GET CONNECTED

ELECTRIC VEHICLE QUARTERLY REPORT

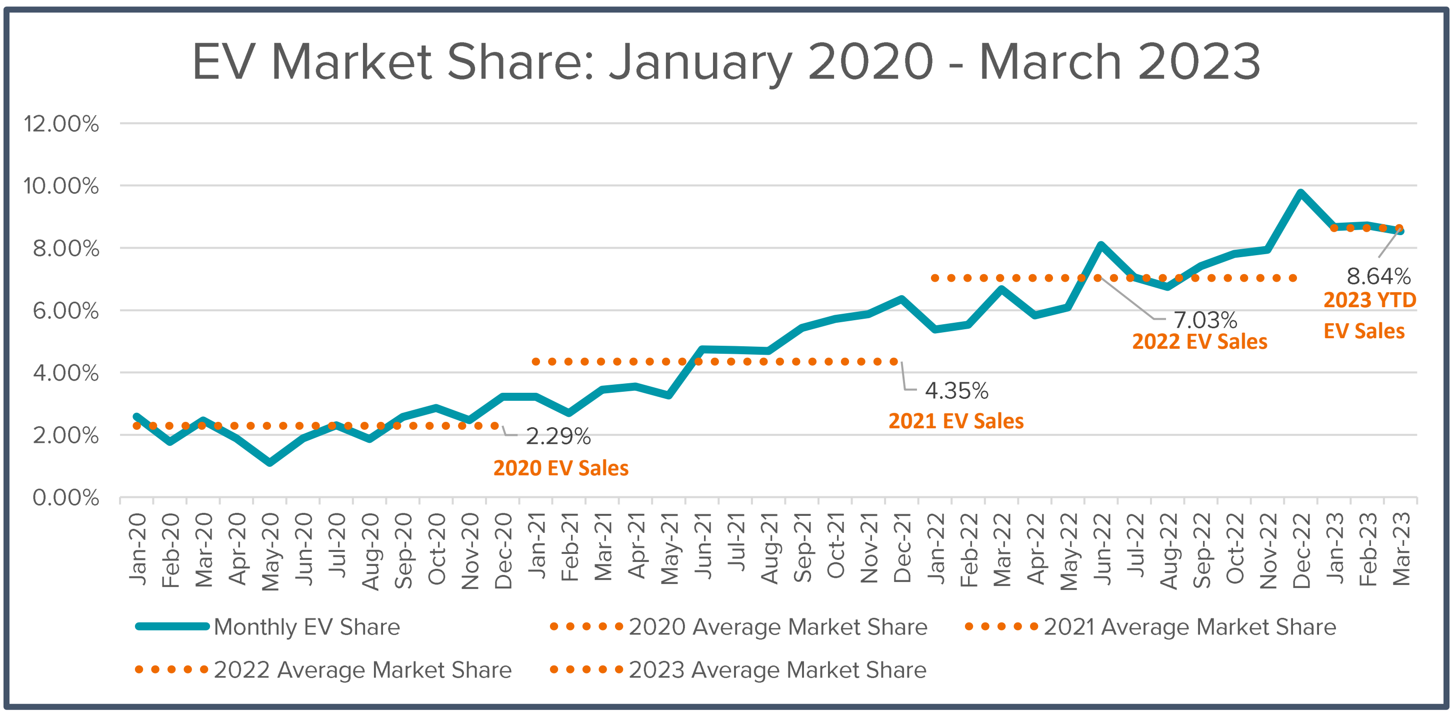
ALLIANCE FOR AUTOMOTIVE INNOVATION

FIRST QUARTER, 2023

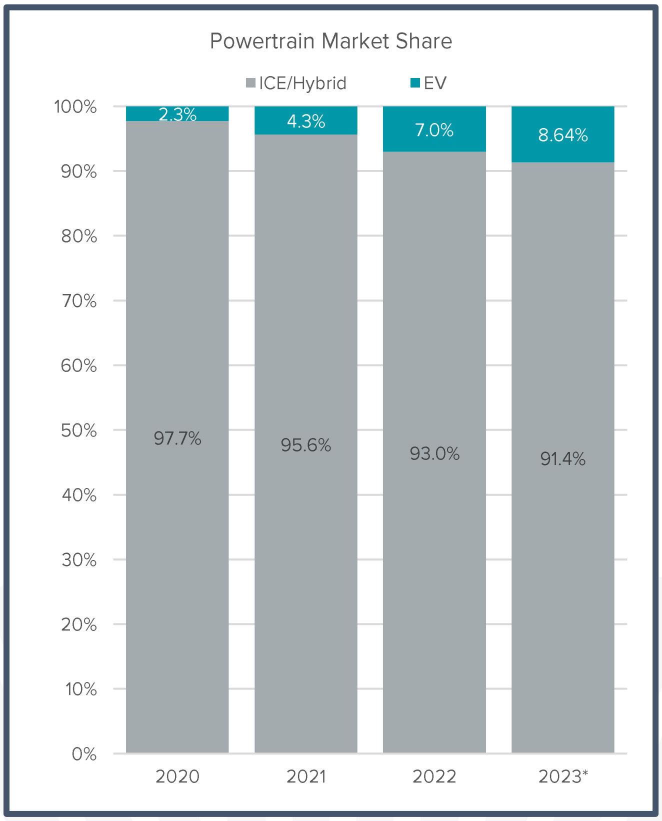
Contents

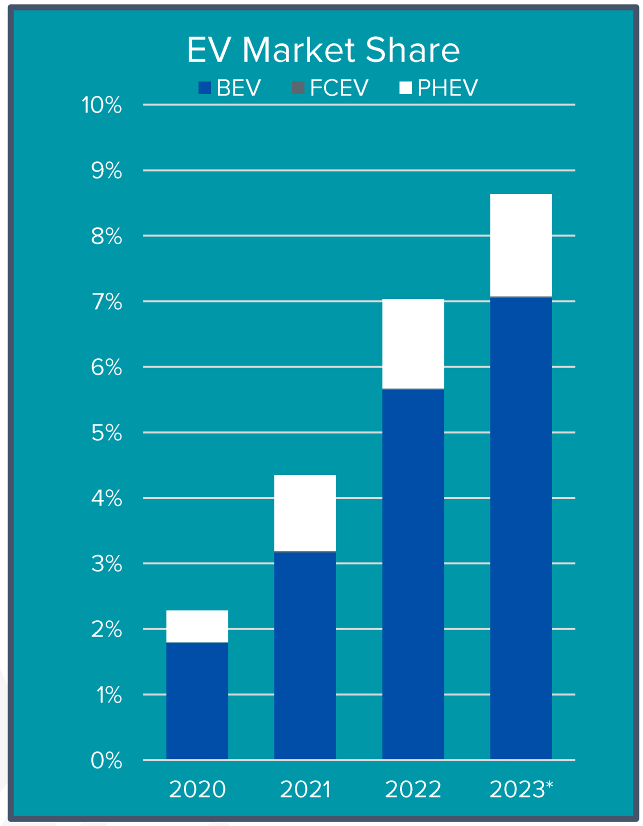
ELECTRIC VEHICLE SALES OVERVIEW (2023)

In the first quarter of 2023, automakers sold about 305,000 electric vehicles (EVs, including battery, plug-in hybrid, and fuel cell electric vehicles) in the United States, representing 8.6 percent of overall light-duty vehicle sales. Year-over-year (YoY), market share increased 2.7 percentage points (pp) from the first quarter of 2022. Over 109,500 more EV units were sold than the same period in 2022, a 56 percent increase. Compared to the last quarter (Q4) of 2022, EVs sales increased by more than 22,000 units with a market share increase of 0.12 pp[1]. For comparison, internal combustion engine (ICE) vehicle market share decreased by 1.0 pp during the first quarter of 2023 compared to the fourth quarter of 2022 and decreased 3.4 pp compared against the same time a year ago [2].



[1] *See* past editions of "Get Connected: Electric Vehicle Report" for previous quarters.
[2] Hybrid vehicles comprised the remainder of the gains in vehicle share.





*2023 through first quarter

SEE ADDITIONAL HISTORIC DATA ON EV SALES HERE

Electric Vehicle Sales by Segment

While passenger cars once dominated the EV market, manufacturers continue to introduce new models to satisfy a variety of consumer needs. Utility vehicle (UV) offerings continue to grow, and while electric pickup trucks are a relatively new entry to the market (making their commercial debut in September 2021), more models are expected soon. As a result, non-car segments are continuing to make gains, and in the first quarter of 2023, light truck (UVs, minivans, and pickups) sales comprised 73 percent of the EV market – a 5 pp increase over the last quarter and 11 pp more than the first quarter of 2022.

Quarterly sales of BEV and PHEV UVs have grown from about 19 percent of EVs at the start of 2020 to 68 percent in the first quarter of 2023.

For a list of EVs that qualify for the federal government's new clean vehicle tax credit of up to $7,500 click here.

