OPPORTUNITIES AND RISKS: Automotive Electrification in Illinois

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9 November 2022

MISSION:

to produce independent research, convene stakeholders, and analyze critical issues facing the automotive industry and its impact on the economy and society.

Sustainable, Automated, Digital and Electric

Driving the future

Sustainability
Using processes that use fewer resources and emit fewer emissions to create products that are do the same

Electric
The BEV is an enabling technology for shifting how we view mobility

Automated and Connected
From automated driver assist systems to robo-taxis, technology is leading to a change in who is driving

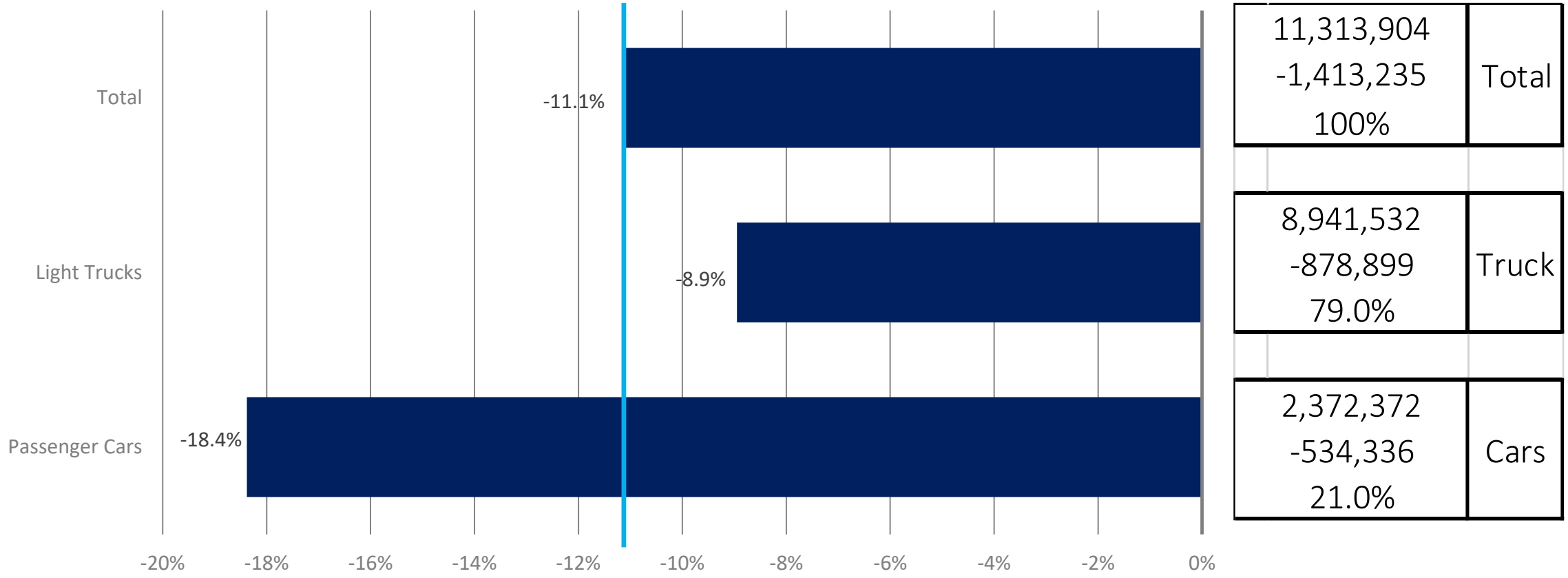
Digital Transformation
From product development to manufacturing through in-service and final disposition, data is changing the industry

Vehicle Slides

Year-to-date sales are down compared to 2021

U.S. Light Vehicle Sales

Percent Change (YTD) Through October: 2022 vs. 2021



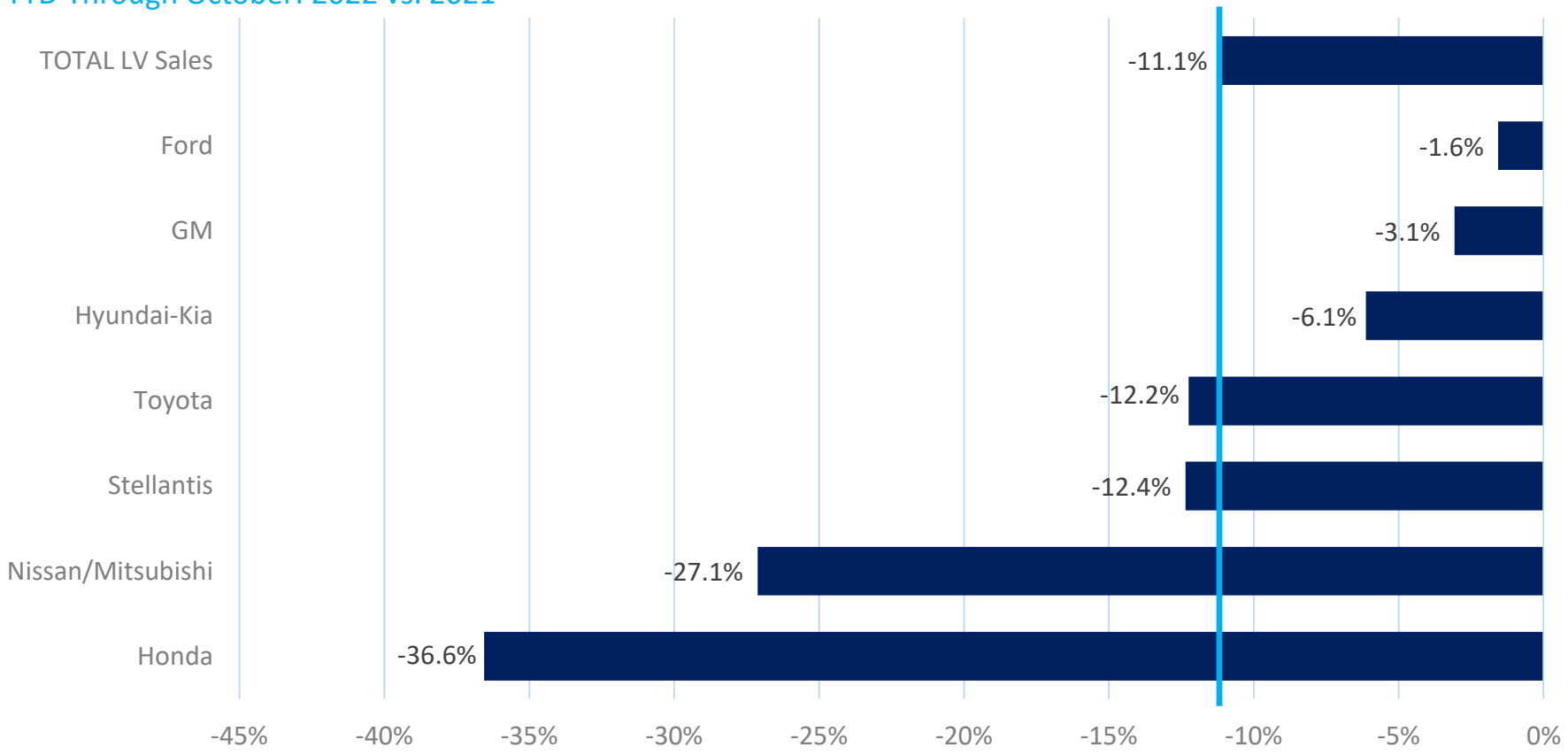
11,313,904 -1,413,235 100%	Total
8,941,532 -878,899 79.0%	Truck
2,372,372 -534,336 21.0%	Cars

