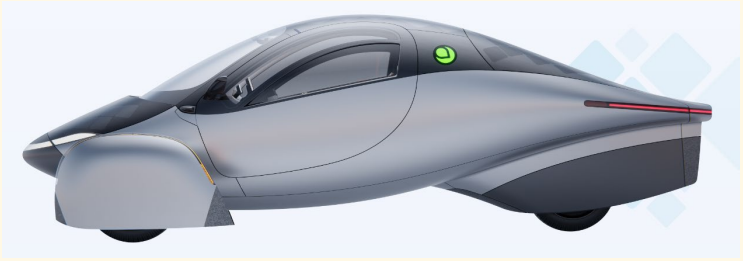
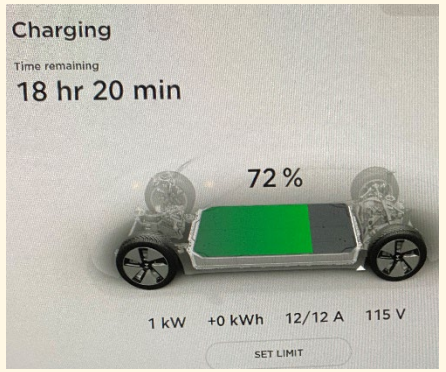
Wednesday, February 21, 2024

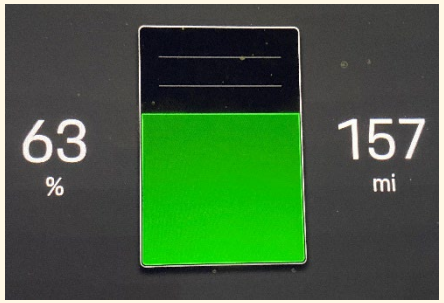


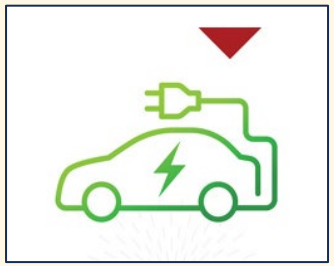


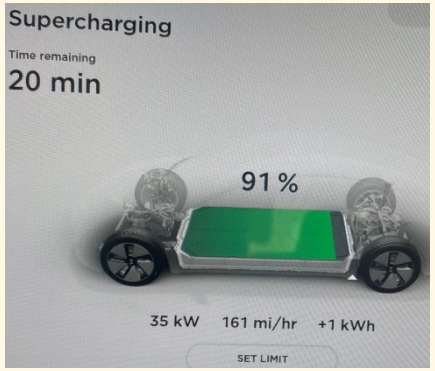
WELCOME TO

ELECTRIC VEHICLE BASICS CLASS (EVBC)

OLLI-UA Green Valley CPAC







ELECTRIC VEHICLE (EV) BASICS CLASS

Wednesdays, 1:00pm, February 21 through March 27, 2024

CPAC, Room 203, Green Valley

Damond Osterhus

damondlosterhus@verizon.net

Your Study Group Leader (SGL)

CLASS RULES:

- There are no stupid questions
- Feel free to ask questions at anytime
- None of is as smart as all of us

TODAY'S AGENDA

- Introductions
- The Story About EV Basics Class Content
- EV Basics Class Overview
- Lingo/Terminology Topic
- Summary of Terms
- Next Week

