



Electric vehicles and charging infrastructure: Why and how?



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Presentation description and objectives:

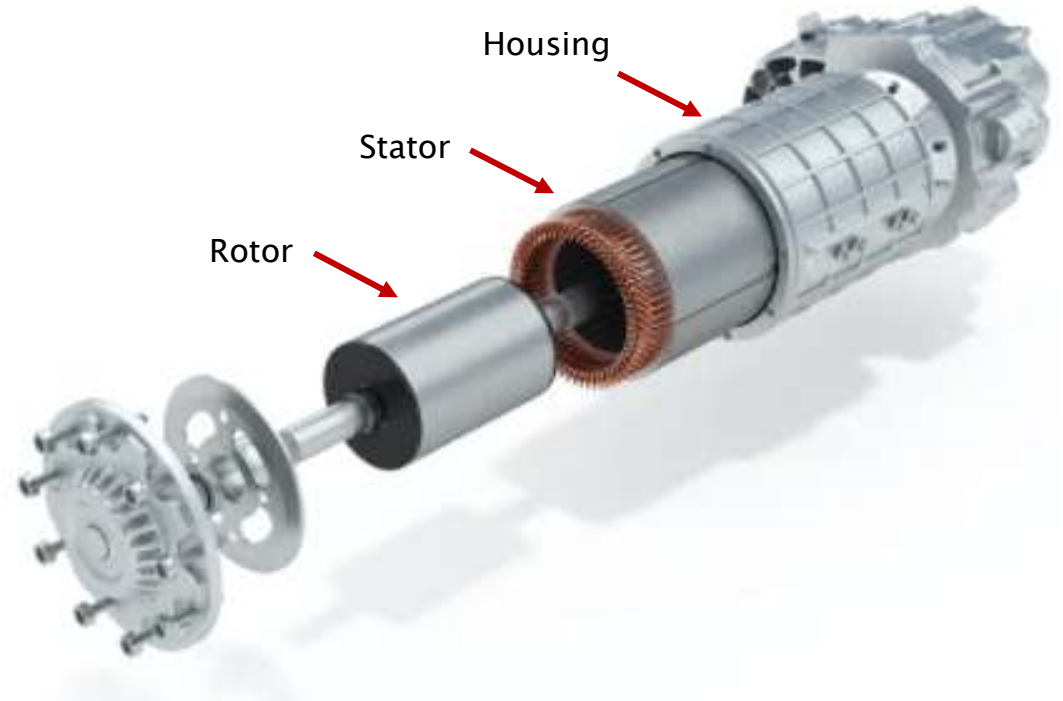
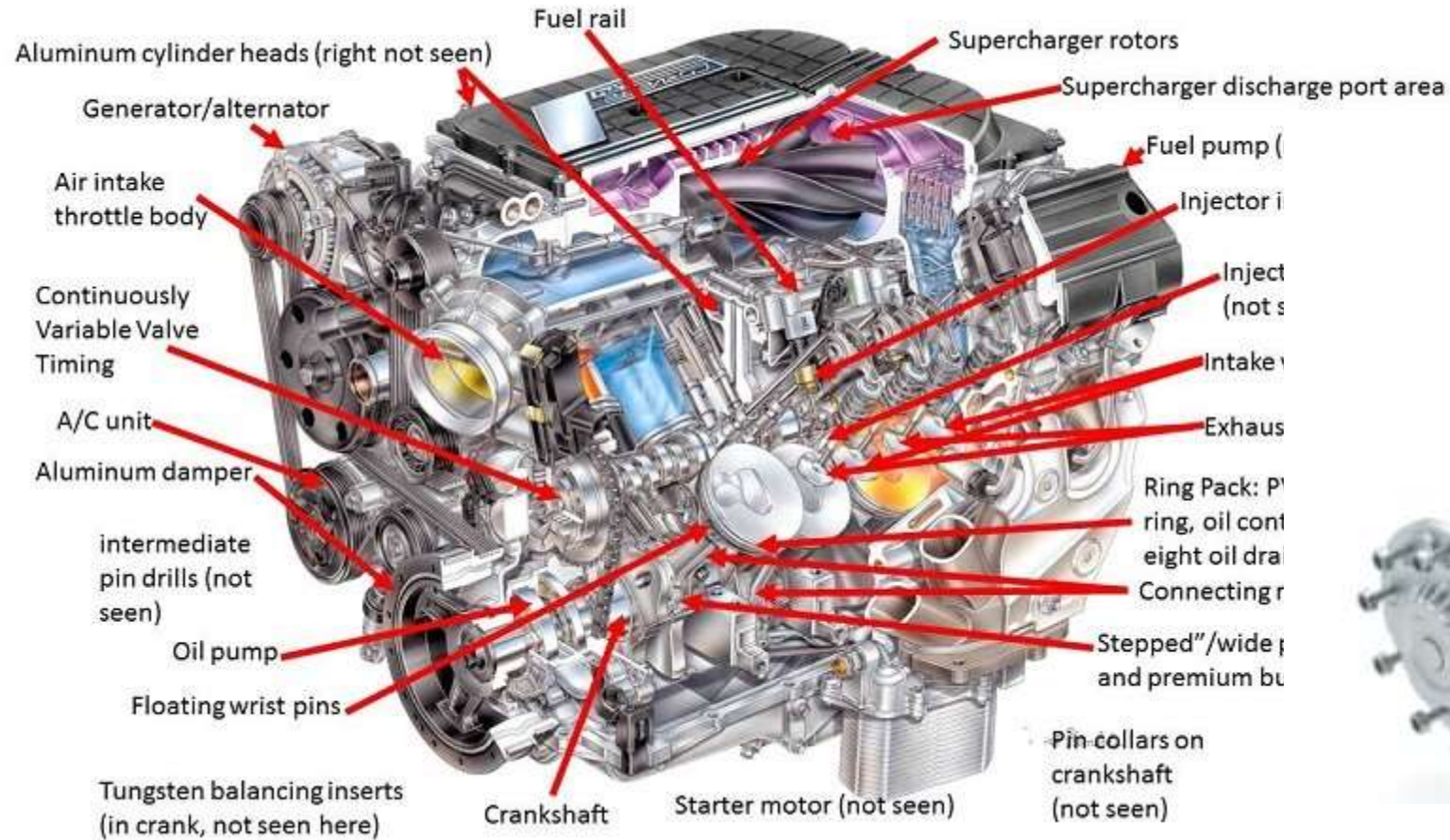
Presentation Description:

Electric Vehicles (EVs) provide a new opportunity for cleaner and more efficient transportation. Current surveys show that about 30% of people would consider an EV as their next vehicle, and auto manufacturers are bringing new, exciting options to the market at a rapid pace. Most EV charging happens overnight at home, so all residential properties including apartment buildings and condominiums will need to get EV ready. We will also need charging at hotels, grocery stores, shopping centers, parks and by highways. Different locations will require different solutions and we will talk about all that at this workshop.

