

# EV Cost Parity – The Opportunities and Challenges Ahead

---



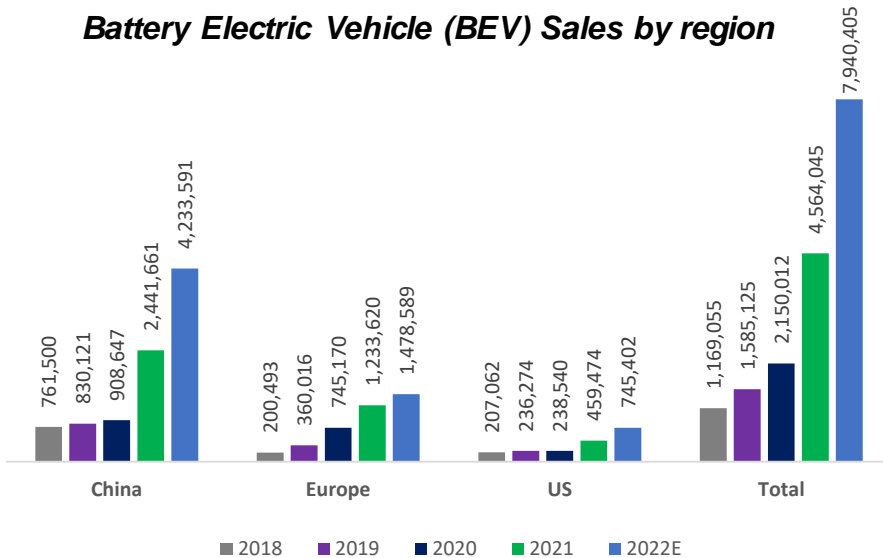


The information contained in this webcast is intended for the exclusive use of the addressee(s) and may contain confidential or privileged information. Any review, use, disclosure, distribution or copying of this transmittal is prohibited except by or on behalf of the intended recipient. The contents of this webcast, including any attachments, is to be used solely for informational purposes, and should not be regarded as an offer, or a solicitation of an offer to buy or sell a security, financial instrument or service discussed herein. Opinions in this communication constitute the current judgment of the author as of the date and time of this webcast and are subject to change without notice. Information herein is believed to be reliable but Wolfe Research, LLC and its affiliates, including but not limited to WR Securities, LLC doing business as Wolfe Research Securities, makes no representation that it is complete or accurate. Recipients are encouraged to seek financial advice from their financial advisor regarding the appropriateness of investing in a security or financial instrument referred to in this webcast and should understand that statements regarding the future performance of the financial instruments or the securities referenced herein may not be realized. We will not be able to accept orders by email to buy or sell securities, transfer funds or which involve time-sensitive instructions. Subject to applicable law, Wolfe Research and its affiliates reserve the right to intercept, monitor and retain communications transmitted through its systems. For important disclosures regarding companies covered by Wolfe Research, LLC, please see <http://www.WolfeResearch.com/disclosures>.

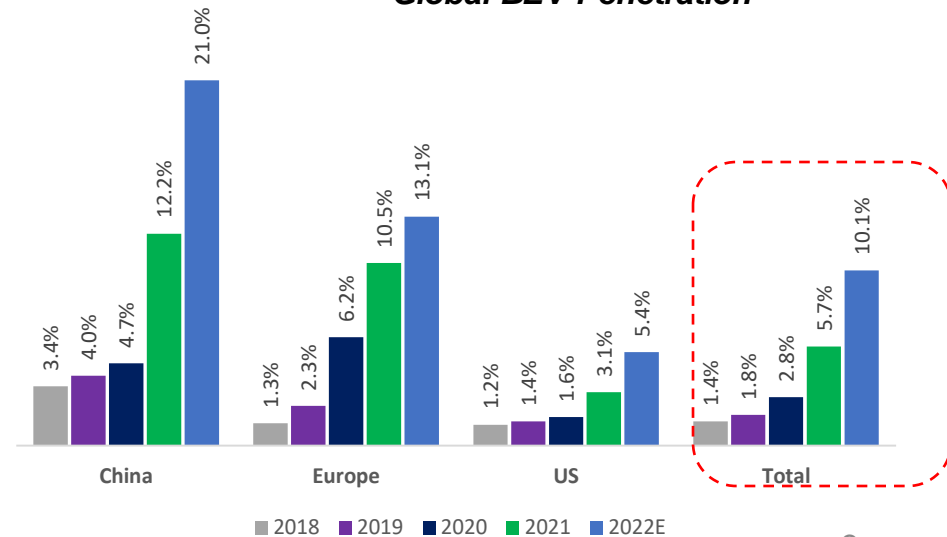
# What's Happening in the EV Market?

- BEV penetration tracking towards 10% in 2022 (7.5 MM units), up sharply vs ~2% (1.6 MM) in 2019.
- **Several Key Drivers:**
  - **China** – Largest EV market and biggest driver of global EV growth. Huge Govt Support for EVs (Subsidies, 0% Purchase Tax, License Plates, funding for low-cost New Entrants).
  - **Europe** – CO2 emission standards (required BEV penetration of ~8%-10% by 2021 vs 2% in 2019); plans to ban ICE Vehicles in some major cities; govt incentives (including up to €6k subsidies in Germany; €6k in France; tax benefits across several major markets).
  - **US** – Incentives in certain States (CA, NY, NJ). But penetration relatively low. Growth mainly driven by consumer interest in tech / environment + to some extent, EV's have become more mainstream.

