ELECTRIC VEHICLE BASICS

Brian Anderson
Sep 12, 2022

BRIAN ANDERSON

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

39 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 (29), Daughter Louise (22)
- 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

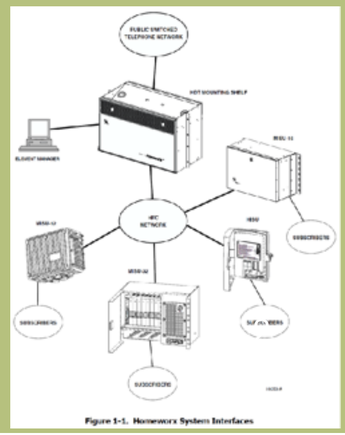
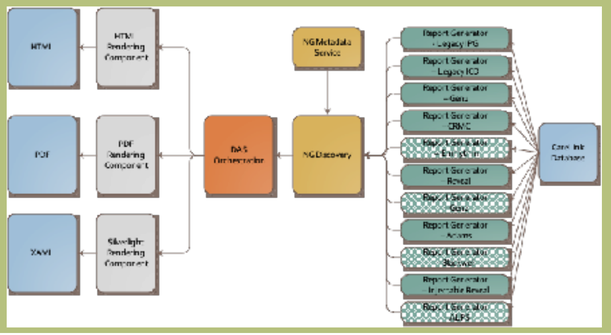


Figure 1-1. Homeworx System Interfaces



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).
- I love to talk to people about electric vehicles and renewable energy. One year, my Tesla Model 3 was on display at the State Fair for several days.

Hobbies

- Camping /Hiking
- Cycling
- Tree Care Advisor
- 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

Topics

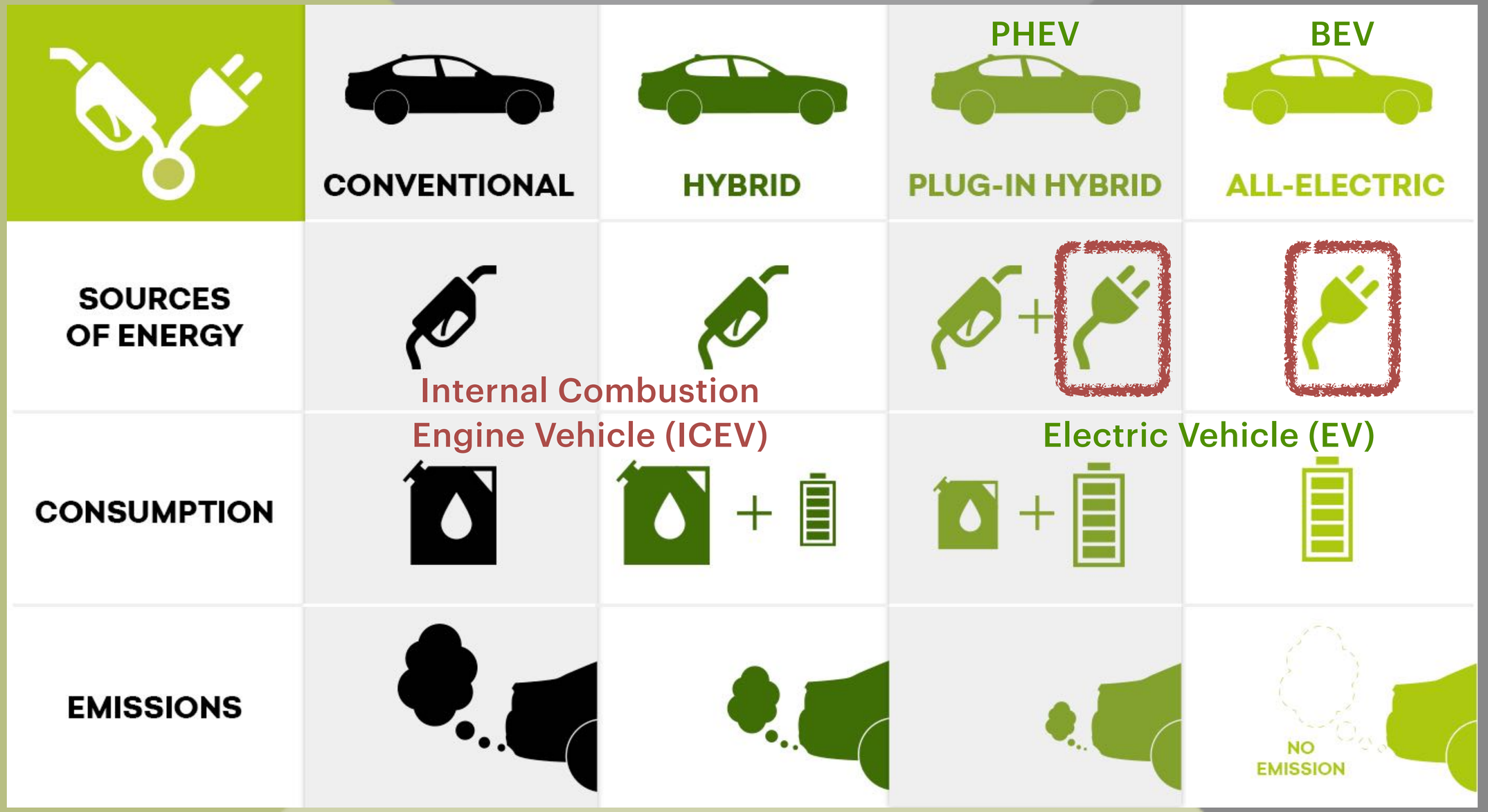
- Basics: Terms, Differences to Internal Combustion Engine Vehicles
- Charging (How, How Long, When, Where)
- Buying and Market (including changes to US EV tax credit)