Source: Wards Auto; CAR Research

All major automakers' year-to-date sales decline

Percent Change in Sales of Light Vehicles Per OEM

YTD Through October: 2022 vs. 2021



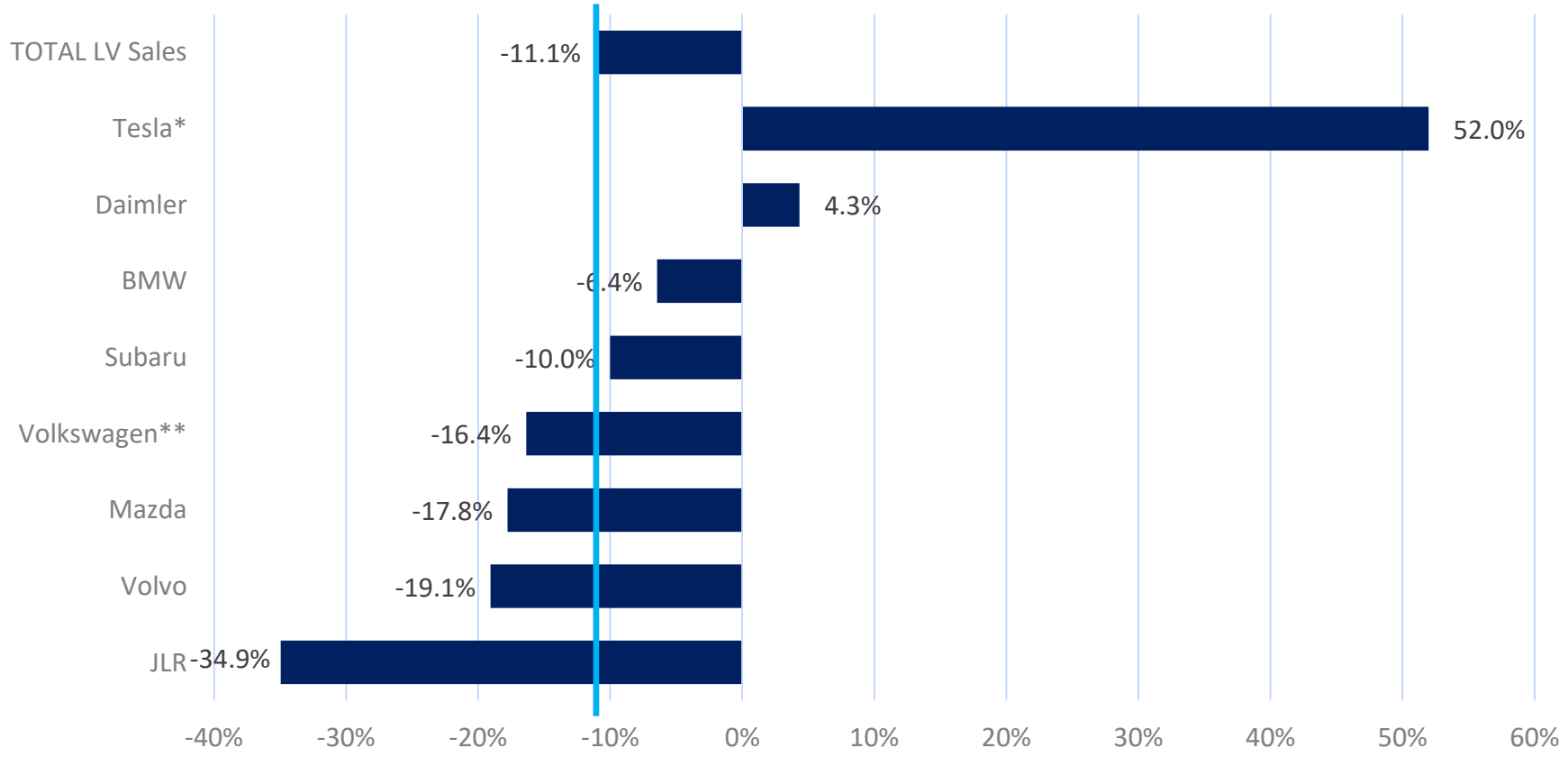
11,313,904 -1,413,235 100%	TOTAL LV Sales
1,480,733 -23,506 13.1%	Ford
1,841,033 -58,354 16.3%	GM
1,210,559 -79,049 10.7%	Hyundai-Kia
1,759,084 -245,470 15.5%	Toyota
1,299,875 -183,214 11.5%	Stellantis
674,970 -251,137 6.0%	Nissan/Mitsubishi
809,802 -466,705 7.2%	Honda

Source: Wards Auto; CAR Research

Tesla and Daimler are the only automakers with a year-to-date sales growth

Percent Change in Sales of Light Vehicles Per OEM

YTD Through October: 2022 vs. 2021



11,313,904 -1,413,235 100%	TOTAL LV Sales
373,900 127,872 3.3%	Tesla*
286,456 11,897 2.5%	Daimler
274,835 -18,906 2.4%	BMW
449,683 -49,936 4.0%	Subaru
460,047 -89,944 4.1%	Volkswagen**
240,710 -52,022 2.1%	Mazda
86,164 -20,292 0.8%	Volvo
52,340 -28,111 0.5%	JLR

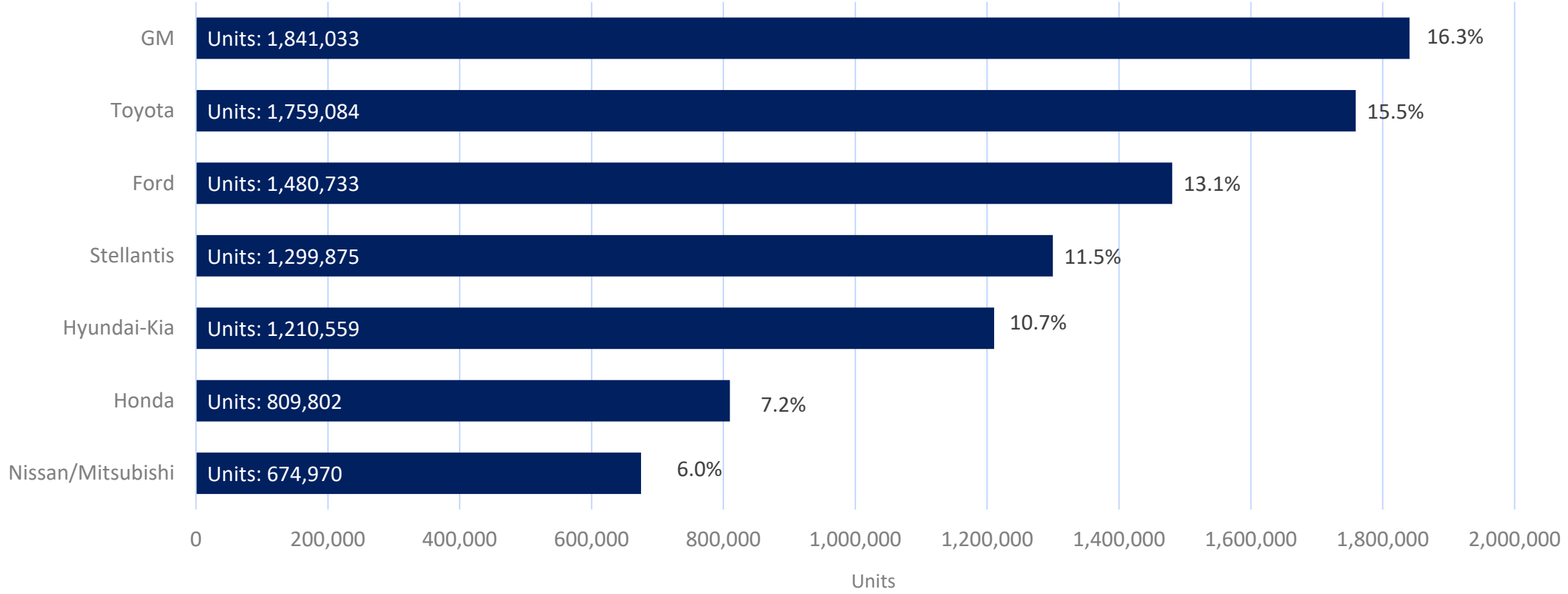
**Estimated. **Including Audi and Porsche.*

