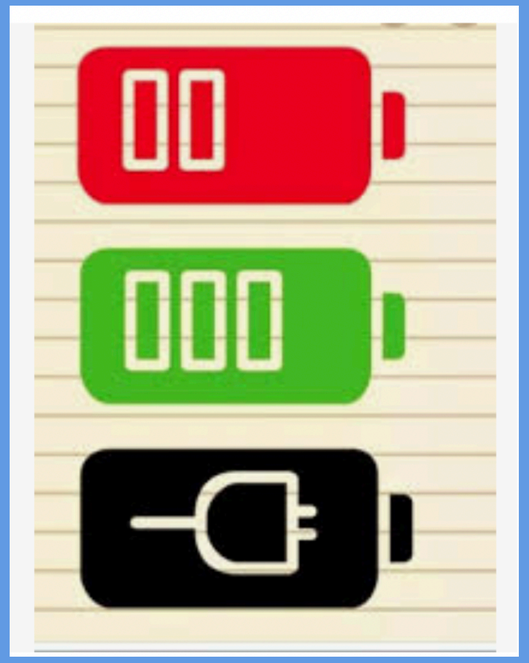
Looking Into Electric Cars

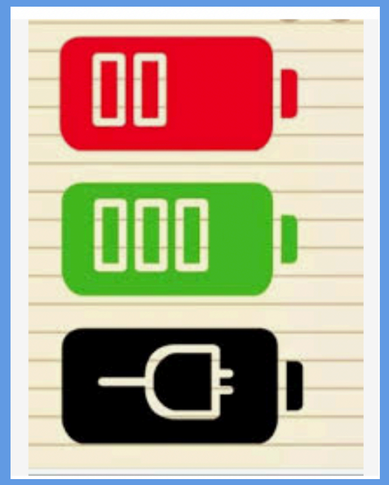
Session 4 : Range (and its anxiety)



EV Battery Life and Death

Looking Into Electric Cars

Session 4 : Range (and its anxiety)



How often do Tesla batteries need to be replaced

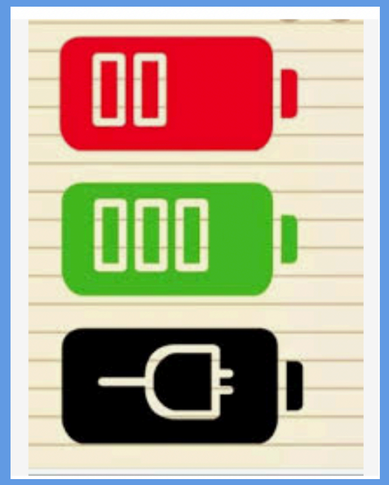
Your Tesla is due for a battery replacement once it has lost 20% of its range. Tesla owners reportedly only lose 5% after 100,000 miles.

Tesla CEO Elon Musk claimed in a Tweet that a Tesla battery can last between 300,000 to 500,000 miles. If you're driving within the national average of 273 miles per week, expect your battery life to last anywhere from 21 to 35 years.

The point is a Tesla battery replacement will rarely (if ever) happen. There's a higher chance you'll need to replace your electric vehicle before you replace your battery.

Looking Into Electric Cars

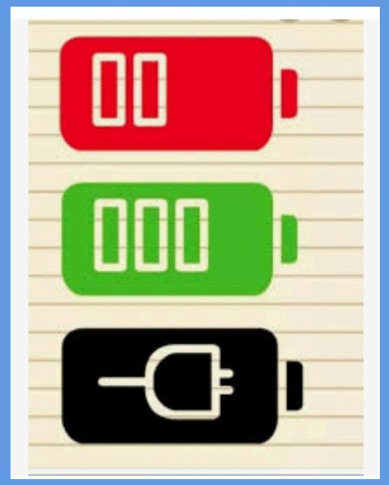
Session 4 : Range (and its anxiety)



Further muddying the data is the fact that EV battery longevity is a moving target. In these past ten years, there have been numerous tweaks to battery cell chemistry, cell structure design, and battery management systems. The packs from ten years ago are very different from the packs in Tesla vehicles today.

Looking Into Electric Cars

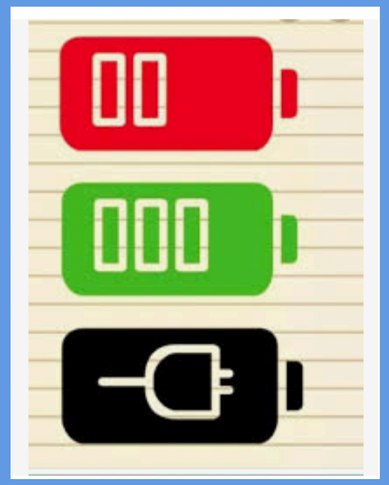
Session 4 : Range (and its anxiety)



The U.S. Department of Energy, meanwhile, predicts today's EV batteries ought to last a good deal past their warranty period, with these packs' service lives clocking in at between 12 and 15 years if used in moderate climates. Plan on a service life of between 8 and 12 years if your EV is regularly used in more extreme conditions.

Looking Into Electric Cars

Session 4 : Range (and its anxiety)

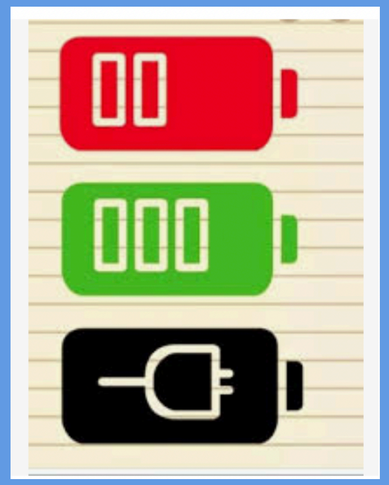


How long will the battery last ?

My personal speculation is the older batteries are often from cars with smaller batteries and shorter ranges. These batteries were probably taken through longer cycles and more often. I would expect newer cars that can be used mostly in that 60% range and charged less frequently will fare better than their forerunners . And battery life will be longer.

Looking Into Electric Cars

Session 4 : Range (and its anxiety)



The first second life for an EV is after several years it becomes the second car. Short trips in town, the kids car, etc and reduction in range caused by battery degradation is not an issue. The next use put the battery on land where size and weight is not an issue (backup electric supply) Eventually it will be recycled.

Looking Into Electric Cars

Session 3 : Charging

Breaking news

Tesla Stock: EV Giant Slashes Prices As Much As 25% Ahead Of Earnings

KIT NORTON

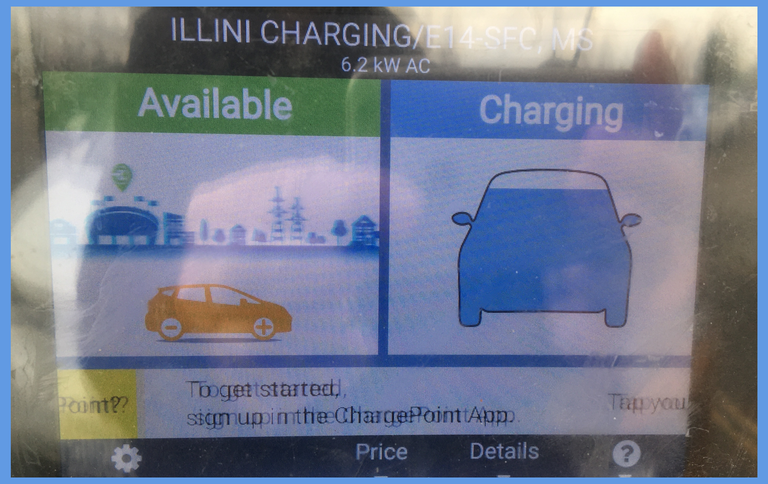
Tesla (TSLA) on Friday put in place additional vehicle price cuts in Europe, Israel and Singapore, continuing its 2023 price-slashing strategy ahead of its first-quarter financials release next week. TSLA shares edged lower Friday.

Tesla on Friday reduced prices in several European markets, including Germany and France, for all versions of the Model 3, S and X, as well as the Model Y Performance. In early March, Tesla had offered significant discounts

Last week Tesla lowered prices - this week Tesla raised prices

The broken level 2 charger where I made a video has been repaired.

New listing of vehicles eligible started a little chaotically but seems to be coming more orderly.



Looking Into Electric Cars

Session 3 : Charging

Breaking news

The Electrify America started first. It took 4 tries to pour the concrete and is now making progress.

6 Chargers

But it looks like the Tesla Supercharger at the Champaign County Market will open first.

12 Chargers

Looking Into Electric Cars
Session 4 : Range (and its anxiety)

"Which is more important," asked Big Panda, "the journey or the destination?"

"The company." said Tiny Dragon.

Looking Into Electric Cars
Session 4 : Range (and its anxiety)

There's a reason lots of people call it the . . .

