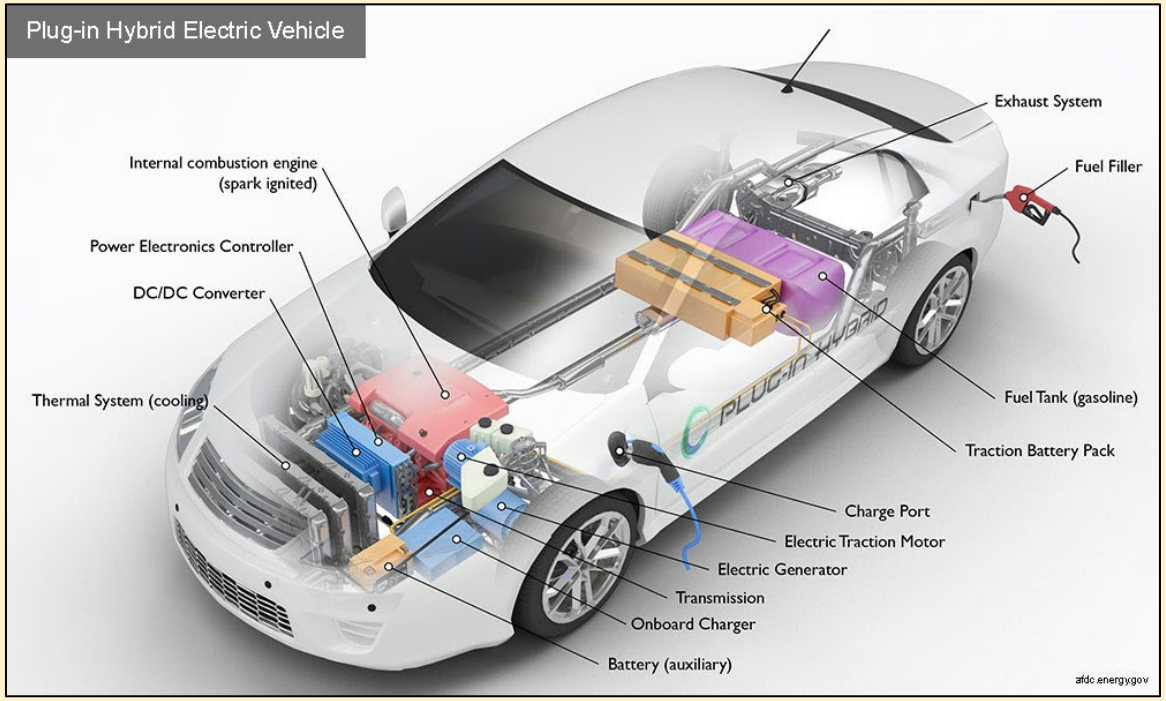
Consumer Reports Recommended 2024 Hybrids

Toyota: Camry, Prius, Crown, Corolla, RAV4, Highlander, Sienna
Honda: Accord, & CRV
Kia: Niro, Sportage, Sorrento
Hyundai: Elantra, Sonata, Tucson, Santa Fe
Lexus: ES, NX, RX, UX
Ford: Escape, Maverick Pickup

What Are the Different EV Types? How Do They Differ? Cont'd

What is a Plug-In Hybrid Vehicle (PHEV)?

- **PHEV also teams an electric motor with a gasoline engine to drive the vehicle**.
- **EV battery is bigger than the HEVs.**
  - Drives the PHEV 15 to 60 miles on EV battery before the PHEV switches over to gasoline engine operation.
  - PHEVs EV battery needs to be externally charged
    - EV battery also charged via regeneration and ICE operation.
- **4 modes of operation**
  - Normal/Hybrid – the same as a Hybrid EV,
  - EV Only – Like a BEV until the battery is depleted
  - Gas Only/Save-like low-cost ICE vehicle; saves EV battery charge
  - Charge-Uses the ICE to charge the EV battery as much as possible while also driving the PHEV; results in poorer mpg.
- **Significantly Less Costly Local Driving**
  - When driven as much as possible on electricity only, & charging up at night at home using significantly cheaper cost/mile electricity.



