Future of Mobility: Disruptive Technologies Create New Realities

November 2023

About Plante Moran

99
Years serving clients (founded in 1924)

25
Years on FORTUNE's Best Workplace list

2,500+
Manufacturing & distribution clients

39,000
Professionals worldwide

3,500+
Professionals in U.S. With dedicated Japanese practice

Mobility Intelligence Center

Research on Critical Information for Mobility Technologies to OEMs, Suppliers and New Entrants

Comprehensive Services for our Clients

- **Strategy Consulting**
  - Strategic planning
  - Market research and analytics
  - Product commercialization
  - Business development strategies
  - Sales channel strategies
- **Supplier-Customer Relationship Analytics**
- Transaction Advisory Services – financial, commercial, operational, IT due diligence
- Merger Integration
- Restructuring Services
- Operations and Supply Chain Consulting
- Risk Advisory and Accounting Services
- Valuation
- Information Technology Consulting
- Cyber Security
- Human Capital
- Audit and Accounting
- Tax Compliance and Consulting
- Government & Infrastructure
- Wealth Management
- Life Insurance
- Investment Banking (PM Corporate Finance)
- Real Estate (Plante Moran CRESA)

Automotive Market Overview

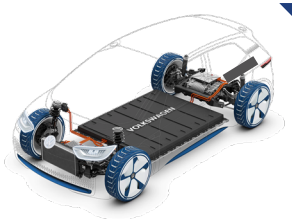
Future Mobility - *A Lot has Changed in 5 Years*

2018

1. Autonomy

2. Mobility

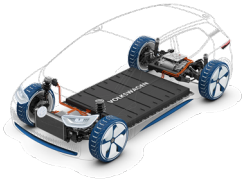
3. Electrification



4. Manufacturing the vehicle

2023

1. Electrification



2. Connectivity

3. Mobility

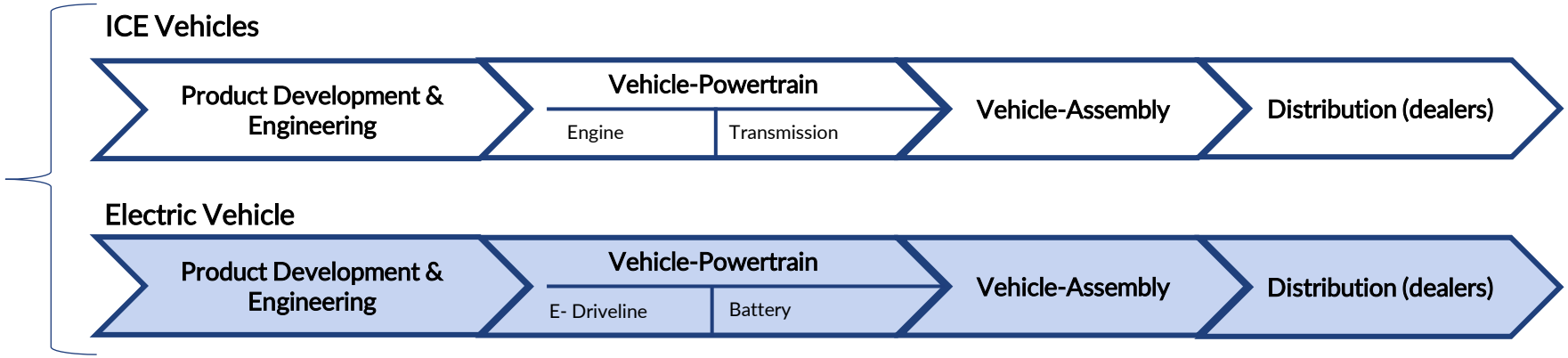
4. Autonomy

5. Manufacturing Simplification

Automotive Manufacturing Value Chain
Transition Across Automotive Industry

To make the transition to electric vehicles the automotive industry has to change both product and production approaches and do so in a "smart" and sustainable way

1. Product Transition



2. Production Transition

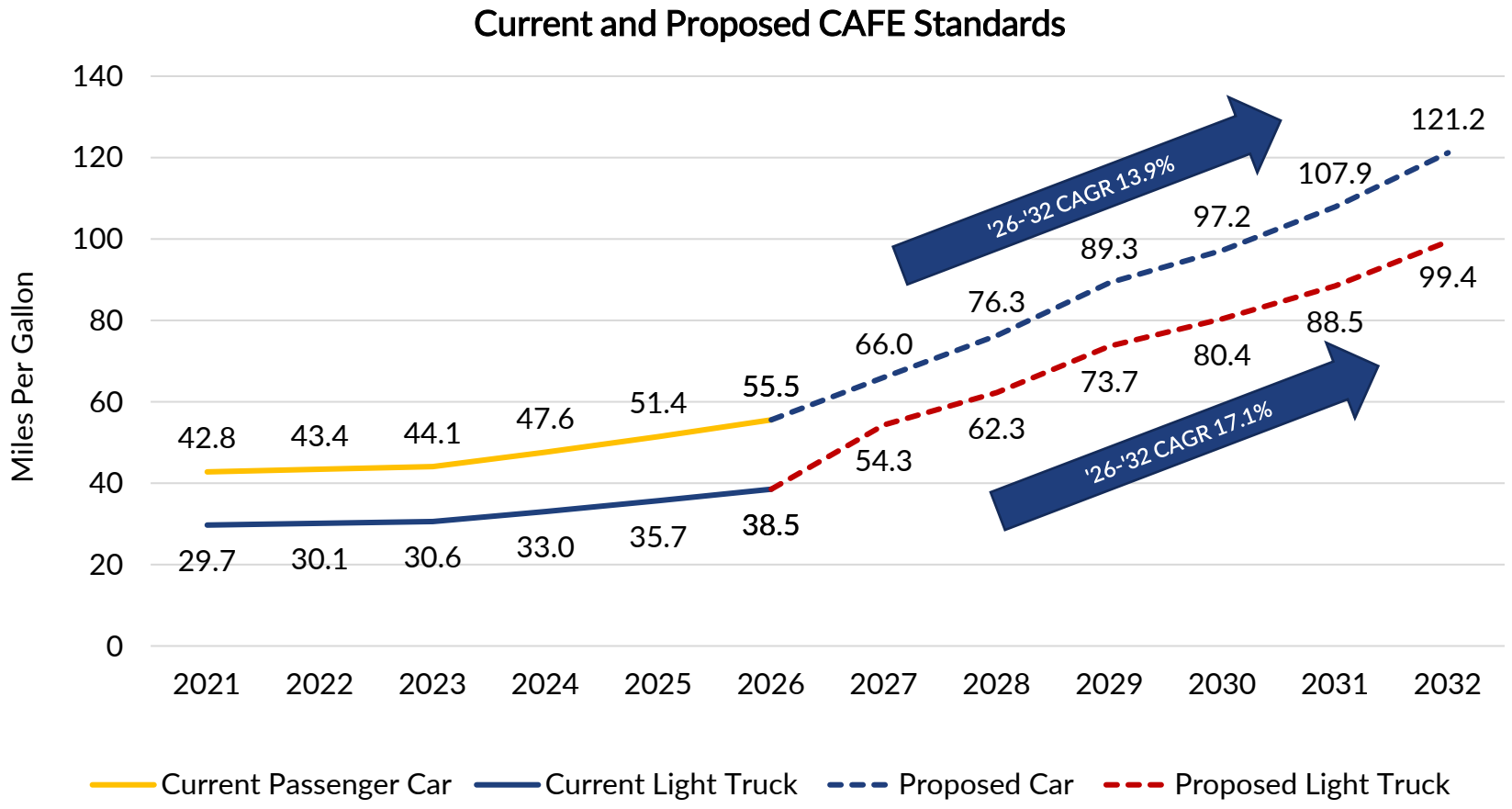
- Product Development & Engineering focused on EV technologies—reduced development for ICE vehicles
- Retrofit of current facilities (engine, transmission, assembly, dealerships)
- Greenfield construction of new required facilities (traction motor, e-axle, assembly)
- Transition of equipment and production techniques to take advantage of technology enablers and combined with the opportunity to reduce carbon emissions
- Creation of new supply chains
- Nearshoring / Geographic Shift
- Impact of IRA on USMCA investment decisions/business cases