Source: Wards Auto; CAR Research

GM retakes top position of the market share

U.S. Market Share

YTD Through October 2022

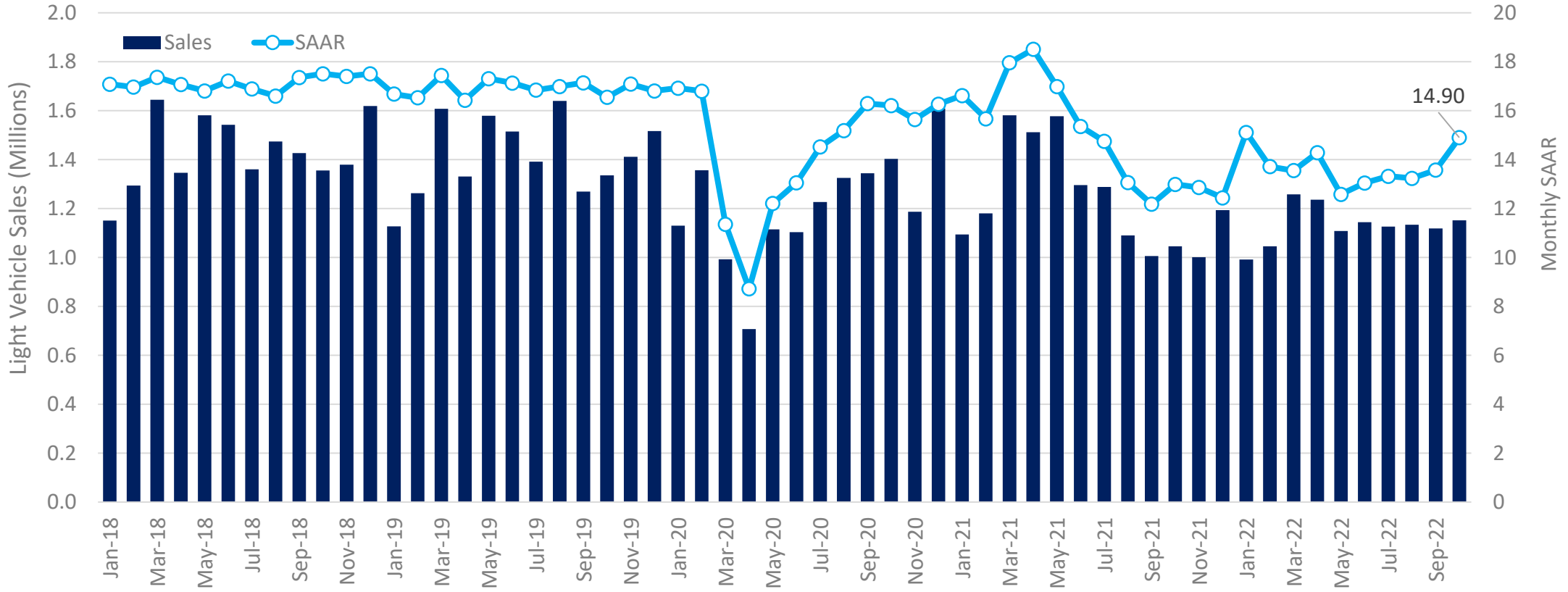


Source: Wards Auto; CAR Research

U.S. light vehicle sales rose in October

U.S. Light Vehicle Monthly Sales and SAAR

January 2018 – October 2022

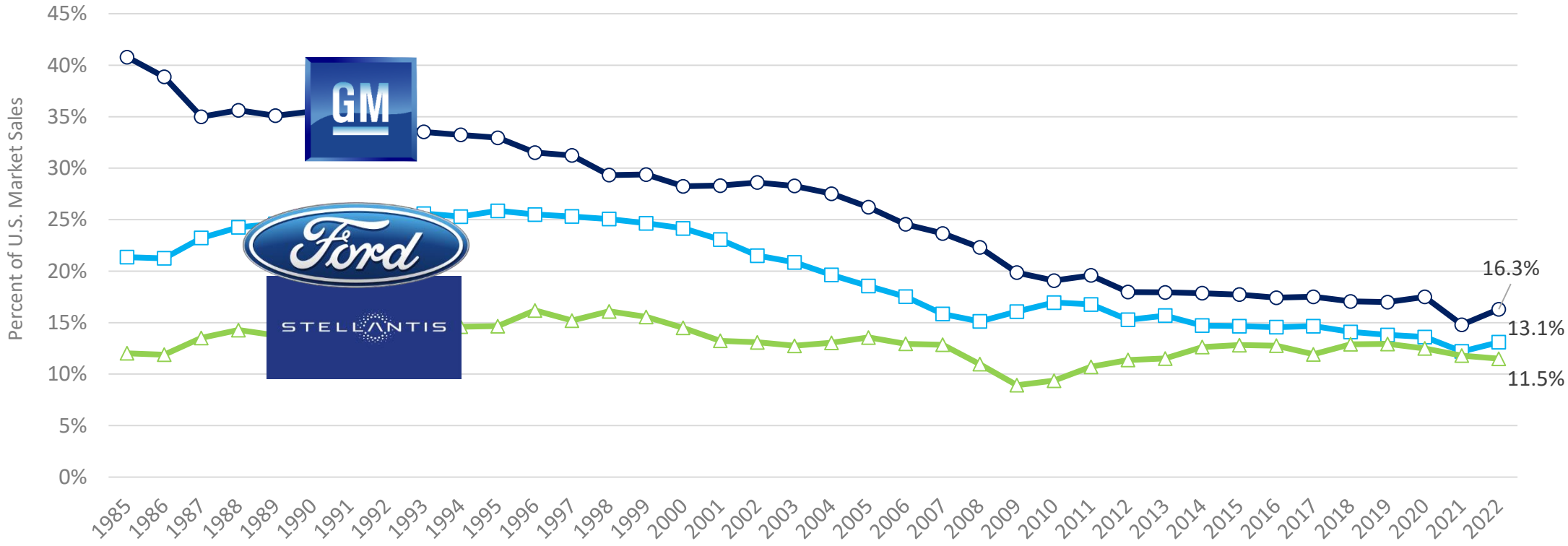


Source: Wards Auto; CAR Research

Detroit 3 year-to-date market share improved slightly, but still below 2020 levels

