Analysis of the impact of automaker strategies on lithium price elasticity using a novel bottom-up demand model: Supplementary Information File

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1. Related Literature: EV Rollout Forecasting

Table S1.1 Electric vehicle demand forecast studies.

Reference	Author and publication year	Title	Years considered	Chemistries considered	Region(s) considered	Summary
[1]	(IEA, 2023)	Critical Minerals Market Review 2023	2022-2050	NMC, NCA, LFP, Na-ion, All-solid-state (Li or Si), Li-S	Global (29 regions)	3 EV rollout scenarios, 5 chemistry scenarios
[2]	(Zhang et al., 2023)	Trade-off between critical metal requirement and transportation decarbonization in automotive electrification	2010-2050	NMC, NCA, LFP, Li-air, Li-S (based on Xu et al., 2020)	Global (16 regions)	4 EV share scenarios, 4 chemistry scenarios. LDV and HDV. ICE, PHEV, BEV, and FCEV. GHG analysis
[3]	(Maisel et al., 2023)	A forecast on future raw material demand and recycling potential of lithium-ion batteries in electric vehicles	2020-2040	NMC, NCA, LFP, LMFP, LMO, LMNO	Global	3 EV rollout scenarios. 2 chemistry scenarios
[4]	(Aguilar Lopez et al., 2023)	Evaluating strategies for managing resource use in lithium-ion batteries for electric vehicles using the global MATILDA model	2014-2050	NMC, NCA, LFP, Li-air, Li-S (based on Xu et al., 2020)	Global	3 EV rollout scenarios (IEA), 5 chemistry scenarios (Xu et al.), 3 vehicle size scenarios. 3 recycling scenarios
[5]	(Baars et al., 2021)	Circular economy strategies for electric vehicle batteries reduce reliance on raw materials	2017-2050	NMC, NCA, All-solid-state, “alternative chemistries”	EU	3 rollout scenarios. 3 chemistry scenarios. Cobalt focus
[6]	(Xu et al., 2020)	Future material demand for automotive lithium-based batteries	2005-2050	NMC, NCA, LFP, Li-air, Li-S	Global	2 IEA EV rollout scenarios. 3 chemistry scenarios
[7]	(Hao et al., 2019)	Impact of transport electrification on critical metal sustainability with a focus on the heavy-duty segment	2000-2100	Avg. of multiple (Appx. Li intensity of NMC 111)	Global (10 regions)	4 scenarios based on rollout, range, and battery durability. Rollout differs by region. Battery size decreases over time
[8]	(Weil et al., 2018)	The Issue of Metal Resources in Li-Ion Batteries for Electric Vehicles	2015-2050	NMC, NCA, LFP, LMO, LTO	Global	3 chemistry scenarios based on LFP share
[9]		Electric Vehicle Outlook 2023	2022-2035	Current (Undisclosed),	Global	Multiple scenarios on EV rollout, battery

				All-solid-state, Na-ion		size, chemistry, pack cost, charging infrastructure, etc.

Table S1.2 Major automaker electrification targets

Automaker	Target	Automaker	Target
BMW Group	30% EV by 2025. 50% EV by 2030 [10]	Renault	100% EV in Europe by 2030 [11]
Ford	100% EV by 2040. 50% EV by 2030, 100% EV in Europe by 2035 [10], [12]	Nissan	44% EV by 2026. 55% EV by 2030 [10], [13]
Geely	600,000 EV sales in 2023 [10]	Mitsubishi	50% EV by 2030. 100% EV by 2035 [10]
Volvo	50% EV by 2025. 100% EV by 2030 [10], [14]	Stellantis	100% BEV in Europe and 50% BEV in US by the end of 2030. [10], [15]
GM	1 million EV production in North America by 2025. 100% EV by 2035 [10], [16], [17]	Lancia	100% EV by 2028 [10]
SAIC-GM-Wuling	40% NEV sales in China by 2025 [10]	Subaru	50% EV by 2030 [18]
Honda	2 million EV production by 2030 [10]	Suzuki	First EV model to be sold in 2025 [19]
Hyundai	940,000 BEV sales by 2026. 2 million BEV production by 2030 [20], [21]	Tata	50% EV by 2030 [22]
Kia	1 million EV sales by 2026. 1.6 million EV sales by 2030 [23]	Jaguar	100% EV by 2025 [10]
Mahindra	20-30% electric SUV sales by 2027 [24]	JLR	100% EV by 2036 [10]
Mazda	25% BEV sales by 2030 [10]	Toyota	1.5 million BEV sales by 2026. 3.5 million BEV sales by 2030 [10], [25]
Mercedes Benz Group	50% EV by 2026. 100% EV by 2030 [26]	Volkswagen	11% EV in 2023. 20% EV in 2025. 100% EV in Europe by 2033 [10], [27]
RNM Alliance	90% of models to be EVs by 2030. 220 GWh production by 2030 [28]	Porsche	80% EV in Europe by 2030 [10]

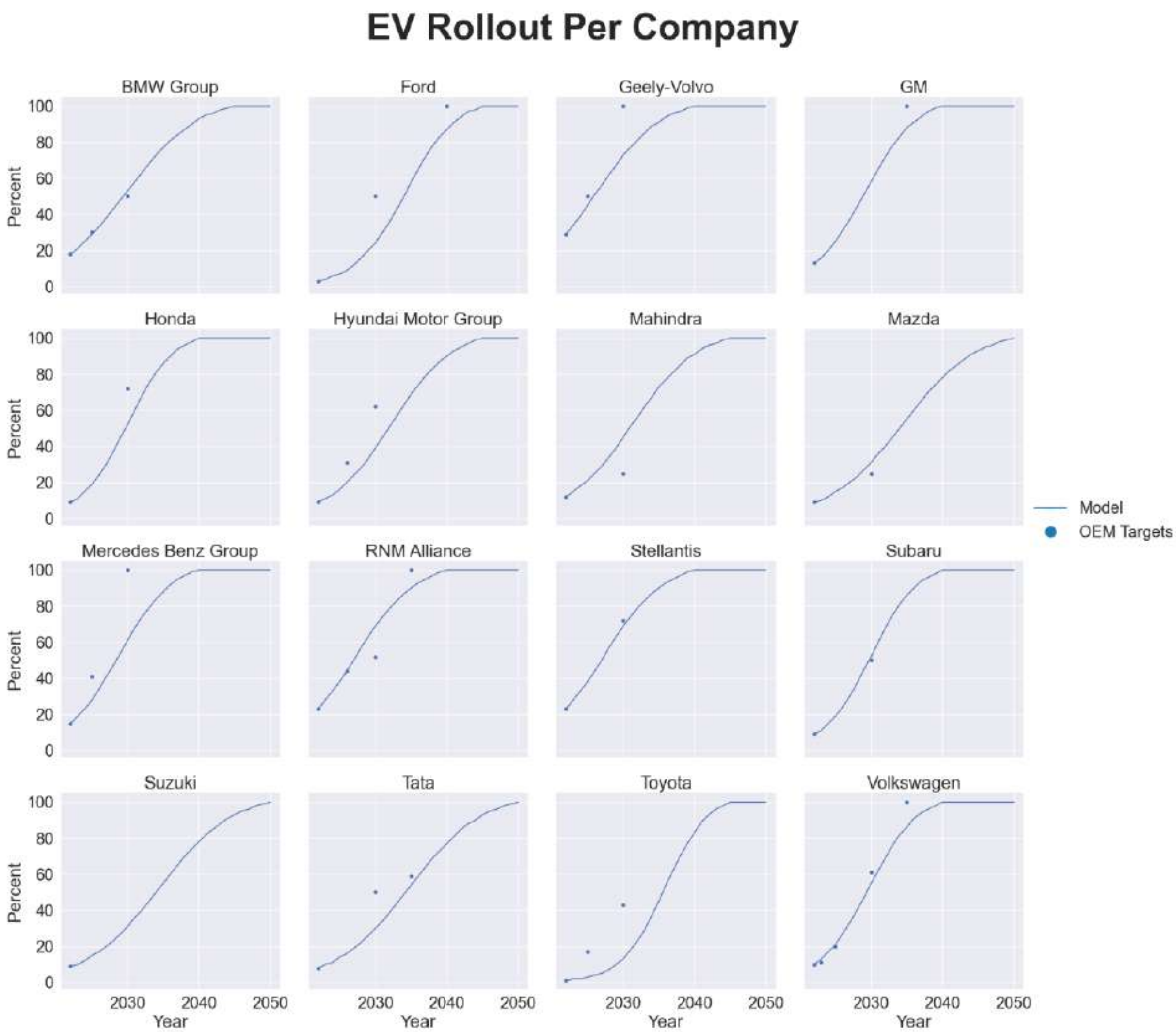


Figure S1.1 Comparison of modelled EV rollout to other forecasts and OEM targets for each automaker.

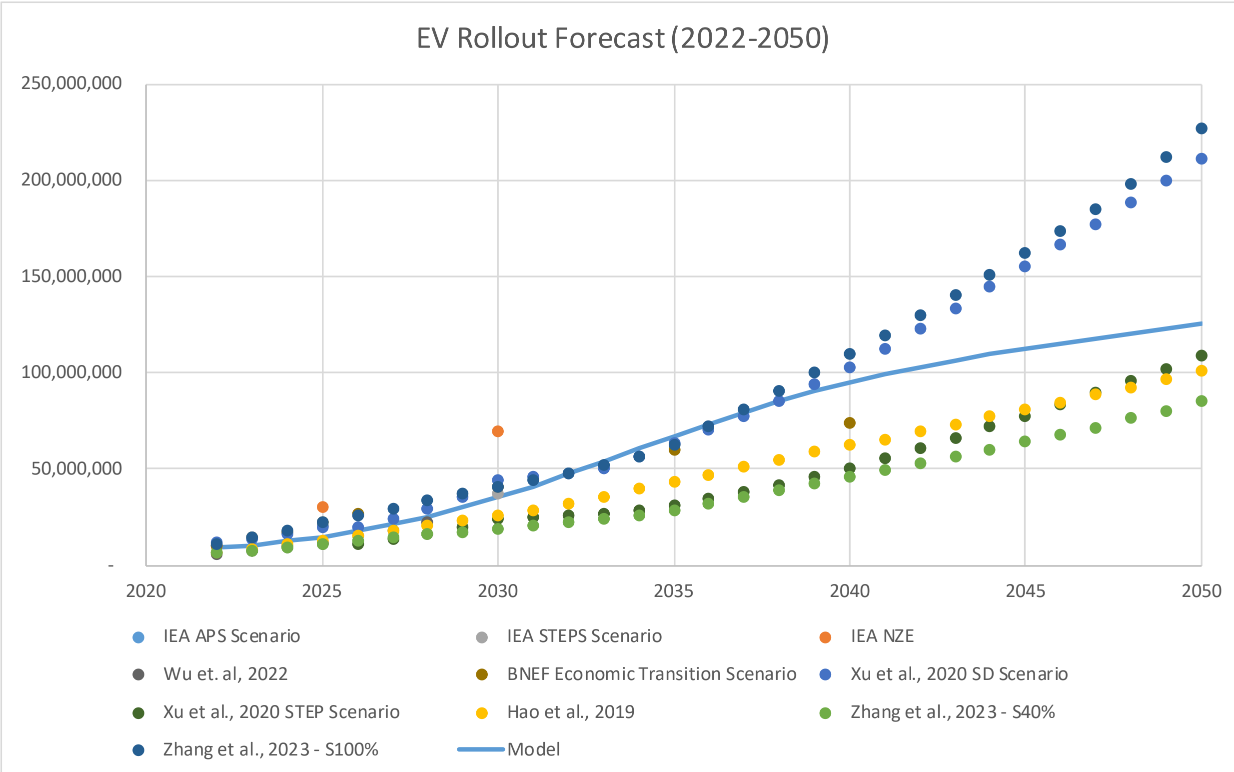


Figure S1.2 Model EV rollout forecast compared to literature. The model was calibrated to fit within projections from literature. The overall s-curve shape reflects overall growth in vehicle production, including ICEs, and rollout reaching 100% EV for automakers between 2040 and 2050.