EV Model Availability

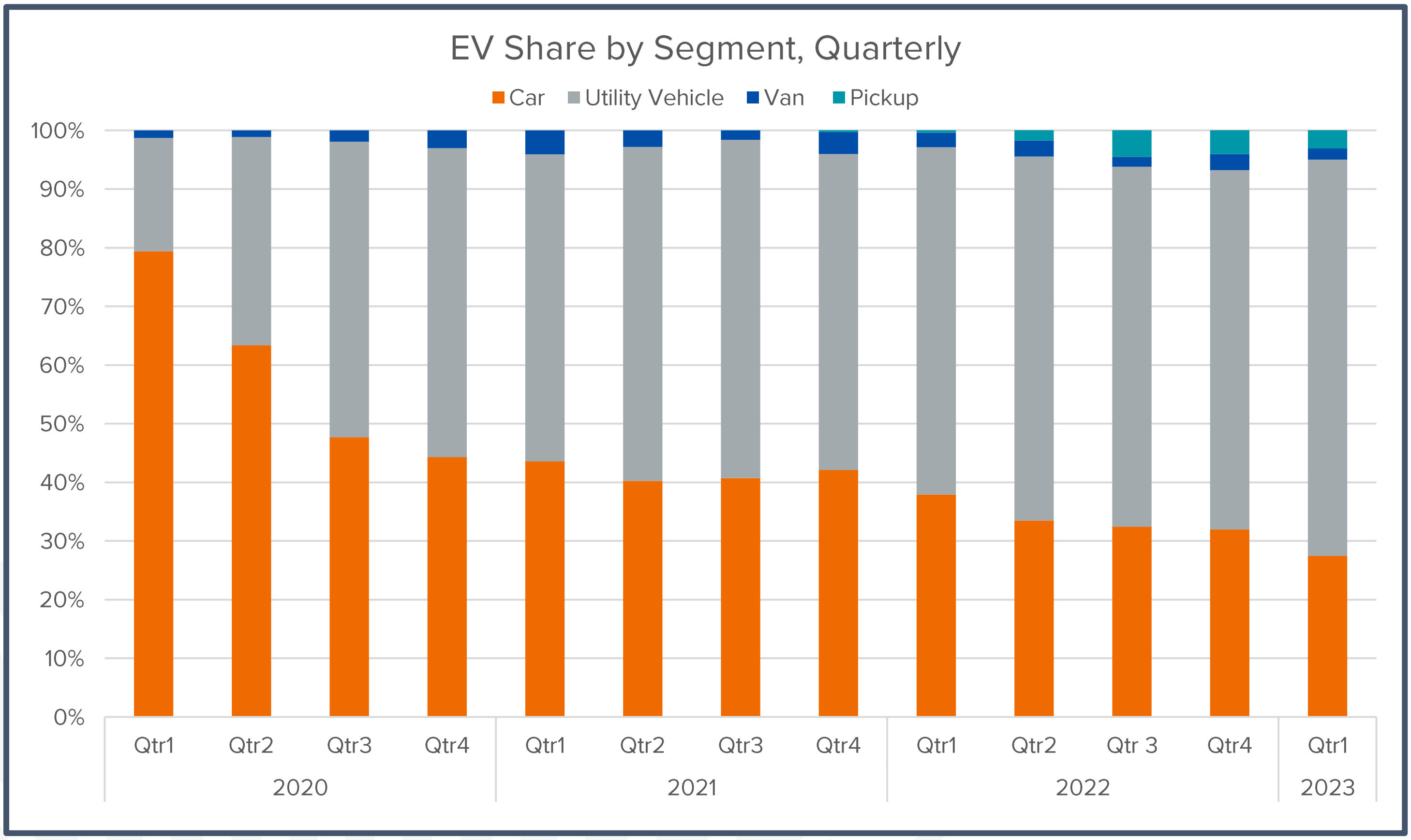
97 Vehicle Models Sold in Q1 2023:

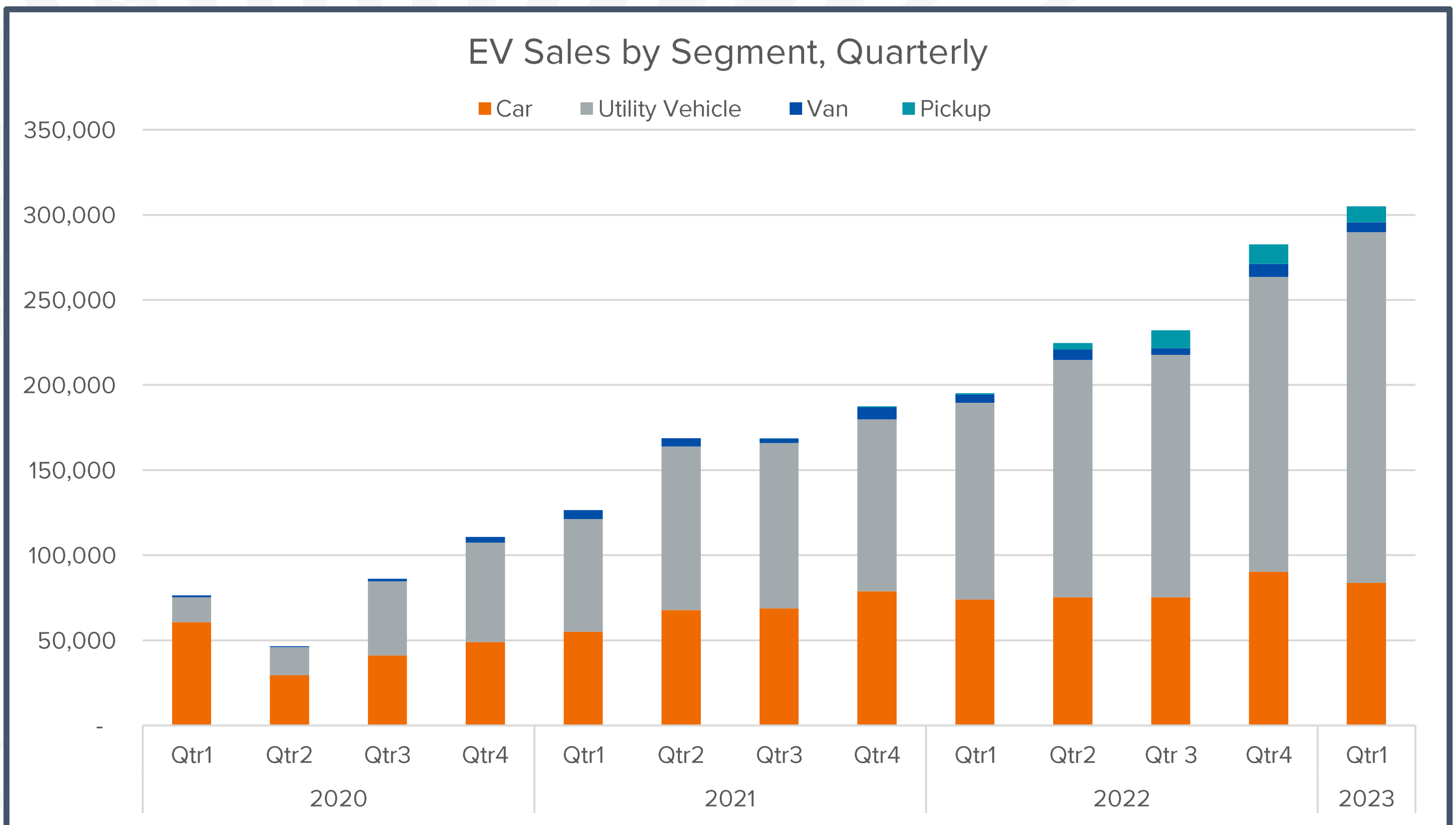
55 Battery Electric Vehicles
- 20 Cars
- 29 Utility Vehicles
- 4 Pickups
- 2 Vans