Detroit 3 U.S. Market Share

1985 – 2022 October YTD

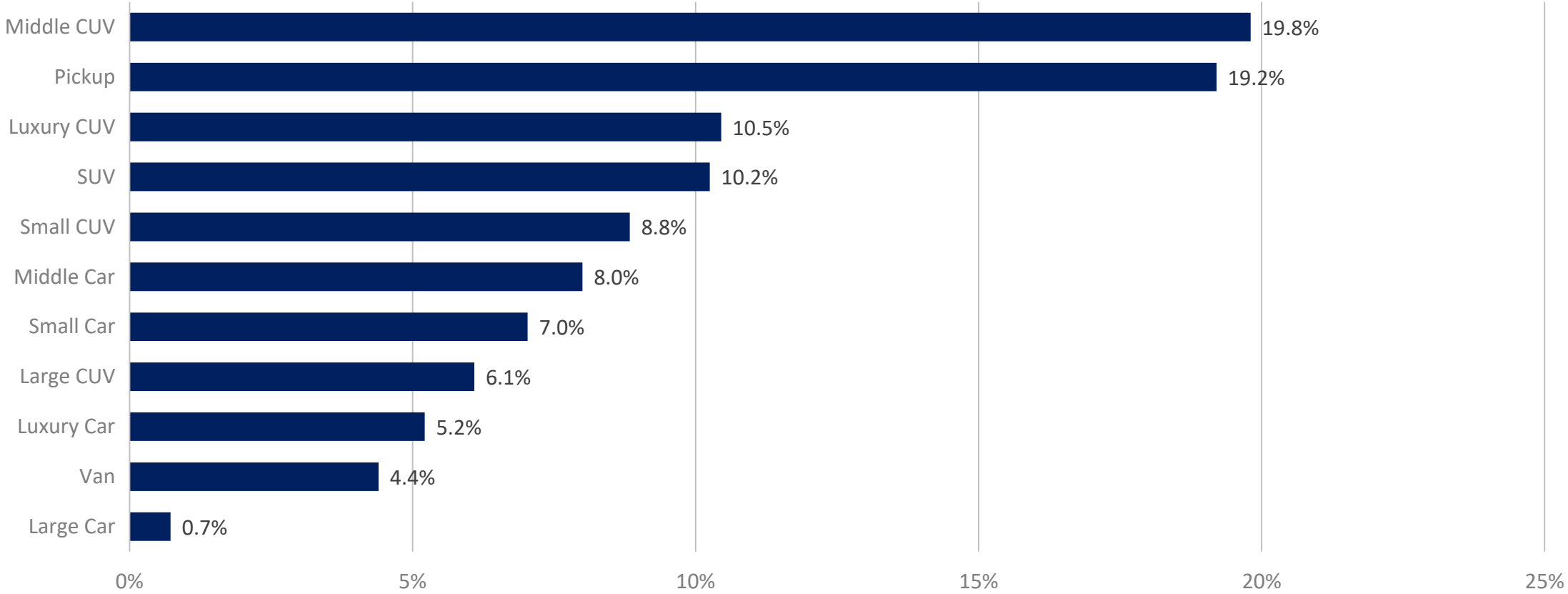


Source: Automotive News; Wards Auto (2012 and on); CAR Research

Middle CUVs are the top segment in the market

Market Share: Segment Breakdown

U.S. LV Sales 2022 YTD Through October



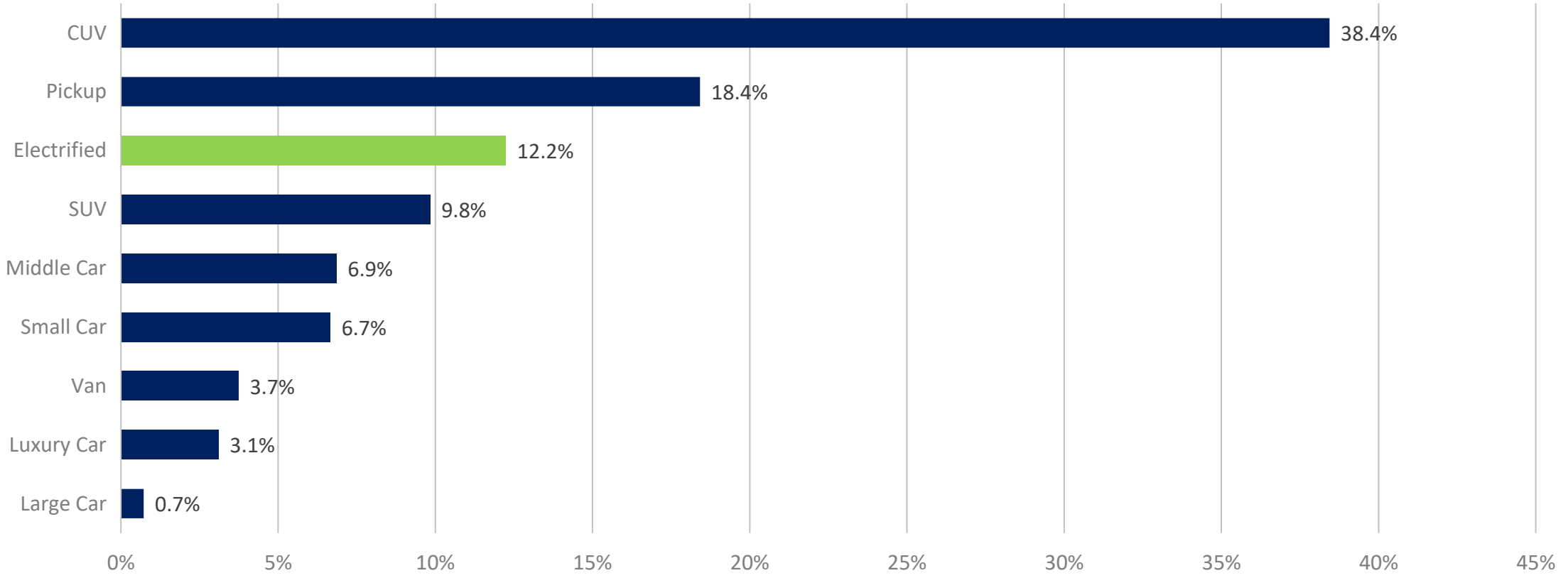
Source: Wards Automotive Reports

Electrified Vehicle Slides

Electrified vehicles comprise 12.2% of the LV market

Market Share: Segment Breakdown

U.S. Light Vehicle Sales 2022 YTD Through October



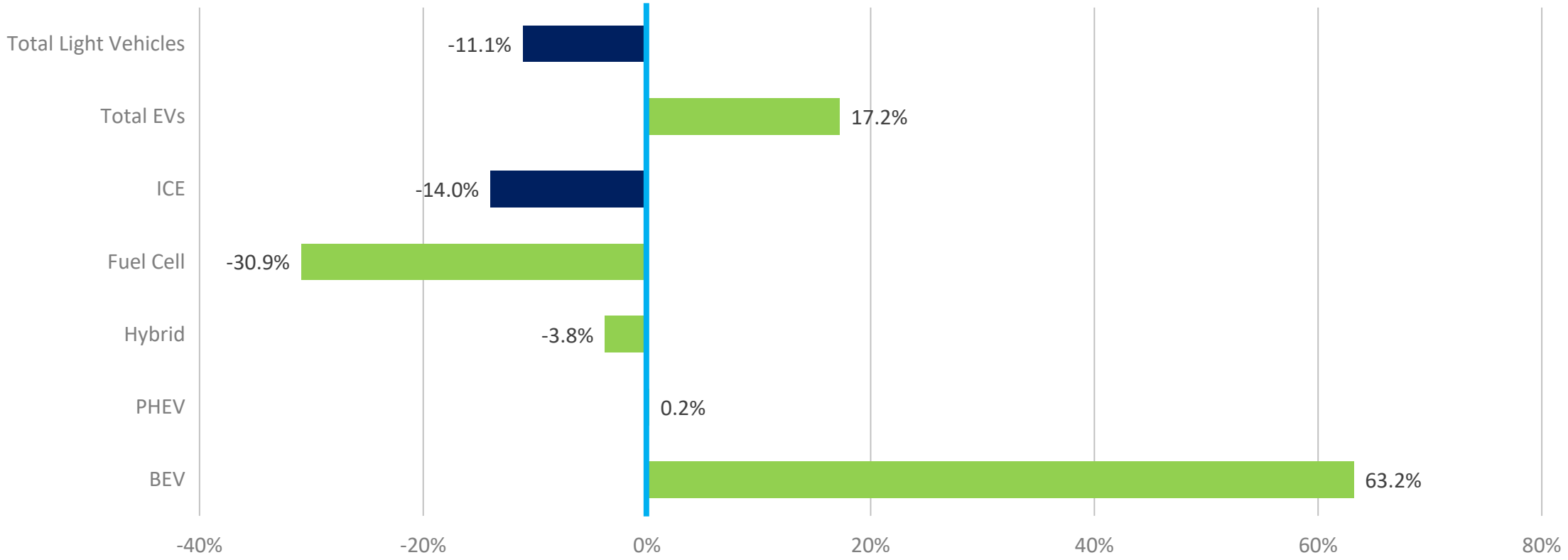
Note: Electrified Segment consists of BEVs, HEVs and PHEVs; all other segments are sales exclusive of Hybrid models