2. Battery Technology

Battery Chemistry	Legacy	Emerging
High-performance	NMC/NCA	Li-metal
Low-cost	LFP	Na-ion

Table S2.1 Matrix of included battery chemistries. Each drive train has a different balance of high-performance and low-cost chemistries, with high-range BEVs using a greater share of high-performance chemistries. Over time, emerging chemistries replace legacy chemistries within their respective categories.

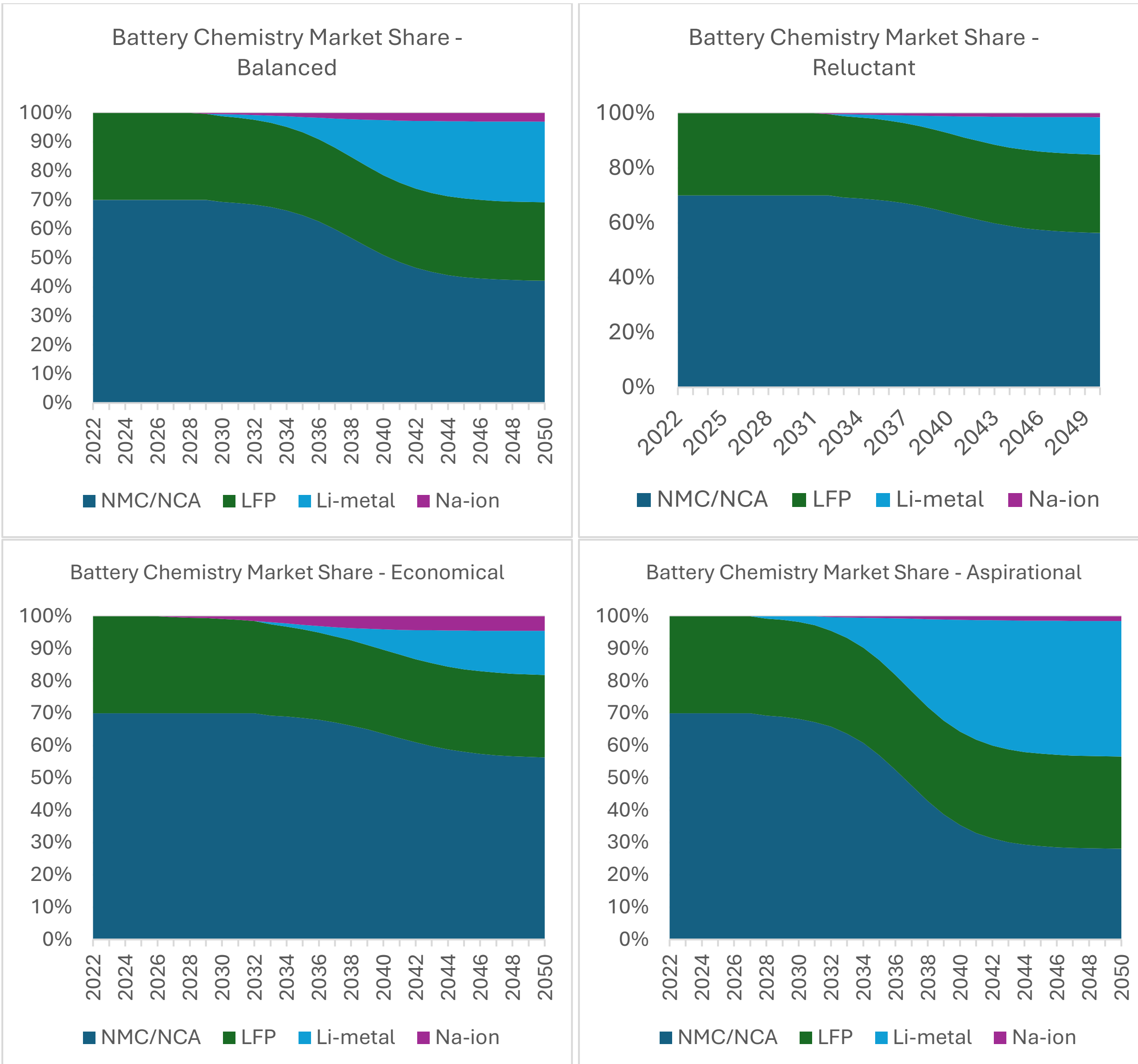


Figure S0.1 Model battery chemistry share projections based on "strategy". Each automaker is assigned one of four chemistry strategies that differentiate the rate of emerging chemistry adoption. The method for calculating these chemistry shares is available in Appendix A.

3. Scenario Analysis

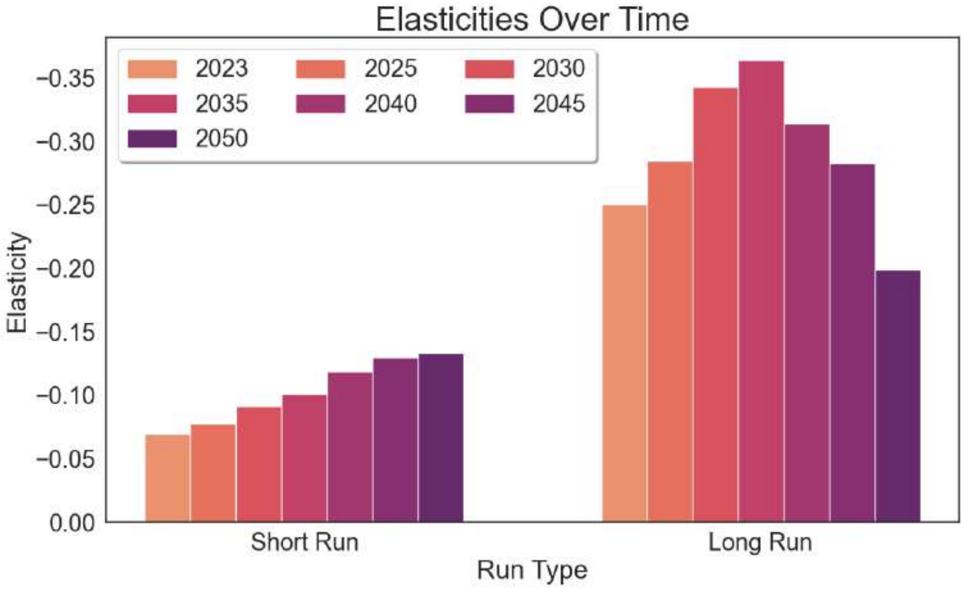
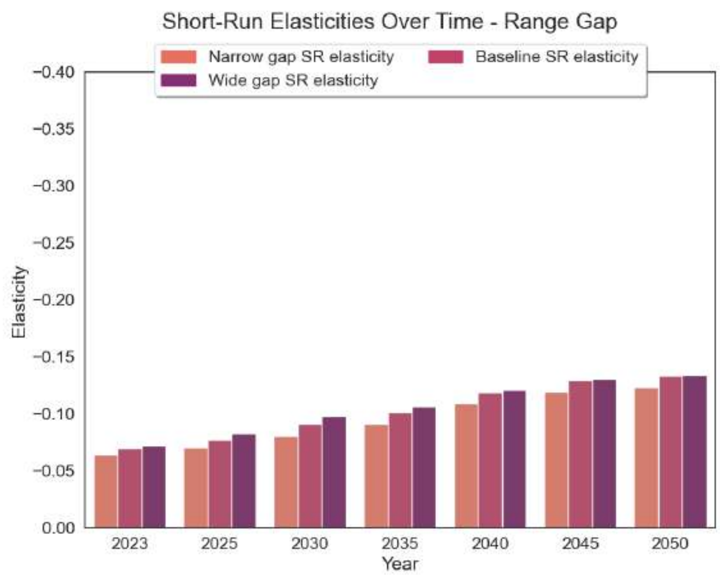
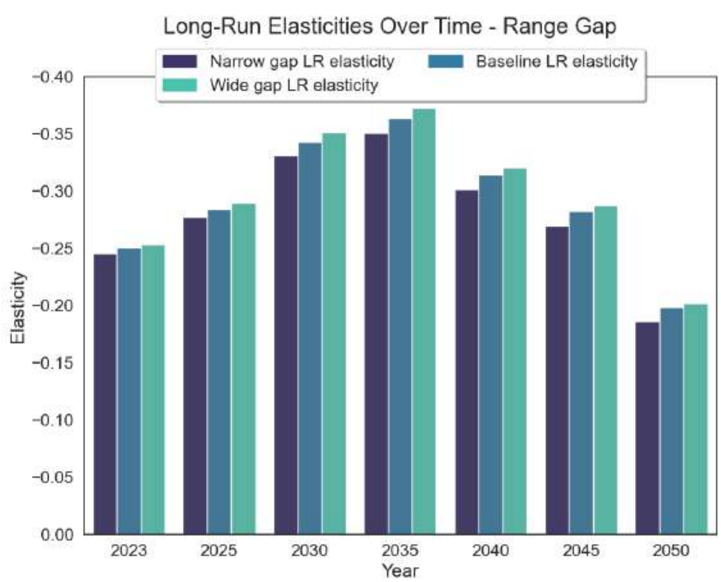


Figure S3.1. Short-run and long-run elasticity values over time. While the short-run elasticity to lithium price steadily increases, long-run increases only until 2035 when it falls off precipitously, approaching the short-run value. The long-run mechanism allows automakers *to delay EV rollout only until full electrification is reached. Therefore, removing the options of shifting production to ICEs or PHEVs reduces long-run elasticity.*





b)

Figure S3.2. a) Short-run and b) long-run elasticity trends with different range gaps between low- and high-range BEV models. Offering BEV models in more distinct range variants allows for quicker reduction of lithium demand in response to high LCE prices.