ELECTRIC VEHICLE BASICS

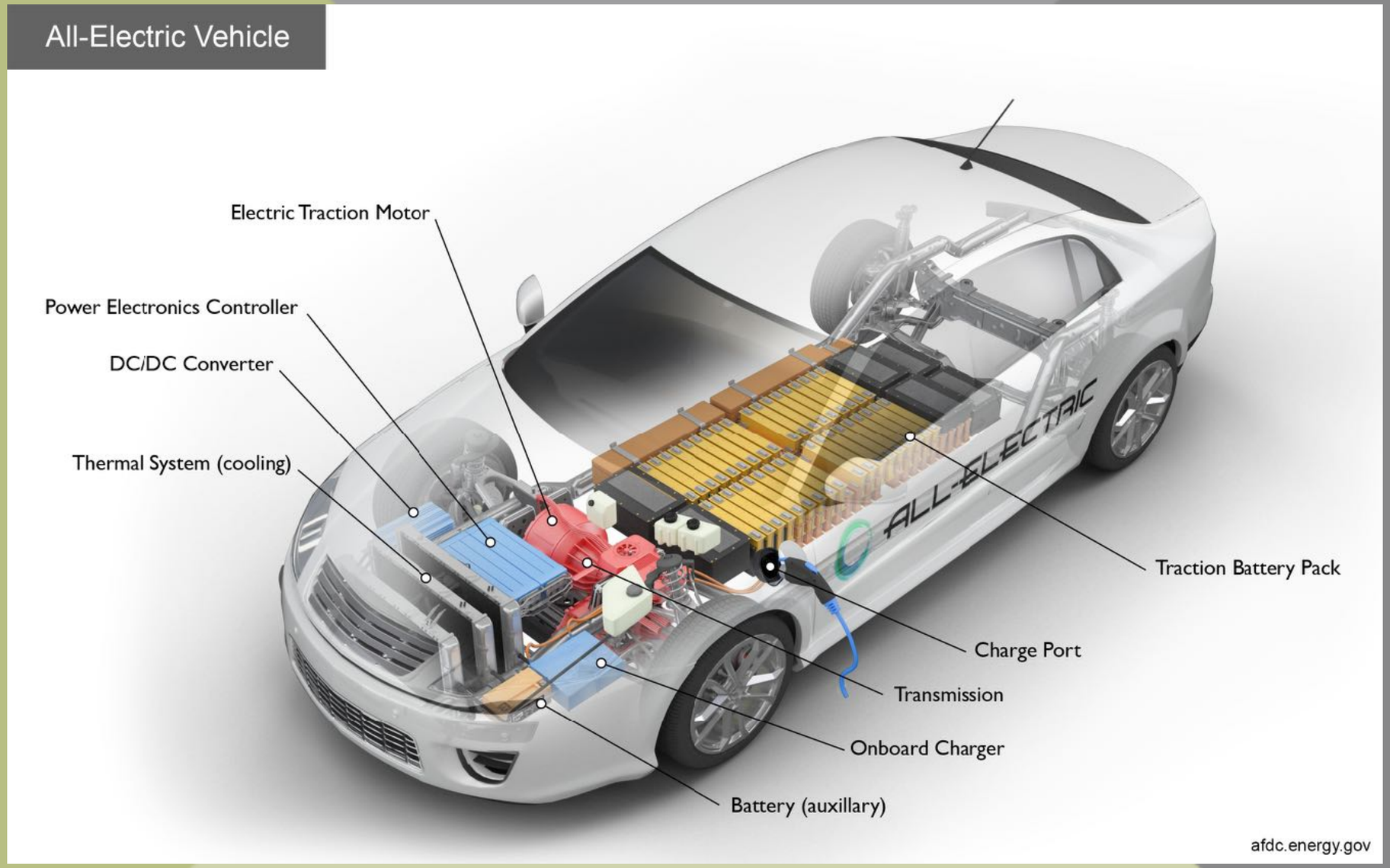
There are some new terms to learn when talking about the future of personal transportation.

