The Automobile Industry: Makers, Money, and the Electric Turn

Figures current as of October 2026

How the world's vehicles are designed, built, sold, financed, and regulated, and who profits: the global industry and its makers, the plant and its workers, the money, China's electric lead, Europe's squeeze, the American market, Japan, Korea, India, and the rest, the electric transition, tariffs and trade, the rules, software and the driverless car, the buyer, and what to watch.

MODULE 1 — The World's Car Industry

Goal: Map who builds the world's vehicles, who buys them, and where they go.

The 96.4 million vehicles built in 2025, more than a third of them in China; the largest markets; the ten largest makers, from Toyota's 11.3 million to Honda's 3.5 million; China as the largest exporter since 2023; and the forecasts for 2026.

MODULE 2 — Making a Car

Goal: Understand how a car is designed, built, and supplied, and who builds it.

From design and platform to stamping, body, paint, and final assembly; the suppliers, who make about three-quarters of a car's value; the shocks that stopped the lines, from the 2021 chip shortage to rare earths, Nexperia, and the 2026 memory squeeze; the workers and their contracts.

MODULE 3 — The Money

Goal: Understand why carmakers earn so little, and weigh whether the older makers should keep spending on electric cars.

Margins from Kia's 8.0% to Honda's -1.9%, and Stellantis's €22.3 billion loss; capital, fixed costs, and break-even; why pickups pay and small cars do not; the captive lenders; a stock market that values Tesla at more than 13 other large makers combined; the 2009 bankruptcies and the electric write-downs.

MODULE 4 — China

Goal: Understand how China came to lead the electric car, and weigh whether its industry is a model of efficiency or overcapacity fed by subsidies.

From joint ventures to the electric bet; BYD, which makes its own batteries and chips; the price war, 129 brands, and plants for 55 million cars; 2026's fall in sales at home and surge in exports, with new-energy vehicles a record 67% of retail sales in September.

MODULE 5 — Europe

Goal: Understand the squeeze on Europe's makers, and weigh whether Europe should protect them or invite Chinese plants and partners.

A market still below its 2019 size; Volkswagen's profit warning and 100,000 planned job cuts; Chinese brands at a record 11.7% of sales, mostly with plug-in hybrids that the EU's duties do not cover; the duties, the price deals, and the October 2026 understanding to curb China's hybrid exports, with a cap still only proposed.

MODULE 6 — America

Goal: Read the American market and its makers in 2026.

16.2 million sold in 2025, trucks and SUVs about 83% of them; the Detroit Three near a record-low share; GM's and Tesla's third quarters; the electric retreat, from Ford's December 2025 reset to cancelled plants; the dealers; and gasoline above $4.50 a gallon from May into the summer.

MODULE 7 — Japan, Korea, India, and the Rest

Goal: Follow the makers and markets beyond China, Europe, and America.

Toyota's hybrid bet; Honda's first annual loss and Nissan's restructuring; Hyundai-Kia's American plants and the 2025 raid; India's record sales after its 2025 tax cut; Mexico as an export platform; Chinese brands' gains from Brazil to Russia.

MODULE 8 — The Electric Transition

Goal: Measure how far and how fast the shift to electric cars has gone, and weigh whether it is stalling outside China.

More than 20 million electric cars sold in 2025, a quarter of the world's new cars; 2026's split, with Europe and the emerging markets up and China and North America down; battery packs at $108 a kilowatt-hour; prices, charging, and emissions over a car's life.

MODULE 9 — Tariffs and Trade

Goal: Understand the walls around the world's car markets, and weigh whether America's tariffs protect its industry or tax its buyers.

Where America's cars come from; the 25% tariff and the 15% deals; the courts, the review of the North American trade pact, and the threat to Canada; the bills, from GM's $3.1 billion to Toyota's ¥1.38 trillion; the walls against Chinese cars.

MODULE 10 — The Rules

Goal: Learn how emissions, fuel economy, and safety are regulated, and weigh whether the emissions rules should be loosened.

America's reversal: the end of the electric-car credits and fuel-economy penalties, the new fuel-economy rule, and the rescinded endangerment finding; Europe's fleet targets and the 2035 debate; China's credits; deaths on American roads, recalls, and the safety rules.

MODULE 11 — Software and Autonomy

Goal: Understand the car's software and the driverless car, and weigh whether robotaxis are safe enough to scale.

The computer on wheels; driver assistance and its levels, from Tesla's 1.74 million subscriptions to Mercedes's paused Level 3 system; robotaxis, from Waymo's 500,000 weekly rides to Tesla's Cybercab and China's fleets; driverless trucks; the rules and the risks.

MODULE 12 — The Buyer

Goal: Understand what a car costs to buy and to own, and weigh whether cars have become unaffordable.

An average new car at $50,562; a record $787 monthly payment and loans of seven years; $1.7 trillion of auto debt and record subprime delinquency; insurance and repair costs; the used car and a fleet averaging 12.8 years old.

MODULE 13 — Where Things Stand, and What to Watch

Goal: Close with the argument, the contradictions, and a dated watch list.

The course's argument on a page; the contradictions no single module states; what to watch from October 2026 on; and a last word.

A note on the sources: the world's production and sales figures come from the International Organization of Motor Vehicle Manufacturers (OICA), which counts cars, vans, trucks, and buses. China's come from the China Association of Automobile Manufacturers (CAAM), whose wholesale count includes exports, and the China Passenger Car Association (CPCA), which counts retail sales at home. Europe's come from the European Automobile Manufacturers' Association (ACEA). American sales come from the official monthly series of the Bureau of Economic Analysis (BEA) and from the counts of the National Automobile Dealers Association (NADA) and others, which differ slightly. Prices come from Kelley Blue Book, run by Cox Automotive, and from Edmunds, and credit from the Federal Reserve Bank of New York and Fitch Ratings.

Electric-car sales come from the International Energy Agency (IEA) and the research firm Rho Motion, and battery prices from BloombergNEF (BNEF). The rules come from the Environmental Protection Agency (EPA), the National Highway Traffic Safety Administration (NHTSA), the European Commission, and China's Ministry of Industry and Information Technology. Company figures come from the companies' own reports. Their fiscal years and measures differ: Toyota's year ends in March, and General Motors (GM) reports a margin that excludes items it calls special, so each table says which is which. Companies' targets and claims, from robotaxi plans to job cuts, are reported as claims.

Amounts in other currencies are converted at the Federal Reserve's exchange rates for October 16, 2026, unless a company gives its own dollar figure. Where the field argues, over spending on electric cars, China's industry, Europe's policy, the pace of the transition, tariffs, the emissions rules, robotaxis, and the cost of a car, the course makes each case as its advocates make it, gives the evidence, and then states its own reading once.

Key Numbers, as of October 2026

The measurements the course relies on

Measure	Figure	Period	Source and release
World production and sales	96.4 million vehicles built, 34.5 million (36%) of them in China; 99.8 million sold	2025	OICA (2026)
Largest makers	Toyota 11.32 million vehicles; Volkswagen 8.98 million; Hyundai-Kia 7.27 million; GM 6.18 million; BYD 4.60 million, sixth	2025	Company reports (January 2026)
China's exports	7.1 million vehicles in 2025; 8.205 million in January-September 2026, up 65.8%	2025-26	CAAM (October 2026)
China's market at home	Retail car sales down 21.7%; new-energy vehicles (NEVs) 67.0% of retail sales in September	January-September 2026	CPCA (October 2026)
Electric cars worldwide	More than 20 million battery-electric cars (BEVs) and plug-in hybrids (PHEVs) sold in 2025, about a quarter of new cars; 15.5 million in January-September 2026, up 3%	2025-26	IEA, *Global EV Outlook 2026* (May 2026); Rho Motion (October 2026)
Battery packs	$108 per kilowatt-hour (kWh) on average; $84 in China	2025	BNEF price survey (December 9, 2025)
Europe	EU registrations 10.82 million in 2025; BEVs 21.7% of EU sales in January-August 2026; Chinese brands a record 11.7% of Europe's sales in August 2026	2025-26	ACEA; Dataforce
American sales	16.2 million light vehicles in 2025; 11.99 million in January-September 2026, down 2.0%; a seasonally adjusted annual rate (SAAR) of 15.98 million in September	2025-26	NADA (2025); Bureau of Economic Analysis (2026)
American electric and hybrid shares	BEVs 6.5% of sales in the third quarter; hybrids 15.6% of sales in January-September	2026	Cox Automotive (BEVs); NADA (hybrids), October 2026
Margins	Toyota 7.4% operating margin in the year to March 2026; Volkswagen 2.8% in 2025, with a 2026 forecast of "up to 1%"	2025-26	Company reports
Tesla and GM	Tesla: revenue $28.0 billion, operating margin about 2.6%. GM: adjusted earnings before interest and taxes (EBIT) $4.1 billion, 8.2% of revenue	Third quarter of 2026	Tesla (October 21, 2026); GM (October 20, 2026)
Market values	Tesla $1.40 trillion, about 1.5 times 13 other large makers combined; Toyota $229 billion	October 16, 2026	companiesmarketcap.com
US tariffs on cars	25% on imported cars and parts under Section 232 since April-May 2025; 15% for Japan, the EU, and South Korea; 10% for British cars within a quota	October 2026	White House proclamations
EU duties on Chinese BEVs	7.8% (Tesla) to 35.3% (SAIC), on top of the 10% tariff	Since October 2024	European Commission
Gasoline	US average above $4.50 a gallon from May 6, 2026 into the summer; $4.284 in the week of October 19, 2026; up 34.2% in a year in the consumer price index (CPI)	May-October 2026	AAA, the motorists' association, via Cox; Energy Information Administration (EIA); Bureau of Labor Statistics (BLS), October 14, 2026
New-car price	Average transaction price $50,562	September 2026	Kelley Blue Book (October 2026)

Measure	Figure	Period	Source and release
Car payments	Average new-car payment $787 a month; 25.5% of new loans run 84 months or longer	Third quarter of 2026	Edmunds (October 2026)
Auto debt and delinquency	$1.713 trillion of auto loans; subprime auto-loan securities a record 6.90% 60 days or more past due in January 2026, easing to 5.98% by August	Second quarter of 2026; January-August 2026	Federal Reserve Bank of New York (August 11, 2026); Fitch Ratings
The fleet	The average American car on the road is 12.8 years old	2025	S&P Global Mobility
Road deaths	39,254 in 2024; 36,640 estimated for 2025	2024-25	NHTSA
Robotaxis	Waymo: about 500,000 paid rides a week, more than 4,000 vehicles, 15 US metro areas	September 2026	Waymo; TechCrunch
Interest rates	Federal funds target 3.75-4.00%, after a quarter-point rise	Set September 16, 2026	Federal Reserve (the Fed)

Measures differ between sources: OICA counts all vehicles, national sales counts usually light vehicles, and the electric-car counts of the IEA, Rho Motion, CAAM, and Cox each include different kinds of car (Module 8). Company figures are on each company's own fiscal year and measure (Module 3).

Who's Who

The people the course names, as of October 22, 2026

The makers

Name	Who they are	Why they matter to the industry
Akio Toyoda	Chairman of Toyota Motor since 2023, after 14 years as president; age 70	The founder's grandson chairs the world's largest carmaker and championed its bet on hybrids over an all-electric line
Kenta Kon	President and chief executive of Toyota since April 1, 2026, previously its chief financial officer; age 58	A finance chief now runs Toyota after a year in which US tariffs pushed its North American business into loss
Oliver Blume	Chief executive of the Volkswagen Group since September 2022, and of Porsche from 2015 until the end of 2025; age 58	Leads the world's second-largest carmaker through a profit warning and 100,000 planned job cuts
Michael Leiters	Chief executive of Porsche since January 1, 2026; formerly chief executive of McLaren Automotive	Took over a company whose profit collapsed in 2025
Chung Euisun	Executive chair of Hyundai Motor Group since October 2020; age 56	Heads the group of Hyundai, Kia, and Genesis, which is building its largest American plants
José Muñoz	President and chief executive of Hyundai Motor since January 1, 2025, the first non-Korean in the post	Runs Hyundai through the American tariffs and the 2025 raid at its Georgia battery site
Mary Barra	Chief executive of General Motors since January 2014 and chair since January 2016; age 64	Leads America's largest carmaker, which cut its electric plans and leans on pickups and sport utility vehicles (SUVs) for its profit
Jim Farley	President and chief executive of Ford since October 2020; born 1962	Reset Ford's electric plans in December 2025 and bet on a cheaper electric platform
Antonio Filosa	Chief executive of Stellantis since June 23, 2025, succeeding Carlos Tavares; born 1973	Leads the maker of Jeep, Ram, Peugeot, and Fiat through its 2025 losses and its retreat from an all-electric plan
Wang Chuanfu	Founder (1995), chairman, and president of BYD; age 60	Built a battery maker into the largest seller of new-energy vehicles in the world
Li Shufu	Founder and chairman of Zhejiang Geely Holding Group, which owns Volvo Cars and stakes in other carmakers; age 63	Built a refrigerator-parts maker into one of the world's ten largest car groups
Toshihiro Mibe	President and chief executive of Honda since April 2021	Led Honda into its first annual loss, after its electric write-downs, and out of merger talks with Nissan
Ivan Espinosa	President and chief executive of Nissan since April 2025	Is closing plants and cutting jobs to save a maker that lost money for two years
Elon Musk	Chief executive of Tesla since October 2008; age 55	Runs the most valuable carmaker; shareholders approved on November 6, 2025 a pay award tied to goals that include a million robotaxis
Ola Källenius	Chief executive of Mercedes-Benz since May 2019; age 57	Leads a luxury maker squeezed by falling sales in China
Milan Nedeljković	Chief executive of BMW from May 14, 2026, succeeding Oliver Zipse, after more than six years as its board member for production; age 57	Took over as BMW launches its new generation of electric cars
François Provost	Chief executive of Renault since July 2025, succeeding Luca de Meo	Runs the third-largest seller of cars in the EU

Name	Who they are	Why they matter to the industry
Lei Jun	Founder, chairman, and chief executive of Xiaomi; age 56	Took a phone maker into cars with its first sedan in March 2024
Yin Tongyue	Chairman of Chery Automobile, which he has led since its founding in 1997	Leads China's largest car exporter

Suppliers, technology, and labor

Name	Who they are	Why they matter to the industry
Robin Zeng (Zeng Yuqun)	Founder (2011) and chairman of CATL (Contemporary Amperex Technology); born 1968	Runs the world's largest maker of electric-car batteries, which licenses its technology to Ford
Tekedra Mawakana and Dmitri Dolgov	Co-chief executives of Waymo, Alphabet's driverless-car company, since April 2021	Run the largest robotaxi service outside China
Shawn Fain	President of the United Auto Workers (UAW) since March 26, 2023; unofficial results reported October 12, 2026 give him a second term, pending certification; age 57	Led the 2023 strikes at the Detroit Three, whose contracts expire on April 30, 2028
Christiane Benner	First chair of IG Metall, Germany's metalworkers' union, since October 2023, the first woman in the post; age 58	Bargains for German car and supplier workers as the makers cut jobs

Officials

Name	Who they are	Why they matter to the industry
Sean Duffy	US Secretary of Transportation since January 28, 2025; age 55	Oversees NHTSA, which sets fuel-economy and safety standards
Jonathan Morrison	Administrator of NHTSA since September 2025	Leads the regulator that issued the 2026 fuel-economy rule and runs recalls and the rules for driverless cars
Lee Zeldin	Administrator of the EPA since January 29, 2025; age 46	His agency rescinded the finding behind its greenhouse-gas standards for vehicles
Howard Lutnick	US Secretary of Commerce since February 21, 2025; age 65	His department runs the Section 232 case behind the tariffs on cars and parts
Jamieson Greer	US Trade Representative since February 2025	Negotiates the trade deals and led the review of the United States-Mexico-Canada Agreement (USMCA)
Lauren Sanchez	Chair of the California Air Resources Board (CARB) since October 1, 2025	Leads the state agency whose stricter car rules lost their federal waivers in 2025
Maroš Šefčovič	European Commissioner for Trade and Economic Security since December 1, 2024; age 60	Negotiates with China over its electric cars and hybrids
Wopke Hoekstra	European Commissioner for Climate, Net Zero and Clean Growth since December 2024; age 51	Responsible for the EU's carbon dioxide (CO2) rules for cars and the proposal to soften the 2035 target
Stéphane Séjourné	European Commission Executive Vice-President for Prosperity and Industrial Strategy since December 2024; age 41	Leads the EU's industrial policy for its carmakers
Li Lecheng	China's Minister of Industry and Information Technology since April 30, 2025; age 61	His ministry regulates China's carmakers and their price war
Wang Wentao	China's Minister of Commerce since December 2020; age 62	Negotiates China's car trade with Europe and America
Mark Carney	Prime Minister of Canada since March 2025; age 61	Faces a threatened 50% US tariff on Canadian cars