Learning Objectives:

1. Participants will know basic technologies, electric vehicle models and the latest market developments
 2. Participants will know how people use and charge EVs and the effects on energy consumption and GHG emissions
 3. Participants will be able to calculate EV energy consumption and charging costs.
 4. Participants will learn about different charging options and how those choose right charging levels for the use case.
 5. Participants will be able to use cost effective, safe and future-proof approaches in their projects.
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Internal Combustion Engine vs. Electric Motor



Technology advancements

Battery tech advancement

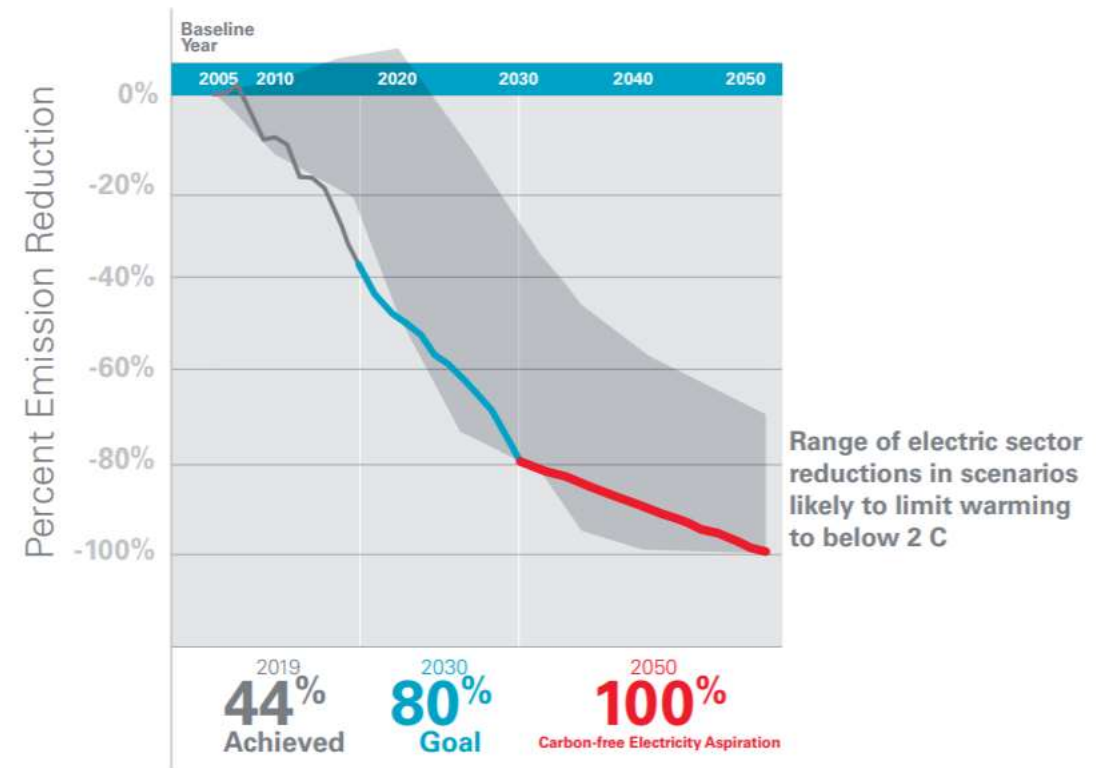
Lithium-ion battery price survey results (volume-weighted average)