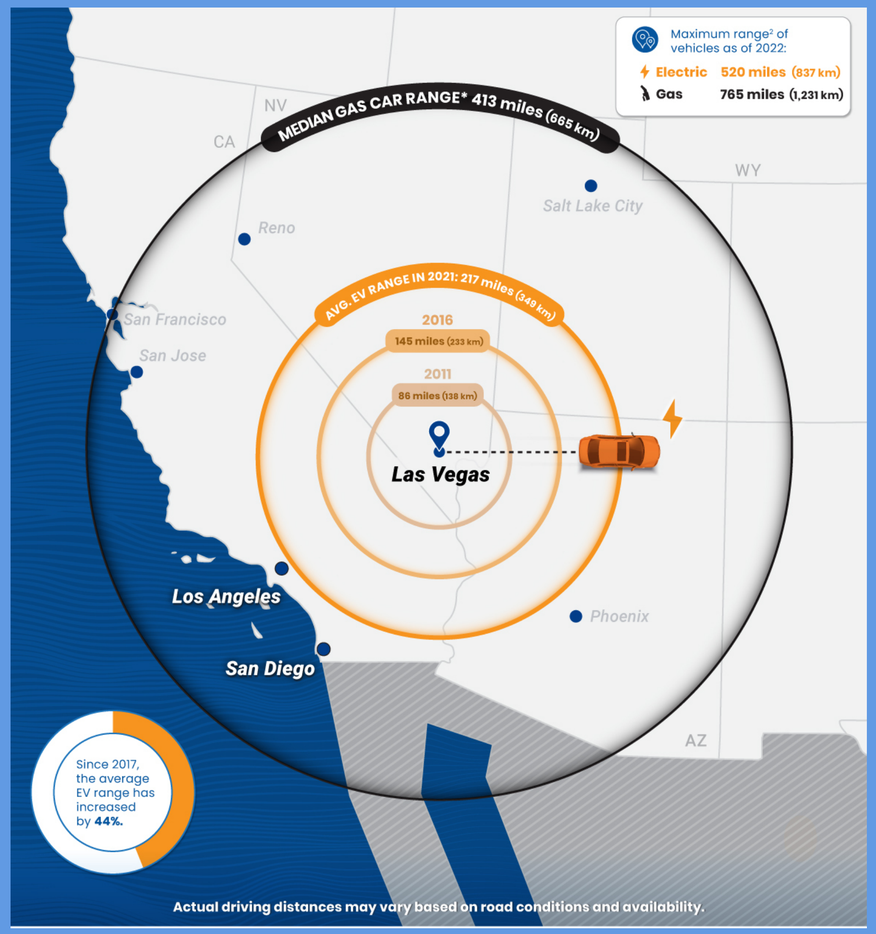
The Guess-o-Meter

Past performance does not guarantee future results

Anxiety can make you do strange things

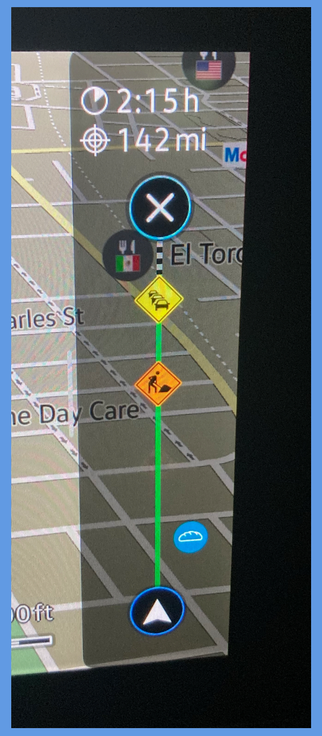
Range anxiety = not knowing how far you can actually drive. And is there enough charge to drive to the next adequate charger.

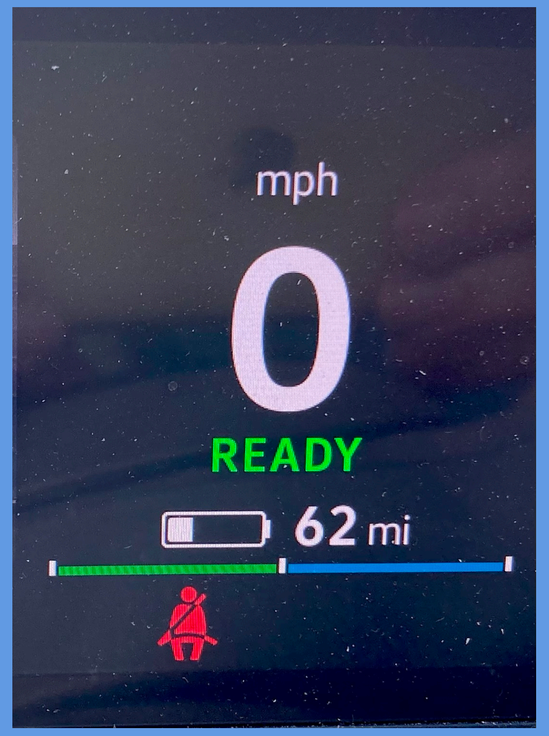
Session 4 : Range

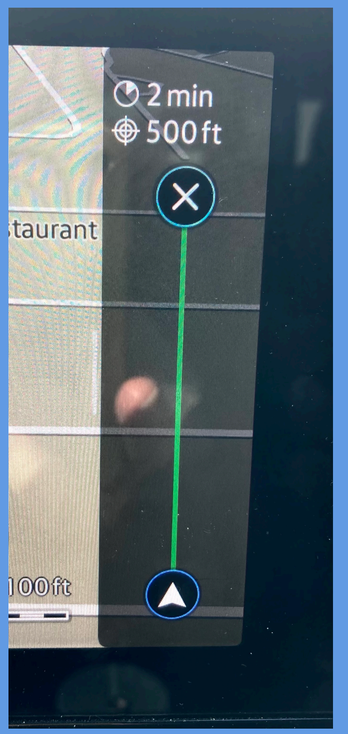


Possibly some anxiety is the result of how recently EVs with the longest range still didn't go that far. And still recently, there are a lot of horror stories out there. Some from people who just bought a car and took off down the road. Some from automotive press writers with a short time with a vehicle and little real life EV experience.

And the “range” on the dash doesn’t help

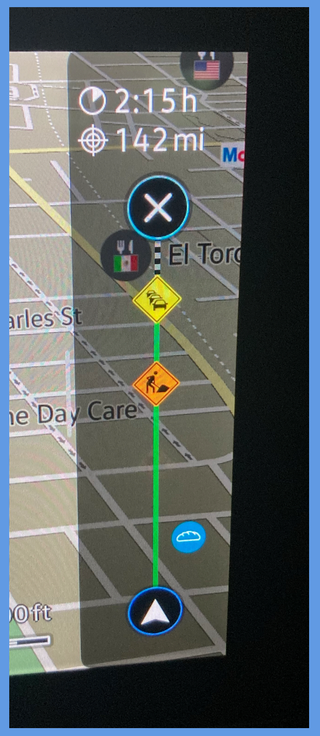


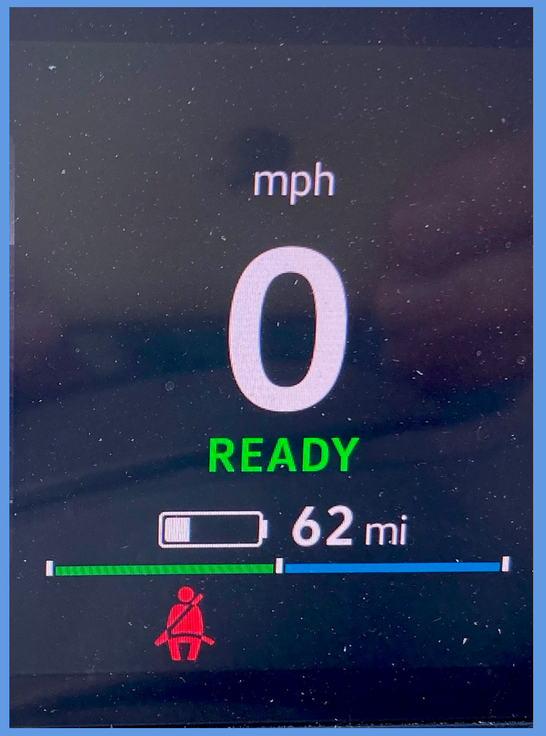


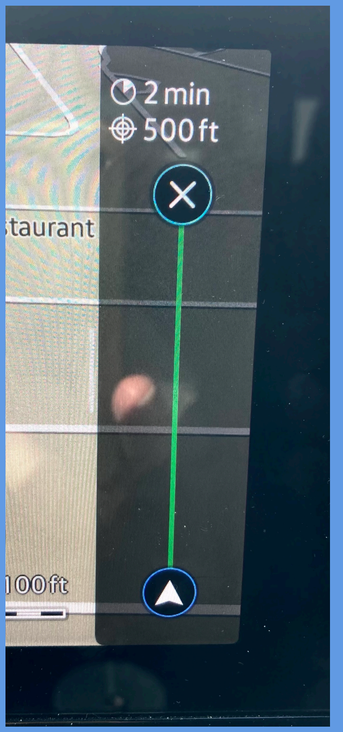


267 miles of range at start of trip. After driving 142 miles, the range is said to be 62 miles. If original was correct, the end of trip range should be 125 miles. “Range” was off by 65 miles. A 100% error.

And the “range” on the dash doesn’t help







A 100% error is bound to trigger range anxiety.

Looking Into Electric Cars
Session 4 : Range (and its anxiety)

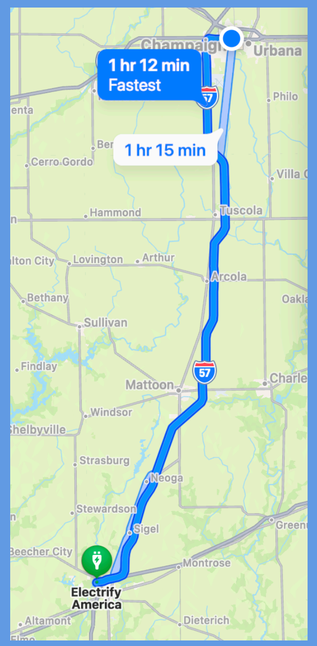
We'll work on that

But First

The good news. Even in the WORST weather that I have data. The next DCFC station is within range. The worst I have seen is 1.9 miles per kWh. This is weather that just maybe you should stay off the roads. But even with the 60% rule, My car can be driven 90 miles.