Source: Wards Automotive Reports and CAR Research

Electrified vehicles see a massive increase in year-to-date sales since last year

Segment Breakdown: U.S. Light Vehicles Sales Percent Change

2022 YTD vs. 2021 YTD Through October



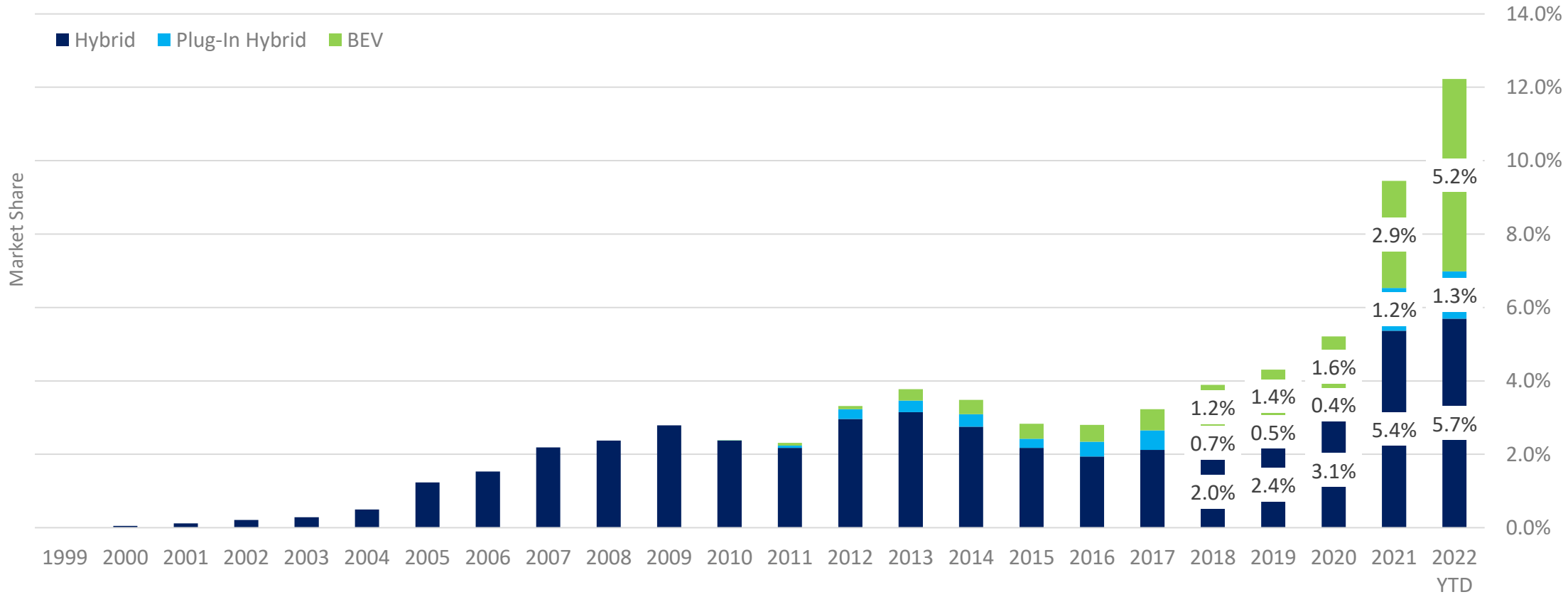
Note: All other segments are sales exclusive of Hybrid models

Source: Wards Automotive Reports and CAR Research

Hybrid, Plug-In Hybrid, and BEVs are all at historically high market shares in the new year

U.S. Electrified Light Vehicle Sales by Propulsion Technologies

1999 – 2022 YTD Through October



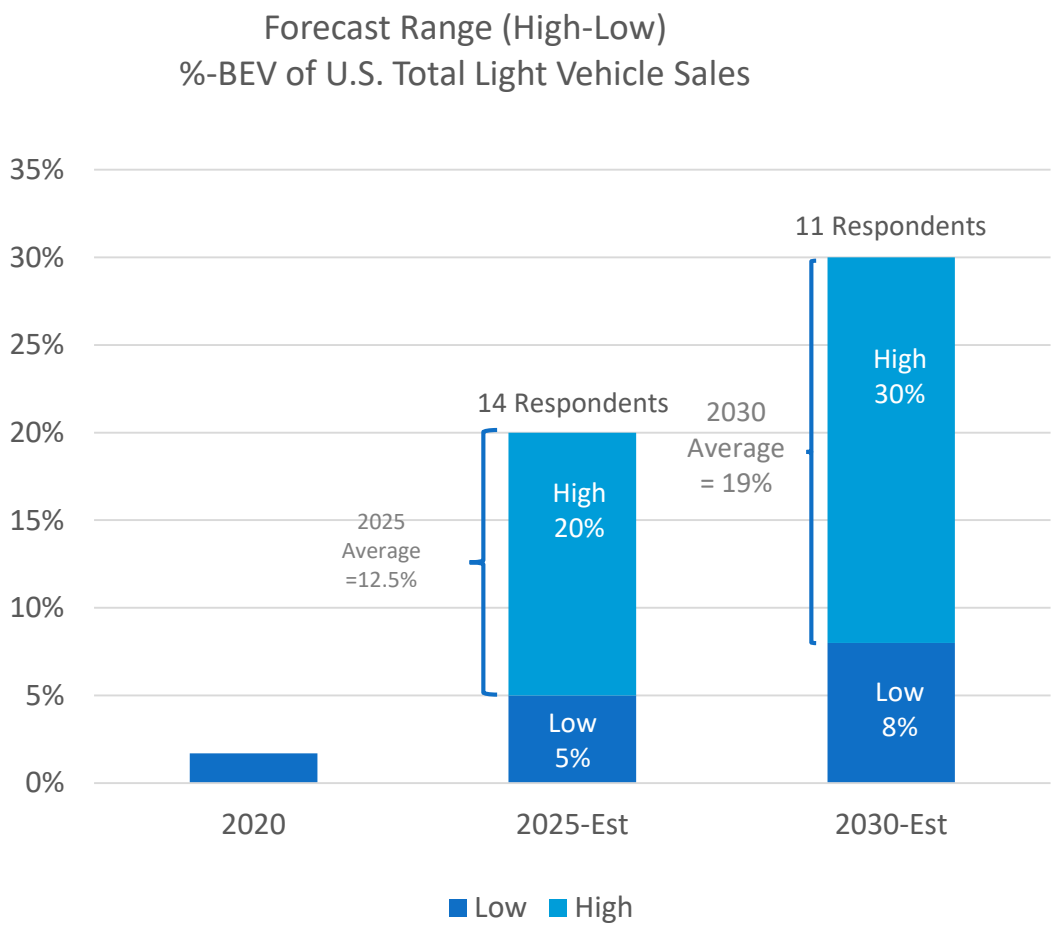
Note: Electrified vehicles consist of BEV, HEV and PHEV

Source: Ward's Automotive Reports (from 2010 and on), HybridCars.com and CAR Research

EV Market Uncertainty

BEV U.S. Market Outlook

Forecast Views Vary Widely Through 2030



Directionally, all forecasters are raising forecasts

Uncertainty driven by the 5 primary factors:

- Customer acceptance
- Battery performance & cost
- Charging infrastructure
- Availability (product and batteries)
- Government policy