Name	Who they are	Why they matter to the industry
Claudia Sheinbaum	President of Mexico since October 1, 2024; age 64	Governs the largest exporter of cars to the United States

Terms

The vocabulary of the car industry

Term	Meaning
Light vehicle	A passenger car, sport utility vehicle (SUV), pickup, or van. National sales counts are usually of light vehicles; OICA's world totals also include heavy trucks and buses
Platform	The shared engineering base, the floor, suspension, electronics, and power layout, on which a maker builds several models, spreading the cost of developing it across them
Tier 1, 2, and 3 suppliers	Tier 1 suppliers sell finished systems, such as seats, brakes, or electronics, to the carmaker; Tier 2 suppliers sell components to Tier 1, and Tier 3 sell materials and simple parts
Just-in-time	Delivering parts to the assembly line as they are needed, in the order the cars are built, instead of holding stocks: cheap when every part arrives, costly when one does not
Hybrid (HEV)	A car with a gasoline engine and an electric motor, whose small battery is charged by the engine and by braking; it cannot be plugged in
Plug-in hybrid (PHEV)	A hybrid with a larger battery that can be charged from the grid and can drive a limited distance on electricity alone
Extended-range electric vehicle (EREV)	A plug-in whose wheels are driven only by electric motors; a small engine runs a generator to recharge the battery. Some counts group EREVs with PHEVs, others with BEVs
Battery-electric vehicle (BEV)	A car powered only by a battery charged from the grid
Electric car (EV)	In this course, BEVs plus PHEVs, as the IEA and Rho Motion count them, unless the text names another measure
New-energy vehicle (NEV)	China's official category: BEVs, PHEVs, EREVs, and fuel-cell cars
Seasonally adjusted annual rate (SAAR)	A month's sales, adjusted for the usual seasonal pattern and the number of selling days, and expressed as a yearly pace
Average transaction price	What buyers paid for new vehicles on average, after the maker's discounts and before taxes and fees, as Kelley Blue Book measures it
EBIT and operating margin	Earnings before interest and taxes (EBIT) is a measure of operating profit; the operating margin is operating profit as a share of revenue. A company's "adjusted" figures leave out items it calls special
Captive finance arm	A carmaker's own lender, such as GM Financial, Ford Credit, or Toyota Financial Services, which lends to buyers and dealers
Capacity utilization	Output as a share of what the plants could build. Definitions differ, by nameplate capacity or by an assumed number of shifts and working days, so the same plants can show very different rates
Model year	The year a vehicle's design is sold as; a model year usually begins months before the calendar year of the same number
Corporate Average Fuel Economy (CAFE)	America's fuel-economy standard, set by NHTSA, which applies to the average of each maker's fleet rather than to each car
Regulatory credits and pooling	Makers that beat an emissions or fuel-economy standard earn credits they can sell to makers that fall short; in the EU, makers may pool their fleets to meet a joint target
Endangerment finding	The EPA's 2009 finding that greenhouse gases endanger public health and welfare, the legal basis for its greenhouse-gas standards for vehicles (Module 10)
Section 232 and Section 301	Section 232 of the Trade Expansion Act of 1962 lets the president impose tariffs on imports that threaten national security; Section 301 of the Trade Act of 1974 lets him act against another country's unfair trade practices
Anti-subsidy (countervailing) duty	A tariff set after an investigation to offset the subsidies a foreign government gives an exporter

Term	Meaning
Rules of origin and regional value content	The tests a car must pass to count as made inside a trade area, such as the share of its value that must come from the region under the United States-Mexico-Canada Agreement (USMCA)
Franchise laws	State laws that require new cars to be sold through independent dealers and protect those dealers from their makers; they are why Tesla's direct sales are fought state by state
The Detroit Three	GM, Ford, and Stellantis, whose American roots are Chrysler
Driving-automation levels (SAE Levels 0-5)	The scale of SAE International, an engineering society. At Level 2 the car steers and brakes but a driver must watch; at Level 3 it drives itself in set conditions and hands back control; Levels 4 and 5 need no driver, Level 4 only within set limits
Operational design domain	The conditions, such as roads, places, weather, and times of day, in which an automated system is designed to drive
Software-defined vehicle and over-the-air update	A car whose functions are run mainly by central computers and software, which the maker can change remotely by sending updates over the mobile network
Robotaxi	A car that carries paying passengers with no human driver aboard
Negative equity	Owing more on a car loan than the car is worth, a debt often rolled into the next loan at trade-in

Module 1 — The World's Car Industry

Who Builds the Cars, Who Buys Them, and Where They Go

Recommended Reading / Reference

Book: Peter Dicken, *Global Shift: Mapping the Changing Contours of the World Economy* (7th edition, 2015), whose chapter on the automobile industry explains how carmaking spread beyond its home countries and why it clusters in regions

Reference: OICA's production and sales statistics by country (oica.net, published each spring), with CAAM's monthly figures for China, the sources for most of the figures here

1a. What the Industry Is and How It Is Counted

The car industry has four main parts. Carmakers design vehicles, build their bodies, and assemble them, while suppliers make most of the parts, from steel and seats to chips and batteries (Module 2). Dealers sell and service the cars in most countries (Module 6), and lenders, many of them owned by the carmakers, finance a large share of the purchases (Module 3). This module counts the vehicles, and the modules after it follow the money, the trade walls, the rules, and the technology.

Counting starts with what a vehicle is. OICA, the International Organization of Motor Vehicle Manufacturers, counts every motor vehicle: passenger cars plus commercial vehicles, which run from vans and light trucks to heavy trucks and buses. By its count the world built 96.4 million vehicles in 2025, up 4% from 92.7 million in 2024. Forecasters count **light vehicles** instead, cars and light trucks without the heavy trucks and buses, and on that measure Mobility Global, the forecasting business spun out of S&P Global in 2026, put 2025's output at 92.9 million.

Production and sales measure different things: production counts vehicles where they are assembled, and sales count them where they are sold or registered. OICA counted 99.8 million vehicles sold in 2025, up 4.7% from 95.3 million in 2024, which is more than the world built. The reason is a double count, because OICA takes China's figure from CAAM, whose "sales" are carmakers' shipments from the factory, exports included. The vehicles China exported in 2025 (section 1e) therefore appear twice, once in China's total and again in the countries where they were registered. Without them, the world's sales in 2025 come to about 92.7 million, by coincidence almost exactly what it built in 2024, and fewer than it built in 2025.

Companies count in their own ways too, reporting their volumes as sales to customers, as deliveries, or as **wholesales**, their shipments to dealers and fleets, and some on fiscal years that end in March. A **joint venture** is a company that two firms own together, and in China foreign carmakers have long built cars through ventures with Chinese groups (Module 4). Volkswagen and GM count all the cars their Chinese ventures sell, and so does SAIC, their partner in some of those ventures, so some cars appear in the totals of two of the ten largest groups (section 1d).

No official body adds up the industry's revenue, but the 13 groups whose results Module 3 compares, counting Porsche within Volkswagen, took in about $2.2 trillion in their latest fiscal years. That is at today's exchange rates, those of October 16, 2026, which this module uses for every dollar figure. The sum leaves out SAIC, Geely, and many smaller makers, and it includes the groups' lending arms. Adding the parts makers' revenue would count most of it twice, because a carmaker's revenue already pays for the parts it buys (Module 2). In the US, making vehicles and their parts provides about one factory job in thirteen (Module 2).

1b. Where the World’s Vehicles Are Built

China built 36% of the world’s vehicles in 2025, more than the next five countries combined: the US, Japan, India, Germany, and South Korea. Its output grew by about 3 million vehicles in a year, most of the world’s increase of 3.7 million. Asia and Oceania together built about 59.2 million vehicles, more than 61% of the world’s output, while output fell 0.8% in Europe, to 17.2 million, and 2.1% in the Americas, to 18.74 million.

The table sets each large producer’s output beside its home market, and the gaps show who builds for whom. Japan and South Korea build far more than they buy and export the rest (section 1e), and Mexico builds more than two and a half times what it sells, mostly for the US (Module 7). India, now the fourth-largest producer, builds about a million more vehicles than it sells. The US does the opposite: Americans bought about 6.4 million more vehicles than American plants made, a gap that imports fill and that Module 9 traces to its sources. China’s factories built about 7.2 million more than Chinese buyers took, which is roughly what China exported. Two producers not shown in the table, Thailand (Southeast Asia’s largest) and the Czech Republic, each built about 1.45 million vehicles, more than Turkey.

Country	Built, 2025 (millions)	Change from 2024	Sold, 2025 (millions)	Change from 2024
China	34.53	+10%	34.40, including exports	+9.4%
United States	10.24	-3%	16.68	+2.1%
Japan	8.41	+2%	4.57	+3.3%
India	6.49	+8%	5.52	+5.5%
Germany	4.15, cars only	+2%	3.21	+0.5%
South Korea	4.10	-1%	1.68	+2.8%
Mexico	4.09	-3%	1.56	+0.1%
Brazil	2.64	+4%	2.69	+2.1%
Spain	2.27	-4%	1.37	+12.3%
France	1.46	+8%	2.04	-5.2%
Turkey	1.42	+4%	1.41	+10.0%
Canada	1.24	-8%	1.93	+1.4%
Indonesia	1.15	-4%	0.80	-7.2%
Russia	0.85	-13%	1.49	-19.0%
United Kingdom	0.76	-16%	2.40	+1.3%

OICA, production and sales (registrations) of all motor vehicles, 2025, published April 2026; OICA rounds production changes to whole percentages. China’s sales are CAAM’s count, which includes its exports. Germany reports cars only.

1c. Where They Are Sold

Asia, Oceania, and the Middle East bought 55.0 million vehicles in 2025, up 7.1%, while the Americas bought 24.9 million, up 2.9%, and Europe 18.6 million, down 0.4%. Africa bought 1.3 million, up 22.0%, the fastest growth of any region, from the smallest base. More than half the world’s new vehicles are sold in Asia, Oceania, and the Middle East, even after China’s exports are taken out, and that region is also where the growth is.

China is the largest market by far, even without its exports: Chinese buyers took about 27.3 million vehicles in 2025, about 1.6 times as many as Americans bought. India has become the third-largest market, ahead of

Japan, and Germany, Brazil, Britain, and France follow. Russia's market shrank most among the large ones, under high interest rates and rising fees on imported cars (Module 7).

National counts differ from OICA's, because each country counts its own way. America's usual count covers light vehicles only (Module 6), Europe's carmakers' association counts cars (Module 5), and India counts passenger vehicles separately from trucks and buses (Module 7). China's home market, which shrank in 2026, is Module 4's subject. This module uses OICA's count throughout, so that every country is measured the same way.

1d. Who Builds Them

Ten groups sold about 60.4 million vehicles in 2025 between them, three-fifths of OICA's world total, though their counts overlap. Toyota has been the largest for six years running, and its own production was 11.2 million, up 5.7% (Bloomberg, January 29, 2026). Three of the ten are now Chinese, BYD, SAIC, and Geely Holding, and Nissan dropped out of the top ten (CarNewsChina, February 26, 2026). Rankings differ, and CarExpert's (February 14, 2026), which leaves out SAIC, puts Nissan tenth with 3.21 million.

Most of the ten are groups of brands, built up by mergers and purchases. Stellantis was formed in January 2021, when Fiat Chrysler Automobiles merged with France's PSA Group, Geely bought Volvo Cars from Ford in 2010, and Hyundai Motor owns about a third of Kia. A group can share engines, electronics, and platforms, the engineering beneath a family of models (Module 2), across its brands, so that one development budget pays for many cars.

Rank	Group (home)	Main brands	Vehicles, 2025 (millions)	Change
1	Toyota (Japan)	Toyota, Lexus, Daihatsu, Hino	11.32	+4.6%
2	Volkswagen (Germany)	Volkswagen, Audi, Skoda, Seat and Cupra, Porsche	8.98	-0.5%
3	Hyundai Motor Group (South Korea)	Hyundai, Kia, Genesis	7.27	+0.6%
4	GM (US)	Chevrolet, GMC, Buick, Cadillac	6.18	+3.0%
5	Stellantis (Netherlands)	Jeep, Ram, Peugeot, Fiat, Citroën, Opel	5.48	+1.3%
6	BYD (China)	BYD and its premium brands (Module 4)	4.60	+7.7%
7	SAIC (China)	MG, Roewe, and ventures with Volkswagen and GM	4.51	+12.3%
8	Ford (US)	Ford, Lincoln	4.40	-1.7%
9	Geely Holding (China)	Geely, Volvo Cars, Zeekr, Lynk & Co, Polestar	4.12	+26%
10	Honda (Japan)	Honda, Acura	3.52	-7.5%

Each group's own 2025 count, compiled by CarNewsChina (February 26, 2026) from company reports: sales for most, deliveries for Volkswagen, wholesales for Ford. Toyota's includes Daihatsu and Hino. GM's, Volkswagen's, and SAIC's include Chinese joint ventures, so some cars are counted twice.

Chinese brands built about 24.8 million light vehicles in 2025, about 26.5% of the world's, and about 1.1 million of them outside mainland China, by Mobility Global's count (January 2026). China's share of the world's output is larger than its brands' share because foreign makers build millions of cars in China, in joint ventures and in plants of their own, such as Tesla's in Shanghai. The gap between the two shares shows that part of China's industry still belongs to foreign companies.

1e. The Trade in Cars

China became the world's largest exporter of vehicles in 2023, passing Japan, and stayed first in 2025 (CnEVPost, May 13, 2026). By CAAM's count it exported 7.1 million vehicles in 2025, up 21.1%, and 8.205 million in January-September 2026, up 65.8%, more in nine months than in the whole of 2025. A customs-based count compiled by the CPCA gives 8.32 million for 2025, because it also counts cars registered in China and shipped abroad with almost no miles on them, which makers do not report as exports. In May 2026 He Yi, CAAM's deputy secretary-general, forecast exports of 10 million for 2026, and Module 4 covers what China exports and where it goes.

The other large exporters ship a steady share of what they build. Japan exported 4.17 million vehicles in 2025, down 1%, about half its output (SteelOrbis, March 9, 2026). South Korea exported 2.7 million, down 1.7%, though their value rose 2% to a record $72.0 billion, by its trade ministry's count. Germany exported about 3.2 million, by the count of Autopreneur, a German industry-data service, and Mexico sends most of its output to the US (Module 7). China's exports in 2025 were nearly as many as Japan's and Germany's combined, and its exports in the first nine months of 2026 already exceeded what those two countries exported in all of 2025.

Most cars that cross an ocean travel on car carriers, ships that vehicles drive on and off, and about 800 of them serve the trade. The largest carry about 9,000 cars and cost about $100 million each, and BYD, among others, now runs carriers of its own. Within a continent, cars travel by rail and by truck. Shipping a $30,000 car across an ocean costs about $700-1,500, so freight rarely decides where a car is built. Tariffs weigh far more, and the EU's duties on Chinese electric cars are Module 5's subject and America's tariffs Module 9's.

1f. The Market in 2026 and the Forecasts

Forecasts for 2026 have fallen all year. GlobalData, a London-based data company that counts light vehicles, expected 93.7 million in 2026 when it forecast in January, up 1.9%. It cut the forecast to 90.5 million in July, to 89.7 million in August, and to 88.3 million in September, a fall of 4.3% from 2025, although in August the world was buying at a rate of more than 91 million a year (*The Shop*, a trade magazine, September 25, 2026). Mobility Global, which also counts light vehicles, forecast 89.4 million in June, down 2.7%, after 90.5 million in April and about 91.8 million in January, and it expects a recovery to 91.6 million in 2027. Both forecasters put 2025's light-vehicle sales at about 92 million, so their figures cannot be set against OICA's totals. The January forecasts were made before the oil shock of 2026, and the later ones during it.

Two causes run through the cuts, and the first is China, where smaller tax breaks and subsidies for car buyers have shrunk the home market in 2026 (Module 4). In a forecast of June 15, 2026, Mobility Global expected Chinese sales of 25.38 million in 2026, down 7% on its own count; CPCA's retail count was down about 22% in January-September (Module 4). The second is the oil shock of 2026 (Module 6). Mobility Global assumed that Brent crude, the international benchmark price of oil, would peak at $126 a barrel in July and average $105 for the year, and on that assumption it estimated that dearer fuel would cost 511,000 sales worldwide by making cars less affordable, plus 194,000 in the Middle East directly.