Term	Definition
BEV	Battery Electric Vehicle
CCS	Combined Charging Standard
DCFC	DC Fast Charger
EV	Electric Vehicle
EVSE	Electric Vehicle Service Equipment (for L1 & L2 AC charging)
ICE(V)	Internal Combustion Engine (Vehicle)
PHEV	Plug-in Hybrid Electric Vehicle

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



Electric Vehicle Components



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

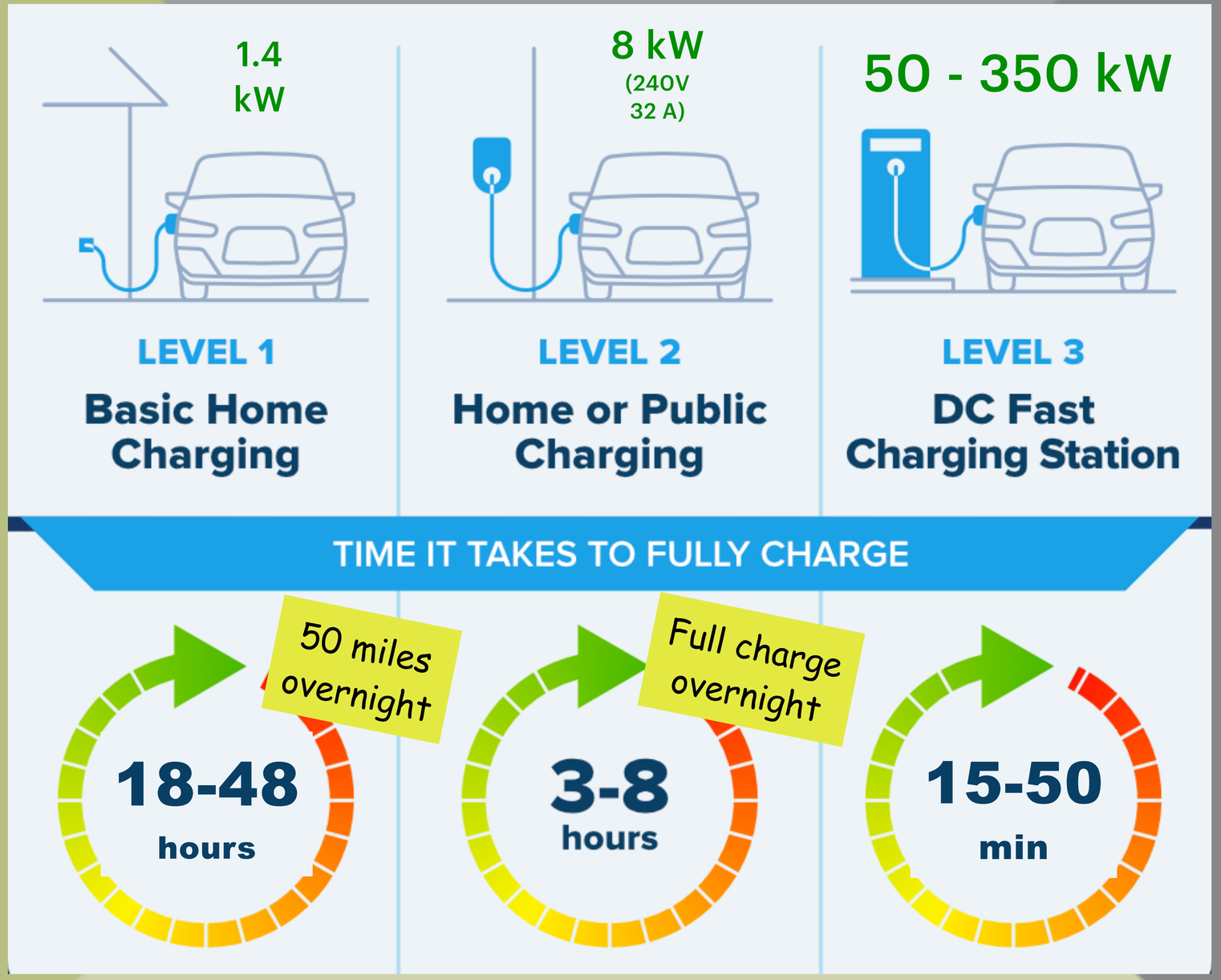
	ICE	EV
Powertrain Components	2000	20
Maintenance	👨🏼‍🔧 👨🏼‍🔧 👨🏼‍🔧	👨🏼‍🔧
Energy efficiency (source to wheels)	15-25%	75-85%
Energy cost / mile	$$$	$
Torque curve		