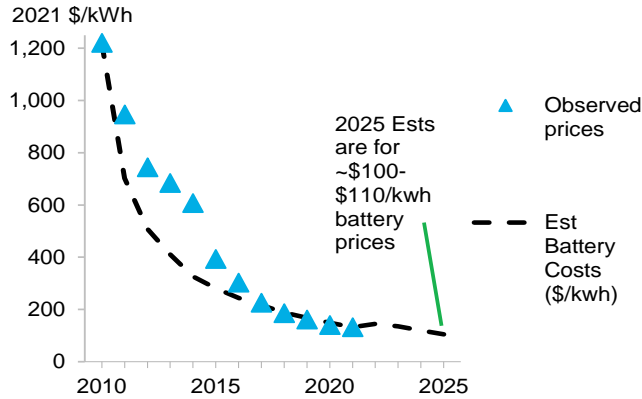
**Battery Electric Vehicle (BEV) Sales by region**



**Global BEV Penetration**



## The \$45/kWh Production Credit should bring EV costs down to parity vs. ICEs



Internal Combustion	Estimate Cost	EV Components	Current	Cost w/EV Manufacturing Credits	Est 2025 w/EV Manufacturing Credits
Engine*	\$4,500	Cost/kWh	\$165	\$165	\$165
Transmission	\$1,200	Manufacturing Credit (\$/kwh)		(\$45)	(\$45)
Fuel System	\$750	Expected Battery Cost Reduction (\$/kwh)			(\$55)
Exhaust/Aftertreatment	\$700	kWh	75	75	75
Other	\$250	<b>Est Battery Cost</b>	<b>\$12,395</b>	<b>\$9,020</b>	<b>\$4,895</b>
<b>Total</b>	<b>\$7,400</b>	Electric Motor/Gearbox	\$900	\$900	\$847
<b>Total Range Estimate</b>	<b>\$6000-\$8000</b>	On-Board Charger & DC/DC Conv	\$700	\$700	\$659
		Battery Disconnect	\$700	\$700	\$659
		Battery Mgmt System	\$300	\$300	\$282
		HV Cabling / T&Cs	\$710	\$710	\$668
		<b>Total*</b>	<b>\$15,705</b>	<b>\$12,330</b>	<b>\$8,010</b>
		<b>Incremental Cost vs ICE</b>	<b>\$8,305</b>	<b>\$4,930</b>	<b>\$0</b>
		Available Purchase Credits (upto)		\$7,500	\$7,500

### Drivers of cost reduction

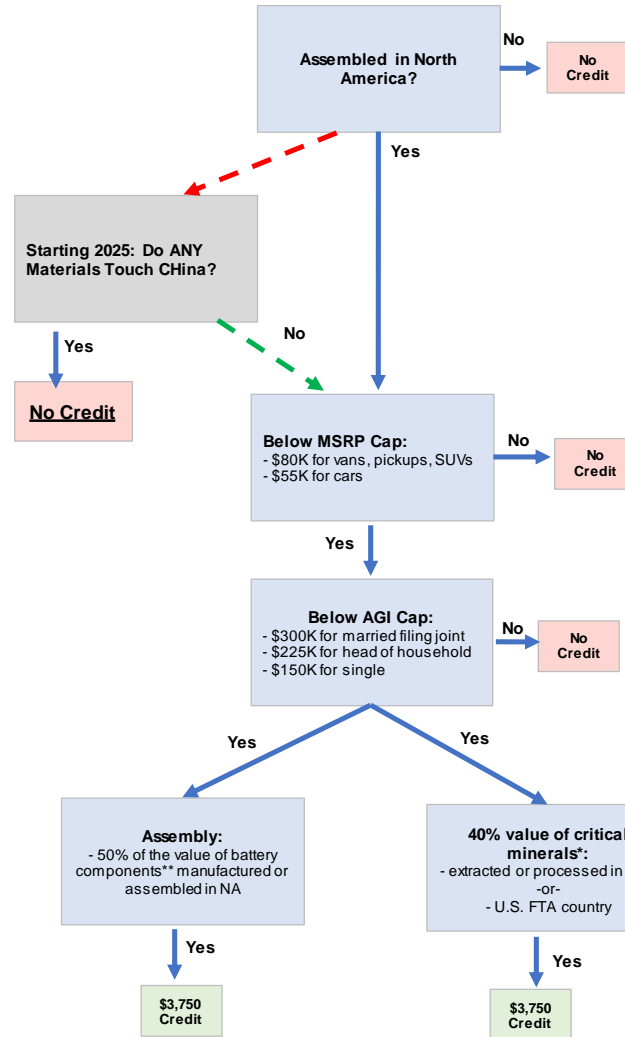
F Battery Pack Cost Decline	\$/kWh	% Reduction
Starting Pack Cost	\$ 220.0	
Array Design	\$ 11.0	5%
Pack Structural Optimization	\$ 8.8	4%
Manufacturing process	\$ 13.2	6%
Cell Format	\$ 4.4	2%
Value Chain	\$ 33.0	15%
Localization	\$ 17.6	8%
<b>Mid-Decade Estimate</b>	<b>\$ 132.0</b>	<b>40%</b>

GM Battery Pack Cost Decline	\$/kWh	% Reduction
Starting Pack Cost	\$ 185.0	
Cell Design	\$ 14.8	8%
Manufacturing	\$ 14.8	8%
Anode Material	\$ 7.4	4%
Cathode Material	\$ 16.7	9%
Pack/Vehicle Integration	\$ 20.4	11%
<b>Mid-Decade Estimate</b>	<b>\$ 110.0</b>	<b>40%</b>

TESLA Battery Pack Cost Decline	\$/kWh	% Reduction
Starting Pack Cost	\$ 133.0	
Cell Vehicle Integration	\$ 6.0	7%
Cathode Material	\$ 10.2	12%
Anode Material	\$ 4.3	5%
Cell Factory	\$ 15.3	18%
Cell Design	\$ 11.9	14%
<b>Mid-Decade Estimate</b>	<b>\$ 85.0</b>	<b>56%</b>

**Purchase Credit:** Could be worth up to \$7,500 for a EVs bought by retail customers and at least \$7,500 for any EV bought by Commercial customers.