For the US, Mobility Global expects about 16 million light vehicles in 2026 (Module 6) and little growth by 2030, below the pace before the pandemic (Module 12). Outside China, 2026 has been mixed: Europe's market has grown (Module 5), India's has boomed after a tax cut (Module 7), and America's has slipped (Module 6). China's surge of exports has absorbed part of the fall at home, so its makers' weak home

market reaches every market they can sell in. The forecasters' cuts are mostly cuts to China's own sales, not to the world's appetite for Chinese cars.

Worked example — The World's 96 Million Vehicles as 100

Shrink the 96.38 million vehicles built in 2025 to 100 by dividing each count by 96.38 million, and count three ways. Who builds them: China 36, the US 11, Japan 9, India 7, Germany, South Korea, and Mexico 4 each, and every other country together 25. By maker, the ten largest groups sold 60.4 million, the equivalent of 63 of the 100, though their totals count some joint-venture cars twice, and Chinese brands built about 26 of every 100 light vehicles. Who buys them: OICA's 99.8 million sales would be 104, but China's 7.1 million exports are counted twice. Taking them out leaves 92.7 million, about 96 of the 100: China 28.3, the rest of Asia, Oceania, and the Middle East 21.4, Europe 19.3, the US 17.3, and the rest of the Americas and Africa 9.9. The other 4 went into stocks, were still at sea, or are lost in the differences between national counts. What powers them: more than 20 million electric cars were sold (Module 8), about 21 of the 100. That is fewer than the quarter of new cars that Module 8 reports, because these 100 also include vans, trucks, and buses, and the other 79 or so ran mostly on gasoline or diesel, alone or in a hybrid. The result: China builds more than a third of the world's vehicles, buys more than a quarter, and sends the difference abroad.

Module 1 Key Points

The World’s Car Industry

• The world built 96.4 million vehicles in 2025, up 4%; China built 36%, more than the next five countries combined.

• OICA’s 99.8 million sales count China’s 7.1 million exports twice; counted once, sales were about 92.7 million.

• Toyota led with 11.32 million sales; BYD, SAIC, and Geely put three Chinese groups in the top ten.

• China, the largest exporter since 2023, shipped 8.205 million vehicles in January-September 2026, up 65.8%.

• GlobalData cut its 2026 forecast to 88.3 million light vehicles, down 4.3%, after China’s slump and the oil shock.

Module 1 Quiz

Check Your Understanding

1. What share of the world's vehicles did China build in 2025?

A) About 28%
B) Just over 40%
C) 36%
D) About 26.5%, the same as the share of the world's light vehicles built by Chinese brands

2. Why did OICA's count of vehicles sold in 2025 exceed the number built?

A) Heavy trucks are counted twice
B) China's exports count twice
C) Dealers cut stocks
D) It adds used cars sold in Europe and Japan

3. Why can the same car appear in the totals of two of the ten largest carmakers?

A) Because Ford counts its wholesales.
B) Because Toyota's total includes the vehicles that Daihatsu and Hino sell.
C) Because OICA adds every maker's exports to the sales of the country where the maker has its headquarters.
D) Because Volkswagen, GM, and their partner SAIC all count the ventures' cars.

4. How did China's vehicle exports change in January-September 2026?

A) They rose 65.8% to 8.205 million, more than China exported in all of 2025.
B) They rose 21.1% to 7.1 million.
C) They fell after Russia raised the fees on imported cars.
D) They held steady at about 4.2 million, level with Japan's.

5. What did GlobalData forecast in September 2026 for world light-vehicle sales in 2026?

A) It forecast a rise of 1.9%, to 93.7 million, as it had in January.
B) It forecast a fall of 2.7%, to 89.4 million, the figure it shared with Mobility Global.
C) It forecast a fall of 4.3%, to 88.3 million.
D) It forecast sales of 99.8 million, the same as OICA counted in 2025, as exports made up for China's slump at home.

Module 2 — Making a Car

The Plant, the Suppliers, and the Workers

Recommended Reading / Reference

Book: James P. Womack, Daniel T. Jones, and Daniel Roos, *The Machine That Changed the World* (1990), the Massachusetts Institute of Technology's study of the Toyota Production System, which named "lean production" and still explains how plants and suppliers work together

Reference: The Bureau of Labor Statistics page *Automotive Industry: Employment, Earnings, and Hours* (updated monthly), and the International Federation of Robotics' *World Robotics* (each September)

2a. From Design to Platform

A new model begins years before it reaches a showroom. McKinsey, the consultancy, found in August 2025 that Chinese electric-car makers take about 24 months from concept to launch, including the platform, against 40 to 50 months or more for long-established makers. A maker that needs four years has to guess what buyers will want, and what rules will apply, four years ahead, and a rival that needs two can answer it with a newer car.

Most of the engineering is shared. A **platform** is the engineering beneath a family of models: the floor, the mounting points for the suspension and for the engine or motors, and the electrical system, on which different bodies and interiors can be built. Volkswagen builds Volkswagens, Skodas, Seats, and Audis on shared platforms, and Toyota builds most of its range on its New Global Architecture. The more cars a platform carries, the less each one has to pay toward the cost of developing it.

That cost is large, and most of it is paid before the first car is sold. The only published estimate found is old: John Wolkonowicz, then of the research firm IHS Global, put a new vehicle at $1 billion or more, and over $6 billion with a new engine and gearbox, figures that a news report repeated in 2021. Module 3 shows why volume decides whether that money is earned back.

2b. The Plant

A car plant runs four main shops in sequence. In the stamping shop, presses cut and shape steel and aluminum sheet into doors, roofs, and floor panels, and in the body shop robots weld and bond the panels into the bare body. The paint shop cleans, coats, and bakes the body, and in final assembly workers along a moving line fit the engine or battery, the wiring, the seats, the glass, and the wheels. A car is made of more than 30,000 parts, by Toyota's count.

The speed of the line sets the plant's output. **Takt time** is the time the plant can give each car: the working time available divided by the number of cars to be built. Xiaomi's Beijing plant was built to make 40 cars an hour at full capacity, a takt time of 90 seconds (CarNewsChina, May 2024). On two eight-hour shifts for 235 days a year, that line would build about 150,000 cars, and a plant that runs fewer shifts or a slower line builds proportionally fewer.

Carmakers are among the largest buyers of industrial robots. The International Federation of Robotics (IFR) counted 603,307 robots installed worldwide in 2025, up 11%, bringing the number at work to about 5.08 million. The car industry installed 138,429 of them, a record and 22.9% of the total, but came second to electronics by about 3,800 robots (*World Robotics 2026*, September 2026). In the US it was still the largest

buyer, with 13,500 of the 38,400 robots installed. In 2024 South Korea had 1,220 robots for every 10,000 factory workers, Germany 449, Japan 446, the US 307, and Mexico 62.

New methods aim to cut the number of parts and steps. **Gigacasting** replaces dozens of stamped and welded parts with one large aluminum casting, made in a press of 6,000 tons or more. Tesla replaced 70 parts of the Model 3's rear structure with two castings in the Model Y, and by January 2021 with one. Xiaomi casts a rear floor that replaces 72 parts and 840 welds in a 9,100-ton press, and Toyota has shown a casting that turns 86 parts made in 33 steps into one. Tesla said in March 2023 that its "unboxed" method, which builds sections of a car side by side and joins them late, would cut production cost by half and factory space by 40%, figures that are Tesla's own.

2c. The Suppliers

A carmaker usually stamps, welds, paints, and assembles the car, and often makes its own engines, but it buys most of the rest. **Tier 1** suppliers sell finished systems, such as seats, brakes, or electronic controls, straight to carmakers. Tier 2 suppliers sell components to Tier 1 suppliers, and Tier 3 suppliers sell materials and simple parts to those above them. Suppliers provide about 77% of the value of a vehicle built in the US, Michael Haughey of North American Stamping Group, a parts maker, told the Senate Finance Committee in September 2018, the most recent such estimate found.

The largest suppliers are as large as mid-sized carmakers. The table lists the ten largest by 2025 sales to carmakers in Automotive News's ranking of 2026, which is behind a paywall, as reported by NetEase, a Chinese news site, on August 5, 2026. CATL, the Chinese battery maker, rose from fifth to third, a move that DigiTimes, a Taiwanese trade publication, also reported. The list includes 17 Chinese suppliers, counting those based in Hong Kong, the first time that China has outnumbered the US on it.

Rank	Supplier	Home	Main products	Sales to carmakers, 2025 ($ billion)
1	Bosch	Germany	Electronics, brakes, and powertrain parts	63.09
2	Denso	Japan	Electronics, heating and cooling, and powertrain parts	47.18
3	CATL	China	Batteries	44.06
4	Magna	Canada	Bodies, seats, and whole cars built for other makers	42.01
5	ZF	Germany	Transmissions, steering, and chassis parts	37.95
6	Hyundai Mobis	South Korea	Modules and parts, mainly for Hyundai and Kia	33.50
7	Aisin	Japan	Transmissions and body parts	32.62
8	Forvia	France	Seats, interiors, and electronics	28.44
9	Lear	US	Seats and electrical systems	23.26
10	Motherson	India	Wiring, mirrors, and bumpers	21.95

Automotive News, Top 100 Suppliers (2026 list, 2025 sales to carmakers), as reported by NetEase, August 5, 2026; the original is behind a paywall. Main products are this course's summary.

Most carmakers run on **just-in-time**, one of the two pillars of the Toyota Production System: making "only what is needed, when it is needed, and in the amount needed," in Toyota's words. Parts arrive hours before they are fitted, often in the order the cars come down the line, so the plant holds little stock and ties up little money in it. The other pillar, jidoka, lets any machine or worker stop the line when something goes wrong, so that faults are fixed where they start. Kiichiro Toyoda, who founded Toyota's car business, also stated the system's risk: "A complete car cannot be built if even one part is missing."

2d. The Shocks That Stop Lines

The shortage of 2021 showed how a small part can stop a large plant. When plants closed in early 2020, carmakers cancelled chip orders and chipmakers sold the capacity to makers of computers and phones, so when demand for cars returned the chips were not there. AlixPartners, a consultancy, estimated in September 2021 that the shortage would cost the industry 7.7 million vehicles of output and $210 billion of revenue that year, about double its May forecast of 3.9 million vehicles and $110 billion.

China's controls on rare earths showed the same weakness in a raw material. Rare earths are a group of 17 metals, some of which make the strong magnets in electric motors, from the small ones that move windows and seats to the motors that drive electric cars. From April 4, 2025, China required a license for each shipment of seven medium and heavy rare earths and the magnets made with them. Magnet exports fell about 75% and plants stopped in Asia, Europe, and the US, and Jim Farley, Ford's chief executive since October 2020, said in June 2025 that Ford had had to shut factories for lack of magnets (Reuters).

In October 2025 China announced wider controls, including a rule reaching foreign-made goods that contain Chinese rare earths. After the US-China truce of late October, its Commerce Ministry suspended them on November 7, 2025, originally to November 10, 2026, while the April 2025 licensing stayed in force. From December 2025 China also issued year-long licenses, and Ford said some of its suppliers had received them. The truce itself now runs to January 10, 2027 (Module 9), but as of mid-October 2026 its extension did not explicitly cover the rare-earth suspension (FXStreet, October 14, 2026).

Nexperia, a maker of basic chips based in the Netherlands and owned by China's Wingtech, was the next shock. On September 30, 2025, the Dutch government moved to take control of the company, and in October China blocked exports from Nexperia's Chinese plant, which made about half its output. Honda shut its plant in Mexico on October 28, 2025, and put the cost at 110,000 vehicles and about ¥150 billion, $949 million at today's exchange rate (the October 16, 2026 rates used for every dollar figure in this module).

China allowed exports again under exemptions after the US and Chinese presidents met in late October, and the Dutch suspended their order in November. Nexperia's Chinese unit then declared itself independent and switched to Chinese-made wafers, the silicon discs on which chips are made. On February 11, 2026, a Dutch court, the Amsterdam Enterprise Chamber, ordered a formal investigation of the company's management and kept its Chinese chief executive suspended, at a time when output was back to only about half its level before the crisis.

A fire can do the same. A fire at Novelis's aluminum plant in Oswego, New York, a supplier of the sheet for Ford's aluminum-bodied F-Series pickups, cost Ford $1.5-2.0 billion of 2025 profit by its estimate of October 2025, of which it expected to recover at least $1 billion in 2026. Aluminum shortages still cut the profit of Ford Pro, its commercial-vehicle business, by $0.6 billion in the second quarter of 2026.

The newest shock comes from the boom in artificial intelligence (AI). Data centers' demand has pushed up the price of dynamic random-access memory (DRAM), the chips that hold a computer's working data, about sixfold in a year, Morgan Stanley estimated in July 2026, and Nikkei reported the same rise for the grades that cars use. On GM's earnings call of July 21, 2026, Paul Jacobson, its chief financial officer, said its costs would rise $1.5-2 billion in 2026, mostly because of component prices, with DRAM above all. GM and Ford signed long-term supply deals with Micron, the American memory maker, in July 2026, and the CPCA said that shortages and price rises slowed the launch of new electric models in China in September 2026.

2e. America’s Car Workers and the UAW

In September 2026 the Bureau of Labor Statistics (BLS) counted 962,500 people making motor vehicles and parts in the US, a preliminary figure and about 7.6% of all factory jobs. That was 1,600 more than a year earlier and 11,500 above the low of 951,000 in December 2025, but 33,700 below October 2024. Parts makers employ far more people than the carmakers’ own plants, 516,600 against 297,400 in August 2026 before seasonal adjustment, and another 151,600 build truck bodies and trailers. The whole economy added 29,000 jobs in September 2026, and unemployment was 4.2%.

Production and nonsupervisory workers in the industry earned an average of $34.93 an hour in September 2026, $1.86 more than a year earlier. In August, those in vehicle assembly averaged $40.73 and those making parts $31.17. They worked an average of 46.2 hours a week in September, against 42.5 a year earlier, a sign of heavy overtime.

The United Auto Workers (UAW) struck GM, Ford, and Stellantis at once for the first time on September 15, 2023, and the strike lasted about six weeks. The contracts that ended it raised wages 25% over four and a half years, 11% of it at once, restored cost-of-living adjustments, cut the time to reach top pay from eight years to three, and gave the union the right to strike over plant closures. Members ratified them by 69.3% at Ford, 54.7% at GM, and 70.0% at Stellantis, and they expire on April 30, 2028.

John Lawler, then Ford’s chief financial officer, put the contract’s cost at $8.8 billion over its life, about $900 a vehicle by 2028, or 0.6 to 0.7 percentage points of profit margin, and the strike’s cost at $1.7 billion of profit (November 30, 2023). The carmakers’ own labor is about 7% of the cost of building a car, an estimate CNN published in November 2023 without naming its source. A large raise therefore moves a car’s cost less than a small rise in what the maker pays its suppliers (worked example).

Shawn Fain, the UAW’s president since March 2023, won about 68% in the preliminary count of the union’s October 2026 election, on a turnout of about a tenth of members, a result its court-appointed monitor had not yet certified in mid-October.

2f. The Workers Elsewhere

Most of the foreign carmakers’ American plants are in the South, in states whose right-to-work laws bar contracts that require workers to pay a union, and before April 2024 the UAW had never won a vote of a whole plant’s workers at one of them. Workers at Volkswagen’s plant in Chattanooga, Tennessee, voted for the union that month, while those at Mercedes-Benz’s plant in Alabama voted against it in May 2024. Volkswagen’s first contract, ratified by 96% in February 2026, raises pay 20% by its end in February 2030, when top rates reach $39.41 an hour for production workers and $49.86 for skilled trades, before cost-of-living adjustments. It also paid a $6,550 bonus on ratification, and Volkswagen committed to keep the plant open for the contract’s term.

Mexico’s car workers earn a fraction of American pay. The UAW puts Mexican auto pay at about $3 an hour, roughly a twelfth of the US average for production workers (Mexico Business News, July 20, 2026), and Rice University’s Baker Institute puts the gap for the same occupation at nearly ten times. Mexico’s minimum wage rose 13% on January 1, 2026, to 315.04 pesos a day, about $17.03. Employment in Mexico’s transport-equipment industries, which include cars and parts, was 5.9% lower in April 2026 than a year earlier, after falls in each earlier month of 2026 (Mexico’s national statistics institute).