Comparison of Internal Combustion Engine (ICE) and Electric Vehicles—Ownership Experience

	ICE	EV
Recharging / refueling at home	Not available	Plug in at home
Recharging / refueling locally	Local gas station	Public DCFC or L2 (AC)
Recharging / refueling on road trips	Truck stop	DCFC (car nav)
Driving	Baseline	Instant torque No engine noise Low center of gravity Regenerative braking
Health and safety impacts	Fuel and exhaust both toxic Fuel explosively flammable	No fuel, no emissions
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
Getting to remote destinations	Plan to have enough fuel	Plan to have enough charge

ELECTRIC VEHICLE CHARGING

There are three levels of Electric Vehicle charging.



There are several types of Electric Vehicle charging equipment.

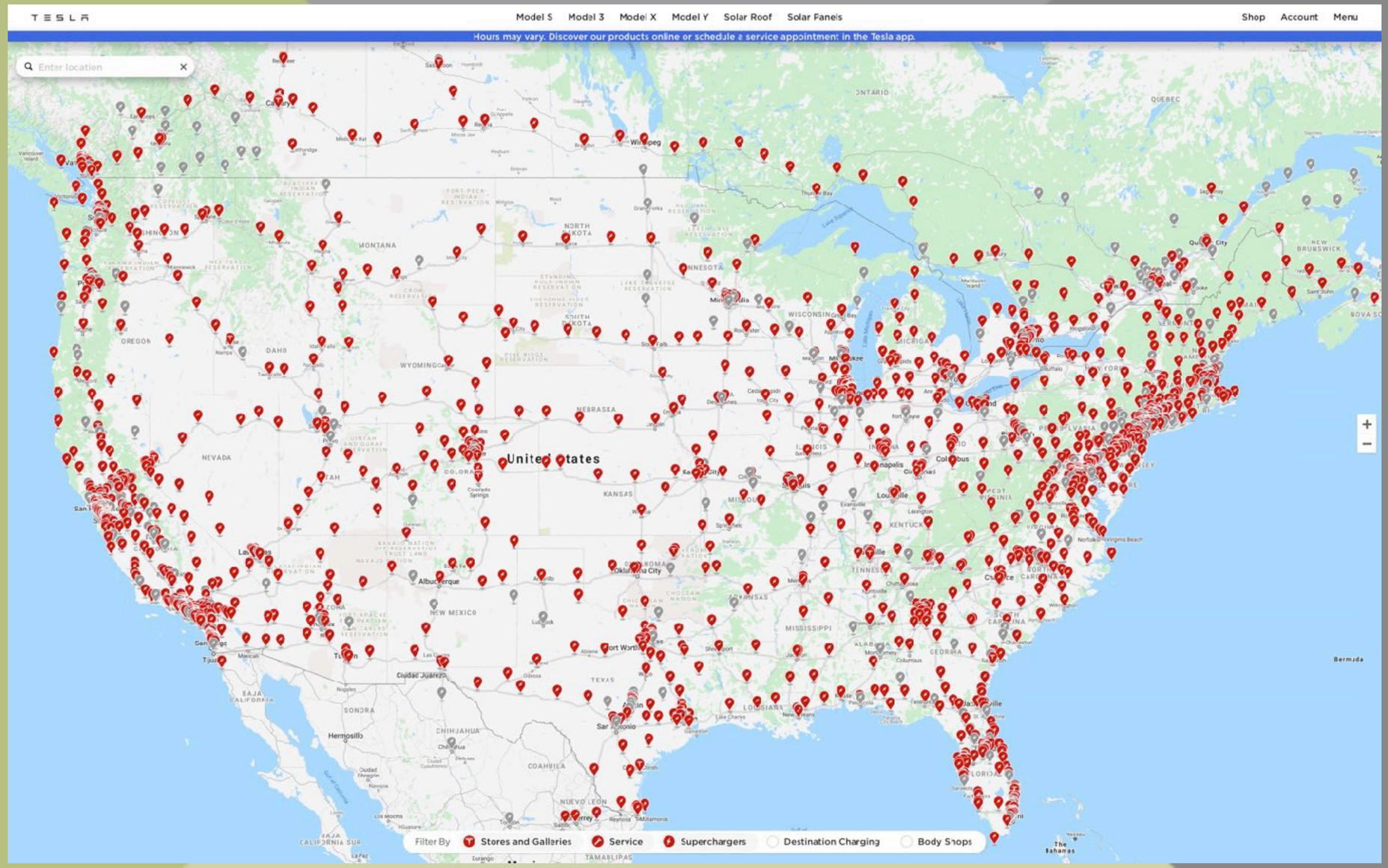
Portable EVSE
(home charger)
L1-L2
120V or 240V AC