3. Industry Sustainability

Increased focus on carbon reduction for both product and production

Proposed CAFE Standards

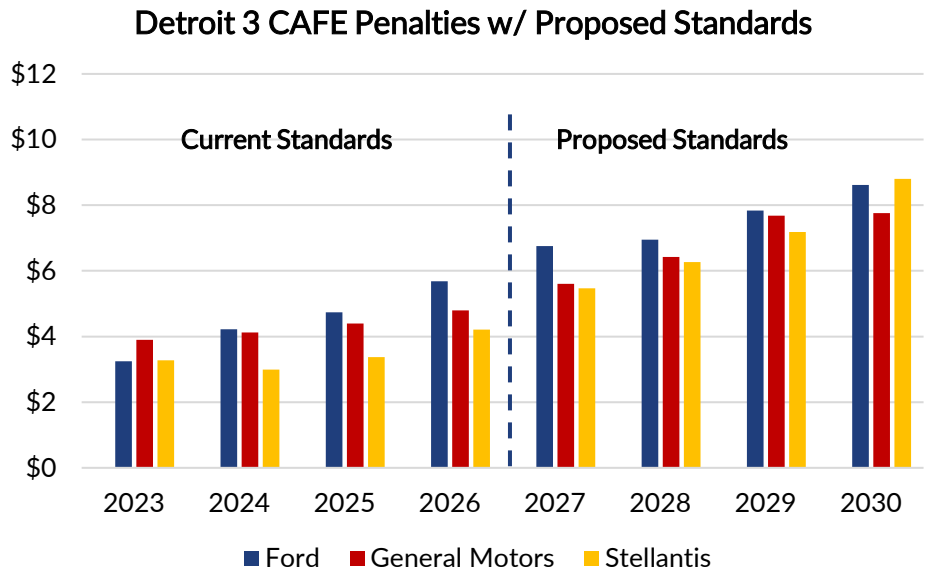
Accelerated industry shift towards electrified vehicles driven by new Administration's strengthened policies related to fuel economy, EV purchasing incentives, infrastructure, and continued industry cost reductions

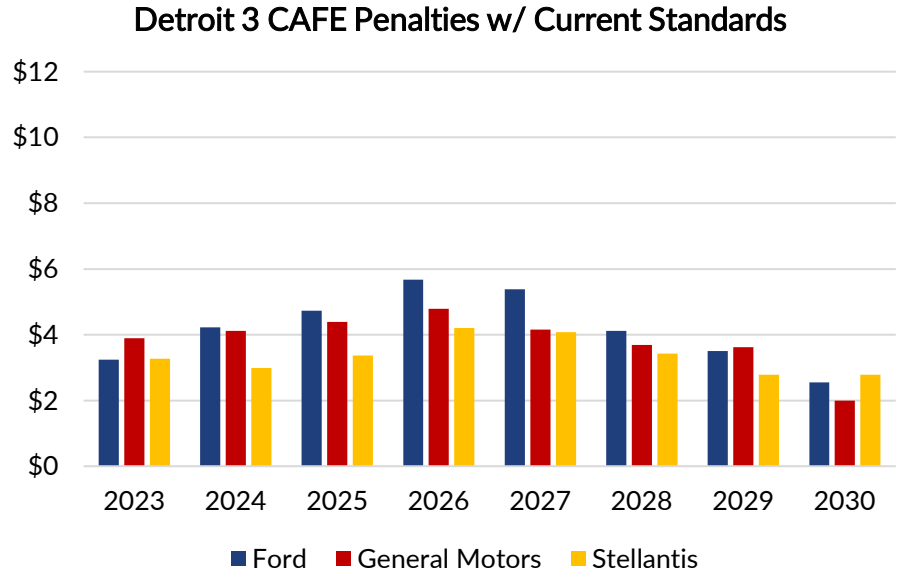


OEM CAFE Calculation—Detroit 3 OEMs

Baseline Penalties

The Detroit 3 OEMs (GM, Ford, Stellantis), due to concentration of large sized vehicle production, will be subject to CAFE penalties. The CAFE penalty forecast analysis illustrated below incorporates proposed CAFE standards through MY2030, as well as using current standards through MY2026

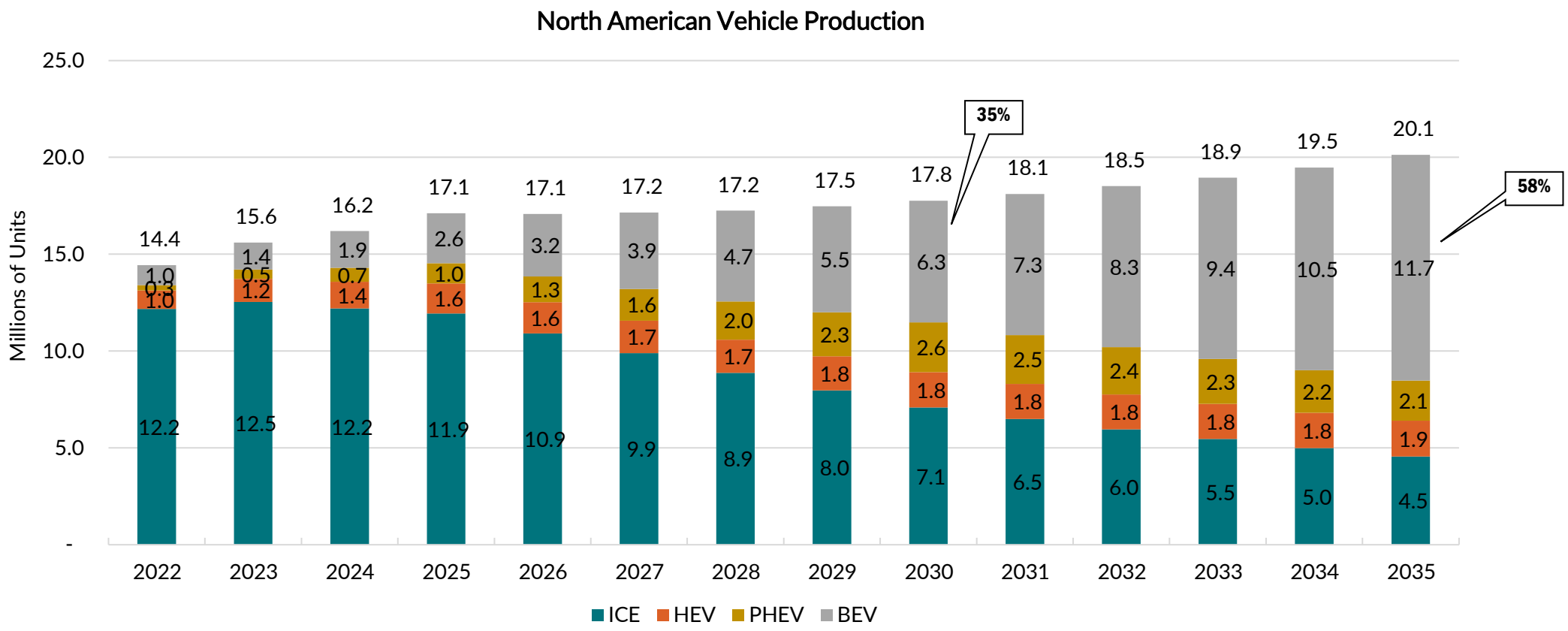




Incremental Impact due to Proposed Standards	
OEM	Cumulative $
Ford	~$11B
General Motors	~$14B
Stellantis	~$15B

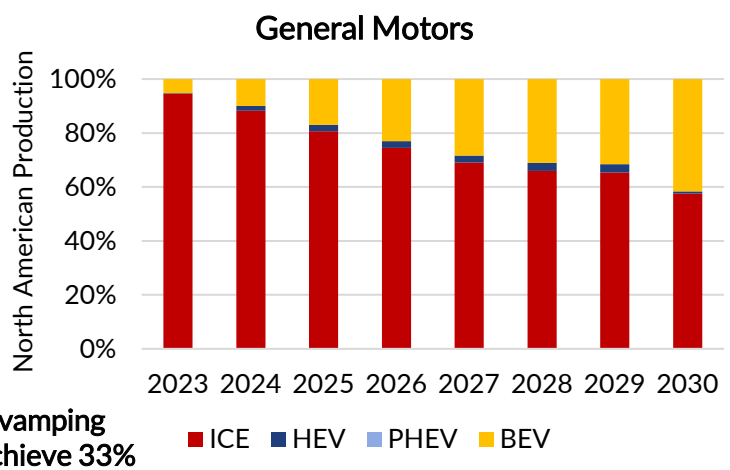
Electrified Vehicle Production
North America Projections