For China, no current official figure for car workers’ pay was found, and the best guide is BYD, the country’s largest carmaker. It spent an average of about 147,000 yuan, about $22,000, per employee in 2025,

counting wages, bonuses, and social insurance, up from 124,000 yuan in 2024, by the calculation of the news site eletric-vehicles.com (April 6, 2026) from BYD's annual report. That average covers engineers and managers as well as assembly workers. An American production worker paid $34.93 an hour for 2,080 hours a year earns $72,654 in wages alone, more than three times as much.

Germany's car industry is shrinking. It cut about 50,000 jobs in 2025, more than any other German industry, out of about 124,000 lost across German manufacturing, and 111,000 since 2019, or 13% of its workforce, according to the accounting firm EY's analysis of official data for firms with 50 or more workers (February 17, 2026). In 2024, the German Association of the Automotive Industry (VDA) had counted 772,900 people in the industry, with the carmakers' employment flat and the suppliers' down 2% to 266,800, the fewest since 1997. Module 5 covers the carmakers' and suppliers' plans for further cuts.

Worked example — One Car's Cost, from Steel to the Showroom

Take an illustrative American-built SUV that sells for $42,000 in the showroom. The dealer keeps an assumed $2,000, so the carmaker receives $40,000. At GM's 2025 margin of 6.9% (Module 3), the maker's profit is $2,760, and its costs are the other $37,240. Suppliers provide about 77% of the vehicle's value, $30,800 of parts and materials. The steel in them is a small part of that: an assumed 900 kilograms at an assumed $1,000 a tonne costs $900, 2.9% of what the suppliers are paid, and the rest pays for their own materials, labor, machines, research, and profit. The carmaker's own labor, at about 7% of its $37,240 of costs, comes to $2,607. Warranty, set aside at GM's rate of 3.0% of sales in late 2025 (Module 3), takes $1,200. That leaves $2,633 for engineering, the wear on plants and tooling, freight, advertising, and overhead: $30,800 + $2,607 + $1,200 + $2,633 + $2,760 = $40,000. Now test the costs. A 10% rise in the parts bill adds $3,080, more than the whole $2,760 profit. A 10% raise for the maker's own workers adds $261, under a tenth of the profit, so the same percentage rise in parts costs about twelve times as much. The UAW contract's extra cost of about $900 a vehicle by 2028 would take a third of this car's profit if none of it were passed on to buyers. GM's $1.5-2 billion of extra component costs in 2026, spread over the 3.8 million vehicles it shipped in 2025 outside its Chinese ventures, comes to $395-526 a vehicle, a seventh to nearly a fifth of the profit. The lesson: a carmaker's margin depends more on what it pays its suppliers than on what it pays its own workers.

Module 2 Key Points

Making a Car

• Chinese electric-car makers take about 24 months from concept to launch, against 40 to 50 or more for older makers (McKinsey).

• Suppliers provide about 77% of a US-built vehicle’s value; Bosch, the largest, sold $63.09 billion to carmakers in 2025.

• Just-in-time keeps stocks low, so one missing part stops a line: AlixPartners estimated the 2021 chip shortage cost 7.7 million vehicles.

• China’s April 2025 rare-earth licensing still applies; its wider October 2025 controls were suspended, originally to November 10, 2026.

• US vehicle and parts plants employed 962,500 in September 2026, and their production workers averaged $34.93 an hour.

• The UAW’s 2023 contracts raised pay 25% to April 30, 2028; Ford put their cost at about $900 a vehicle.

Module 2 Quiz

Check Your Understanding

1. About what share of the value of a vehicle built in the US do suppliers provide?

A) Two-thirds
B) Roughly 77%
C) Half
D) About 7%, because carmakers make most of their own parts and buy only raw materials

2. What happened to the wider rare-earth controls that China announced in October 2025?

A) They were lifted for good
B) They took effect on January 10, 2027
C) The Dutch government suspended them
D) China suspended them in November 2025, originally to November 10, 2026, while its April 2025 licensing stayed in force

3. By the estimate this module cites, what share of the cost of building a car is the carmaker's own labor?

A) About 7%
B) 77%
C) About a quarter
D) About 40%, more than parts

4. What did AlixPartners estimate in September 2021 that the chip shortage would cost the industry that year?

A) 3.9 million vehicles
B) 7.7 million vehicles and $210 billion
C) $110 billion
D) 11 million vehicles, about a fifth of world output, as nearly every plant closed for months

5. In the worked example, why does a 10% rise in parts prices hurt the carmaker more than a 10% raise for its own workers?

A) Because the UAW contract caps raises at 11%.
B) Because suppliers can raise prices at any time, while wages are fixed until 2028.
C) Because steel, the largest single cost, makes up most of the parts bill.
D) Because parts and materials are about 77% of the maker's revenue and its own labor only about 7% of its costs, so the same rise costs about twelve times as much.

Module 3 — The Money

Why Carmakers Earn So Little

Recommended Reading / Reference

Book: Steven Rattner, *Overhaul: An Insider's Account of the Obama Administration's Emergency Rescue of the Auto Industry* (2010), by the financier who led the government's auto task force in 2009, on how GM and Chrysler went bankrupt and were rebuilt

Reference: The carmakers' annual reports and quarterly results releases, and *Warranty Week*'s annual comparison of warranty costs, the sources for the margins, write-downs, and warranty rates here

3a. How a Carmaker Makes Money

A carmaker earns most of its revenue by selling vehicles to dealers and fleets, and it books each sale when the vehicle leaves for the dealer, not when a customer drives it away. Ford's three vehicle businesses took in $174.0 billion in 2025, about $39,600 for each vehicle they shipped. Out of that money come the parts, the plants, the engineers, the warranty repairs, and the advertising, and what is left is the operating profit. Makers also sell replacement parts through their dealers for as long as a car stays on the road.

Operating margin is operating profit divided by revenue, the share of each dollar of sales left after the costs of running the business, before interest and taxes. EBIT, earnings before interest and taxes, is close to it. Carmakers also publish "adjusted" measures that leave out **special items**, such as write-downs of assets, restructuring costs, and legal settlements. The adjusted figure shows what the ongoing business earns and the net result what shareholders actually earned, and in 2025 the two differed by billions (section 3f).

Most large carmakers own a lender, a **captive finance arm**, that makes loans and leases to buyers and lends dealers the money to pay for the cars on their lots. GM Financial earned $2.802 billion before taxes in 2025 on revenue of $17.06 billion, and it held $126.5 billion of loans, leases, and other earning assets at the end of the year. Ford Credit earned $2.557 billion before taxes, more than a third of Ford's adjusted EBIT, a figure that includes the lender's earnings, while GM Financial's came to about a fifth of GM's EBIT-adjusted. A captive lender also helps sell cars, because the maker can pay it to offer low interest rates instead of cutting the price.

3b. The Margins of 2025

The table compares 14 makers' latest full years, each on its own measure, and few earned much. Only four, Kia, Toyota, GM, and Hyundai, earned more than 6%, and Toyota's margin fell by about a quarter as US tariffs cut its profit (Module 9). Tesla, whose margin was 7.2% in 2024, earned less on its sales in 2025 than BMW's car business, and BYD's net margin equaled China's industry average (Module 4).

Maker (fiscal year)	Revenue	Operating margin (measure)	Net result
Kia (2025)	114.1 trillion won ($85.5 billion)	8.0% (operating)	7.6 trillion won
Toyota (year to March 2026)	¥50.68 trillion ($320.8 billion)	7.4% (operating; 10.0% a year earlier)	¥3.85 trillion
GM (2025)	$185.0 billion	6.9% (EBIT-adjusted)	$2.697 billion
Hyundai Motor (2025)	186.3 trillion won ($139.7 billion)	6.2% (operating)	10.36 trillion won
BMW (2025)	€133.5 billion ($149.9 billion)	5.3% (automotive EBIT)	€7.45 billion

Maker (fiscal year)	Revenue	Operating margin (measure)	Net result
Mercedes-Benz (2025)	€132.2 billion ($148.5 billion)	5.0% (Cars, adjusted); 4.4% (group EBIT)	€5.3 billion
Tesla (2025)	$94.8 billion	4.6% (operating)	$3.8 billion
BYD (2025)	Module 4	4.1% (net)	Module 4
Ford (2025)	$187.3 billion	3.6% (adjusted EBIT)	-$8.182 billion
Volkswagen (2025)	€321.9 billion ($361.5 billion)	2.8% (operating)	€6.9 billion
Porsche AG (2025)	€36.27 billion ($40.7 billion)	1.1% (return on sales; 14.1% in 2024)	€310 million
Nissan (year to March 2026)	About ¥12.0 trillion ($75.9 billion)	0.5% (operating)	Loss (Module 7)
Stellantis (2025)	€153.5 billion ($172.4 billion)	-0.5% (adjusted operating)	-€22.3 billion
Honda (year to March 2026)	¥21.8 trillion ($138.0 billion)	-1.9% (operating)	-¥423.9 billion

Company results releases and filings. Dollar figures at October 16, 2026 exchange rates, a simplification for results earned in 2025 and early 2026. Margins are each company's own measure; "adjusted" measures leave out special items, and GM's and Ford's include their lending arms. Porsche AG is part of Volkswagen. BYD's revenue and profit are in Module 4, and Nissan's net loss in Module 7.

Four of the 14 lost money on the bottom line. Ford, Stellantis, and Honda lost it mostly through charges for electric-car plans they had cut back (section 3f), and Nissan through the cost of its restructuring (Module 7). Ford earned an adjusted margin in the same year that it lost money overall, the gap between the two measures that section 3a describes. In money rather than margins, Toyota stood apart: its net income, about $24.4 billion at today's exchange rates, was more than Volkswagen's, BMW's, and GM's combined.

3c. Why Margins Are Thin

Carmaking ties up a great deal of capital for the profit it earns. Volkswagen spent 6.7% of its automotive revenue on research and development (R&D) in 2025, €19.4 billion, and 11.8% on R&D and plant investment together, and it expected 11-12% in 2026. BYD spent 63.4 billion yuan on R&D, 7.9% of its revenue. A maker that spends a tenth of its revenue on the future and earns a twentieth of it as profit has little room for error.

Most of the costs are fixed: a plant, its tooling, and its engineers cost nearly the same whether the plant runs one shift or two. **Capacity utilization**, the share of a plant's capacity actually used, therefore decides profit. By the Harbour standard, long used in the industry, a plant's capacity is two eight-hour shifts on 235 days a year, and a plant typically breaks even at 70-80% of it. Stellantis said in February 2022 that its break-even point had fallen below 50% of capacity in 2021, under Carlos Tavares, then its chief executive. Boston Consulting Group (BCG) treats average utilization of about 80% as the benchmark for a network of plants to pay its way (June 2026), and Europe's makers fall well short of it (Module 5).

Fixed costs also make profits swing with sales. Take a maker whose fixed costs equal a quarter of its revenue and whose margin is 5%. Each car it sells contributes 30% of its price toward fixed costs and profit, so a fall in sales of one-sixth wipes out the profit, and a deeper fall turns it into a loss. Car sales fall hard in recessions, because owners can keep driving the cars they have, as GM and Chrysler found in 2009 (section 3f).

Warranty takes a further slice. Carmakers set aside part of each sale for future repairs under warranty, and Ford's accrual rate, the share of its product sales set aside, reached 4.0% in the fourth quarter of 2025, against GM's 3.0% and Tesla's 3.2% (*Warranty Week*, March 12, 2026). That was more than Ford's

adjusted margin. Ford paid $5.73 billion in warranty claims in 2025, more than GM's $5.32 billion, and GM added $3.25 billion to its estimates for vehicles sold before 2025.

3d. Where the Profit Is

The profit is in big vehicles. In 2018 GM told investors that its large pickups earned at least $17,000 a vehicle before tax (Reuters, January 2019). No newer figure has been found, so it shows the scale of the profit, not its level today.

Ford's segments show the same pattern. Dividing each segment's 2025 EBIT by the vehicles it shipped gives about $4,600 a vehicle for Ford Pro, which sells vans, pickups, and services to businesses and governments, at a margin of 10.3%. Ford Blue, its gasoline and hybrid business for retail buyers, earned about $1,100 a vehicle in 2025, a year of tariffs (Module 9) and the Novelis fire (Module 2), at a margin of 3.0%, down from about $3,000 a vehicle in the first nine months of 2023. Model e, Ford's electric business, lost about $27,000 on every vehicle, against about $48,600 in 2024.

Small cars cost almost as much to build as big ones but sell for far less. A compact needs much the same engine controls, airbags, electronics, and assembly steps as a pickup, and its development cost is spread over fewer, cheaper vehicles (worked example). Reuters reported in January 2019 that many Detroit sedans had become so unprofitable that their makers stopped building them. The American makers now earn most of their profit on pickups and SUVs sold in North America, behind the tariff walls that Module 9 describes.

3e. The Market's Verdict

A share price puts a value on a company's expected future profits, and its market value is that price times the number of its shares. On October 16, 2026, investors valued Tesla at more than one and a half times the other 13 makers in the table combined, whose values summed to about $909 billion. That was about 370 times Tesla's 2025 net income, against about 9 times for Toyota's, a valuation that rests more on profits Tesla has not yet earned, from driverless taxis and software (Module 11), energy storage (Module 6), and robots, than on the cars it sells.

Maker	Market value, October 16, 2026 ($ billion)	Change since December 31, 2025
Tesla	1,400	-6%
Toyota	229.2	-18%
BYD	114.5	-12%
Xiaomi (whole company)	88.3	-33%
GM	73.7	-5%
Ferrari	69.7	+6%
Hyundai Motor	63.1	—
Ford	49.6	—
Honda	44.5	—
Mercedes-Benz	43.8	-36%
Porsche AG	43.1	—
Volkswagen	38.7	-38%
BMW	38.4	-42%

Maker	Market value, October 16, 2026 ($ billion)	Change since December 31, 2025
Stellantis	12.7	—

Values at the close of October 16, 2026, as listed by companiesmarketcap.com on October 18. Changes against values for December 31, 2025 compiled by CLS, a Chinese financial news service (via CarNewsChina, January 5, 2026), whose list gave only the ten largest (— marks a maker not in it). The two sources may count share classes differently, so the changes are approximate. Volkswagen owns most of Porsche AG.

The older makers are priced for shrinking profits. Stellantis was worth about half of its 2025 net loss at today's exchange rates, and of the makers whose change is shown, the German ones have fallen furthest since the end of 2025, as their profits fell in China and the US (Module 5). Ferrari, which makes few cars at high prices, was the only one of them whose value rose.

3f. When It Goes Wrong

Thin margins leave little to fall back on in a crisis. In the recession of 2008-09 Chrysler filed for bankruptcy on April 30, 2009, and GM on June 1. Both came out within weeks, after their main assets were sold to new companies, Chrysler's to one managed by Fiat and GM's to one majority-owned by the US Treasury. The Treasury's rescue, part of the Troubled Asset Relief Program, also covered GMAC, GM's former lending arm, now Ally Financial. It paid out $79.7 billion and had recovered $70.4 billion by December 2014, when it sold its last shares, a loss of about $9.3 billion (Treasury, via PolitiFact).

The industry's latest losses came from electric-car plans. Ford announced about $19.5 billion of charges on December 15, 2025, when it cancelled electric models and left its battery venture (Module 6 describes the decisions). Most fell in the fourth quarter of 2025, whose special items of $15.5 billion included $10.7 billion for **writing down** Model e's assets, cutting their value in Ford's accounts to what they are now expected to earn, and for cancelling electric programs. They also included $3.2 billion for leaving the battery venture, BlueOval SK, and $0.8 billion for cancelling a three-row electric SUV, and about $9.4 billion of the charges used no cash. Another $4.2 billion of special items followed in the second quarter of 2026, $3.6 billion of it for the battery venture. Model e lost $4.806 billion in 2025 on revenue of $6.7 billion, and $1.696 billion more in the first half of 2026.

GM took $7.914 billion of charges for what it calls its "EV strategic realignment" in 2025. They included $1.6 billion in the third quarter, tied to turning its Orion plant over to gasoline trucks, and $5.992 billion in the fourth, $4.2 billion of it paid in cash to settle with suppliers and cancel contracts. Another $3.356 billion followed in the first half of 2026 and $238 million in the third quarter, about $11.5 billion in all. Paul Jacobson, GM's chief financial officer, said in January 2026 that GM had "not impaired our existing retail portfolio of EVs": the charges were for capacity and contracts, not for the cars it sells.

Honda counted ¥1.45 trillion of electric-car losses in its year to March 2026, more than $9 billion, which turned its year into a loss. It expects about ¥500 billion more in the year to March 2027, and it warned in March 2026 that the total could reach ¥2.5 trillion. Stellantis booked €25.4 billion of unusual charges for 2025, about €22.2 billion of them from the "reset" of its product plans that it announced on February 6, 2026, which covered its electric supply chain, warranty provisions, and European job cuts, and it suspended its 2026 dividend.