Source 2: Purchase Credits



- \*\*Battery Components**
- 50% threshold before 2024
  - 2024 - 2025- 60%
  - 2026 - 70%
  - 2027 - 80%
  - 2028 90%
  - 2028+ 100%

- \*Critical Minerals**
- 40% threshold before 2024
  - 2024 - 50%
  - 2025 - 60%
  - 2026 - 70%
  - 2026+ 80%

# Buying a US EV in 2023/2024/2025 Could Get A Lot Cheaper



## Model 3

Est. Delivery: Dec 2022

[See Early Delivery Options for 32128](#)

Purchase Price	Potential Savings*
----------------	--------------------

**272mi**   **140mph**   **5.8sec**  
 Range (EPA est.)   Top Speed   0-60 mph

Rear-Wheel Drive

Model 3	\$46,990
---------	----------

Purchase Credit	(\$7,500)
Manufacturing Credit	(\$3,400)
Internal Cost Redux	(\$5,000)
<b>Net Price</b>	<b>\$31,090</b>



## Model Y

Est. Delivery: Dec 2022 - Mar 2023

[See Early Delivery Options for 32128](#)

Purchase Price	Potential Savings*
----------------	--------------------

**330mi**   **135mph**   **4.8sec**  
 Range (EPA est.)   Top Speed   0-60 mph

Dual Motor All-Wheel Drive

Model Y Long Range	\$65,990
--------------------	----------

Purchase Credit	(\$7,500)
Manufacturing Credit	(\$3,400)
Internal Cost Redux	(\$5,000)
<b>Net Price</b>	<b>\$50,090</b>

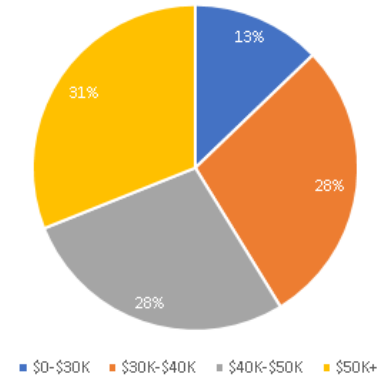


## Model 2

Est Delivery: 2024

Cost to Build	\$20,000
Gross Price	\$25,000-\$35,000
Purchase Credit:	(\$7,500)

U.S. Sales Breakdown by ASP



# EV Challenge 1 – Strange Interpretation of the IRA Rules

1. Disincentivizes cost reduction
2. Disproportionate advantages for Non-US companies

## Tesla Model Y



Vehicle Weight (varying trims): 5,302-5,712 lbs

## Volkswagen ID.4 AWD Pro S



Vehicle Weight: 6,063 lbs

### Monthly Payments for a leased EV could decline 14%

Lease payment for a 36 month, 10,000 mileage lease without credit

Model	Trim	Advertised Vehicle Price	Lease Payment Without \$7,500 Credit	% of YTD US EV Sales (Through Nov.)
Model Y	Long Range AWD	\$65,990	\$789	28%
Model 3	Long Range AWD	\$57,990	\$669	26%
Mustang Mach E	Premium AWD	\$59,215	\$789	5%
Model X	AWD	\$120,990	\$1,729	4%
Model S	AWD	\$104,990	\$1,479	4%
Bolt EUV	Premier	\$37,885	\$601	3%
Ioniq 5	SEL	\$52,840	\$886	3%
<b>Total</b>				<b>75%</b>

Lease payment for a 36 month, 10,000 mileage lease with credit

Model	Trim	Advertised Vehicle Price With \$7,500 Credit	Lease Payment With \$7,500 Credit	% Savings
Model Y	Long Range AWD	\$ 58,490	\$684	13%
Model 3	Long Range AWD	\$ 50,490	\$565	16%
Mustang Mach E	Premium AWD	\$ 51,715	\$671	15%
Model X	AWD	\$ 113,490	\$1,608	7%
Model S	AWD	\$ 97,490	\$1,357	8%
Bolt EUV	Premier	\$ 30,385	\$455	24%
Ioniq 5	SEL	\$ 45,340	\$741	16%
<b>Average Savings</b>				<b>14%</b>