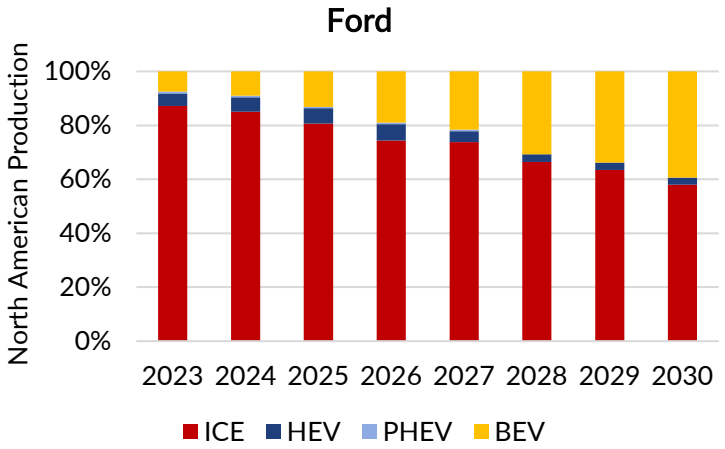
The transition to electrified powertrains is becoming more certain. North American EV volume is projected to grow to 35% of production by 2030 and continues to grow to 58% of production by 2035

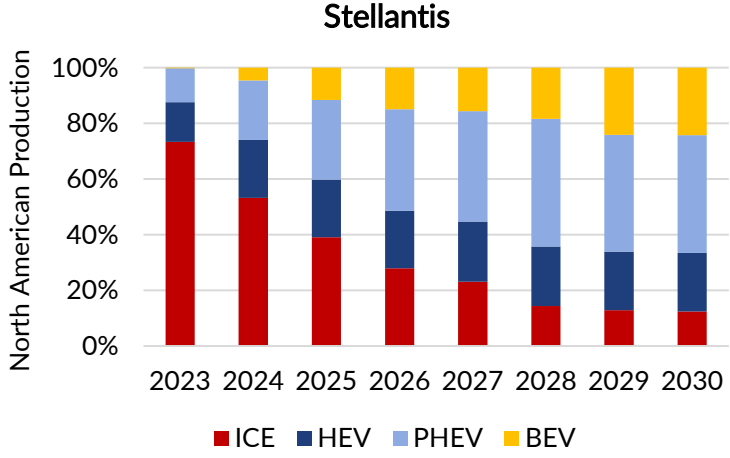


ICE, EV, and Hybrid North American Production
Detroit 3, Toyota, Honda, Nissan

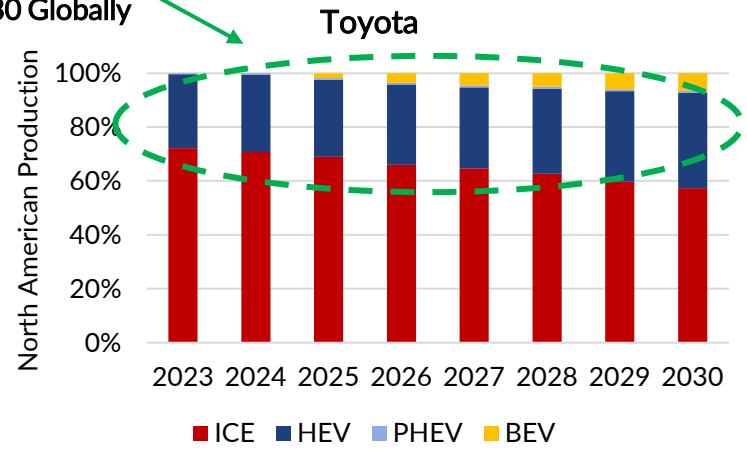
OEMs have timing variances in their transition plans to electrified vehicles. GM and Honda have the most aggressive EV plans, with a little focus on hybrid offerings - Toyota and Stellantis focusing on diversification of their product portfolio