Added together at today's exchange rates, and counting the whole of Stellantis's reset, the four companies' charges come to about $65 billion since the third quarter of 2025. That is more than Ford and Stellantis together were worth on October 16, 2026.

3g. Should the Older Makers Keep Spending on Electric Cars? The Cases as Their Advocates Make Them

The case for cutting back: Its advocates, among them the makers that have retreated, argue that the money went into electric cars that American buyers would not pay for once the federal credit ended on September 30, 2025 (Module 10) and the emissions rules loosened. Every electric vehicle Ford sold lost money, and the write-downs measure capital that earned nothing. Hybrids, they argue, cut fuel use now and earn a profit. A maker that waits can buy batteries and software later, more cheaply, from partners such as Leapmotor, the Chinese maker in which Stellantis owns a stake.

The case for staying the course: Its advocates argue that electric cars keep gaining wherever prices and charging allow. They are now most of the new cars sold at retail in China (Module 4), their share keeps rising in Europe (Module 5), and world sales grew again in 2026 (Module 8). Volkswagen blamed part of its September 2026 profit warning on demand for battery-electric cars rising faster than it had planned (Module 5). The cost of each electric car falls as volume grows, and the oil shock of 2026 has raised the cost of driving on gasoline (Module 6). A maker that stops now, they argue, will meet Chinese rivals with a cost lead in every market outside the walls of Module 9, and will end up buying the technology from them.

What the evidence says: The losses are real, and they come mostly from scale and timing. Ford's electric vehicles cost it about $64,600 each to build and sell in 2025, down from about $85,800 in 2024 as its volume rose 70%, while its revenue held at about $37,000-38,000 a vehicle. GM's charges paid for factories and supplier contracts sized for American demand that did not come after the credit ended, not for the cars themselves. The specialists' thin margins (section 3b) show that electric cars are not yet a better business than gasoline ones, only a growing one. Toyota, whose sales are mostly gasoline cars and hybrids (Module 7), kept one of the highest margins in section 3b's table, while Honda's electric-car losses exceeded its whole operating profit of the year before. Demand differs by market: American buyers turned away from electric cars after the credit ended, Europe's bought more of them, and China's, though they bought fewer cars in all, bought a record share (Modules 4 and 8).

The course's reading, stated once: The evidence supports cutting back, not stopping. The money was lost on factories built ahead of an American demand that policy then removed, while the cost of each electric car fell as volume grew, the pattern of a young business rather than a failed one. The makers that keep developing cheaper electric cars on shared platforms, while hybrids and trucks pay the bills, keep the option to compete when Chinese rivals reach their markets. Those that stop are betting that the walls of Module 9 will stand for as long as the cars they now sell, and whether the time the walls buy is used is the question the decade will answer.

Worked example — The Profit on a Pickup, a Compact, and an Electric SUV

Every number here is an illustrative assumption, not any maker's figure, and each price is what the dealer pays. A pickup sells for $58,000. Its parts and materials cost $33,000, labor $2,800, warranty at 3% of the price $1,740, and freight and selling $2,500, which leaves $17,960 toward fixed costs. Its program costs $6 billion to develop and tool, spread over six years at 700,000 a year, or 4.2 million trucks, which comes to $1,429 a truck. Profit: $16,531 a truck, 28.5% of the price, close to GM's 2018 figure (section 3d). A compact sells for $24,000: parts $17,500, labor $2,000, warranty $720, and freight and selling $1,500, leaving $2,280. Its $1.5 billion program over six years at 200,000 a year adds $1,250 a car, for a profit of $1,030, 4.3% of the price and a sixteenth of the pickup's. An electric SUV sells for $45,000: parts $34,000, of which an assumed $9,000 is the battery, labor $2,400, warranty at 3.2% $1,440, and freight and selling $2,000, leaving $5,160. Its $4 billion program at 60,000 a year for six years adds $11,111 a vehicle, for a loss of $5,951 on each one. At 250,000 a year the program cost falls to $2,667 a vehicle and the SUV earns $2,493, 5.5% of its price, and it breaks even at about 129,000 a year ($4 billion divided by $5,160, over six years). The pickup pays because its price is high and its volume large, the compact barely pays at any volume, and the electric SUV's result turns on how many are sold.

Module 3 Key Points

The Money

• Most large makers earned operating margins of 2-8% in 2025; Toyota’s fell to 7.4% from 10.0% as US tariffs bit.

• Captive lenders matter: Ford Credit earned $2.557 billion before tax in 2025, more than a third of Ford’s adjusted EBIT.

• Fixed costs make volume decisive: on the Harbour standard, a plant typically breaks even at 70-80% of capacity.

• Ford’s 2025 profit per vehicle: about $4,600 at Ford Pro, $1,100 at Ford Blue, and a $27,000 loss at Model e.

• On October 16, 2026, Tesla was worth $1.40 trillion, more than 13 other large makers combined ($909 billion).

• Electric write-downs at Ford, GM, Honda, and Stellantis total about $65 billion; the course reads them as reason to cut back, not stop.

Module 3 Quiz

Check Your Understanding

1. How much did Ford Credit earn before taxes in 2025?

A) $2.557 billion
B) $6.8 billion, all of Ford's adjusted EBIT
C) About $17 billion
D) About $1 billion, a third of what GM Financial earned

2. By the Harbour standard, at what share of its capacity does a car plant typically break even?

A) Below 50%, as Stellantis says of all its plants
B) 59%
C) 70-80%
D) Nearly 100%

3. Why did Ford's Model e lose less per vehicle in 2025 than in 2024?

A) Its prices rose
B) Its volume rose 70%, so its cost per vehicle fell while its revenue per vehicle held steady
C) Tariffs on its rivals' imports
D) It sold only pickups

4. How much did the Treasury lose on its rescue of the car industry, by its accounting of December 2014?

A) $79.7 billion, the whole amount it paid out
B) It earned $1.3 billion, the price of its last Ally shares
C) $70.4 billion
D) About $9.3 billion

5. What is the course's reading of whether the older makers should keep spending on electric cars?

A) Cut back, but keep developing cheaper electric cars
B) Stop now and rely on hybrids
C) Spend more than ever
D) Keep every plant and model planned before 2025, because the federal credit will return and American demand will recover by 2027

Module 4 — China

How It Won the Electric Car

Recommended Reading / Reference

Book: Michael J. Dunne, *American Wheels, Chinese Roads: The Story of General Motors in China* (2011), an insider's account of the joint ventures through which foreign carmakers built China's industry

Reference: CAAM's monthly sales and export figures and CPCA's retail data, reported in English by CnEVPost and Gasgoo

4a. From Joint Ventures to the Electric Bet

For three decades China built its car industry with foreign help on its own terms: from the mid-1990s a foreign carmaker could build cars there only through a joint venture with a Chinese partner, usually a state-owned group, and could own no more than half of it. Volkswagen paired with SAIC, the Shanghai city group, and with FAW in Changchun, while GM paired with SAIC, Toyota with FAW and with GAC of Guangzhou, and Honda and Nissan with Dongfeng of Wuhan. The foreign partners brought models, plants, and methods, and the two sides split the profits.

The joint ventures taught Chinese engineers to build gasoline cars, but Chinese brands stayed behind in engines and gearboxes, where the foreign makers had decades of lead. Electric cars offered a way around, because a battery-electric car has no engine or gearbox, and its costliest part, the battery, is a chemistry that Chinese companies could master. The government adopted that reasoning as policy.

The state backed the bet with money, starting in 2009 with a program that put electric buses and taxis into city fleets. Rebates for private buyers followed, and from September 2014 an exemption from the 10% purchase tax that Chinese buyers pay on a car. The Center for Strategic and International Studies (CSIS), a Washington research group, estimates that government support for electric vehicles totaled $230.9 billion from 2009 to 2023, a figure it calls conservative, and rebates and the tax exemption made up the vast majority of it (Scott Kennedy, June 2024). The national rebate was cut in 2022 and ended in 2023, while the tax exemption continued (section 4e).

The ownership rule then ended: China lifted the 50% cap for makers of new-energy vehicles in 2018, which let Tesla build its Shanghai plant without a partner, and for all passenger-car makers in 2022. Since then the joint ventures have lost ground to Chinese brands, and their plants run well below capacity (section 4d).

4b. BYD

BYD, the clearest case of the bet paying off, was started in Shenzhen in 1995 by Wang Chuanfu, its founder and chairman, as a maker of rechargeable batteries for phones, and it bought a small carmaker, Qinchuan, in 2003. It makes most of what goes into its cars itself: the lithium iron phosphate (LFP) "Blade" batteries, the power chips that run its motors, and many other parts. It stopped making cars powered only by gasoline in 2022.

In 2025 BYD sold 4,602,436 vehicles, up 7.7%, all of them NEVs, and of its passenger cars 2,256,714 were battery-electric, up 27.9%, and 2,288,709 plug-in hybrids, down 7.9%. Its battery-electric total beat Tesla's 1,636,129 deliveries by 620,585, the first full year in which BYD sold more battery-electric cars than Tesla, and it sold 1,046,083 vehicles abroad, up 151% and 22.7% of its total.

Profits did not keep pace with sales: revenue rose 3.5% to 803.97 billion yuan ($120.2 billion at October 16, 2026 exchange rates, the rates used for every dollar figure in this module), while net profit fell 19% to 32.62 billion yuan ($4.88 billion), its first fall in five years. That is a net margin of about 4.1%, the same as the industry's (section 4d), with a gross margin, the share of revenue left after the direct cost of building, of 20.49% on its cars. Overseas revenue, which includes electronics sold abroad, was 310.7 billion yuan, 38.7% of the total.

In 2026 BYD has struggled at home and grown abroad: it sold 3,131,576 vehicles in January-September, down 4%, of which 1,337,831, or 42.7%, went abroad, while its home sales fell 32.7% in January-August. Its target for the year is 5.0-5.5 million vehicles, which even at the low end would need 1.87 million in the fourth quarter, about 623,000 a month, against 463,561 in September.

BYD builds abroad where markets tax imports: its plant at Rayong, Thailand, opened on July 4, 2024, with room for 150,000 cars a year. A joint venture at Jizzakh, Uzbekistan, was assembling cars by June 2024, with a first stage of 50,000 a year. At Camaçari, Brazil, on a site Ford left in 2021, BYD inaugurated a 5.5 billion reais ($1.08 billion) complex on October 9, 2025, which assembles semi-knocked-down kits, cars shipped part-built, with a first stage of 150,000 a year. Its plant at Subang, Indonesia, opened on September 3, 2026, while a plant at Manisa, Turkey, announced in 2024, was put on hold in June 2026 before construction began. Module 5 covers its car plant in Hungary.

4c. The Other Makers

China had 129 car brands on sale in 2025, down from a peak of 132 in 2023-24, and the five largest held about 40% of sales, against 32% in 2021 (Euromonitor). The state groups, SAIC, FAW, Dongfeng, Changan of Chongqing, and GAC, own the joint ventures as well as brands of their own, and Chery is owned by the city of Wuhu. The private groups, BYD, Geely, and Great Wall, built their own brands rather than foreign ones, and the newcomers, from Nio, Xpeng, and Li Auto to Leapmotor and the phone maker Xiaomi, entered in the 2010s and 2020s.

Two other Chinese groups are in the world's top ten (Module 1). Geely, controlled by its founder, Li Shufu, bought Volvo Cars from Ford in 2010 and owns the Zeekr and Lynk & Co brands, and NEVs were 56% of its sales in 2025. SAIC, owned by the Shanghai government, builds cars with Volkswagen and GM and sells its own MG brand abroad. Chery sold more than 2.8 million vehicles in 2025, about 1.3 million of them abroad (Caixin).

Two technology companies have joined the industry in different ways: Xiaomi builds its own cars, the SU7 sedan and the YU7 SUV, in its own plant in Beijing, while Huawei builds no cars at all. Huawei supplies software, driver-assistance systems, and its shops to the Harmony Intelligent Mobility Alliance (HIMA), whose brands are built by Seres, Chery, BAIC, JAC, and SAIC, and which delivered 589,107 cars in 2025, up 32%. Huawei takes about a tenth of each car's price for licensing and sales (36Kr, a Chinese business publisher).

The table shows how unevenly profit is spread, with a few newcomers reaching their first profits while state groups slipped into loss. Stellantis bought about 21% of Leapmotor in 2023 and sells its cars outside China (Module 5), and its stake fell to 18.99% when FAW, a state group, invested 3.74 billion yuan in December 2025. The consultancy AlixPartners expects only 15 of the 129 brands to be financially viable by 2030.

Maker	Owner	2025 result
Leapmotor	Private; Stellantis 18.99%	Deliveries doubled to 596,555; first annual net profit, 540 million yuan

Maker	Owner	2025 result
Xiaomi (cars)	Private phone and electronics maker	Deliveries tripled to 411,082; first operating profit, 0.9 billion yuan; a loss of 2.6 billion yuan in the second quarter of 2026
Voyah	Dongfeng (state); listed March 19, 2026	First net profit, 1.02 billion yuan, less than its 1.08 billion yuan of subsidies
GAC	Guangzhou city (state)	First annual loss since listing, 8.8 billion yuan
Changan	Central government (state)	Net profit down 44%
Geely	Private (Li Shufu)	Net profit flat
Neta	Private start-up	Bankruptcy reorganization from June 2025; sales peaked at about 152,000 in 2022

CnEVPost (Leapmotor, Xiaomi, March 2026); Xiaomi's call of August 18, 2026; Gasgoo (Voyah, March 20, 2026); Caixin, April 15, 2026 (GAC, Changan, Geely); CarNewsChina (Neta).

4d. The Price War and Overcapacity

With more plants than buyers, China's makers have cut prices since early 2023, and on about May 23, 2025, BYD cut prices on 22 models by up to 34%. Its smallest car, the Seagull, fell 20% to 55,800 yuan, and dealers then held about 3.5 million unsold cars of all brands, 57 days of sales (Bloomberg). Over 2025, 177 models cut their official prices, the average price of NEVs fell 11%, and 52.6% of dealers lost money in the first half (36Kr).

The government calls this "involution", its word for competition so fierce that no one gains from it, and moved against it in mid-2025. In June 2025 the *People's Daily*, the Communist Party's newspaper, said a price war would have "no winners". Revised rules requiring large companies to pay small suppliers within 60 days of delivery took effect on June 1, 2025. On June 10-11, BYD, FAW, Geely, Chery, and Seres pledged to pay within 60 days, and within days 17 makers had pledged. In February 2026 the State Administration for Market Regulation banned selling cars or parts below cost to drive out rivals, except to clear old stock.

How much spare capacity China has depends on how it is measured, and the research institute of Gasgoo, a Shanghai industry publisher, counts nameplate capacity, what the plants were approved and built to make. On that count the industry could build 55.5 million vehicles a year in 2024 and used 49.5% of it (Bloomberg, June 19, 2025). The National Bureau of Statistics (NBS) instead surveys companies and compares the value of their output with the value they could produce. On its measure the car industry used 73.2% of its capacity in 2025 and 70.6% in the first half of 2026, against a "healthy line" of 75% often cited in China. Neither measure is wrong: one counts what was built, the other what companies report they can run.

Averages hide the spread: in 2025 Great Wall's plant at Jingmen ran at 216% of its nameplate capacity while its plant at Tianjin ran at 16%, and the SAIC-Volkswagen plant built for Volkswagen's electric cars ran at 14% (annual reports compiled by Hello China Tech). The joint-venture plants ran at 40% to 60%, and the weakest makers below 10% (36Kr). The strongest makers are short of capacity while their weakest rivals keep plants open.

The price war has squeezed the whole industry's profit: China's car industry earned 461 billion yuan ($68.9 billion) on revenue of 11.18 trillion yuan in 2025, a margin of 4.1%, a record low, against 4.3% in 2024. That is about 13,400 yuan ($2,000) per vehicle sold, and in December 2025 alone the margin was 1.8% (Cui Dongshu, CPCA's secretary-general, from official data). In January-August 2026 profit fell 16% to 253.4 billion yuan, a margin of 3.6%. China's listed parts makers earned a net margin of 6.1% in the first half of 2025, more than the carmakers they supply (36Kr).

4e. 2026: The Turn Abroad

In 2026 China's home market shrank while its exports surged: retail sales of passenger cars, CPCA's count of cars sold to buyers in China, fell 21.7% to 13.33 million in January-September 2026 and 28.0% in September alone, and from October 1 to 11 they were 24% below a year earlier. CAAM's count of total sales, which includes exports (Module 1), fell only 4.5% to 23.271 million in January-September, and the home sales it implies fell about 22%. CPCA blamed a high base, since local subsidies had lifted September 2025, along with fuel prices and the shortage of memory chips caused by demand from data centers (Module 2).

