ELECTRIC VEHICLES — READY FOR PRIME TIME

Brian Anderson

Apr 15, 2025

BRIAN ANDERSON

Project Management Institute

Senior Research Program Manager (retired)
Medtronic Corporate
Minneapolis, Minnesota

40+ YEARS
Hardware/software product development in multiple industries

25 YEARS
Medical device software development and quality

About Me

- Hometown: Portage, Wisconsin
- Current Residence: Plymouth, MN
- Family: Wife Karen, Son Tor (31), Daughter Louise (25)
- EV driver since Oct 2015
- Home powered by solar since Sep 2015

Professional Experience

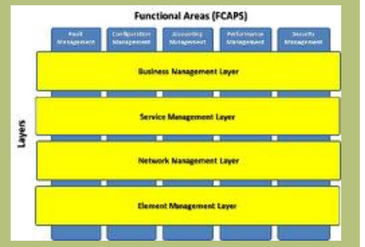
- RF Design - 2-way radios & power amps
- Automotive Diagnostic Software
- Telecommunications Systems and Software
- Medical Device Systems and Software

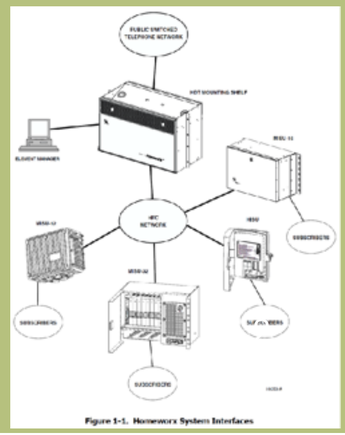
EFJohnson

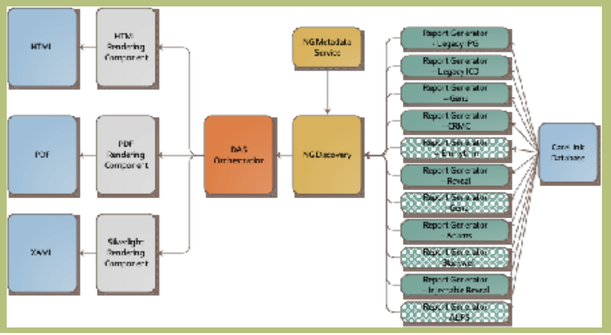
Medtronic

OTC

ADC







Fun Facts

- At Argonne National Labs outside Chicago, my father conducted experiments using CP-5. This sparked my interest in science and engineering.
- Of the 18 countries I have visited, 5 begin with the letter 'I' (there are only 9 in total).
- My Tesla Model 3 was on display at the State Fair for several days in 2018.

Hobbies

- Camping /Hiking
- Cycling
- Music
- Travel
- Electric vehicle & Renewable Energy advocacy

Our EV experience started in 2015 with leasing a BMW i3 and we have been 100% EV since March 2020.

BMW i3 charging at Carlton College in Northfield, MN

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2017 Chevy Bolt

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2018 Tesla Model 3

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2020 Chevy Bolt and 2020 Tesla Model Y (100% electric garage)

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Tesla Model Y towing Safari Condo Alto and charging at Supercharger

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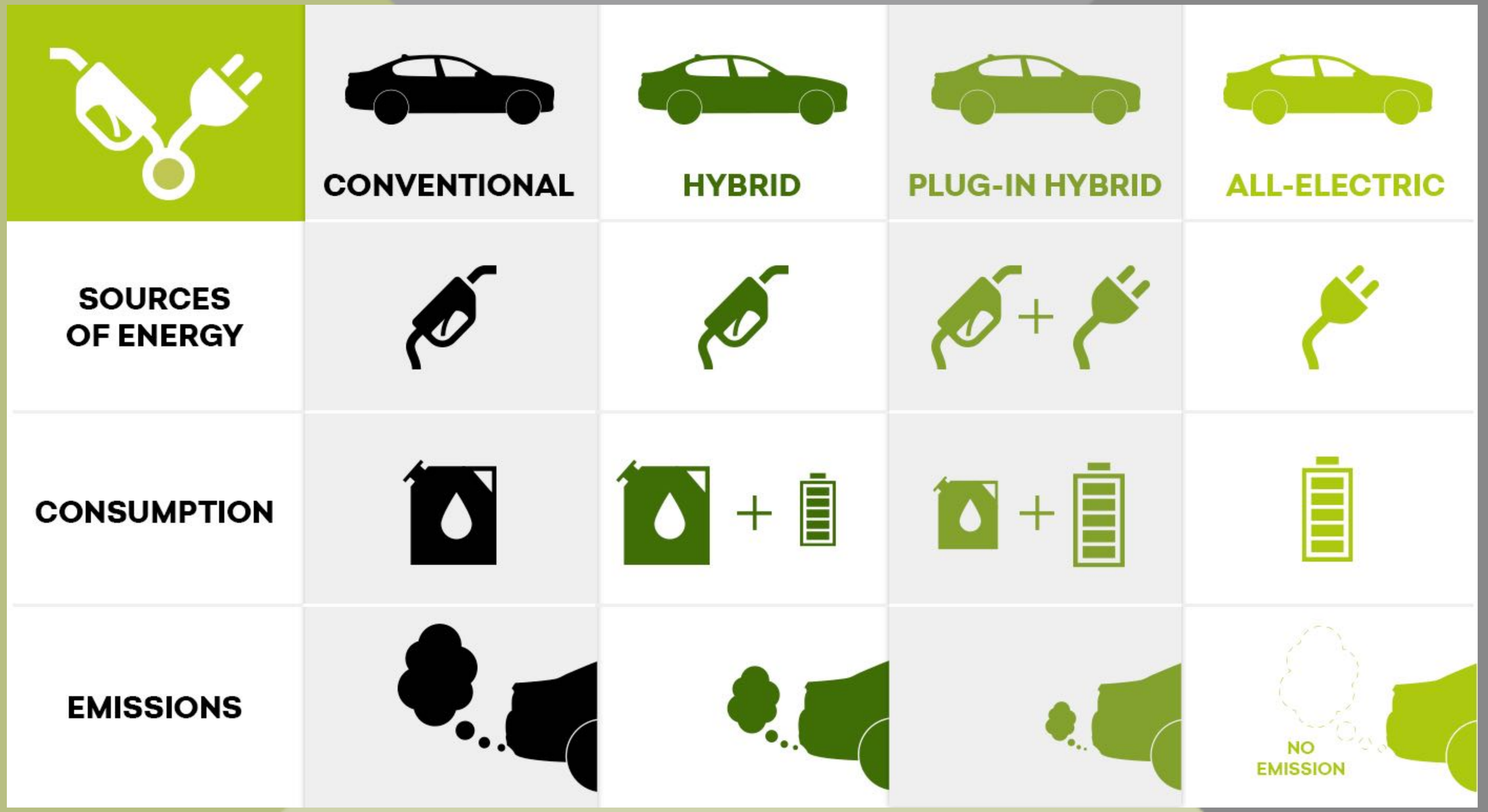
Topics

- Basics: Terms, Differences to Internal Combustion Engine Vehicles
- ~~Electricity: Power and Energy~~
- Charging ~~(How, How Long, When, Where)~~ Basics
- ~~Environmental and~~ Financial Cost Savings (including New and Used US EV tax credits)
- Electric Vehicle Models and Market

ELECTRIC VEHICLE BASICS

The source of energy for a vehicle is key to understanding it’s environmental impact. For example, hybrids are 100% fossil fuel powered.