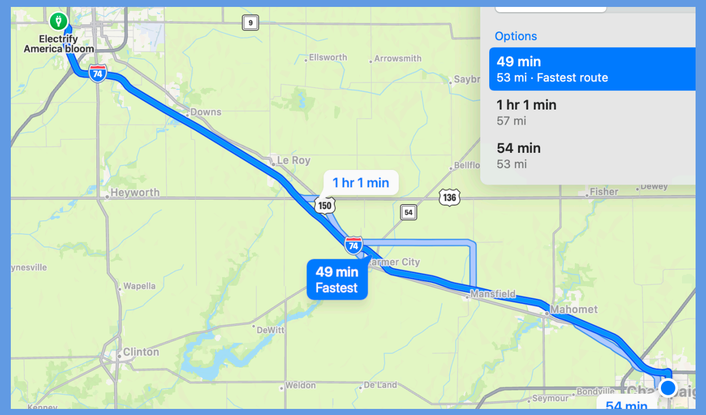
Session 4 : Range

Kankakee

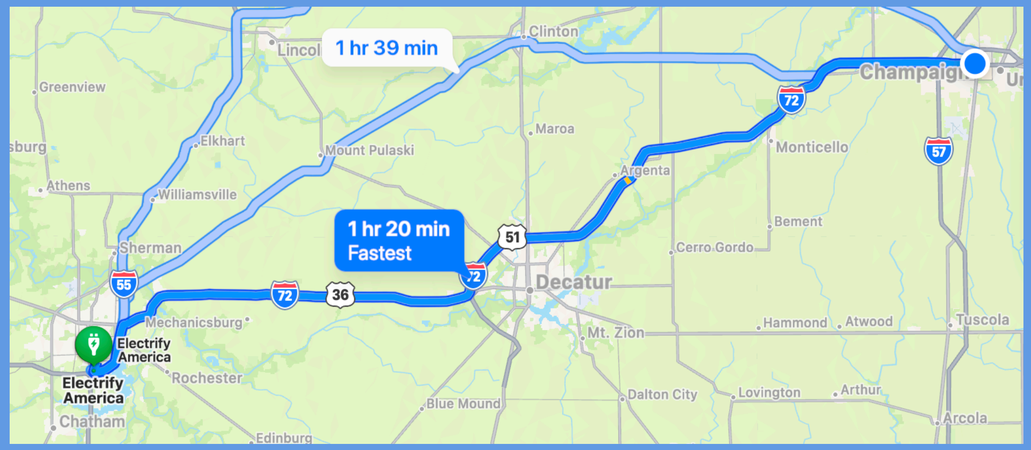


Effingham

There are five ways to leave C-U by interstate.
Here are four of them.
I 57 to Effingham 79 miles
I 57 to Bradley 86 miles
I72 to Springfield 88 miles
I74 to Bloomington 50 miles
All can be easily reached in terrible conditions

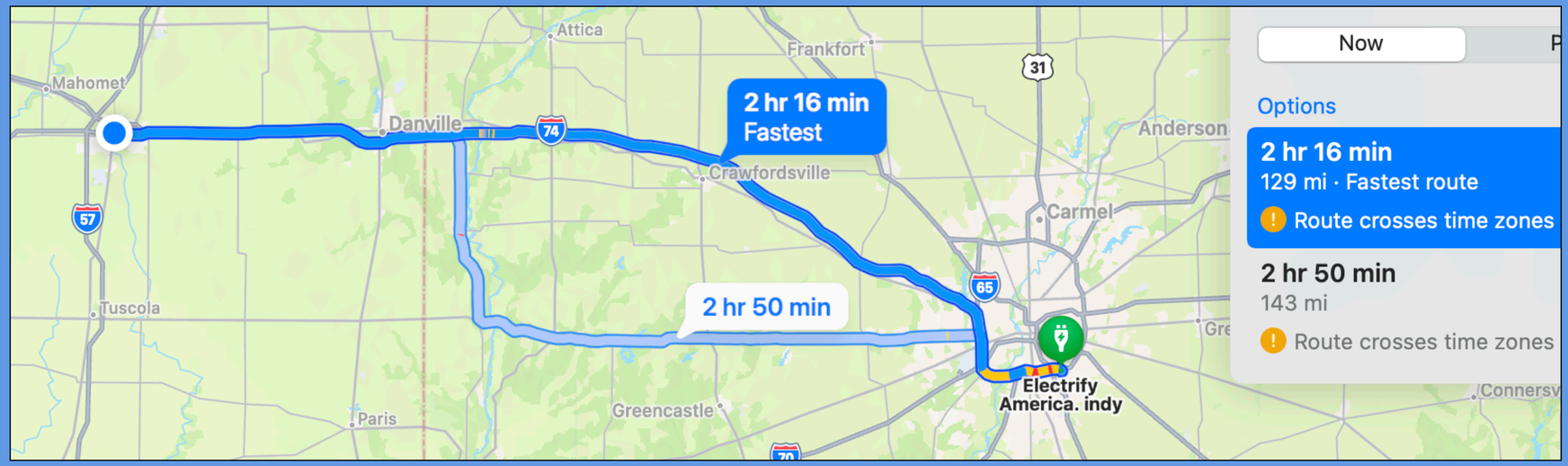


Bloomington



Springfield

The Indianapolis is still a little harder.
I74 to lindianapolis 129 miles
But can be reached - but speed reduction for some weather conditions is recommended.



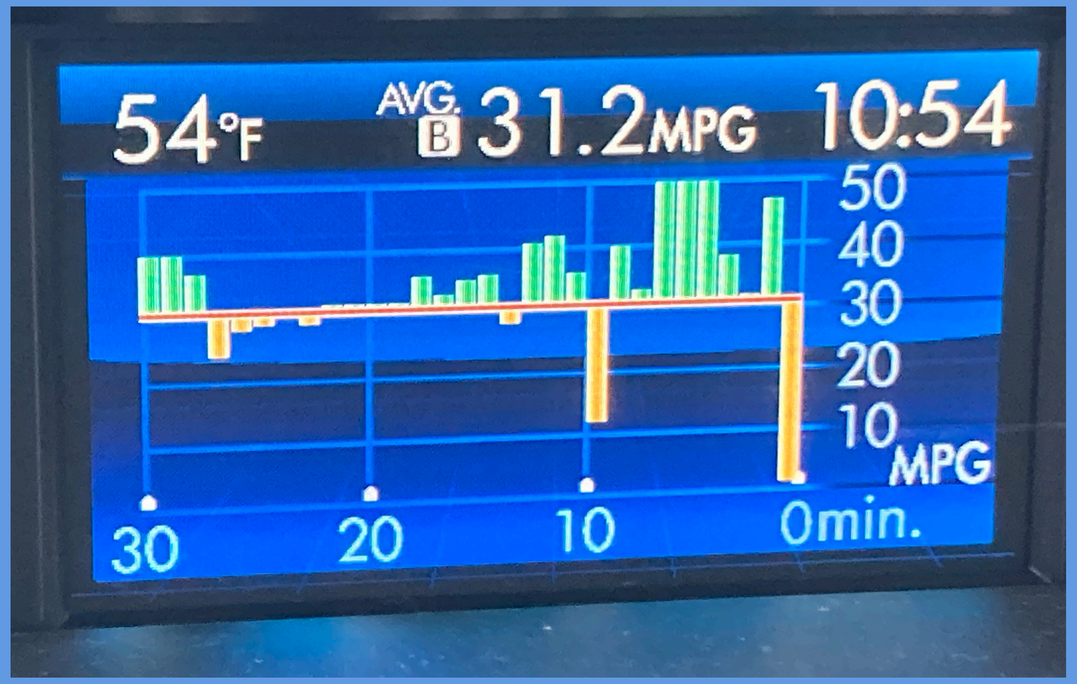
Looking Into Electric Cars
Session 4 : Range (and its anxiety)

Variability

All vehicles, gas and electric, have a variable range. Because they use different amounts of energy in changing weather conditions.

Session 4 : Range

Past Performance vs Future Results



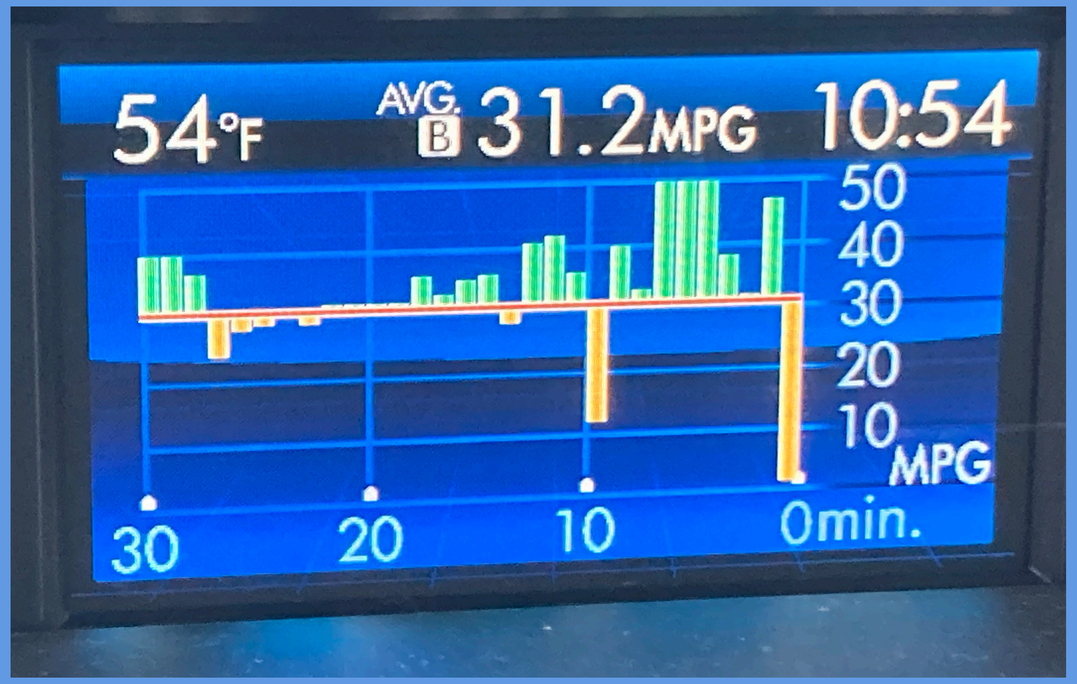
31.9	30.6	31.6
25.9	28.2	31.2
32.9	27.7	32.9
33.6	18.1	30.1
34.3	25.8	30.4
30.0	23.6	32.1
31.7	30.6	30.8

Efficiency can change at any time and throughout the year.

This a 30 minute graph of a Subaru hybrid as the MPG varies. On the right, a list of average MPG with each tank of gas in the last year that I owned the car.