40 Plug-in Hybrid Vehicles
- 14 Cars
- 25 Utility Vehicles
- 1 Van

2 Fuel Cell Electric Vehicles
- 1 Car
- 1 Utility Vehicle

See more information about ***EV CHOICE HERE***

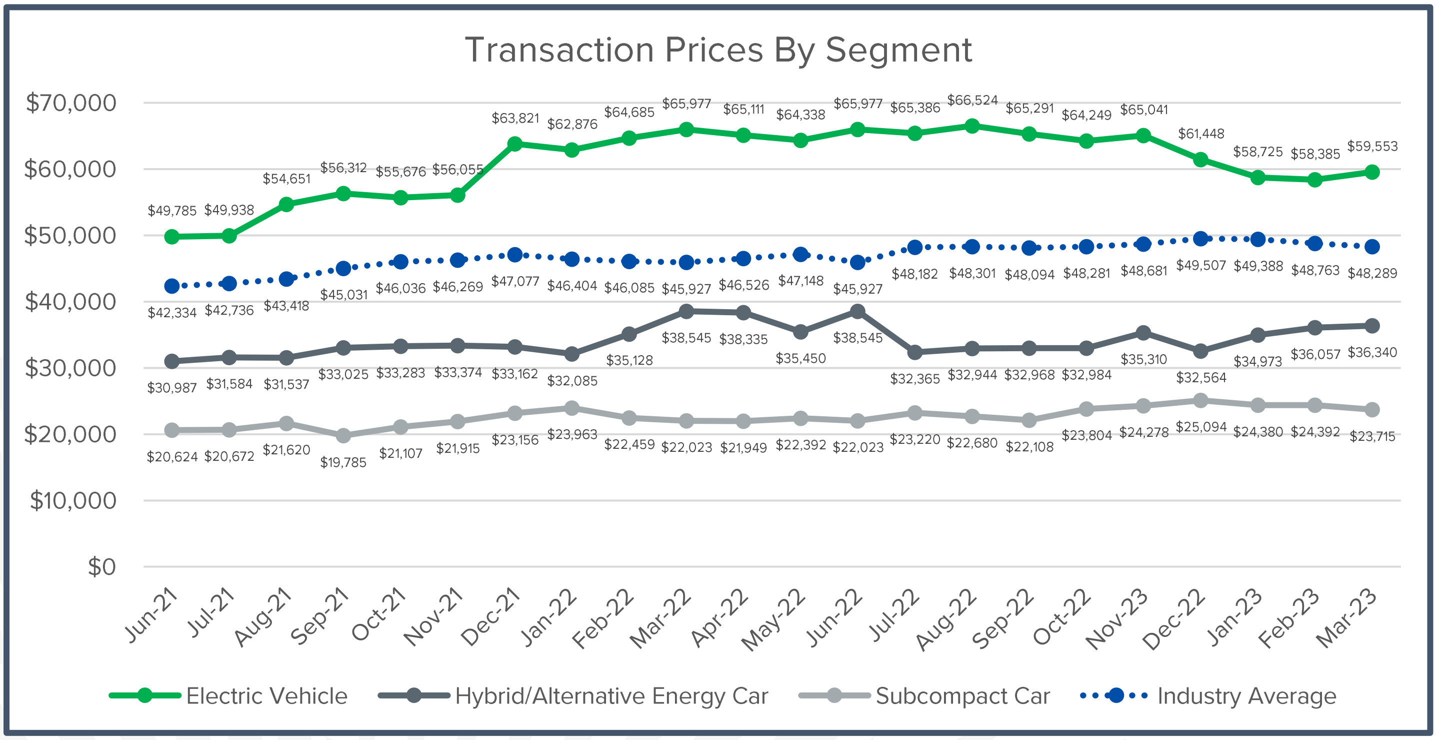




Source: Figures compiled by Alliance for Automotive Innovation with new registrations for retail and fleet data provided by S&P Global Mobility covering January 1, 2020 – March 31, 2023

ELECTRIC VEHICLE TRANSACTION PRICES

The cost of the average EV in the first quarter of 2023 was about $58,800 while the average cost of all new light-duty vehicles in that time period was about $48,800. Year-over-year, EV prices declined more than $5,600 from the first quarter of 2022 while the average cost of all new light vehicles rose just under $2,700.[3]



ELECTRIC VEHICLE SALES BY STATE

For the First Quarter of 2023:

California continued to lead the nation in EV sales, with BEVs, PHEVs and FCEVs making up nearly 24 percent of new light-duty vehicle registrations in the first quarter of 2023. There are currently 26 additional states[4] and the District of Columbia with new vehicle EV registrations above 5 percent.

The market share of new EVs registered increased in all but one state[5], year-over-year, in the first quarter of 2023. Twenty-five states and the District of Columbia witnessed an increased market share of EVs by 2 pp or more. Making the largest increases were Washington (7.2 pp), Nevada (7.2 pp), District of Columbia (6.6 pp), Oregon (6.6 pp), and California (6.0 pp).

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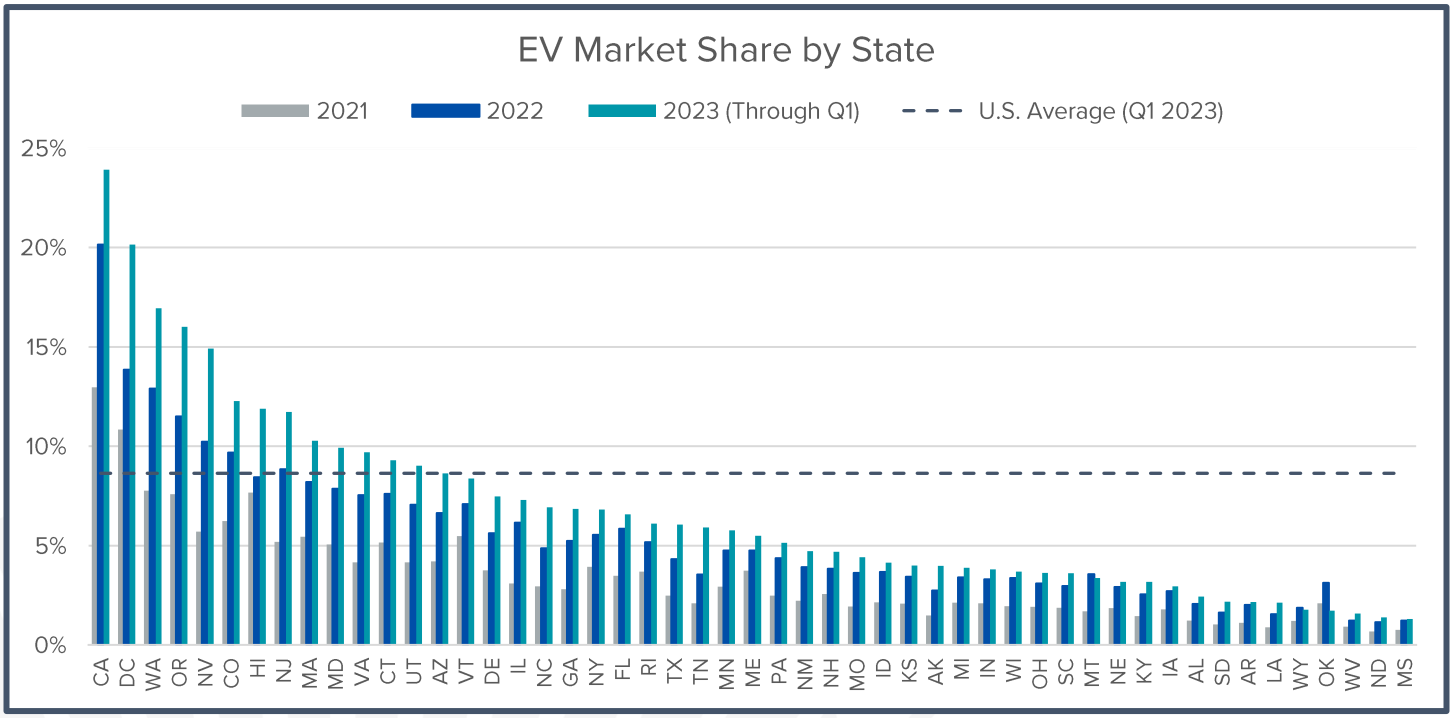
[3] Average transaction prices from Kelley Blue Book, monthly press releases

[4] States with more than a 5 percent market share of EVs: California, District of Columbia, Washington, Oregon, Nevada, Colorado, Hawaii, New Jersey, Massachusetts, Maryland, Virginia, Connecticut, Utah, Arizona, Vermont, Delaware, Illinois, North Carolina, Georgia, New York, Florida, Rhode Island, Texas, Tennessee, Minnesota, Maine, and Pennsylvania.

[5] Oklahoma is often an outlier due to rental fleet registrations.

Eight states and the District of Columbia had an EV market share above 10 percent while five states had an EV market share under 2 percent; California and the District of Columbia were above 20 percent.



[6]

2023 EV Market Share by State (Through Q1)

1	CA*	23.92%	**11**	VA*	9.7%	**21**	FL	6.6%	**31**	ID	4.13%	**41**	KY	3.18%
2	DC	20.14%	**12**	CT*	9.3%	**22**	RI*	6.1%	**32**	KS	3.99%	**42**	IA	2.95%
3	WA*	16.93%	**13**	UT	9.0%	**23**	TX	6.1%	**33**	AK	3.97%	**43**	AL	2.42%
4	OR*	16.00%	**14**	AZ	8.6%	**24**	TN	5.9%	**34**	MI	3.88%	**44**	SD	2.18%
5	NV*	14.92%	**15**	VT*	8.4%	**25**	MN*	5.8%	**35**	IN	3.81%	**45**	AR	2.15%
6	CO*	12.28%	**16**	DE	7.5%	**26**	ME*	5.5%	**36**	WI	3.69%	**46**	LA	2.12%
7	HI	11.89%	**17**	IL	7.3%	**27**	PA	5.1%	**37**	OH	3.62%	**47**	WY	1.78%
8	NJ*	11.73%	**18**	NC	6.9%	**28**	NM	4.7%	**38**	SC	3.62%	**48**	OK	1.72%
9	MA*	10.27%	**19**	GA	6.8%	**29**	NH	4.7%	**39**	MT	3.37%	**49**	WV	1.58%
10	MD*	9.91%	**20**	NY*	6.8%	**30**	MO	4.4%	**40**	NE	3.18%	**50**	ND	1.39%
												51	MS	1.31%