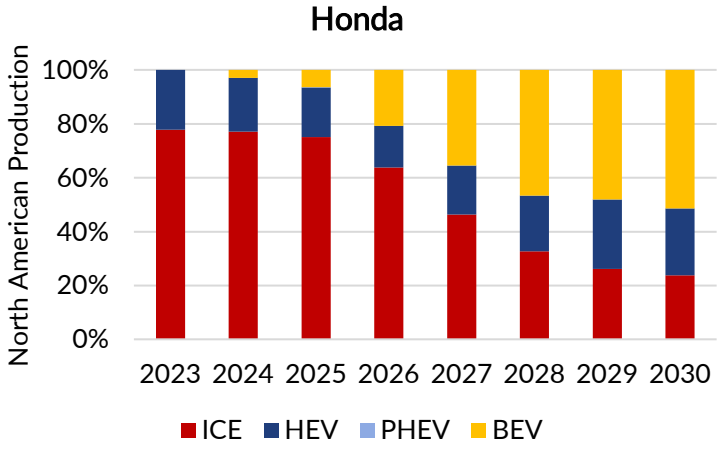


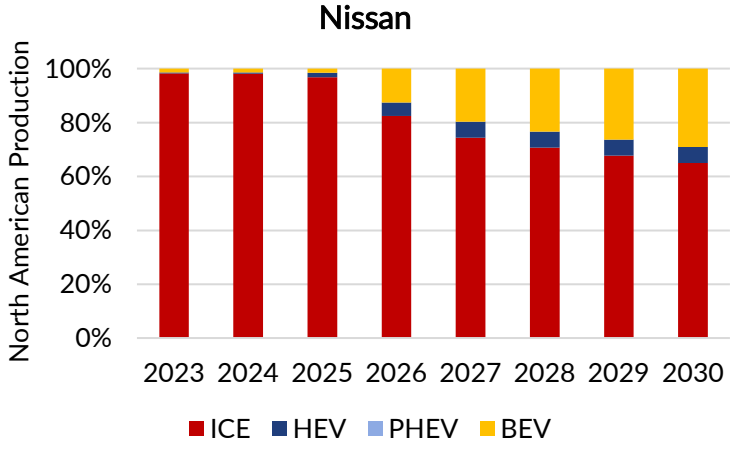




Toyota is revamping efforts to achieve 33% BEV by 2030 Globally

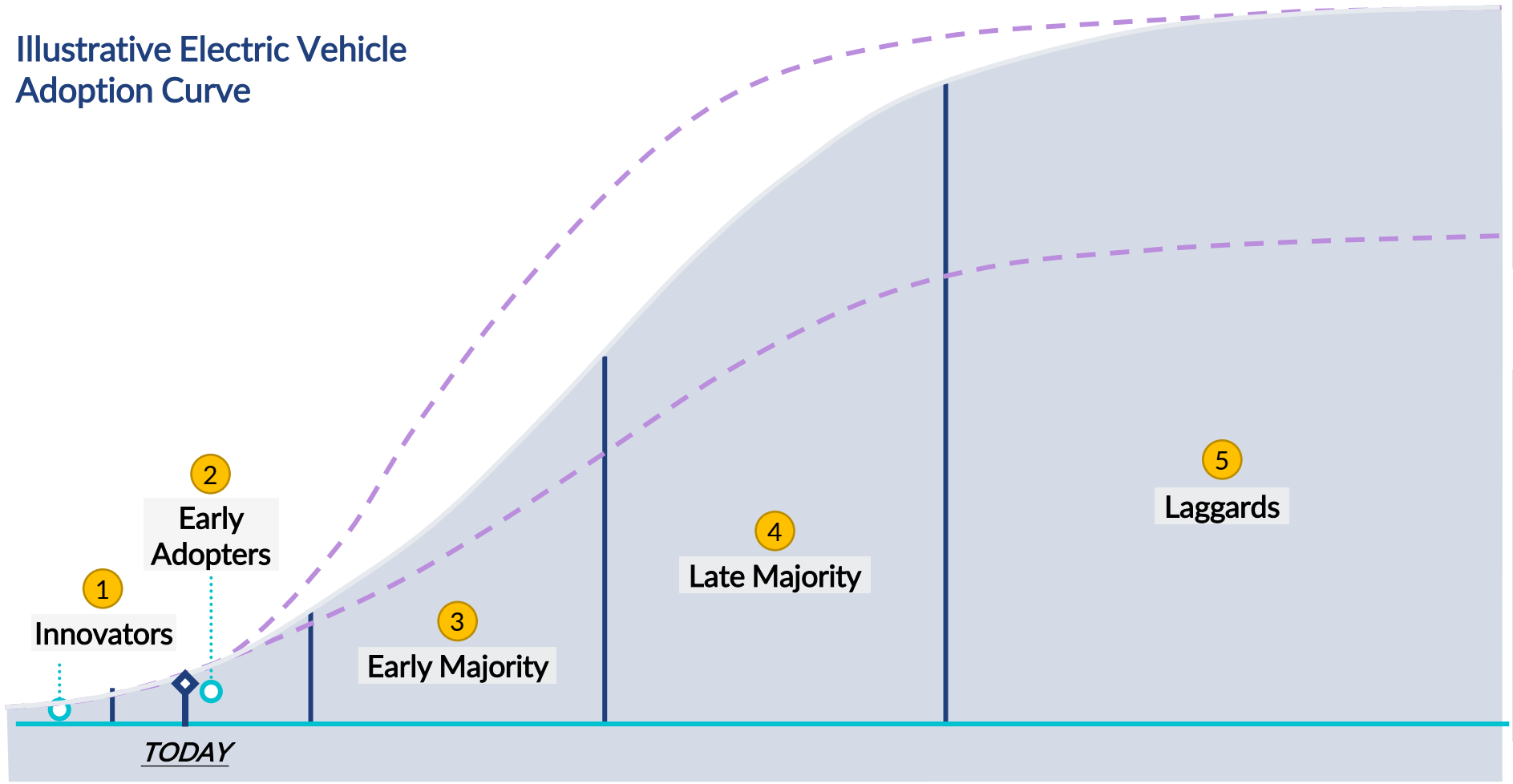






EV adoption curve is influenced by several outside factors

Illustrative Electric Vehicle Adoption Curve



Example "Bull" Case:

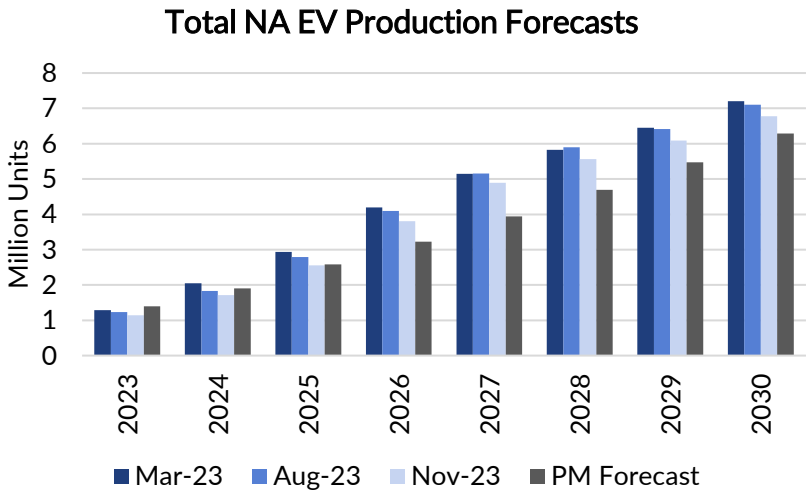
- Battery cost and range advances accelerated (e.g., due to Lithium-solid)
- Emissions regulations continue to tighten, requiring greater electrification
- High infrastructure investment due to consumer demand / public incentives

Example "Bear" Case:

- BEV cost remains high, limiting adoption to near-luxury market and top end of mainstream
- Regulations loosened, driven by recognition that EVs not ready for widespread adoption
- Availability of reliable public chargers limited, making EVs as a daily driver challenging

Is N.A. EV Demand Slowing?
EV Forecast Model Comparison

Forecast of EV adoption in the US maintains growth despite industry challenges such as UAW labor strike and high interest rates—forecast likely to maintain growth as the US Government and OEMs remain steadfast in their targets and continued investment



- North American EV forecasts have remained consistent throughout the year amidst industry disruptions and economic headwinds
- Plante Moran Forecast remains consistent with industry forecasts with more conservative growth due to required manufacturing capacity
- OEMs have yet to reduce their stated EV targets—expect forecasts to remain consistent as OEMs continue to build to reach demand

EV % of Total NA Production by Forecast Model								
Forecast	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
March 2023	8%	13%	18%	25%	30%	33%	36%	39%
August 2023	8%	11%	17%	24%	30%	34%	37%	40%
November 2023	7%	11%	16%	22%	29%	32%	35%	39%
PM Forecast (used in BM construction model)	**9%**	**12%**	**15%**	**19%**	**23%**	**27%**	**31%**	**35%**

Source: *AFS, PM Model*

Is N.A. EV Demand Slowing?
Factors to Monitor

OEM EV program delays and growth in EV inventory reflect short-term market conditions—OEM product strategy driven by multiple factors that will overcome current challenges long-term

Factors to Monitor	Implications
Pace of EV Adoption	• 6 weeks in lost production resulting in new EV program delays as OEMs work to build inventory of existing saleable vehicles • GM Delays: Equinox EV, Sierra EV, and Silverado EV • Average Tesla transaction prices is ~11% higher than ICE today—GM EV prices ~150% higher • Current EV models are typically higher trim levels focused on specialized vehicles—higher manufacturing cost leads to greater MRSP to gain cost recovery and profit margin • Interest rates are driving higher monthly payments and leases • OEM's EV profit margin targets dependent on the ability to launch lower cost EVs—the inability to obtain profitability on EVs due to the lack of high-volume offering

UAW Strike	• The proposed UAW contracts include significant domestic investment from OEMs over contract period (November 2023-April 2028):
	  • GM: $11B investment previously announced—$8.4 EV investment
	  • Ford: $8.1B in investment in existing facilities—$5.5 EV investment
	  • Stellantis: $19B across US including idled facilities—$16.0 EV investment
	• Increased labor rates due to the UAW negations will drive the need for cost efficiencies through the manufacturing process—implementation of automation and manufacturing simplification are greater enabled by EV vehicle architecture

Government Policy	• Emissions regulations continue to increase, creating increased pressure for OEMs to electrify their fleets to avoid growing CAFE penalties • IRA incentives (~$400B) expected to end in 2032—OEMs expected to take advantage of existing funding • Government and OEMs driving onshoring of battery value chain to reduce foreign reliance and cost • Facility demand for upstream operations expected to remain strong to support build-out of domestic supply chain

Transition to Electric

Supplier and Component Impacts

Vehicle Technology - Electrification

Radical Powertrain Shift in Supplier Components for EVs

Electrification will greatly impact vehicle and component manufacturing – financial investment in new EV powertrain component manufacturing will be required from the supply base