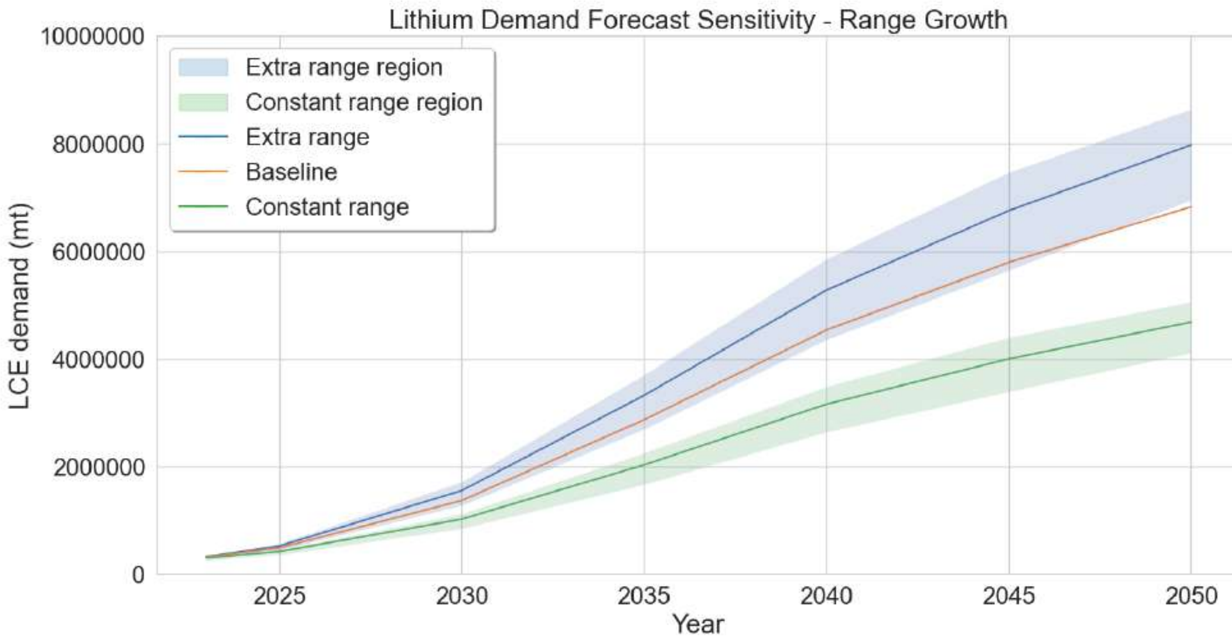


Figure S3.3. Lithium demand under different scenarios of range growth. The lines indicate demand at the baseline LCE price of $20/kg, while the shaded regions represent demand forecasts between $10 and $40/kg. In addition to lowering demand by 31% from the baseline, the constant range scenario also narrows the forecast region, indicating lower long-run elasticity.

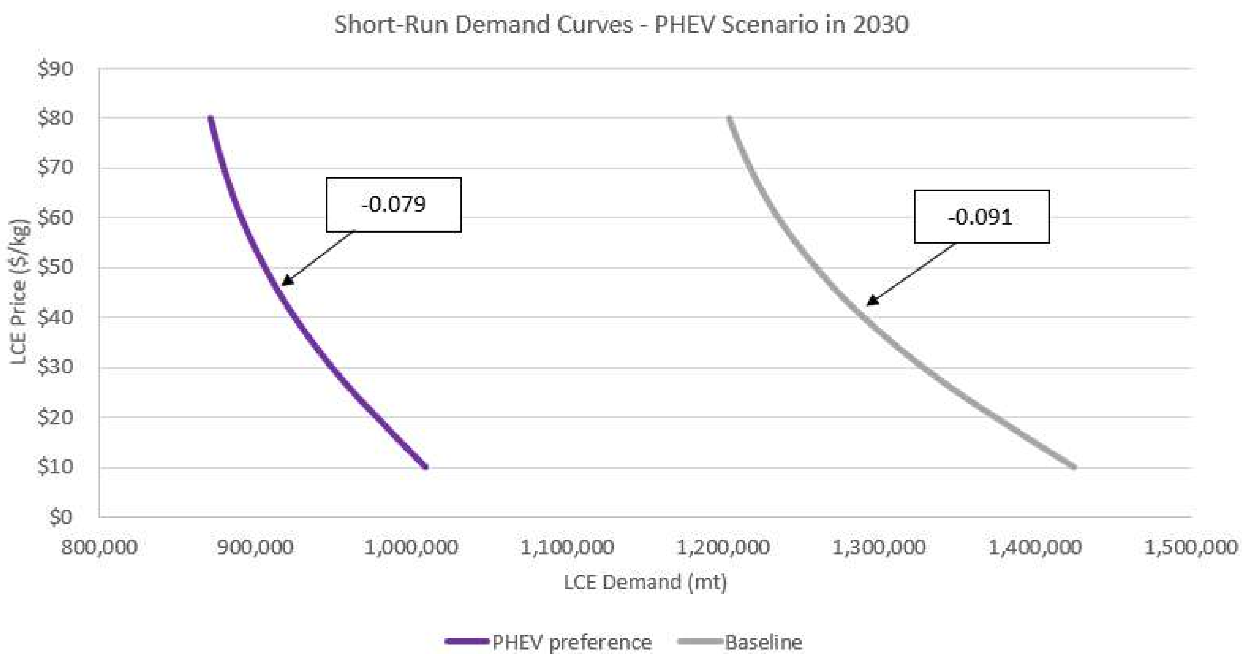


Figure S3.4. Short-run demand curves from the 2030 forecast. The PHEV preference scenario curve has shifted left, in response to a decrease in demand from a greater production share of small

PHEV batteries. The curve has also become less elastic, as automakers are less able to decrease lithium demand in a vehicle fleet with a higher PHEV share.

4. Interview Questions

EV commitments

a. What are your company's EV production targets up to 2030?
    i. What percentage of overall annual production will this constitute?
    ii. What capital investments and strategies have been made to achieve these targets?
b. Do you think policies mandating 100% EVs will be delayed? Why or why not?
    i. If not, do you think consumers will only purchase EVs anyway?

Electrification priority

a. If high battery prices lead to slower EV penetration, how would you rank your models in terms of priority?
    i. What is the rationale for this ranking (e.g., is this based on profit margins or something else)?
b. What is the current profit margin of your EV sector?
    i. How do you expect the profit margin to change? For example, when do you expect it to hit zero? Turn positive?
    ii. What is the latest year your EV sector could continue to operate at a loss before making changes to your EV fleet?
    iii. If you don't achieve a positive margin by the expected date, what changes will you make?

Batteries

a. What battery chemistries do you use currently?
    i. Does this vary by vehicle model?
b. What battery chemistries do you plan to switch to in the future?
c. What battery sizes do you use?
d. By how much do current battery prices have to decline in order to meet your EV targets?(10%, 25%, >50%)
e. What strategies are you preparing to adopt if battery costs do not decline sufficiently? Select all that apply:
    i. Smaller battery size
    ii. Different battery chemistry
    iii. Raising MSRP
    iv. Reverting to ICE models
    v. Other?
f. How significantly would battery prices have to depart from expected prices before you shifted to each of these strategies? (10% above estimates, 25%, 50%)
    i. How long would this price have to sustain? (6 months, 1 year, 2 years, 5 years)

Appendix

The development of an original Microsoft Excel-based model formed the backbone of this work. The model takes inputs on industry-wide and automaker-specific production data (Appendix A) and calculates lithium demand at different price points, deriving elasticity values from the fitted curves the demand values (Appendix B). Appendix C provides additional sourcing and calculation steps for where the data came from and what methodologies were used to fill in gaps of incomplete data. Automakers publish different production metrics at different levels of specificity, so consistent methods were applied to the available data in order to complete the model. The following appendices present the individual tabs in the Excel model.

Appendix A – Model Input Tabs

Automaker Overview Tab

Inputs for 2022 production values, regional breakdown, and strategies. Per the color key, blue are inputs and black are calculations. Sources for the data used to populate this section can be found in Appendix C. Individual strategies for each automaker were assigned based on these sources and the semi-structured interviews with auto industry personnel.

Color Key	User input (data or assumption)
	Calculation

					Regional Breakdown							
Company	Total Production	EV Share	BEV Share of EV's	High-range share of BEV's	China	Europe	North America	Asia (non-China)	Other	Rollout Strategy	Chemistry Strategy	Willingness-to-Pay Strategy
BMW Group	2,399,632	18.1%	49.7%	71.3%	33.1%	36.6%	15.1%	9.9%	5.3%	Transitional	Aspirational	High
BYD	1,857,379	100.0%	49.1%	50.0%	100.0%	0.0%	0.0%	0.0%	0.0%	Specialty	Economical	Low
Ford	4,231,000	2.7%	48.0%	64.8%	11.7%	24.0%	55.2%	2.4%	6.7%	Transitional	Balanced	High
Geely-Volvo	2,300,000	29.3%	39.7%	96.2%	69.9%	18.4%	7.3%	3.8%	0.6%	Aggressive	Aspirational	Medium
GM	5,939,000	9.8%	97.6%	62.6%	38.8%	0.0%	45.1%	8.5%	7.6%	Aggressive	Balanced	High
Honda	3,247,000	1.0%	54.3%	85.8%	31.8%	3.1%	30.2%	33.3%	1.6%	Aggressive	Balanced	Medium
Hyundai Motor Grou	6,837,000	7.2%	75.0%	85.8%	6.4%	16.9%	24.1%	36.8%	15.8%	Transitional	Balanced	Medium
Mahindra	297,600	0.1%	70.2%	50.0%	0.0%	0.0%	0.0%	99.5%	0.5%	Transitional	Economical	Low
Mazda	1,116,107	1.1%	70.2%	85.8%	9.7%	13.6%	26.4%	26.8%	23.5%	Incremental	Reluctant	Medium
Mercedes Benz Grou	2,040,500	15.6%	36.9%	71.3%	36.8%	31.1%	16.0%	11.6%	4.5%	Aggressive	Balanced	High
RNM Alliance	5,858,735	3.8%	73.5%	62.6%	20.3%	27.3%	18.7%	13.1%	20.6%	Aggressive	Aspirational	Medium
Stellantis	5,817,000	9.0%	55.1%	64.8%	1.6%	44.2%	31.0%	1.8%	21.4%	Aggressive	Aspirational	Medium
Subaru	852,000	0.3%	70.2%	85.8%	1.2%	2.7%	74.5%	11.7%	9.9%	Aggressive	Reluctant	Medium
Suzuki	1,303,000	0.2%	70.2%	50.0%	4.2%	15.5%	0.4%	74.5%	5.4%	Incremental	Reluctant	Medium
Tata	1,246,588	4.0%	40.0%	50.0%	7.7%	10.9%	6.5%	74.8%	0.1%	Incremental	Economical	Low
Tesla	1,369,611	100.0%	100.0%	100.0%	35.4%	26.6%	31.3%	0.0%	6.7%	Specialty	Balanced	High
Toyota	9,567,184	1.2%	21.3%	72.9%	20.3%	10.8%	25.6%	27.9%	15.4%	Transitional	Aspirational	Medium
Volkswagen	8,262,800	9.9%	70.0%	71.2%	38.5%	38.2%	10.2%	4.0%	9.1%	Aggressive	Aspirational	Medium
Other Chinese	2,500,000	20.4%	83.0%	50.0%	100.0%	0.0%	0.0%	0.0%	0.0%	Incremental	Balanced	Low
Other Specialty EV	100,000	100.0%	75.0%	100.0%	0.0%	0.0%	100.0%	0.0%	0.0%	Specialty	Balanced	High
Other General	5,000,000	12.6%	69.0%	74.4%	0.0%	0.0%	30.0%	70.0%	0.0%	Transitional	Balanced	Medium
TOTAL	72,142,136	12.3%	60.7%	71.1%	26.3%	18.6%	24.6%	20.4%	10.1%			