Yes the 18.1 mpg was for late January.

Session 4 : Range



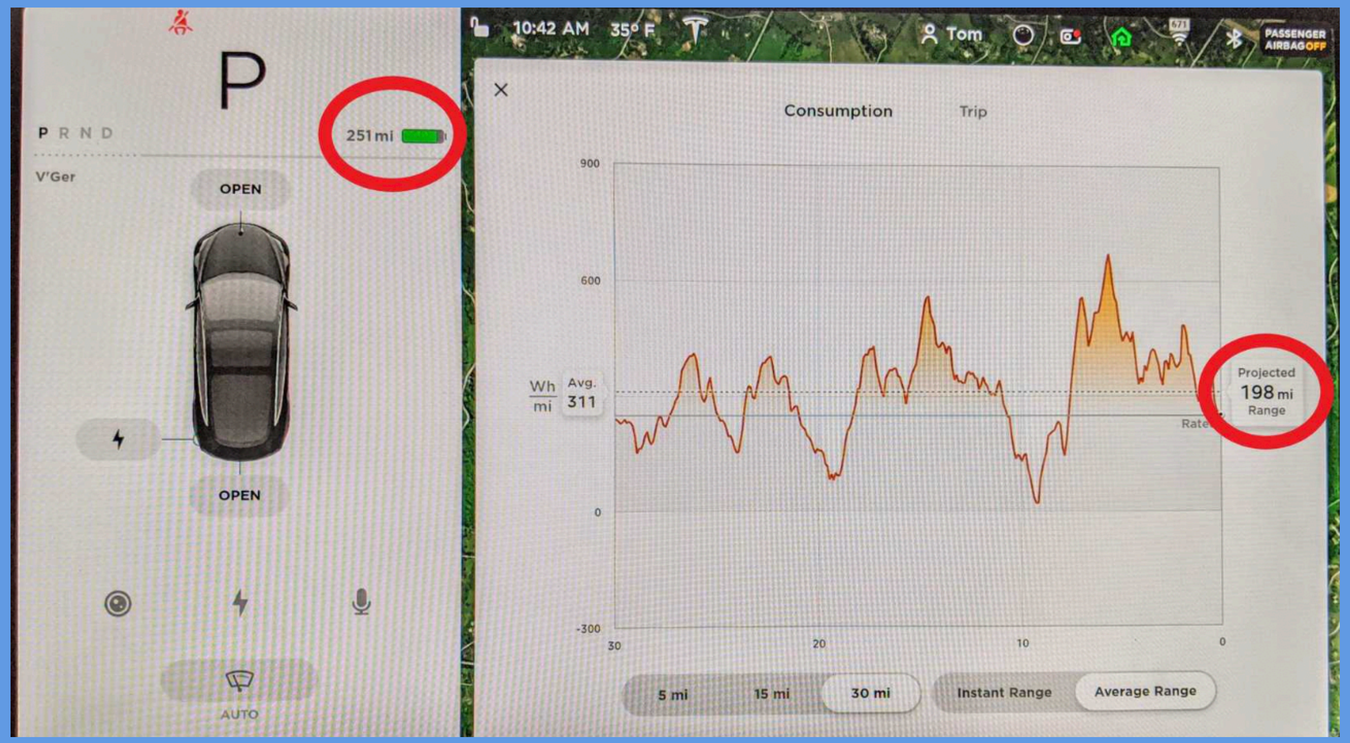
Tesla has a similar screen in the Model 3, but my VW doesn't.

Since efficiency can change at any time, it might be more surprising if the range estimate was accurate.

This usage is from a gas Subaru hybrid. Efficiency of both gas and electric varies with wind, speed, temperature and load. Its just more obvious with electric.

Session 4 : Range

Past Performance vs Future Results



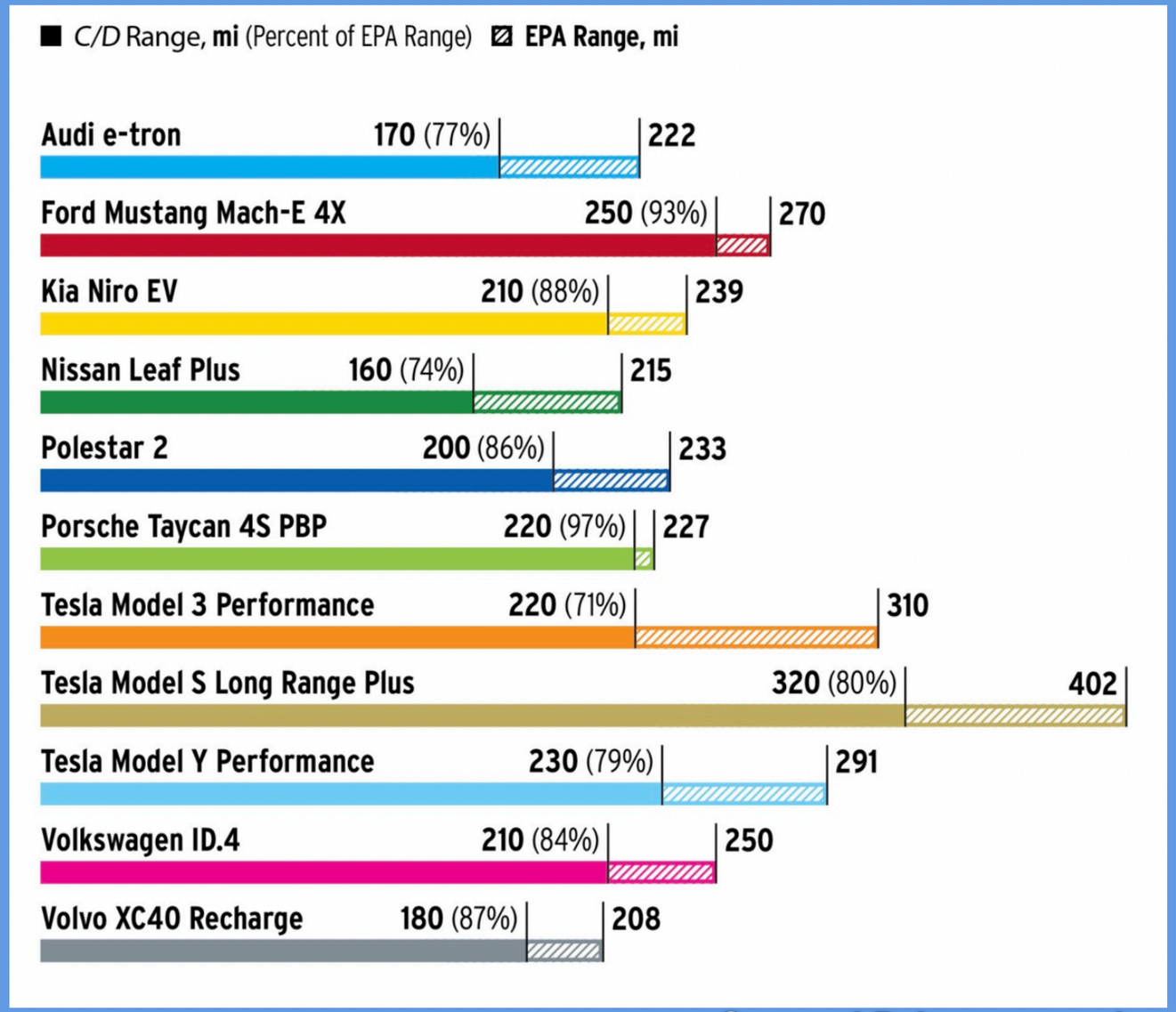
Tesla screen in the Model 3, The graph is useful but still has a discrepancy between the two range predictions.

Efficiency can change at any time and throughout the year.

Since I don't own a Tesla model 3 to play with, I have basic idea of what this represents but I am not sure. In my VW I get miles/kWh and this is WH per mile. One is the inversion of the other. You adapt to the one you get.