ICE Powertrain Components

Internal combustion engine

Turbocharger

Fuel system

Transmission

Exhaust system

Air intake system

Market Shifts

EV Powertrain Components

Battery pack

Traction motor

Inverter

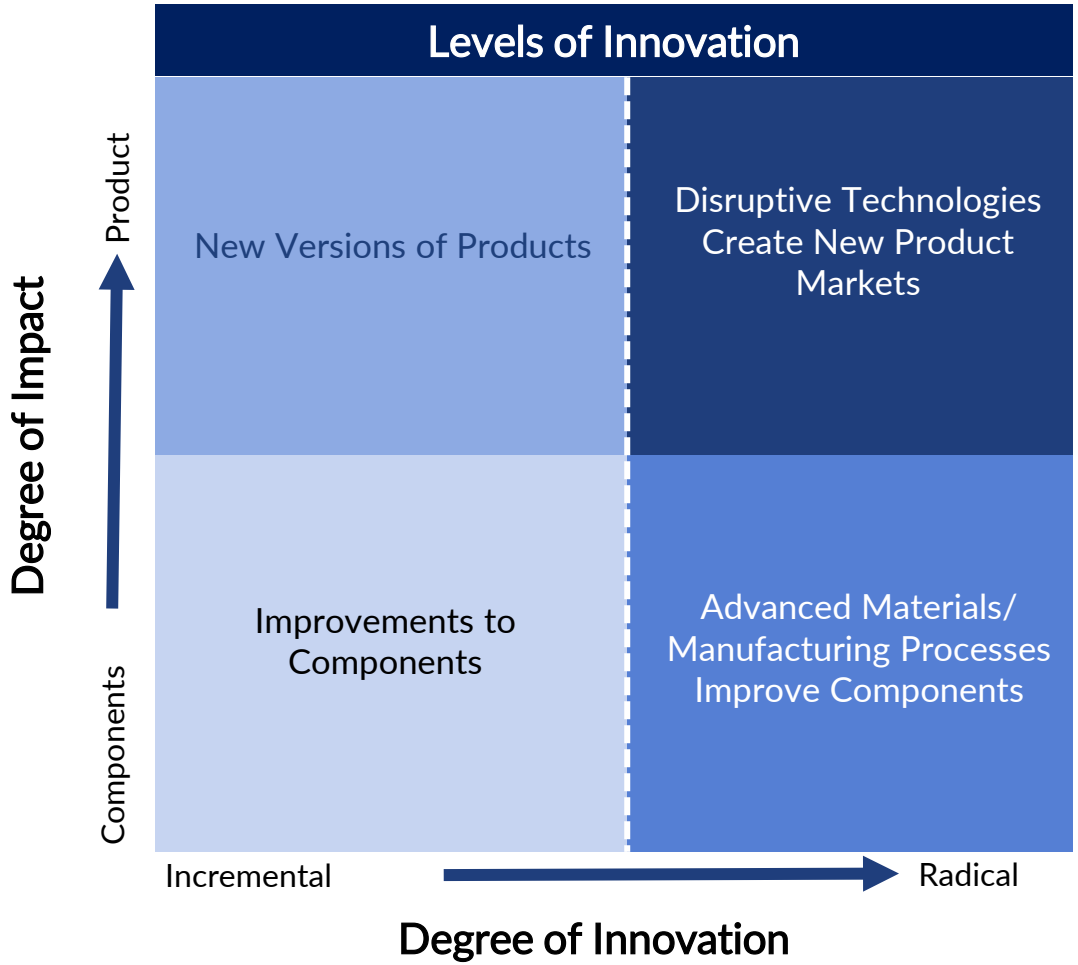
DC/DC converter

Gearbox

Onboard charging module

Innovation in the Automotive Market
Innovation Impact

- Some innovations are incremental; some are disruptive and create new market opportunities
- Innovations are occurring in multiple areas: components, product, material, manufacturing process, and technology/software
- Innovations across all these areas will continue to drive dramatic changes and adoptions across electric, connected, autonomous and shared vehicles in the automotive industry



Vehicle Bill of Material
New Segments

Current EV bill of material is ~41% larger than the ICE equivalent—new vehicle components are focused on EV value chain with changes impacting propulsion and electrical components

Vehicle Segment	Component	ICE ($000's)	EV ($000's)	EV Impact %
Body & Structural	BIW	$4.16	$4.89	17%
	Body Glass	$0.20	$0.20	-1%
Chassis	Braking	$0.66	$1.00	52%
	Suspension	$0.81	$0.80	-2%
	Steering	$0.53	$0.53	-2%
	Wheels and Tires	$0.45	$0.44	-3%
Driveline	Axles, Driveshafts, Components	$1.35	$0.99	-26%
Electrical	Electronics & Electrical	$3.08	$3.02	-2%
	EV Electrical Architecture	$0.00	$1.30	-
ICE Propulsion	Transmission	$2.13	$0.00	-100%
	Fuel System	$0.52	$0.00	-100%
	Engine	$4.26	$0.00	-100%
	Exhaust	$0.43	$0.00	-100%
Interior	Interior	$1.90	$1.86	-2%
	Audio & Telematics	$0.53	$0.73	37%
	Passenger Restraints	$0.49	$0.49	-2%
Thermal	Climate Control and Powertrain Cooling	$1.10	$1.51	37%
EV Propulsion	Battery Pack	$0.00	$10.96	-
	Power Electronics	$0.00	$1.78	-
	Electric Motor/Drive	$0.00	$1.40	-
	Total	**$22.60**	**$31.85**	**41%**

Shifts to EV technologies will provide opportunities and change:

- New component opportunities for electric motors and gearbox, power electronics, and battery packs
- Declining market opportunities for engines, transmissions, fuel systems, and exhaust
- Shifting customized component needs for electrical & electronics, climate control, thermal management, body & structural, interior, axles/drive

Overtime EV value per vehicle will fall as:

- Increased production volumes provide economies of scale (1.7M BEV built in 2019 vs 7.3M in 2022est)
- Proliferation of EVs models into mass market applications and lower price points
- Expansion of capable supply base and increased competitive bidding processes
- Technology innovations (i.e. battery chemistries, manufacturing processes)

ICE costs will rise as market share and volumes decline

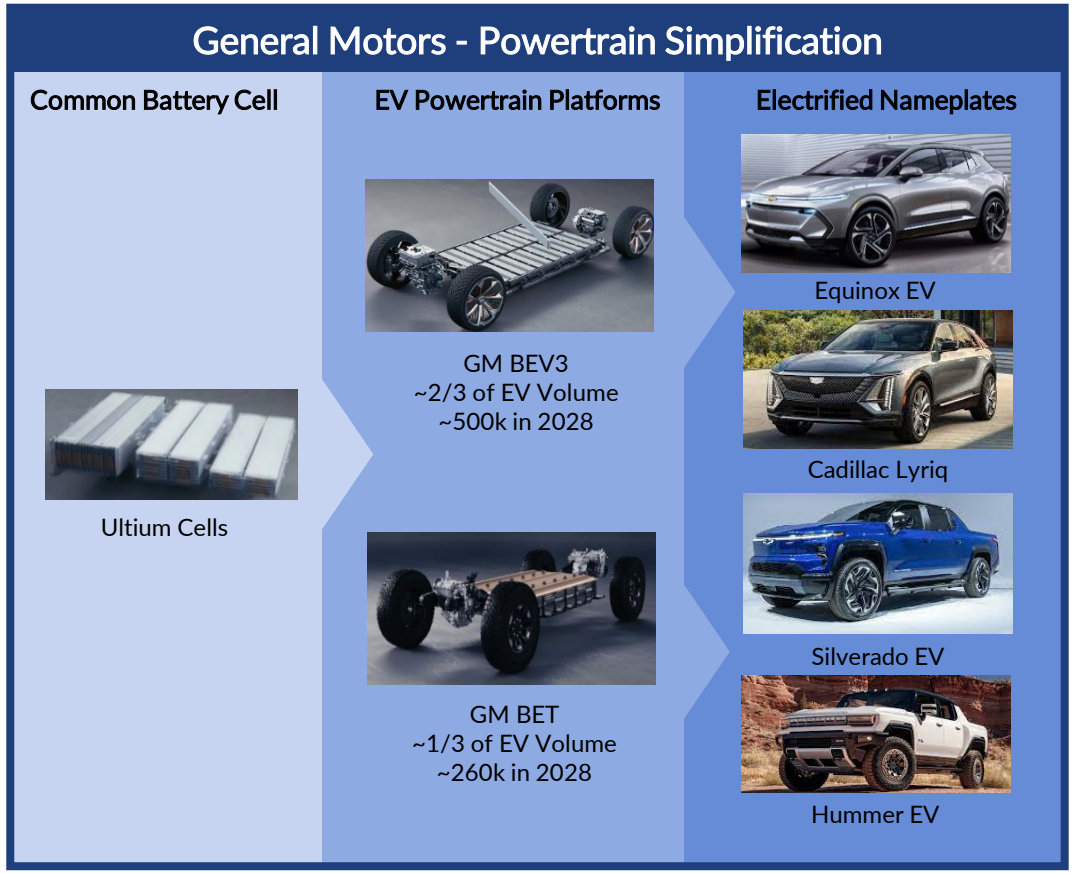
Note: EV cost estimates impacted by lower initial volumes, and expected to reach cost parity with ICE by 2025-2027