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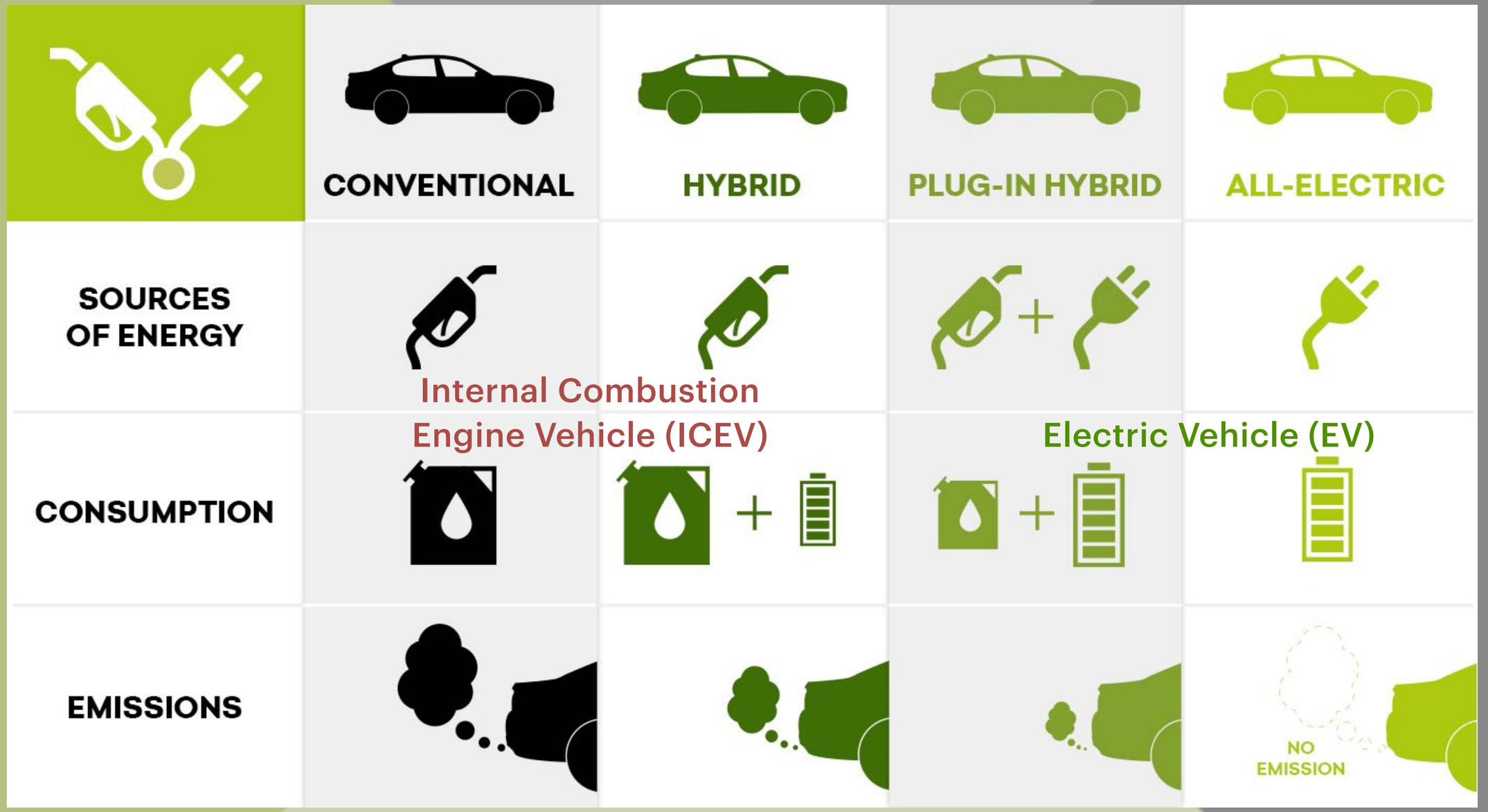

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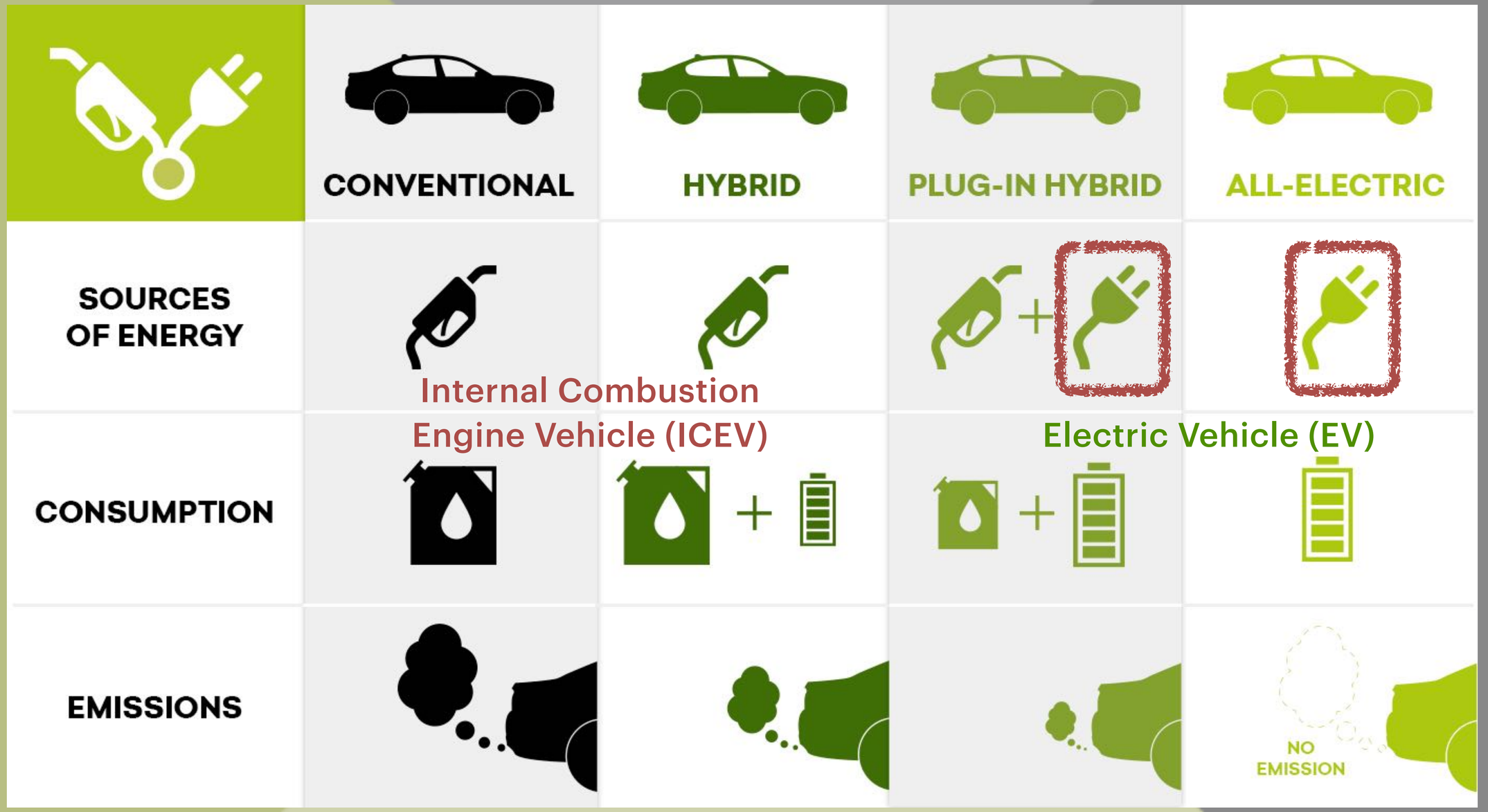

