

Trade, Tariffs and the Global Automotive Industry: A Primer in How and Where Cars Are Made



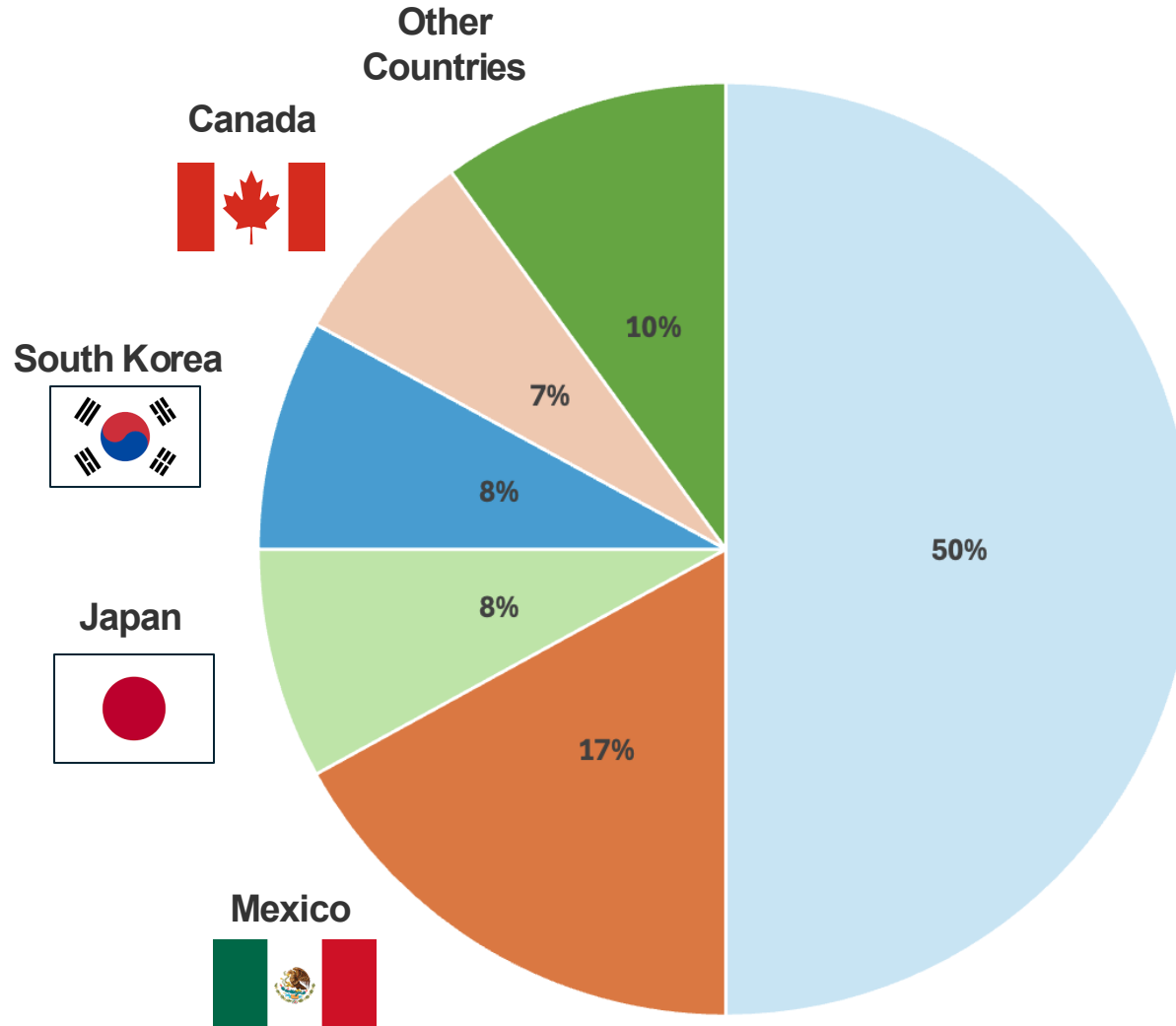
John Moavenzadeh
Executive Director, MIT Mobility Initiative
MMI Forum April 18, 2025

The US Automotive Market Sales: Roughly Half Vehicles Assembled in the US, Half Imports



1962: GM opens
Bupyeong Assembly
Plant in South Korea

Roughly 8 million
Vehicles Imported
to the USA



Roughly 8
million Vehicles
Built in the USA



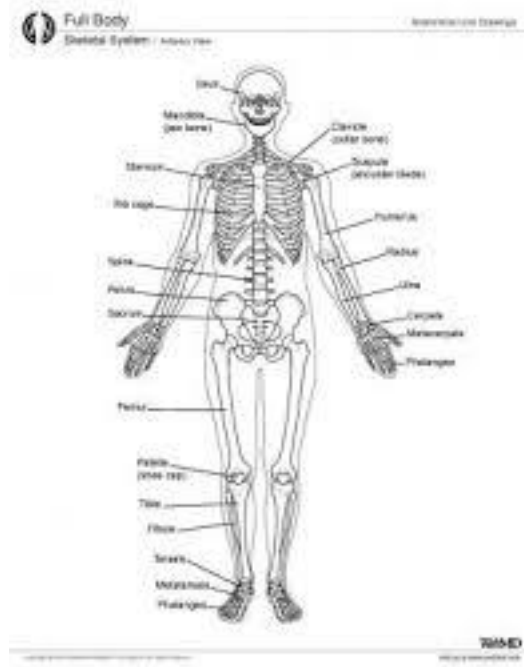
1982: Honda
opens Marysville,
OH "transplant"

An automobile is a complex electro-mechanical system composed of 30,000+ parts

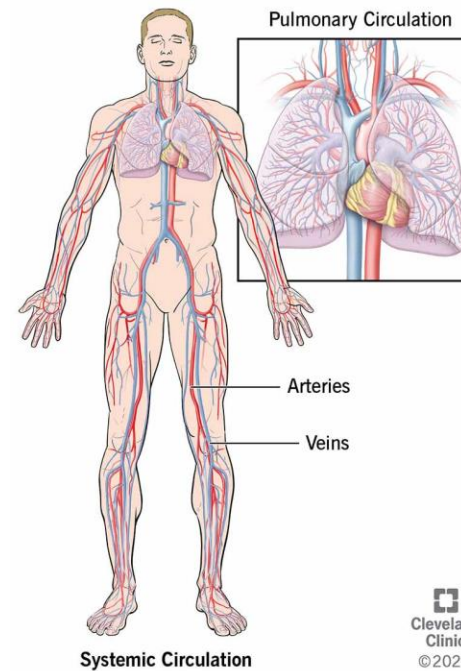


Just as human anatomy can be organized into major sub-systems ...