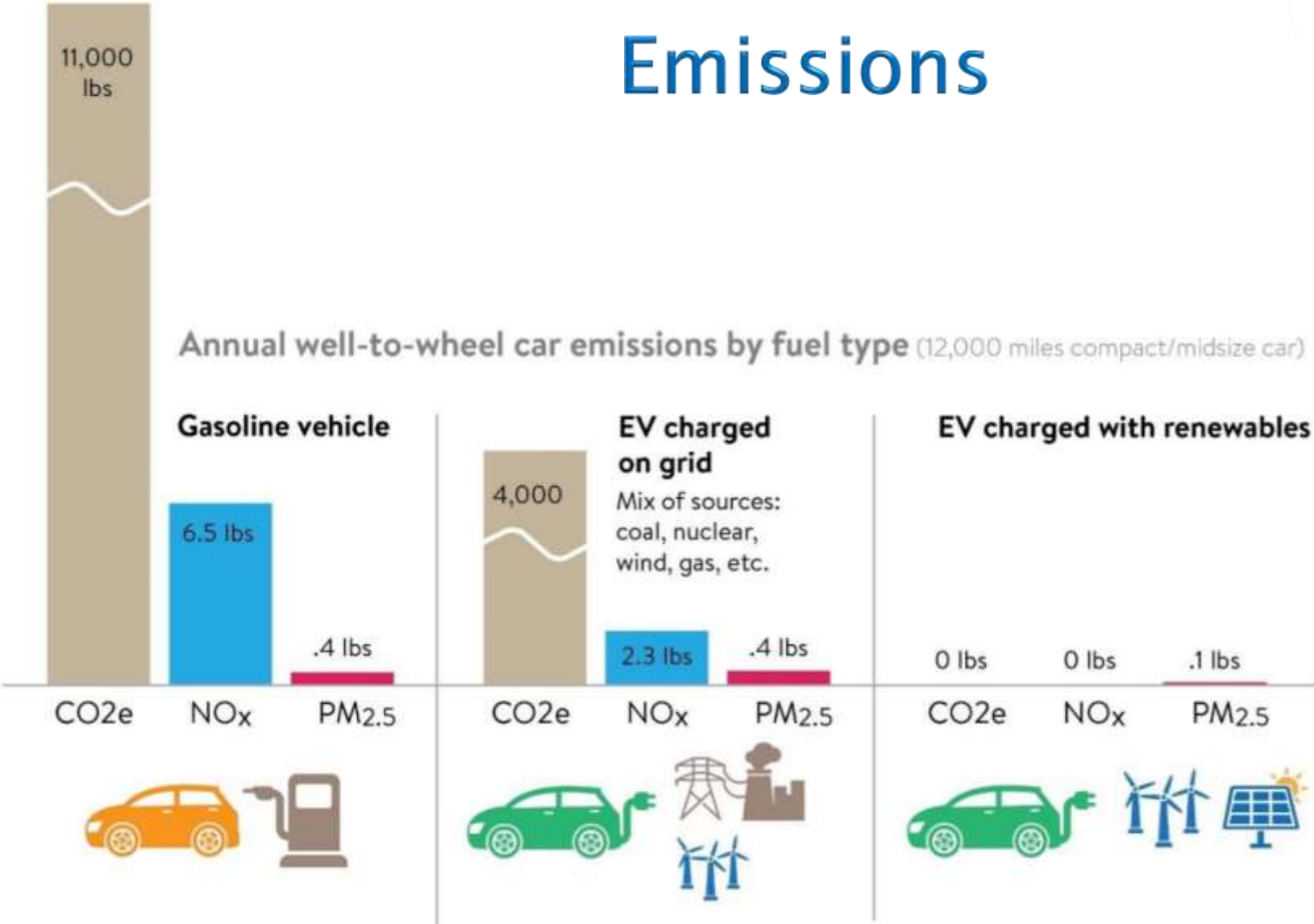
BloombergNEF

Shift to renewable electricity

Xcel Energy's carbon emissions

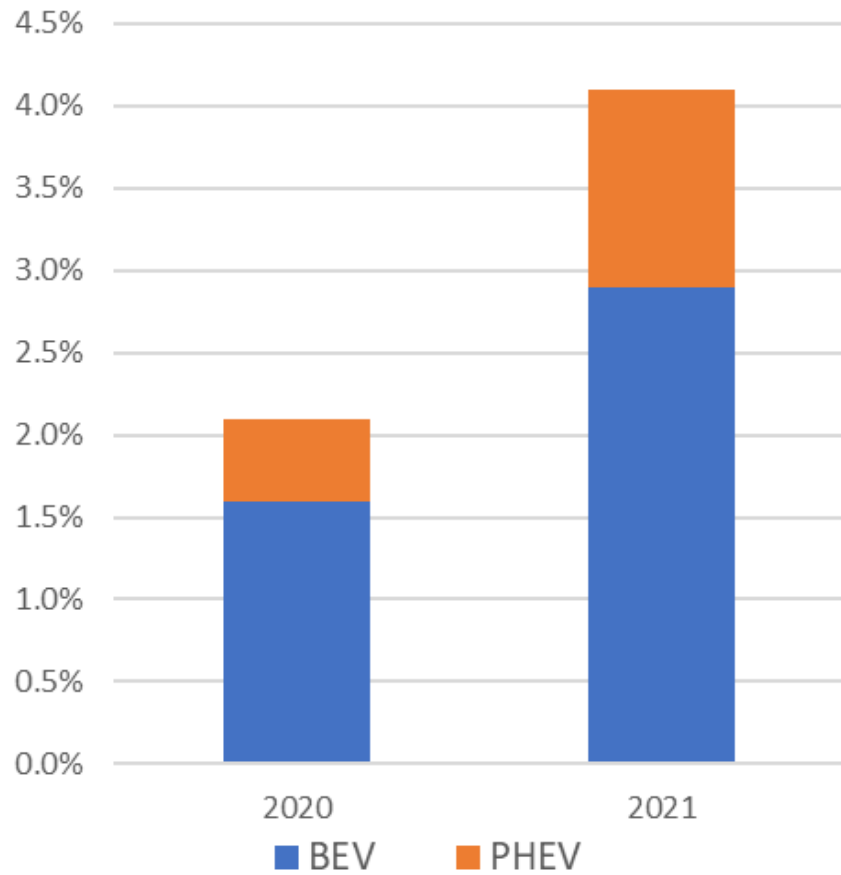


Emissions



Source: MOVES2014a and 2014 EPA National Emissions Inventory Database

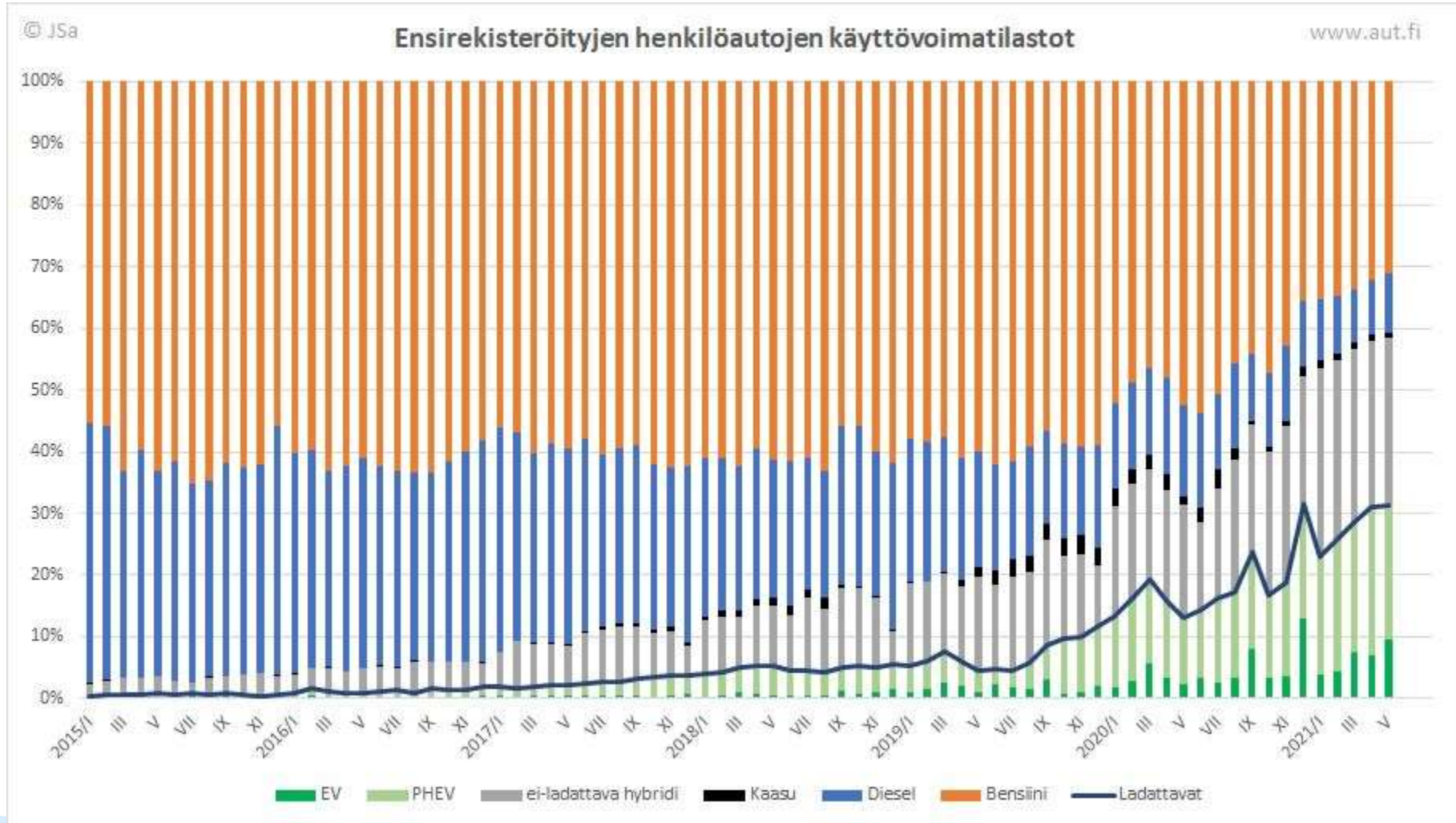
US EV Sales 2020-2021



12 most sold EV models in 2021

1	Tesla Model Y	172,700
2	Tesla Model 3	128,600
3	Jeep Wrangler 4xe	28,000
4	Toyota RAV4 Prime	27,707
5	Ford Mustang Mach-E	27,140
6	Toyota Prius Prime	25,042
7	Chevrolet Bolt/EUV	24,803