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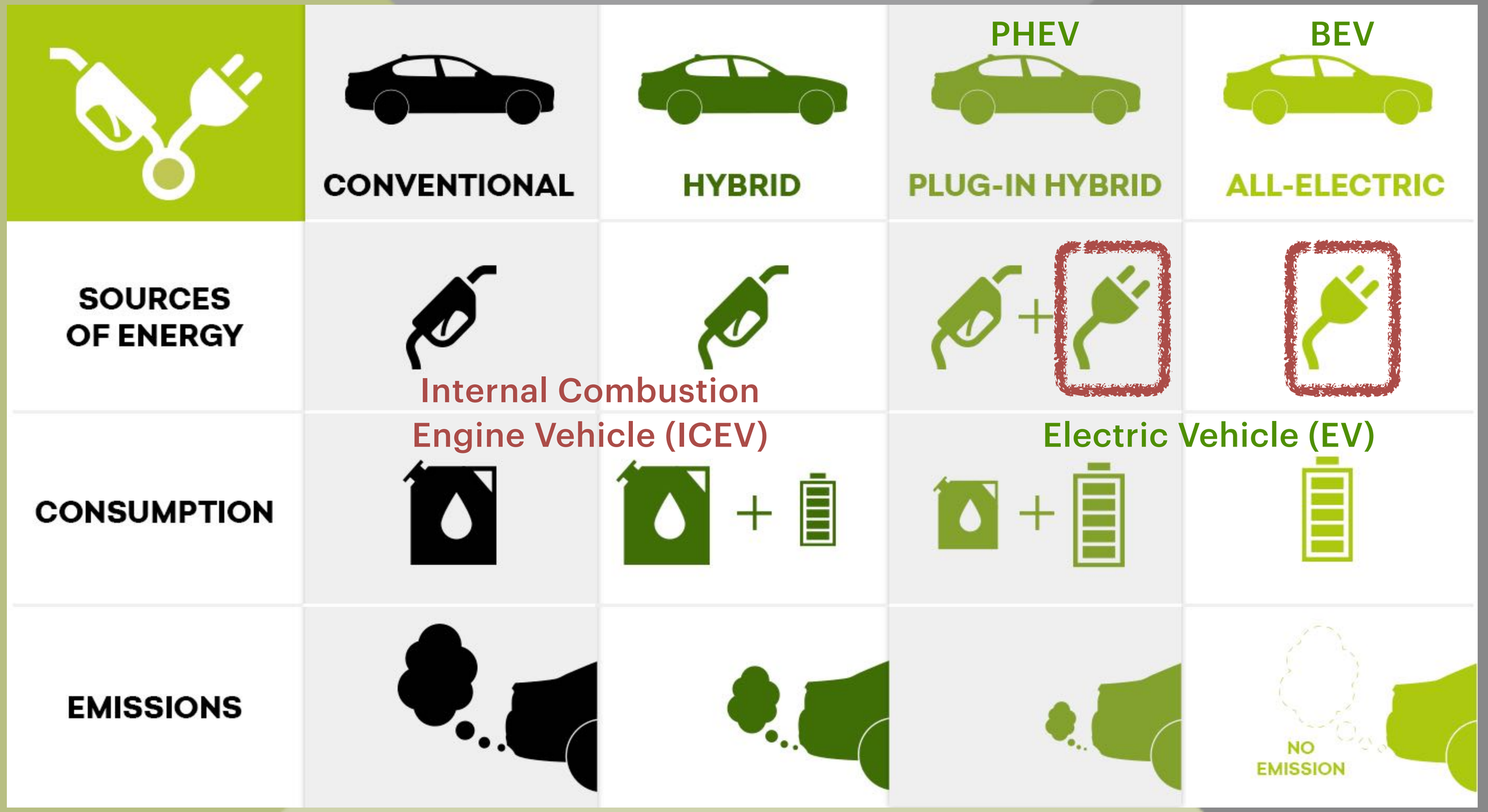

Comparison of Internal Combustion Engine (ICE) and Electric Vehicle—Design

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Torque curve		

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Health and safety impacts	Fuel and exhaust both toxic Fuel explosively flammable	No fuel, no tailpipe emissions Electricity source emissions vary but always cleaner than petrol

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Winter driving	Slower warm-up, idling wasteful, can’t idle in closed spaces	Fast warm-up Preheating in closed spaces Range loss when parked outside