Skeletal System



Circulatory System

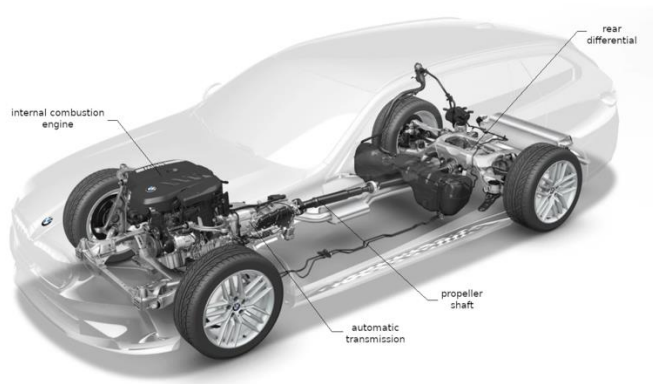


Nervous System

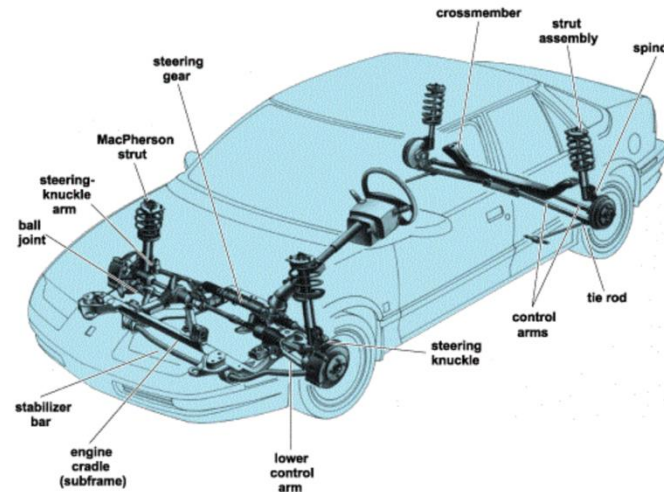


An automobile is also be organized into major sub-systems

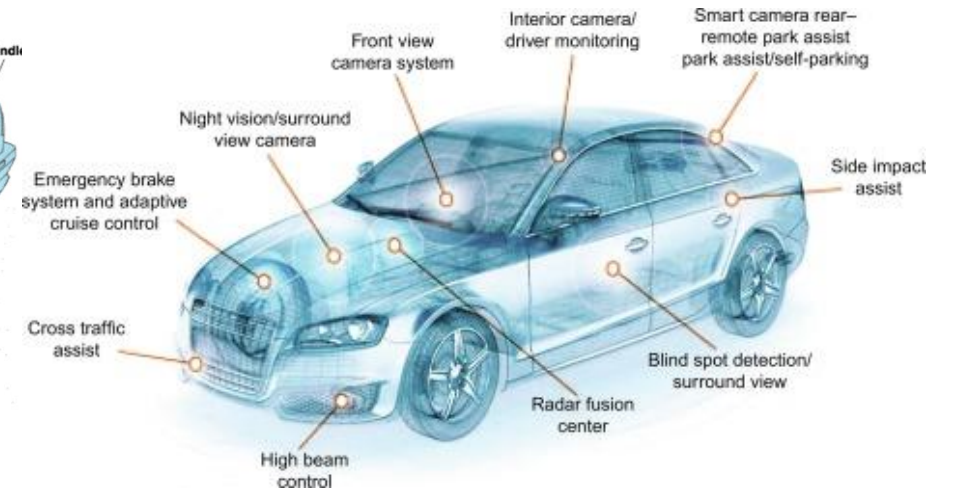
Powertrain



Steering & Suspension System



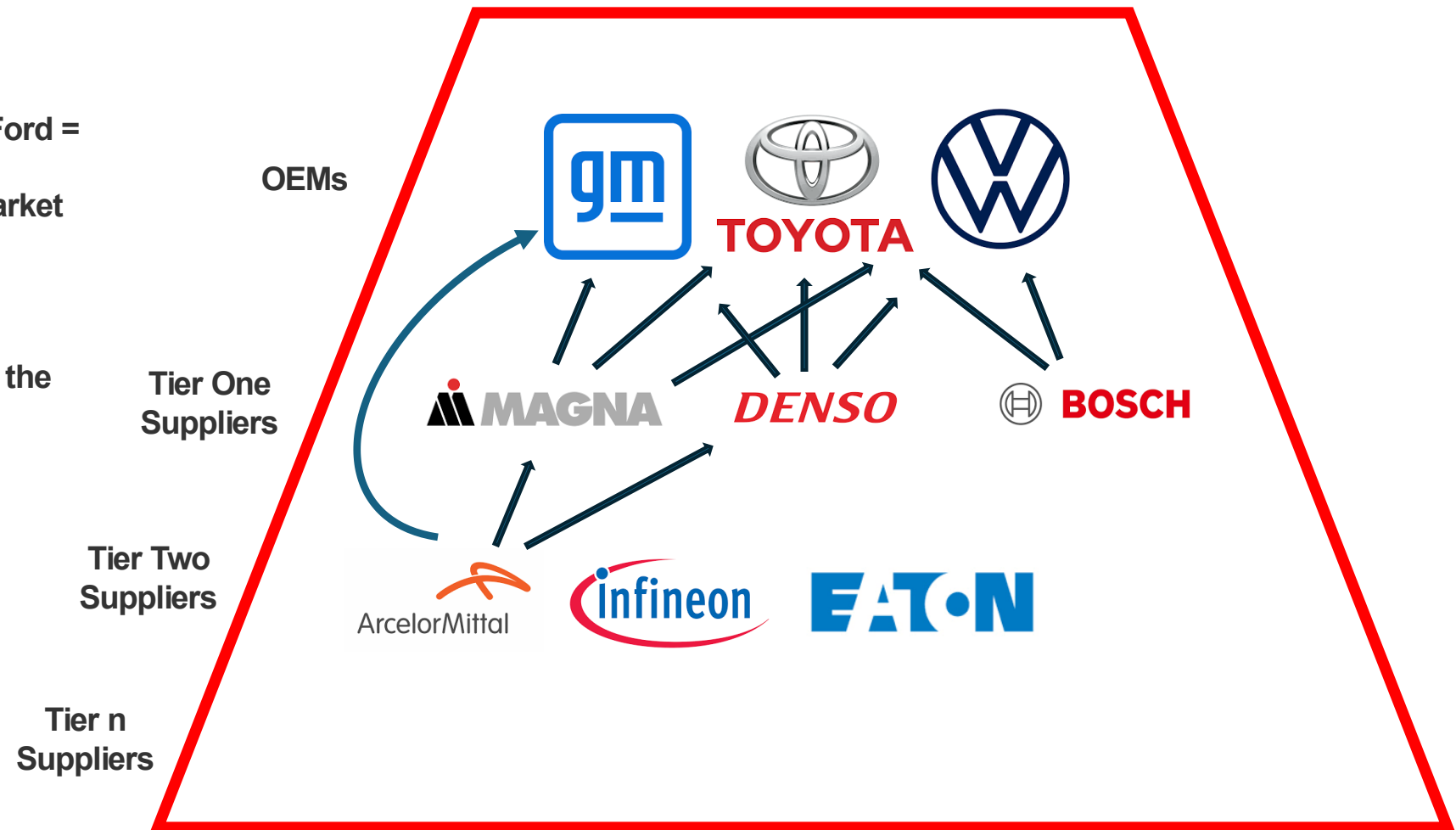
Electronics and Control System



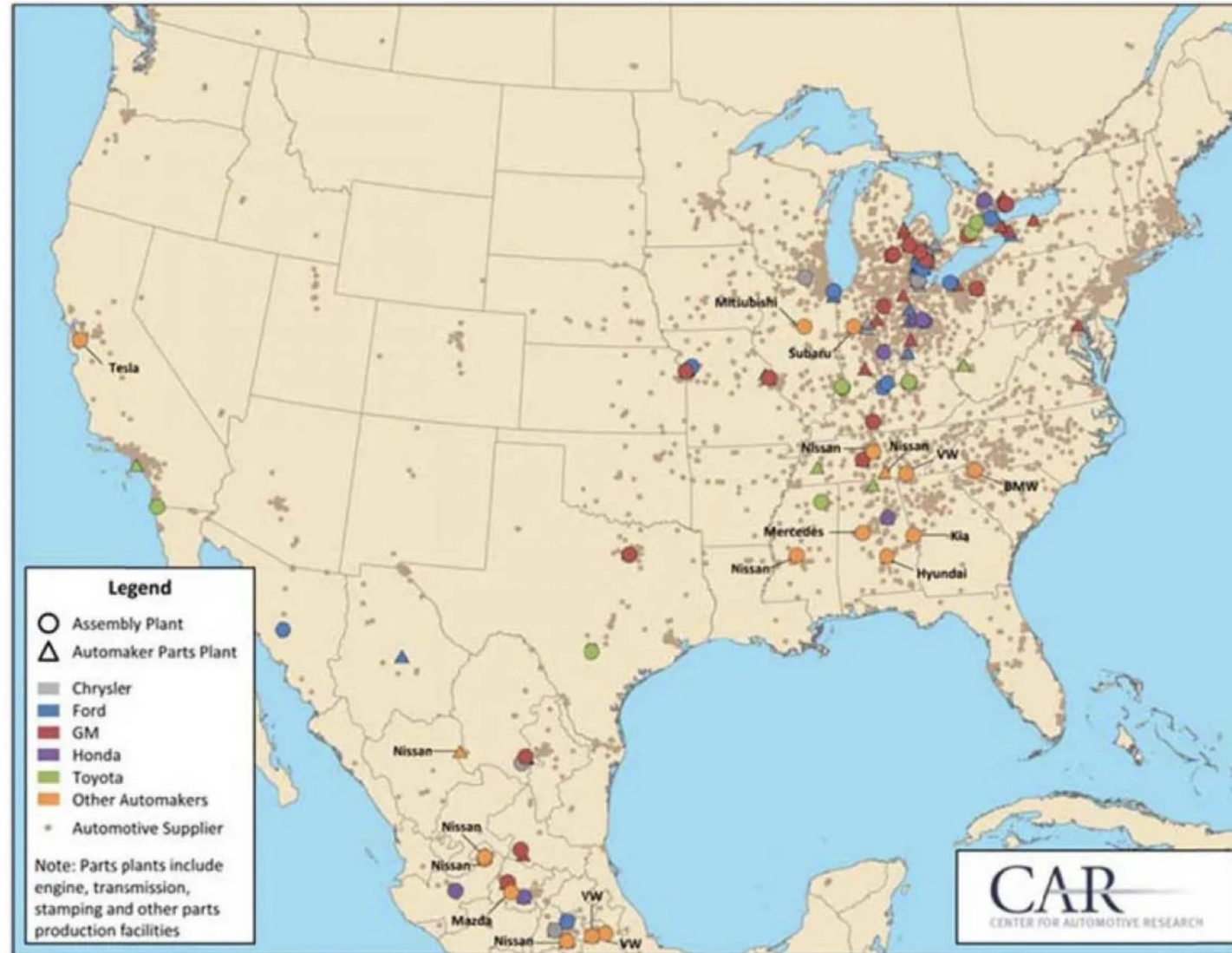
Suppliers – and their sub-suppliers – deliver more than half the value of a typical automobile

Concentration: GM, Toyota + Ford = 43% of US Market (2024)
Top Ten OEMs = 92% of US Market

Supplier CEO: "OEMs shop at the global mall."

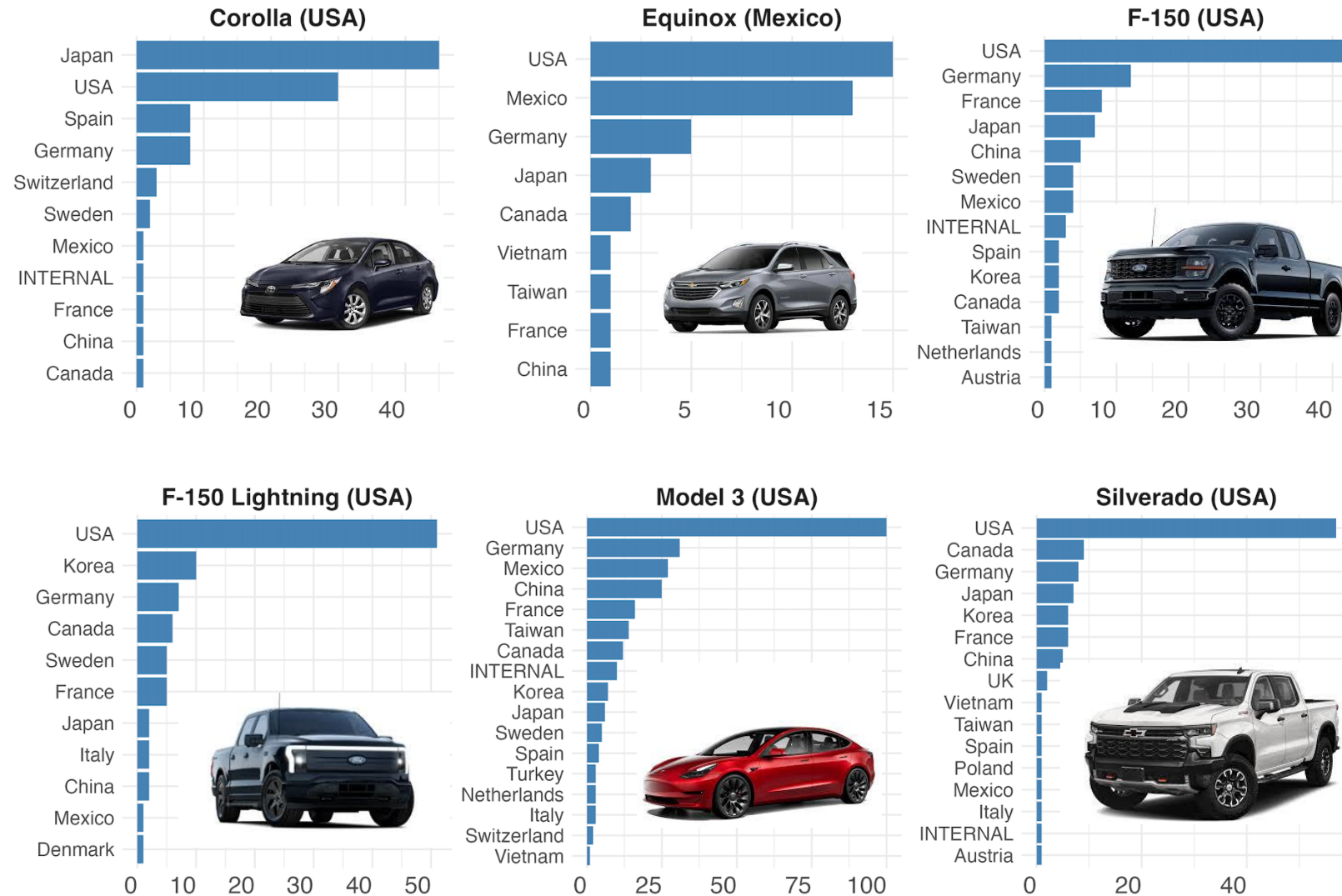


OEM Assembly Plants, OEM Manufacturing Plants (e.g., Engine, Transmission) and Supplier Production is Spread across North America