[7]

[6] Figures compiled by Alliance for Automotive Innovation with new registrations for retail and fleet data provided by S&P Global Mobility covering January 1, 2021 – March 31, 2023

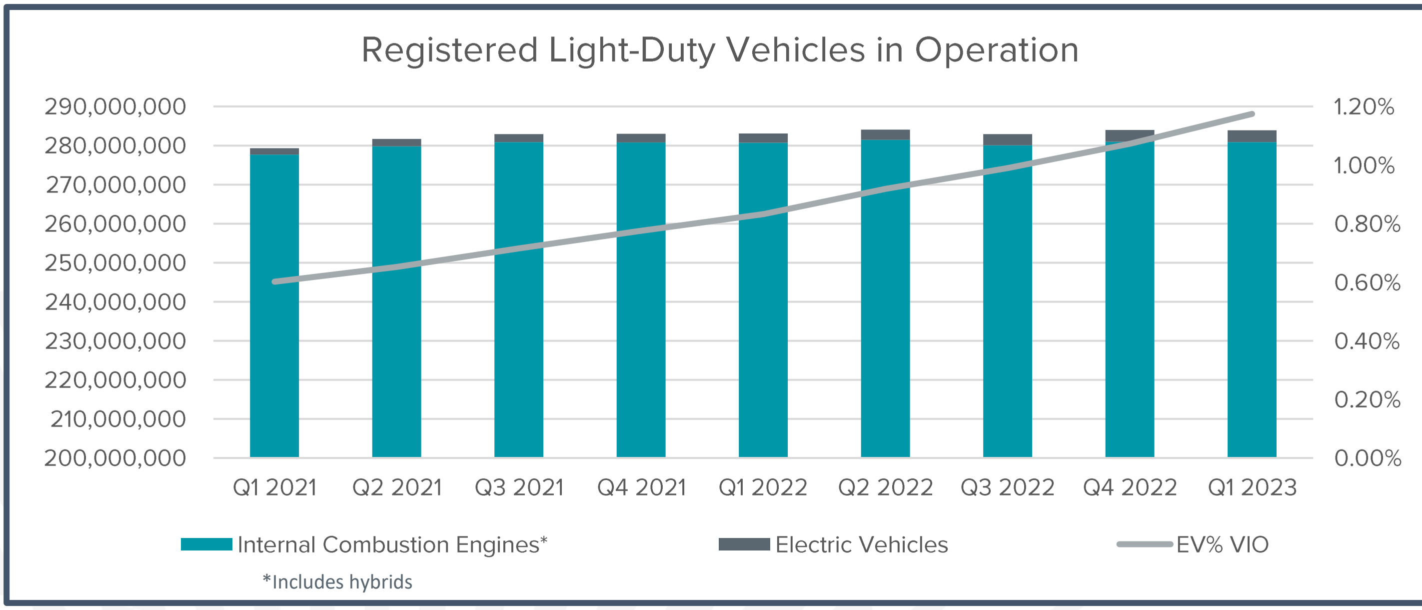
[7] Figures compiled by Alliance for Automotive Innovation with new registrations for retail and fleet data provided by S&P Global Mobility covering January 1, 2023 – March 31, 2023
*Denotes states that have adopted California's ZEV program

State	First Quarter 2023, New Light-Duty Vehicle Registrations By Powertrain: Advanced Powertrain Market Share				Change In Market Share (2023 Q1 vs 2022 Q1), New Light-Duty Vehicle Registrations Powertrain: Advanced Powertrain Market Share (Percentage Point Change)			
	PHEV	BEV	FCEV	EV Total	PHEV	BEV	FCEV	EV Total
AK	0.93%	3.04%	0.00%	**3.97%**	0.24	1.08	0.00	**1.32**
AL	0.48%	1.94%	0.00%	**2.42%**	0.10	0.79	0.00	**0.88**
AR	0.52%	1.64%	0.00%	**2.15%**	0.06	0.58	0.00	**0.63**
AZ	1.07%	7.57%	0.00%	**8.63%**	0.09	3.21	0.00	**3.30**
CA*	3.48%	20.26%	0.18%	**23.92%**	1.00	5.03	-0.07	**5.96**
CO*	3.55%	8.73%	0.00%	**12.28%**	1.56	2.41	0.00	**3.97**
CT*	2.72%	6.56%	0.00%	**9.29%**	0.65	2.45	0.00	**3.11**
DC	4.29%	15.86%	0.00%	**20.14%**	0.47	6.15	0.00	**6.62**
DE	1.76%	5.71%	0.00%	**7.48%**	0.50	2.75	0.00	**3.25**
FL	0.92%	5.66%	0.00%	**6.57%**	0.15	1.91	0.00	**2.06**
GA	0.72%	6.12%	0.00%	**6.84%**	0.03	2.54	0.00	**2.57**
HI	1.01%	10.88%	0.00%	**11.89%**	-0.71	4.95	-0.02	**4.21**
IA	0.80%	2.15%	0.00%	**2.95%**	-0.03	0.24	0.00	**0.22**
ID	1.18%	2.95%	0.00%	**4.13%**	0.33	0.63	0.00	**0.95**
IL	1.12%	6.17%	0.00%	**7.30%**	-0.02	2.37	0.00	**2.35**
IN	0.85%	2.96%	0.00%	**3.81%**	0.01	1.26	0.00	**1.27**
KS	0.76%	3.23%	0.00%	**3.99%**	0.02	1.31	0.00	**1.33**
KY	0.71%	2.46%	0.00%	**3.18%**	-0.05	1.04	0.00	**1.00**
LA	0.46%	1.66%	0.00%	**2.12%**	0.10	0.95	0.00	**1.05**
MA*	3.04%	7.23%	0.00%	**10.27%**	0.49	3.04	0.00	**3.53**
MD*	2.11%	7.80%	0.00%	**9.91%**	0.43	2.65	0.00	**3.08**
ME*	2.28%	3.22%	0.00%	**5.50%**	-0.01	1.22	0.00	**1.22**
MI	1.10%	2.78%	0.00%	**3.88%**	0.04	1.33	0.00	**1.37**
MN*	1.25%	4.52%	0.00%	**5.76%**	0.22	2.14	0.00	**2.36**
MO	1.06%	3.36%	0.00%	**4.41%**	0.17	1.72	0.00	**1.89**
MS	0.29%	1.02%	0.00%	**1.31%**	-0.01	0.63	0.00	**0.62**
MT	1.04%	2.32%	0.00%	**3.37%**	0.22	0.44	0.00	**0.66**
NC	1.07%	5.85%	0.00%	**6.92%**	0.26	3.06	0.00	**3.32**
ND	0.68%	0.71%	0.00%	**1.39%**	0.31	0.15	0.00	**0.47**
NE	1.02%	2.16%	0.00%	**3.18%**	0.15	0.70	0.00	**0.85**
NH	1.52%	3.17%	0.00%	**4.69%**	0.38	1.09	0.00	**1.47**
NJ*	2.03%	9.70%	0.00%	**11.73%**	0.37	4.26	0.00	**4.63**
NM	1.15%	3.56%	0.00%	**4.72%**	0.32	0.73	0.00	**1.06**
NV*	1.60%	13.32%	0.00%	**14.92%**	0.51	6.67	0.00	**7.18**
NY*	2.74%	4.07%	0.00%	**6.81%**	0.99	1.25	0.00	**2.24**
OH	0.89%	2.73%	0.00%	**3.62%**	0.15	0.78	0.00	**0.92**
OK	0.53%	1.19%	0.00%	**1.72%**	-1.10	-0.17	0.00	**-1.27**
OR*	3.37%	12.64%	0.00%	**16.00%**	0.45	6.15	0.00	**6.60**
PA	1.46%	3.68%	0.00%	**5.13%**	0.56	1.21	0.00	**1.77**
RI*	2.32%	3.79%	0.00%	**6.11%**	0.50	1.54	0.00	**2.04**
SC	0.80%	2.81%	0.00%	**3.62%**	0.12	1.15	0.00	**1.27**
SD	0.85%	1.33%	0.00%	**2.18%**	0.42	0.34	0.00	**0.76**
TN	0.68%	5.24%	0.00%	**5.92%**	0.00	2.97	0.00	**2.97**
TX	0.70%	5.36%	0.00%	**6.06%**	0.15	2.51	0.00	**2.66**
UT	1.45%	7.56%	0.00%	**9.01%**	0.22	2.90	0.00	**3.12**
VA*	1.22%	8.47%	0.00%	**9.69%**	-0.28	3.94	0.00	**3.66**
VT*	2.79%	5.58%	0.00%	**8.37%**	-0.06	2.10	0.00	**2.03**
WA*	2.88%	14.05%	0.00%	**16.93%**	1.31	5.91	0.00	**7.22**
WI	0.87%	2.83%	0.00%	**3.69%**	0.10	0.97	0.00	**1.07**
WV	0.55%	1.03%	0.00%	**1.58%**	0.17	0.34	0.00	**0.50**
WY	0.78%	1.00%	0.00%	**1.78%**	0.35	-0.11	0.00	**0.24**
U.S.	**1.56%**	**7.05%**	**0.02%**	**8.64%**	**0.31**	**2.44**	**-0.01**	**2.74**