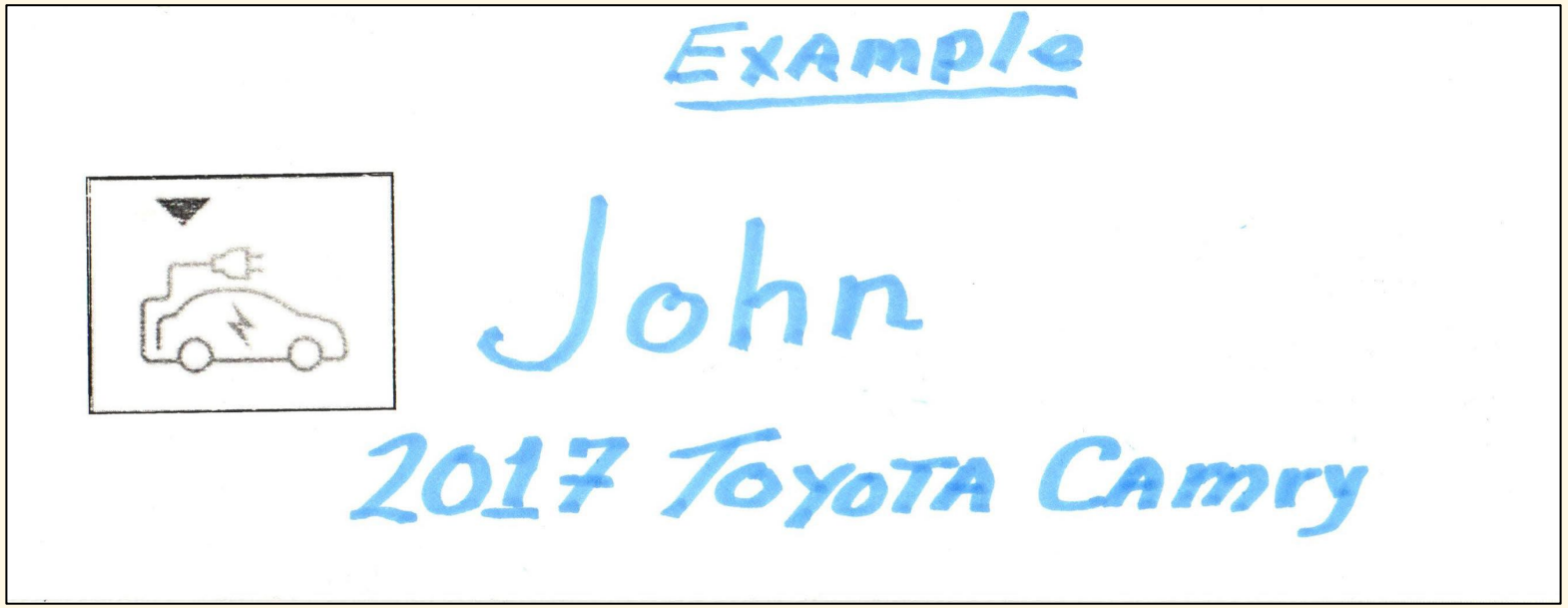
INTRODUCTIONS

STUDENT INTRODUCTIONS 😀

- Please fill out the name tent provided using any color you wish from the markers

  NOTE: The markers are smelly markers so be careful not to touch your nose when smelling them. 😲

  - Name you wish to be addressed by
  - The year make, and model of the car you usually drive.



- Introduce yourself and tells us what you'd like to get out of the class.

DAMOND'S INTRODUCTION

No I don't own an EV YET 😮 . I have one I like but am planning to wait until 2025 to get it. During the class I will let you know which one and why I want to wait until 2025.

I also own a 2017 Porsche 911 Cabriolet (convertible). At 78, it is my bucket list item. I am a Southern California raised sports-car-loving guy 😎

Here's what I'd like for you all to get out of the class

I'd like for you to get a factual answers to all the questions you have about Electrical Vehicles 🤗

The Story About EV Basics Class Content

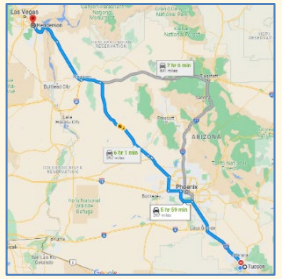
EVBC Content is based on 4 years of research and documented test driving of different EVs

January 2020, where it all began.

Interested in the Porsche Taycan EV - Possible 911 replacement and its many trips to Henderson

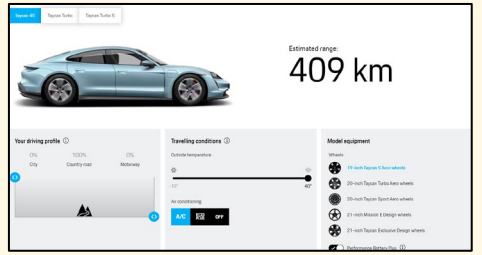
OLLI-UA owner of a Tesla Model S and his *You Can't Get There From Here* problem in Oregon.