ELECTRIC VEHICLE CHARGING

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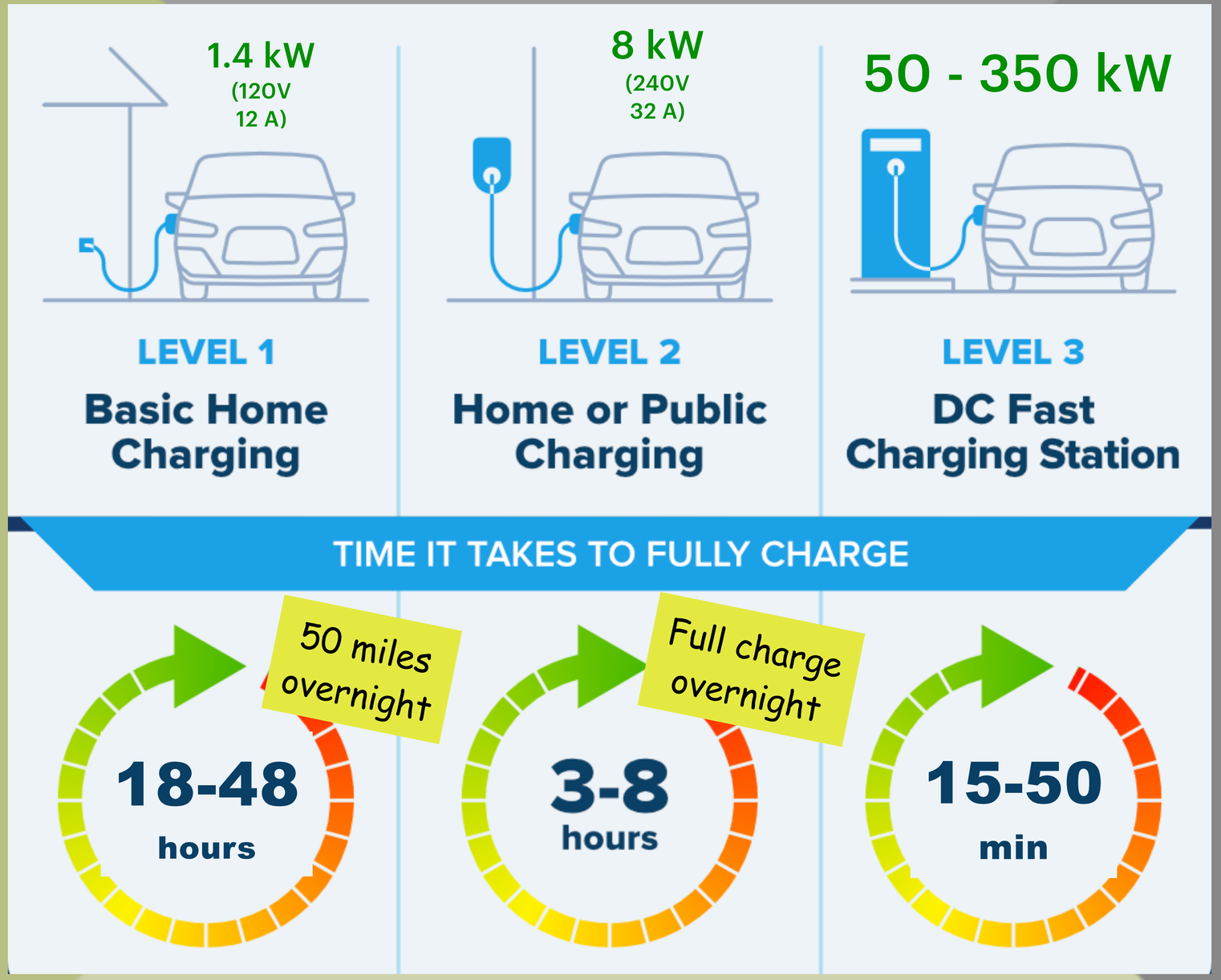

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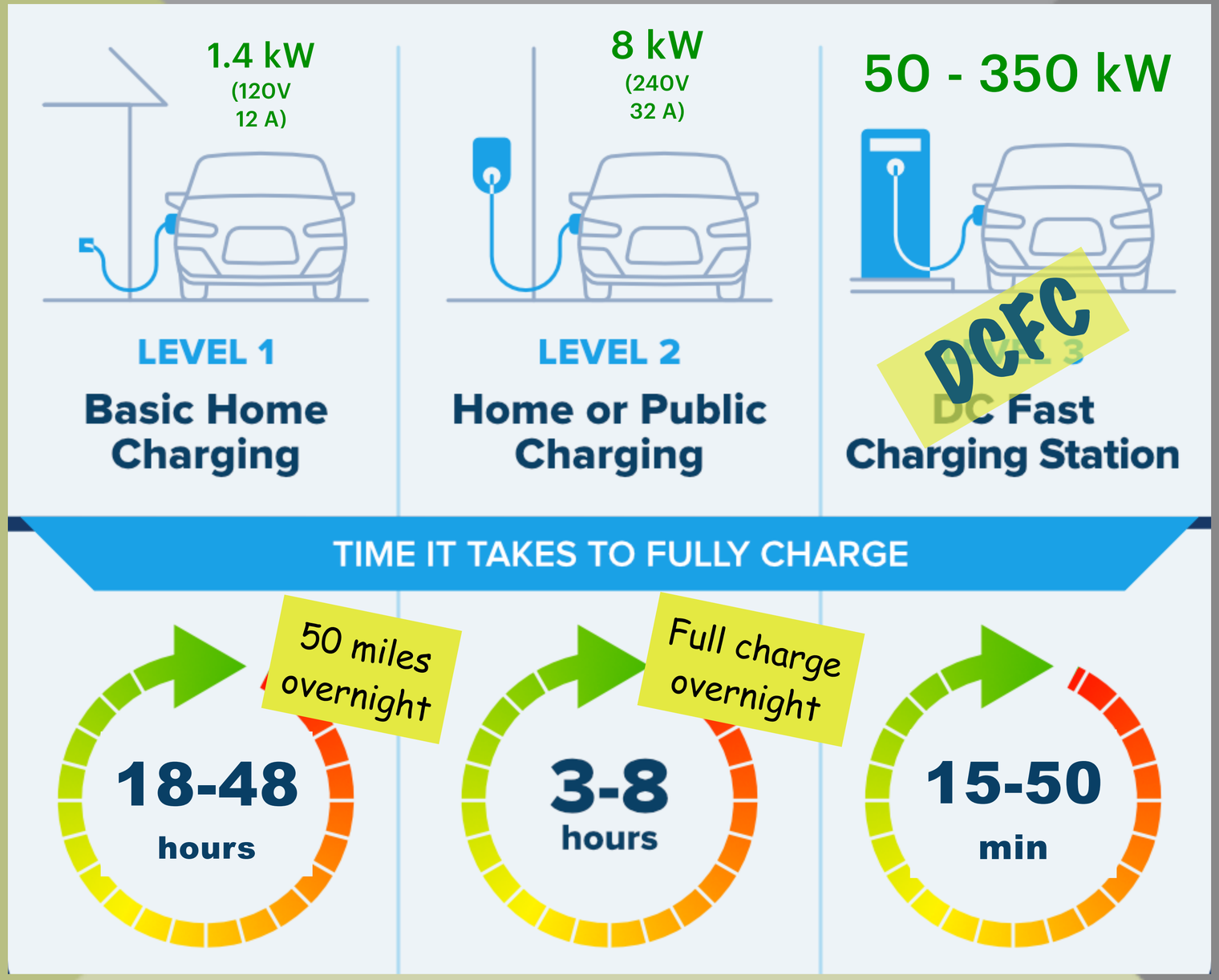