PROS
- Lower emissions than ICE vehicles
- Cheap charging at home/work
- Possibly eligible for Federal Tax Credit
- 25-60 miles of electricity only driving
- More control over driving modes

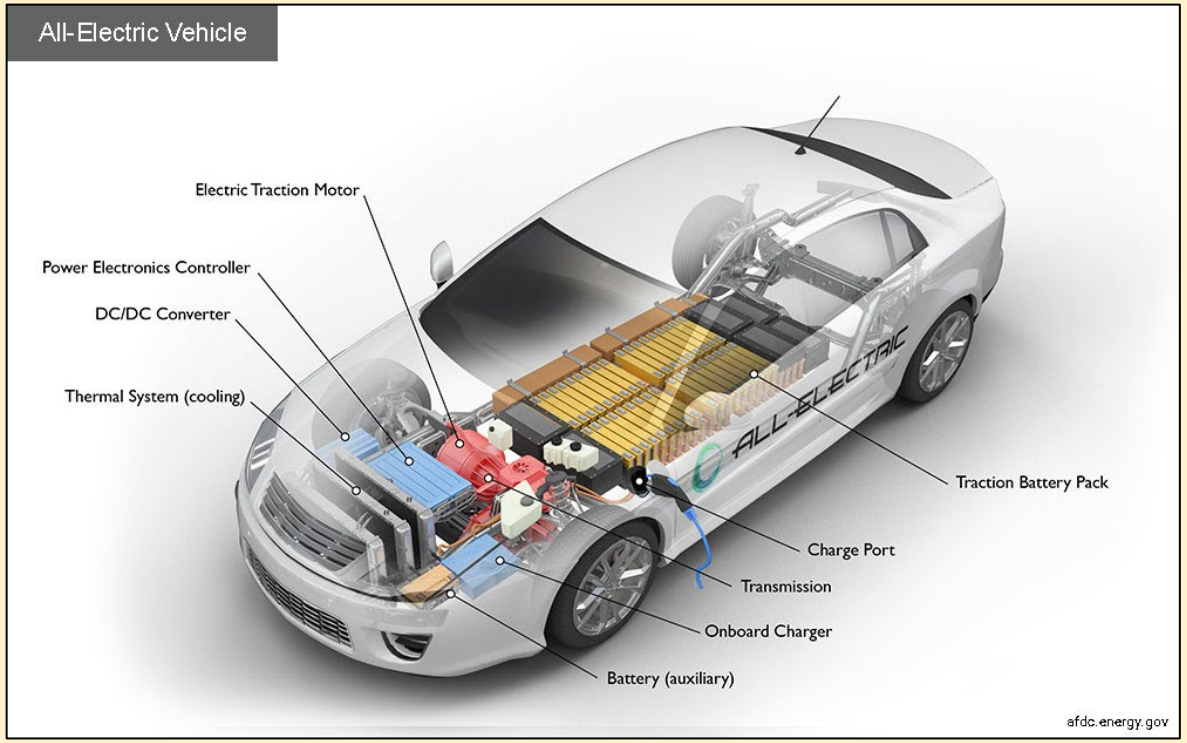
CONS
- Higher purchase price than ICE/HEV
- Max fuel cost savings only when using EV mode & charging at home
- Gas Only mode mpg worse than HEV
- Complex system less reliable

SOME CR RECOMMENDED PHEVS
- Toyota: Prius Prime, RAV4 Prime
- Kia: Niro PHEV, Sportage PHEV,
- Hyundai: Tucson PHEV
- Mazda: CX-90
- BMW: X5 PHEV

What Are the Different EV Types? How Do They Differ? Cont'd

What is a Battery [All] Electric Vehicle (BEV)?

- **Uses only electric motors to drive the vehicle wheels**
- **Traction motors get electricity from rechargeable Lithium EV batteries**.
  - Lithium-ion battery cells are packaged in Traction Battery Packs
  - Battery pack capacity is measured in kilowatt hours (kWh)
    - Capacity ranges from 50 to over 200 kWh
- **Traction Battery Packs are a structural member of the BEV.**
  - Lie between the axles and at the bottom of the car frame
  - Provides a low center of gravity for the BEV that improves handling
  - Battery pack is a heaviest and most expensive part of a BEV
- **A 12-volt battery is used to provide power to non-drive accessories**
  - 12-volt battery is charged from the drive battery



PROS

- Zero tailpipe emissions
- Low maintenance/service costs
- Very Low fueling cost when charged at home
- No engine noise; mostly
- Fun to drive
- Unique features; e.g., Pet Mode

CONS

- More expensive MSRP
- Home charging equipment installation can be expensive
- Less convenient Not At Home
- Range often less than ICEV when fully charged
- Charging can take time

CR Recommended BEVs

- Audi: Q4 E-Tron, Audi Q8 E-Tron
- BMW: i4, iX
- Ford: Mach-E
- Genesis: GV60, GV70
- Hyundai: Ioniq 6
- Kia: Niro EV, EV6
- Tesla: Model 3, Model Y

What Is The Difference In Maintenance Costs Between BEVs and Vehicles With Internal Combustion Engines (ICE)?