*Denotes states that have adopted California's ZEV program
Source: Figures compiled by Alliance for Automotive Innovation with new registrations for retail and fleet data provided by S&P Global Mobility covering January 1 – March 31, 2022, and January 1 – March 31, 2023

REGISTRATIONS AND INFRASTRUCTURE

Share of Registered EVs In U.S. Light-Duty Fleet Continues to Increase Incrementally. As sales of EVs increase, so does the total number of EVs operating on U.S. roads. While there are more than 284 million light-duty vehicles in operation (VIO) in the United States, EVs represent just 1.17 percent of all light vehicles in the country (just over 3.3 million EVs). EVs represented more than 1 percent of total VIO for the first time at the end of 2022. The EV VIO of 1.17 percent is an increase of 0.3 pp since the first quarter of 2022 and nearly double the EV VIO from first quarter in 2021 (0.60 percent).[8]



U.S. Public Charging Infrastructure: Overview

While the U.S. Department of Energy notes that roughly 80 percent of all EV charging occurs at home, reliable and convenient access to workplace and public charging and refueling stations help to support customers that purchase EVs. Workplace and public charging infrastructure not only eases perceived "range anxiety" concerns but also increases consumer awareness of the technology. The bipartisan Infrastructure Investment and Jobs Act (IIJA) that was signed into law in November 2021, includes $5 billion in funding for states to establish a nationwide EV charging network and $2.5 billion in competitive grants to deploy publicly available EV charging, hydrogen fueling, propane fueling, and natural gas fueling stations through 2026. Here is a snapshot of publicly available EV charging and refueling infrastructure available across the United States at the end of the first quarter of 2023[9]:

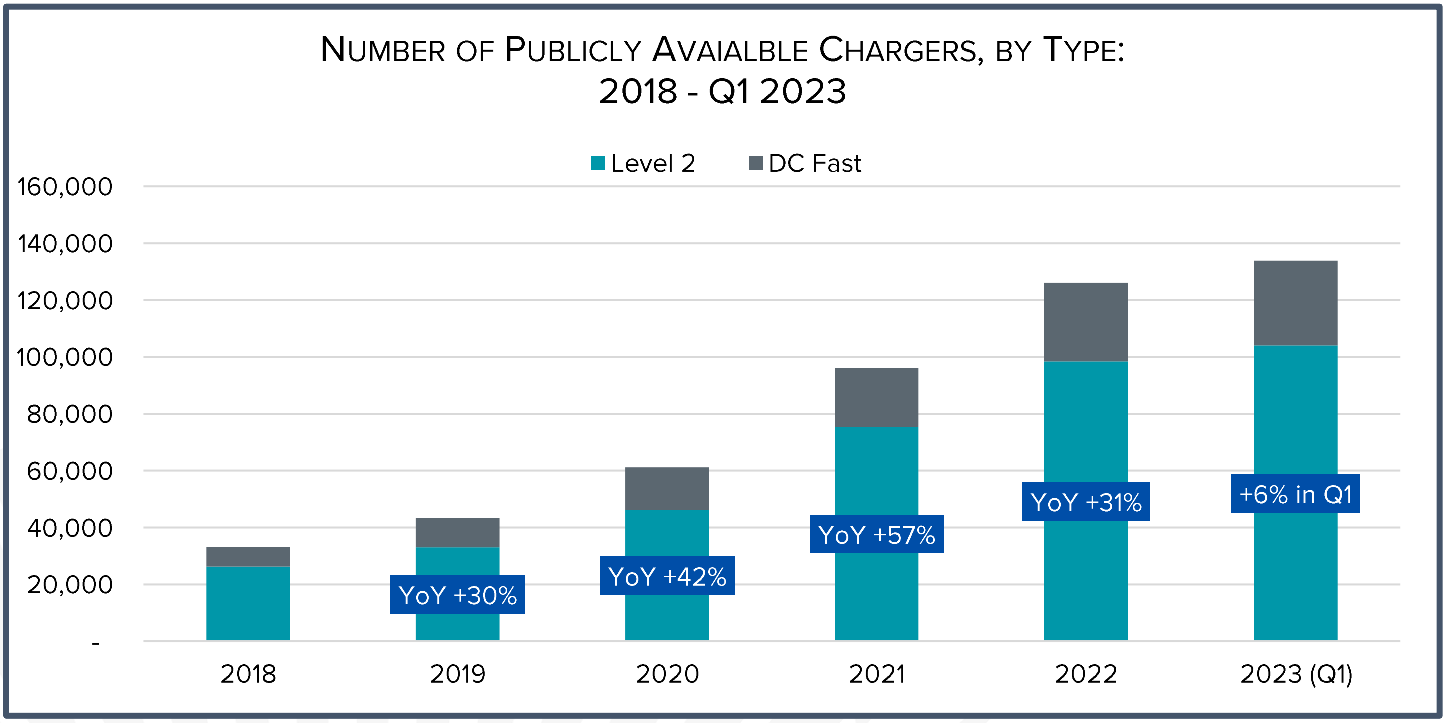
Level 2: 45,928 Locations, 104,100 EVSE Ports
DC Fast: 7,009 Locations, 29,825 EVSE Ports
Hydrogen Refueling: 57 Stations (56 are in California)
U.S. Total: *51,916 Locations, 133,982 EVSE Ports*

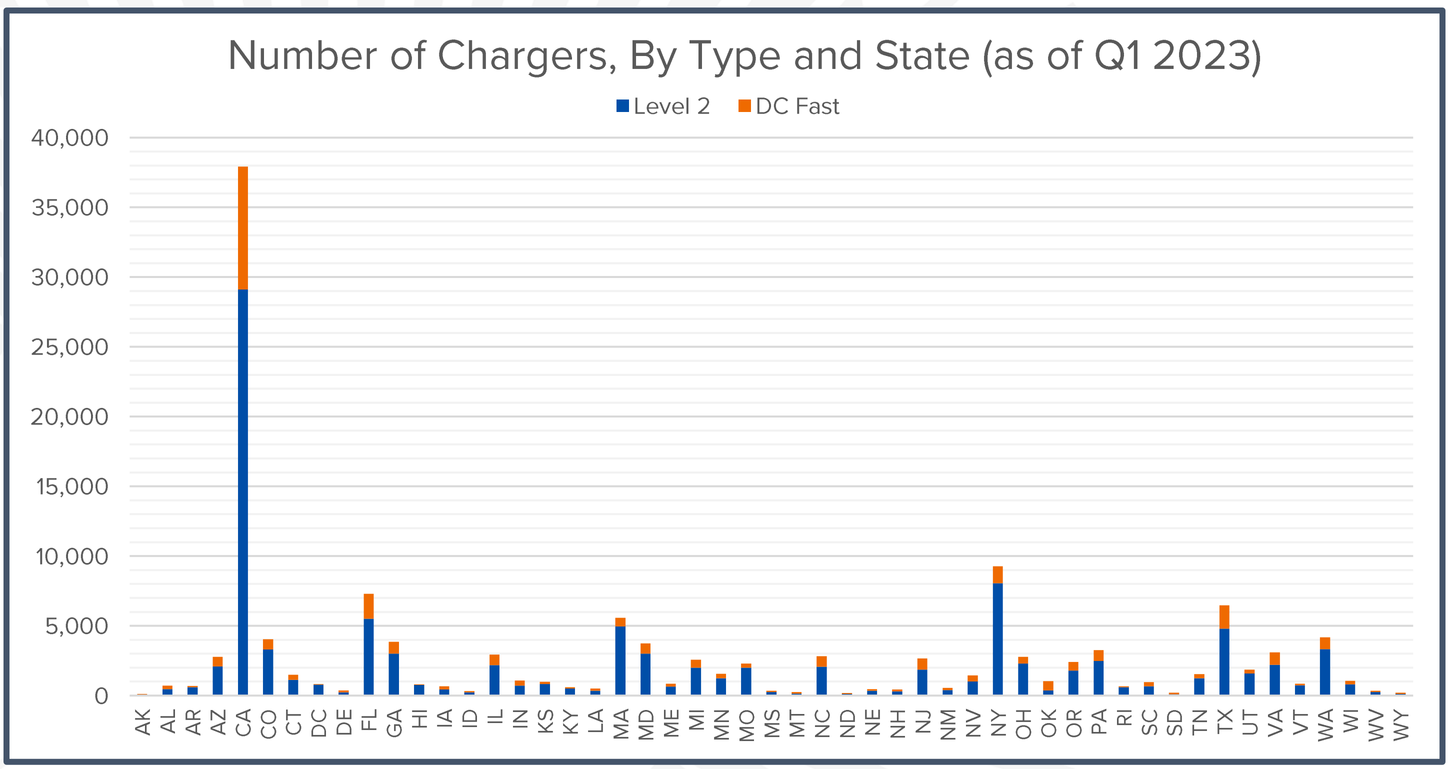
See Recommended Attributes for EV Charging Stations