### Estimated EV Volume growth from lease affordability improvement

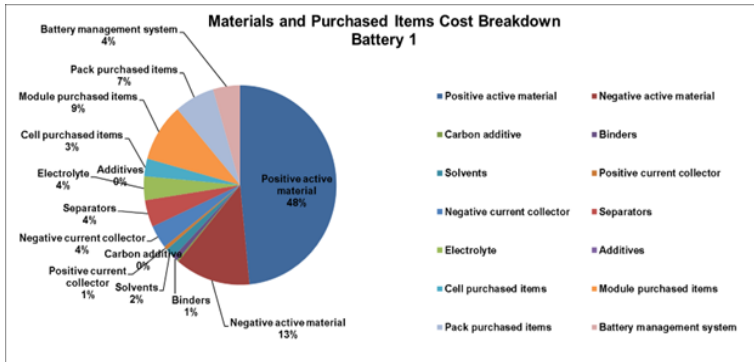
Potential US EV Sales Growth in 2023 from Lease Payment Savings	
EV Lease Mix	28%
2022E US EV Sales	745,402
Estimated 2022 Leased EVs	206,476
Average Savings	14%
Additional sales at 1x elasticity	29,421
<b>Potential 2023 Sales Growth</b>	<b>4%</b>

# EV Challenge 2: In North America, securing IRA compliant material and meeting North American Content requirements will take time

To get Manufacturing Credit, you need to have US battery manufacturing, and many weren't prepared



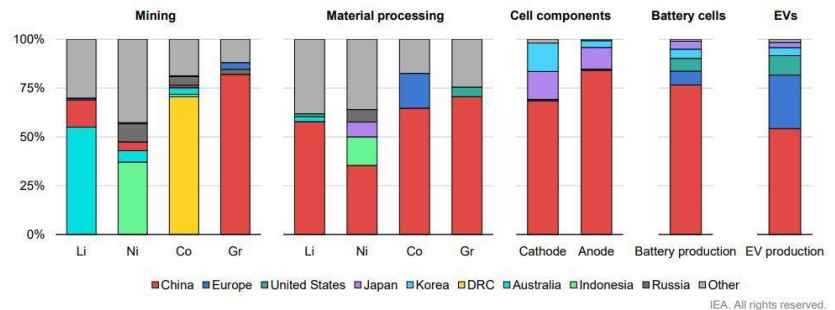
	% of US LV Auto Sales (Today)	Installed NA Battery Capacity by Mid-Decade (gwh)	# of EVs/yr Supported	Expect Start of Battery Production
GM	16%	160	>1.0 MM	Active
Tesla	4%	140	1.5 MM	Active
Ford	13%	86	~0.8 MM	2025
STLA	11%	45	0.5 MM	Q1 2024
Hyundai/Kia	11%	20	0.25 MM	2025
Toyota	15%	6	0.08 MM	2025/2026
Honda	7%	NA		
Nissan	5%	NA		



**Cathode Manufacturing critical to achieving the threshold >50% NA Content and \$3,750 Purchase Credit**



NA OEMs also have to wean themselves off of China Supply by 2025... and that won't be easy

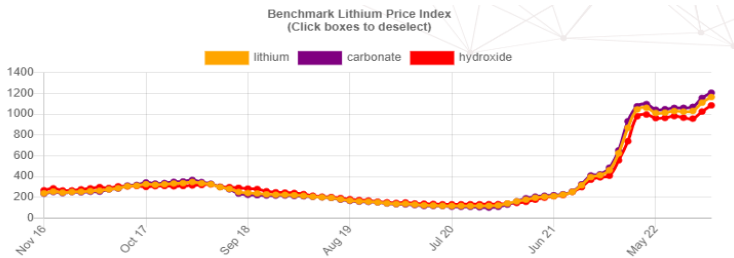




## Breakdown of Global Avg Battery Costs

	2021 (May Spot Prices)	May 2022 Spot Prices	Sept 2022 Spot Prices	Current
<b>Cathode Materials \$/kWh</b>	<b>22.50</b>	<b>40.76</b>	<b>35.35</b>	<b>39.95</b>
Anode Material \$/kWh	7.91	8.50	9.00	9.16
Electrolyte	1.74	5.89	6.11	7.79
Separator	2.44	3.33	3.33	3.39
Current Collector	2.04	2.05	2.00	1.81
Other Materials	5.00	7.00	6.00	6.00
<b>Total Materials \$/kWh</b>	<b>41.64</b>	<b>67.53</b>	<b>61.79</b>	<b>68.10</b>
Other Costs	21.00	30.00	30.00	24.00
Profit	12.53	19.51	18.36	18.42
<b>Implied Cell Cost</b>	<b>75.17</b>	<b>117.04</b>	<b>110.15</b>	<b>110.52</b>
Pack Cost	33.00	31.00	31.00	31.00
Usable kwh	85%	85%	85%	85%
<b>Total Cost \$/kWh</b>	<b>\$127</b>	<b>\$174</b>	<b>\$166</b>	<b>\$166</b>

### Surging Lithium and Nickel Prices



## EV Demand for Nickel and Lithium

### LFP Capacity

Est Lithium Carbonate Supply	2021	2025	2030
<b>BNEF Capacity, tons (Risk-adjusted)</b>	<b>431,785</b>	<b>845,704</b>	<b>1,024,664</b>
Est Demand, Non- Auto	245,130	387,466	569,378
<b>Implied Auto Capacity, tons</b>	<b>186,655</b>	<b>458,238</b>	<b>455,286</b>
Incremental Capacity Adds		0	204,933
Est Adj Auto Capacity, tons	186,655	458,238	660,219
LCE kg/kwh		0.55	0.55
<b>Implied kwh</b>		<b>833,160,000</b>	<b>1,200,397,818</b>
Est Weighted-avg kwh/vehicle		64	67
Implied Vehicles (MMs)		13.0	17.9
WRe Est LFP-Cathode BEVs (, MMs)	1.8	6.6	16.2