8	Volkswagen ID4	16,742
9	Nissan Leaf	14,239
10	Audi e-tron and Sportback	10,921
11	Porsche Taycan	9,419
12	Tesla Model S	9,100

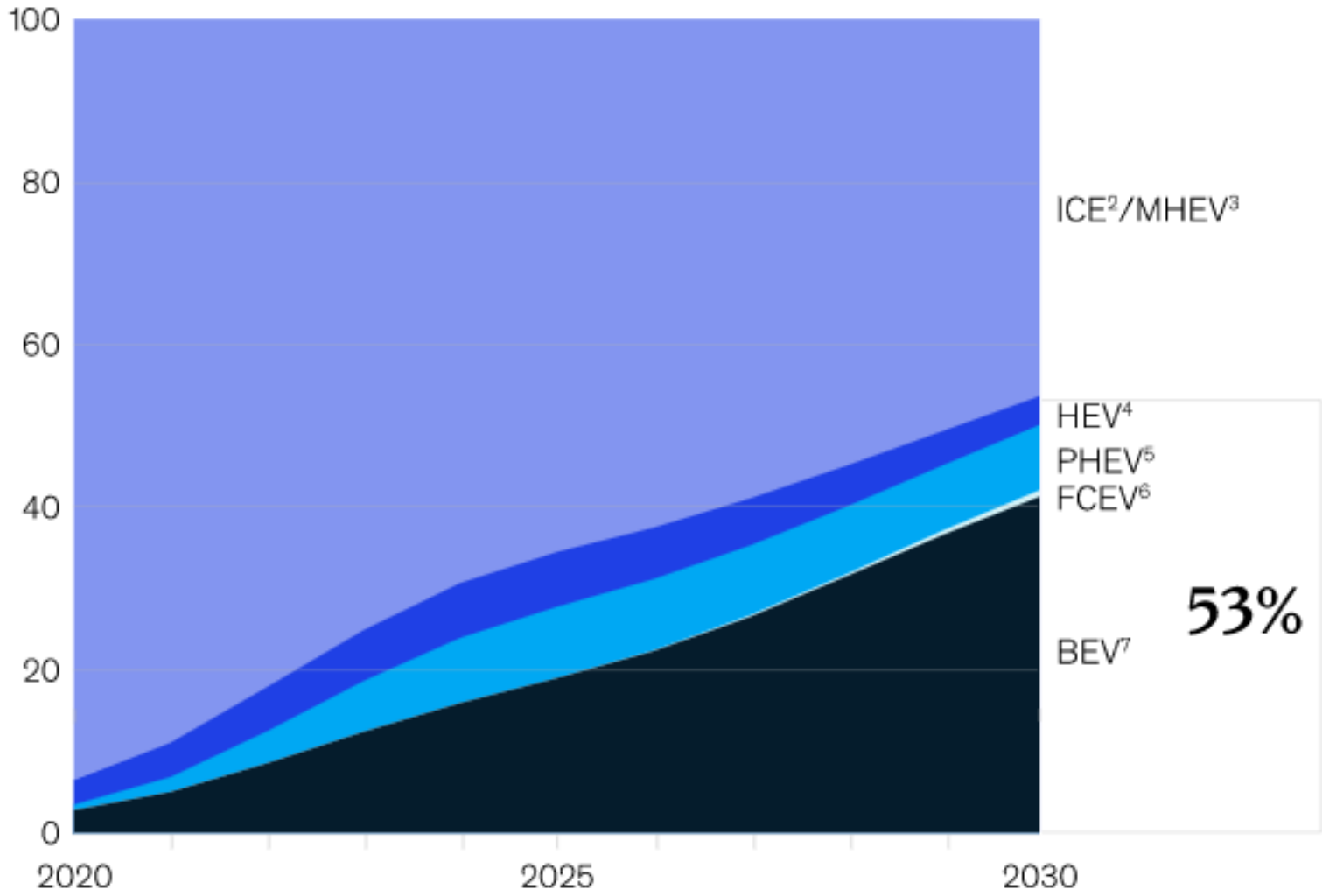
EV adoption in Finland



If electric-vehicle adoption continues to accelerate, EVs are likely to account for more than half of all US passenger car sales by 2030.

US new light-vehicle sales,¹
% of total sales

McKinsey
& Company



Range has changed!



Jeep Wrangler 4xe, BMW 330e, Mitsubishi Outlander PHEV Chrysler Pacifica PHEV, Honda Clarity PHEV, Volvo XC 90 Recharge