Regional Breakdown Tab

Vehicle class breakdown for each region (China, Europe, North America, Asia (non-China), and Other). There are separate tables for BEVs, PHEVs, and ICEs, reflecting differences in vehicle class for each drivetrain. See Appendix C for how these values were calculated from industry-wide data and EV specific data.

Regional Breakdown - Vehicle Class

	BEV					
Region	A/B	C/D	E/F	PUP	Small SUV	Large SUV
China	11.3%	33.9%	12.1%	0.0%	21.1%	21.6%
Europe	36.0%	20.5%	8.9%	0.1%	17.0%	17.4%
North America	5.2%	16.2%	14.3%	10.9%	26.3%	27.1%
Asia (non-China)	41.8%	17.0%	4.8%	2.8%	16.6%	17.0%
Other	37.7%	28.3%	6.4%	2.1%	12.5%	12.9%
Global	23.3%	23.0%	10.0%	3.5%	19.8%	20.4%

	PHEV					
Region	A/B	C/D	E/F	PUP	Small SUV	Large SUV
China	0.0%	33.6%	7.6%	0.0%	25.2%	33.6%
Europe	0.0%	27.7%	7.7%	0.0%	27.7%	36.9%
North America	0.0%	16.2%	9.1%	0.0%	32.0%	42.6%
Asia (non-China)	0.0%	25.4%	4.6%	0.0%	30.1%	40.0%
Other	0.0%	41.8%	6.0%	0.0%	22.4%	29.8%
Global	0.0%	27.4%	7.2%	0.0%	28.1%	37.4%

	ICE					
Region	A/B	C/D	E/F	PUP	Small SUV	Large SUV
China	8.9%	28.4%	17.6%	0.0%	22.5%	22.5%
Europe	29.9%	18.0%	13.7%	0.3%	19.1%	19.1%
North America	3.5%	11.6%	17.8%	18.8%	24.1%	24.1%
Asia (non-China)	34.6%	14.9%	7.3%	6.0%	18.6%	18.6%
Other	31.6%	25.3%	9.9%	4.6%	14.3%	14.3%
Global	19.0%	19.3%	14.0%	6.4%	20.7%	20.7%

EV Rollout Tab

Automaker-specific forecasts for EV share and BEV share (share of EVs that are BEVs) based on initial 2022 production values and the assigned rollout strategy. EV share by year is calculated from the below S-curve equation. BEV Share is calculated linearly based on the initial value and 100% BEV share year.

$$y = \frac{c}{1 + ae^{-bx}}$$

Rollout Strategy	100% EV year	100% BEV year
Incremental	2050	2060
Transitional	2045	2055
Aggressive	2040	2050
Specialty	2022	2032

		EV Share					BEV Share		
	Strategy	Initial	100% EV year	a	b	c	Initial	100% BEV year	Slope
BMW Group	Transitional	18.1%	2045	4.80834501	0.19852544	1.05	49.7%	2055	0.015231431
BYD	Specialty	100.0%	2022	0.05	0	1.05	49.1%	2032	0.050944799
Ford	Transitional	2.7%	2045	37.4356831	0.28775464	1.05	48.0%	2055	0.015757576
Geely-Volvo	Aggressive	29.3%	2040	2.57777778	0.21903667	1.05	39.7%	2050	0.021535714
GM	Aggressive	9.8%	2040	9.6670008	0.29246947	1.05	97.6%	2050	0.000857143
Honda	Aggressive	1.0%	2040	107.367503	0.42622166	1.05	54.3%	2050	0.016309308
Hyundai Motor Group	Transitional	7.2%	2045	13.5833333	0.24367721	1.05	75.0%	2055	0.007575758
Mahindra	Transitional	0.1%	2045	1279.65574	0.44130777	1.05	70.2%	2055	0.009041377
Mazda	Incremental	1.1%	2050	96.5861729	0.27022028	1.05	70.2%	2060	0.007851722
Mercedes Benz Group	Aggressive	15.6%	2040	5.71217105	0.26324064	1.05	36.9%	2050	0.022534014
RNM Alliance	Aggressive	3.8%	2040	26.6420474	0.34879016	1.05	73.5%	2050	0.009474812
Stellantis	Aggressive	9.0%	2040	10.6513542	0.29785663	1.05	55.1%	2050	0.016035714
Subaru	Aggressive	0.3%	2040	340.71123	0.49037598	1.05	70.2%	2050	0.010655909
Suzuki	Incremental	0.2%	2050	580.696429	0.3342843	1.05	70.2%	2060	0.007851722
Tata	Incremental	4.0%	2050	25.155854	0.22217225	1.05	40.0%	2060	0.015789474
Tesla	Specialty	100.0%	2022	0.05	0	1.05	100.0%	2032	0
Toyota	Transitional	1.2%	2045	86.4955858	0.32416633	1.05	21.3%	2055	0.02384557
Volkswagen	Aggressive	9.9%	2040	9.61570538	0.29217389	1.05	70.0%	2050	0.010713927
Other Chinese	Incremental	20.4%	2050	4.14705882	0.15779042	1.05	83.0%	2060	0.004473684
Other Specialty EV	Specialty	100.0%	2022	0.05	0	1.05	75.0%	2032	0.025
Other General	Transitional	12.6%	2045	7.33333333	0.21687663	1.05	69.0%	2055	0.009393939

Battery Chemistry Share Tab

Battery chemistry share forecasts under four strategies of balanced, reluctant, economical, and aspirational. Ratio of high-performance to low-cost chemistry is static over time and different for each drivetrain. The s-curves generated for Li-metal and Na-ion correspond to their share of high-performance or low-cost respectively. Baseline defined by the balanced strategy, with others defined by their difference from the baseline.

Battery Chemistry	Legacy	Emerging
High-performance	NMC/NCA	Li-metal
Low-cost	LFP	Na-ion

	High-range BEV	Low-range BEV	PHEV
High-performance chemistry ratio	81%	44%	70%

		Difference from baseline		Chemistry share forecast				S-curve parameters		
Strategy	Chemistry	start year	upper limit	start year	initial value	upper limit	95% growth year	a	b	c
Balanced	Li-metal			2030	1%	40%	2045	39.00	0.44	0.40
Balanced	Na-ion			2029	1%	10%	2044	9.00	0.34	0.10
Reluctant	Li-metal	3	-50%	2033	1%	20%	2048	19.00	0.39	0.20
Reluctant	Na-ion	3	-50%	2032	1%	5%	2047	4.00	0.29	0.05
Economical	Li-metal	3	-50%	2033	1%	20%	2048	19.00	0.39	0.20
Economical	Na-ion	-2	50%	2027	1%	15%	2042	14.00	0.37	0.15
Aspirational	Li-metal	-2	50%	2028	1%	60%	2043	59.00	0.47	0.60
Aspirational	Na-ion	3	-50%	2032	1%	5%	2047	4.00	0.29	0.05

Willingness-to-Pay Tab

Three sets of tables used for calculating willingness-to-pay (WTP) elasticity values for battery budget, EV rollout, and BEV share of EVs. Region and vehicle class define WTP values. Automaker strategy assignments correspond to modifier values that are added to WTP values.

Short-run Willingness-to-Pay

Battery Budget Willingness-to-Pay Regional Elasticity	A/B	C/D	E/F	PUP	Small SUV	Large SUV
China	0.2	0.4	0.5	0.5	0.4	0.5
Europe	0.5	0.7	0.9	0.9	0.7	0.9
North America	0.5	0.7	0.9	0.9	0.7	0.9
Asia (non-China)	0.3	0.5	0.7	0.7	0.5	0.7
Other	0.2	0.4	0.5	0.5	0.4	0.5

Battery Budget Willingness-to-Pay Strategy Modifier	
Low	-0.1
Medium	0.0
High	0.1

Long-run Willingness-to-Pay

EV Rollout Regional Elasticity	A/B	C/D	E/F	PUP	Small SUV	Large SUV
China	-0.075	-0.075	-0.050	-0.050	-0.075	-0.050
Europe	-0.075	-0.075	-0.050	-0.050	-0.075	-0.050
North America	-0.100	-0.100	-0.075	-0.075	-0.100	-0.075
Asia (non-China)	-0.100	-0.100	-0.075	-0.075	-0.100	-0.075
Other	-0.125	-0.100	-0.075	-0.075	-0.125	-0.075

EV Rollout Strategy Modifier	
Low	-0.025
Medium	0.000
High	0.025

BEV Share of EVs Regional Elasticity	A/B	C/D	E/F	PUP	Small SUV	Large SUV
China	-0.15	-0.1	-0.075	-0.075	-0.15	-0.075
Europe	-0.15	-0.1	-0.075	-0.075	-0.15	-0.075
North America	-0.2	-0.15	-0.1	-0.1	-0.2	-0.1
Asia (non-China)	-0.2	-0.15	-0.1	-0.1	-0.2	-0.1
Other	-0.2	-0.15	-0.1	-0.1	-0.2	-0.1

BEV Share of EV's Strategy Modifier	
Low	-0.025
Medium	0.000
High	0.025

Material Content Tab

Definitions of initial vehicle characteristics for BEVs and PHEVs for each vehicle class. Range values increase over time, but specific fuel economy and lithium intensity are static.