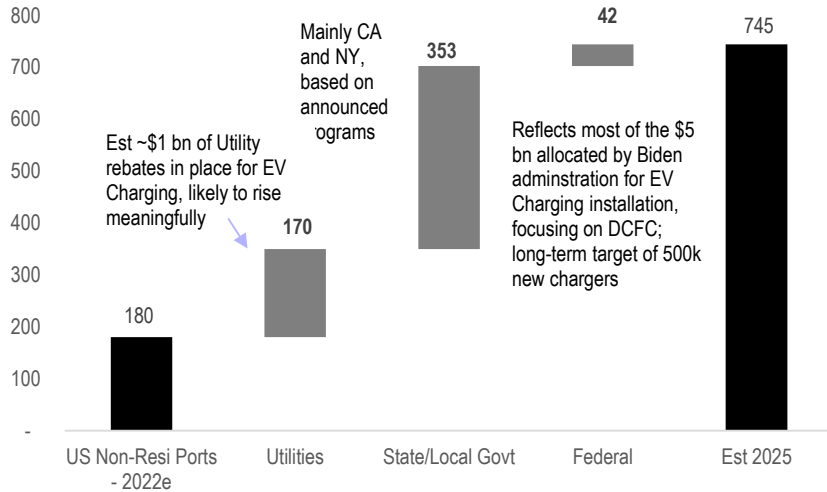
### Nickel-based Capacity

Est Lithium Hydroxide Supply	2021	2025	2030
<b>BNEF Capacity(Risk-adjusted), tons, l</b>	<b>189,011</b>	<b>545,994</b>	<b>598,613</b>
Est Demand, Non- Auto	33,444	124,529	302,891
<b>Implied Auto Capacity, tons</b>	<b>155,567</b>	<b>421,465</b>	<b>295,722</b>
Incremental Capacity Adds	0	0	149,653
Total Capacity, tons		421,465	445,376
LH kg/kwh		0.20	0.202
<b>Implied kwh</b>		<b>2,086,461,517</b>	<b>2,204,830,293</b>
Est Weighted-avg kwh/vehicle		75	80
Implied Vehicles		27.8	27.6
WRe Est Ni-Cathode BEVs (, MMs)	3.0	10.3	21.6

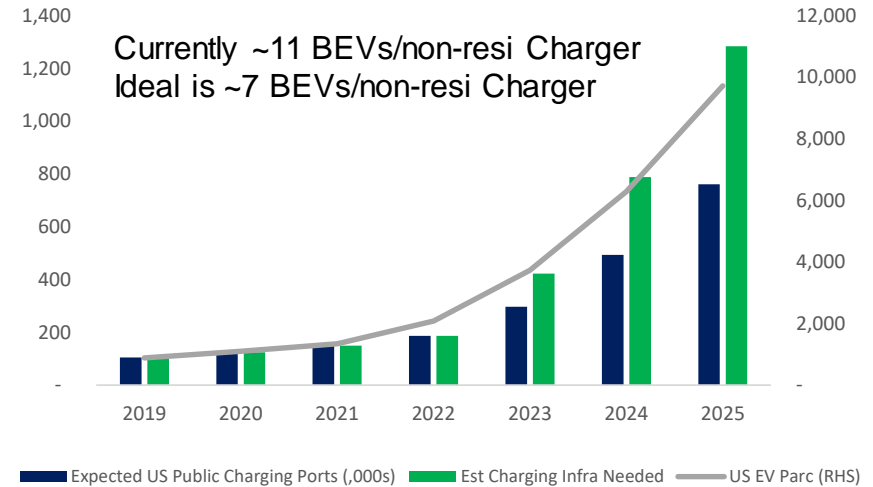
### Implied Battery Gwh per Region

Europe	53.2	127.7	407.8
China	63.5	187.2	376.0
NA	43.4	265.6	419.3
Other	19.8	104.1	271.9
<b>Global Nickel-based Ba</b>	<b>179.9</b>	<b>684.6</b>	<b>1474.9</b>
Est Nickel kg/kwh	0.78	0.79	0.82
<b>Total Nickel (tonnes)</b>	<b>139,819</b>	<b>542,554</b>	<b>1,203,998</b>
<b>Global Nickel Supply (Tonn</b>	<b>2,700,000</b>	<b>2,981,018</b>	<b>3,372,748</b>
% EVs	5%	18%	36%

**Significant Utility, State, and Federal Funding available to support a ~4x increase in non-Resi Charging...**



**...but we don't see this as enough given the rapid growth ahead in US EV adoption**



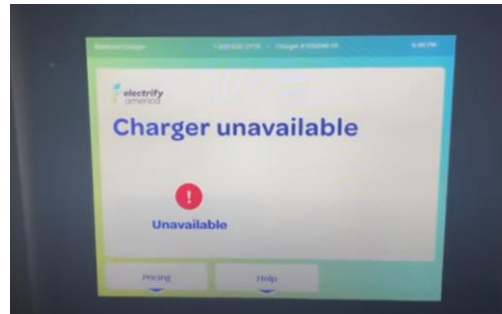
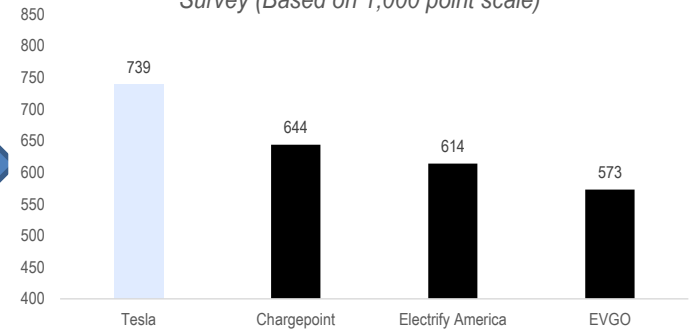
**Meanwhile, Network reliability is a major pain-point for EV drivers, especially non-Tesla Owners**

Ex: Electrify America claims to have ~3,600 active DC Fast Chargers with 98-99% uptime....