Many Parts of US-Built Vehicles Are Sourced from Other Countries

Number of Supplier Relationships by Country



Suppliers to the Ford F-150 Lightning



Spain



HEADLINERS
GRUPO ANTOLIN

France



FASTENERS/FIXINGS
EFC INTERNATIONAL

FLUID TUBING
DELFINEN

UK



DASH-INNER
AURIA

FUEL FILLER
ADAC

DOOR WATERSHIELDS
CADILLAC PRODUCTS

OVERHEAD-LIGHTING CONSOLES
GRUPO ANTOLIN

BRANDED AUDIO
HARMAN

DOOR-CONTROL UNIT
KOSTAL

E-AXLE SUN GEARS
MACLEAN-FOGG

FRONT LIGHT BAR
MARELLI

OIL PUMP
MNP

DRIVER AIRBAG
ZF

SEAT DAMPERS
VIBRACOUSTIC

BATTERY-COOLING LINES
NOVARES

SIDE-DOOR CHECKS
MULTIMATIC

WINDSHIELD-WASHER FLUID RESERVOIR
ABC TECHNOLOGIES

FASTENERS/FIXINGS
EFC INTERNATIONAL

SWITCHES
KOSTAL

EXTERIOR LIGHTING
MARELLI

BATTERY PARTS
MNP

INTEGRATED BRAKE CONTROL
ZF

SUSPENSION-CONTROL ARMS
MULTIMATIC

E-MOTOR
NEMAK

BATTERY-COOLING LINES
NOVARES

CENTER DISPLAY
PREH

SEALS
PLASTOMER

SEAT BELTS
ZF

GEARBOX
MNP

HANDLES/LATCHES
ADAC

OVERHEAD MODULE/SYSTEM
CULTRARO

REAR-WHEEL ARCH LINERS
CORVAC COMPOSITES

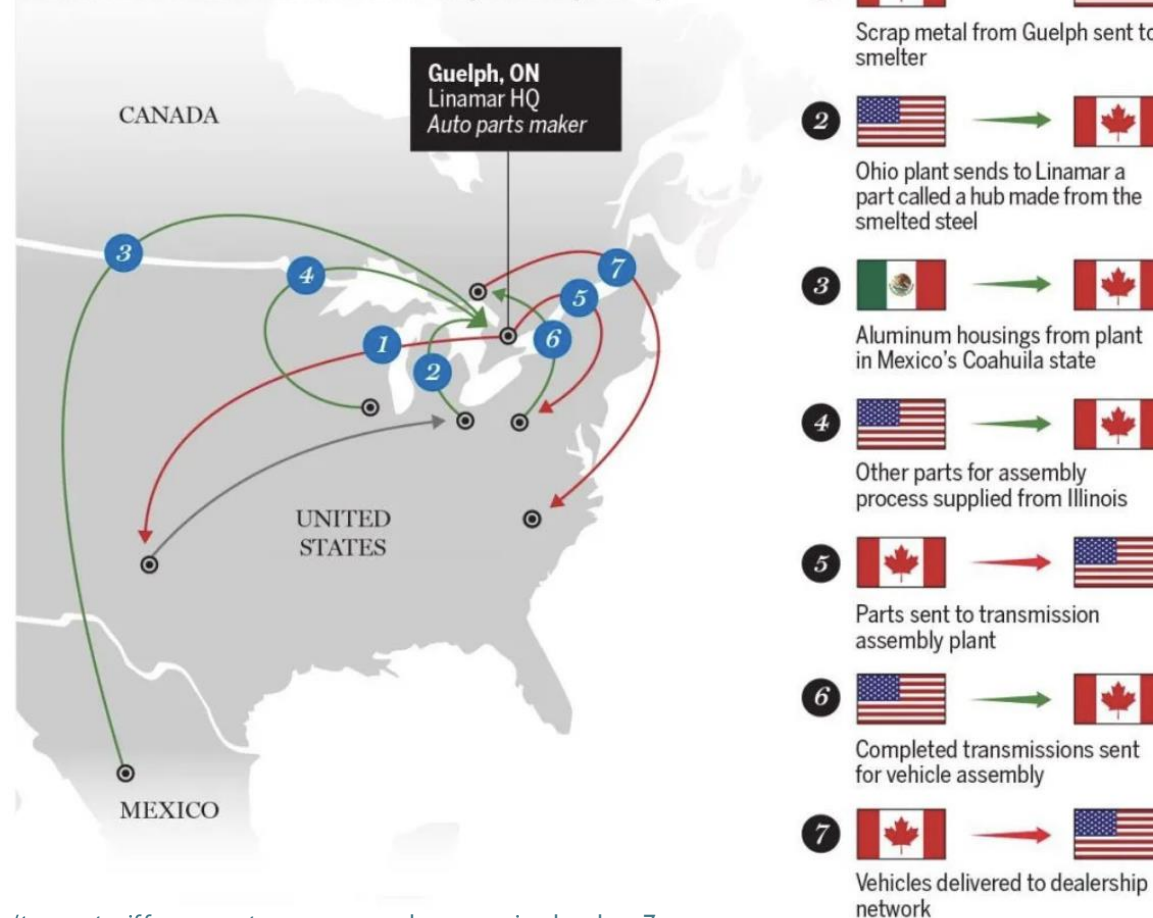


Battery supplied by JV between SK Innovation (South Korea) and Ford, Built in Georgia USA

Linamar Corp. Example of Auto Part Crossing US-CA-MX Borders Seven Times

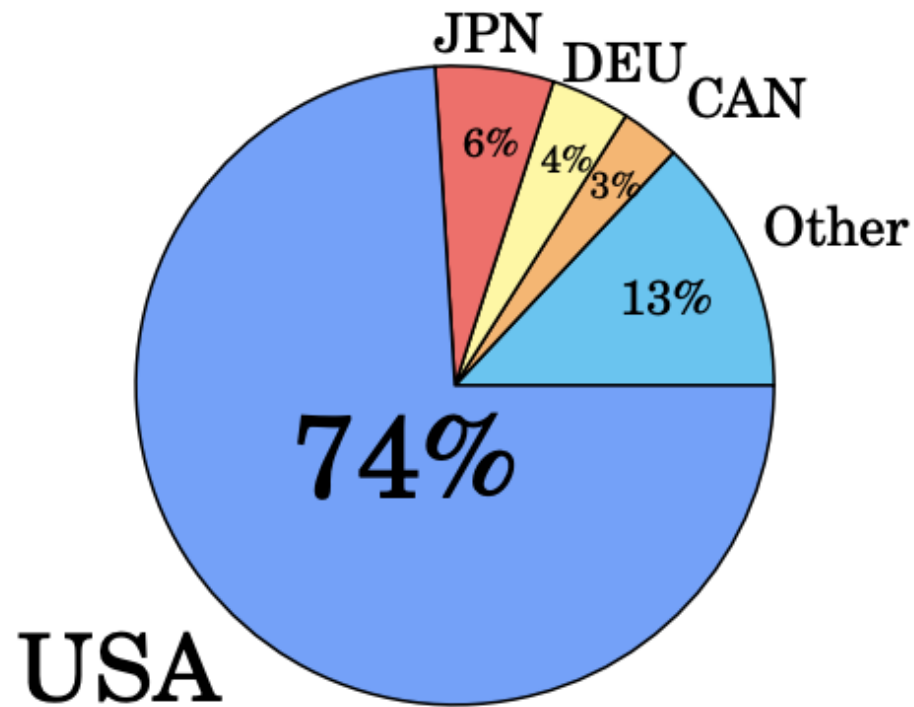
NORTH AMERICAN AUTO SUPPLY CHAIN

A transmission module, through seven steps, starts life in Ontario as scrap metal and goes back and forth across the border seven times. This is a summary of that journey.



Cross Border Value Add Is Difficult to Calculate

Foreign Value Content of Motor Vehicles
Imported to USA from Mexico
(2014 analysis)



DISENTANGLING GLOBAL VALUE CHAINS

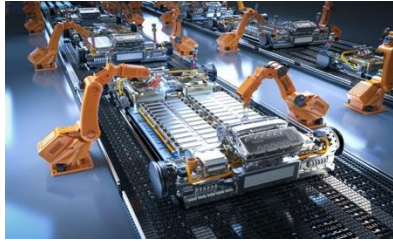
Alonso de Gortari

Working Paper 25868
<http://www.nber.org/papers/w25868>

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
May 2019

So What? Imposing tariffs on Mexican vehicle imports hurts
US industry, at least to some extent

Four Major Forces Reshaping Automotive Value Chains



Electrification: In 2024, Electric Vehicles (EVs) accounted for roughly one out of every two vehicles sold in China, one out of every five sold in Europe, and one out of every ten sold in the USA



Software and Intelligence: Rising content of semiconductors, electronics, software, sensors and intelligence built into vehicles



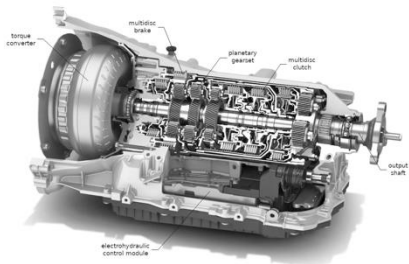
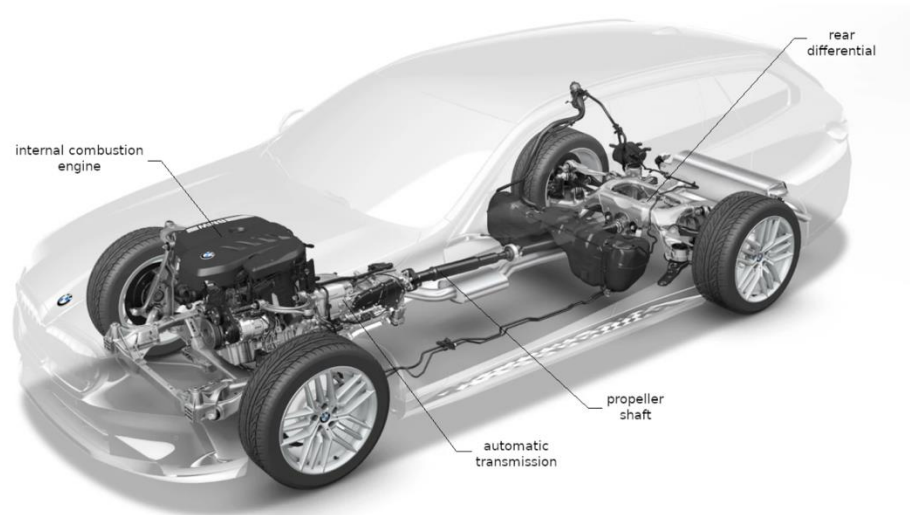
(Re) Vertical Integration: Some newer EV-only OEMs (e.g., Tesla, Nio) are sourcing more of the vehicle content in-house