ICE Vehicle
≈10¢/mile

RecurrentAuto.com YouTube Video

https://www.youtube.com/watch?v=VOKa6ZP834Q
5 min 39 seconds

BEV
≈6¢/mile

Some Data Differences Between an ICE Vehicle and Popular EVs

[Sources: EPA and Auto Website Specs]

				
VEHICLE/VEHICLE TYPE	2024 Toyota RAV4 AWD **ICE Vehicle (ICEV)**	2024 Toyota RAV4 Hybrid AWD **Hybrid EV (HEV)**	2024 Toyota RAV4 Prime 4WD **Plug-in Hybrid EV (PHEV)**	2024 Kia Niro WAVE FWD **Battery EV (BEV)**
MSRP	$31,585-$38,380	$31,725- $40,030	$43,690 - $47,560	$39,600 - $44,600
Drive Powered By or Assisted By	Internal Combustion Engine (ICE) - 2.5L, 4 cyl, Auto	ICE - 2.5L, 4 cyl, Auto Electric Motor	ICE - 2.5L, 4 cyl, Auto Electric Motor	Electric Motor Only
External Replenshible Energy	Gasoline Only	Gasoline	Gasoline Electrical Energy - Battery	Electrical Energy - Battery Only
Energy Storage	Gas Tank - 14.5 gallons	Gas Tank - 14.5 gallons Lithium Ion Battery	Gas Tank - 14.5 gallons Lithium Ion Battery	Lithium Ion Battery Only
Drive Battery Size*	N/A	240VDC Lithium Ion or NiMH Battery	18.1 kWh	64.8 kWh
Efficiency	28 mpg, Regular	39 mpg Regular	38 mpg - Regular gas only 2.8 miles/kWh - Electric Only 42 mile Range on EV Only	3.4 miles/kWh 253 EPA 100%-0% SOC **
Maintenance	ICE Vehicle (ICEV) Maintenance	ICEV + HEV Item Maintenance	ICEV + PHEV Item Maintenance	BEV Item + Vehicle Maintenance
"Greenness"	5.3 tons of CO2 annually*** 319 grams per mile	3.7 tons of CO2 annually 224 grams per mile	1.2 tons of CO2 annually 72 grams per mile	Zero tons of CO2 Annually 0 grams per mile

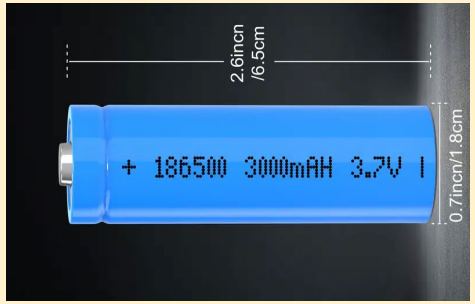
COMMON FAQs – What Abouts?

What about EV Batteries?

How long do they last?

- **Recent data shows that they can last for over 200,000 miles**
- **Federal law requires all high voltage EV batteries to be warranted for at least 8 years or 100,000 miles**
- **Replacement rate for cars from 2016 to present less than 1%**
- **Original concern came from early Nissan Leaf EV batteries**
  - Early Leaf's were air cooled
- **All modern EVs have very sophisticated heating and cooling systems**
  - Their ideal temperature range 75F-95F; both for charging and for operating.

18560 Lithium Ion
Nickel Cobalt Aluminum (NCA)
3.7 Volt Battery Cell

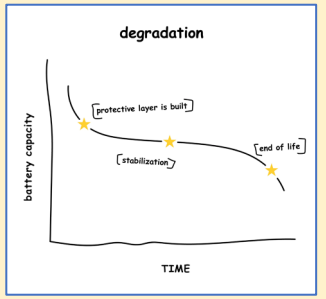


Model 3 Long Range: 4,416 ea 18650 cells

COMMON FAQs – What Abouts?