Public EVSE L2 240V AC

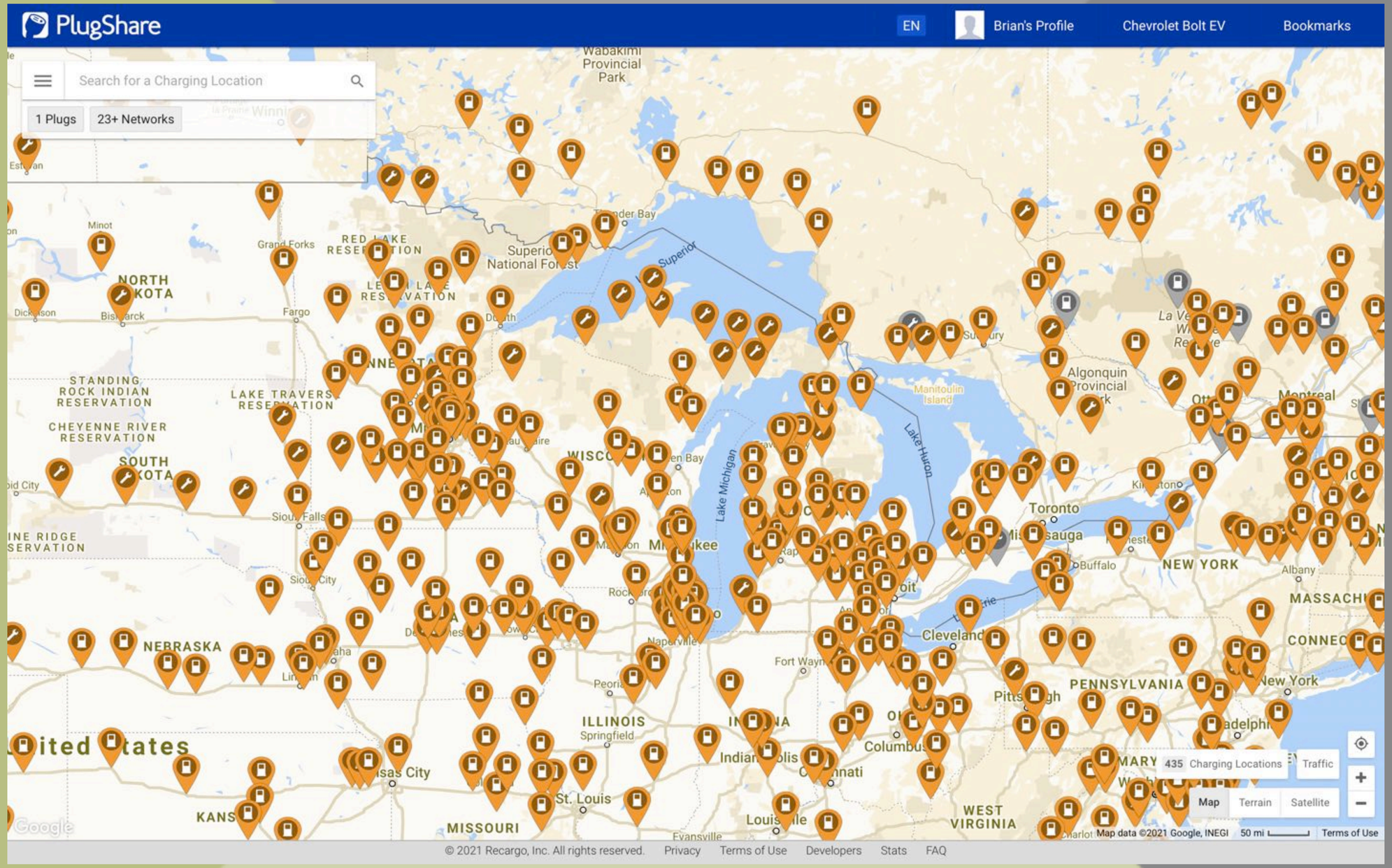
Public DC Fast Charger
(Electrify America)
L3 - Main Battery DC Voltage