Two policy changes did much of the damage, the first being the halving on January 1, 2026 of the purchase-tax exemption, worth up to 30,000 yuan a car in 2024-25. NEVs now pay 5% of the price before value-added tax (VAT), with the relief capped at 15,000 yuan, through 2027, and plug-in hybrids and EREVs qualify only with at least 100 km of electric range. The national trade-in subsidy became a share of the price instead of a fixed sum. A buyer who scraps an old car and buys an NEV gets 12% of the price, capped at 20,000 yuan, and one who trades in without scrapping gets 8%, capped at 15,000 yuan. In 2025 those buyers got a flat 20,000 and 15,000 yuan, so cheap cars now get less. The central budget for all consumer trade-ins fell to 250 billion yuan in 2026 from 300 billion yuan in 2025.

NEVs have kept gaining share as the market shrank, and they were 47.9% of all vehicles sold in 2025, 16.49 million, on CAAM's count, which includes exports and commercial vehicles, and more than half of sales at home. In September 2026 they were a record 61.6% of CAAM's count and a record 67.0% of CPCA's domestic retail sales of passenger cars. NEV retail sales fell 16.7% in September, but gasoline cars fell faster, and within NEVs plug-in hybrids fell 35.6%, against 7.4% for battery-electric cars (CPCA).

Exports took up the slack, absorbing 35.3% of China's vehicle output in January-August 2026, against about a fifth in 2025 (Ministry of Industry and Information Technology). NEV exports doubled to 2.62 million in 2025, 1.65 million of them battery-electric and 969,000 plug-in hybrids, on CAAM's count. They reached 4.006 million in January-September 2026, 2.3 times a year earlier and 32.1% of NEV output, against about 16% in 2025.

Destination, 2025	All vehicles (customs count)	Passenger NEVs (Gasgoo)
Mexico	625,187	174,493
Russia	582,738	Not in the top seven
United Arab Emirates	571,937	187,603
United Kingdom	335,551	224,542
Brazil	322,076	190,378
Belgium (a port of entry for Europe)	300,103	277,857
Indonesia	Not in the top eight	118,111 (up 172%)
Thailand	Not in the top eight	111,162 (up 57%)

All vehicles: China's customs data compiled by CPCA (CarNewsChina, January 25, 2026), a broader count than CAAM's, because it includes new cars registered in China and exported as used. Passenger NEVs: Gasgoo Research, February 11, 2026.

Mexico was the largest destination for China's vehicles in 2025, by the customs count. Exports of passenger cars to Russia, second on that count, fell 46.1% in 2025 (Gasgoo) after Russia raised its fee on imported cars (Module 7). Beijing has also started to manage the flow: from January 1, 2026, exporters of battery-electric passenger cars need a license, a rule the Ministry of Commerce announced on September 26, 2025 to curb exports by unauthorized traders that left buyers without service. Exporters of NEVs now get back the full 13% VAT on cars they sell abroad, and from April 1, 2027 they will get back 9% (Benchmark

Mineral Intelligence, October 16, 2026). Abroad the cars meet walls: duties in Europe (Module 5) and tariffs in the United States, Mexico, Canada, Brazil, and Turkey (Module 9).

4f. A Model of Efficiency, or Overcapacity Fed by Subsidies? The Cases as Their Advocates Make Them

The case that China's industry is a model of efficiency: Edward Tse, founder of the consultancy Gao Feng Advisory, argues that China's leading makers run their plants at more than 90% of capacity, and that world demand for electric cars exceeded China's electric-car output (*China Daily*, July 18, 2025). Chinese commentators add that official utilization of 70-73% is close to American levels, and that battery costs have fallen by more than 60% since 2018 (36Kr, September 20, 2026). They read foreign tariffs as proof that Chinese cars compete, not that they are dumped. Subsidies, on this view, launched the industry and are fading, as even CSIS's figures show: support fell from more than 40% of sales in the early years to 11.4% in 2023, and from $13,860 a vehicle in 2018 to under $4,800. The price war is competition doing its job: buyers get cheaper cars, and weak firms such as Neta go under.

The case that it is overcapacity fed by subsidies: Scott Kennedy of CSIS argues that 15 years of state support (section 4a) have "fundamentally altered the playing field". About 200 electric-car makers, he says, built more capacity than China's market can absorb, and few of them make money (June 2024). On the nameplate count about half of China's capacity stands idle, and the industry's margin is at a record low and still falling (section 4d). State groups such as GAC are losing money, and most of the 129 brands are not expected to survive (section 4c). Local governments keep weak firms alive, and at Voyah the subsidies exceeded the profit. With home sales falling (section 4e), exports are absorbing what China cannot sell, at prices other countries' makers cannot match.

What the evidence says: both sets of facts are true at once, of different firms. The spread between Great Wall's own plants (section 4d) shows efficient leaders beside idle lines within a single company. Listed parts makers earn more than the carmakers they supply (section 4d), which is what surplus capacity among carmakers does to their prices. Central subsidies have shrunk as a share of sales, but CSIS calls its total conservative because local support is harder to see, and Voyah's accounts show that support can still exceed profit. Exports rose as home sales fell, the pattern of a surplus looking for buyers rather than of new demand abroad.

The course's reading, stated once: efficiency explains who wins, and subsidies explain why there is so much capacity. China's leading makers, BYD first, are efficient by any measure of cost, speed, and scale, which is why they sell abroad even over tariffs. But the industry as a whole is overbuilt, because two decades of central and local support let weak firms build and keep plants that the market would have closed. The price war and the export surge are how that surplus is being cleared. For the countries receiving the cars the second fact matters more, because exports will keep coming as long as the home market shrinks, whatever the leaders' efficiency.

Worked example — A 55,800-Yuan Electric Car, from Its Battery to BYD's Profit

Take a small battery-electric car priced at 55,800 yuan ($8,346), the Seagull's price after BYD's cut of May 2025. Chinese car prices include VAT of 13%, so the price before VAT is 55,800 ÷ 1.13 = 49,381 yuan, and VAT is 6,419 yuan. In 2026 the buyer also pays purchase tax of 5% of 49,381 yuan, 2,469 yuan, for a total of 58,269 yuan ($8,715). Assume the dealer keeps 4% of the price before VAT, 1,975 yuan, so BYD receives 47,405 yuan ($7,090). Assume a 30 kWh battery, about the size of the base Seagull's, at China's average pack price of $84 per kWh in 2025 (Module 8): $2,520, or 16,849 yuan, 35.5% of what BYD receives. At BYD's 2025 gross margin on cars of 20.49%, building the car costs 47,405 × 0.7951 = 37,692 yuan. Take away the battery, and the motor, body, electronics, labor, and plant cost 20,843 yuan ($3,117), which leaves a gross profit of 9,713 yuan. At BYD's 2025 net margin of 4.06% (32.62 billion yuan of profit on 803.97 billion yuan of revenue), the net profit is 1,923 yuan, $288 a car. Research, selling, administration, interest, and tax take the other 7,790 yuan of the gross profit. The state collects 6,419 + 2,469 = 8,888 yuan in taxes, 4.6 times BYD's profit. BYD's profit across all its vehicles averaged 7,088 yuan ($1,060), because it sells costlier cars and runs other businesses. Applying its average margins to its cheapest car is a simplification, and since small cars usually earn less than the average, the true profit on a Seagull is likely lower than $288.

Module 4 Key Points

China

• BYD sold 4,602,436 vehicles in 2025, including 2,256,714 battery-electric cars, 620,585 more than Tesla delivered.

• China’s car industry earned a record-low 4.1% margin in 2025 and 3.6% in January-August 2026, as a price war cut prices.

• Capacity use was 49.5% on Gasgoo’s nameplate count (2024) and 73.2% on the statistics bureau’s output-value measure (2025).

• Home retail sales fell 21.7% in January-September 2026 after the purchase-tax break was halved and trade-in subsidies shrank.

• Exports took 35.3% of output in January-August 2026; NEV exports reached 4.006 million in January-September, 2.3 times a year earlier.

• China’s leaders are efficient, but support worth $230.9 billion in 2009-2023, by CSIS’s count, left the industry overbuilt.

Module 4 Quiz

Check Your Understanding

1. What did BYD's 2025 battery-electric total show?

A) BYD outsold Toyota for the first time, counting its plug-in hybrids.
B) Tesla kept its lead in battery-electric cars over BYD in 2025.
C) BYD sold more battery-electric cars than Tesla delivered.
D) BYD's battery-electric sales fell as plug-in hybrids took over.

2. How does Gasgoo's measure of China's plant use differ from the statistics bureau's?

A) It counts only electric-car plants
B) It is the same survey, published a year later
C) It counts nameplate capacity, what the plants were built to make
D) It values output in yuan rather than counting vehicles, which is why it gives the higher figure of 73.2% for 2025

3. What happened to China's purchase-tax break for NEVs on January 1, 2026?

A) Halved: NEVs pay 5%
B) It ended, so NEVs pay the full 10%
C) It was extended in full through 2027
D) It was abolished for battery-electric cars only

4. What share of China's vehicle output did exports take in January-August 2026?

A) 61.6%
B) About a fifth, as in 2025
C) Under 10%, because most Chinese cars are still sold at home
D) 35.3% of output

5. What is the course's reading of whether China's car industry is efficient or overbuilt?

A) It is efficient, and subsidies played no part
B) Its leading makers are efficient, but subsidies left the industry as a whole with far more plants than its market needs
C) It is overbuilt, and its leading makers are inefficient too
D) Neither, since official utilization is close to American levels

Module 5 — Europe

The Squeeze

Recommended Reading / Reference

Book: Jack Ewing, *Faster, Higher, Farther: The Volkswagen Scandal* (2017), by a *New York Times* correspondent in Frankfurt, on the diesel-emissions fraud uncovered in 2015 and the company culture that produced it

Reference: ACEA's monthly releases on new-car registrations, and the Boston Consulting Group's white paper *Europe's Automotive Overcapacity Imperative* (June 2026)

5a. Europe's Market

The European Union registered 10,822,831 new cars in 2025, up 1.8%, and 13,271,270 counting Britain and the four members of the European Free Trade Association (EFTA): Iceland, Liechtenstein, Norway, and Switzerland (ACEA). Registrations rose a further 5.3% in the EU and 5.8% in the wider market in January-August 2026. Even so, ACEA says that volumes "remain well below pre-pandemic levels", so Europe's plants can build more cars than Europe's buyers take (section 5c).

What Europeans buy has changed faster than how many they buy. Battery-electric cars were 17.4% of EU registrations in 2025, up from 13.6% in 2024, and 21.7% in January-August 2026, against 15.8% a year earlier, and in August alone they passed a quarter (ACEA). Plug-in hybrids rose to 9.4% in 2025 and 10.0% in 2026. Hybrids that do not plug in are the largest group, at 34.5% in 2025 and 36.6% in 2026, while petrol and diesel cars together fell from 45.2% of the market in 2024 to 35.5% in 2025 and 29.0% in January-August 2026.

Volkswagen's group sold 26.5% of the EU's new cars in January-August 2026, Stellantis 15.9%, and Renault 10.4%, followed by Hyundai at 7.1%, Toyota at 7.0%, BMW at 6.9%, and Mercedes-Benz at 4.9%, with Tesla at 1.9% (ACEA). The Chinese makers are still small on ACEA's count, BYD at 2.4%, SAIC at 2.2%, and Chery at 1.5%, but their sales are growing fastest (section 5d).

5b. The Makers in 2026

Volkswagen, led by its chief executive, Oliver Blume, cut its forecast for 2026 on September 18 (table), and it now expects revenue of about €315 billion ($353.8 billion at October 16, 2026 exchange rates, the rates used for every dollar figure in this module). The cut comes from about €10 billion of special items. The largest is a non-cash charge of €6 billion on the goodwill of Porsche, the part of what Volkswagen paid for it above the value of its assets. Another €2 billion covers early retirements, the planned sale of its Osnabrück plant, and write-downs in China, and the rest, including €0.9 billion booked in the first half, was not itemized. Before special items it expects a margin of about 4%. It blamed China and "an accelerated shift in demand in favor of battery-electric vehicles" that left Audi and the Volkswagen brand short of models, and its shares fell 5.6% that day.

Volkswagen's job cuts have grown in three steps. In December 2024 it agreed with the IG Metall union to cut about 35,000 jobs at the Volkswagen brand in Germany by 2030, without compulsory layoffs. In March 2026 it raised the target to about 50,000 across the group in Germany, adding Audi, Porsche, and its software unit, Cariad. On September 3, 2026, its supervisory board unanimously approved a plan to cut another 50,000, taking the total to 100,000 by 2030, about 15% of a workforce of more than 650,000 (Agence

France-Presse, September 4). The plan also halves the group's number of models. Four German plants, Volkswagen's at Hanover, Emden, and Zwickau and Audi's at Neckarsulm, have no production assured into the 2030s, and other uses for them are being studied.

Porsche, which Volkswagen controls, has retreated from its electric plans. In September 2025 it decided to keep gasoline and plug-in hybrid versions of the Cayenne and Panamera "well into the 2030s" and pushed back its next electric platform, after a 2022 plan for more than 80% of its sales to be battery-electric by 2030.

Maker	First half of 2026	Outlook and notes
Volkswagen Group	Operating margin 3.8%; deliveries 4.13 million, down 6.3%; China down 31.6%	Margin forecast cut to "up to 1%" from 4.0-5.5% on September 18
Porsche	Deliveries 122,306, down 16.5%; China about 14,500, down 32%	Run by Michael Leiters since January 1, 2026; about €9 billion of its goodwill written down by Volkswagen in a year, the €6 billion of September 2026 included
Mercedes-Benz Cars	Adjusted return on sales 4.0% (6.2% a year earlier); sales 837,195, down 7.0%; China down 30% in the second quarter	Forecast of 3-5% kept on July 28
BMW Automotive	EBIT margin 3.6% (6.2% a year earlier); deliveries 1.157 million, down 4.2%; China down 20.4%; Europe up 5.4%	Forecast cut to 1-3% from 4-6% in June
Stellantis	Adjusted operating margin 2.1%; net profit €670 million, against a €2.3 billion loss; shipments 2.96 million, up 11%	Back in profit after its 2025 loss (Module 3)

Company releases: Volkswagen, July 24 and September 18, 2026; Mercedes-Benz, July 28; BMW, July 30, as reported; Stellantis, July 30. Porsche: BigGo Finance and The Auto Wire, September 2026. Adjusted return on sales is operating profit before one-off items as a share of revenue.

Stellantis, formed in 2021 from Fiat Chrysler and Peugeot's parent, PSA (Module 1), set out a five-year plan of €60 billion ($67.4 billion) at an investor day in May 2026 under its chief executive, Antonio Filosa. It puts €36 billion into brands and products, 70% of it for Jeep, Ram, Peugeot, and Fiat, and promises 60 launches by 2030 and €6 billion of annual cost cuts by 2028. It plans closer ties with Dongfeng of China, including a European joint venture, alongside its partnership with Leapmotor (section 5d). Renault, the third-largest seller in the EU, saw its registrations there fall 4.0% in January-August 2026 (ACEA).

The suppliers are cutting too, because they lose sales when carmakers build fewer cars and lose engine parts when cars go electric. Bosch, the world's largest supplier (Module 2), said on September 25, 2025 that it would cut another 13,000 jobs in Germany by the end of 2030, on top of about 9,000 announced in 2024. It said Chinese suppliers' sales had grown 14.7% a year since 2020, against 5.7% for German suppliers. ZF has said it will cut up to 14,000 jobs this decade, Schaeffler announced 4,700 cuts in Europe in November 2024, and Continental has spun off its car-parts business as Aumovio.

5c. Too Many Plants

Europe has more car plants than its market needs. The Boston Consulting Group (BCG) estimates that Europe's plants ran at 59% of capacity in 2025 and have run at about 60% for years, against the 80% it treats as the "pragmatic benchmark" for a network that pays its way (June 2026). The gap is more than 20% of capacity, about 5.4 million vehicles a year, which BCG equates to the capacity of more than 35 of Europe's roughly 90 assembly plants. Individual makers' average utilization ranged from 44% to 76%.

Closing a plant in Europe is slow and costly. Union agreements protect jobs, governments own stakes, and in Volkswagen's case the state of Lower Saxony holds 20% of the votes, enough to block major decisions.