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CONNECTORS	LEVEL	ALL OTHER MAKES	TESLA
Wall outlets (Nema 515, Nema 520)	1	With EVSE	With EVSE
J1772 (SAE)	2	✓	With adapter
Nema 1450 (RV plug)		With EVSE	With EVSE
Tesla HPWC		With adapter	✓
SAE Combo CCS	3	✓	With adapter
Tesla supercharger		Brands adopting NACS SC locations with Magic Dock	✓

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Sources: https://www.thedrive.com/guides-and-gear/which-cars-nacs-charge-plugs
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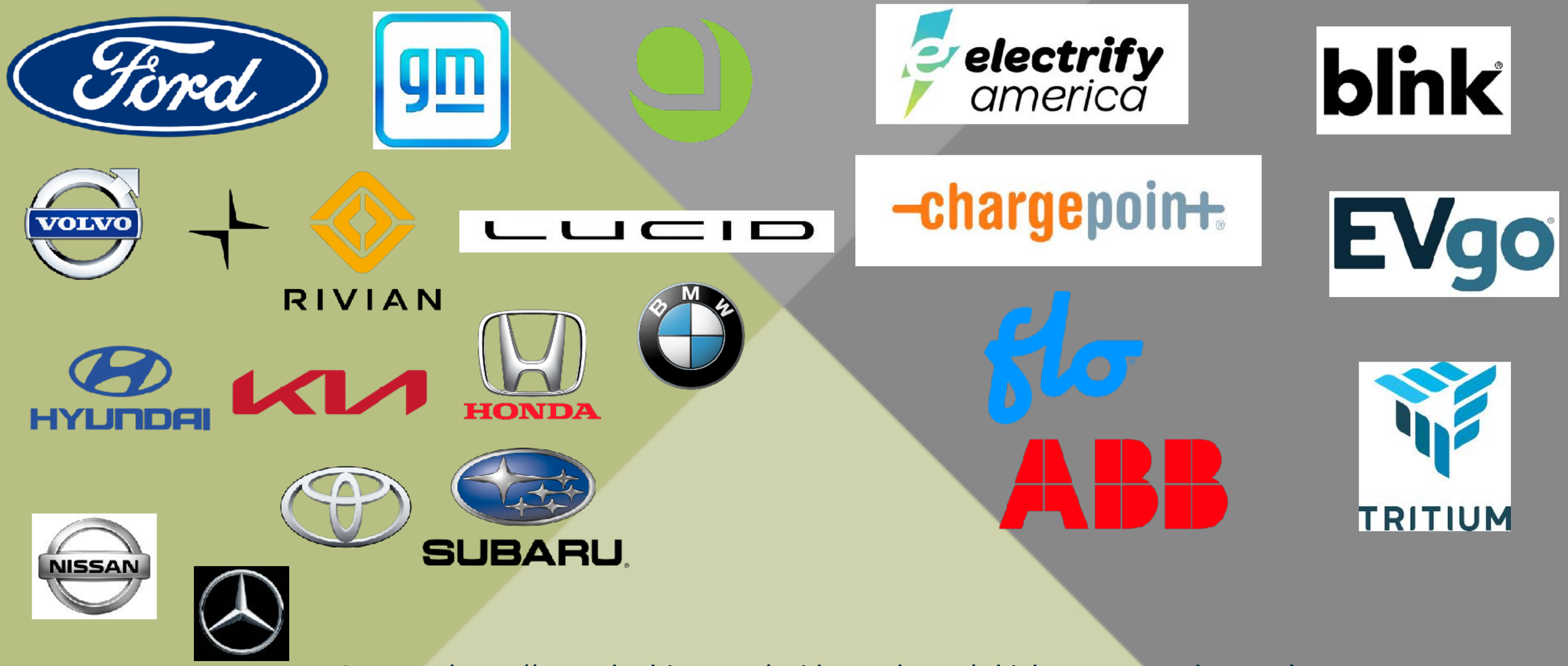

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RIVIAN

SUBARU

Standardized as J-3400 by SAE

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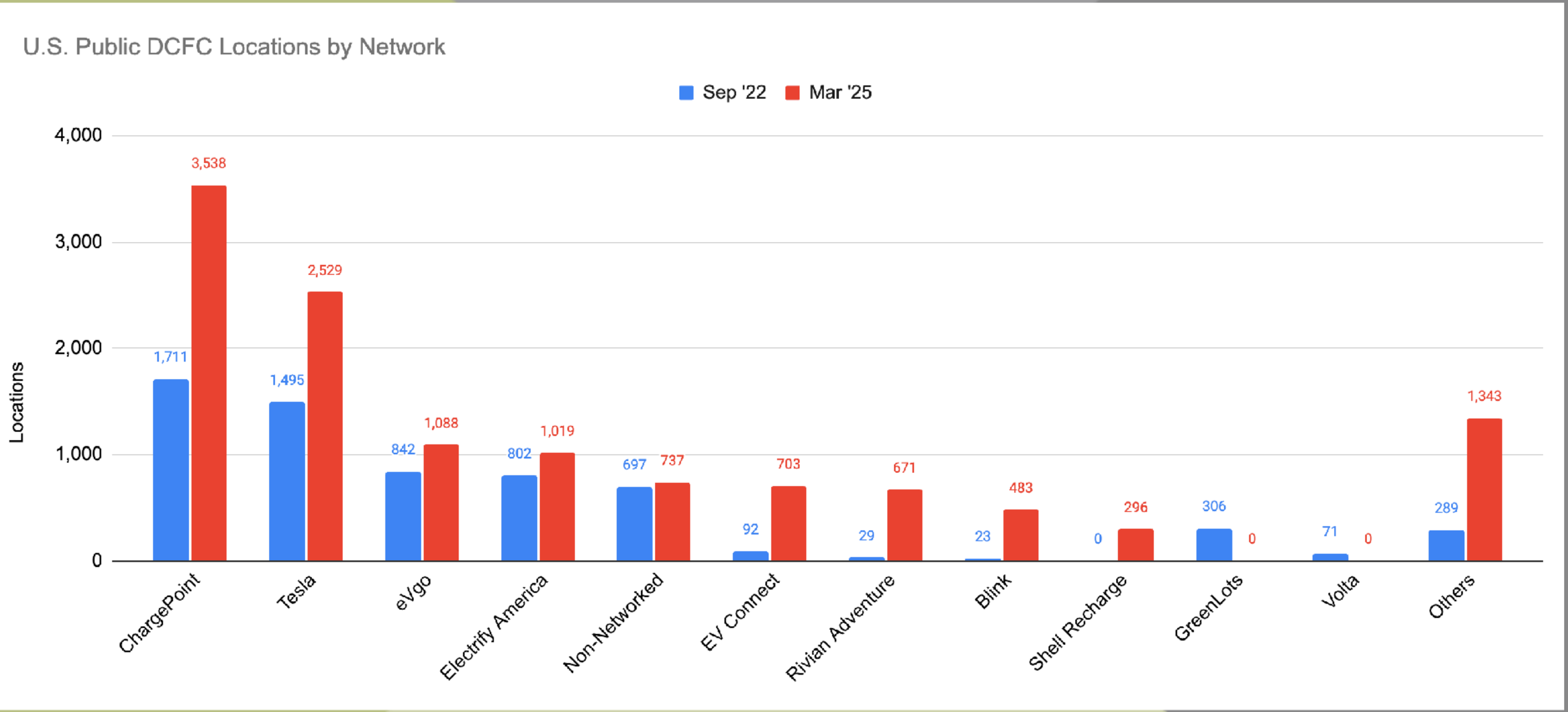
DC fast charging infrastructure is already robust and is in a high-growth mode. Tesla has fewer locations, but more connections / location.