Session 4 : Range

Past Performance vs Future Results

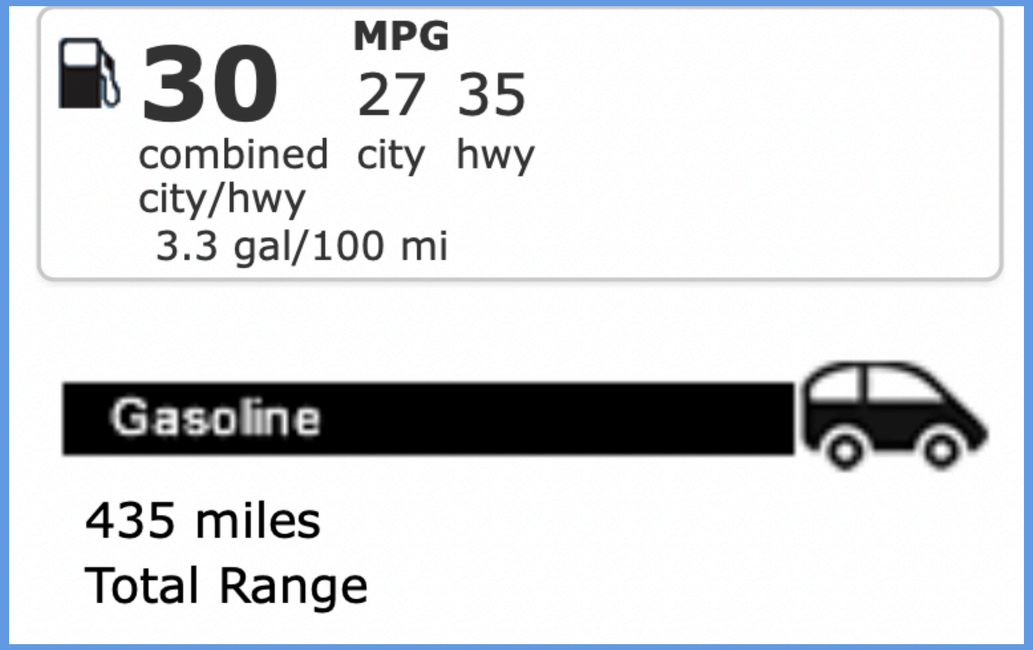


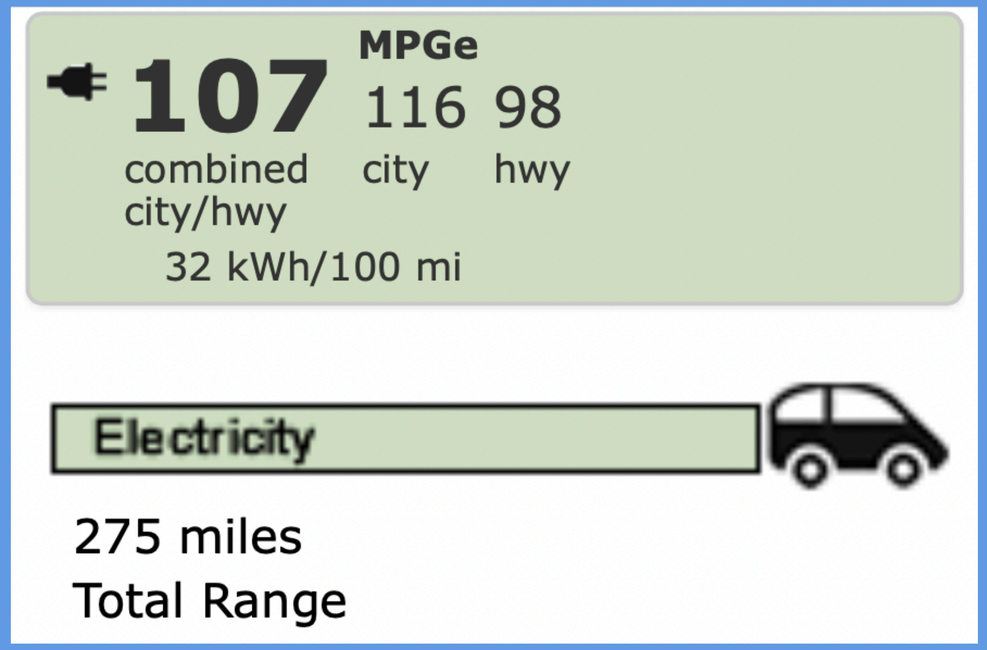
Car and Driver magazine

The variations with wind, speed, temperature and load results in disagreements . Different organizations arrive at different mile numbers for that range. And this disagreement is for range tests done at similar conditions.

Session 4 : Range

Past Performance vs Future Results

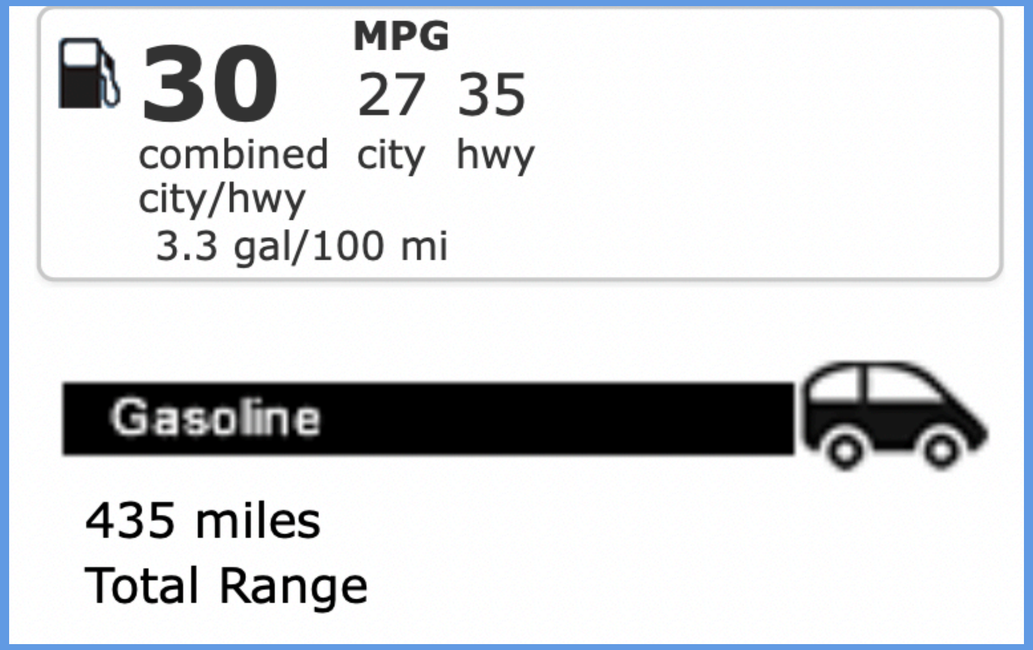


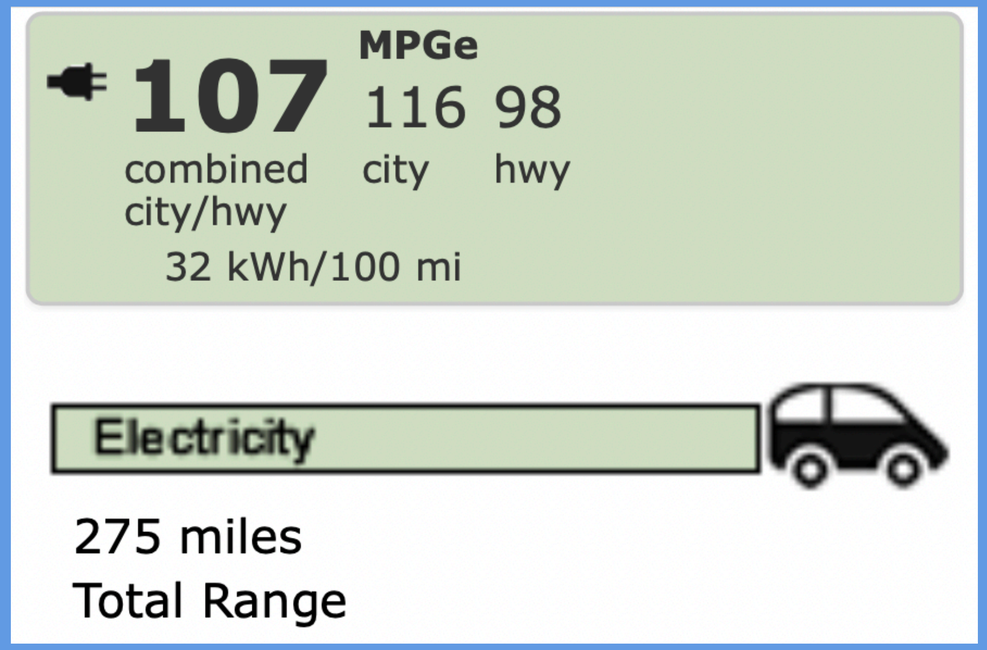


Epa numbers

At 27 - 30 - 35 a gas Vehicle is more efficient on the highway

At 116 - 107 - 98 an EV Vehicle is more efficient in the city





Epa numbers

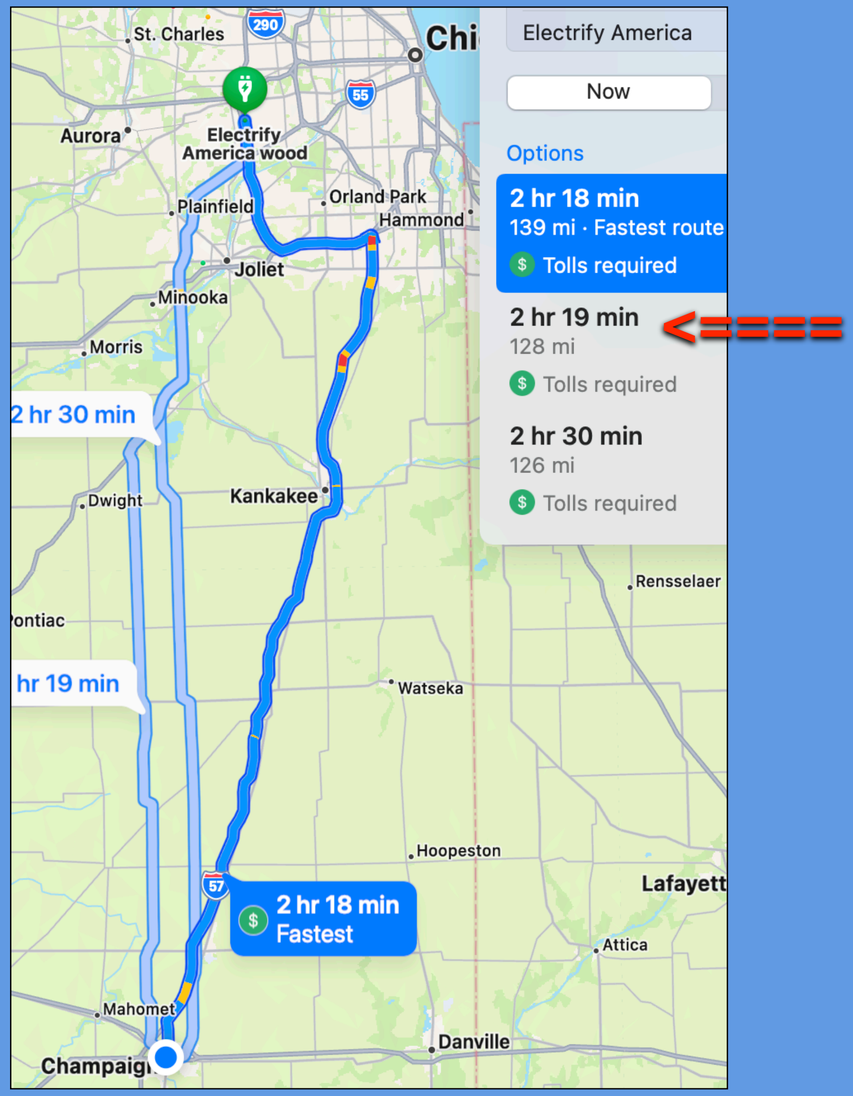
Look at the MPGe - even though an EV is less efficient on the highway, it is still more efficient than a gasoline vehicle.