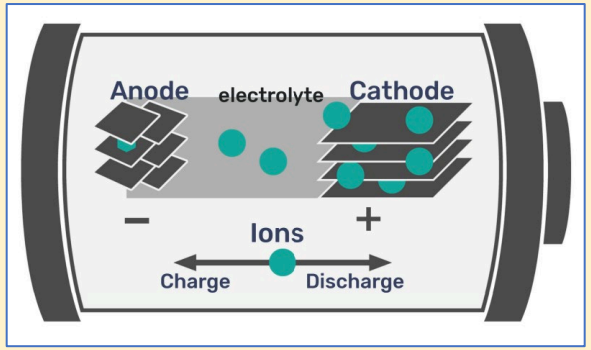
What's EV battery degradation?

Electric vehicle (EV) battery degradation is a natural process that reduces a battery's ability to store energy and deliver power over time.



SOME CAUSES

- **Battery Age (aka calendar aging)**
  - **Normal aging is 1-2% of range per year**; less than 30%/8 years
- **High Heat, high voltage charging, & extreme state of charge** can degrade batteries faster; e.g.,
  - **High Heat:**
    - Chemical & physical reactions happen too fast
    - Battery thermal management systems help control temperature*
  - **High voltage charging**, particularly at low temperatures:
    - Causes ions to move too fast for them to enter the cold anode
  - **Extreme state of charge while storing**:
    - Charging to 100% State of Charge (SOC)** or having only 5% SOC, and "storing"
      - ✓ Never charge to 100% SOC then not using the EV almost immediately
      - ✓ Never let the battery get down to less than 5% SOC without starting to charge it



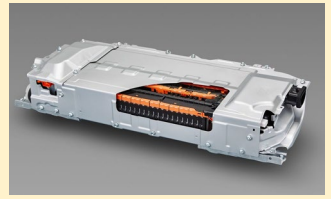
*NOTE: Cellphone and Tablet Lithium-Ion batteries have NO thermal management systems; they don't last as long as EV Batteries do!
** SOC is similar to the gas gauge reading for a battery. SOC is the percentage of electrical energy remaining in a battery.

COMMON FAQs – What Abouts?

What about EV Batteries? contd

How safe are they?

- **NTSB figures show that gas cars have seen fires in 1,530 out of 100,000 cars while battery electric vehicles had 25 out of 100,000 cars.**
- **What are the safest electric vehicle batteries?**
  - **Lithium Iron Phosphate (LFP) batteries are safer than Lithium Nickel Manganese Cobalt (Li-NMC)**
    - LFPs are highly stable and less susceptible to catching fire
    - Li-NMC are not resistant to high temperature and have poor thermal stability, can catch fire
  - **Tesla and Ford are currently changing to LFPs along with most of the other EV manufacturers**
    - Cheaper to make
    - Do not use unsustainable raw materials (Nickel, Manganese, and Cobalt)
    - Longer life: 2,500 discharge cycles vs 1,000 for Li-NMC
    - HOWEVER, LFPs have a lower energy density; weigh more per kWh than Li-NMC
  - **Sodium (Na) batteries are currently being used in some Chinese EVs**



Significant Developments In Battery Technology Is Currently Occurring: Solid State Batteries, ...

COMMON FAQs – What Abouts?

What about the tires?

Do they wear out faster?

Depends on how they are driven and maintained!

- **PHEV & BEV Weight**.
  - 2024 Kia Niro Hybrid : 3,071 lbs
  - 2024 Kia Niro Plug-in Hybrid : 3,336 lbs
  - 2024 Kia Niro EV: 3,721 lbs
- **Torque/acceleration: New EV owners like to "punch it" a lot.**
- **Important to maintain the specified tire pressure**
- **Avoid "Aggressive" acceleration and deceleration**
- **City of London, Dept of Transportation, have shown no excessive tire wear as a result of "training"**
- **Tire manufacturers are responding to EV tire wear issues**
  - Tire life warrantees are now the same as non-EV vehicles

COMMON FAQs – What Abouts?