		Baseline fuel consumption - max range (kWh/km)	Range maximum (km)	Battery energy max (kWh)	Range minimum (km)	Battery energy min (kWh)	Typical vehicle curb weight w/o battery (kg)	Specific fuel economy (kWh/km/kg)
BEV	A/B	0.120042	262	31.5	156	18.7	1100	9.2996E-05
	C/D	0.151437	448	67.8	344	52.1	1650	7.34843E-05
	E/F	0.170668	612	104.4	451	76.9	2200	6.02512E-05
	PUP	0.179211	482	86.3	396	70.9	3000	5.08677E-05
	Small SUV	0.159582	430	68.7	303	48.3	1650	7.72393E-05
	Large SUV	0.179211	482	86.3	396	70.9	2100	6.83209E-05
PHEV	A/B	0.152114	60	9.1	60	9.1	1100	0.000131665
	C/D	0.198825	60	11.9	60	11.9	1650	0.000115442
	E/F	0.242781	60	14.6	60	14.6	2100	0.000110946
	PUP	0.291352	60	17.5	60	17.5	3000	9.38046E-05
	Small SUV	0.252323	60	15.1	60	15.1	1850	0.000129946
	Large SUV	0.291352	60	17.5	60	17.5	2200	0.000126348

Chemistry	Li intensity (kg/kWh)	Ni intensity (kg/kWh)
LFP	0.1007	0
NMC/NCA	0.1193	0.6241
Li-metal	0.1790	0.6241
Na-ion	0	0

Technology Improvement Tab

Rates of total vehicle growth (ICE, BEV, and PHEV), range growth (BEV only), battery energy density improvement, and battery cost decrease. Battery cost calculation incorporates a fixed cost and a variable cost, which change over time for each chemistry. The S-curves in this section are calculated by adding a 'k' term as in the below equation:

$$y = k + \frac{c}{1 + ae^{-bx}}$$

Total Vehicle Fleet and Range Growth Rates

Annual Vehicle Production Growth Rate	2.0%	/yr

	start year	initial value	upper limit	95% growth year	a	b	c	k
Range	2022	0%	40%	2037	1	0.2442374	0.8	-40.0%

Battery Chemistry Energy Density

chemistry	start year	initial value	upper limit	95% growth year	a	b	c	k
LFP	2022	135	220	2032	1	0.2671009	170	50
NMC/NCA	2022	165	300	2032	1	0.2833213	270	30
Li-metal	2028	300	600	2043	1	0.1962959	600	0
Na-ion	2027	135	200	2042	1	0.1656604	130	70

Battery Cost Structure

chemistry	Fixed cost ($)	Variable cost rate ($/kWh)	Baseline LCE cost rate ($/kWh)	Basline Ni cost rate ($/kWh)	Remaining variable cost rate ($/kWh)	Price limit decrease (%)
LFP	$ 1,777.44	$ 87.70	$ 10.71	$ -	$ 76.99	50%
NMC/NCA	$ 1,815.98	$ 101.78	$ 12.70	$ 11.23	$ 77.85	50%
Li-metal	$ 2,000.00	$ 110.00	$ 19.05	$ 11.23	$ 79.72	66%
Na-ion	$ 1,900.00	$ 90.00	$ -	$ -	$ 90.00	52%

Fixed Cost

chemistry	start year	initial value	lower limit	95% growth year	a	b	c	k
LFP	2022	$ 76.99	$ 38.49	2032	1	0.37	-76.99	115.48
NMC/NCA	2022	$ 77.85	$ 38.92	2032	1	0.37	-77.85	116.77
Li-metal	2028	$ 79.72	$ 27.10	2043	1	0.29	-105.23	132.33
Na-ion	2027	$ 90.00	$ 43.20	2042	1	0.25	-93.60	136.80

Variable Cost

chemistry	start year	initial value	lower limit	95% growth year	a	b	c	k
LFP	2022	$ 1,777.44	$ 1,117.38	2032	1	0.32	-1320.13	2437.51
NMC/NCA	2022	$ 1,815.98	$ 1,141.60	2032	1	0.32	-1348.75	2490.35
Li-metal	2028	$ 2,000.00	$ 1,418.00	2043	1	0.19	-1163.99	2582.00
Na-ion	2027	$ 1,900.00	$ 1,419.71	2042	1	0.18	-960.57	2380.29

Appendix B – Analysis Tab

Calculation of short-run and long-run elasticity values overall and broken down by automaker, vehicle class, and region. Excel-based data tables vary forecast price inputs and track resulting changes in demand to generate elasticity values.

Price Inputs			
Baseline Lithium Price		$ 20	/kg LCE
Lithium Price Forecast		$ 20	/kg LCE
Percent Change in Price (dP/P)		0.00	
Baseline Nickel Price		$ 18	
Nickel Price Scales with Li		0.0	
Future Nickel Price		$ 18	

Demand (mt LCE)

Total Demand (mt LCE)	**2023**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
Short Run	320,052	491,145	1,362,665	2,852,117	4,510,115	5,761,960	6,786,711
Long Run	320,052	491,145	1,362,665	2,852,117	4,510,115	5,761,960	6,786,711

Demand by Class	**2023**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
A/B	24,613	40,038	122,910	272,643	450,792	594,596	713,383
C/D	79,461	120,840	327,330	671,153	1,050,333	1,337,113	1,575,764
E/F	49,157	75,214	207,422	431,446	678,932	867,148	1,026,321
PUP	10,613	17,139	53,220	121,238	200,831	262,761	313,101
Small SUV	66,044	100,641	276,110	575,363	905,569	1,150,479	1,347,556
Large SUV	90,163	137,275	375,673	780,273	1,223,658	1,549,862	1,810,586
Total	320,052	491,145	1,362,665	2,852,117	4,510,115	5,761,960	6,786,711

Demand by Region	**2023**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
China	143,541	205,287	480,072	882,812	1,301,683	1,616,391	1,896,615
Europe	50,482	80,725	240,931	505,104	788,437	993,569	1,171,000
North America	77,236	121,461	362,185	805,733	1,299,832	1,660,182	1,948,379
Asia (non-China)	30,734	52,683	173,442	414,407	719,800	977,113	1,163,724
Other	18,059	30,989	106,036	244,061	400,363	514,705	606,992
Total	320,052	491,145	1,362,665	2,852,117	4,510,115	5,761,960	6,786,711

Elasticity

Total Elasticity	2023	2025	2030	2035	2040	2045	2050
Short Run	-0.0707	-0.0794	-0.0938	-0.1033	-0.1197	-0.1300	-0.1339
Long Run	-0.2504	-0.2852	-0.3444	-0.3654	-0.3153	-0.2832	-0.1996

Elasticity by Class	2023	2025	2030	2035	2040	2045	2050
A/B	-0.136	-0.155	-0.187	-0.205	-0.230	-0.245	-0.248
C/D	-0.091	-0.101	-0.120	-0.133	-0.155	-0.168	-0.172
E/F	-0.055	-0.061	-0.069	-0.072	-0.082	-0.088	-0.090
PUP	-0.015	-0.018	-0.026	-0.032	-0.040	-0.044	-0.045
Small SUV	-0.078	-0.089	-0.107	-0.117	-0.136	-0.148	-0.153
Large SUV	-0.046	-0.051	-0.059	-0.065	-0.077	-0.085	-0.089

Elasticity by Region	2023	2025	2030	2035	2040	2045	2050
China	-0.104	-0.118	-0.142	-0.158	-0.184	-0.200	-0.206
Europe	-0.039	-0.046	-0.059	-0.067	-0.079	-0.086	-0.089
North America	-0.021	-0.024	-0.032	-0.038	-0.045	-0.050	-0.051
Asia (non-China)	-0.077	-0.089	-0.111	-0.126	-0.147	-0.160	-0.166
Other	-0.112	-0.129	-0.158	-0.178	-0.209	-0.227	-0.233

Appendix C – Data Tabs

Production Data Tab

Sources of 2022 production EV data and regional breakdown inputs for overview tab. In some cases, data for the automakers was unavailable at the required granularity of region and electric vehicle type (BEV or PHEV). In these cases, the listed sources were used as bases to make approximations on the data to populate the model. Data from similar automakers and the industry as a whole were also considered when making these approximations.

EV Production	Link	Total	EV	EV Share (	BEV	BEV Share	PHEV
BMW Group	https://www.press.bmwgroup.com/global/article/detail/T0410919EN/bmw-group-report-2022?language=en	2399632	433792	18.1%	215752	49.7%	218040
BYD	https://insideevs.com/news/629273/byd-plugin-car-sales-december2022/	1857379	1857379	100.0%	911141	49.1%	946238
Ford	https://shareholder.ford.com/Investors/financials/default.aspx	4231000	115584	2.7%	55480	48.0%	60104
Geely-Volvo	https://zgh.com/media-center/news/2023-01-16/?lang=en	2300000	675000	29.3%	267975	39.7%	407025
GM	https://elements.visualcapitalist.com/visualizing-global-ev-production-in-2022-by-brand/	5939000	584602	9.8%	570572	97.6%	14030
Honda	https://www.statista.com/outlook/mmo/passenger-cars/worldwide	3247000	31461	1.0%	17094	54.3%	14367
Hyundai Motor Group	https://www.hyundai.com/worldwide/en/company/sustainability/sustainability-report	6837000	490686	7.2%	368198	75.0%	122488
Mahindra	https://www.autopunditz.com/post/cy2022-indian-battery-electric-vehicle-industry-analysis	297600	244	0.1%	171	70.2%	73
Mazda	Proprietary data	1116107	12009	1.1%	8426	70.2%	3583
Mercedes Benz Group	https://www.best-selling-cars.com/brands/2022-full-year-global-mercedes-benz-sales-worldwide-by-region-and-model/	2040500	319200	15.6%	117800	36.9%	201400
RNM Alliance	Proprietary data	7261013	275814	3.8%	202642	73.5%	73172
Stellantis	https://www.media.stellantis.com/em-en/corporate-communications/press/stellantis-delivers-record-full-year-2022-results-global-bev-sales-up-41-progressing-fast-on-dare-forward-2030-execution	5817000	522686	9.0%	288000	55.1%	234686
Subaru	Proprietary data	852000	2618	0.3%	1837	70.2%	781
Suzuki	Proprietary data	1303000	2352	0.2%	1650	70.2%	702
Tata	https://economictimes.indiatimes.com/industry/renewables/tata-motors-sees-its-ev-sales-doubling-in-2024-25/articleshow/106935310.cms?from=mdr	1246588	50043	4.0%	20017	40.0%	30026
Tesla	https://ir.tesla.com/press-release/tesla-vehicle-production-deliveries-and-date-financial-results-webcast-fourth-quarter	1369611	1369611	100.0%	1369611	100.0%	0
Toyota	https://global.toyota/en/company/profile/production-sales-figures/202212.html	9567184	114812	1.2%	24466	21.3%	90346
Volkswagen	https://annualreport2022.volkswagenag.com/services/downloads.html	8262800	817274	9.9%	572100	70.0%	245174