Level 2 Chargers and DC Fast Chargers. Both Level 2 and DC fast charging play important roles in electrifying the fleet. However, the key difference between Level 2 and DC Fast is how fast each will charge an EV's battery. Level 2 equipment is common for home, workplace, and public charging. Level 2 chargers can charge a BEV from empty in 4-10 hours and a PHEV from empty in 1-2 hours. DC Fast charging equipment enables rapid charging of BEVs in 20

[8] Registered vehicles in operation compiled by Alliance for Automotive Innovation with data provided by S&P Global Mobility as of March 31, 2023
[9] Charging information from U.S. Department of Energy Alternative Fuels Data Center, stations in operation as of 3/31/2023
Note: prior editions of this report excluded proprietary chargers; as of 3/31/23, Tesla had 18,609 DC fast chargers but recently announced that its charging system would be available to EVs manufactured by Ford and GM when customers utilize a charging port adaptor.

minutes to 1 hour along heavy-traffic corridors, in city centers, at transportation hubs, and fleet depots. Wider installation of both Level 2 chargers, DC Fast chargers, and hydrogen fueling will be necessary to support wider-scale adoption of EVs. The number of Level 2 charging increased 6 percent in the first quarter over 2022's year-end. DC Fast chargers increased 8 percent. Total charging increased 6 percent.[10]

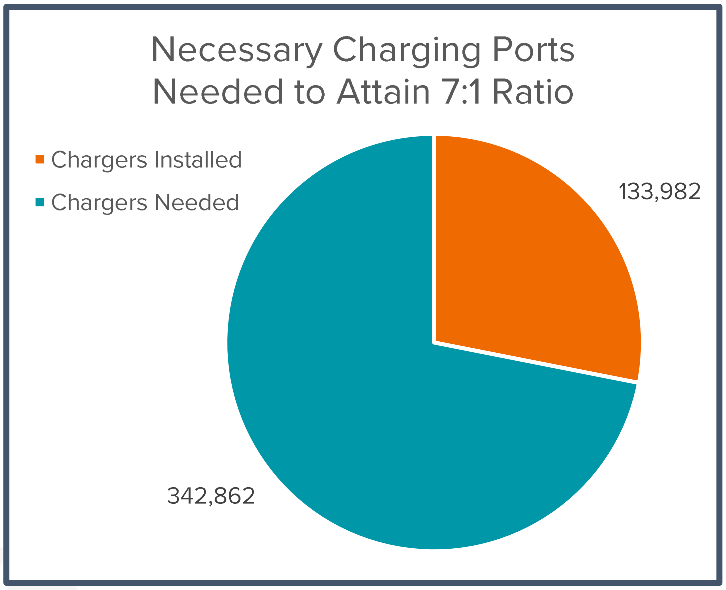




10 Charging information from U.S. Department of Energy Alternative Fuels Data Center, stations in operation as of 3/31/2023

Infrastructure Falling Behind

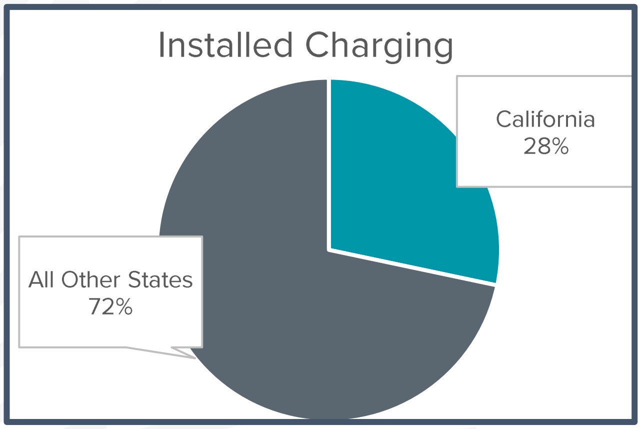
Infrastructure Still Well Below Estimated Needed Ratio of 7:1 – And Losing Ground. An assessment by the California Energy Commission concluded that 700,000 public and shared private chargers are needed to support 5 million EVs, amounting to a ratio of 7 EVs per public charger. At the end of the first quarter of 2023, there were about 134,000 public charging outlets across the country and 3.34 million EVs on the road, a ratio of 25 EVs per charger. For charging to meet the 7:1 ratio, more than 342 thousand additional chargers are needed today, which is two and a half times the currently available chargers across the U.S. as of March 31, 2023.



Thirty-Nine EVs Added For Each New Port In The First Quarter Of 2023: More than 305,000 new EVs were added to the roads in the first quarter of 2023, but only 7,802 new chargers were added – a ratio of 39 new EVs for every new public port – more than five times higher than recommended ratio of 7:1. Contrary to recent narratives, the U.S. is falling further behind in installing publicly available chargers for the number of EVs that are being sold, and that government regulations (both state and federal) require in the near future.

Infrastructure Disparities by Geography

Geographic disparities in charging infrastructure are pervasive. At the end of the first quarter in 2023, nearly 30 percent of all public charging infrastructure was located in California, which had 36 percent of all registered EVs.



Vehicles in Operation and Charging by State

Public Charging Outlets And Registerd EVs (as of 3/31/2023)

	EV Level 2	EV DC Fast	H2** Fueling	Total	Percent EVs of Total VIO***	Share of Registered EVs****	EVs Per Charger	Additional Chargers Needed to Support 25% EV VIO*****	EVs Per 10K Residents
AK	79	28	-	107	0.45%	0.08%	24	20,329	34.85
AL	460	242	-	702	0.25%	0.38%	18	181,702	25.89
AR	598	89	-	687	0.23%	0.19%	9	97,523	21.36
AZ	2,088	697	-	2,785	1.24%	2.56%	31	243,970	119.07
CA*	29,113	8,806	56	37,975	3.91%	36.56%	32	1,076,479	308.53
CO*	3,304	737	-	4,041	1.49%	2.42%	20	190,457	142.09
CT*	1,129	371	-	1,500	1.13%	1.01%	22	105,066	94.19
DC	792	44	-	836	2.54%	0.26%	10	11,415	124.16
DE	242	122	-	364	0.89%	0.24%	22	32,310	84.41
FL	5,510	1,795	-	7,305	1.11%	6.25%	29	661,130	97.91
GA	3,009	846	-	3,855	0.79%	2.21%	19	331,998	70.21
HI	756	57	1	814	2.18%	0.75%	31	40,192	175.81
IA	429	244	-	673	0.34%	0.32%	16	112,995	33.91
ID	236	83	-	319	0.49%	0.29%	30	69,676	54.48
IL	2,178	749	-	2,927	0.88%	2.68%	31	357,776	70.11
IN	714	363	-	1,077	0.43%	0.80%	25	217,856	39.82
KS	824	173	-	997	0.40%	0.35%	12	102,862	40.30
KY	497	112	-	609	0.28%	0.34%	19	144,550	25.28
LA	343	159	-	502	0.23%	0.26%	17	135,372	18.76
MA*	4,952	620	-	5,572	1.42%	2.32%	14	188,549	112.10
MD*	2,997	740	-	3,737	1.32%	2.01%	18	178,106	111.06
ME*	651	193	-	844	0.80%	0.32%	13	46,765	80.05
MI	2,008	560	-	2,568	0.59%	1.51%	20	300,705	50.54
MN*	1,247	307	-	1,554	0.68%	1.05%	22	182,224	62.17
MO	1,988	308	-	2,296	0.47%	0.79%	12	200,256	43.23
MS	264	88	-	352	0.13%	0.12%	11	106,288	13.29
MT	147	113	-	260	0.33%	0.15%	19	55,031	47.62
NC	2,076	745	-	2,821	0.68%	1.94%	23	338,159	62.39
ND	113	65	-	178	0.15%	0.04%	7	28,254	16.08
NE	342	108	-	450	0.35%	0.22%	16	74,206	37.66
NH	292	137	-	429	0.85%	0.34%	27	47,351	84.19
NJ*	1,856	811	-	2,667	1.47%	3.17%	40	254,858	118.83
NM	399	160	-	559	0.54%	0.32%	19	70,461	51.27
NV*	1,016	427	-	1,443	1.67%	1.25%	29	87,840	137.18
NY*	8,051	1,213	-	9,264	1.23%	4.24%	15	401,604	72.35
OH	2,303	478	-	2,781	0.48%	1.53%	18	378,402	43.78
OK	380	654	-	1,034	0.64%	0.88%	28	162,486	74.20
OR*	1,799	614	-	2,413	1.79%	2.04%	28	133,537	162.55
PA	2,483	776	-	3,259	0.66%	2.17%	22	389,297	56.63
RI*	592	79	-	671	0.87%	0.22%	11	29,504	69.53
SC	678	290	-	968	0.37%	0.59%	20	189,407	38.90
SD	104	94	-	198	0.21%	0.06%	11	35,518	24.27
TN	1,243	288	-	1,531	0.46%	0.94%	21	240,802	46.38
TX	4,807	1,661	-	6,468	0.75%	5.44%	28	860,186	63.32
UT	1,582	272	-	1,854	1.25%	1.10%	20	103,571	116.55
VA*	2,206	888	-	3,094	0.97%	2.21%	24	268,540	86.58
VT*	744	105	-	849	1.65%	0.27%	11	18,932	146.21
WA*	3,319	847	-	4,166	1.87%	3.92%	31	245,220	173.53
WI	798	265	-	1,063	0.46%	0.74%	23	187,743	42.26
WV	245	107	-	352	0.20%	0.10%	9	55,054	17.61
WY	117	95	-	212	0.21%	0.04%	7	23,206	24.30
U.S.	**104,100**	**29,825**	**57**	**133,982**	**1.17%**	**100.00%**	**25**	**10,015,719**	**102.02**