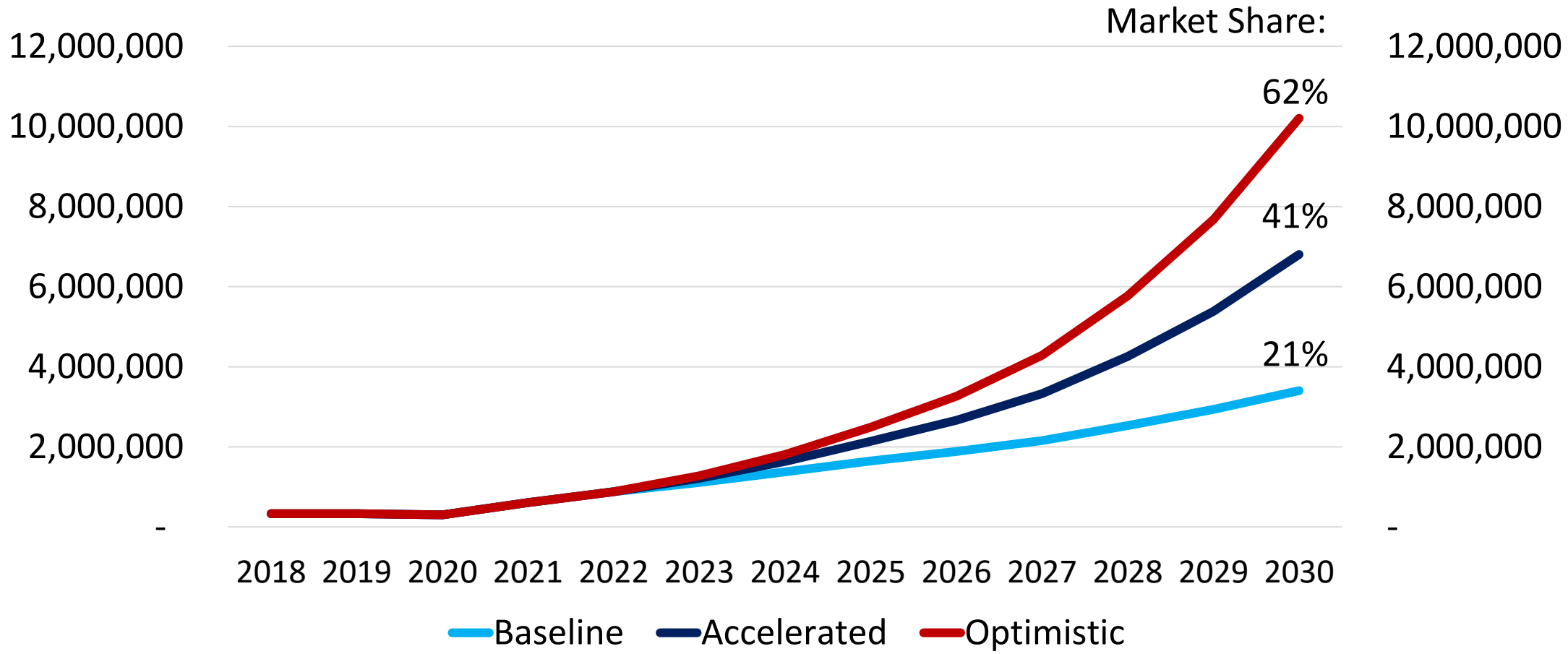
Source: Glen Mercer, Automotive Research & Advisory Services (10 February, 2021)

"They're a vision of the future that is now beginning to happen — a future of the automobile industry that is electric. Battery electric, plug-in, hybrid electric, fuel cell electric — it's electric, and there's no turning back. The question is whether we'll lead or fall behind in the race for the future."

–President Joseph R. Biden, Jr.
5 August 2021

U.S. Electric Vehicle Sales

2018 – 2021 Actual; 2022 – 2030 Forecast



Electric Vehicle: BEVs and PHEVs

Source: Center for Automotive Research

What matters to U.S. consumers?

1

Cost Parity→
Makes consumers indifferent to propulsion system

2

Utility Parity→
A vehicle to fit their needs & take them where they need to go

3

Convenience Parity→
Does not require extra time or planning to use

Product is Coming to Market

Key segments are about to be filled

Source: Ford Media

Source: General Motors Media

CENTER FOR AUTOMOTIVE RESEARCH

Impacts of Electrification Transition on Illinois' Automotive Industry

IMEC

ILLINOIS MANUFACTURERS' ASSOCIATION

9 November 2022

Illinois Automotive Electrification Analysis Introduction

CAR would like to thank the Illinois Manufacturing Excellence Center (IMEC) for its support and guidance in the performance of this study.

The automotive industry is in the midst of its greatest transformation in over a century.

The transition to electric vehicles brings unprecedented opportunity for Illinois to benefit from an enormous wave of automotive investment, while bringing risk to producers of components not used on electric vehicles.

This study

- Provides estimates of the scale and composition of the automotive industry in Illinois
- Describes the sweeping scale of automotive electrification transformation and the role played by Illinois automotive stakeholders
- Classifies Illinois automotive producers into high risk, low-to-moderate risk, and growth categories
- Makes recommendations intended to help Illinois maximize the benefit from automotive electrification while minimizing the risk it brings to traditional automotive component manufacturing

2021 Motor Vehicle and Parts Manufacturing Establishments – Top 10 States

	3361 MV Mfg.	3362 MV Body & Trailer Mfg.	3363 MV Parts Mfg.	Total
U.S. Total	695	2,339	5,867	8,901
Michigan	86	91	811	988
California	86	203	552	841
Ohio	32	116	461	609
Texas	41	202	333	576
Indiana	28	175	335	538
Tennessee	40	66	288	394
Illinois	39	60	282	381
Florida	27	118	234	379
Alabama	36	58	211	305
Kentucky	18	49	212	279

Source: Bureau of Labor Statistics, Quarterly Census of Employment and Wages; U.S. Census, Annual Survey of Manufactures

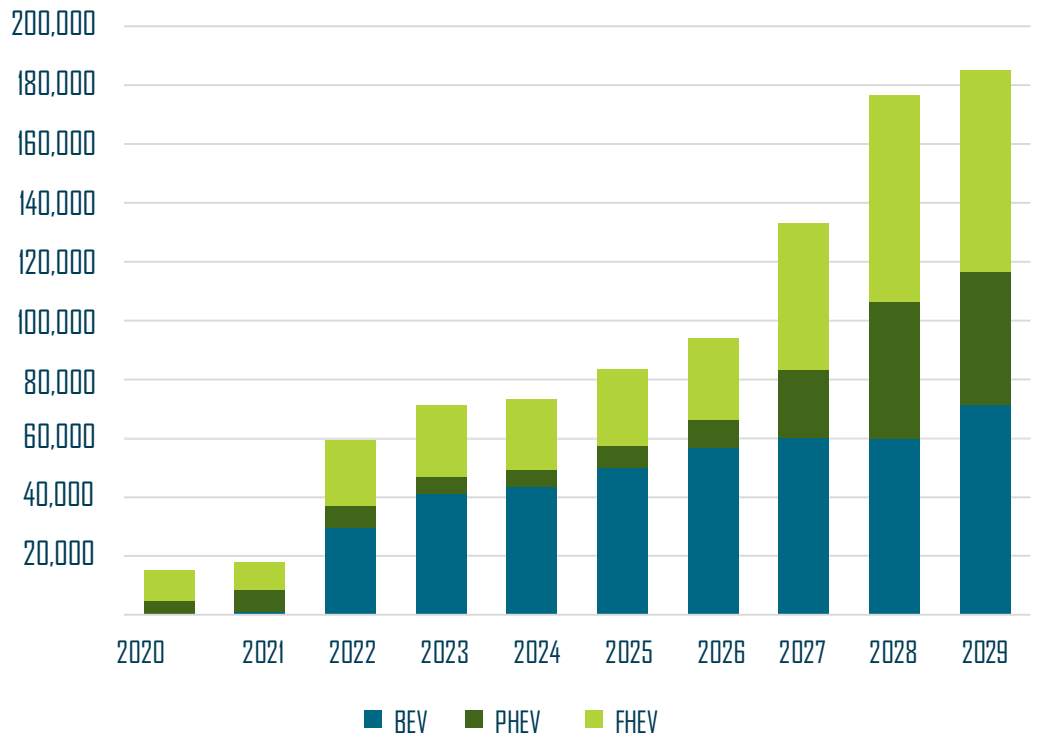
2021 Motor Vehicle and Parts Manufacturing Employment – Top 10 States