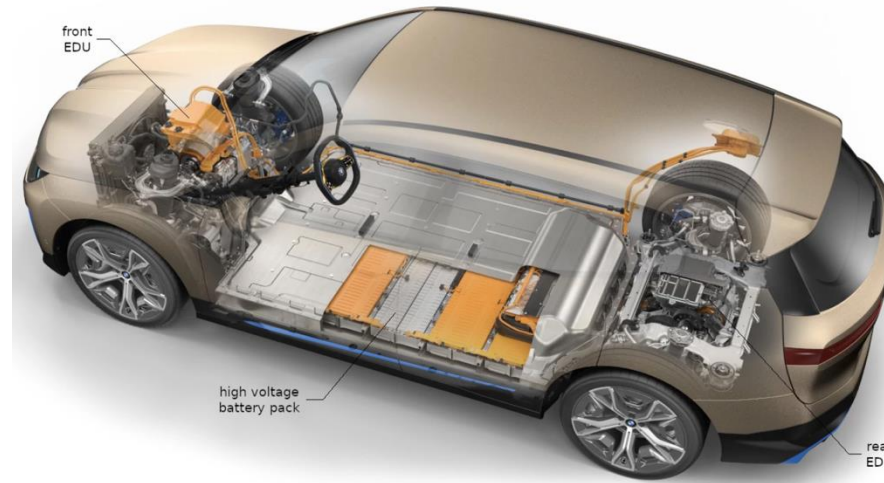
Factory Automation: The shift from industrial to more flexible humanoid robots and other advanced manufacturing technology could shift the location of production facilities

Electric Vehicle versus ICE Vehicle Architecture

Internal Combustion Engine (ICE) Architecture



Battery Electric Vehicle (BEV) Architecture



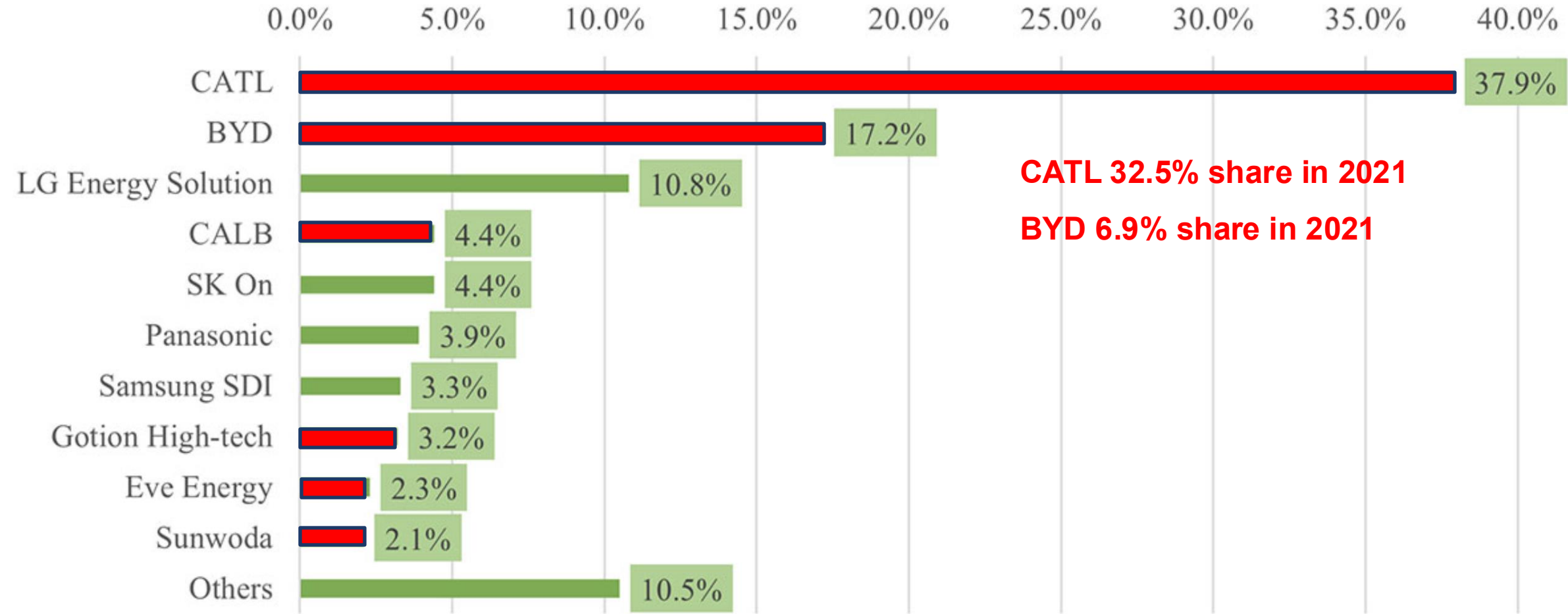
EV has far fewer parts than an ICE

And more of those parts are sourced from China – especially the battery

The battery of an EV accounts for 25-35% of the value add

China Dominates the Global EV Battery Market

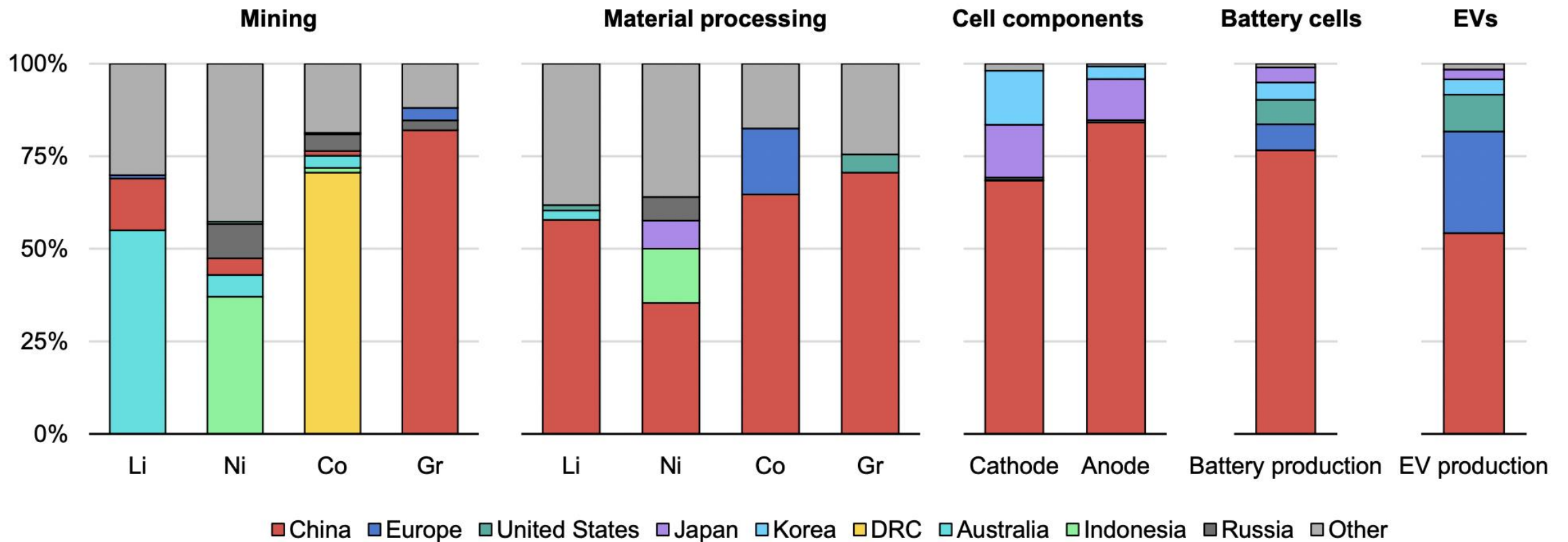
Global EV Battery Market 2024



Source: SNE Research, chart from <https://cnevpost.com/2025/02/11/global-ev-battery-market-share-2024/>