- Wanted to go inland from I-5 along the coast to a middle Oregon locations
- Model S's navigation/trip planning system indicated he couldn't get there and back!
- Because there weren't any chargers close to where he was and weren't any chargers inland
- He wouldn't have enough charge to make it back to a charger along the coast.



Started my search for answer to Can I Get There (Henderson) From Here (Tucson)?

- Initially in a Porsche Taycan but essentially in any EV.
- When driven at Interstate speeds (up to 84mph), when it was hot (105F+), and when it's hilly terrain
- And when given the location and power of the chargers (aka Charging Infrastructure)



Research on both range and charging/chargers failed to answer the question

- Searched car publications, websites, & talked to dealerships about range and infrastructure
- Only real world test driving and charging could help to answer the question

July 2021 Did Documented Test Drives and Chargings of a 2021 Taycan 4S

- Test drives to/from Dateland – 360 miles RT, & Quartzite – 500 miles RT; Avg Speed: 70-80mph Temp: 100-107F
- Answer to Question: **NO**. Mostly due to the charging infrastructure. Also back seats uncomfortable for an adult!

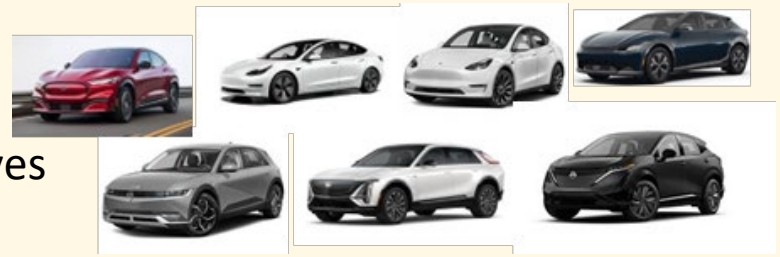
The Story About EV Basics Class Content continued

Continued the Research and Test Driving EVs – What EV Can I Get There From Here? With

Research: Technical papers, Consumer Reports, EV Owner Websites, and Car Magazine "best EVs" articles

Test Driving EVs of Interest (candidate EVs and ones that OLLI-UA EV class students were interested in).

Since July 2021, I have:

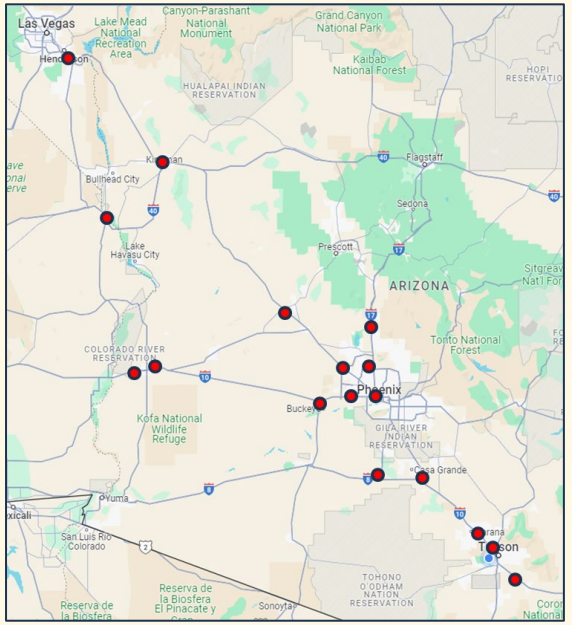


Tested 7 EVs: Ford Mustang Mach-e*, Tesla Model 3, Tesla Model Y*, Kia EV 6*, Hyundai IONIQ 5*, Cadillac Lyriq*, and Nissan Ariya *Local & Long Distance Test Drives

Documented Test Drives ≈ 6,500 miles at speeds up to 84 mph, & temperatures up to 115F

Locally (less than ≈250 miles RT): Phoenix, Scottsdale, Sierra Vista, Tubac, Mt Lemmon

Long Distance - 13ea 350 mile plus RT: Dateland AZ, Tacna AZ, Quartzite AZ, Camp Verde, Henderson



Recorded Charge up Experiences at an overall total of 75 times at the following locations :

Tesla: Home**, La Encantada, Marana**, Casa Grande, Benson**, Sierra Vista**, Litchfield Park, Buckeye, Quartzite, Needles, Henderson **Using a Non-Tesla to Tesla adapter