Regional Breakdown	Link	Total	China		Europe		North America		Asia (non-China)		Other	
BMW Group	https://www.press.bmwgroup.com/global/article/detail/T0410919E	2399600	793500	33.1%	878500	36.6%	363500	15.1%	237500	9.9%	126600	5.3%
BYD	https://www.statista.com/outlook/mmo/passenger-cars/byd/worldwide#unit-sales	480900	480900	100.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Ford	https://shareholder.ford.com/Investors/financials/default.aspx	4231000	495000	11.7%	1014000	24.0%	2335000	55.2%	102000	2.4%	285000	6.7%
Geely-Volvo	https://www.statista.com/outlook/mmo/passenger-cars/worldwide	1284800	898500	69.9%	235800	18.4%	93600	7.3%	48500	3.8%	8400	0.7%
GM	https://www.sec.gov/Archives/edgar/data/1467858/000146785823000029/gm-20221231.htm	5939000	2303000	38.8%	2000	0.0%	2680000	45.1%	502000	8.5%	452000	7.6%
Honda	https://www.statista.com/outlook/mmo/passenger-cars/worldwide	3247000	1033300	31.8%	100200	3.1%	979400	30.2%	1080400	33.3%	53700	1.7%
Hyundai Motor Group	https://www.statista.com/statistics/684070/hyundai-motors-unit-sales-overseas-by-region/	3940000	253957	6.4%	666223	16.9%	949059	24.1%	1447950	36.8%	0	0.0%
Mahindra	https://stockdividendscreener.com/auto-manufacturers/mahindra-car-and-vehicle-sales-figures-and-growth-rates/#C2	297600	0	0.0%	0	0.0%	0	0.0%	296200	99.5%	0	0.0%
Mazda	https://newsroom.mazda.com/en/publicity/release/2023/202301/230130a.html	1116107	108123	9.7%	151331	13.6%	294909	26.4%	299000	26.8%	0	0.0%
Mercedes Benz Group	https://www.best-selling-cars.com/brands/2022-full-year-global-mercedes-benz-sales-worldwide-by-region-and-model/	2040500	751700	36.8%	635100	31.1%	327000	16.0%	236100	11.6%	0	0.0%
RNM Alliance	See Renault, Nissan, Mitsubishi	6190174	1258265	20.3%	1690875	27.3%	1156000	18.7%	808000	13.1%	1277034	20.6%
Renault	https://www.renaultgroup.com/wp-content/uploads/2023/02/rg_2022_fy_results_earnings-report_en.pdf	2051174	165265	8.1%	1320875	64.4%	0	0.0%	0	0.0%	565034	27.5%
Nissan	https://www.nissan-global.com/EN/IR/LIBRARY/ASSETS/DATA/2022/2022results_financialresult_991_e.pdf	3305000	1045000	31.6%	309000	9.3%	1023000	31.0%	454000	13.7%	474000	14.3%
Mitsubishi	https://www.mitsubishi-motors.com/en/investors/finance_result/segment.html	834000	48000	5.8%	61000	7.3%	133000	15.9%	354000	42.4%	238000	28.5%
Stellantis	https://www.stellantis.com/content/dam/stellantis-corporate/investors/financial-reports/Stellantis-NV-20221231-Annual-Report.pdf	5817000	94000	1.6%	2570000	44.2%	1791000	30.8%	103000	1.8%	1259000	21.6%
Subaru	https://www.subaru.co.jp/en/ir/library/pdf/Ir/Ir2023e.pdf	852000	10000	1.2%	23000	2.7%	635000	74.5%	100000	11.7%	0	0.0%
Suzuki	https://www.statista.com/outlook/mmo/passenger-cars/suzuki/	1303000	54500	4.2%	202100	15.5%	5300	0.4%	970600	74.5%	0	0.0%
Tata	https://www.statista.com/statistics/1195972/tml-sales-volume-by-region/	1246588	95773	7.7%	136491	10.9%	81629	6.5%	932695	74.8%	0	0.0%
Tesla	https://www.reuters.com/business/autos-transportation/china-was-top-market-tesla-model-y-worlds-best-selling-car-q1-2023-05-30/	267171	94469	35.4%	71114	26.6%	83664	31.3%	17924	6.7%	0	0.0%
Toyota	https://global.toyota/en/company/profile/production-sales-figures/202212.html	9567184	1940590	20.3%	1032159	10.8%	2445348	25.6%	2673277	27.9%	0	0.0%
Volkswagen	https://www.best-selling-cars.com/brands/2022-global-volkswagen-group-sales-worldwide-by-brand-and-country/	8262800	3184500	38.5%	3153200	38.2%	842600	10.2%	329500	4.0%	0	0.0%

Regional Breakdown Data Tab

Calculation process for drivetrain specific vehicle class data inputs for regional breakdown tab. Vehicle class breakdowns only available by region for the industry as a whole (all drivetrains combined). Production data shows vehicle class breakdowns for BEVs and PHEVs deviate considerably from the industry overall.

Regional breakdown data for all vehicles (million vehicles)							
Region	A/B	C/D	E/F	PUP	Small SUV	Large SUV	Total
China	1.34	4.29	2.66	-	3.41	3.41	15.10
Europe	3.06	1.85	1.40	0.03	1.96	1.96	10.25
North America	0.51	1.68	2.58	2.73	3.50	3.50	14.49
Asia (non-China)	3.97	1.71	0.84	0.69	2.14	2.14	11.49
Other	1.24	0.99	0.39	0.18	0.56	0.56	3.92
TOTAL	10.12	10.52	7.87	3.63	11.56	11.56	55.25

Region	A/B	C/D	E/F	PUP	Small SUV	Large SUV
China	8.9%	28.4%	17.6%	0.0%	22.5%	22.5%
Europe	29.9%	18.0%	13.7%	0.3%	19.1%	19.1%
North America	3.5%	11.6%	17.8%	18.8%	24.1%	24.1%
Asia (non-China)	34.6%	14.9%	7.3%	6.0%	18.6%	18.6%
Other	31.6%	25.3%	9.9%	4.6%	14.3%	14.3%
Global	18.3%	19.0%	14.2%	6.6%	20.9%	20.9%

BEV Breakdown

Proprietary data used to find global vehicle class breakdown for BEVs in 2021. Assume that over time, this breakdown will approach the industry as a whole. In order to keep these values static in the model, average shares were taken between the whole industry and the 2021 BEV data. The following calculation is used to apply regional differences to the global class breakdown from the average.

Average share = (Overall share + 2021 BEV data)/2

The following calculation is used to apply regional differences to the global class breakdown from the average.

New share = Normalized(Old share * (% difference overall to Avg over time + 1))

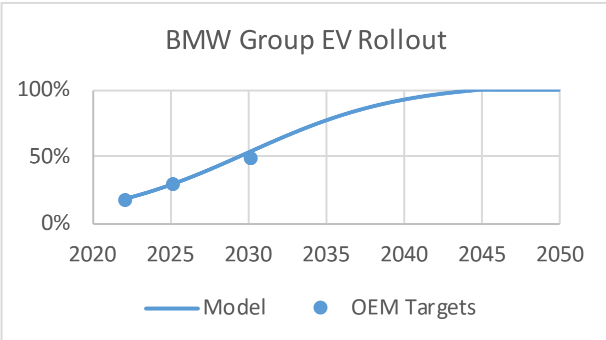
PHEV Breakdown

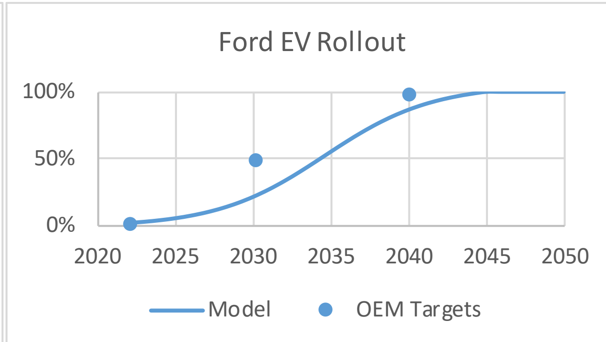
Since PHEVs serve a different role than BEVs, assume that class breakdown from 2021 data will remain unchanged. The following calculation is used to apply regional differences to the global class breakdown from the 2021 data.

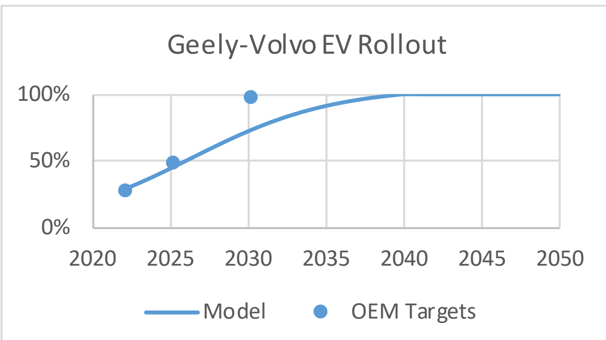
New share = Normalized(Old share * (% difference overall to 2021 PHEV data + 1))

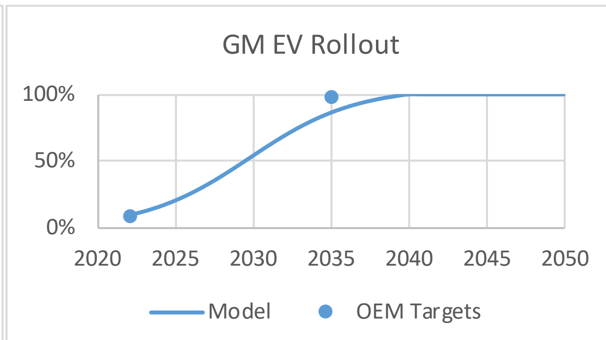
EV Rollout Forecasts Data Tab

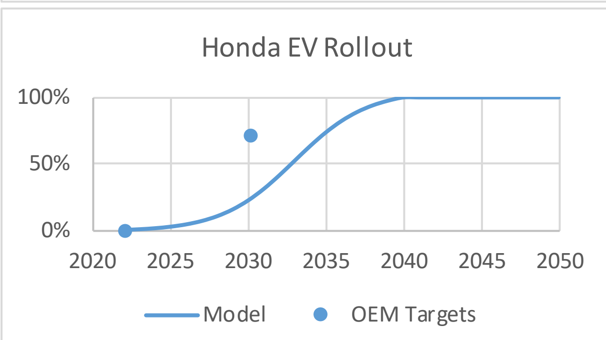
Comparison of modelled EV rollout to other forecasts and OEM targets for each automaker.