	3361 MV Mfg.	3362 MV Body & Trailer Mfg.	3363 MV Parts Mfg.	Total
U.S. Total	253,558	163,345	538,967	955,870
Michigan	45,057	8,038	121,783	174,878
Indiana	20,258	47,965	58,739	126,962
Ohio	21,591	8,994	66,683	97,268
Tennessee	17,572	2,574	41,606	61,752
Kentucky	22,043	3,866	31,738	57,647
Alabama	16,635	4,452	24,189	45,276
Texas	13,326	9,321	20,029	42,676
California	24,871	6,702	10,850	42,423
South Carolina	12,783	3,017	20,932	36,732
Illinois	10,383	3,256	21,151	34,790

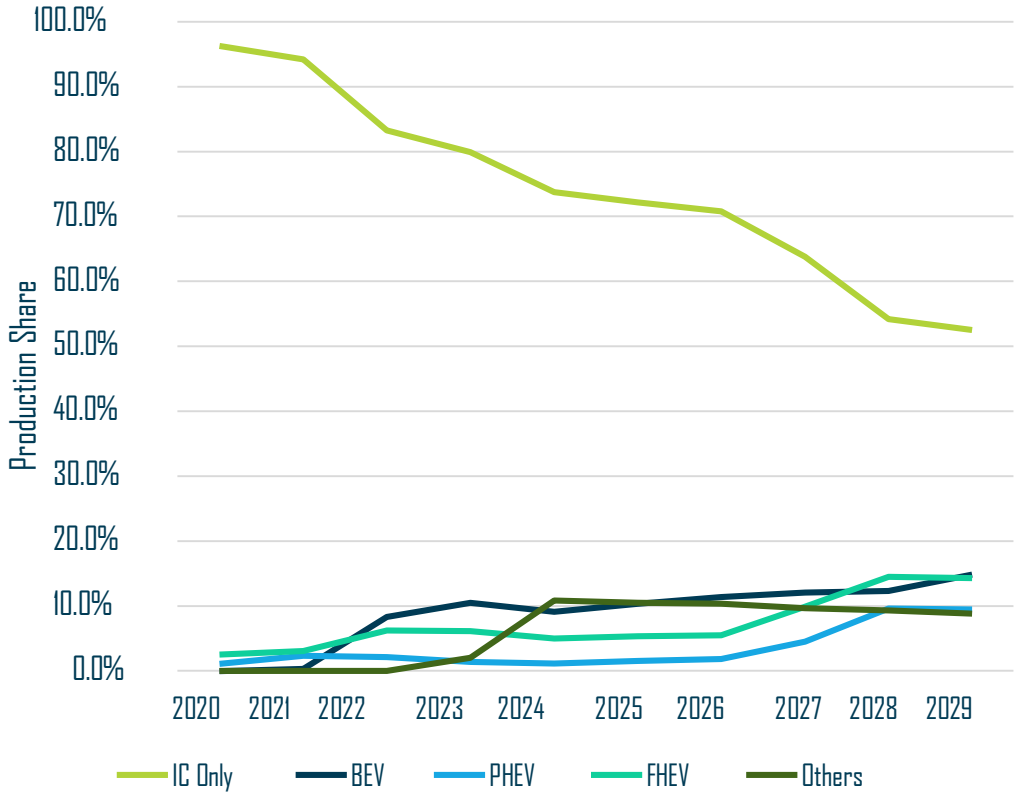
Source: Bureau of Labor Statistics, Quarterly Census of Employment and Wages; U.S. Census, Annual Survey of Manufactures

Illinois' Electrified Vehicle Production Forecast

Illinois Electrified Vehicle Production Forecast



Illinois ICE and EV Production Share

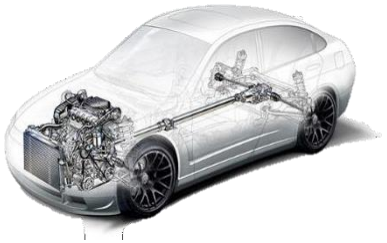


Source: LMC Automotive

BEV Drivetrain

Important USD-Content Implications for Suppliers

ICE Example @ $35,000 MSRP Passenger Car



Major Systems Affected by Transitioning to BEV	Est-USD Impact per Vehicle
Axles, driveshafts & auxiliary components (Reduced complexity)	↓ $300
Exhaust system (Eliminated)	↓ $400
Fuel system (Eliminated)	↓ $500
Transmission including clutches, planetary gears & torque converter (eliminated & replaced with electric drive unit & electric motors, 2 assumed in example but up to 4 possible)	↓ $500 net
Engine (Eliminated)	↓ $4,500
Power electronics & high-voltage electrical architecture (Added)	$3,000
Battery pack (Added)	$10,000
Other systems affected including body structures (increased content), audio/infotainment (upgraded), braking (upgraded), climate control/HVAC (upgraded)	$2,000

Insourcing Risk by Automakers

Source: BofA Global Research, Intellicosting LLC , Wolfe Research & CAR analysis; Note - For illustrative purposes & figures rounded. to the nearest $100 Light trucks & performance models could differ significantly.

Bill of Materials (BOM) – Risk Rankings – Highest Risk

Risk Profile	Rank:	BOM Category:	Key Trends:
Highest Risk	#1	Engine Components	Displaced by BEVs cost pressures to accelerate; consolidation likely
	#2	Drivetrain – Transmission	Reduced dollar content/vehicle with electrified powertrain;
	#3	Drivetrain – Axles, Driveshafts	Reduced dollar content/vehicle with an electrified powertrain
	#4	Fuel System	Eliminated with BEVs; consolidation likely
	#5	Exhaust/Emission Control	Eliminated with BEVs; consolidation and offshoring likely (after-market business model)

Source: CAR Analysis

Bill of Materials (BOM) – Risk Rankings – Low to Moderate Risk

Risk Profile	Rank:	BOM Category:	Key Trends:
Low to Moderate Risk	#6	Thermal Management – HVAC & Engine Cooling	Increased dollar content with electrified powertrain; consolidation likely
	#7	Body/Chassis – Structural	Increased dollar content with electrified powertrain (higher vehicle weights, need to protect battery); consolidation likely
	#8	Passenger Restraint / Passive Safety Systems	Already highly concentrated, further consolidation unlikely; restructuring expected
	#9	Interior Systems	No meaningful changes from current practices expected
	#10	Body/Chassis – Windows	Already highly concentrated, further consolidation unlikely
	#11	Wheels/Tires	Already highly concentrated, further consolidation unlikely
	#12	Steering System	Already highly concentrated, further consolidation unlikely
	#13	Suspension System	Increased dollar content with electrified powertrain (higher vehicle weights); already highly concentrated, further consolidation unlikely
	#14	Braking	Increased dollar content with electrified powertrain (regenerative braking); potential for high growth by more complex systems

Source: CAR Analysis

Bill of Materials (BOM) – Risk Rankings – Growth Opportunities

Risk Profile	Rank:	BOM Category:	Key Trends:
Growth Opportunities	#15	Electronics & Electrical – ADAS & Automation	High growth potential; large total addressable market; falling piece prices
	#16	Audio & Telematics	High growth potential / increasing market penetration; already highly concentrated, further consolidation unlikely
	#17	Vehicle Electrification—Electric/Drive/Motors	Displacing ICE transmission; select insourcing my automakers; scale hurdles for small/mid suppliers
	#18	Vehicle Electrification—Power Electronics & Other	Displacing ICE transmission components
	#19	Electronics & Electrical	Growing dollar content per vehicle with high- powered wiring architecture
	#20	Vehicle Electrification—Battery Pack Assembly	Displacing ICE; falling piece price but growing total addressable market
	#21	Vehicle Electrification— Battery Cells	Displacing ICE; falling piece price but growing total addressable market