Non-Tesla: Home, Marana, Casa Grande, Phoenix, Tempe, Glendale, Scottsdale, Buckeye, Quartzite, Blythe, Needles, Wickenburg, Kingman, Henderson NV

RESULT - Most EV Class Content Comes From My Research and Test Drives

Pictures, research info, test drive and charging data

And Yes I was able to drive an EV to Henderson and back 4 different times 😀

EV BASICS CLASS OVERVIEW

OBJECTIVE: Provide you all with Facts About EVs – Good 🙂, Bad ☹️, & Ugly 😛

ORGANIZATION: 6 Sessions, 5 Weekly Topic Areas & a Cars & Coffee 🤗

TOPIC AREAS AND SCHEDULED DATES

February 21, 2024

Basic EV "Lingo"

ICE HEV PHEV BEV
kWh SOC
Li-NMC/Li-NCA LiPo LiFePO4
Regen & 1-Pedal
Level I, II, III
EVSE J1772 DCFC
PCN kW
NACS CCS
Wh/mi
kWh/100mi
mi/kWh

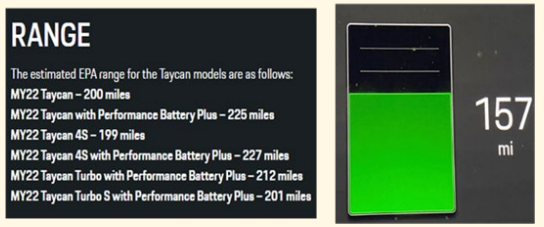
February 28, 2024

Charging – The Details

At Home | Not At Home

March 6, 2024

Range & Range Estimates



& Charging Infrastructure

March 13, 2024

Trip Planning Local & Long Distance

March 20, 2024

Buying An EV

March 27, 2024

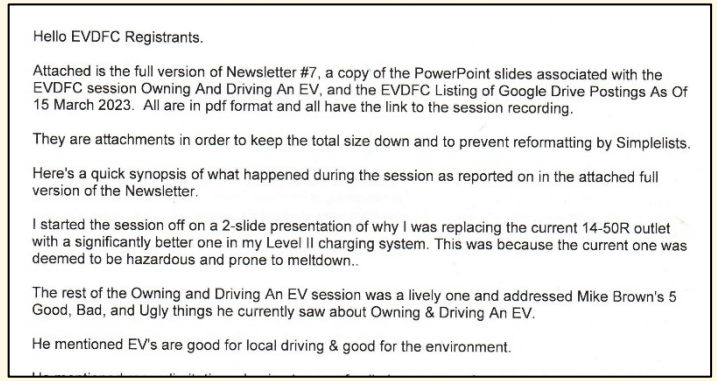
OLLI-UA GV EV Basics Class

CARS AND COFFEE

EV BASICS CLASS "HANDOUTS"

The EV Basics Class Weekly Newsletter Package

Plain Text UA-Simplelists Transmittal Email Sent to All EV Basics Class Registrants...usually by Sunday



Hello EVDFC Registrants.

Attached is the full version of Newsletter #7, a copy of the PowerPoint slides associated with the EVDFC session Owning And Driving An EV, and the EVDFC Listing of Google Drive Postings As Of 15 March 2023. All are in pdf format and all have the link to the session recording.

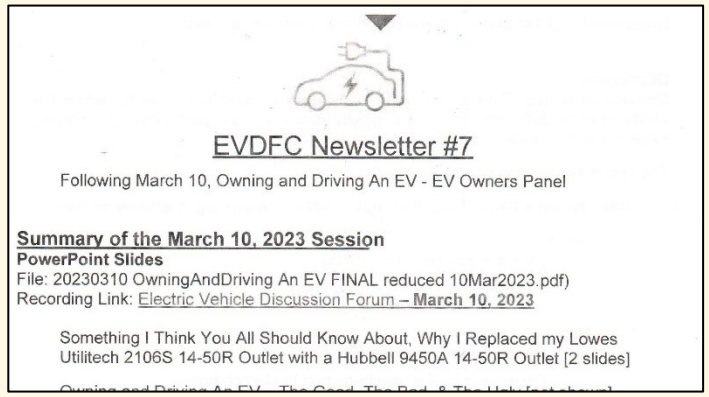
They are attachments in order to keep the total size down and to prevent reformatting by Simplelists.