...but there is no industry standard for "uptime", and drivers often find charger that don't work

Charging providers score poorly on Customer Satisfaction surveys

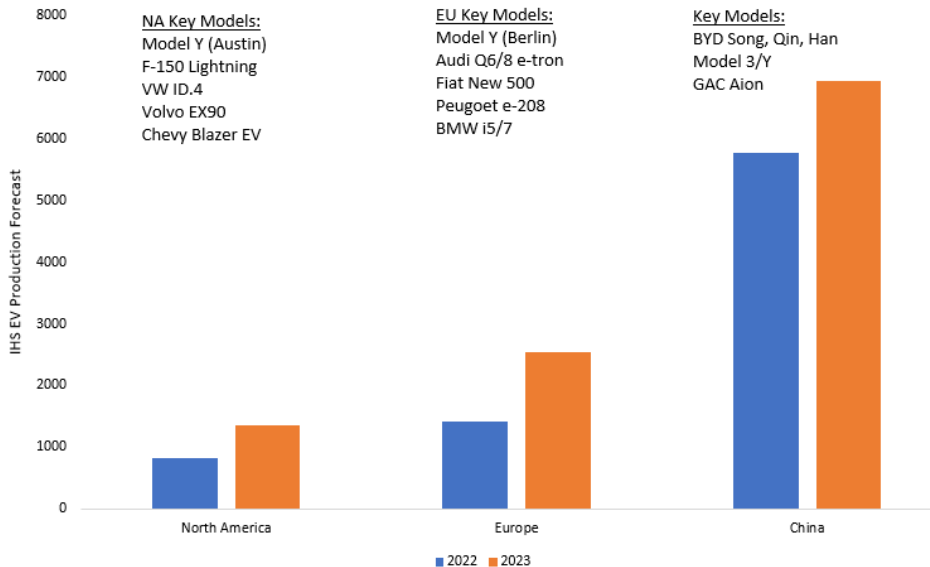
JD Power DC Fast Charger Customer Satisfaction Survey (Based on 1,000 point scale)



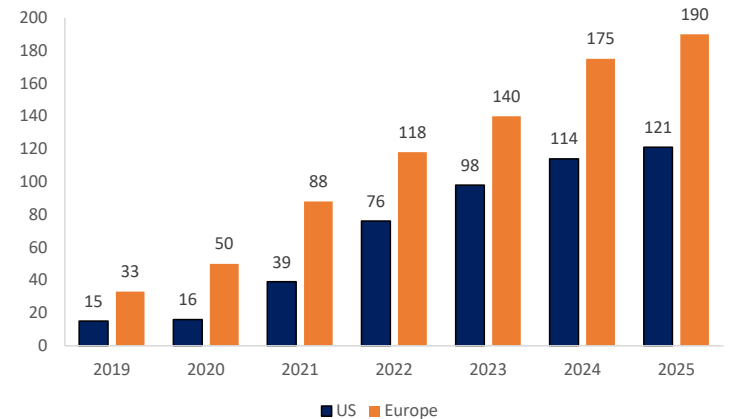
# EV Outlook – Forecasts supported by specific model introductions

## Contribution to 2023 EV growth by company

North America (Units 000s)			Europe (Units 000s)			China		
Company	Contribution to Annual Growth	YoY Growth	Company	Contribution to annual growth	YoY Growth	Company	Contribution to annual growth	YoY Growth
General Motors	157	30%	Tesla	295	26%	BYD	347	30%
Tesla	137	26%	Volkswagen	246	22%	Tesla	203	17%
Ford	76	15%	Stellantis	215	19%	SAIC	93	8%
Volkswagen	44	9%	Renault-Nissan-Mitsubishi	117	10%	Volkswagen	86	7%
Rivian	43	8%	BMW	79	7%	Toyota	78	7%
Mercedes-Benz	38	7%	Mercedes-Benz	51	5%	Dongfeng	78	7%
Lucid Motors	12	2%	Geely	38	3%	Geely	53	5%
Hyundai	7	1%	Ford	34	3%	Mercedes-Benz	52	4%
Geely	6	1%	Fisker	26	2%	Renault-Nissan-Mitsubishi	52	4%
Stellantis	3	0%	TOGG	6	1%	General Motors	50	4%
Zoox	2	0%	Dongfeng	6	0%	Great Wall	49	4%
Arrival	1	0%	Hyundai	4	0%	NIO	43	4%
Jianghuai	0	0%	Toyota	3	0%	Changan	34	3%
Canoo	0	0%	Tata	2	0%	Honda	30	3%
BMW	0	0%	e.GO	1	0%	Hyundai	24	2%
Fisker	0	0%	B-ON	1	0%	Lixiang Auto	24	2%
Honda	0	0%	Iveco Group	0	0%	Xpeng EV	22	2%
Karma Automotive	0	0%	Karsan	0	0%	BMW	22	2%
Oshkosh Defense	0	0%	Daimler Truck	0	0%	Other	2	0%
Toyota	0	0%			(0%)	Niutron	6	1%
Renault-Nissan-Mitsubishi	-5	-1%				Chery	-16	(1%)
<b>YoY Growth Total North America</b>	<b>520</b>		<b>YoY Growth Total Europe</b>	<b>1,125</b>		Leapmotor	-24	(2%)
						Hoizon EV	-25	(2%)
						SAIC-General Motors-Wuling	-90	(8%)
						<b>YoY Growth Total China</b>	<b>1176</b>	