Tesla Model X, Lucid Air, Mercedes EQS and Tesla Model S



Ford Mustang Mach-e, Tesla Model Y and 3



Volvo XC 40 Recharge, Audi e-tron, Volkswagen ID4 Chevrolet Bolt



Nissan Leaf 2012

Nissan Leaf 2018

2019 Leaf Plus

0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360 380 400

miles

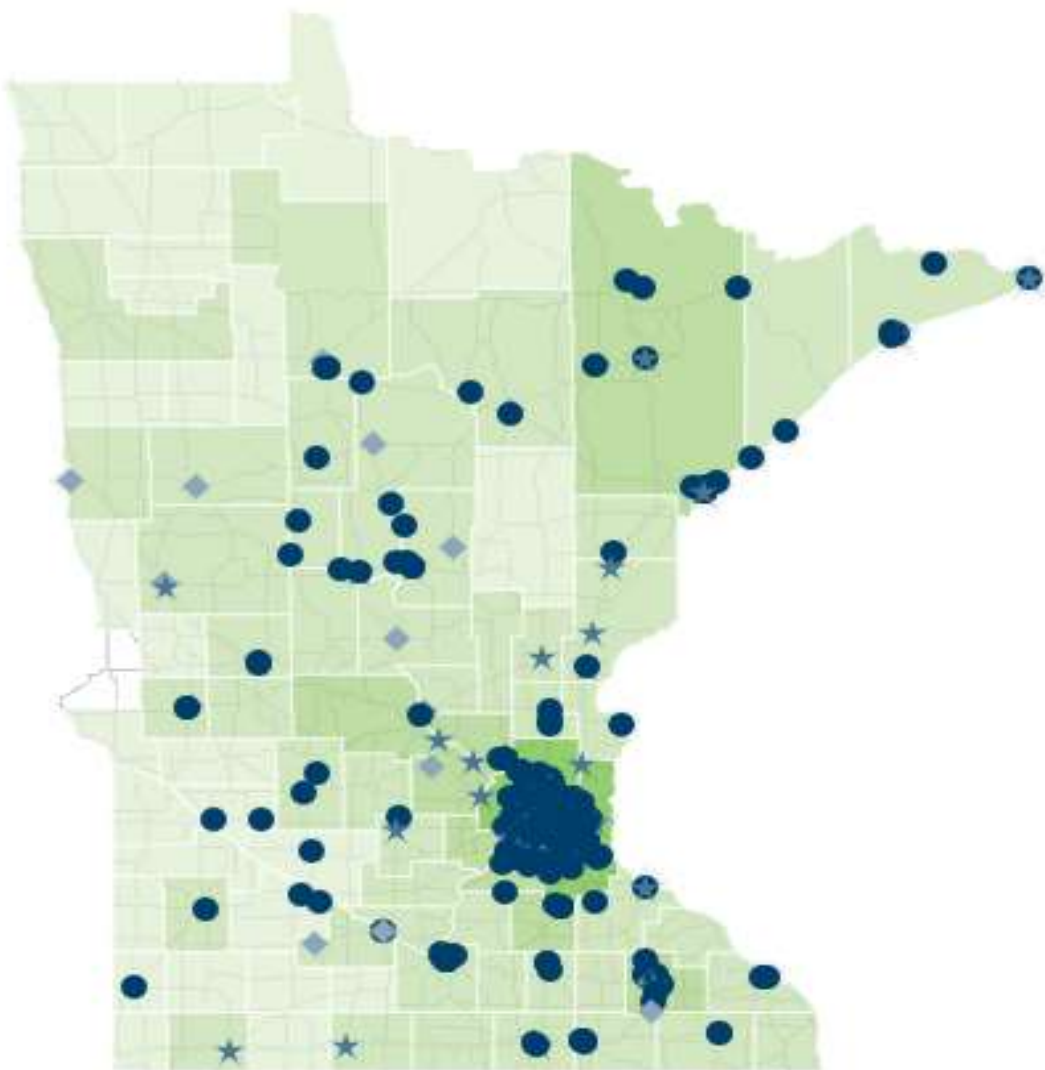
Electric range

Hybrid mode

Manufacturer			Range										Charging speed (miles/hr)			Performance				
Make	Model	Photo	Seating	EV Type	FWD/ RWD/ AWD	Base MSRP	Federal tax credit	Price after 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)	Crash Ratings: IIHS/NHTSA
Audi	e-tron		5	BEV	AWD	\$74,800	\$7,500	\$67,300	95	204	204	11/130	3	24	228	74	155	5.5	4000	Top Safety Pick + / Not rated
Audi	Q5 e		5	PHEV	AWD	\$52,900	\$6,712	\$46,188	14.1	20	390	7.4	2	14	N/A	65/27	130	5	4400	Good/ Not rated
Audi	A8L PHEV		5	PHEV	AWD	\$94,000	\$6,795	\$87,205	14.1	17	420	7.4	2	12	N/A	54/23	130	4.9	0	Not Rated
BMW	i3		4	BEV	RWD	\$44,450	\$7,500	\$36,950	42	153	153 (200)	7.4/50	4	27	147	124 (39)	93	6.9-7.2	0	Good-Acceptable/ Not rated
BMW	i8		4	PHEV	AWD	\$147,500	\$3,793	\$143,707	7.2	15	330	3.3	3	7	N/A	76/28	155	4.2	0	Not rated/ Not rated
BMW	X3 xDri																			Top Safety Pick + / Not rated
BMW	53i																			Top Safety Pick + / Not rated
BMW	745e		5	PHEV	AWD	\$95,550	\$5,836	\$89,714	12	16	290	3.7	2	6	N/A	56/22	155	4.9	0	Not rated / Not rated
Chevrolet	Bolt EV		5	BEV	FWD	\$36,620	\$1,875	\$34,745	66	259	259	7.2/50	4	25	140	118	98	6.5	0	Top Safety Pick / 5 star
Chrysler	Pacifica Hybrid (PHEV)		7	PHEV	FWD	\$39,995	\$7,500	\$32,495	16	33	570	6.6	3	16	N/A	84/32	107	7.8	0	Top Safety Pick / 5 star
Ford	Fusion Energi		5	PHEV	FWD	\$35,000	\$4,609	\$30,391	9	26	610	3.3	3	9	N/A	97/42	85	8.5	0	Good/ 5 star
Honda	Clarity PHEV		5	PHEV	FWD	\$33,400	\$7,500	\$25,900	17	48	340	6.6	4	22	N/A	110/42	110	8.8	0	Not rated/ Not rated
Jaguar	I-PACE		5	BEV	AWD	\$69,850	\$7,500	\$62,350	90	246	246	7.0/85	3	16	153	76	124	4.5	0	Not rated
Kia	Niro PHEV		5	PHEV	FWD	\$28,500	\$4,543	\$23,957	8.9	26	560	3.3	4	10	N/A	105/46	107	9	0	Top Safety Pick + / 4 star