Source: CAR Analysis

Bill of Materials – Illinois Risk Rankings

Risk Profile	Category	Establishments				Employment			
		High Risk	Moderate Risk	Growth	Overall	High Risk	Moderate Risk	Growth	Overall
Moderate Risk	Aftermarket		32		32		1,044		1,044
High Risk	Axle, Brake, and Body Control	23			23	2,417			2,417
Moderate Risk	Body and Exterior		39		39		8,360		8,360
Growth	Clean Energy System			43	43			7,590	7,590
Moderate Risk	Climate Control		6		6		546		546
High Risk	Drive Train	21			21	2,019			2,019
Growth	Driving Support and Telematics			12	12			1,302	1,302
Growth	Electrical and electronics			184	184			10,566	10,566
High Risk	Engine and Engine Parts	56			56	6,382			6,382
Growth	Engineering Service			19	19			821	821
Moderate Risk	Interior		25		25		2,398		2,398
Moderate Risk	Metalworking, Stamping, Machining		440		440		18,564		18,564
Moderate Risk	Motor Vehicle Manufacturing Equipment		26		26		1,265		1,265
Moderate Risk	Motor Vehicles Assembly		8		8		13,094		13,094
Growth	Research and Development			1	1			10	10
Moderate Risk	Small and General Parts		91		91		5,185		5,185
Moderate Risk	Suspension and Steering		47		47		7,496		7,496
Overall		100	714	259	1,073	10,818	57,952	20,289	89,059

Source: CAR Analysis

Illinois Employment and Company Risk Assessment

- High Risk – Engines and Engine Parts, Drivetrain, Axle, Fuel Systems, Exhaust Systems
  - 10,800 employment (12.1%)
  - 100 establishments and companies (9.3%)
- Low to Moderate Risk – HVAC, Body & Exterior, Interior, Wheel/Tire, Steering and Suspension, Aftermarket, Metalworking, Stamping, Machining, Molding, Equipment Manufacturing, Assembly, General Parts,
  - 58,000 employment (65.1%)
  - 714 establishments and companies (66.5%)
- Growth Opportunities – Electrical and Electronics, Clean Energy Systems, Driving Support, Sensors, Engineering Service, Research and Development
  - 20,300 employment (22.8%)
  - 259 establishments and companies (24.1%)

Recommendations and Conclusions

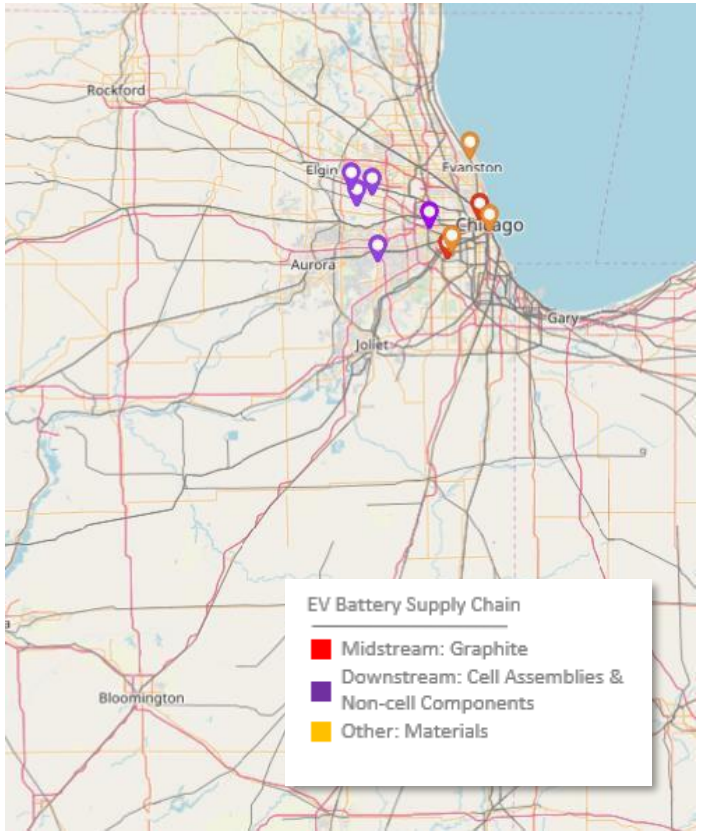
Inflation Reduction Act: Implications and Opportunities for Illinois

- Balance of policy supporting electrification and North American manufacturing
- The resulting anticipated growth in U.S. EV supply chain is an opportunity for existing Illinois companies and for the attraction of new firms to the state
- Near-term: expand existing supply base for electrolytes and anode materials
- Medium and Long-term: attract localized battery supply for Rivian (currently source cells from Korea) and potentially cathodes (no plants currently exist in North America)
- Battery content requirements likely biggest source of opportunity for Illinois
  - 2024: 40% of content from NA or Free Trade Agreement (FTA) countries
  - 2029: 100% of content from NA or Free Trade Agreement (FTA) countries
- Long-term content requirements will be challenging for automakers without substantial additional investment in localized North American supply chain (only Tesla, GM, and Ford have publicly announced plans so far for cathode manufacturing in North America)

Conclusions and Recommendations

Investment Opportunities – EV Supply Chain

Illinois Battery Supply Chain Locations – Current



* *Other materials include battery-grade graphite, used in anode manufacturing*

- Existing facilities are well positioned to benefit under the Inflation Reduction Act (IRA), to meet localized battery materials content requirements
- Automakers appear to be prioritizing "shovel-ready" supply chain projects, and may need to leverage existing supply chain infrastructure to launch key BEV programs on time
- Illinois can leverage existing supply chain endowment, including:
  - Electrolyte manufacturing facilities – Honeywell
  - Graphite, battery-grade materials manufacturing – Superior Graphite*
  - Advanced battery materials R&D – Nanograf, Superior
  - Graphite, and Volexion
- Opportunities to expand existing supply chain footprint to meet improving demand outlook for battery materials

Source: NAATBATT and CAR analysis

Electrification: Top Five Illinois Opportunities

- Capitalize on growth potential of the 259 Illinois companies in growth product areas (over 20,000 Illinois employees), e.g. electrical and electronics, driving support and telematics, clean energy and engineering services
- Rivian assembly plant is an opportunity to establish localized battery supply chain
- Support additional investment by existing Illinois battery supplier companies within anode materials, graphite (including graphite-alternatives and additives), and electrolytes
- Develop supporting ecosystem for anodes and electrolytes by attracting sub-component suppliers, e.g. battery materials processors
- Foster regional ties with other state governments to encourage battery ecosystem development and advanced R&D activities
- Streamline residential/commercial building codes and utility regulatory policy to encourage EV charger adoption, to support infrastructure build-out and EV adoption

Electrification: Top Five Concerns

- No major battery assembly plants announced in Illinois so far (they are becoming anchors for battery supplier parks in some cases, and centers of battery supplier ecosystems)
- Lack of battery assembly plants may limit opportunities to lure full-service battery recycling companies to collection facilities-only (lower value add)
- No cathode plants, which account for approximately 50% of battery cost – an important driver of localized content to meet proposed IRA content requirements
- Traditional ICE powertrain suppliers (transmissions, engines, and related subsystems) to consolidate, and could become "distressed" assets during electrification transition
- Advanced R&D battery activities currently focused on anodes and graphite applications – important growth opportunities but may be insufficient without additional investment within other areas

Electrification: Top Five Recommendations for Illinois Stakeholders

- Take action based on CAR's Illinois automotive supplier analysis
  - Highest Risk: assist with product transition
  - Low to Moderate Risk: nurture
  - Growth Opportunities: assist existing firms in expansion, pursue new investment from similar firms
- Diversify existing battery supply chain to include cathodes and advanced battery materials, e.g. solid-state components
- Target battery assembly plant to serve as anchor for battery supplier ecosystem
- Leverage Rivian assembly plant to established localized battery supply chain
- Streamline residential/commercial building codes and utility regulatory policy to encourage EV charger adoption, to support infrastructure build-out and EV adoption

Thank you

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