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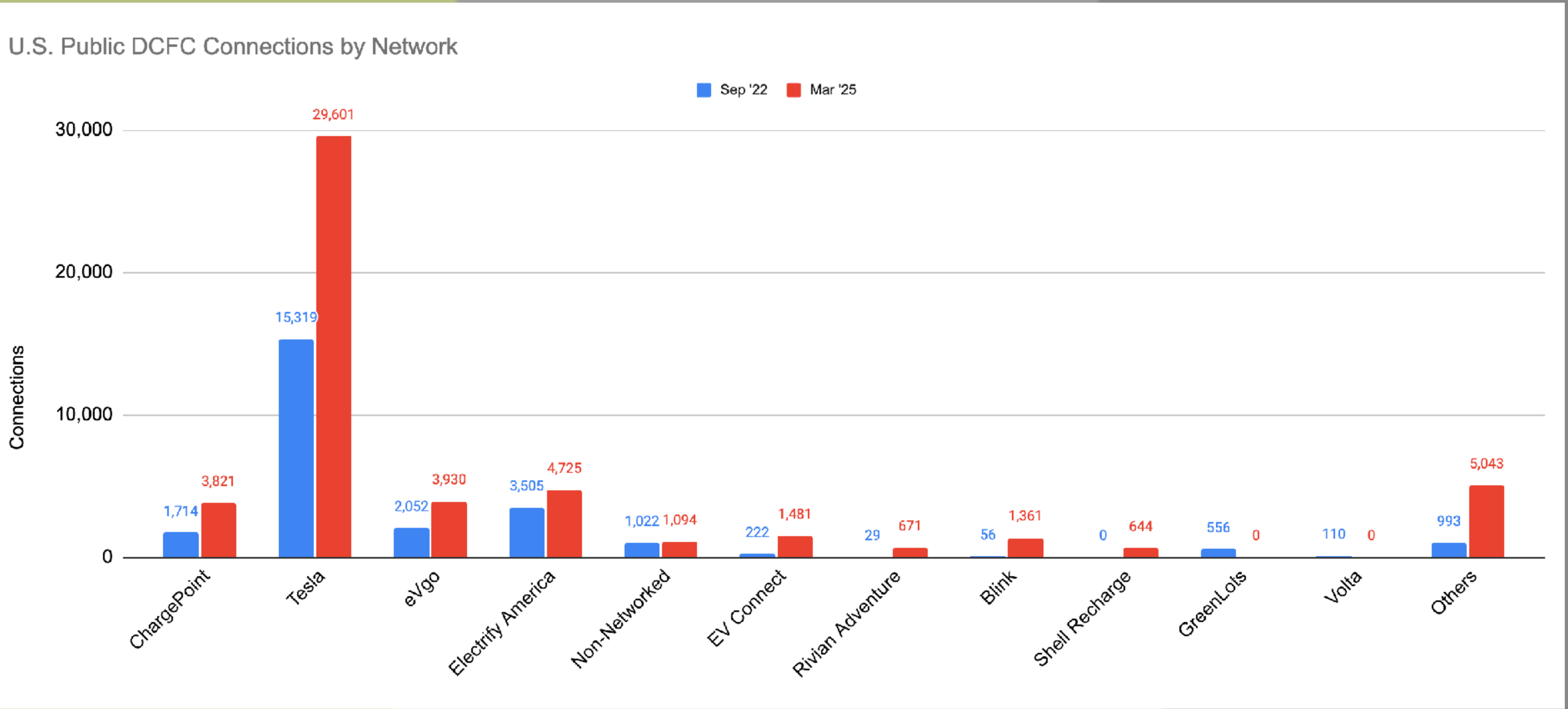