Volkswagen is cutting jobs through early retirement and departures rather than layoffs, and its four German plants without assured production have until the early 2030s. Closing any of them would be Volkswagen's first closure of a full-scale car plant in Germany (Agence France-Presse).

Idle capacity is also what Chinese makers can use. Chery assembles cars for Europe in a Barcelona factory that Nissan closed in 2021, and Leapmotor's are being built on a Stellantis line at Zaragoza (section 5d). For a European maker with idle lines, a Chinese partner can fill a plant that would otherwise close. For the Chinese maker, a plant inside the EU avoids the duties on imports (section 5e).

5d. The Chinese Arrival

Chinese brands took a record 11.7% of Europe's car market in August 2026, 97,639 cars, up from 7.1% a year earlier, by the count of Dataforce, a data firm whose figures cover the EU, EFTA, and Britain. It counts 913,703 Chinese-brand cars registered in January-August: 234,099 for BYD, up 144%, 230,290 for SAIC, mostly under its MG brand, up 20%, 207,871 for Chery's brands, up 280%, and 73,297 for Leapmotor, up 450%. Counterpoint Research forecasts that Chinese brands will pass 20% of the market by 2030.

Most of the growth is in plug-in hybrids, which the EU's anti-subsidy duties do not cover (section 5e). Chinese brands had 25% of the EU's plug-in hybrid market and 14% of its hybrid market in the first half of 2026, against 2% of each in 2024 (ACEA). Imports of Chinese hybrids into the EU rose from 3,800 a month in October 2024 to 50,000 in July 2026, by data the *Financial Times* compiled.

Chinese makers have also begun building cars inside the EU, where no import duty applies. Chery and the Spanish company Ebro began assembling cars in November 2024 at the former Nissan plant in Barcelona's Zona Franca district, an investment of about €400 million meant to build 150,000 cars a year by 2029. Leapmotor's B10 began series production on a Stellantis line at Zaragoza on October 16, 2026, with its battery modules assembled at nearby Mallén. BYD's plant at Szeged, Hungary, began test production by the end of January 2026 and is to start series production in the fourth quarter of 2026, a year later than planned, and BYD has said it is looking for a second European plant, possibly an existing one in Spain.

5e. The EU's Answer

The EU's main answer so far has been duties on battery-electric cars built in China. After investigating Chinese subsidies, it imposed definitive countervailing duties, which offset subsidies an exporter has received, from October 31, 2024, on top of the 10% duty the EU charges on all imported cars. The rate depends on the subsidy found for each maker and on whether it cooperated with the investigation (table). Plug-in hybrids and hybrids pay only the 10% duty.

Maker of China-built battery-electric cars	Anti-subsidy duty	Total with the 10% duty
Tesla (Shanghai)	7.8%	17.8%
BYD	17.0%	27.0%
Geely	18.8%	28.8%
Other cooperating makers, including Chery	20.7%	30.7%
SAIC, and makers that did not cooperate	35.3%	45.3%
Cupra Tavascan (Volkswagen Anhui), under a price undertaking	0%	10%

Definitive duties under Implementing Regulation (EU) 2024/2754, in force from October 31, 2024 (Reuters factbox, February 11, 2026; CnEVPost, June 20, 2026). The provisional rate for BYD in July 2024 was 17.4%.

Instead of paying the duty, an exporter can offer a price undertaking, a promise to sell at or above a minimum import price. Guidance of January 12, 2026 said undertakings should set a minimum price for each model and version, may cap annual volumes, and may count verifiable investment in the EU. The only one reported accepted by October 2026 came on February 10, 2026, for Volkswagen's Cupra Tavascan, built in China by Volkswagen (Anhui). It combines a minimum price, an export quota, and phased investment in electric cars in the EU, and if its terms are broken the duty can be charged retroactively.

Because plug-in hybrids remained outside the duties, the European Commission asked China in September 2026 to limit its hybrid exports voluntarily, and China's commerce ministry refused, saying such limits break the rules of the World Trade Organization (WTO). The Commission then prepared a safeguard, a temporary limit on imports that WTO rules allow when a surge of imports harms domestic producers. At talks in Beijing on October 8-9, 2026, Maroš Šefčovič, the EU's trade commissioner, and Wang Wentao, China's commerce minister, reached what Šefčovič called "a shared understanding to moderate China's export of hybrids and plug-in hybrids", which he said could cut them by more than half.

The limit itself is still a proposal. According to a Commission document seen by Bloomberg, the safeguard would cover hybrids and plug-in hybrids from all countries and would hold imports of Chinese ones to 350,000 a year, a ceiling rising 6% a year for four years. It could take effect as soon as December 1, 2026 (Just Auto, October 12, 2026). The Commission expects about 800,000 Chinese hybrids and plug-in hybrids to arrive in 2026. Nothing has been decided, and EU governments must approve any safeguard.

A third line of policy, still under debate, would favor cars made in Europe through local-content rules (section 5g), and the rules on carbon dioxide offer their own incentives for European production (Module 10).

5f. Britain

Britain, outside the EU since 2020, built 764,715 vehicles in 2025, down 15.5% and the fewest since the 1950s, of which 717,371 cars, down 8%, by the count of the Society of Motor Manufacturers and Traders (SMMT). Commercial-vehicle output fell 62.3% after Stellantis closed its Vauxhall van plant at Luton in March 2025. The cyberattack on Jaguar Land Rover (Module 11) cut car output further, and total output fell another 7.5% in the first half of 2026, to 385,979.

Britain exports most of what it builds: 77.5% of its vehicles in 2025, 56.7% of them to Europe and 15% to the United States, where a quota sets the tariff (Module 9). Cars cross to the EU duty-free only if enough of their value is British or European. From January 1, 2027, that share for electric cars rises from 40% to 55%, or the car pays a 10% tariff (SMMT).

Britain's market grew to just over 2 million new cars in 2025. It charges its normal 10% tariff on cars from China and has not added duties like the EU's, and Chinese brands took 9.7% of the market in 2025, almost 200,000 cars, led by SAIC's MG with 85,155 and BYD with 51,422. By July 2026 their share was about 15% (SMMT). Chery's Jaecoo 7, 85% of whose British sales were plug-in hybrids, was Britain's best-selling car in March 2026, with more than 10,000 registered. SMMT says Chinese brands are forcing established sellers into "ever-deeper discount schemes".

5g. Protect Europe's Makers, or Invite Chinese Plants and Partners? The Cases as Their Advocates Make Them

The case for protecting Europe's makers: its advocates point out that Chinese brands' share of Europe's market rose by two-thirds in a year, while Volkswagen and the suppliers cut jobs by the tens of thousands

(section 5b). Chinese prices, they argue, reflect state support and a home market with far more plants than buyers (Module 4), not only efficiency. As Kevin Thozet of the fund manager Carmignac put it, “Europe is importing not only Chinese cars but Chinese price deflation.” Chinese makers sidestepped the duties on battery-electric cars by shipping plug-in hybrids within two years, so the advocates want duties on plug-in hybrids, a cap on Chinese hybrid exports, and “Made in EU” rules for cars bought with public money (autoevolution, September 23, 2026). Chinese plants that assemble imported parts, they add, would keep the profit, the technology, and most of the supply chain in China.

The case for inviting Chinese plants and partners: Stellantis has acted on this case, building Leapmotor’s cars in Spain and planning a European venture with Dongfeng. Its advocates argue that the duties mainly redirected Chinese sales into plug-in hybrids and drew Chinese plants into Europe. Europe, they say, should court Chinese investment and technology through partnerships and compete on cost. Its makers have idle plants to fill and are behind in batteries and software, which Chinese partners can supply. They cite the 1980s, when Japan’s makers answered American and European limits on their exports by building plants in the United States and Britain.

What the evidence says: the duties changed what China sends rather than how much, since its share of plug-in hybrids and its hybrid imports multiplied while battery-electric cars paid the duty (section 5d). A ceiling of 350,000 a year is about 29,000 a month, against the 50,000 a month arriving by July 2026, so the proposed cap would bind. Chinese plants have come, but they are small beside the cuts: Barcelona is to employ up to 1,250 people. The incumbents’ falling margins come mainly from China, where Mercedes-Benz and BMW lost a fifth to nearly a third of their sales in 2026 while BMW grew in Europe (section 5b). Europe’s surplus capacity (section 5c) leaves room for Chinese production without new plants, and the one accepted price undertaking shows a middle path: a minimum price combined with investment in the EU.

The course’s reading, stated once: walls that make building in Europe the price of selling there serve Europe better than either pure case. Duties alone shifted Chinese brands into plug-in hybrids rather than stopping them, and an open door would let in prices shaped by China’s subsidies and surplus. The mix the EU is reaching for, duties on imports, a proposed cap on hybrids, and undertakings that reward investment in the EU, pushes Chinese makers to build in Europe’s idle plants. Those walls buy time, and the time is worth something only if Europe’s makers use it to cut their costs and catch up in batteries and software. Their 2026 margins show they have not done so yet.

Worked example — A Chinese Battery-Electric Car and a Chinese Plug-in Hybrid, Landed in Germany

Take two cars built in China by BYD, a battery-electric car and a plug-in hybrid, each with a customs value of €20,000, the price plus freight and insurance to the EU border (an assumption). The battery-electric car pays the EU's 10% duty, €2,000, and BYD's anti-subsidy duty of 17.0%, €3,400, so it lands at €25,400. The plug-in hybrid pays only the 10%, €2,000, and lands at €22,000. Assume the importer and dealer add 15% for shipping inland, marketing, and margin: €3,810 on the first car and €3,300 on the second, for prices before tax of €29,210 and €25,300. Germany then adds its value-added tax of 19%, €5,550 and €4,807. The battery-electric car sells for €34,760 ($39,039) and the plug-in hybrid for €30,107 ($33,813). The two cars cost the same to bring to Europe, yet the battery-electric one costs the buyer €4,653 ($5,226) more, and duties and tax take 31.5% of its price against 22.6% of the hybrid's. The same battery-electric car from SAIC, at 35.3%, would sell for €39,769. Built at BYD's Hungarian plant it would pay no import duty: at the same €20,000 cost, it would sell for €27,370. So Szeged's costs can run up to €5,400, or 27%, above the €20,000 that the China-built car costs at the EU border before importing from China becomes the cheaper choice. The hybrid's €4,653 advantage explains why Chinese makers have shipped plug-in hybrids, and why a cap on them would push the next wave of production into Europe.

Module 5 Key Points

Europe

• Battery-electric cars were 21.7% of EU registrations in January-August 2026 (ACEA), up from 17.4% in 2025.

• Volkswagen cut its 2026 margin forecast to “up to 1%” on September 18, 2026, and plans 100,000 job cuts by 2030.

• Europe’s plants ran at 59% of capacity in 2025, by BCG’s estimate, about 5.4 million vehicles a year of surplus.

• Chinese brands took a record 11.7% of Europe’s market in August 2026, led by plug-in hybrids that escape the anti-subsidy duties.

• The EU’s duties on China-built battery-electric cars range from 7.8% (Tesla) to 35.3% (SAIC), on top of the 10% tariff.

• A proposed EU safeguard would hold Chinese hybrid and plug-in hybrid imports to 350,000 a year; nothing has been decided.

Module 5 Quiz

Check Your Understanding

1. What was the battery-electric share of EU registrations in January-August 2026, by ACEA's count?

A) 17.4%, as in 2025
B) About a quarter in every month
C) 36.6%, the same as hybrids
D) 21.7%

2. What did Volkswagen's supervisory board approve on September 3, 2026?

A) A cut of 35,000 jobs
B) The closure of four plants
C) Job cuts totaling 100,000 by 2030
D) The sale of Porsche

3. Why have Chinese brands grown fastest in Europe in plug-in hybrids?

A) They are cheaper to ship
B) The anti-subsidy duties apply only to battery-electric cars
C) EU rules banned imports of Chinese battery-electric cars from January 2026
D) Buyers prefer them

4. In the worked example, why does the battery-electric car cost more in Germany than the plug-in hybrid?

A) BYD's 17.0% anti-subsidy duty
B) A higher VAT rate
C) Its battery costs more to insure and ship from China to Hamburg than the hybrid's smaller pack
D) Germany charges an extra registration tax on imported electric cars

5. What is the course's reading on protecting Europe's makers or inviting Chinese plants?

A) Protect them fully
B) Walls that make building in Europe the price of selling there, if the makers use the time to cut costs
C) Open the market to Chinese imports
D) Ban Chinese partnerships with European makers

Module 6 — America

The Makers and the Market

Recommended Reading / Reference

Book: Bill Vlasic, *Once Upon a Car: The Fall and Resurrection of America's Big Three Auto Makers—GM, Ford, and Chrysler* (2011), a Detroit reporter's inside account of how the three came to the edge in 2008-09 and what they changed to survive

Reference: The National Automobile Dealers Association's annual *NADA Data* report and monthly *Market Beat*, and Cox Automotive's quarterly sales forecasts, the sources for most of the market figures here

6a. The Market

Americans bought 16.2 million new light vehicles in 2025, 2.4% more than in 2024 and the most since 2019, by the count of the National Automobile Dealers Association (NADA), the trade group of franchised dealers (December 31, 2025). A light vehicle is a car, SUV, pickup, or van, without the heavy trucks and buses in the world totals of Module 1. Other counts differ because they include different vehicles and estimate differently. The Bureau of Economic Analysis (BEA), whose monthly series is the official one, has 16.26 million, and GlobalData, a data firm, 16.33 million. GM, which counts more vehicle types in its industry total, has 16.631 million, and this course uses NADA's figure. Sales have not returned to their level before the pandemic, when BEA counted 17.22 million in 2018 and 16.96 million in 2019.

In January-September 2026 Americans bought 11.99 million light vehicles, 2.0% fewer than a year earlier, by BEA's monthly figures. The seasonally adjusted annual rate of sales (SAAR) was 15.98 million in September, down from 16.57 million in August and a year earlier, after a low of 14.96 million in January. Forecasters expect about 16 million for the year: Cox Automotive, a car-data and dealer-services company, raised its forecast to 16.1 million from 15.8 million on September 24, and NADA expects 16.0 million (October 5). Mobility Global, the forecaster that left S&P Global on July 1, 2026, also expects 16.1 million. Fleet buyers have held the market up: sales to rental companies, businesses, and governments rose 17.6% in September and made up 17% of sales (Cox).

Pickups, SUVs, crossovers (SUVs built on car platforms), and vans, which the statistics call light trucks, were 83.2% of sales in 2025 and 83.4% in January-September 2026, against 72.2% in 2019 (BEA). Edmunds, a car-shopping website, puts midsize sedans at 4.5% of 2025 sales, down from 5.3% in 2024. Pickups top the sales list: in the third quarter of 2026 Ford sold 203,707 F-Series pickups, Chevrolet 146,639 Silverados, and Ram 117,757 pickups, 33.7% more than Ram sold a year earlier (Reuters, October 5).

Two rushes shaped 2025: buyers hurried to beat the tariff on imported cars (Module 9), so that the SAAR reached 17.8 million in March, the highest since April 2021, NADA reported. Buyers of electric cars rushed again before the federal purchase credit ended on September 30, 2025 (Module 10). Each rush borrowed sales from the months that followed it.

Cars take a large share of household budgets: the average household spent $13,318 on transportation in 2024, 17.0% of all its spending, including $5,337 of net outlays on vehicles, in the Consumer Expenditure Survey of the Bureau of Labor Statistics (BLS), released on December 19, 2025. Vehicles and the cost of running them, from insurance and repairs to fuel and fees, carry about 15% of the weight in the CPI.

6b. Who Sells Them

Measured by brand, the Detroit Three are at a record low. On September 24, 2026 Cox forecast that the brands of GM, Ford, and Stellantis would take “just over 36%” of third-quarter sales, “the lowest level on record,” and that Asian brands would take more than half for a second straight quarter. These shares go by the brand’s owner, not by where the vehicle was built. A Chevrolet built in Korea counts as Detroit, and a Toyota built in Kentucky counts as Asian. Module 9 covers where America’s cars are made.

Maker group	Main US brands	Share of US sales, January-September 2026
GM	Chevrolet, GMC, Buick, Cadillac	16.7%
Toyota	Toyota, Lexus	15.6%
Ford	Ford, Lincoln	12.5%
Hyundai Motor Group	Hyundai, Kia, Genesis	11.9%
Honda	Honda, Acura	9.6%
Stellantis	Jeep, Ram, Dodge, Chrysler, and smaller European brands	7.8%
Nissan and Mitsubishi	Nissan, Infiniti, Mitsubishi	6.5%
Subaru	Subaru	4.0%
Volkswagen Group	Volkswagen, Audi, Porsche	3.4%
Tesla	Tesla	3.0%
Mazda, BMW, Mercedes-Benz	Their own brands, with Mini under BMW	2.6%, 2.5%, and 2.1%
All others	Smaller importers	1.7%

Cox Automotive, third-quarter forecast of September 24, 2026, with September estimated. The Detroit Three are GM, Ford, and Stellantis.