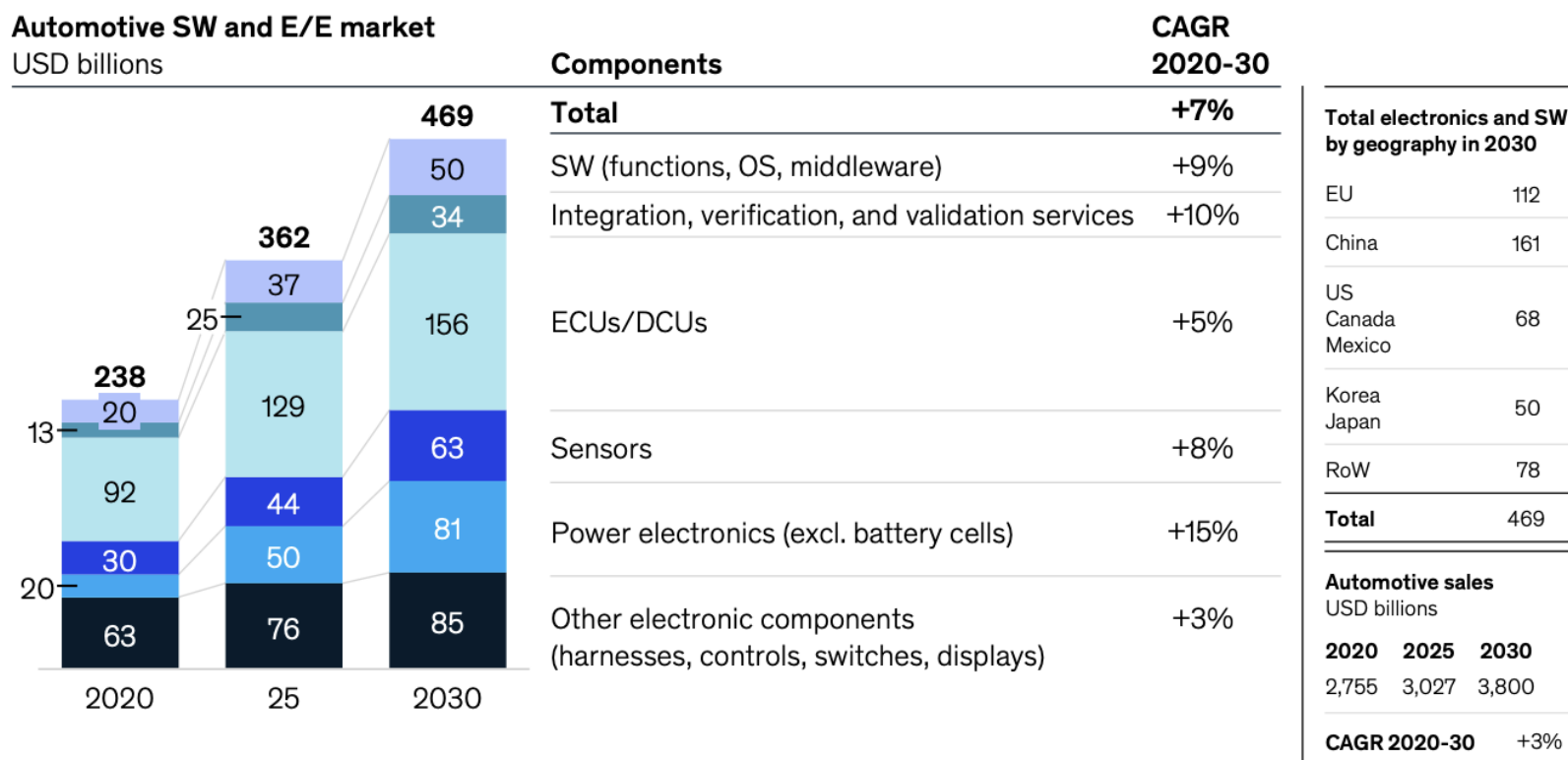
China dominates the global battery supply chain

Geographic Distribution of Global EV Battery Supply Chain



Automotive Software and Intelligence Value Add Is Increasing

Global Automotive Software and Electronics Market (US\$ Billion)



US-China Trade Decoupling: Mexico as “Back Door” to US?

Feb. 7, 2024

The New York Times

For First Time in Two Decades, U.S. Buys More From Mexico Than China

Dec. 17, 2023

FINANCIAL TIMES

US concern over Mexico attracting Chinese electric vehicle factories



CHIREY



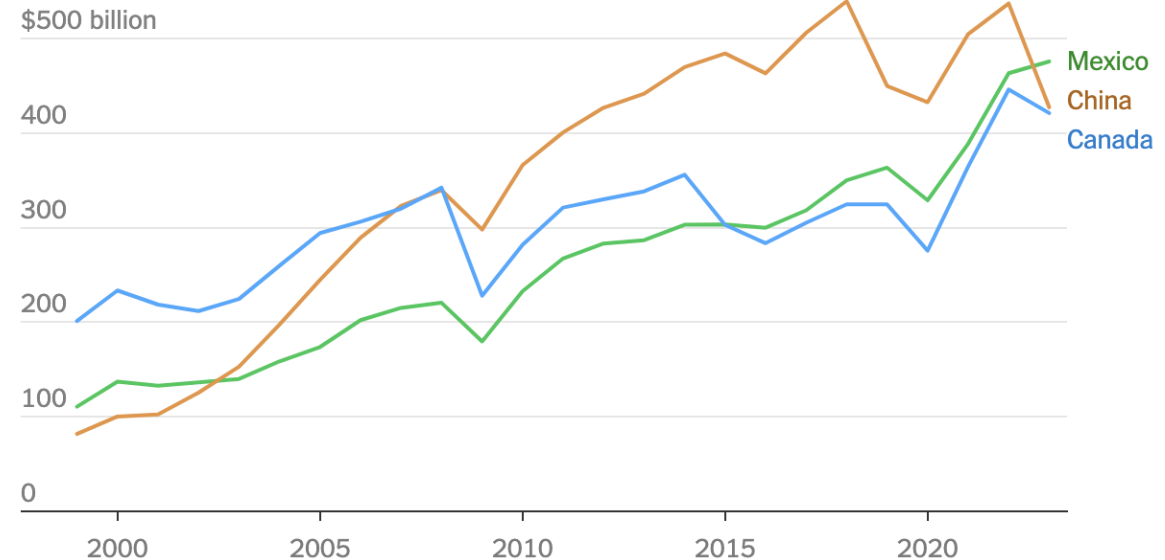
CHERY



BYD

Imports from China fell last year

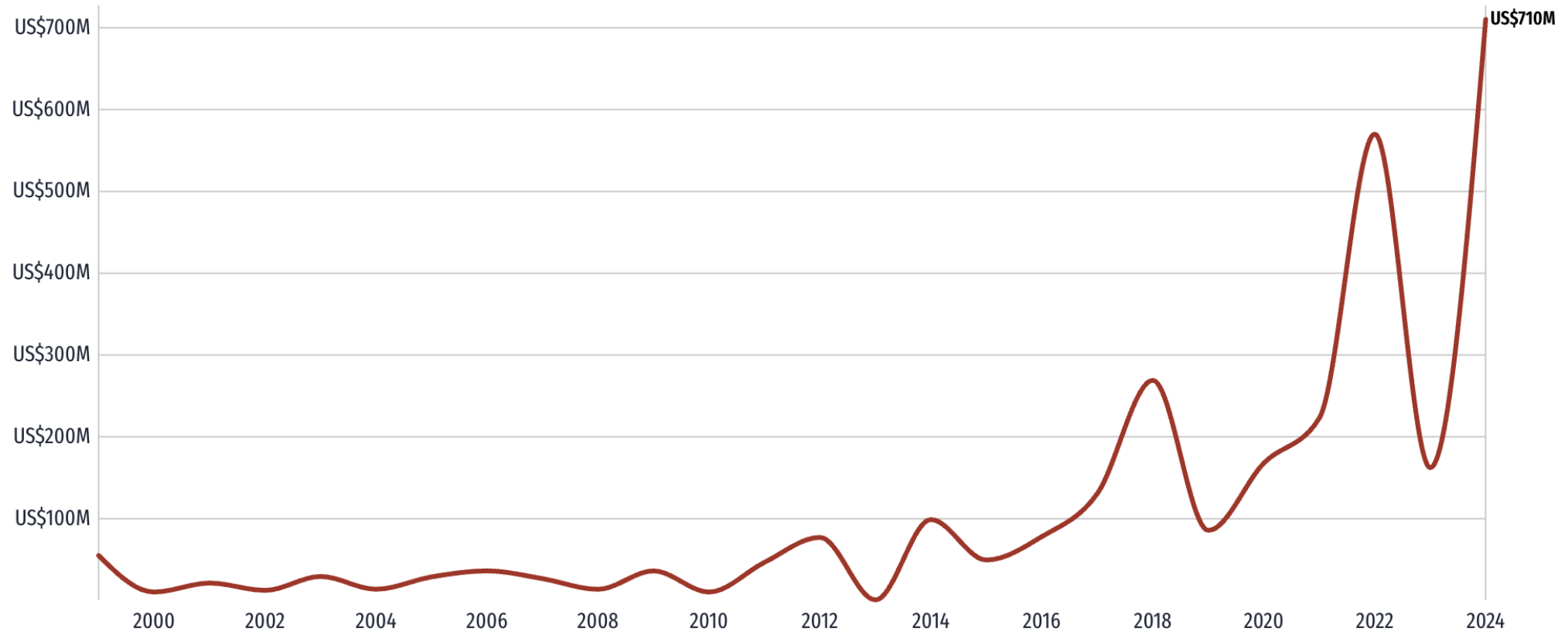
U.S. imports of goods by origin



Sources: U.S. Census Bureau; U.S. Bureau of Economic Analysis • By The New York Times

China has been investing in Mexico – including auto FDI

Annual Flow of FDI from China to Mexico



Our Geopolitical Moment: The De-Globalization of the Auto Industry

electrek ▾

Chinese authorities delay approval for BYD's pending EV plant in Mexico amid fears of the technology leaking into the US



Scooter Doll | Mar 19 2025 - 7:42 am PT | 102 Comments



Booming global EV automaker Build Your Dreams (BYD) has hit a snag with the [Chinese government](#), which has delayed the green light to build a new plant in Mexico amid fears that proprietary technology in the southern part of North America could more easily make its way into the United States

EV in a Fractured World: US-China Trade War

Prof. Jinhua Zhao

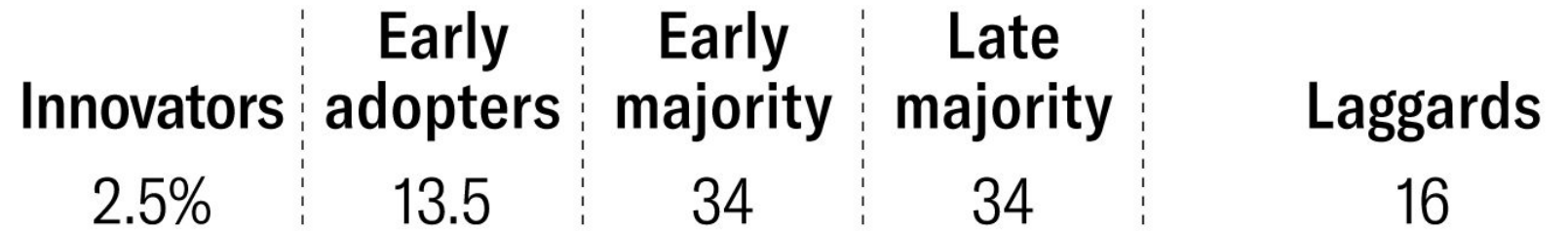
Massachusetts Institute of Technology

EV (BEV & PHEV) New Sales: 2024

	US	China
Units (million)	1.7	10.1
YoY Growth	10%	40%
Market Share	10%	48%

SOURCE: US Energy Information Administration, Road Genius, Electrify, CleanTechnica, Argonne National Laboratory

Everett Rogers in *Diffusions of Innovations* (1962).