## Increasing Number of EV Models available



## Updated BEV Forecasts – we see EV growth moderating in 2023/2024

Units (MMs)	2019	2020	2021	2022	2023	2024	2025	2030
North America	0.3	0.3	0.6	0.8	1.6	2.5	3.8	6.6
Europe	0.4	0.7	1.2	1.5	1.8	2.1	3.0	9.7
China	0.8	0.9	2.4	4.2	4.8	5.2	6.9	13.9
<b>Global</b>	<b>1.6</b>	<b>2.2</b>	<b>4.6</b>	<b>7.9</b>	<b>10.0</b>	<b>12.0</b>	<b>16.9</b>	<b>37.8</b>

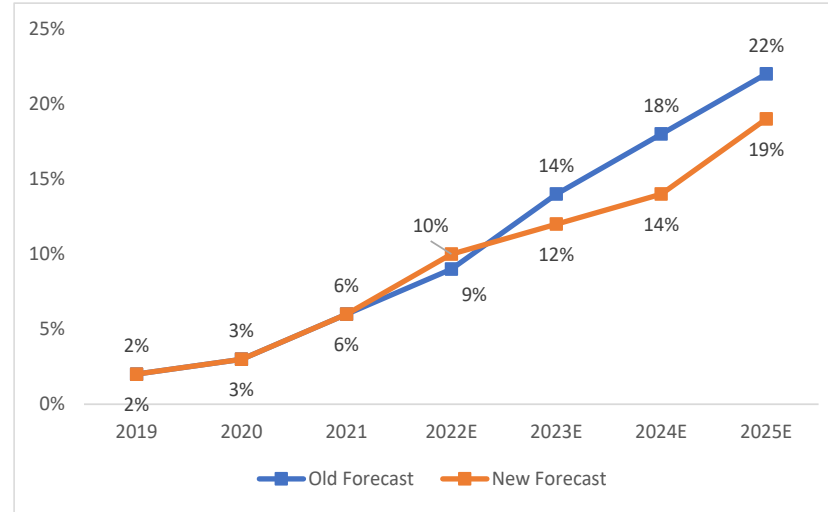
### y/y % growth

North America	14%	107%	36%	92%	57%	51%
Europe	101%	63%	25%	20%	22%	41%
China	9%	169%	73%	13%	8%	32%
<b>Global</b>	<b>36%</b>	<b>112%</b>	<b>74%</b>	<b>25%</b>	<b>21%</b>	<b>40%</b>

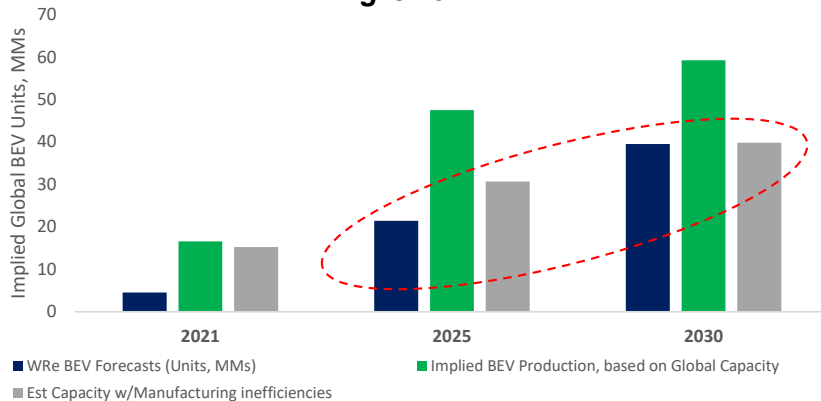
### Penetration Rate

North America	1%	2%	3%	5%	9%	14%	21%	39%
Europe	2%	6%	10%	13%	15%	18%	22%	60%
China	4%	5%	12%	21%	24%	25%	32%	55%
<b>Global</b>	<b>2%</b>	<b>3%</b>	<b>6%</b>	<b>10%</b>	<b>12%</b>	<b>14%</b>	<b>19%</b>	<b>40%</b>