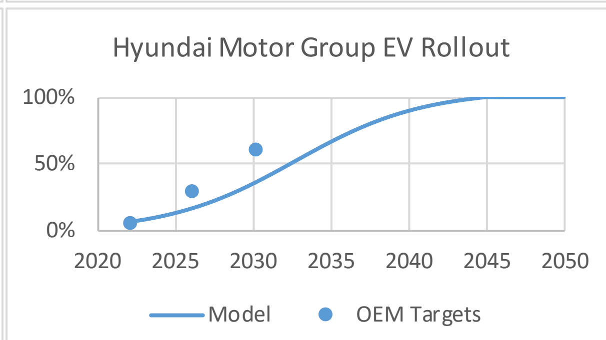


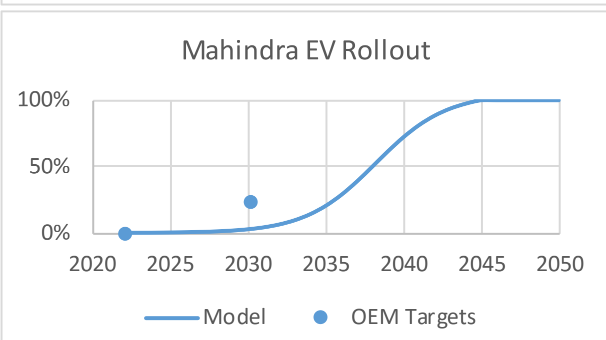


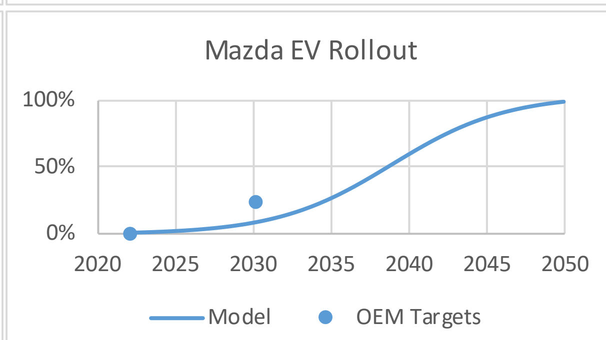


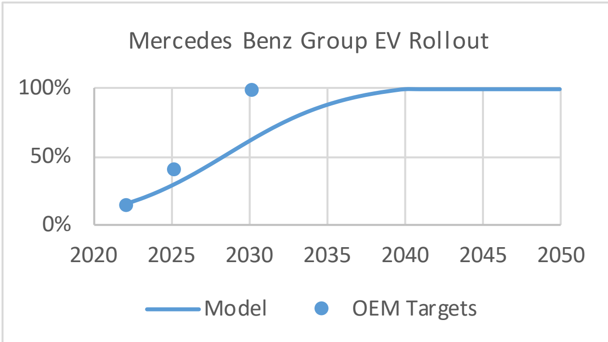


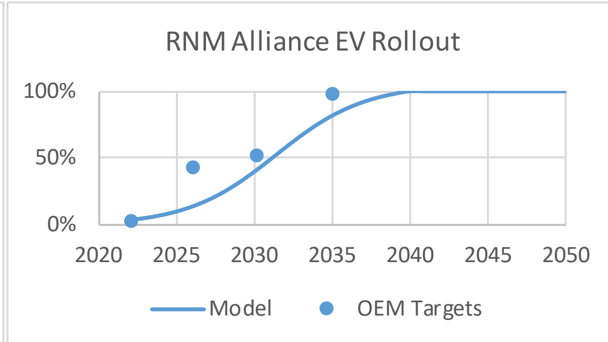


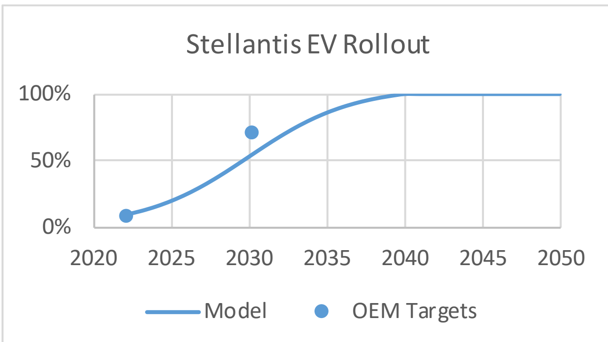


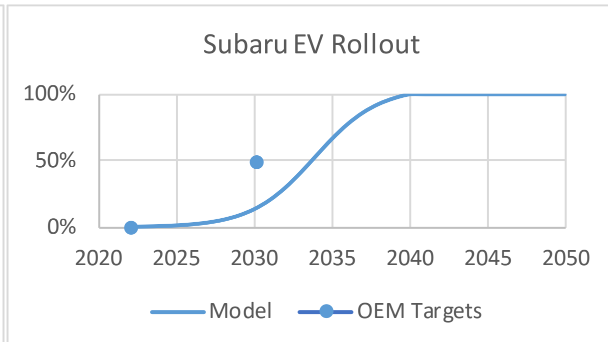


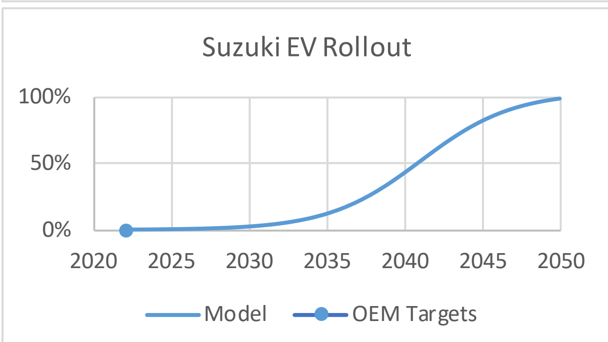



Mercedes Benz Group EV Rollout
100%
50%
0%
2020
2025
2030
2035
2040
2045
2050
Model
OEM Targets


RNM Alliance EV Rollout
100%
50%
0%
2020
2025
2030
2035
2040
2045
2050
Model
OEM Targets


Stellantis EV Rollout
100%
50%
0%
2020
2025
2030
2035
2040
2045
2050
Model
OEM Targets


Subaru EV Rollout
100%
50%
0%
2020
2025
2030
2035
2040
2045
2050
Model
OEM Targets


Suzuki EV Rollout
100%
50%
0%
2020
2025
2030
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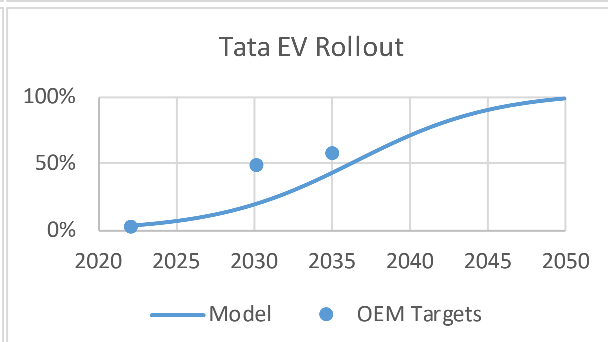
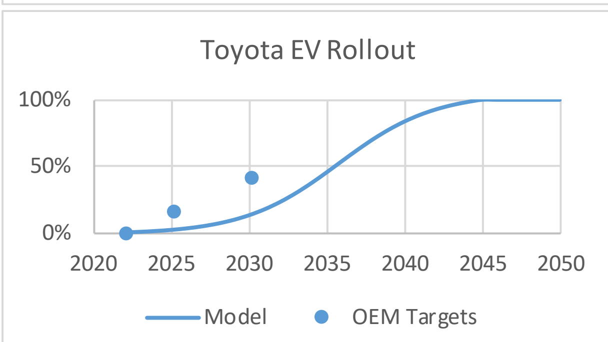
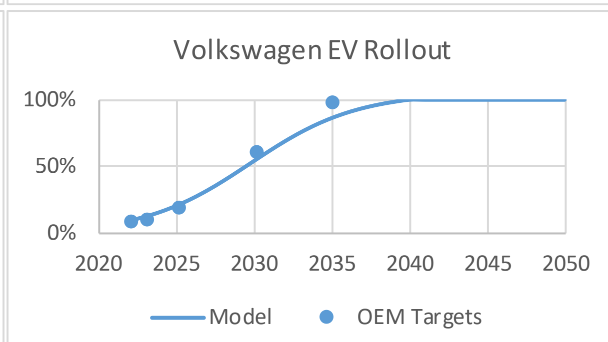
2040
2045
2050
Model
OEM Targets


Tata EV Rollout
100%
50%
0%
2020
2025
2030
2035
2040
2045
2050
Model
OEM Targets

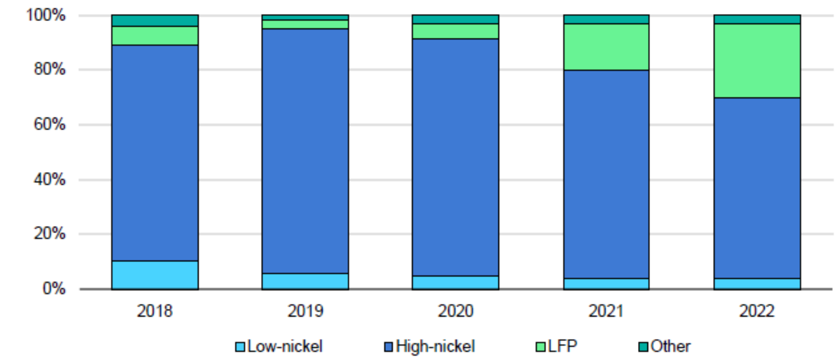

Toyota EV Rollout
100%
50%
0%
2020
2025
2030
2035
2040
2045
2050
Model
OEM Targets


Volkswagen EV Rollout
100%
50%
0%
2020
2025
2030
2035
2040
2045
2050
Model
OEM Targets

Chemistry Share Forecasts Data Tab

Battery chemistry share forecasts from other literature sources. These figures and tables were taken directly from the referenced literature and are not products of this work. They were used in calibrating the battery chemistry share forecasts in the model, as seen in Appendix A.