www.EVInfoList.com

Electric Vehicle Dashboard



Charging points

Level 2 charger	DC fast charger	Total
1,024	235	1,259

Total vehicles per Level 2 charger	Total vehicles per DC fast charger
23	102

Vehicles

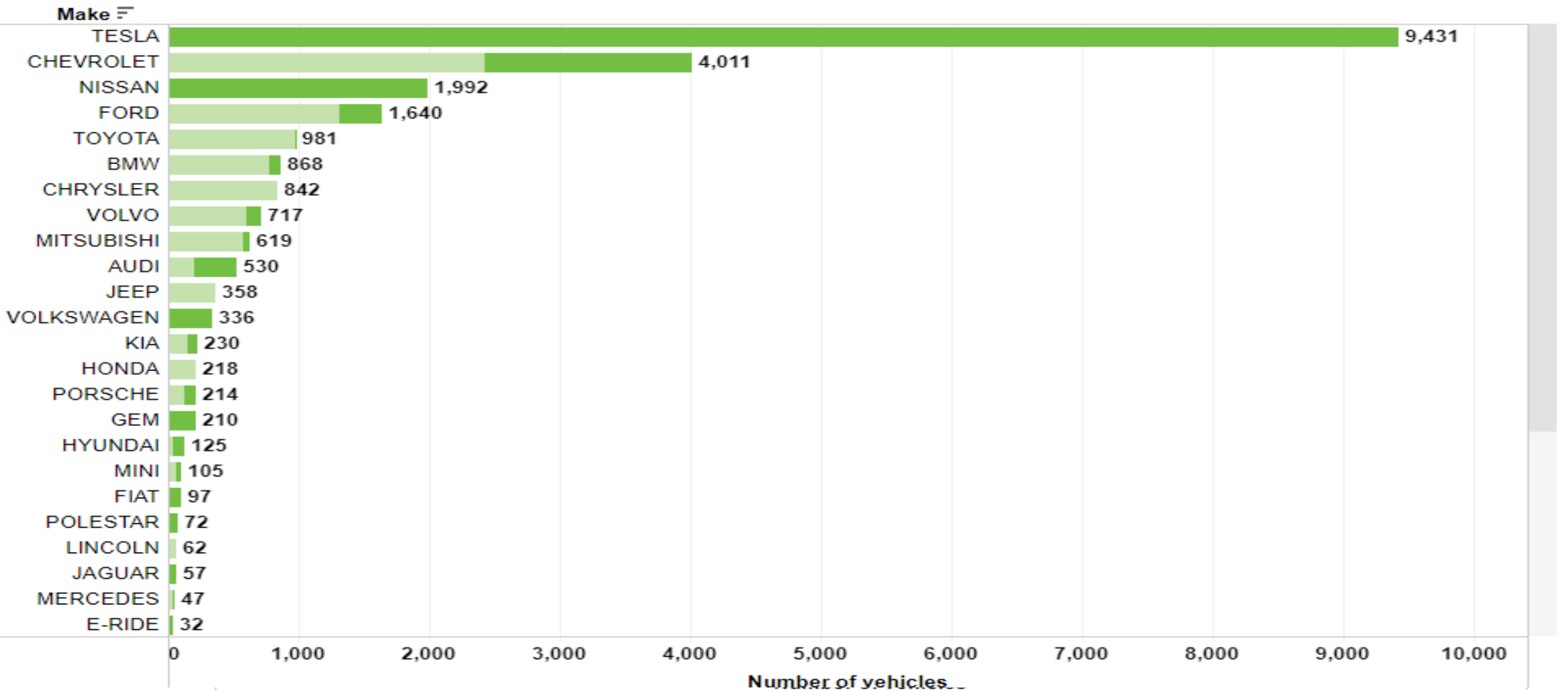
Battery electric vehicles (BEV)	Plug-in hybrid electric vehicles (PHEV)	Total
15,062	8,835	23,897

Electric Vehicle Dashboard

Vehicle details



■ Battery electric
■ Plug-in hybrid electric



Electric CUVs, SUVs and Pickup trucks



2020

2021

2022

2023

Trend 4 New EVs to the US market 2021

Sedans



Polestar 2



Audi e-tron GT



Lucid Air

Crossovers and SUVs



Volkswagen ID.4



Jeep Wrangler 4xe



Kia Sorento PHEV



Ford Mustang Mach-E



Chevrolet EUV



Ford Escape PHEV



Volvo XC40 Recharge



Hyundai Tucson PHEV



Hyundai Santa Fe PHEV

Pickup trucks



Rivian R1T

EVs coming to the US market 2022

Crossovers and SUVs

Sedans



BMW i4



Mercedes EQS



BMW iX



Audi Q4 e-tron



Volvo C40 Electric



Nissan Ariya



Hyundai Ioniq 5



Cadillac Lyric



Volvo XC 90 Electric



Lexus NX 450h+



Kia EV 6



Jeep Grand Cherokee 4xe



Polestar 3



Toyota bX4X / Subaru Solterra



Rivian R1S

Pickup trucks



GMC Hummer EV



Ford F-150 Electric



Tesla Cybertruck

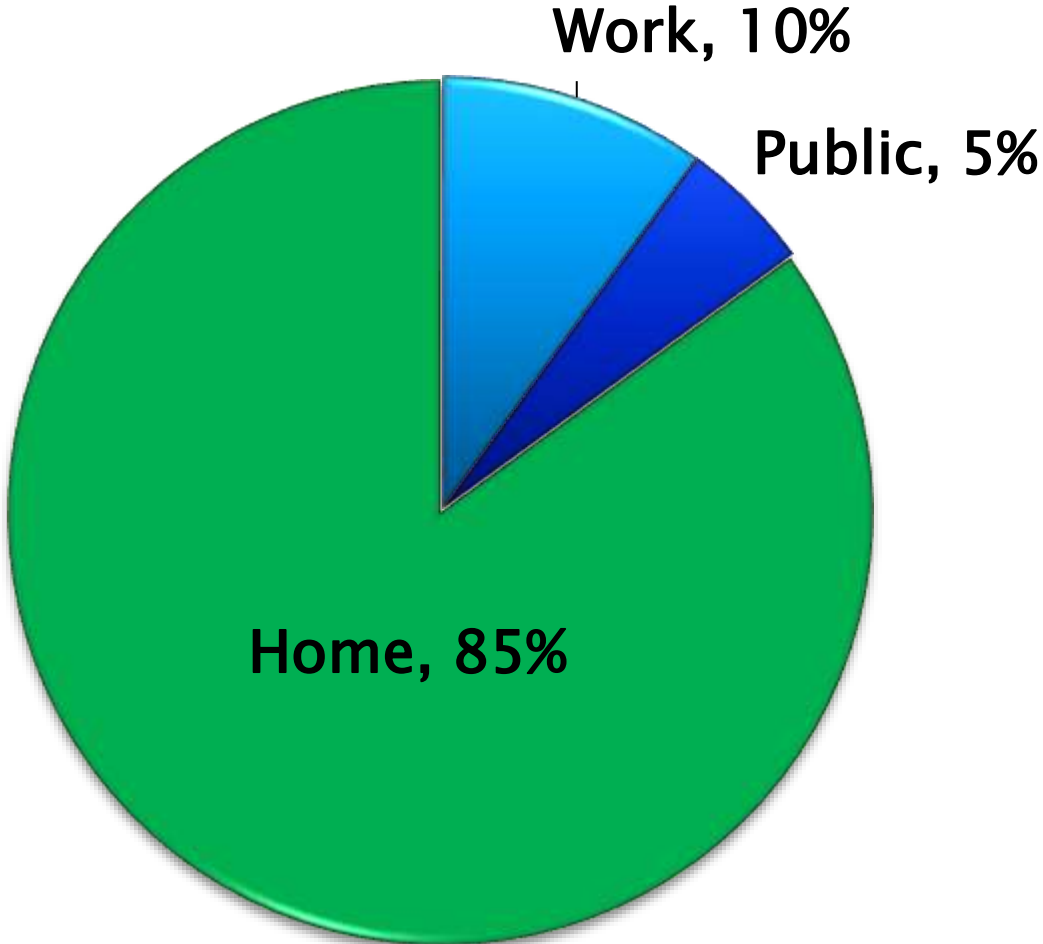


Ford E-Transit

Electric pickups are coming



Where does the energy flow?