CONNECTORS	LEVEL	ASIAN MAKES	US / EU MAKES	TESLA
Wall outlets (Nema 515, Nema 520)	1	With adapter	With adapter	With adapter
Port J1772	2	✓	✓	With adapter
Nema 1450 (RV plug)		With adapter	With adapter	With adapter
Tesla HPWC		✗	✗	✓
CHAdeMO	3	✓	✗	With adapter
SAE Combo CCS		✗	✓	✗
Tesla supercharger		✗	✗	✓

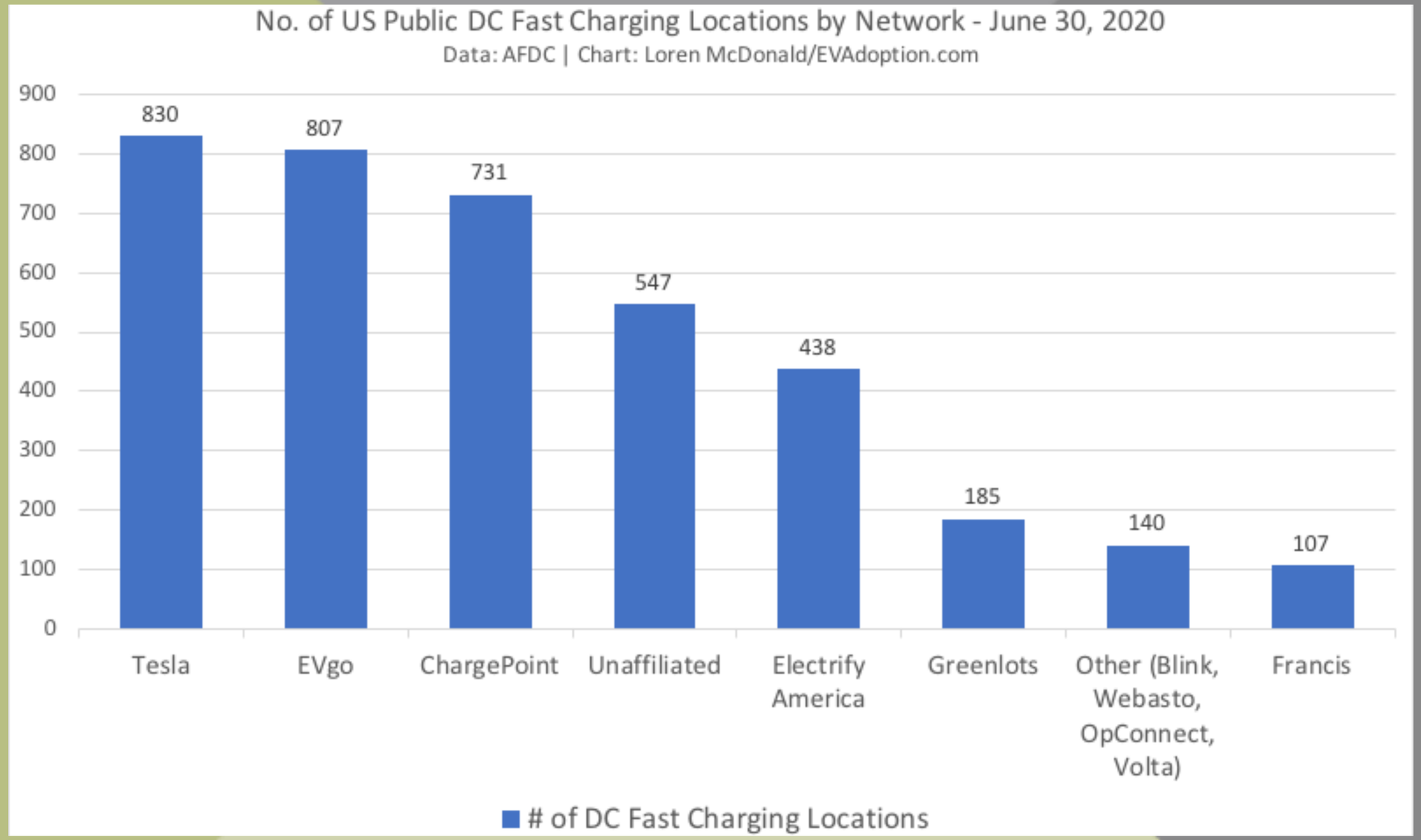
The Tesla charging network provides convenient travel to any location via the in-car navigation and automatic billing for energy.