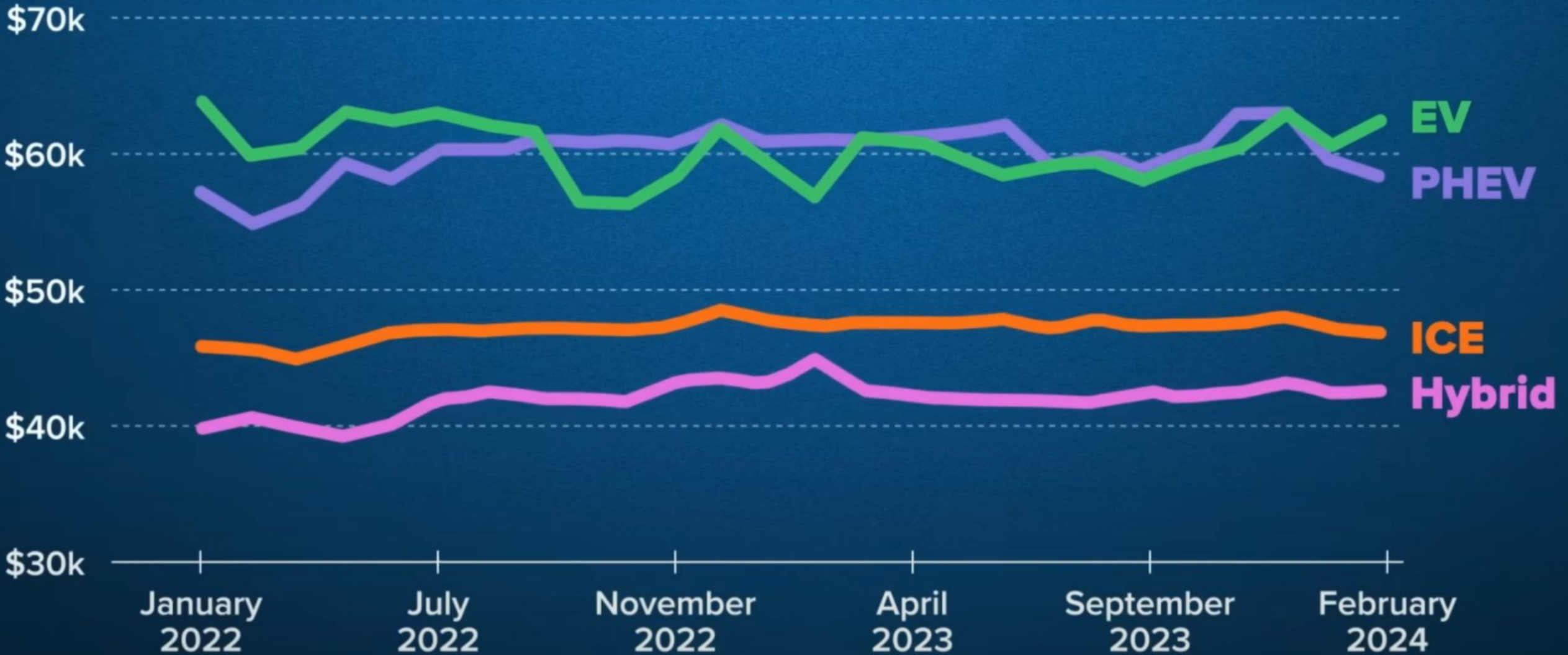
Crossing the chasm

US: is struggling

China: has crossed

Price and Charging

Average automobile prices



China in 2023

60% of EVs are **cheaper** than ICE equivalents

without support from national
subsidies for EV purchases

Public Charging Ports (as of 2024)

US

China

204,000

3,600,000

17.6x

% DC Fast

25.6%

48%

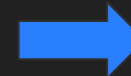
Grid



Charging



**Electric
Vehicles**



Mineral

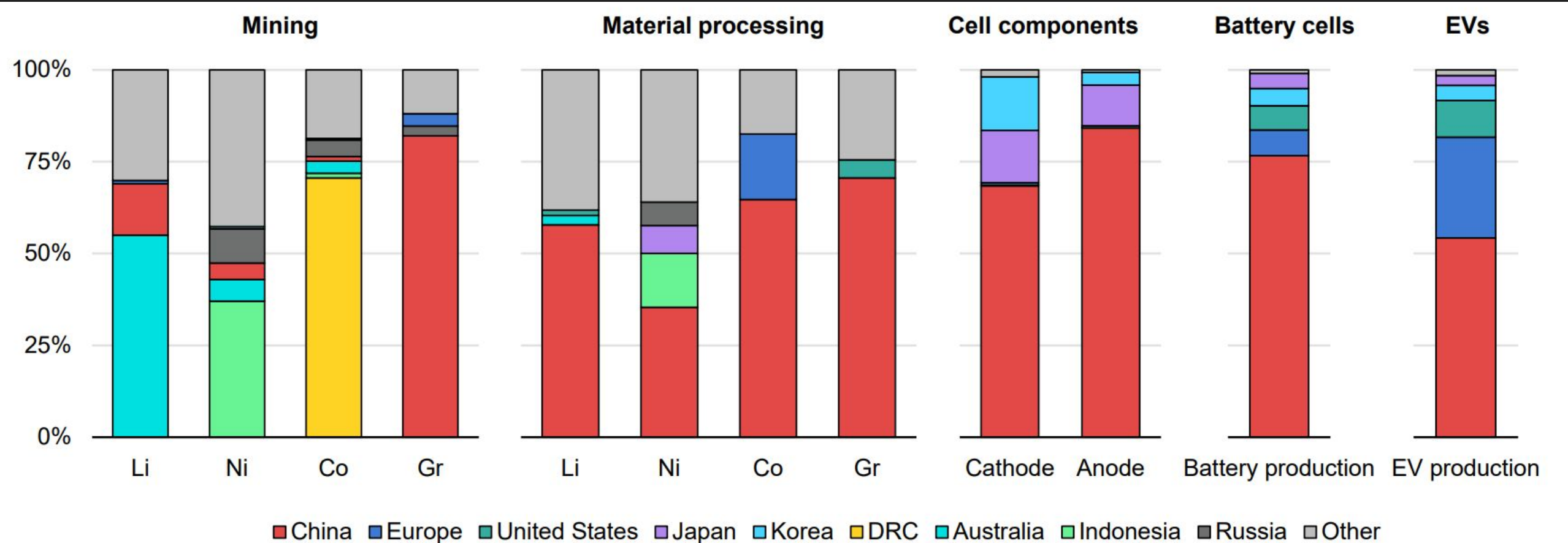


Battery



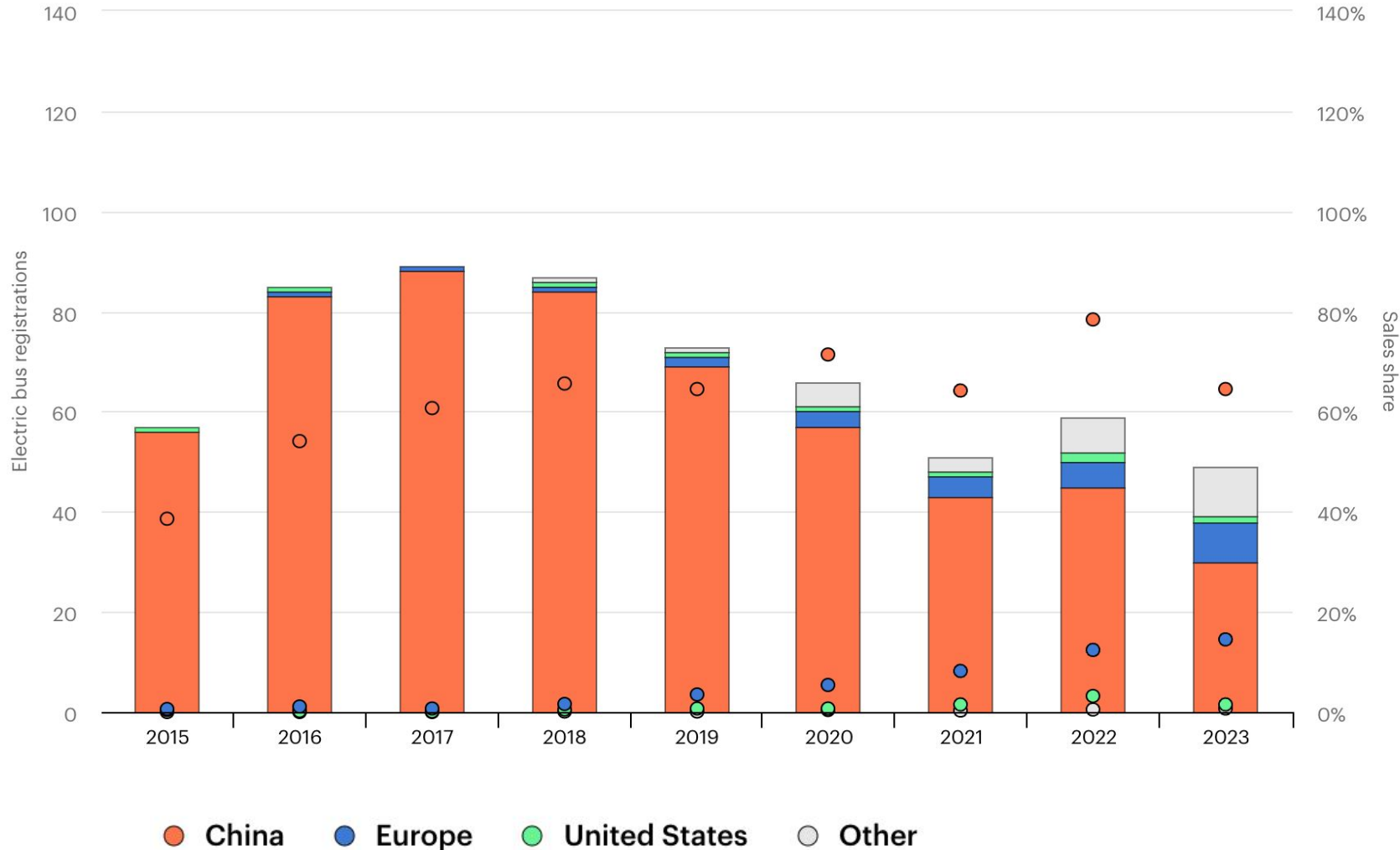
**Finance
Safety
Emission
Equity**

China dominates battery supply chain



*In 2022, lithium nickel manganese cobalt oxide (NMC) remained the dominant battery chemistry with a market share of 60%, followed by lithium iron phosphate (LFP) with a share of just under 30%, and nickel cobalt aluminium oxide (NCA) with a share of about 8%.
SOURCE: International Energy Agency

Electric buses



- In 2020, China was responsible for **about 90% of electric bus sales worldwide**. In **2023**, this fell to around **60%**, largely due to a decrease in domestic demand.
- Chinese manufacturers export large volumes of electric buses, accounting for over 85% of electric city bus deployments in Latin America. They have also increased their market share in the European Union to 30% in 2023, driven by companies such as **Yutong** and **BYD**.