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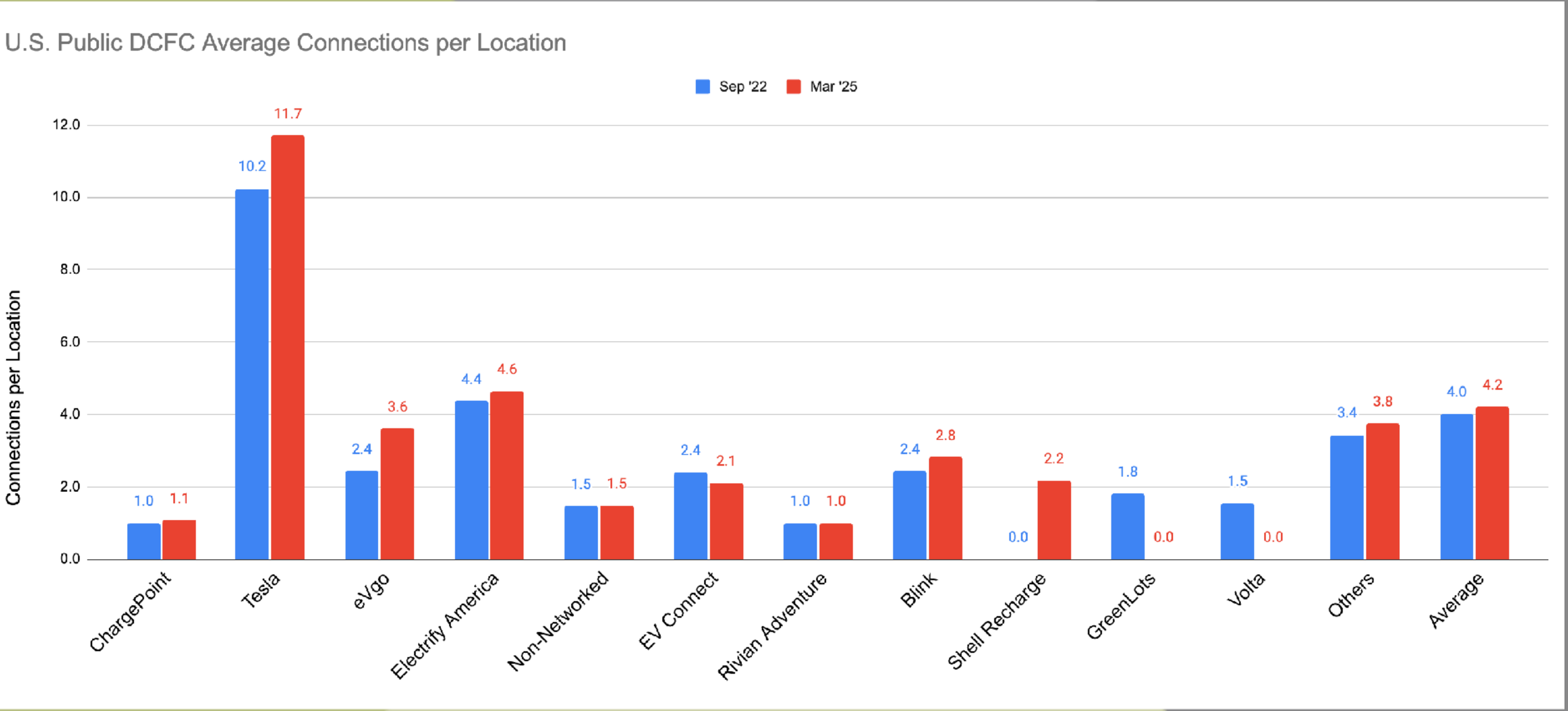
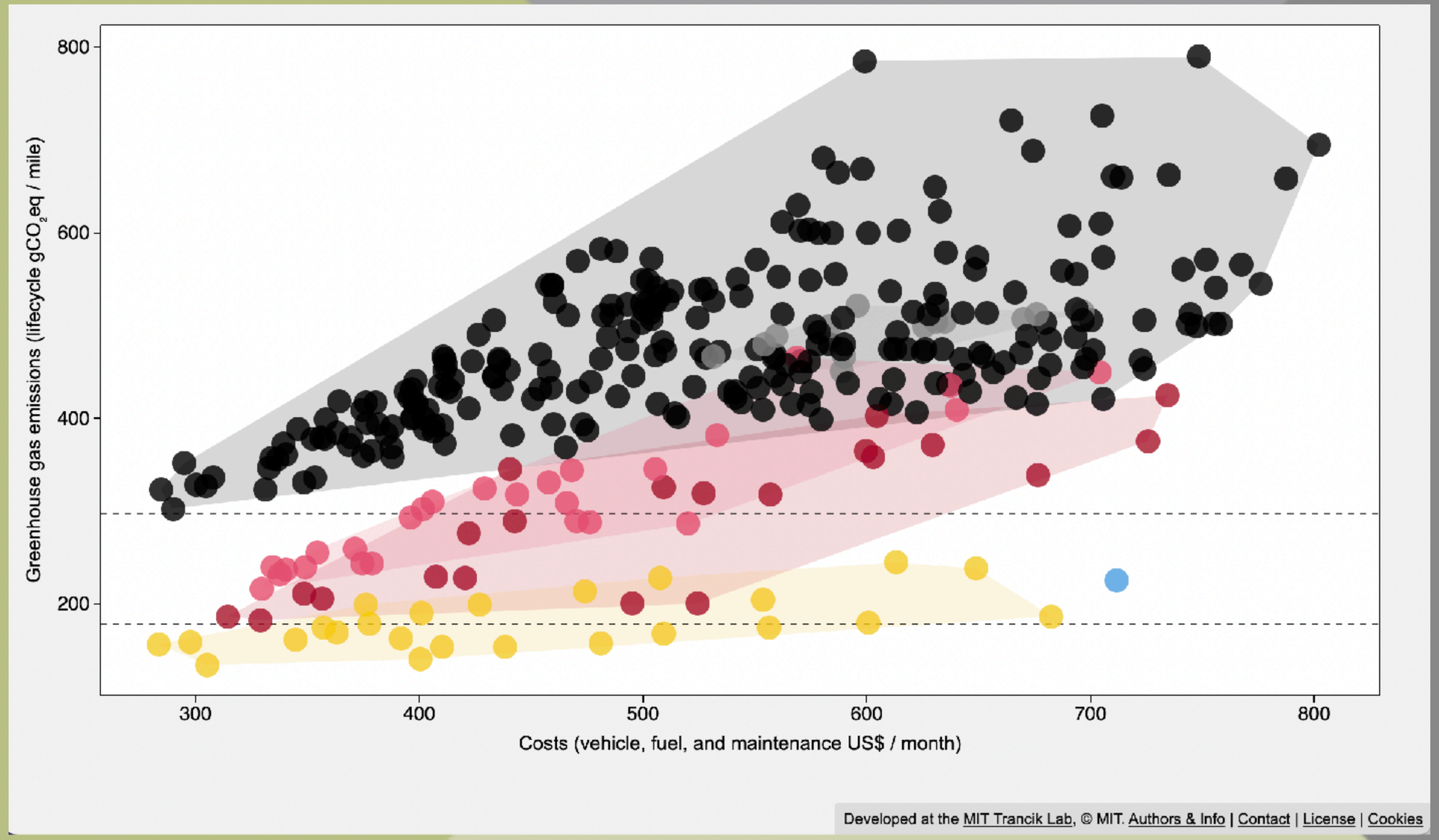


ELECTRIC VEHICLE ENVIRONMENTAL AND FINANCIAL COST SAVINGS

Lifecycle Greenhouse Gas Emissions and Cost / Mile for All Vehicle Fuel Types (Minnesota Gas Prices and Grid Emissions)



Data and methods

Greenhouse gas emissions account for the entire lifecycle, including vehicle production and battery production, supply chains raw materials, the fuel use cycle and vehicle disposal (GREET2), as well as the fuel production cycle (GREET1).

Note: other pollutants such as Nitrogen Oxides, Carbon Monoxide and particulates (PM2.5 and PM10) are **not** included.