Range also varies by speed of the vehicle.
This is a chart of projected range on the same day with the same wind speed an temperature.

wind	dir	temp	dist		speed	eff	Range	change in R	k/wh per 100mi
8	nw	45	7		70	2.9	223.3	standard	34.48
8	nw	45	7		75	2.6	200.2	89.66%	38.46
8	nw	45	7		65	3.1	238.7	119.23%	32.26
8	nw	45	5		55	3.9	300.3	125.81%	25.64
			no significant change in DCFC charge times (opinion)						

Electric has an advantage over gas. With a gas vehicle the range can drop as you slow down. With electric the range (for the remainder of the trip can increase as much as 24% by just slowing down. But please, if you slow down to 55 mph please take

Session 4 : Range

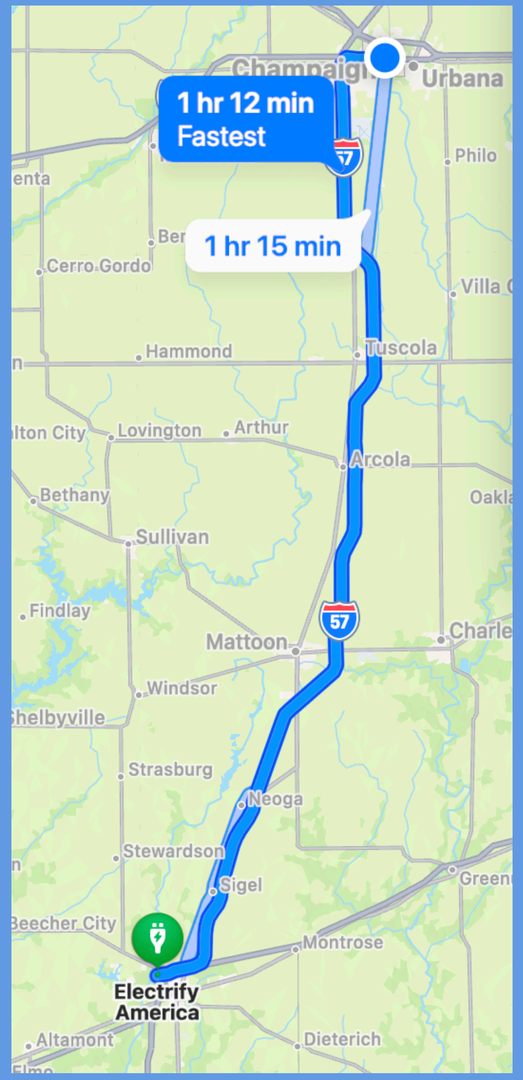


That 20% increase in range can be taken advantage of. Note the travel time using I55 and US47. Only 1 minute longer on US47. Planning to use that route could cut charging time 10 minutes. A bigger gain on some days since the prevailing winds here are typically from the south. With cold temps and winter winds – keeping this route in mind could really pay off in Dec through early Feb.

With the NEVI program and large movements from the private sector, the range part is taken care of. Start with 80% and just go anywhere.

But some will still have anxiety - next up the anxiety part.

Session 4 : Range

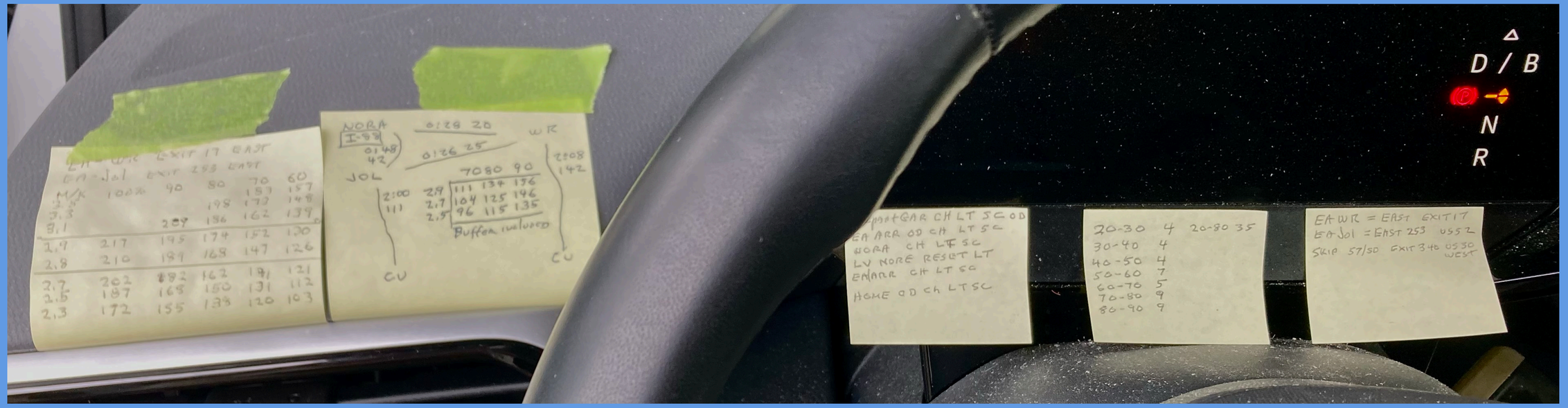


Effingham

We could just stop here. If you have an 80% charge in your car, just pick up and go ANYWHERE.

However it is common for some to have lingering doubts. Will the current variation in efficiency be enough to prematurely end the journey ?

How to check the current status.



If you didn't already know I'm a wonky nerdy geek, you will soon. It can be said that I "puzzle" things a lot. Range for distance is mostly about turbulence. Most of you will be happier if I don't go there. In the graph a few slides back, Turbulence is the main reason the range drops as speed (and wind) increases.

This is the screen on my ID4 that tells me how I'm doing.
The red arrow points to the momentary energy use of the car, everything off but radio and electronics. Lowest that it goes, 0.4 with headlights on.

Session 4 : Range

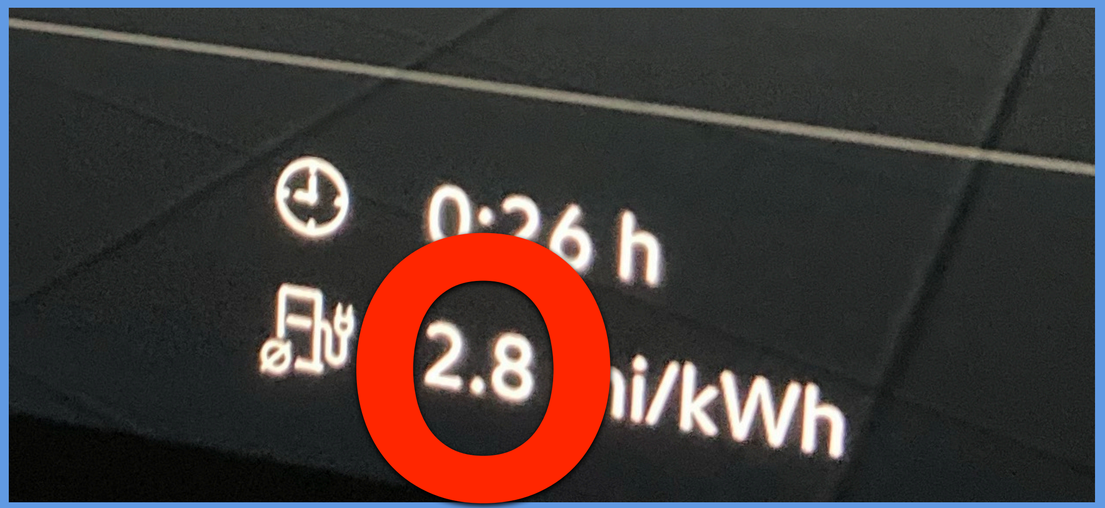
Past Performance vs Future Results

The “128 mi” is the distance for this interval , “6:19 h” is the total time elapsed (but only while you’re in the car) and “20 mph” is the average speed for the 6 ish hours.

The “4.1 mi/kWh” is the average efficiency for the 6 ish hours. So over a few days my “range” was about 315 miles. (Obviously in town- only get that number at highway speeds in your dreams.

The “0.0” is the reset button - click it and the four numbers reset to 0 and start over.

Session 4 : Range



Trivia: the arrow points to the momentary efficiency. With foot off the pedal, a negative number is regenerative braking charging the battery

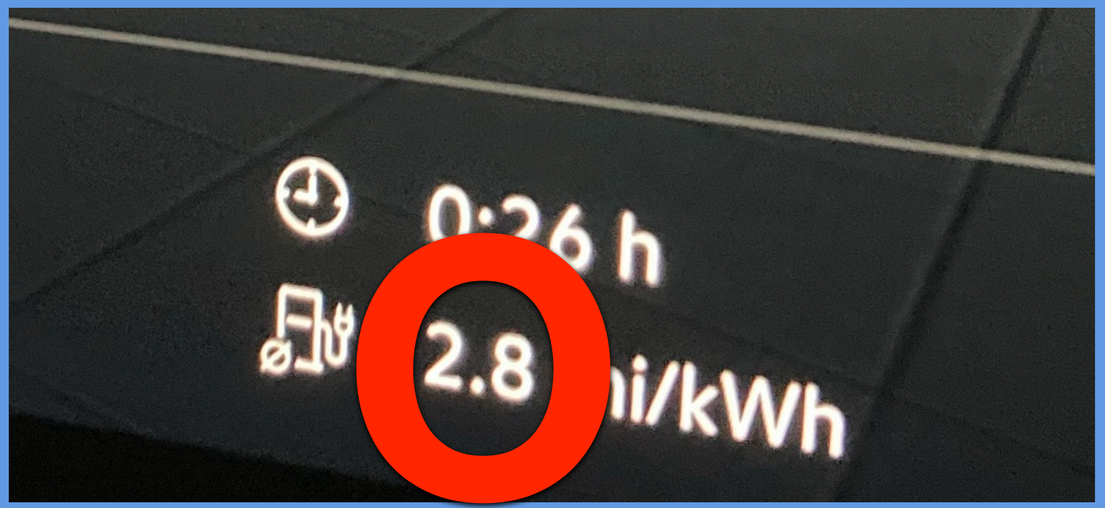
The previous screen was for city driving. This screen is for highway driving. I was getting 2.8 mi/kWh and averaging 68 mph.