*Denotes states that have adopted California's ZEV program; **Hydrogen count denotes stations
*** VIO is vehicles in operation; **** State share of U.S. Total; *****Calculated at 1:7 ratio at 25 percent of the existing state fleet. Ratio derived from CEC AB 2127 Report of July 14, 2021; VIO at the end of the 1st quarter was about 284 million vehicles (25% = 71 million)
Source: Figures compiled by Alliance for Automotive Innovation with registered vehicle data provided by S&P Global Mobility as of March 31, 2023; Charging information from U.S. Department of Energy Alternative Fuels Data Center, as of 3/31/2023

REGISTRATIONS

EV registrations as a share of all registered light-duty vehicles are 1.17 percent (as of March 31, 2023). There are about 284 million registered light-duty vehicles in the U.S.

At the end of Q1 2023, California accounted for 36.6 percent of all registered light-duty EVs in the U.S.

States with highest portion of total EVs registered:

1. CA* (1,220,435, 3.91%)
2. DC (8,722, 2.54%)
3. HI (24,973, 2.18%)
4. WA* (130,767, 1.87%)
5. OR* (68,120, 1.79%)
6. NV* (41,627, 1.67%)
7. VT* (9,157, 1.65%)
8. CO* (80,928, 1.49%)
9. NJ* (105,862, 1.47%)
10. MA* (77,376, 1.42%)
11. MD* (67,110, 1.32%)

States with worst ratio of registered EVs per non-proprietary public charger:

1. NJ*
2. CA*
3. WA*
4. HI
5. AZ
6. IL
7. ID
8. NV*
9. FL
10. OK

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Spotlight On Battery Components and Critical Minerals

EV Tax Credit Eligibility

EV tax credit eligibility changed significantly with passage of the Inflation Reduction Act in August 2022. In addition to North American vehicle assembly requirements, price caps, and income limits, new critical mineral and battery component rules were recently instituted. Specifically, Congress split the revised $7,500 EV tax credit in two and based eligibility on EVs meeting certain requirements related to the origin of the battery's critical minerals and components:

1. To be eligible for half of the incentive ($3,750), fifty percent (increasing to 100 percent by 2029) of the value of the battery components must be manufactured or assembled in North America.
2. To be eligible for the other half of the incentive ($3,750), forty percent of the value of critical minerals (increasing to 80 percent by 2027) in the EV battery must be extracted or processed in the U.S. – or in a country with a *U.S. free trade agreement or recycled in North America.*

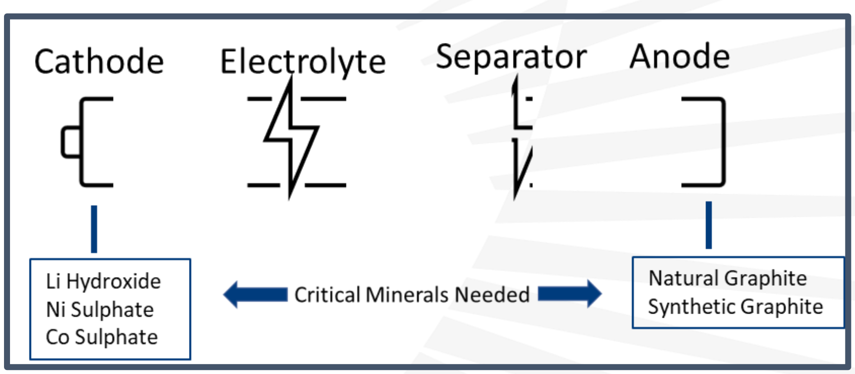
After December 31, 2023, a vehicle may not qualify for the credit if any "components" contained in its battery are "manufactured or assembled by a foreign entity of concern."[11] Additionally, after December 2024, a clean vehicle will not qualify for any portion of the tax credit if it contains any critical minerals that were "extracted, processed, or recycled by a foreign entity of concern."

The ability of automakers to certify that certain vehicles qualify for the revised tax credit will largely hinge on meeting the new battery requirements and excluding minerals and components from foreign entities of concern – which the U.S. Department of Treasury plans to issue guidance on later this year.

North American Battery Cell Production Capacity on Track to Meet Demand Thanks to Automotive and Battery Partner Investments: Automakers and battery producers have announced plans to build nearly two dozen battery factories in the U.S. over the next few years – increasing GWh capacity from today's 99 to 742. This 649 percent increase represents an investment of over $57 billion. While the domestic infrastructure to build the batteries is increasing, these plants will rely on materials sourced abroad for the foreseeable future.

Battery Components (50% of Tax Credit)

There are four major components of an EV battery cell. The cathode, anode, electrolyte, and separator. The cathode and anode (collectively the electrodes) account for nearly two-thirds of the overall battery cost and require a combination of critical minerals.



- **Cathode:** "The cathode is the positively charged electrode of the battery. When a battery is discharged, both electrons and positively-charged molecules flow from the anode to the cathode, which stores both until the

[11] Benchmark Minerals, Report, Q1 2023

battery is charged again. That means that cathodes effectively determine the performance, range, and thermal safety of a battery, and therefore of an EV itself, making them one of the most important components." [12] BloombergNEF estimates the cathode represents 51 percent of the overall cell cost.[13]

- **Anode:** "The anode is another significant component of the battery, and it makes up 12% of the total cost—around one-fourth of the cathode's share. The anode in a Li-ion cell is typically made of natural or synthetic graphite, which tends to be less expensive than other battery commodities."[14]

- **Other EV Battery Cell Components:** "The manufacturing process, which involves producing the electrodes, assembling the different components, and finishing the cell, makes up 24% of the total cost."[15]

Battery Component Supply and Demand

Increased demand for batteries in North America, driven not only by EVs but also energy storage systems, is forecast to increase nearly six-times between 2022 and 2030, according to Benchmark Minerals Intelligence (BMI).[16] Automakers and battery suppliers are investing billions of dollars to build battery cell manufacturing plants to meet the increased demand through the end of this decade.

However, while the capacity is being built up to manufacture the cells, there is a forecast lack of upstream (mining) and midstream (processing and cathode/anode production) capacity to supply the new battery factories with the necessary battery materials.

As noted previously, in order to qualify for the federal government's EV tax credit (30D) in 2023, 50 percent of the value of battery components must be manufactured or assembled in North America, ramping up to 100 percent by 2029. However, Benchmark Minerals forecasts that in 2030 North America will only be able to fulfil 3.5 percent and 3.4 percent of its domestic cathode and anode demands domestically.[17]

Cathode Supply

China (designated as a foreign entity of concern) is predicted to remain the largest producing country for cathode active materials from today through at least 2040. BMI expects Chinese production to comprise 71 percent of the globally produced cathode material – almost seven times the amount of the world's second largest producer, South Korea. [18]