Here's a quick synopsis of what happened during the session as reported on in the attached full version of the Newsletter.

I started the session off on a 2-slide presentation of why I was replacing the current 14-50R outlet with a significantly better one in my Level II charging system. This was because the current one was deemed to be hazardous and prone to meltdown..

The rest of the Owning and Driving An EV session was a lively one and addressed Mike Brown's 5 Good, Bad, and Ugly things he currently saw about Owning & Driving An EV.

He mentioned EV's are good for local driving & good for the environment.



EVDFC Newsletter #7

Following March 10, Owning and Driving An EV - EV Owners Panel

Summary of the March 10, 2023 Session

PowerPoint Slides

File: 20230310 OwningAndDriving An EV FINAL reduced 10Mar2023.pdf)

Recording Link: Electric Vehicle Discussion Forum – **March 10, 2023**

Something I Think You All Should Know About, Why I Replaced my Lowes Utilitech 2106S 14-50R Outlet with a Hubbell 9450A 14-50R Outlet [2 slides]

With the Following PDF Attachments

- The newsletter covering:
  - What was presented and discussed in class
  - Answers to unanswered/not completely answered questions
  - Links to articles responding to issues/concerns raised
  - Additional reference materials
  - EV Event announcements

- A copy of all the PowerPoint slides presented during the class

Feel free to print out the attachments and distribute them to your friends or acquaintances. They aren't copyrighted.

BASIC ELECTRIC VEHICLE (EV) "LINGO"/ TERMINOLOGY

Commonly Used Terms & Abbreviations

- Sometimes Not Well Understood
- Helps to be able to talk about EVs

☺

Basic EV Terminology

- Vehicle Types
- EV "Fuel"/Energy, & how its measured
- EV Battery Chemistry Types
- EV "Efficiency"- How it is Expressed
- EV "Fuel" How it is "dispensed"

Electric Vehicle (EV) Basic "Lingo" Terminology

VEHICLE TYPES & ABBREVIATIONS

Internal Combustion Engine (ICE) Vehicles

Not to be confused with Immigration and Customs Enforcement !

Vehicles using:

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

burned internally to the engine to provide energy to move the vehicle

Electric Vehicle (EV) Basic "Lingo"/Terminology

VEHICLE TYPES & ABBREVIATIONS continued

Hybrid Electric Vehicles (HEV)

2024 Toyota Prius HEV

- **Powered by <u>both</u> gasoline ICE engines & drive-battery powered motors working in combination to provide increased gas mileage.**
- **<u>Gasoline only</u> as its replenishable energy source**
- **<u>Smallest drive-battery of EVs</u>.**
- **Batteries charged by ICE engine & regeneration**
- **Normally Least expensive of EVs**

Plug-In Hybrid Electric Vehicles (PHEV)

2024 RAV4 Prime PHEV

- **Powered by <u>both</u> gasoline ICE engines & drive-battery powered motors - better gas mileage.**
- **<u>Needs gas & battery charging</u>**
- **Battery chargeable at home & when not at home.**
- **<u>Larger drive-battery than an HEV.</u>**
- **Longer battery-only range,**
- **Has battery regenerative charging**

Battery Powered Electric Vehicles (BEV)

2024 Kia Niro BEV

- **Powered by <u>only</u> drive-battery powered motors.**
- **Needs to have it's <u>drive-battery recharged</u> before it is depleted!**
- **Cold & Heat affect battery use**
- **Battery chargeable at home & not at home.**
- **<u>Largest Battery of all</u>**
- **<u>Longest battery-only range</u>**
- **Has battery regenerative charging.**

The EV "Fuel" And How It's Measured

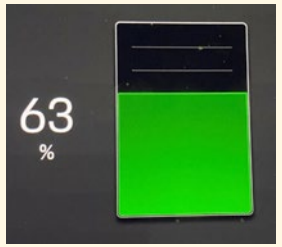
Kilowatt Hour (kWh) – The EV "Fuel"/Energy