Now lets see it work.

After resetting the screen - that number will be your CURRENT efficiency and can verify your range goal.

Session 4 : Range

Past Performance vs Future Results



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M/K	90%	80	75	70	65%
3.2	182	157	145	132	120
3.0	168	145	133	122	110
2.9	161	138	127	116	105
2.8	154	132	122	111	100
2.6	140	120	111	100	90
2.4	126	108	98	90	80
2.2	112	95	87	78	70
2.0	98	83	75	67	60

<====

At this efficiency level & using my dashboard cheat sheet, I can drive from 100 to 154 miles depending on SOC

Session 4 : Range

Past Performance vs Future Results

M/K	90%	80	75	70	65%
3.2	182	157	145	132	120
3.0	168	145	133	122	110
2.9	161	138	127	116	105
2.8	154	132	122	111	100
2.6	140	120	111	[illegible]	90
2.4	126	108	98	90	80
2.2	112	95	87	[illegible]	70
2.0	98	83	75	67	60

===>

<=====

For example: previously it was mentioned that it is 88 miles to the Springfield EA charger. Starting with a 70% charge an efficiency of 2.4 is needed.

Session 4 : Range

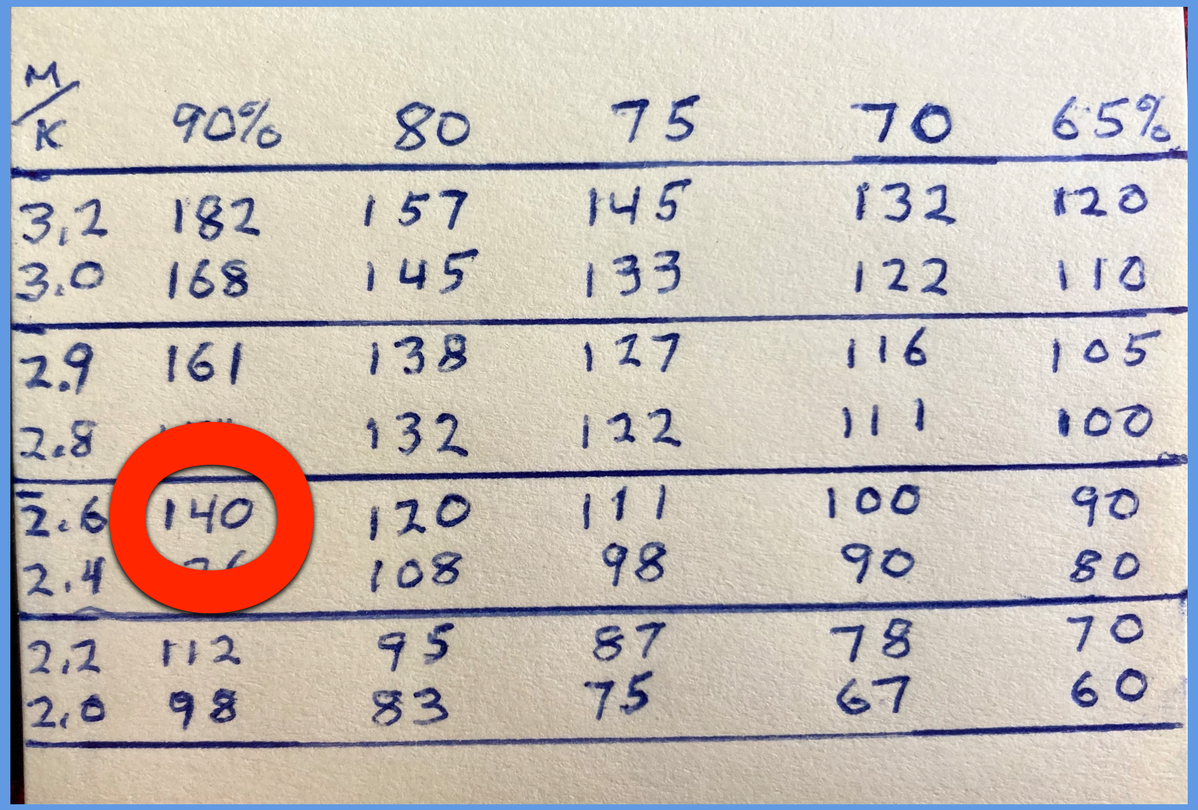
Past Performance vs Future Results

	batt								
“mi-kwh	100.00%	90.00%	80.00%	75.00%	70.00%	65.00%	60.00%	50.00%	40.00%
3.5	229.5	202.55	175.6	162.125	148.65	135.175	121.7	94.75	67.8
3.3	214.1	188.69	163.28	150.575	137.87	125.165	112.46	87.05	61.64
3.2	206.4	181.76	157.12	144.8	132.48	120.16	107.84	83.2	58.56
3	191	167.9	144.8	133.25	121.7	110.15	98.6	75.5	52.4
2.9	183.3	160.97	138.64	127.475	116.31	105.145	93.98	71.65	49.32
2.8	175.6	154.04	132.48	121.7	110.92	100.14	89.36	67.8	46.24
2.7	167.9	147.11	126.32	115.925	105.53	95.135	84.74	63.95	43.16
2.6	160.2	140.18	120.16	110.15	100.14	90.13	80.12	60.1	40.08
2.4	144.8	126.32	107.84	98.6	89.36	80.12	70.88	52.4	33.92
2.2	129.4	112.46	95.52	87.05	78.58	70.11	61.64	44.7	27.76
2	114	98.6	83.2	75.5	67.8	60.1	52.4	37	21.6
1.9	106.3	91.67	77.04	69.725	62.41	55.095	47.78	33.15	18.52
1.7	90.9	77.81	64.72	58.175	51.63	45.085	38.54	25.45	12.36

YES - I’m lazy and let a spreadsheet do all the math.

Session 4 : Range

Past Performance vs Future Results



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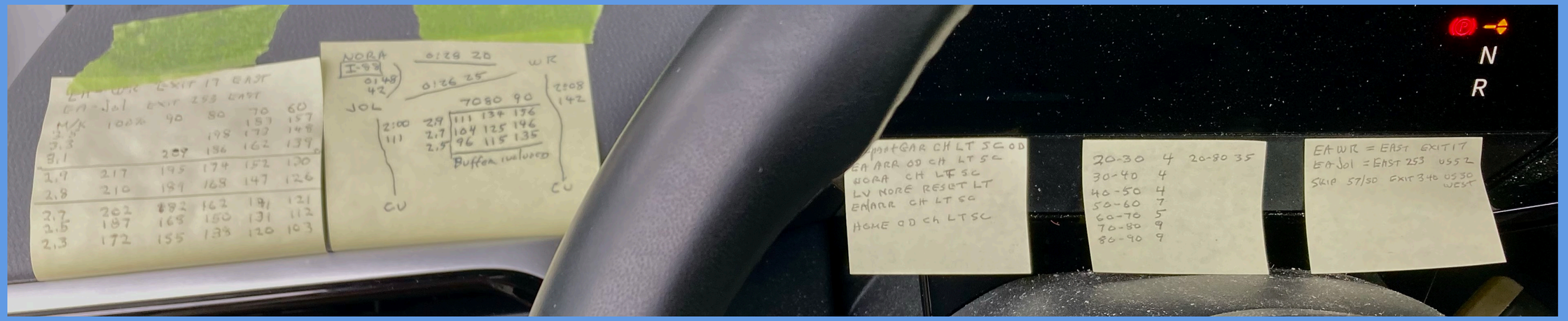
3.2	182	157	145	132	120
3.0	168	145	133	122	110
2.9	161	138	127	116	105
2.8		132	122	111	100
2.6	140	120	111	100	90
2.4		108	98	90	80
2.2	112	95	87	78	70
2.0	98	83	75	67	60

Copied the ones I thought most useful for onto a post-it for the dash. It allows me to choose a charging level using the efficiency that I had getting to the charger and applying that to the distance to the next charger to pick my desired SOC.