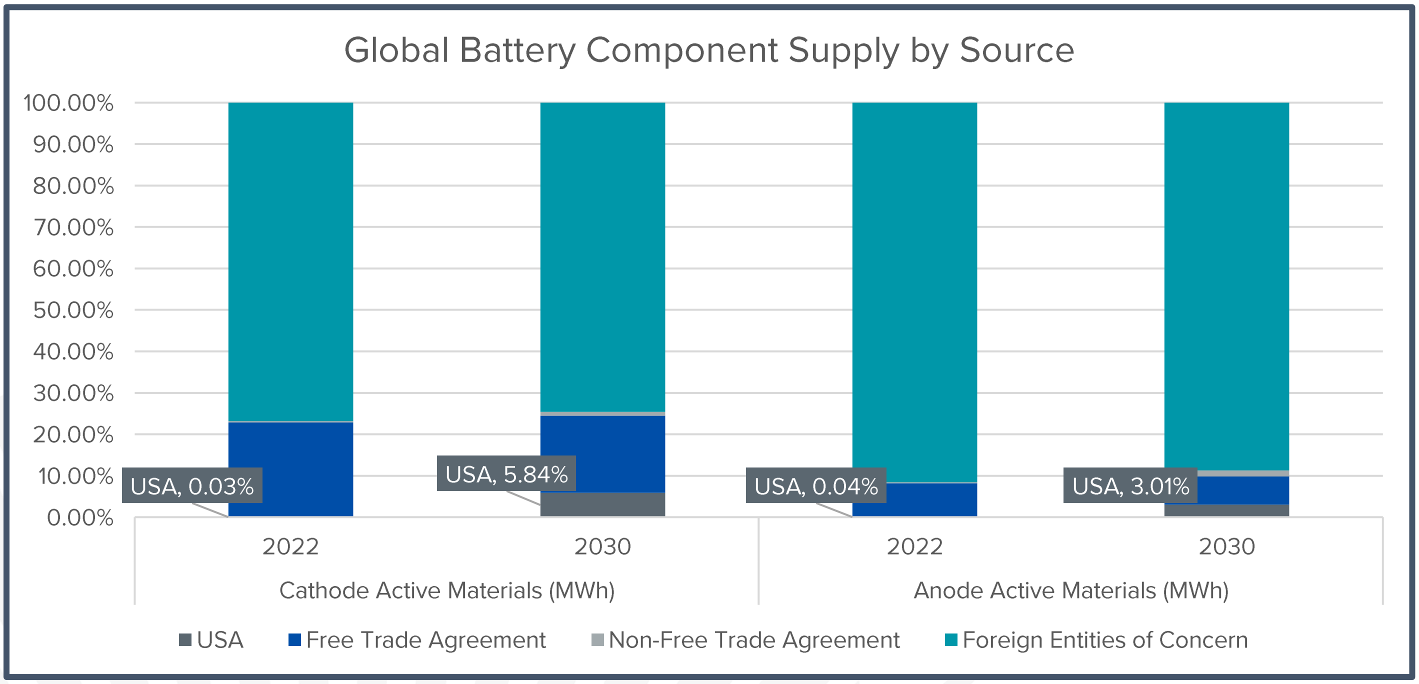
While there are five cathode facilities between the U.S. (4) and Canada (1), they are not at commercial scale yet. Even with additional facilities set to come online through the decade, North America's cathode production deficit is forecast to increase 3.5 times between now and 2030.[19]

Anode Supply

China currently has over 90 percent of the world's anode production capacity and will continue to represent 90 percent global anode output through 2030, despite global efforts to diversify the supply chain.[20] There are only two operating anode facilities in North America, one of which is a small-scale plant.[21]

[12] Elements, Govind Bhutada, "Breaking Down the Cost of an EV Battery Cell," 2/22/22
[13] Elements, Govind Bhutada, "Breaking Down the Cost of an EV Battery Cell," 2/22/22
[14] Elements, Govind Bhutada, "Breaking Down the Cost of an EV Battery Cell," 2/22/22
[15] Elements, Govind Bhutada, "Breaking Down the Cost of an EV Battery Cell," 2/22/22
[16] "Can North America Build A Battery Supply Chain?," *Benchmark Minerals Intelligence*, 11/17/22
[17] "Can North America Build A Battery Supply Chain?," *Benchmark Minerals Intelligence*, 11/17/22
[18] Benchmark Minerals, Report, Q1 2023
[19] "Can North America Build A Battery Supply Chain?," *Benchmark Minerals Intelligence*, 11/17/22
[20] Benchmark Minerals, Report, Q1 2023
[21] "Can North America Build A Battery Supply Chain?," *Benchmark Minerals Intelligence*, 11/17/22

While the capacity exists to build the cells, there is a forecast lack of upstream (mining) and midstream (processing and cathode/anode production) capacity to supply the new battery factories with the necessary battery materials not just here in the United States but globally.



[22]

Critical Minerals (50% of Tax Credit)

Cathode Active Materials

Cathodes are composed of various metals (in refined forms) depending on cell chemistry, typically including lithium and nickel. Common cathode compositions used in modern batteries include:

- Lithium iron phosphate (LFP)
- Lithium nickel manganese cobalt (NMC)
- Lithium nickel cobalt aluminum oxide (NCA) [23]

Forecasts for North American lithium supply are relatively favorable, even though not all raw material needs can be met domestically. BMI forecasts over 60 percent of domestic battery needs can be met with domestic supply of lithium. Similarly, refined nickel production in the region could meet nearly 60 percent of 2030 battery demand.[24] However, geological concentration of nickel in Indonesia currently limits IRA-compliant sourcing options. The U.S. will have to rely on free trade agreements to fill the gaps in demand – competing with other nations for the same raw materials to meet their own battery needs.

[22] Benchmark Minerals, Report, Q1 2023; US has free trade agreements (FTA) in force with 20 countries; Recent announcement to incl. Japanese trade: Australia, Bahrain, Canada, Chile, Colombia, Costa Rica, Dominican Republic, El Salvador, Guatemala, Honduras, Israel, Jordan, Mexico, Morocco, Nicaragua, Oman, Panama, Peru, Singapore, South Korea and Japan.
[23] Elements, Govind Bhutada, "Breaking Down the Cost of an EV Battery Cell," 2/22/22
[24] "Can North America Build A Battery Supply Chain?," *Benchmark Minerals Intelligence*, 11/17/22

Lithium

Despite diverse geographic lithium development around the world, the role of China in the chemical conversion and processing phase of manufacturing represents 61 percent global output in 2023 as the nation manufactures and sells large quantities of lithium hydroxide and lithium carbonate.[25]

Chinese lithium chemical company ownership is "forecast to maintain elevated levels around 70 percent by 2030, placing potentially challenging procurement conditions as determined by the final IRA definitions for 'Foreign Entity of Concern.'"[26]

Nickel

China has a leading position in the control of value-add nickel sulphate manufacturing – and it is expected to continue. They currently have a leading share of 71 percent and are forecast to remain dominant at 62 percent in 2040.

"Chinese manufacturers also dominat[e] the nickel production landscape, accounting for 7 of the top 8 refiners currently operational. Benchmark forecasts China will remain a leader in developing nickel sulphate capacity."[27]

Cobalt

The majority of cobalt is associated with the Democratic Republic of Congo (DRC) which controls 72 percent of the supply (2022), while Indonesia (7 percent) and Australia (3 percent) provide supplementary volumes. The extreme concentration of geological cobalt occurrences in the DRC limits non-free trade agreement procurement options.

"Maturity of the Chinese cobalt refining segment of the battery value chain is evident from the market share of global production, offering over three-quarters output during 2023. There is limited growth and diversification of alternative sources, with Chinese supply falling only to 73% by 2040."[28]

"Global deficits at all stages of the market [are] likely to drive scarcity in global [cathode active materials] markets and leave Western companies with stiff competition from China. This is particularly true when considered in light of the large upstream lead times needed for critical materials which could drive extra market tightness due to inefficiently linking resources to uses."[29]

Anode Active Materials

The U.S. imports 100 percent of its graphite, the mineral used for battery anodes, and almost one-third comes from China. China also converts over 90 percent of the world's graphite into anode material.[30]

"China currently supplies almost 65% of the world's graphite and produces five times more of the raw material than the second largest global producer, Mozambique, and more than all the other producers combined."[31]

[25] Benchmark Minerals, Report, Q1 2023
[26] Benchmark Minerals, Report, Q1 2023
[27] Benchmark Minerals, Report, Q1 2023
[28] Benchmark Minerals, Report, Q1 2023
[29] Benchmark Minerals, Report, Q1 2023
[30] Adam Ragozzino, "Graphite: The Next Battery Mineral Bottleneck," *Wards Intelligence*, 5/24/23
[31] Adam Ragozzino, "Graphite: The Next Battery Mineral Bottleneck," *Wards Intelligence*, 5/24/23

Graphite

As battery cell production in the U.S. ramps up over the decade, the U.S. Geological Survey estimates approximately 1.2 million tons per year of spherical purified graphite (the processed form used in batteries) will be needed. Only six graphite processing plants will come online during that same time period. And, according to the USGS, there are only four graphite mines in the U.S. and of those only two are coming into operation.[32] “Benchmark Mineral Intelligence also foresees a structural deficit this year and estimates the world needs 109 more graphite mines by 2035 to meet projected demand.”[33]

Mine Permitting

While it only takes two to four years to bring battery cell and active component manufacturing online, mining and refining can take 10-15 years of development and an additional ten years until nameplate capacity is reached. The lag time between permitting, opening, mining, and refining available critical minerals domestically and processing the material into components and building the cells is significant, leaving the U.S. dependent on foreign sources of minerals for at least a decade.

On a global scale, Benchmark Minerals forecasts more than 300 new mines could need to be built over the next decade to meet demand for EV and energy storage batteries.

“At least 384 new mines for graphite, lithium, nickel and cobalt are required to meet demand by 2035, based on average mine sizes in each industry, according to Benchmark. Taking into account recycling of raw materials, the number is around 336 mines.”[34]

[32] Adam Ragozzino, “Graphite: The Next Battery Mineral Bottleneck,” *Wards Intelligence*, 5/24/23
[33] Adam Ragozzino, “Graphite: The Next Battery Mineral Bottleneck,” *Wards Intelligence*, 5/24/23
[34] Benchmark Minerals, “More Than 300 New Mines Required To Meet Battery Demand By 2035,” 9/6/22