A measure of how much electricity is used, or delivered in an hour, or stored in the battery.
An EV's drive battery's capacity is specified in kWhs.
No such thing as a 5 kWh bucket of electricity ☹

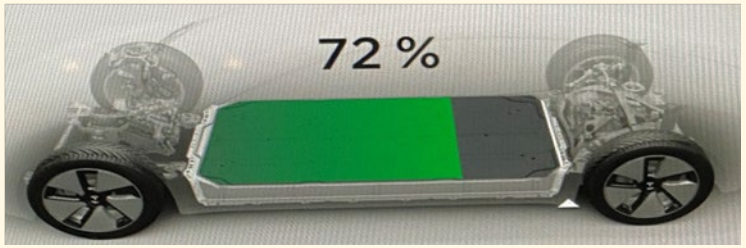
How It's Measured - State of Charge (SOC)

EV Battery Level is measured in kWhs by indicating how much of a full charge remains
Most, but not all EVs, show the SOC as a percentage (%) of the remaining charge.
Different EVs display this SOC in different ways 😮

Taycan 4S

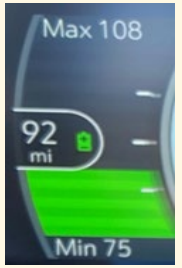


Tesla Model 3 Display



Ford Mustang Mach-E Display

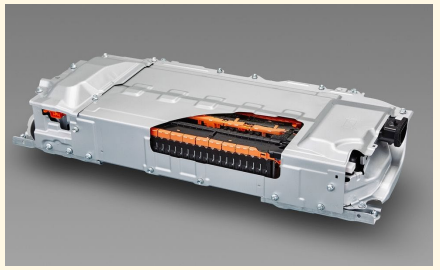
Chevy Bolt –
No %, just bars



EV BATTERY [CHEMISTRY] TYPES - Basics

Individual Cells

Packaged Modules



Assembled EV Battery

Today's Electric Vehicles (EV) use **different battery chemistry types:**

- **Lithium-ion Nickel Cobalt Manganese** (**NCM**) & **Nickel Cobalt Aluminum** (**NCA**), aka **Lithium-Ion**
- **Lithium Polymer**, **Li-Po**
- **Lithium Iron Phosphate**, **LiFePO4**, aka **Lithium Phosphate, LFP**

Each **varies** as to its:

- **Propensity to oxidize (catch fire)** during drastic short circuit or severe impact
- **Energy density** – Watt Hours per weight or volume (Wh per kilogram, or Wh per cubic centimeter **)**
- Ability to quickly **charge at low and high temperatures**
- **Maximum charging rate;** charging to 80% or 100% SOC
- Number of **lifetime chargings;** chargings to 80% SOC
- **Use of environmentally unsustainable materials;** such as nickel, magnesium, and cobalt

EV BATTERY [CHEMISTRY] TYPES – Basics cont'd

Summary Of Characteristics

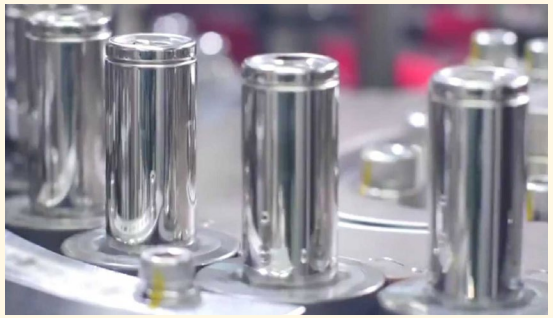
Lithium-Ion EV Batteries: Li-NCM & Li-NCA

- Presently **Most Commonly Used** - ≈70 %; Nissan Leaf, Mercedes Benz EQS
- Not resistant to high temperature, **poor thermal stability**, can catch fire
- **High energy density** – longer range; 200-350 Wh/kg
- **Only 1,000 discharge cycles to 80%**
- Recommended to **charge up to 80% SOC** – avoid long term degradation
- Uses environmentally **unsustainable raw materials** – nickel, manganese, cobalt! 😥

Lithium Polymer Batteries: Li-Po

- **Highest energy density** – lightweight due to lighter cell packaging
- Otherwise **similar characteristics Li-Ion batteries – unsustainable raw materials!** 😥
- Usually a **pouch** vs a cylindrical shape for the cells – but **pouches also swell when hot**