Source: Bank of America

Case Study – General Motors
Reducing Vehicle Architecture Complexity

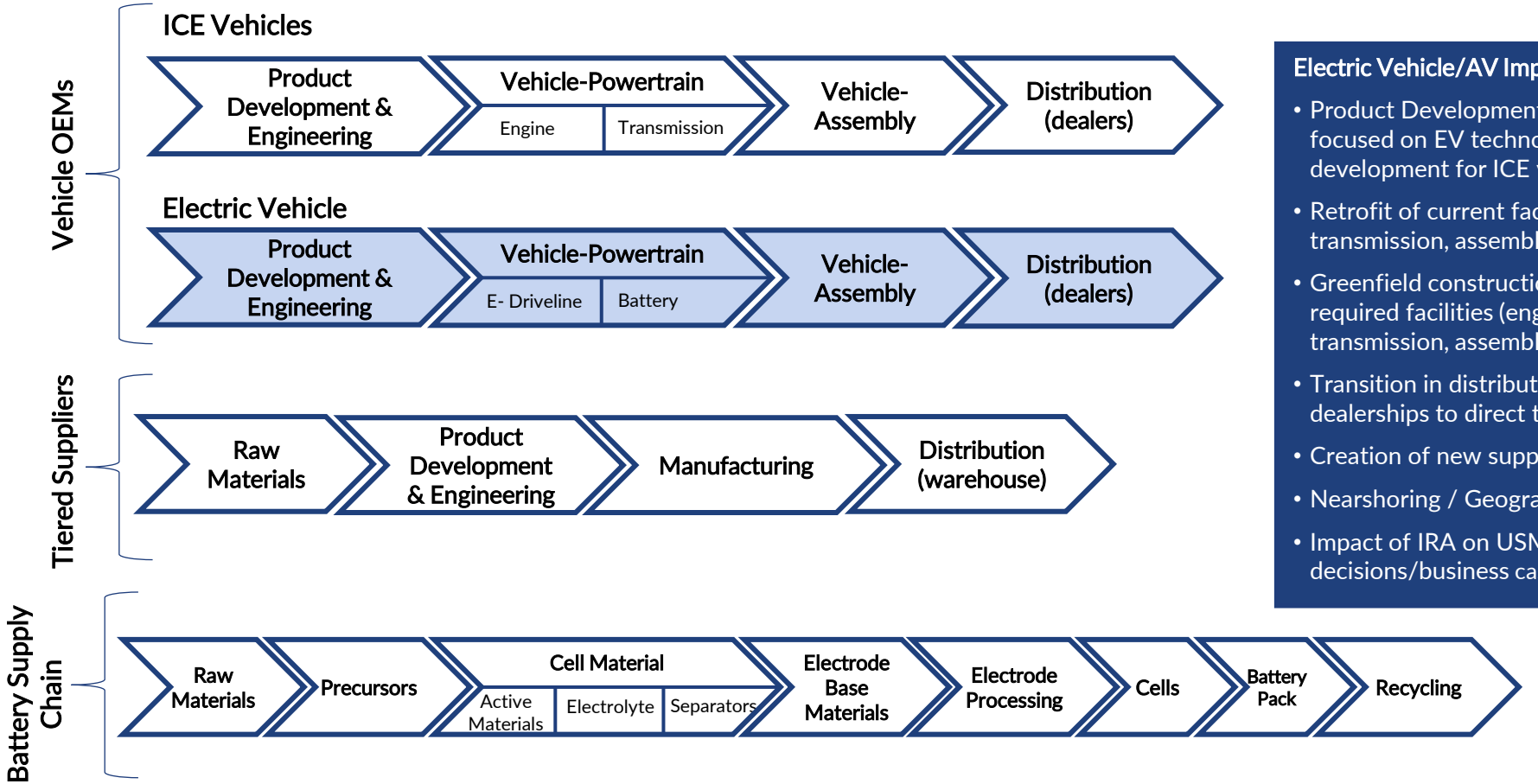
GM's Ultium platform is a large-scale skateboard architecture used for their EV offerings. All OEMs are developing vehicle architectures to utilize the same battery and drivetrain components over multiple vehicle "top hats". Standardization is critical to reduce complexity and drive down costs.

- Battery manufacturers and OEMs to utilize common components for different battery packs
  - Higher volumes to drive down costs – **minimize unique components**
  - Simplify components, supply chain, and assembly
  - GM is targeting **19 different battery and drive configurations**, compared with **550 ICE drivetrain configurations**
- Commonization of cells has the most significant impact on pack costs
  - GM and LG Energy targeting cost below **$100/kWh** with Ultium battery pack
- Flexibility in design is required to meet demands for different vehicle types (sedan, trucks, SUVs, etc.)
  - Differences in pack sizes ranging from **50 to 200kWh**



Automotive Manufacturing Value Chain
EV Transition Opportunities Across the Entire Vehicle

The automotive manufacturing value chain continues to grow more complex with the adoption of electrification – OEMs will need their supply base to support both ICE and EV manufacturing while adapting to ever changing technology capabilities



Electric Vehicle/AV Impacts

- Product Development & Engineering focused on EV technologies—reduced development for ICE vehicles
- Retrofit of current facilities (engine, transmission, assembly, dealerships)
- Greenfield construction of new required facilities (engine, transmission, assembly)
- Transition in distribution model from dealerships to direct to consumer
- Creation of new supply chains
- Nearshoring / Geographic Shift
- Impact of IRA on USMCA investment decisions/business cases

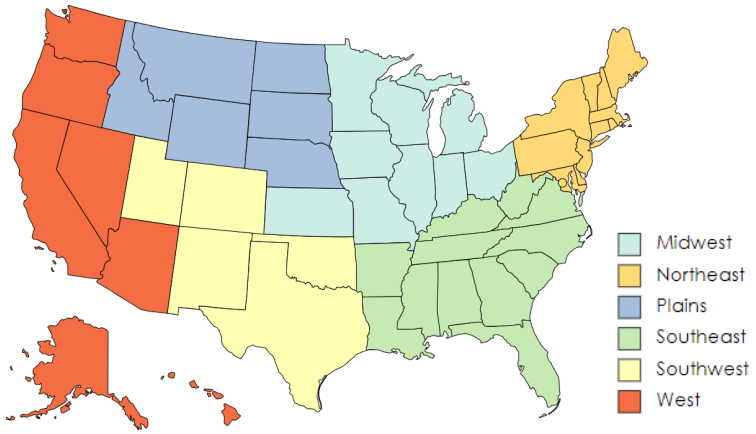
Strategic Development of the EV Value Chain

Supply chain for lithium-ion batteries covers raw materials through end-of-life recycling of packs and cells. OEMs are engaging across the value chain, in some case with minimal knowledge and experience, to secure supply

	Raw Materials	Precursors	Cell Materials			Electrode Base Materials	Electrode Processing	Cells	Battery Pack	Recycling
			Electrode Active Materials	Electrolyte	Separators					
										
End Product of Value Chain Step	Mined materials required for battery production (lithium, graphite, cobalt, etc.)	Intermediate products between raw materials, often from mining, powder form	Active material ready-to-use for cathode and anode production at cell supplier, powder form	Electrolytes ready-to-use for cell manufacturing Powder form or liquid	Separators ready-to-use for cell manufacturing Polyolefin-based film/ semi-permeable membrane or polymer-matrix incl. ceramics	Electro-plating operation to develop electrode base material	Electrode manufacturing: applying active material coating on copper / aluminum foils	Complete cells based on electrodes, separators and electrolytes	Complete battery pack consisting of cells, battery management system, cooling system and housing	Raw materials and waste after deconstructing the battery pack
Examples	Lithium Hydroxide, Nickel Sulfate, Cobalt Sulfate, Aluminum, Copper	Graphite, Nickel Concentrates, Silicon	Graphite, NMC, LFP, NCA	Lithium Hydroxide, Lithium Carbonate	Celgard, SK Innovation, Solvay	Aluminum foils, Copper foils	In-process electrodes	Cylindrical, Prismatic, or Pouch Cells from various manufacturers including LG, SK, Samsung	GM Ultium Platform, Proterra modular packs	Lithium Hydroxide, Nickel Sulfate, Copper, Carbon

Strategic Development of the EV Value Chain
Regional Implications

Investment in the Southeast, Midwest and Canada are leading the new wave of automotive construction opportunities—the establishment of the battery value chain expected to follow OEM investment



- The presence of large renewable energy sources and critical minerals make Canada attractive to downstream battery value chain investment
- Southeast US attracting OEM investment due to reduced labor costs combined with the lack of strong union presence
- Midwest investment focused on expansion and transition of current vehicle production capabilities

Driving Factor	Southeast	Midwest	West	Southwest	Northeast	Plains
OEM Investment	$40B	$21B	$14B	$0.35B	-	-
EV Production Growth 23-30	44%	37%	(1%)	18%	0%	0%
Electricity Cost	Low	Moderate	High	Low	High	Low
Union Presence	Low	High	High	Low	High	High
Concentration of Critical Minerals	Low	Low	High	Moderate	Moderate	Low

Facility Transition
Case Study: Assembly and Powertrain Facilities

Facility transitions are taking place across the entire automotive value chain and at every OEM – Honda is using product and plant consolidation to create an EV hub in Ohio, GM is leveraging dual manufacturing within their existing transmission facility in OH