Are EV's overall environmentally dirtier– No, an EV is not "dirtier"

Manufacturing Emissions

- EV manufacturing creates up to 10 metric tons of CO2 as compared to a conventional vehicle's 6 metric tons

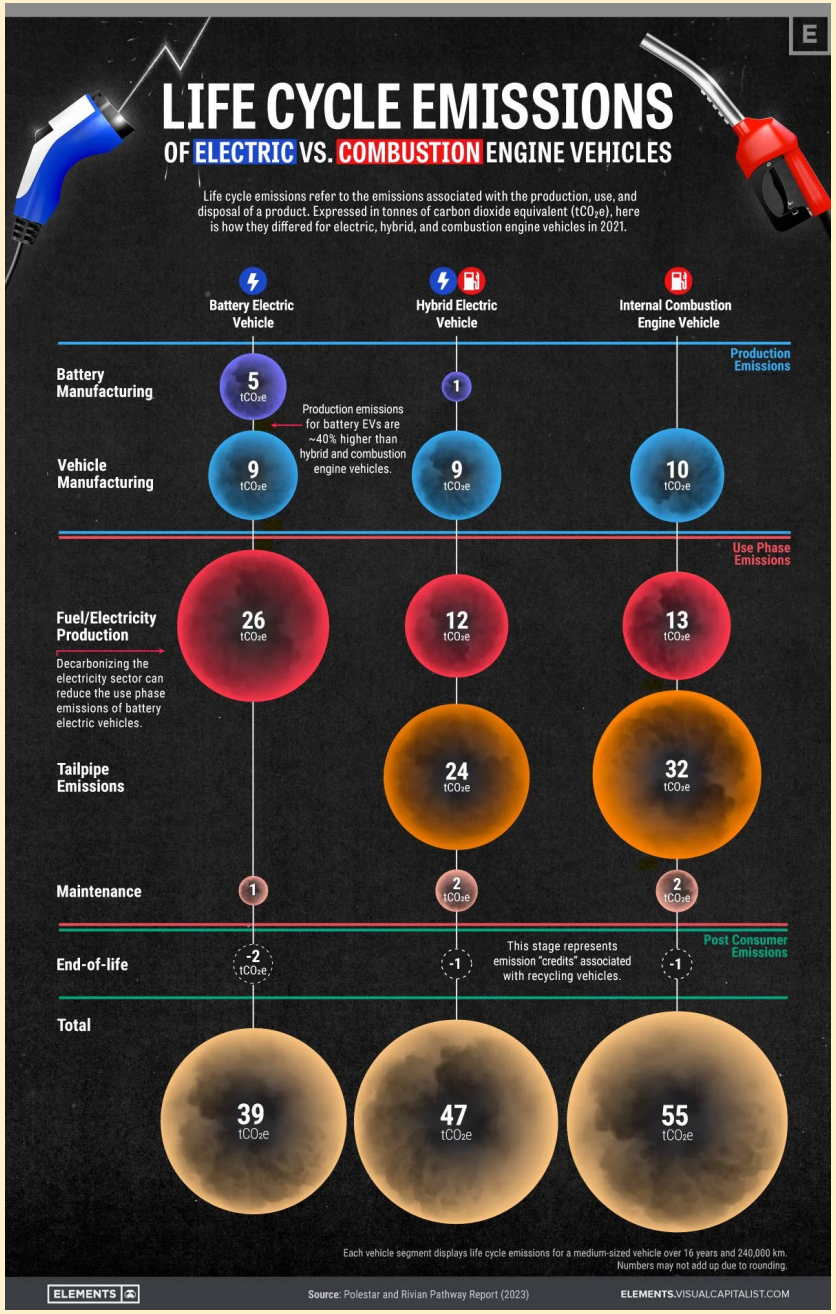
Operational Emissions.

- BEVs produce no tailpipe emissions ICE vehicles
- Others produce at least 32 tons of CO2 over a 16-year lifetime.

Upstream Emissions.

- A lifetime of no tailpipe emissions laps the CO2 "cost" of generating electricity using all but solar or wind!
  - It can take less than 2 years for a BEV to surpass an ICE vehicle when it comes to lifetime emissions.

[Source: River James, October 11, 2023; published by RecurrentAuto.com]



NEXT WEEK

Class Session #2, Answer FAQs About Charging EVs, AT HOME & NOT AT HOME

What are Level I, Level II, and Level III External Charging?

What is Internal Regeneration Charging (and One Pedal driving) all about?

How long do EV batteries take to charge? And How much does it cost to charge them?

- Level I & II At home, and Level I & II, & Level III Not At Home?