Lithium Iron Phosphate: LFP



- Used in 30% of new EVs: **2024 Tesla Model 3 Standard**, soon Ford Mach-E & F-150 Lightning
- **Safer** – highly stable, less susceptible to catching on fire
- **Lower energy density** than LI-NCM/NCA – **160 Wh/kg vs 200-350 Wh/kg**
- **Routine Charges to 100% SOC**
- **Longest Life**: 2,500 discharge cycles to 80%
- **Doesn't like the cold – both operating and charging!***
- **Doesn't use unsustainable raw materials** 😊

*Nice To Know if you are planning to move back to below Zero Temperature Territory 🥶

EV EFFICIENCY & How It's Expressed

Efficiency

Rate the battery's charge is used up over distance

EV's greatest consumer of charge is driving

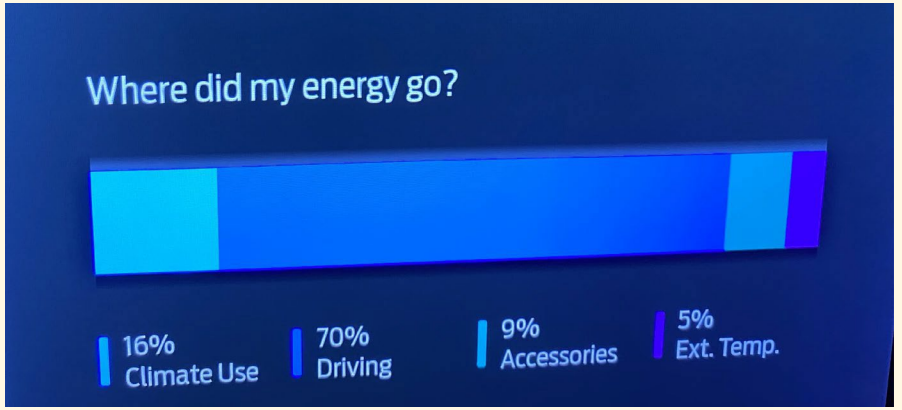
Second biggest is air conditioning or heating

Batteries like it at ≈85-95F

Too cold 🥶 or too hot 🥵 don't work or charge efficiently

Takes electricity to heat or cool the batteries, too

Ford Mustang Mach-E kWh Usage



How It's Expressed – Many Ways

🥴

kWh per 100 miles (kWh/100mi)

European Way of Expressing – Inverse of Miles per kWh (mi/kWh)

34.6 kWh/100mi= 2.9 mi/kWh

Smaller is better

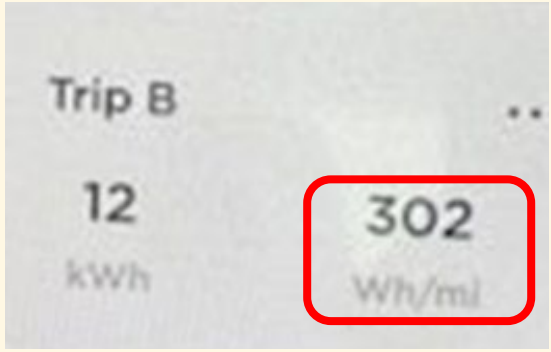
Porsche Taycan

Watt hour per mile (Wh/mile)

Also inverse of mi/kWh

302 Wh/mi= 3.3 mi/kWh

Smaller is better

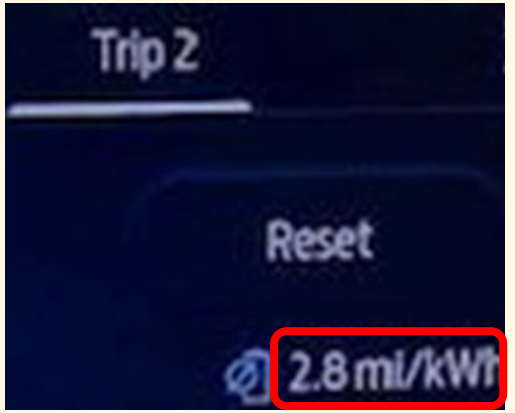


Tesla

Miles per kWh (mi/kWh)