How to charge an EV?

Level 1
120 Vol

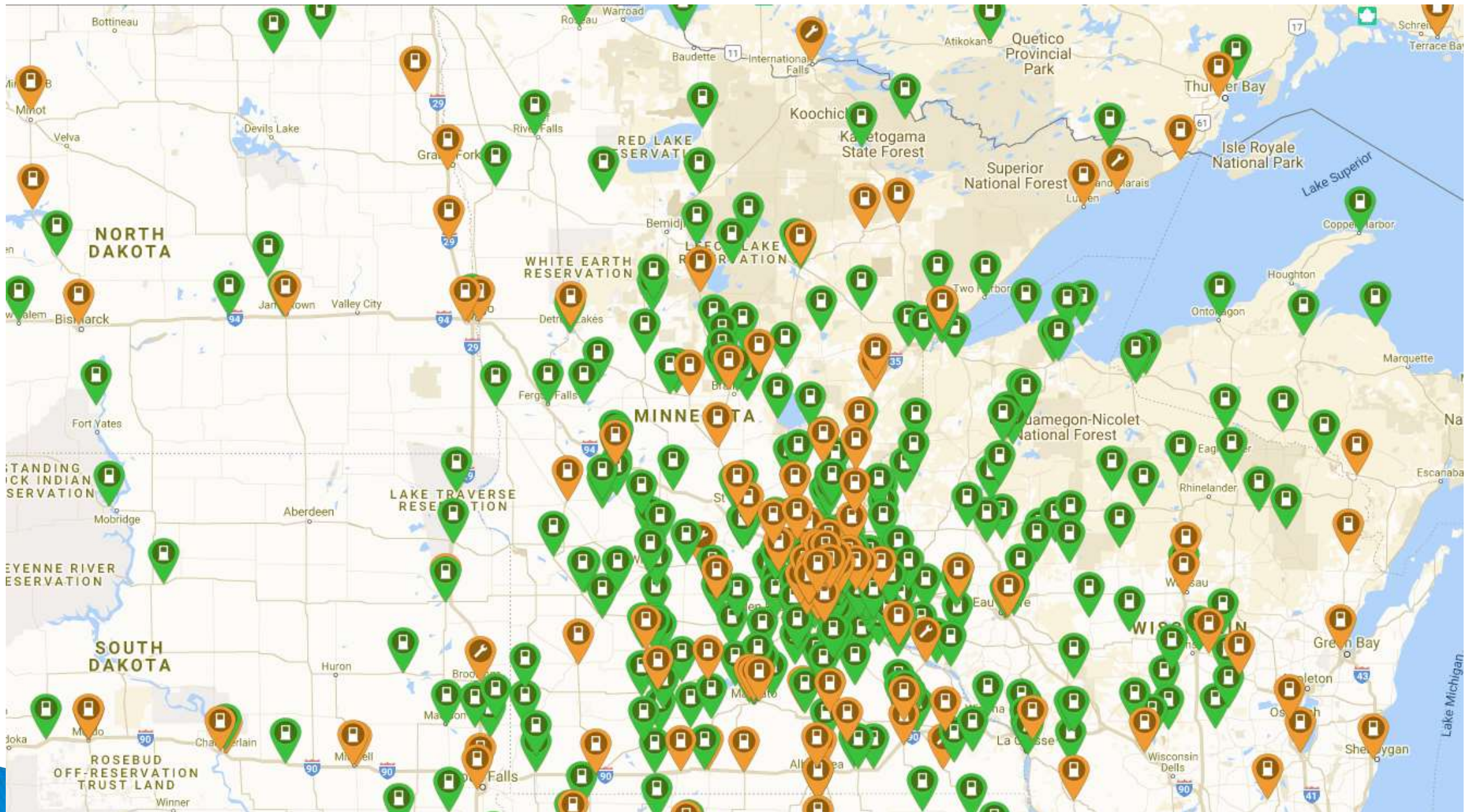


Level 2
240 Volt



DC fast charge



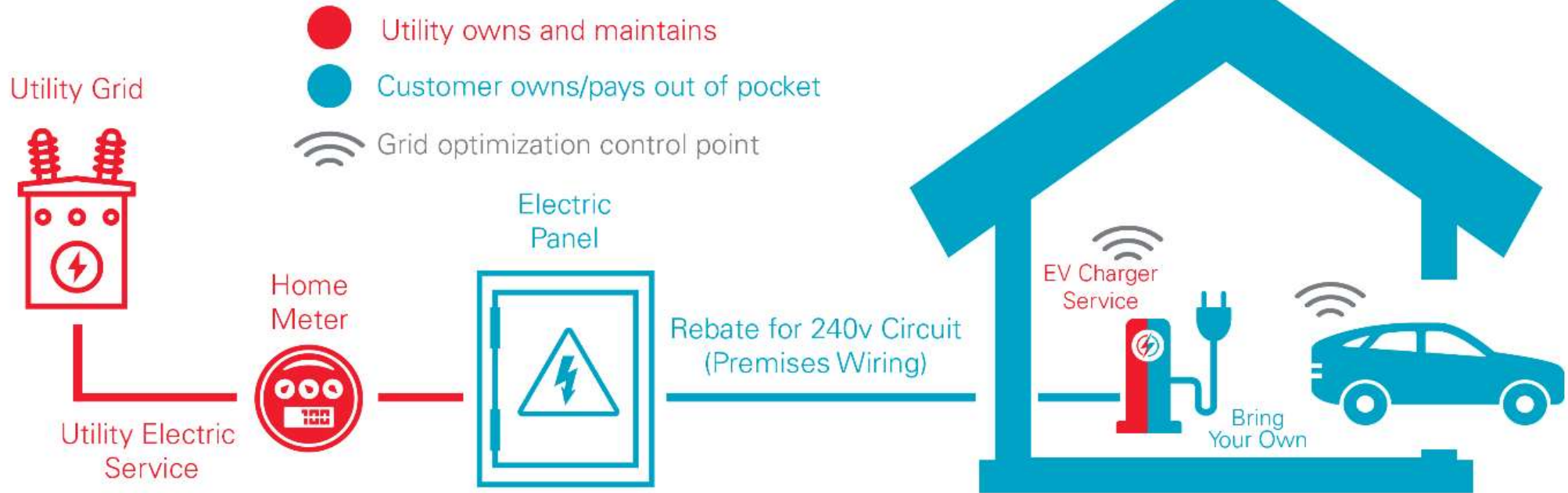


Map: PlugShare.com

Calculate your own charging costs

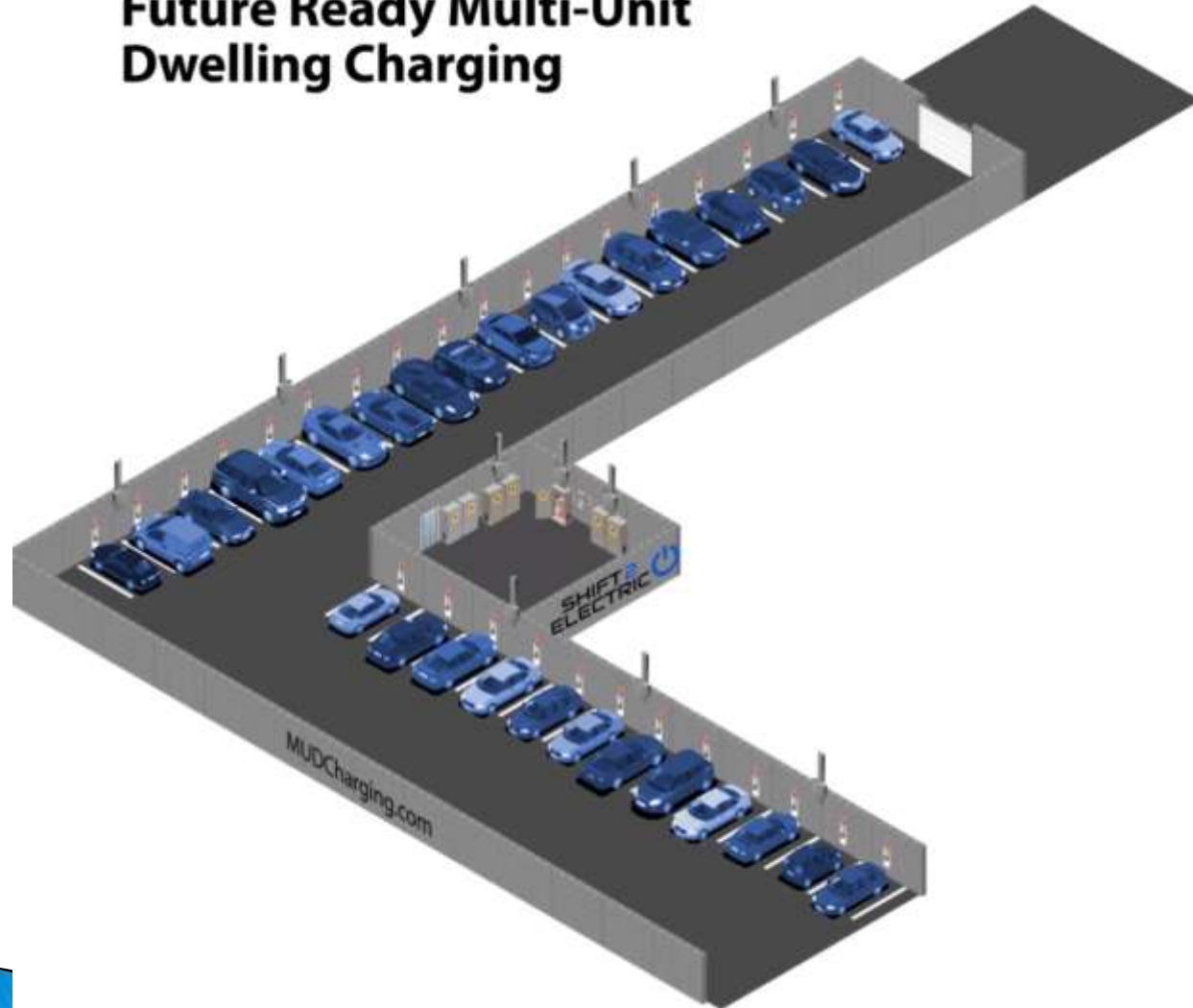
- ▶ How many miles you drive in a month? 1000 miles
- ▶ EV efficiency: (Model detailed numbers: FuelEconomy.gov) 3 miles/kWh
- ▶ Monthly kWh usage: $1000 \text{ miles} / 3 \text{ miles/kWh} = 333 \text{ kWh}$
- ▶ Regular flat rate \$0.12/kWh
Monthly costs: $333 \text{ kWh} \times \$0.12/\text{kWh} = \mathbf{\$40/\text{month}}$
- ▶ EV rate (Time of Day pricing) \$0.07/kWh
Monthly costs: $333 \text{ kWh} \times \$0.07/\text{kWh} = \mathbf{\$23/\text{month}}$

Single family home charging



Condominium and Apartment building charging

Future Ready Multi-Unit Dwelling Charging



1 inch conduit to every 4th parking spot terminated to a junction box.

Breaker panel capacity to serve 208/240V 50A line to these spots.

Simple charging station installation for 25% of vehicles.

EVs 25-50%, Power shared between every two stations

EVs 50-75%, Power shared between every three stations

EVs 75-100%, Power shared between every four stations
Increase power capacity to each junction box to 208/240V 80A

Use charging stations with embedded metering and power sharing capability

For more info, visit [MUDCharging.com](https://www.mudcharging.com)