Source: https://www.carboncounter.com/#!/explore

Inflation Reduction Act (IRA)—EV tax credit requirements

Income Limits for Purchase	Income Limit (New Car)	Income Limit (Used Car)
Married filing jointly	$300,000	$150,000
Head of Household	$225,000	$112,500
Single/Married Filing Separately	$150,000	$75,000

EV Purchase (New)	Tax Credit or Rebate
Vehicle Meets Critical Minerals Requirement	$3,750
Vehicle Meets Battery Components Requirement	$3,750
MAXIMUM TOTAL CREDIT per household:	**$7,500**
MSRP Price Caps	SUV/Truck: $80,000 Car: $55,000

EV Purchase (Used)	Tax Credit or Rebate
Eligible FCV or plug-in EV	30% of sale price, up to $4,000
Qualifications: - Must buy from a dealer - Purchase price under $25,000 - Can only claim once every three years - Car must be 2 years older than calendar year of purchase date	

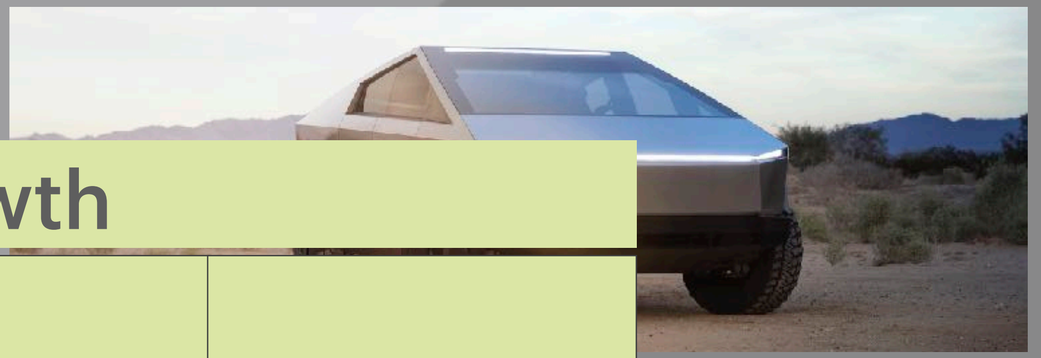
EV MODELS AND AVAILABILITY

Cars

SUVs & Vans

Trucks

Trucks



EV Model Growth

	2022	2025	Increase
Brands	20	30	**50%**
Models	30	69	**130%**

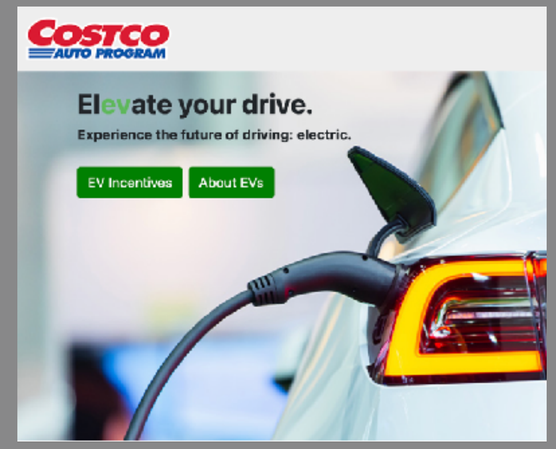
There are a number of EVs available for purchase in the US.

US EV Info List (January 2025) Page 1 of 8

American Lung Association. Clean Air Choice. | MINNESOTA CLEAN CITIES

Manufacturer									Range			Charging speed (miles/hr)			Performance				
Make	Model	Photo	Seating	EV Type	FWD/ RWD/ AWD	Base MSRP	Federal tax credit	Battery size (kWh)	Electric Range (miles)	Total Range (miles)	Charging rates (kW) L2/DCFC	Level 1 120V	Level 2 240V	DCFC 400+V	MPGe/ MPG	Top Spd (mph)	0-60 mph (sec)	Towing capacity (lbs)	Safety Ratings by IIHS
Acura	ZDX		5	BEV	RWD/ AWD	$64,500	Fueleconomy.gov	102	278-313	278-313	11/190	3	28	428	86-88	120-150	4.0-5.5	0	Not Rated
Alfa Romeo	Tonale eAWD		5	PHEV	AWD	$43,845	Fueleconomy.gov	16	33	360	6.6	3	15	N/A	77/29	128	5.6	0	Not rated
Audi	Q4 e-tron		5	BEV	AWD	$49,800	Fueleconomy.gov	82	265	265	11/150	3	31	282	95	112	5.8	2600	Top Safety Pick +
Audi	Q4 Sportback e-tron		5	BEV	AWD	$58,200	Fueleconomy.gov	82	242	242	11/150	3	31	282	95	112	5.8	2600	Top Safety Pick +
Audi	Q6 e-tron		5	BEV	RWD/ AWD	$63,800	Fueleconomy.gov	94	295-321	295-321	11/260	3	31	586	95-99	130	4.9-6.3	4400	Not Rated
Audi	Q8 e-tron (S)		5	BEV	AWD	$74,400	Fueleconomy.gov	106	285	285	9.6-19.2 /170	3	44	315	78	124-130	4.3-5.6	4000	Top Safety Pick +
Audi	Q8 e-tron Sportback (S)		5	BEV	AWD	$77,800	Fueleconomy.gov	106	300	300	9.6-19.2 /170	3	44	311	77	124-131	4.3-5.4	4000	Top Safety Pick +
Audi	e-tron GT		5	BEV	AWD	$125,000	Fueleconomy.gov	97	300	300	9.6/320	3	23	584	82	155	3.1-3.9	0	Not Rated
Audi	Q5 PHEV		5	PHEV	AWD	$58,500	Fueleconomy.gov	17.9	24	400	7.4	2	14	N/A	61/26	130	5	4400	Top Safety Pick +
BMW	i4		5	BEV	RWD/ AWD	$57,900	Fueleconomy.gov	81	227-307	227-307	11/195	4	33	463	80-109	140	3.7-5.5	0	Not Rated
BMW	i5		5	BEV	RWD/ AWD	$67,100	Fueleconomy.gov	81	240-295	240-295	11/195	4	33	463	85-105	120-130	3.7-5.7	0	Not Rated
BMW	i7		5	BEV	AWD	$105,700	Fueleconomy.gov	106	274-321	274-321	11/195	4	33	412	89	130	4.5	0	Not Rated
BMW	iX		5	BEV	AWD	$87,250	Fueleconomy.gov	112	284-309	284-309	11/195	3	28	393	83-86	124	3.6-4.4	0	Not Rated

This table is updated by Jukka Kukkonen, Shift2Electric. Photos and information sources: Manufacturers' websites and www.fueleconomy.gov **Get the latest version: www.EVInfoList.com**



References

- Alternative Fuels Data Center: How do Electric Vehicles Work?
- Find Us | Tesla (https://www.tesla.com/findus)
- Plugshare (https://www.plugshare.com/)
- Alternative Fuels Data Center: Data Download
- Carboncounter (MIT)
- Consumer Reports: EVs Offer Big Savings Over Traditional Gas-Powered Cars
- Aptera referral link

Thank You for your attention

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