Honda Vehicle Assembly Facilities

- **EV Hub, OH** – transforming Marysville, East Liberty and Anna plants to lead EV production – proximity to the new JV battery plant with LGES
- **Marysville, OH** – consolidation of production lines from two to one, training workforce for skills needed for EV production
- **Indiana** – gain production of Accord from Marysville, in addition to current production of Civic Hatchback and CRV-V

Honda Powertrain Facilities

- **Anna, OH** – transferring engine production, engine head machining, and block casting to Alabama to reallocate space for battery casing production
- **Tallapoosa, GA** – filling non-operational transmission space through partnership with supplier to install a new line to build e-axles, the supplier will install, own, and operate the new e-axle facility

GM Transmission Facility

- **Toledo, OH –** retrofitting a dedicated portion of Toledo transmission facility to produce a family of EV drivetrain units. The facility will maintain production of 6-spd., 8-spd., 10 spd. RWD and 9 spd. FWD transmissions

ICE to EV Impact
Vehicle Structure Evolution and Challenges

Electric Vehicles create challenges for legacy automakers as they transition their portfolio away from internal combustion engines. Structural architectures require an even stronger emphasis on light weighting, occupant safety, battery protection, and vehicle performance (range)

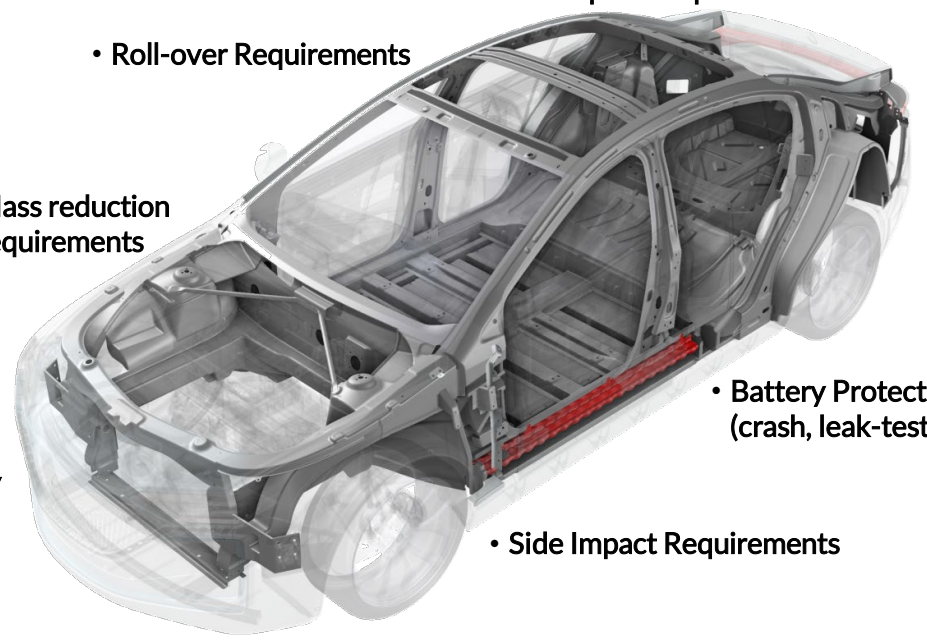
Challenges

Lithium-Ion batteries are heavy—changes the vehicle's light-weighting priorities
- Heavier vehicle means greater chassis loads into body structure, more energy to dissipate in a crash, and less vehicle range

EV architecture evolution requires protection for both the occupant and the lithium-ion battery—requires optimized design and enhanced structural philosophies for energy absorption
- Energy paths change due to the interference of a battery—greater reliance on body structures and assistance from chassis components to protect the battery

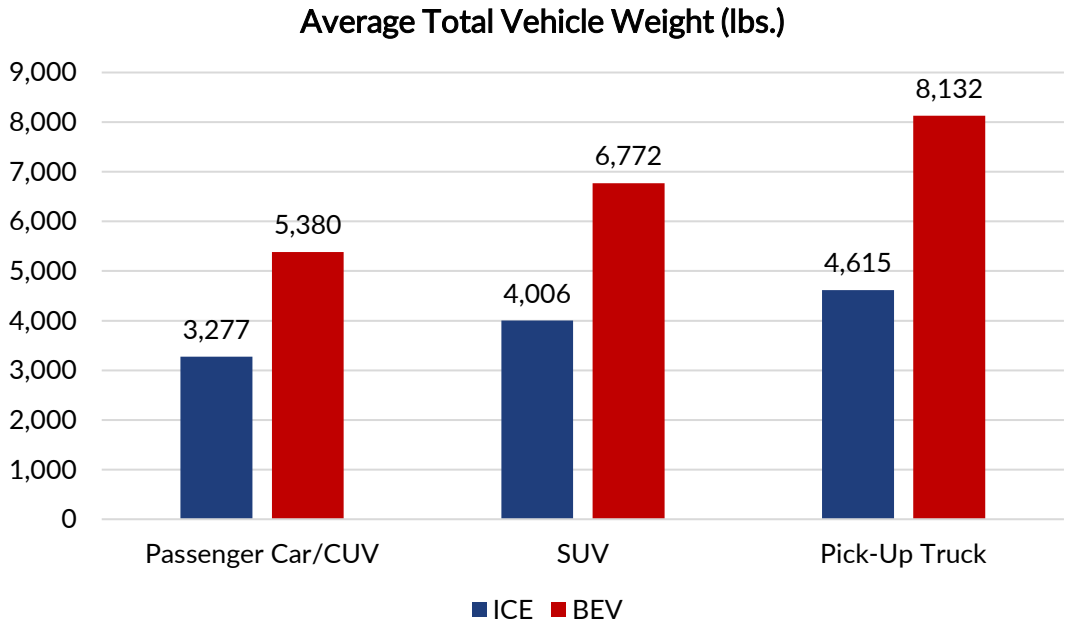
Lithium-Ion batteries are expensive—creates emphasis for reimagining manufacturing efficiency opportunities to reduce vehicle costs
- Larger batteries are required to compensate for lost range due to a heavier vehicle—increases $/kWh

Safety Considerations



Average Total Vehicle Weight
Transition from ICE to BEV

Average vehicle weight increases from ICE to BEV – driven by introduction of new components, material changes, and increased safety standards surrounding electric drivetrains



- Average passenger car/CUV weight change of ~2,100 lbs. primary driven by addition of battery, e-drive system, and other body/chassis updates
- 24% increase in body and chassis weight due to added materials to support battery and increase vehicle safety
- 15% increase in BEV transmission system weight due to higher content of steel

Passenger Car/CUV


Honda Accord


Tesla Model S

SUV


Kia Telluride


Rivian R1S

Pick-Up Truck

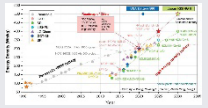
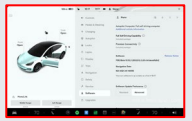
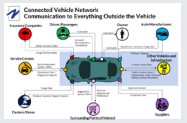
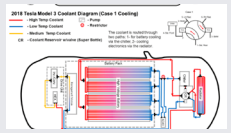

Ford F-150


Ford Lightning

* Source Argonne Laboratory, PM Research

Innovations in the Automotive Market

Innovations are occurring throughout the automotive value chain by OEMs and suppliers – product & component, material & process, and technology & software innovations are driving efficiencies and moving the industry forward

Innovations in the Automotive Market		
Product/Component	**Material/Process**	**Technology/Software**
 Rising Battery Energy Density	 Giga Castings	 OTA Updates
 SiC Inverters	 Thermoplastic Seats/ Pultrusion	 Connectivity
 Thermal Systems	 Stainless Steel Exo-Skeleton	 Autonomous

Transition to Electric

Federal Policy Impact

Inflation Reduction Act
Summary Profile

The Inflation Reduction Act (IRA), signed into law in August 2022, includes nearly $370 billion in investments for projects that repurpose retired fossil fuel infrastructure and employ displaced workers, setting the U.S. on a course for an economic clean energy transition

What did this create?