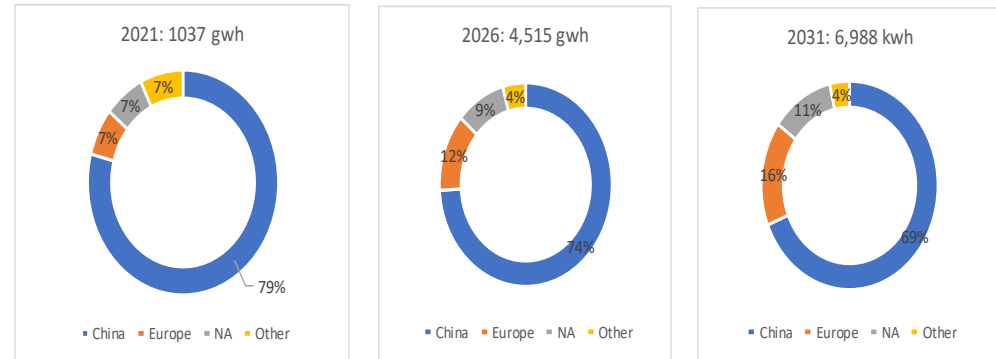
## Global BEV penetration



## We see enough BEV capacity to support rapid growth....



## ...with more than enough battery manufacturer capacity





## DISCLOSURE SECTION

### Analyst Certification:

The analyst of Wolfe Research, LLC primarily responsible for this research report whose name appears first on the front page of this research report hereby certifies that (i) the recommendations and opinions expressed in this research report accurately reflect the research analysts' personal views about the subject securities or issuers and (ii) no part of the research analysts' compensation was, is or will be directly or indirectly related to the specific recommendations or views contained in this report.

### Other Disclosures:

#### **Wolfe Research, LLC Fundamental Stock Ratings Key:**

- Outperform (OP): The security is projected to outperform analyst's industry coverage universe over the next 12 months.
- Peer Perform (PP): The security is projected to perform approximately in line with analyst's industry coverage universe over the next 12 months.
- Underperform (UP): The security is projected to underperform analyst's industry coverage universe over the next 12 months.

Wolfe Research, LLC uses a relative rating system using terms such as Outperform, Peer Perform and Underperform (see definitions above). Please carefully read the definitions of all ratings used in Wolfe Research, LLC research. In addition, since Wolfe Research, LLC research contains more complete information concerning the analyst's views, please carefully read Wolfe Research, LLC research in its entirety and not infer the contents from the ratings alone. In all cases, ratings (or research) should not be used or relied upon as investment advice and any investment decisions should be based upon individual circumstances and other considerations.

#### **Wolfe Research, LLC Sector Weighting System:**

- Market Overweight (MO): Expect the industry to outperform the primary market index for the region (S&P 500 in the U.S.) by at least 10% over the next 12 months.
- Market Weight (MW): Expect the industry to perform approximately in line with the primary market index for the region (S&P 500 in the U.S.) over the next 12 months.
- Market Underweight (MU): Expect the industry to underperform the primary market index for the region (S&P 500 in the U.S.) by at least 10% over the next 12 months.

#### **Wolfe Research, LLC Distribution of Fundamental Stock Ratings (As of January 11, 2023):**

- |               |     |                               |
|---------------|-----|-------------------------------|
| Outperform:   | 51% | 3% Investment Banking Clients |
| Peer Perform: | 37% | 2% Investment Banking Clients |
| Underperform: | 13% | 0% Investment Banking Clients |

Wolfe Research, LLC does not assign ratings of Buy, Hold or Sell to the stocks it covers. Outperform, Peer Perform and Underperform are not the respective equivalents of Buy, Hold and Sell but represent relative weightings as defined above. To satisfy regulatory requirements, Outperform has been designated to correspond with Buy, Peer Perform has been designated to correspond with Hold and Underperform has been designated to correspond with Sell.

Wolfe Research Securities and Wolfe Research, LLC have adopted the use of Wolfe Research as brand names. Wolfe Research Securities, a member of FINRA ([www.finra.org](http://www.finra.org)) is the broker-dealer affiliate of Wolfe Research, LLC and is responsible for the contents of this material. Any analysts publishing these reports are dually employed by Wolfe Research, LLC and Wolfe Research Securities.

The content of this report is to be used solely for informational purposes and should not be regarded as an offer, or a solicitation of an offer, to buy or sell a security, financial instrument or service discussed herein. Opinions in this communication constitute the current judgment of the author as of the date and time of this report and are subject to change without notice. Information herein is believed to be reliable but Wolfe Research and its affiliates, including but not limited to Wolfe Research Securities, makes no representation that it is complete or accurate. The information provided in this communication is not designed to replace a recipient's own decision-making processes for assessing a proposed transaction or investment involving a financial instrument discussed herein. Recipients are encouraged to seek financial advice from their financial advisor regarding the appropriateness of investing in a security or financial instrument referred to in this report and should understand that statements regarding the future performance of the financial instruments or the securities referenced herein may not be realized. Past performance is not indicative of future results. This report is not intended for distribution to, or use by, any person or entity in any location where such distribution or use would be contrary to applicable law, or which would subject Wolfe Research, LLC or any affiliate to any registration requirement within such location. For additional important disclosures, please see [www.WolfeResearch.com/Disclosures](http://www.WolfeResearch.com/Disclosures).

The views expressed in Wolfe Research, LLC research reports with regards to sectors and/or specific companies may from time to time be inconsistent with the views implied by inclusion of those sectors and companies in other Wolfe Research, LLC analysts' research reports and modeling screens. Wolfe Research communicates with clients across a variety of mediums of the clients' choosing including emails, voice blasts and electronic publication to our proprietary website.

Copyright © Wolfe Research, LLC 2023. All rights reserved. All material presented in this document, unless specifically indicated otherwise, is under copyright to Wolfe Research, LLC. None of the material, nor its content, nor any copy of it, may be altered in any way, or transmitted to or distributed to any other party, without the prior express written permission of Wolfe Research, LLC.

This report is limited for the sole use of clients of Wolfe Research. Authorized users have received an encryption decoder which legislates and monitors the access to Wolfe Research, LLC content. Any distribution of the content produced by Wolfe Research, LLC will violate the understanding of the terms of our relationship.