Like MPG

Bigger is better

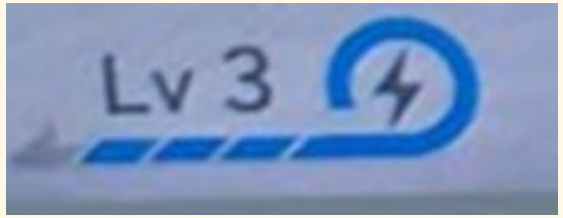


Mach-E, IONIQ 5, EV 6, Niro

EPA On the Window Sticker: MilesPerGallonEquivalent (MPGe) – 100 is better than 90MPGe! 🙄

The EV "Fuel and How It's Dispensed

Regeneration (Regen) & 1-Pedal Driving



EVs employ regen to charge the battery

Turn the drive motors into generators

Feels just like the ICE engine "braking" when driving a "stick"

How strongly it "brakes" can be adjusted

Even **can stop the EV without touching the brake pedal – "1-Pedal Driving"**

Level I, II, & III Charging

Level I and Level II Alternating Current (AC) Charging

Home & Not At Home – Level I(120VAC) , Level II (240VAC)

Uses Electric Vehicle Supply Equipment (EVSE) "charger" – Plug-in or wired

Charging Power Depends on EV's Internal AC Charger & EVSE voltage & amps

Level I – about 1 kW per hour; Level II – 5 to 19 kW per hour

Tesla EVSE NACS Plug

Non-Tesla J1772 Plug

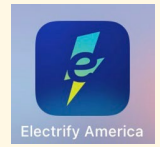
Level III Direct Current (DC) Charging (aka DC Fast Charging – DCFC)

On-The-Road at Public Charging Network (PCN) charging stations

Charging Power – **50 kilowatts (kW) up to 350 kW**

Different EVs Accept Different Charging Power Rates: 55-270 kW

Different PCNs – Different Payment Systems & Different Plugs



Teslas use North America Charge System (NACS) Plugs both AC & DC

NACS Plug

Non-Teslas use Combined Charge System (CCS) Plugs for DC *

CCS Plug

*Soon a majority of Non-Tesla EVs will be able to use NACS charging stations 😀

Key Terms/Abbreviations To Remember for Next Week

Plug-in Hybrid Electric Vehicle (PHEV)

Has both a gas engine and battery powered drive.
Can drive up 30-50 miles on batteries alone
Batteries ultimately require charging via a plug-in charger, Level I, II, or III

Battery Electric Vehicle (BEV)

Uses only battery supplied energy to move
Requires charging of the drive batteries

Kilowatt Hours (kWh)

EV's fuel/energy
Stored in the drive batteries that have a spec'd useable capacity

State of Charge (SOC)

The amount of kWh energy remaining in the drive battery expressed as a percentage (%) of the full charge

Level I Charging using a NACS plug for Teslas and a J1772 plug for Non-Tesla EVs

Alternate Current (AC) charging using a standard 120 volt outlet and a plug-in Level I EVSE ("Charger")
A "trickle charger" that supplies only 1 kilowatt (kW) power per hour of charging; only 1 kWh in an hour

Level II Charging using a NACS plug for Teslas and a J1772 plug for Non-Tesla EVs

AC charging using a 240 volt outlet & plug-in EVSE ("Charger") or a hard-wired 240 volt EVSE ("Charger")
Primarily used as a home EV charging system supplying a 5 – 19 kW power per hour of charging; 5-19 kWh in an hour
Also, available when Not At Home at shopping centers, hotels, shops, etc.

Level III Charging using a NACS plug for Teslas and a Combined Charging System (CCS) plug for Non-Tesla EVs

High voltage **Direct Current Fast Charging (DCFC)** provided by **Public Charging Networks (PCN)** away from home
Charging **charging power in kilowatts (kW),** ranges from 50 to 350 kW; a 20 minute charging 10-80% SOC possible

NEXT WEEK

Charging

At Home | Not At Home

Charging – The Details

At Home Charging: Installation, Cost, and Use

Not At Home: Level I, II, & III on the Road

- What to bring with you
- The cost to charge

Where Are the Chargers

Proper Charging and Battery Degradation

See You All Next Week