Myth:

China's EV is successful only because of its
top-down governance

What happened?

Drivers Behind China's EV Rise



Drivers Behind China's EV Rise

1 Market Size



China is **the world's largest market and producer of automotives**. In Q1 2023, China surpassed Japan and Germany to become the world's **No.1 car exporter** for the first time. The surge in exporting EVs has become one of the main drivers of this growth.

2 Policies



China has implemented national-level policies to expedite **technological advancement, infrastructure development, and climate neutrality**. There is a national strategy to revitalize its automotive industry. Specifically for the EV industry, additional incentive policies include promotion of New Energy Vehicles (NEVs), advanced manufacturing, NEV purchase subsidies, and battery technology development.

3 Investment



Despite a slowdown in mobility investment in 2023, largely attributed to a dip in China's venture ecosystem's momentum, China still boasts **one of the world's most dynamic mobility tech ecosystems**, featuring multiple key players and unicorns. Global automakers are investing in China's mobility tech, while Chinese automakers are making multiple M&As and venture investments in global manufacturers and mobility startups.

4 Industry



China's EV ecosystem is **shaped by three forces – big tech in China** (Huawei, Xiaomi, Baidu), **new EV makers** (NIO, XPeng, Li Auto), and **upstream & downstream tech firms** (CATL, WeRise, Pony.ai). Each contributes through innovation in smart car systems, battery technology, and autonomous vehicles, along with strategic partnerships and investments.

5 Consumer



China has been a global leader in EV innovation, offering **a wide range of models, price points, and smart features** tailored to consumer needs. In China, key consumer demand in EV include charging convenience, safety, and affordability. To address these, EV manufacturers have introduced innovations like **battery swapping, economically priced models, and Extended-Range Electric Vehicles**.

Policies

Chinese EV: National Policies

★ Major policies impacting EV development

China's national-level policies accelerated the advancement of technology, infrastructure, and climate actions

Technology

China's national digital policies prioritize tech leadership, standards, and innovation. Many policies showcase China's commitment to digital transformation and growing global influence through innovation & technology.



"Made in China 2025"

Transform China into a high-tech manufacturing powerhouse, with emphasis on the development of key technologies, incl AI, robotics, and advanced materials.



"New Generation Artificial Intelligence Development Plan"

To become a global leader in AI by 2030, and sets goals for AI research, development, and application in sectors incl healthcare, autonomous vehicles, and smart cities.

"Digital Silk Road"

Expand China's influence in global technology standards and networks. It involves cooperation in digital infrastructure, technology standards, and connectivity.

"China Standards 2035"

China's objectives and roadmap for setting international standards in emerging technologies, incl artificial intelligence, 5G, Internet of Things (IoT), and other key industries.

"Double Hundred Actions"

Accelerate the development of key technologies and strategic industries, incl AI, quantum computing, and advanced materials.

Infrastructure

China has implemented a wide range of infrastructure policies and initiatives to support its rapid economic development and urbanization.



"Belt and Road Initiative (BRI)"

Infrastructure and economic development project aimed at connecting China to countries in Asia, Europe, and Africa through a network of roads, railways, ports, and other infrastructure.

"National Comprehensive Three-Dimensional Transportation Network Plan"

Improving its transportation infrastructure, incl high-speed rail networks, highways, and airports, to facilitate economic development and urbanization.

Climate

China's pledge for carbon neutrality by 2060 signifies a substantial commitment to reduce emissions, transition to clean energy, and combat climate change.



"Carbon Neutrality Goals"

China's commitment to achieving peak carbon emissions by 2030 and carbon neutrality (net-zero emissions) by 2060 is of utmost importance.

"National Carbon Emission Trading Scheme (ETS)"

It is the world's largest carbon trading system and covers industries responsible for a significant portion of the country's emissions.

"National Energy Administration Renewable Energy Development Plans"

Set targets for the development and integration of renewable energy sources, such as wind, solar, and hydroelectric power, into China's energy mix.

National guideline + local implementation

National EV Policies

2001: 10th Five-Year Plan: "863" EV Project - develop EVs became a national strategy to revitalize China's auto industry.

2014: Guiding Opinions on Accelerating the Promotion and Application of New Energy Vehicles

2015: Electric Vehicle Battery Recycling Technology Policy

2015-2020: Electric Vehicle Charging Infrastructure Development Guidelines

Pre-2009
Seeking a world-leading automotive strategy

2009-2013
Refining the strategy through pilot programs

2013-2017
The market gains traction

2018-present
The maturing of the market

2006: "Renewable Energy Law of the People's Republic of China" - provided legal assurance for the utilization and development of new energy. This led to more favorable policies, attracting investments in new energy.

2009: "Ten Cities, Thousand Vehicles" - adopted EV purchase subsidies, tax breaks, a sales mandate, government procurement requirement, and infrastructure subsidies.

2009-2020: New Energy Vehicle Manufacturing Enterprises and Product Access Management Rules - set standards for NEV governance and enterprise management.

Local Implementation Frameworks

Industry Planning

Industrial development planning

Air pollution prevention and control

Energy saving & emission reduction

Industry Support

Whole supply chain support

Technology innovation support

Technology service support

Emerging business model support

Industry Management

Enterprise access

Product standards

Mandatory power battery recycling

Infrastructure industry regulations

Promotion & Application

NEV promotion leadership organization

Demonstration & promotion programs

Purchase incentives

Conveniences & incentives for vehicle use

Infrastructure support

Electric vehicle in China: what type of policy?

transportation policy →

environment policy →

industry policy →

energy security policy

Industry: Innovation, Diversity and Competition

EV Innovations

China's EVs have features that better address consumers' needs & wants



Battery Swap

NIO Power Swap Station 3.0

Instead of conventional recharge from a DC fast charger, Nio's Power Swap battery swap stations, which enable drivers to exchange their depleted battery for a fully charged one in less than five minutes. In China, Nio has installed more than 1,200 Power Swap stations.



Comfort & Entertainment

XPeng P5

It offers a range of entertainment options, including watching movies, football, playing games, and singing karaoke. This vehicle is a flexible and dynamic space that enriches travel experiences, offering diverse applications for entertainment, rest, and outdoor enjoyment, extending to 24 hours of usability.



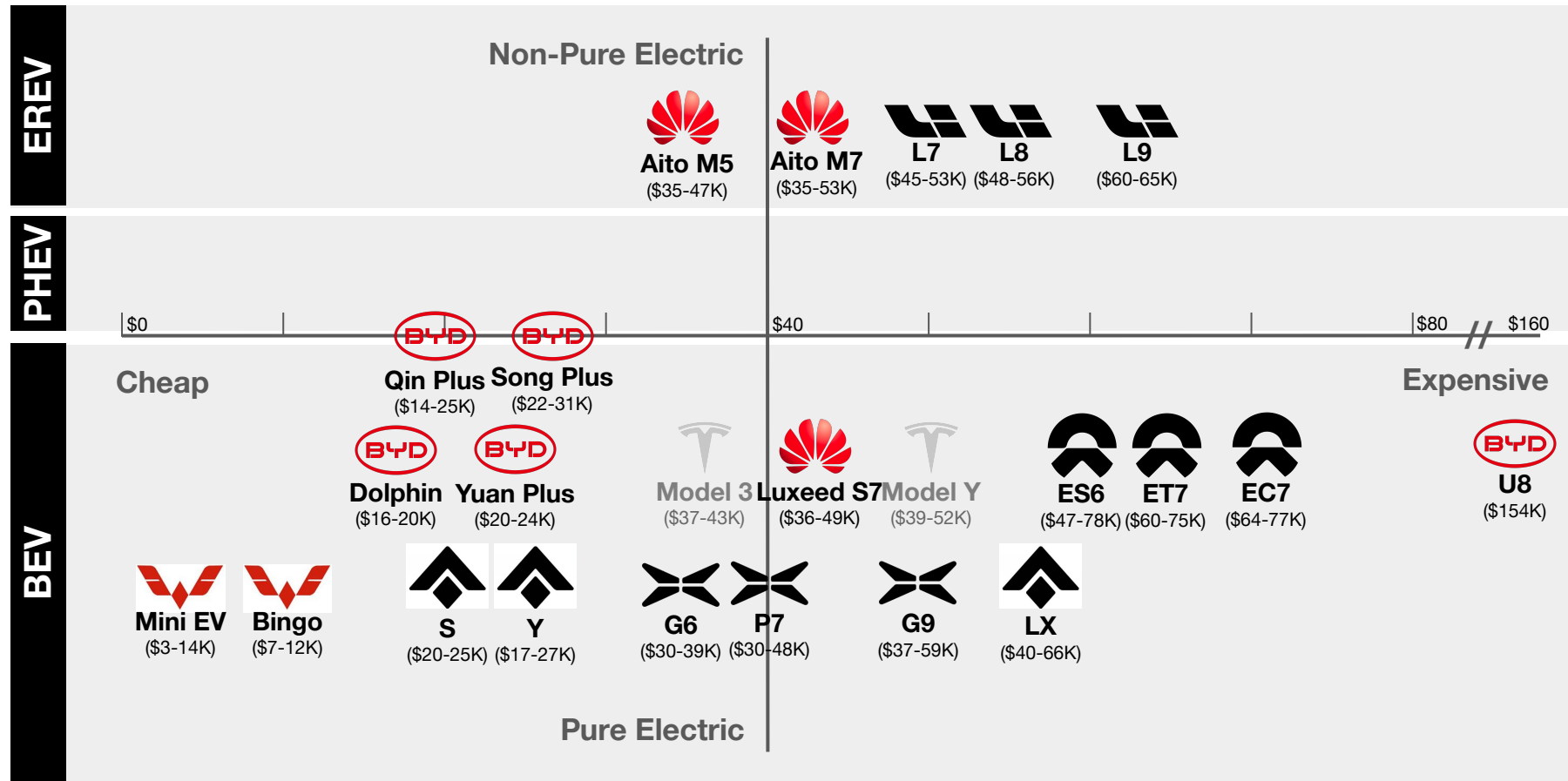
Cost-effective

Wuling Hongguang MINI Macaron

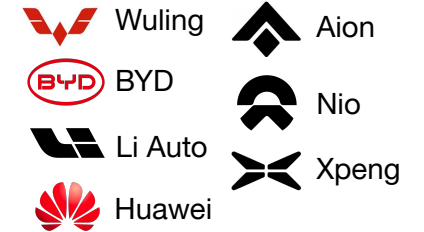
Mini EVs such as the Wuling Hongguang Mini have been introduced in China and a few other countries. Priced from around \$4,700, these vehicles enabled over a million people to get access to a decent affordable vehicle. The Wuling Mini EV knocked Tesla's Model 3 off the top of the sales charts in 2021.