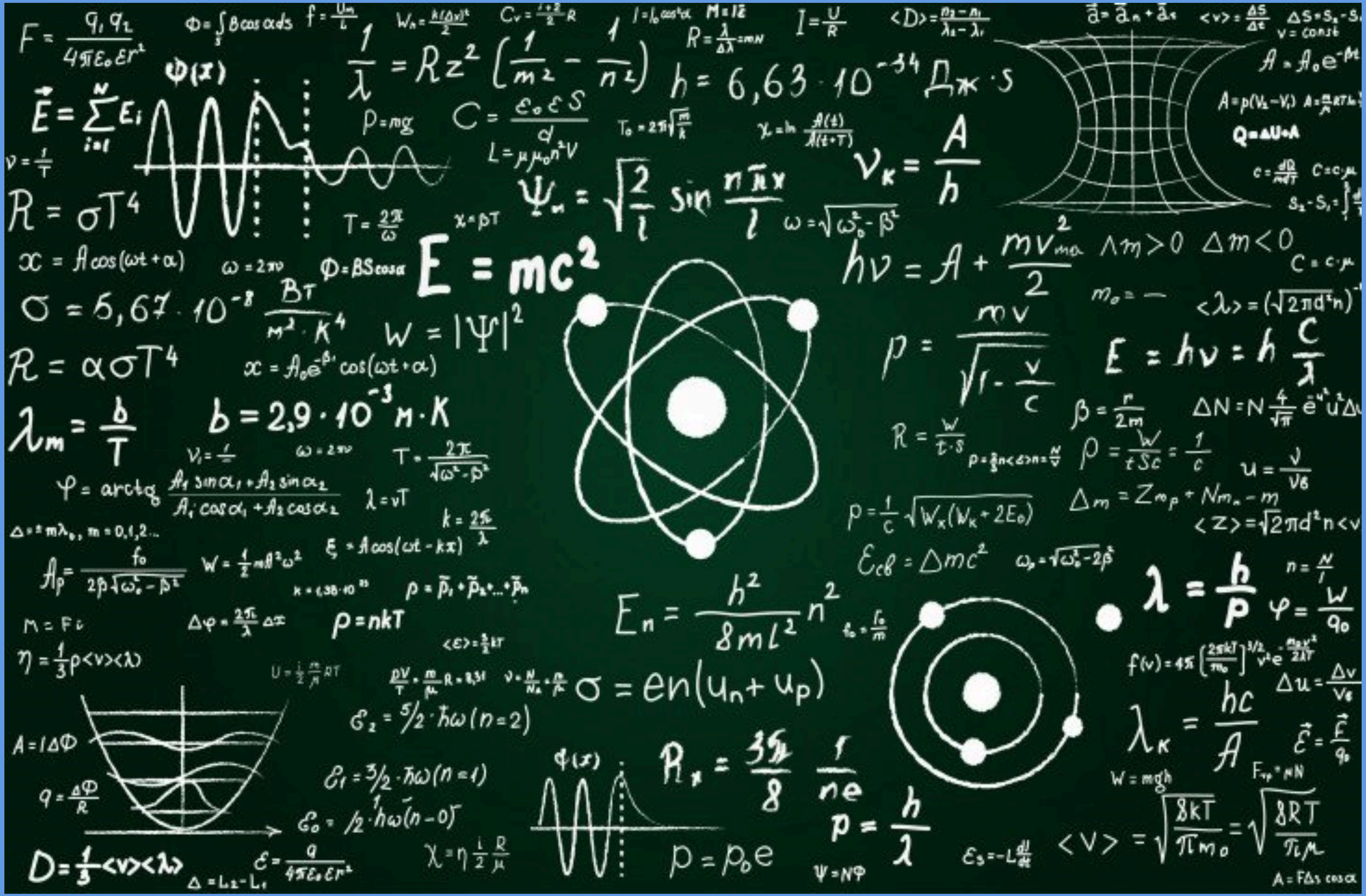
Session 4 : Range

Past Performance vs Future Results



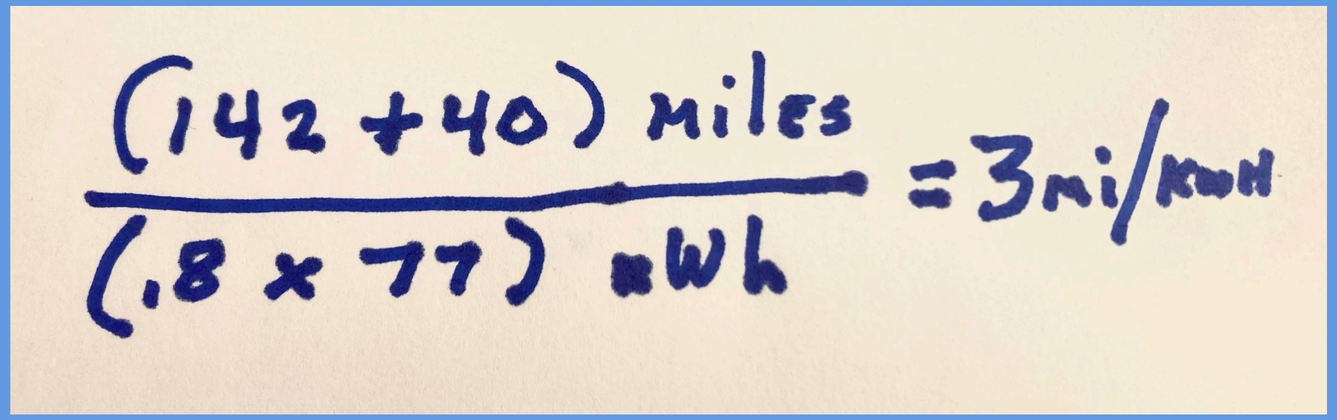
And I am now down to just the one post-it note. Mostly ignored.

Occasionally glanced at as a double check.
As I get more experience, on road trips I might charge minimally to arrive at the next charger with about 20% and minimize my charge times.


$E = mc^2$
$h = 6{,}63 \cdot 10^{-34}$ Дж·с
$W = |\Psi|^2$
$b = 2{,}9 \cdot 10^{-3}$ м·К
$\sigma = en(u_n + u_p)$
$E = h\nu = h\frac{c}{\lambda}$
$\lambda = \frac{h}{p}$

OMG - it's MATH

Not that math – this math. And its fairly simple. Pick a trip, get the miles. Add a few miles for a cushion. (this depends on your bravery) . Pick the starting level of charge. e.g. 80%. Multiply the 80% times the size of the battery. Divide miles by the kilowatts. (kWh) . And you get your number.



For my West Chicago trip -
142 miles to the CHARGER
add 40 miles – 184.
(the 40 miles = not run to 0%)
80% of the VW 77kWh battery – 62

182 / 62 = 3.0

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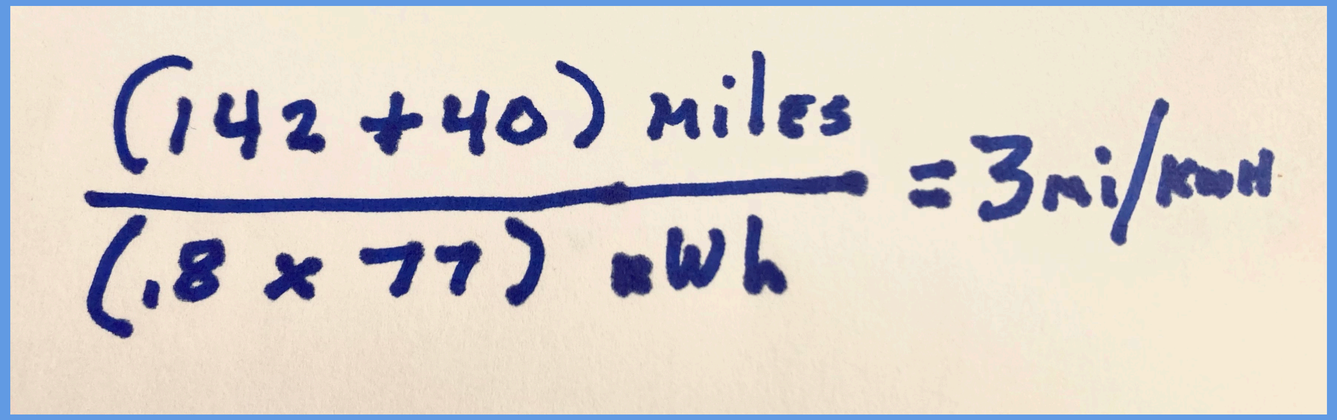

For my West Chicago trip -
142 miles to the CHARGER
add 40 miles (as a cushion) – 182.
80% of the VW 77kWh battery – 62

182 / 62 = 3.0

Since I'm not that brave, and a slow overnight charge is kind to my battery, I charge higher and can drive at 2.8.

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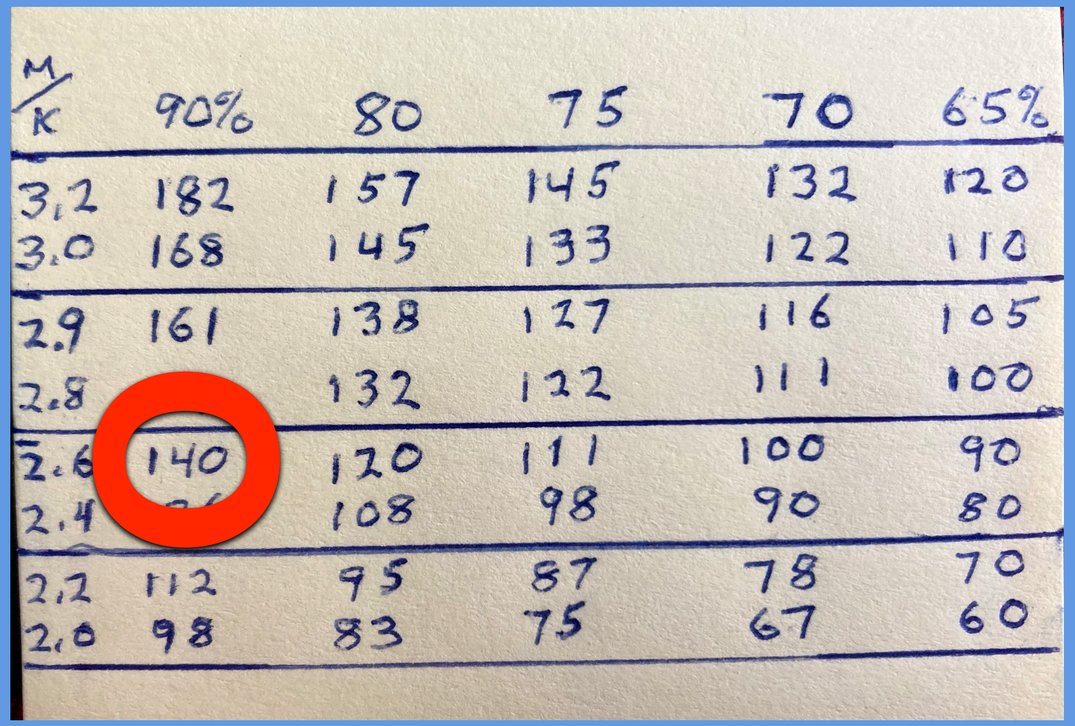

M/K	90%	80	75	70	65%
3.2	182	157	145	132	120
3.0	168	145	133	122	110
2.9	161	138	127	116	105
2.8		132	122	111	100
2.6	140	120	111	100	90
2.4		108	98	90	80
2.2	112	95	87	78	70
2.0	98	83	75	67	60

My Cheat Sheet

I know how far I need to go

I have an Idea what efficiency I can get.

I read off the charge level needed to begin the trip.

On my new cheat sheet the 40 miles is already included.

Stopping point.