Hotels and Parking ramps



Grocery stores



Gas stations



Gas stations



Photo: Kempower

Fast food



Bus depot



Photo:
LaddAlliansen
Nordic AB

National Electric Vehicle Infrastructure Formula Program

Bipartisan Infrastructure Law



Program Guidance


Federal Highway Administration
February 10, 2022



Incentives

- ▶ **Federal tax credit for EVs**
 - Up to \$7500 dollars tax credit
- ▶ **Federal tax credit for EV charging station installations**
 - 30% of installation costs up to \$1000 for homeowners and up to \$30,000 for commercial properties
- ▶ **MnPASS Electric Vehicle Incentive pilot**
 - One time credit
 - \$250 for BEVs
 - \$125 for PHEVs
- ▶ **Check utility credits with www.MNCharging.org**

Small group exercise

- 1) Choose an existing or future project that includes EV charging
 - 2) What kind of approach would you take?
 - How many EV charging capable parking spots?
 - Service size, breaker panel capacity, conduit runs etc.
 - How many station will you install initially?
 - 3) Which stakeholders do you work with to make this happen?
 - 4) How do you highlight the value of EV charging at this property?
- 

Q&A MNEVBuyer.com



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Questions?



Info for EV buyers in Minnesota.

All about charging

Economics

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