EV Diversity: Sheer Variety of Chinese Offerings

Leading EV Automakers have Multiple EV Models in Different Pricing Level



Chinese EV Brands



For Comparison



- Pricing starting at \$2.9K, and on avg. no higher than \$80K.
- High price-point: NIO, Huawei, Li Auto
- Low price-point: Wuling, BYD, Aion
- BEV: Most brands have a BEV offering
- PHEV: BYD
- EREV: Huawei, Li Auto

NOTE: BEV: Battery Electric Vehicle, powered solely by a battery and an electric motor.

PHEV: Plug-in Hybrid Electric Vehicle, utilizes both a battery and a fuel engine for energy supply, with the battery rechargeable via an external socket.

EREV: Extended-Range Electric Vehicles, generates electricity using fuel to charge its battery.

SOURCE: 16888.com

Mainstream EV model: China vs. US

Feature	BYD Seal (China)	Tesla Model 3 (US)
Powertrain	RWD / AWD	RWD / AWD
Range (WLTP)	460–570 km	491–629 km
Battery	61.4 or 82.5 kWh	57.5–82 kWh
Acceleration (0–100 km/h)	3.8–7.5 sec	4.4–6.1 sec
Est. Price	~US\$28,000–\$35,000	~US\$40,000–\$53,000



High-Performance Models: China vs. US

Feature	Xiaomi SU7 Ultra (China)	Tesla Model S Plaid (US)
Powertrain	Tri-motor AWD	Tri-motor AWD
Horsepower / Output	1,548 hp	1,020 hp
0–100 km/h	1.97 sec	2.1 sec
Top Speed	350 km/h	322 km/h
Notable Tech	In-house OS, HyperOS, lidar, AI chip	Autopilot, FSD (optional), Plaid mode
Est. Price	~US\$41,500	~US\$89,990



EV Competition: Severe among Chinese EV companies

while cultivating cross-sector collaborations

EV Manufacturer

In the Chinese EV manufacturing market, several key groups are actively shaping the landscape, each contributing to the diversity of EV offerings to meet various consumer needs.

- **Tech Startups:** Li Auto, NIO, and Xpeng are leading the charge in EV innovation. Li Auto is known for its extended-range electric vehicles, while NIO emphasizes high-performance EVs, and Xpeng focuses on smart, connected EVs.
- **Tech & Automaker Partnerships:** Collaboration is key in this segment, with companies like Baidu partnering with established automakers to create feature-rich, autonomous EVs.
- **Traditional Automakers:** Well-established companies like BYD and Geely are leading the transition to electric mobility. They use their extensive manufacturing experience to offer a diverse range of EVs, from affordable compacts to luxurious models.

 Li Auto

 NIO

 XPENG

 BYD

 HUAWEI

 Baidu 百度

 MI

...

 WeRide

 pony.ai

 CATL

 SVOLT

 地平线
Horizon Robotics

 HESAI

Smart Vehicle Ecosystem

Tech giants in China are expanding their footprint in the mobility industry, primarily by offering essential technology solutions for the backend of smart cars.

- **Connected Vehicle Systems:** Huawei, Tencent, and Baidu, which are developing software and connectivity solutions for smart cars.
- **Human-Vehicle Interaction:** Alibaba, Xiaomi, and Byton are investing in human-vehicle interaction technologies, including voice recognition and gesture control.
- **Autonomous Driving:** Baidu's Apollo platform, Pony.ai, and WeRide are developing autonomous driving platforms and technologies.
- **Battery Technology:** CATL is one of the world's largest producers of EV batteries. BYD is also a key player in battery innovation.
- **Advanced Chips:** Semiconductor giants like NVIDIA, Intel, and local Chinese chip manufacturers like Horizon Robotics and BYD Semiconductor are developing advanced chips for autonomous driving and vehicle connectivity.

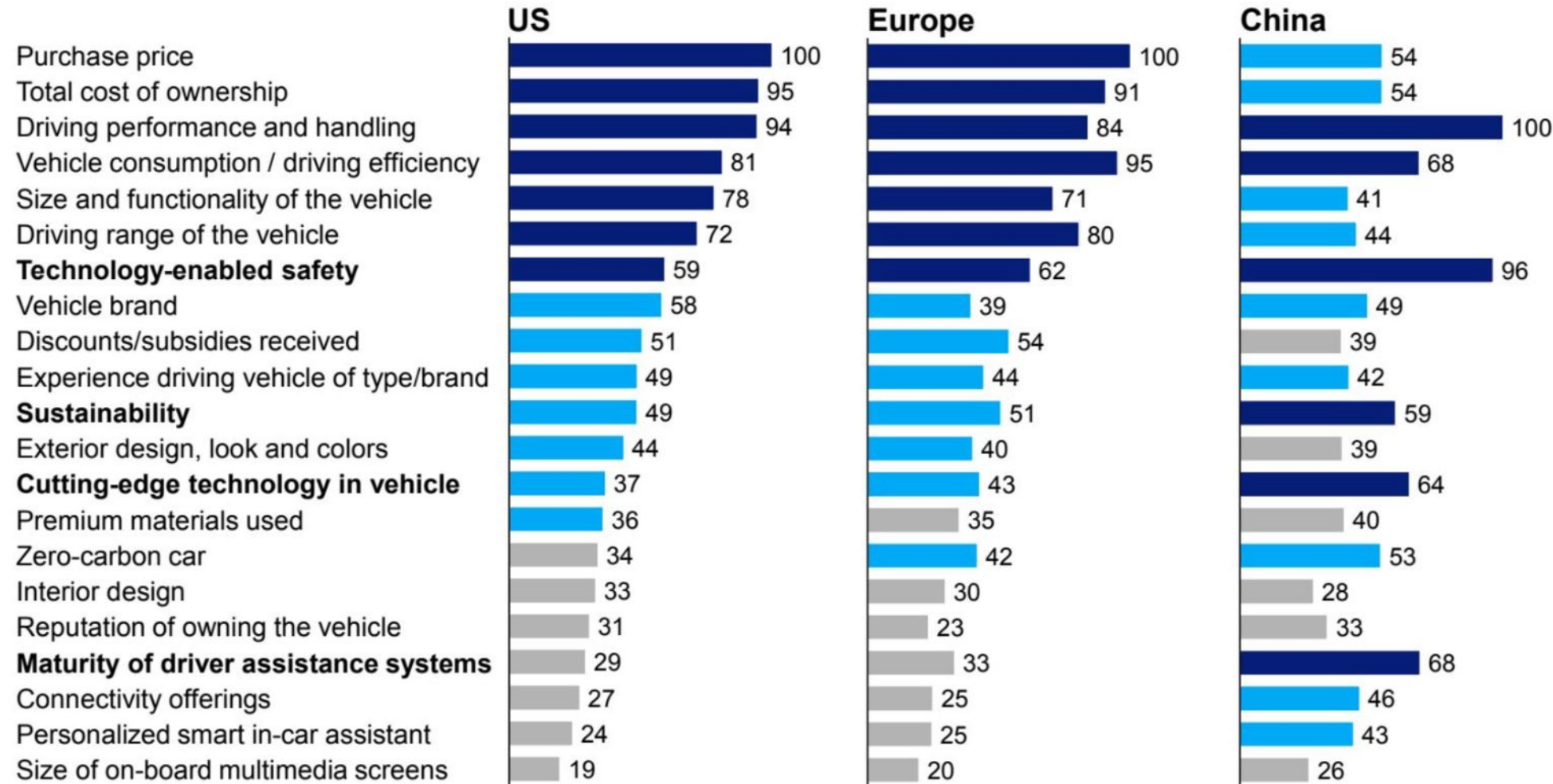
~20 “tesla like” companies competing

Consumer preference

US and European customers exhibit similar purchase criteria, while Chinese consumers more focused on tech and performance

Key decision factors for next car purchase

Relative importance of factor indexed to 100



Main purchase factors

Most important factors for car purchase decision

Rounding out factors

Factors that influence the purchase decision

Non-essential factors

Elements that do not influence car purchase

Drivers Behind China's EV Rise

1 Market Size



China is **the world's largest market and producer of automotives**. In Q1 2023, China surpassed Japan and Germany to become the world's **No.1 car exporter** for the first time. The surge in exporting EVs has become one of the main drivers of this growth.

2 Policies



China has implemented national-level policies to expedite **technological advancement, infrastructure development, and climate neutrality**. There is a national strategy to revitalize its automotive industry. Specifically for the EV industry, additional incentive policies include promotion of New Energy Vehicles (NEVs), advanced manufacturing, NEV purchase subsidies, and battery technology development.

3 Investment



Despite a slowdown in mobility investment in 2023, largely attributed to a dip in China's venture ecosystem's momentum, China still boasts **one of the world's most dynamic mobility tech ecosystems**, featuring multiple key players and unicorns. Global automakers are investing in China's mobility tech, while Chinese automakers are making multiple M&As and venture investments in global manufacturers and mobility startups.

4 Industry



China's EV ecosystem is **shaped by three forces – big tech in China** (Huawei, Xiaomi, Baidu), **new EV makers** (NIO, XPeng, Li Auto), and **upstream & downstream tech firms** (CATL, WeRise, Pony.ai). Each contributes through innovation in smart car systems, battery technology, and autonomous vehicles, along with strategic partnerships and investments.

5 Consumer



China has been a global leader in EV innovation, offering **a wide range of models, price points, and smart features** tailored to consumer needs. In China, key consumer demand in EV include charging convenience, safety, and affordability. To address these, EV manufacturers have introduced innovations like **battery swapping, economically priced models, and Extended-Range Electric Vehicles**.

EV growth in China is NOT a surprise

toy, shirts, furniture, TV, cellphone, computers,
high speed rail, architecture design, gene testing, ...

Tariffs

U.S. Tariffs on Chinese EV & EV Supply Chain

Cumulative tariff on Chinese EVs: **247.5%**

- Standard import duty: **2.5%**
- Biden administration: **100%**
- Trump administration: **145%**

the worst possible combination:

High Ego and High Tariff

When is tariff useful?

When it facilitates learning

Pathway forward: Building walls or laying red carpet

Do what China did 30 years ago

- Invite the best EV companies into the US
- Joint Venture: when US oems still have something to offer
- Market for technology

Remarks on China

Remark #1: Tolerance of pain

Remark #2: Lust for modernity

- Open to technology
- Willing to experiment

Remark #3: *Asymmetry* of Understanding

EV in a Fractured World: US-China Trade War

Prof. Jinhua Zhao

Massachusetts Institute of Technology