Figure 1.19 Electric light-duty vehicle battery capacity by chemistry, 2018-2022



Notes: LFP = Lithium iron phosphate. Low-nickel includes: NMC333. High-nickel includes: NMC532, NMC622, NMC721, NMC811, NCA and NMCA. Cathode sales share is based on battery capacity.
Source: IEA analysis based on EV Volumes.

(IEA, 2023) [10]

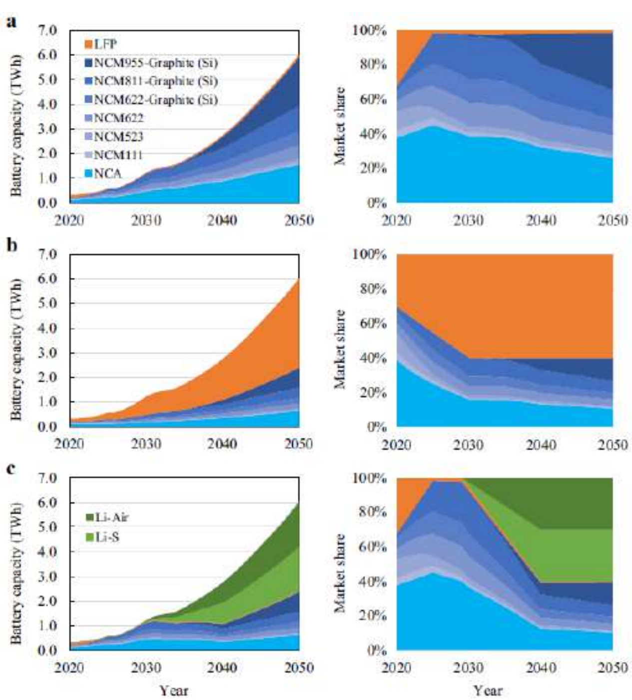


Fig. 2 Battery market shares and yearly EV battery sales until 2050 for the fleet development in the STEP scenario. a NCX scenario. **b** LFP scenario. **c** Li-S/Air scenario. See Supplementary Fig. 4 for the Sustainable Development scenario. See Supplementary Fig. 5 for battery sales in units. LFP lithium iron phosphate battery, NCM lithium nickel cobalt manganese battery, Numbers in NCM111, NCM523, NCM622, NCM811, and NCM955 denote ratios of nickel, cobalt, and manganese. NCA lithium nickel cobalt aluminum battery, Graphite (Si) graphite anode with some fraction of silicon, Li-S lithium-sulphur battery, Li-Air lithium-air battery, TWh 10^9 kWh.

(Xu et al., 2020) [6]

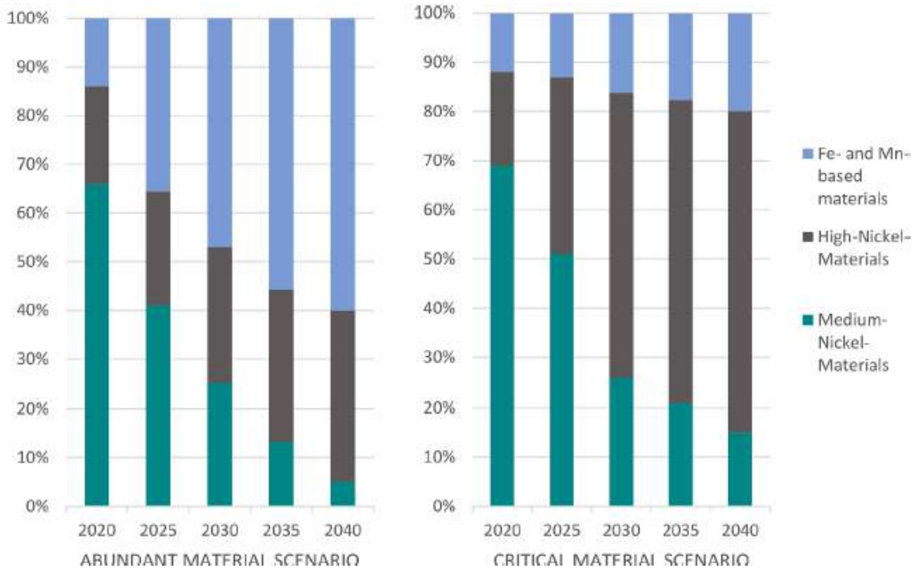


Fig. 3. Estimation of the cathode chemistry market shares until 2040.

(Maisel et al., 2023) [3]

	Baseline scenario		Reduction scenario		Substitution scenario	
	2030	**2050**	**2030**	**2050**	**2030**	**2050**
NCM 622	40%	-	-	-	-	-
NCM 811	50%	90%	50%	-	-	-
NCA-II/NCM9.5.5	10%	10%	50%	100%	100%	-
Alternative chemistry	-	-	-	-	-	100%

(Baars et al., 2021) [5]

Battery technology	Percentage 2050		
	Low LFP (%)	Medium LFP (%)	High LFP (%)
LFP	25	50	75
LMO	10	10	10
NMC	32	20	7.5
NCA	33	20	7.5

(Weil et al., 2018) [8]

Technology Forecast Data Tab

Literature values, current and forecast, for battery energy density, battery cost, and lithium intensity. These values were taken directly from the referenced literature and are not products of this work. They were used in calibrating the technology improvement forecasts and lithium intensity values in the model, as seen in Appendix A.

Battery energy density (Wh/kg)										
			Current				Forecast			
ref	chem	cell or pack	min	middle	max	year	min	middle	max	year
[10]	Na-ion	cell					75		160	
	Li-ion	cell	120		260					
[6]	LFP-Gr	pack	75	102	129	2020				
	NCA/NCM-Gr	pack	103	140.5	178	2020				
	NCM-Si/Gr	pack	116	159	202	2020				
	Li-S	pack	224	266	308	2020				
	Li-Air	pack	272	328	384	2020				
[5]	All	pack	104	133	160	2017		235		2030
[8]	LFP	pack	83.2	96.4	109.6	2018				
	NMC	pack	131.3	135.4	139.5	2018				
	NCA	pack		133.6		2018				
[30]	NMC	cell	180	250	300	2020				
	SSB	cell					300		500	2026
	Li-S	cell					400			2027
[29]	LFP	cell	160		200	2023		351		theory
	LFP	pack	130		150	2023				
	NMC	cell	245		270	2023		530		theory
	NMC	pack	155		175	2023				
	Si-anode	cell					360		500	
	SSB	cell					350			
[32]	SSB Oxide	galv. cell	314		530					
	SSB Sulfide	galv. cell	500		567					
	Li-S	cell	100		600					
	Li-Air	useable	800		894					
[33]	SSB	cell	288.2		477.5					
[34]	NMC-Gr	cell		241						
	NMC-Si/Gr	cell		291						
	SSB	cell		383						
[35]	All	cell					350		370	2030
	All	cyl. cell		287		2020		325		2030
	All	pris. cell		187		2020		285		2030
	All	pouch cell		250		2020		323		2030
[36]	LMO/NMC	pack		128.5		2018	168.9		198.6	

	Na-ion	pack		103.0		2018	146.7		165.7	
[37]	LiB	cell		198.6						
	Na-ion	cell	108.3	117.4	120.5		192	207.2	213.5	

Cost ($/kWh)											
			Current				Forecast				
ref	chem	cell or pack	min	middle	max	year	min	middle	max	year	% change
[10]	All	pack		150		2022					
	Na-ion	cell					30% less than LFP				
	All	cell				2021				2025	-20%
	All	pack				2021				2025	-10%
[29]	All	cell		101		2021		102		2023	
	All	pack		132		2021		127		2023	
[32]	LFP	pack					107	222	526		
	NMC 622	pack					115	198	432		
	NMC 811	pack					84	145	318		
	NCA	pack					98	198	418		
	SSB Oxide	pack					157	198	543		
	SSB Sulfide	pack					113	116	258		
	Li-S	pack					80	135	437		
	Li-Air	pack					70	104	200		
[31]	All	pack	123.5	144.2	154.7	2021	54	75	99	2030	-48%
[33]	SSB	cell	85.4	150	934.2						
[34]	NMC-Gr	cell		118.7							
	NMC-Si/Gr	cell		107.2							
	SSB	cell		102							
[35]	All	C2P	1.94	2.07	2.21	2020	1.17	1.2	1.24	2030	-42%
[36]	LMO/NMC	pack		259.2		2018	240.0		233.8		-10%
	Na-ion	pack		287.0		2018	253.9		235.1		-18%
[38]	LFP	pack	119.2		165.8						
	NCA	pack	106.2		147.4						
	NMC 622	pack	110.9		153.9						
	NMC 811	pack	103.7		143.8						
[37]	LiB	cell		249.37		2014		185.9		2019	
	Na-ion	cell	341.35	366.31	419.93	2014	251.42	267.66	304.2	2019	

Cost by Year ($/kWh)										
	chem	cell or pack	**2020**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**	% change
[32]	All	pack	234	169	132	109	92	80	71	-70%

[31]	All	pack	162	92	75					-54%
	LFP	pack	153	82	67					-56%
	NMC	pack	166	102	88					-47%

Li intensity (kg/kWh)					
ref	chem	cell or pack	min	middle	max
[6]	LFP-Gr	pack		0.100704	
	NCA/NCM-Gr	pack		0.126259	
	NCM-Si/Gr	pack		0.112432	
	Li-S	pack		0.174387	
	Li-Air	pack		0.109902	
[3]	LFP	pack		0.086	
	LMFP	pack		0.079	
	NMC111/811	pack	0.12	0.104	0.096
	NCA/NMCA	pack	0.095	0.098	0.093
[31]	NMC622	pack		0.115493	
	NMC811	pack		0.100622	
[7]	All	pack		0.123	
[34]	NMC-Gr	cell		0.1162	
	NMC-Si/Gr	cell		0.1159	
	SSB	cell		0.1063	
[9]	SSB	cell	45-130% more than NMC		
[39]	NMC-Gr	cell		0.1162	
	SSB	cell		0.1739	

Appendix D: Interview information

Position	**Interview Date**	**Duration (minutes)**	**Experience in materials and/or vehicle production (years)**
Science Technology Advisor	2/14/2024	60	16
Deputy Director Critical Minerals	2/15/2024	60	11
Deputy Director	3/10/2024	60	10
Value Chain Engineer	5/17/2023	60	30
Vehicle Part Global Leader	5/17/2023	60	30+
Business Development Manager	6/20/2023	30	1
Director	5/18/2023	60	14

Material Research Analyst	2/23/2024	60	25
Engineering Group Manager	4/24/2024	75	30+
Chief Analyst	5/3/2024	60	25+
Vehicle Battery Engineer	7/15/2023	60	11

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