Third party networks also cover the US and are expanding rapidly.



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



ELECTRIC VEHICLE BUYING AND MARKET

Inflation Reduction Act (IRA)—EV credit requirements

- Vehicle assembled in North America, effective on passage
- Manufacturer caps in place until Jan 1, 2023 (Tesla and GM)
- Battery assembly (half of credit) and “critical” materials (other half of credit):
  - No “foreign entities of concern”
  - Sliding percentage by year of assembly / processing in North America
- Price caps: Cars $55,000, Trucks/Vans/SUVs $80,000
- Income limits: Single $150,000, Head of household $225,000, Joint $300,000

Source: https://techcrunch.com/2022/09/02/a-complete-guide-to-the-new-ev-tax-credit/

MYTH: EVs are more expensive to own and operate than equivalent ICEVs.

Lifetime savings of Best Selling EVs under $50,000 compared to Best Selling & Top Rated ICE vehicles in each EV's class

Consumer Reports

EV model and trim	Leaf E+ S+	Bolt LT	Prius Prime LE	Clarity PHEV	Mach E Select	RAV4 Prime SE	Escape PHEV SE	Model 3 SR Plus	Model Y LR
Best Selling	Civic Hatchback LX			Camry LE	RAV4 LE			330i	RX 350 FWD
Top Rated	Elantra GT automatic			Legacy 2.5	CX5 Sport			A4	QX50 Pure

Source: https://www.consumerreports.org/hybrids-evs/evs-offer-big-savings-over-traditional-gas-powered-cars/

Several models have been for sale in MN for years and have used model availability.

2021 Nissan LEAF (2011)

Many new EV models have been introduced or are in the pipeline. 2022 is the year of the electric pickup!

Mustang Mach-E (Now)

News Sources - where can I find out more and stay current?

- InsideEVs: insideevs.com
- CleanTechnica: cleantechnica.com
- Electrek: electrek.co
- GreenCarReports: www.greencarreports.com/news/electric-cars
- EV Obsession: evobsession.com

Source: EV News | Shift2Electric: www.shift2electric.com/evnews

Resources

- Alternative Fuels Data Center: How do Electric Vehicles Work?
- Deloitte: Electric vehicles Setting a course for 2030
- ICCT: A global comparison of the life-cycle greenhouse gas emissions of combustion engine and electric passenger cars
- EVadoption: EVGo and GM Partner to Add 2,700 New Fast Chargers Over the Next Five Years
- Consumer Reports: EVs Offer Big Savings Over Traditional Gas-Powered Cars
- Available EV Models

Thank You for your attention

brian@letsgo0.com
www.letsgo0.com