- An ecosystem of credits and incentives supporting green energy, broadly defined
- Combination of 10 new and 12 modified tax credits and incentives
  - Tax credits can be used directly (general business credit), sold for cash payment, or used to generate tax refunds
  - Applicable in some form to all types of taxpayers (businesses, individuals, non-profits, etc.)
- $90 billion in additional funding for grants and loans to support the adoption of technologies and retrofit existing operations

Expected impact

- We expect a transformational impact given the scope of interrelated credits and incentives
- The integration of both supply-side and demand-side programs is expected to impact the market on a long- term basis

IRA Overview
Tax Credit Opportunities

The IRA has created multiple opportunities across multiple area, The main focus of our discussion will surround the opportunities in the manufacturing and transportation areas

Area	IRA Section	Tax Code Section	Program Name
Manufacturing and Transportation	13401	30D	Clean Vehicle Credit
	13502	45X	Advanced Manufacturing Production Credit
	13402	25E	Credit for Previously-Owned Clean Vehicles
	13403	45W	Credit for Qualified Commercial Clean Vehicles
	13404	30C	Alternative Fuel Vehicle Refueling Property Credit
Electricity and Power Generation	13101	45	Production Tax Credit for Electricity from Renewables
	13102	48	Investment Tax Credit for Energy Property
	13103	48(e),48E(h)	Increase in Energy Credit for Solar and Wind Facilities Placed in Service in Connection with Low-Income Communities
	13105	45U	Zero-Emission Nuclear Power Production Credit
	13701	45Y	Clean Electricity Production Tax Credit
	13702(h)	48E	Clean Electricity Investment Tax Credit
	13703	168(e)(3) (B)	Cost Recovery for Qualified Facilities, Qualified Property, and Energy Storage Technology
	13501	48C	Advanced Energy Project Credit
Alternative Fuels & Carbon Sequestration	13201	40A, 6426(c),6427(e)	Extension of Tax Credits for Biodiesel and Renewable Diesel
	13201	6426(d), 6426(e),6427(e)	Extension of Tax Credit for Alternative Fuels
	13202	40	Extension of Second-Generation Biofuel Incentives
	13704	45Z	Clean Fuel Production Credit
	13203	40B	Sustainable Aviation Fuel Credit
	13104	45Q	Credit for Carbon Oxide Sequestration
	13204	45V	Clean Hydrogen Production Tax Credit
Residential & Commercial Clean Energy	13301	25C	Energy Efficient Home Improvement Credit
	13302	25D	Residential Clean Energy Credit
	13304	45L	New Energy Efficient Homes Credit
	13303	179D	**Energy Efficient Commercial Buildings Deduction**

IRA Tax Credits
Opportunities Across Transportation and Mobility Value Chain

Advanced Manufacturing Production Credit (45x)

- Tax credit **10% of the cost of production** for battery critical minerals
- Includes: cathode materials, anode materials, anode foils, and electrochemically active materials, including solvents, additives, and electrolyte salts that contribute to the electrochemical processes necessary for energy storage

Advanced Manufacturing Production Credit (45x)

- Credit for **battery cells is $35/kWh**
- Phase out of Credit begins in 2030
  - 2030 – 75%
  - 2031 – 50%
  - 2032 – 25%
  - 2033 – 0%

Advanced Manufacturing Production Credit (45x)

- Credit for **battery module is $ 10/kWh**
- Phase out of Credit begins in 2030
  - 2030 – 75%
  - 2031 – 50%
  - 2032 – 25%
  - 2033 – 0%

Clean Vehicle Credit (30D)

- **$7,500 Consumer tax credit for new light vehicle EVs**
  - $3,750 if critical mineral requirement met
  - $3,750 for battery components requirement met

Qualified Commercial Clean Vehicles (45W)

- **Up to $40,000 for Electric Medium/Heavy Duty Trucks** (>14,000 GVWR)
- **Up to $7,500 light vehicle EVs** (<14,000 GVWR) **leased for business use**

Previously-Owned Clean Vehicles (25E)

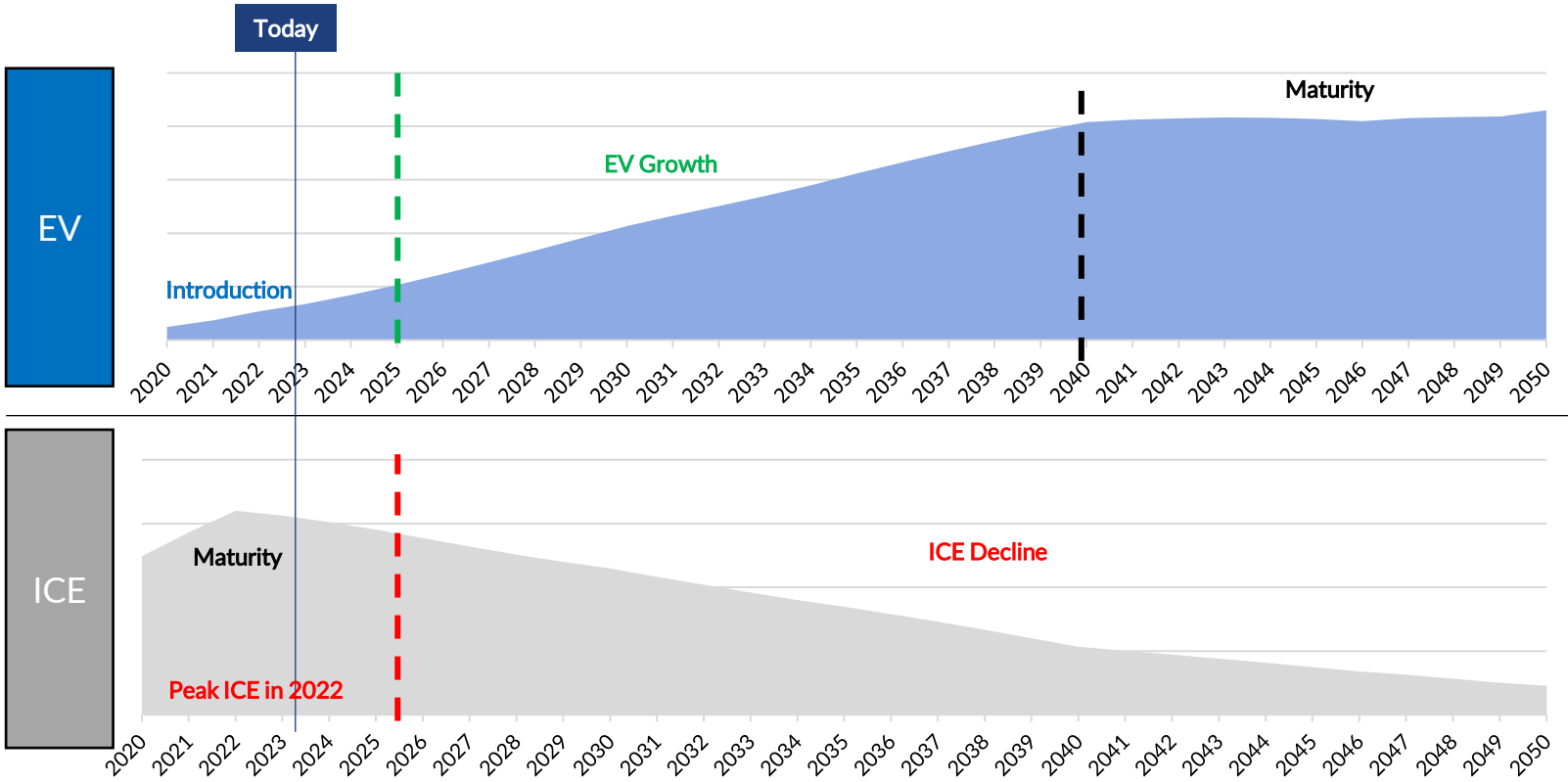
- **$4,000 tax credit for used light vehicle EVs**

Alternative Fuel Vehicle Refueling Property (30C)

- **Provides 30% of the cost per electric vehicle charger, up to $100,000.**
- Companies that install multiple chargers can claim tax credits for each separate charger they install, significantly reducing the cost of electrifying the fleet

Strategic Directions Impacting both OEMs and Suppliers
North American Business Models in transition

OEMs and Suppliers will have critical strategic investment decisions to make over the next 2-3 years. The next decade will bring dramatic product shifts toward Electric Vehicles, while ICE products will begin to decline



Strategic Considerations

- Product strategy & roadmap
- Organic and M&A growth strategies
- Capability gaps
- Viability of EV startups and partners
- Capex decisions

- Product divestitures and operations restructuring
- Consolidation and roll-up
- Operating profit reinvestment strategies
- Pricing strategies