The third quarter’s results pointed the same way. GM sold 671,000 vehicles in the US, 5.5% fewer than a year earlier, and its share fell to 16.1% from 16.8%, by its own count of an industry of 4.174 million (October 20, 2026). In all of 2025 it had sold 2.853 million, a 17.2% share. Ford’s sales fell 6.6% and Stellantis’s 12%, while Honda’s rose 9.3%, Hyundai Motor Group’s 5.4% to 506,200, and Toyota Motor North America’s 0.6% to 633,223 (company reports, via Foley, a law firm that tracks the industry, October 14).

The gains went to makers with hybrids and small crossovers to sell when gasoline passed $4 a gallon (section 6f). The Detroit Three dropped most of their cars from the late 2010s to concentrate on trucks, and Ford’s only car is now the Mustang. Buyers who want a cheaper or more frugal vehicle find most of the choice among Asian brands. Over the first nine months of 2026 Toyota was the best-selling brand, with 1,613,845 vehicles, ahead of Ford with 1,438,570 and Chevrolet with 1,297,869 (CarPro, October 8).

6c. The Makers in 2026

	GM, third quarter	Ford, second quarter	Tesla, third quarter
Revenue	$50.0 billion	$48.3 billion	$28.0 billion
Operating result, on each company's own measure	EBIT-adjusted, $4.106 billion	Adjusted EBIT, $2.503 billion	Operating income, $718 million
Operating margin	8.2%	5.2%	About 2.6%
Net income	$3.335 billion	A loss of $1.327 billion	$804 million

Company releases: GM, October 20, 2026; Ford, July 28, 2026; Tesla, October 21, 2026. Each company defines its operating measure in its own way.

GM's results show where the money is, since its North American business earned $3.592 billion of EBIT-adjusted, GM's measure of operating profit before special items, an 8.7% margin, against $32 million from its joint ventures in China. On October 20 GM narrowed its 2026 range for EBIT-adjusted to $14.5-15.5 billion, from $14.0-16.0 billion. It raised its forecast of adjusted automotive free cash flow, the cash its car business produces after investment, to $11.5-12.5 billion, from $9.5-11.5 billion.

Ford reports its third quarter on October 28, 2026, so its second-quarter results and guidance are its latest. In the first half it earned $5.991 billion of adjusted EBIT on $91.5 billion of revenue, a 6.5% margin, and it booked a refund of tariffs that the Supreme Court had struck down (Module 9). In July it raised its 2026 guidance for adjusted EBIT to $10.0-11.0 billion, from $8.5-10.5 billion. Its second-quarter net loss came from special charges for its electric reset (Module 3). Ford Pro, which sells vans and trucks to businesses, earned $1.718 billion in the second quarter, a 9.7% margin, despite an aluminum shortage after a supplier's plant fire (Module 2).

Tesla's third quarter combined flat revenue, a thin margin, and strong cash. Its operating margin was 3.2 points lower than a year earlier, and its automotive gross margin, the share of car revenue left after the direct cost of building the cars, was 18.5%. Free cash flow was $1.53 billion, because $6.26 billion of cash from operations more than covered $4.73 billion of capital spending. Deliveries were 486,532, 2% fewer than in the third quarter of 2025, when buyers rushed to beat the end of the federal credit. The energy business, which sells stationary storage batteries, brought in $2.881 billion of revenue and installed 13.7 gigawatt-hours (GWh) of storage, against 12.5 GWh a year earlier. Tesla's regulatory credits are in Module 10, its robotaxis in Module 11, and its market value in Module 3.

The newer American makers remain small: Rivian, which builds electric pickups and SUVs in Normal, Illinois, delivered a record 19,248 vehicles in the third quarter as its smaller and cheaper R2 SUV reached buyers. It expects 65,000-70,000 deliveries in 2026, against 42,247 in 2025. Lucid delivered 15,841 cars in 2025 and planned to build 25,000-27,000 in 2026 (February 24, 2026). Scout Motors, Volkswagen's revived American brand, expects its first deliveries from its South Carolina plant in 2028, after reports in February 2026 that production had slipped from 2027. More than 87% of its roughly 160,000 reservations chose a version with a range extender (Jalopnik, April 8, 2026).

6d. The Electric Retreat, Decision by Decision

From mid-2025 the makers turned plants built or planned for electric vehicles to other work. American demand fell short of their plans: electric-car sales were slightly lower in 2025 than in 2024 (Module 8). The federal purchase credit then ended (section 6a), and the fuel-economy and emissions rules were loosened (Module 10). Atlas Public Policy, a research firm, counted more cancelled US electric-vehicle plant projects

in the first quarter of 2025 than in 2023 and 2024 combined. The table lists the largest decisions, and Module 3 has what they cost. Canadian dollars are converted at October 16, 2026 exchange rates.

Maker	Decision, with its date	What replaces it
Ford	The all-electric F-150 Lightning pickup ends, and a planned three-row electric SUV is cancelled (December 15, 2025)	An extended-range electric F-150, whose gasoline engine charges the battery, built at the Rouge plant in Michigan
Ford and SK On	The BlueOval SK battery venture is dissolved (December 15, 2025)	Ford keeps the Kentucky plant and converts it to storage batteries from 2027; SK On takes the Tennessee battery plant
Ford	The electric truck planned for BlueOval City, Tennessee, is dropped (December 15, 2025)	The renamed Tennessee Truck Plant builds gasoline trucks from 2029
GM	Orion Assembly, Michigan, will not build electric trucks (June 10, 2025)	Gasoline full-size SUVs and light pickups from early 2027
GM	Factory Zero, Detroit, goes to one shift, and the Ultium Cells plants in Ohio and Tennessee pause from January 5, 2026 to mid-2026 (October 29, 2025)	About 1,750 indefinite and 1,550 temporary layoffs across the three plants
GM and Samsung SDI	Construction of a $3.5 billion battery-cell plant in New Carlisle, Indiana, is paused (May 2026)	No new date; the partners may switch to cheaper lithium iron phosphate cells, or GM may leave the venture
Volkswagen	ID.4 assembly at Chattanooga, Tennessee, ends in mid-April 2026 (announced April 9, 2026)	The second-generation Atlas, a gasoline SUV
Honda	A C$15 billion ($10.6 billion) electric-vehicle and battery project in Ontario, serving the US market, is shelved indefinitely (May 2026)	Honda cited weak US demand, the end of the federal credit, looser rules, and tariffs

Company announcements; Louisville Public Media (December 16, 2025); Business Insider (October 29, 2025); CarScoops (April 2026 and May 2026).

The decisions follow one pattern, in which capacity meant for electric vehicles went to gasoline trucks and SUVs, which earn the most per vehicle (Module 3), or to range-extended models, which need smaller batteries. Ford’s Kentucky plant moved to a different market, stationary storage batteries for the power grid, packed in containers of 5 megawatt-hours or more. All of the venture’s workers there were laid off, about 1,600 by local reports, and the new storage business planned 2,100 hires (December 16, 2025). Ford budgeted about $1.5 billion of its 2026 capital spending for that business.

The retreat is not an exit. Ford still plans a midsize electric pickup on a new, cheaper platform for 2027, and said in August 2025, when it announced the platform, that the pickup would start at about $30,000. GM consolidated its electric production rather than ending it, and its charges were for capacity and contracts rather than for the cars it sells (Module 3).

6e. The Dealers

Almost every new car in America is sold by an independent franchised dealer, a local business licensed to sell and service one or more makers’ brands. At the end of 2025 there were 16,990 franchised new-car dealerships. Together they sold $1.3015 trillion of new and used vehicles, service, and parts, an average of $76.6 million each, and employed 1,123,100 people with a payroll of $94.44 billion (*NADA Data 2025*). BLS counted 1,283,300 jobs at automobile dealers in September 2026, 8,300 fewer than a year earlier, on a wider definition that includes used-car lots.

New vehicles brought 54.9% of dealers’ 2025 sales, used vehicles 31.8%, and service and parts 13.3%, from 276.1 million repair orders. Profit comes in a different order, as the worked example shows. A dealer

earns little on the new car itself and much more on the loan, the service contract, and the repairs that follow. Stocks of unsold cars fell and then rose again in 2026: Cox counted 2.68 million new vehicles in stock in August, 73 days' supply, the fewest days since April 2025. The total passed 3 million in early October, led by full-size trucks and high-priced SUVs (*Automotive News*).

State franchise laws protect this system by limiting a maker's power to open a store near an existing dealer, to end a franchise, or to sell to the public itself. Bloomberg Government counted 12 states that banned sales of new electric cars by anyone but a franchised dealer, and 16 more that restricted them, in March 2025. Tesla, Rivian, and Lucid have no franchised dealers and sell online and through their own stores where states allow it, and where states ban it, buyers can order online and take delivery in a neighboring state.

6f. Gasoline and the 2026 Market

The war between Iran and the United States and Israel, which began on February 28, 2026, closed the Strait of Hormuz, through which most of the Persian Gulf's oil leaves, and shipping through it has been disrupted since. Brent crude, the international benchmark, settled at $104 a barrel on October 8, 2026. The Energy Information Administration (EIA), the government's energy statistics agency, forecasts an average of $105 in the fourth quarter and $84 in 2027.

Gasoline followed, and Cox reported in July, citing AAA, the motorists' association, that the national average had been above $4.50 a gallon since May 6, 2026. It eased to $4.10 by September 1, by AAA's count, then climbed again. EIA's weekly average for regular gasoline was $4.478 on September 21 and $4.284 on October 19, 2026. AAA's September average, $4.33, beat the previous September record, set in 2023, by 50 cents. In the CPI, gasoline cost 34.2% more in September 2026 than a year earlier (BLS, October 14). Diesel, which heavy pickups and delivery vans burn, averaged a record $6.29 a gallon in September (Bureau of Transportation Statistics, October 6).

Dear gasoline changed what powers the vehicles Americans buy more than what kind of vehicle they buy. Light trucks took 84.3% of September's selling rate, a larger share than in 2025 (section 6a). Buyers moved instead to hybrids, which Toyota, Honda, Hyundai, and Kia sell in their best-selling SUVs, and to smaller crossovers, and Honda's CR-V sold 16.6% more in the third quarter. Module 8 gives the shares of hybrids and electric cars, and the cost of running each at $4.50 gasoline.

Worked example — A Dealership's Year

Take the average franchised dealership of 2025, with $76.6 million of sales: $42.1 million of new vehicles, $24.4 million of used vehicles, and $10.2 million of service and parts, in NADA's mix (section 6e). At NADA's average new-vehicle price of $48,205 (Module 12), that is about 872 new vehicles. At NADA's average used price of $29,281 for the first half of 2026, it is about 832 used ones. Assume, for illustration, a gross margin, the price less what the dealer paid, of 5% on new vehicles, 7% on used ones, and 45% on service and parts. Assume also $2,000 per vehicle sold of finance and insurance income, the fees for arranging the loan and the profit on service contracts and add-ons. The gross profit is $2.10 million on new vehicles, $1.71 million on used ones, $3.41 million from finance and insurance, and $4.58 million from service and parts, $11.80 million in all, or 15.4% of sales. Service and parts, 13.3% of sales, bring 38.8% of the gross profit, and finance and insurance another 28.9%. New vehicles, more than half of the sales, bring 17.8%. From the gross, pay NADA's average payroll of $5.56 million and advertising of $0.59 million. Then pay an assumed $3.20 million for rent, utilities, and the interest on loans that finance about 158 new vehicles in stock, NADA's average at the end of June 2026. That leaves $2.45 million before tax, 3.2% of sales, or about $1,440 for each vehicle sold. A dealer can sell a new car near cost and still profit from the loan, the service contract, and years of repairs, which is why the service bay matters most.

Module 6 Key Points

America

• Americans bought 16.2 million new light vehicles in 2025, the most since 2019, and 11.99 million in January-September 2026, down 2.0%.

• Cox forecast the Detroit Three’s brands at just over 36% of third-quarter 2026 sales, a record low, with Asian brands above half.

• GM earned an 8.7% margin in North America in the third quarter of 2026, while Tesla’s operating margin was about 2.6%.

• From mid-2025 the makers turned electric-vehicle plants to gasoline trucks, storage batteries, and range-extended models.

• The 16,990 franchised dealers sold $1.3 trillion in 2025; service and parts, 13.3% of sales, bring far more of the profit.

• EIA’s weekly gasoline average was $4.284 on October 19, 2026; AAA’s average had stayed above $4.50 from May 6 into the summer.

Module 6 Quiz

Check Your Understanding

1. How does Cox measure the Detroit Three's record-low share of US sales?

A) By the plant where each vehicle was assembled, so that a Chevrolet built in Korea counts as an import and a Toyota built in Kentucky counts as American
B) By dealer franchises
C) By the dollar value of sales
D) By the brand's corporate owner, wherever the car was built

2. In the module's worked example, which part of a dealership brings the largest share of its gross profit?

A) New vehicles, which bring more than half of the dealership's sales
B) Finance and insurance income on every vehicle sold
C) Service and parts
D) Used vehicles bought at auction

3. What will Ford's Kentucky battery plant, formerly part of BlueOval SK, make from 2027?

A) Grid storage batteries
B) EV cells
C) Gasoline trucks from 2029
D) Range-extended F-150 pickups

4. What was EIA's weekly average price of regular gasoline on October 19, 2026?

A) $4.33
B) $3.83, the old September record
C) $4.284, below the $4.50 gasoline topped in May
D) Above $4.50, where it had stayed every week since AAA first reported that level on May 6, 2026

5. Why do counts of 2025 US new-vehicle sales range from 16.2 million to 16.631 million?

A) NADA counts only cars, leaving out the pickups and SUVs that make up most of the market
B) Leases are left out
C) GM's figure adds sales in Canada and Mexico to the US total
D) They count different vehicles and estimate differently

Module 7 — Japan, Korea, India, and the Rest

Makers and Markets from Tokyo to São Paulo

Recommended Reading / Reference

Book: Jeffrey K. Liker, *The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer* (2004), the standard account of the production system that made Toyota the industry's benchmark

Reference: The results releases of Toyota, Honda, Nissan, Hyundai, and Kia; the monthly sales data of the Society of Indian Automobile Manufacturers; and the monthly register of light-vehicle production and exports kept by Mexico's National Institute of Statistics and Geography (INEGI)

7a. Toyota

Toyota, the world's largest carmaker (Module 1), has bet on many technologies at once, which it calls a multi-pathway approach: hybrids, plug-in hybrids, battery-electric cars, and hydrogen fuel cells, each sold where buyers can use it, and it has sold hybrids since the first Prius of 1997. Hybrids were 42% of its Toyota- and Lexus-brand sales in 2025 and battery-electric cars 1.9% (Reuters, January 29, 2026), on a count that leaves out its Daihatsu and Hino subsidiaries, and Toyota and Lexus together sold a record 10.5 million vehicles, up 3.7%. Exports from Japan to the United States rose 14.2% to about 615,000, and sales in China rose 0.2%, the first year without a fall in four. Toyota plans to commercialize solid-state batteries, which use a solid in place of the liquid inside today's cells, between 2027 and 2028, with the Japanese companies Idemitsu Kosan and Sumitomo Metal Mining (annual report filed in the United States, June 10, 2026).

US tariffs have cut into Toyota's profits (Module 9). In the year to March 2026 its North American business made an operating loss of $1.9 billion, its first in 16 years, as WardsAuto reported. Its forecast for the year to March 2027 is in the table, with those of Honda, Nissan, Hyundai, and Kia, all converted at October 16, 2026 exchange rates, the rates used for every dollar figure in this module.

Maker	Period	Forecast	Notes
Toyota	Year to March 2027	Operating income ¥3.0 trillion ($19.0 billion), about 20% below the year before	US tariffs (Module 9)
Honda	Year to March 2027	Revenue ¥23.15 trillion; operating profit ¥500 billion ($3.2 billion); net profit ¥260 billion ($1.6 billion)	About ¥500 billion more of electric-car costs (Module 3); material costs, partly from the Middle East conflict, cut profit by ¥313 billion
Nissan	Year to March 2027	Revenue ¥13 trillion; operating profit ¥200 billion ($1.3 billion); retail sales 3.3 million vehicles	No dividend
Hyundai	2026	Revenue up 1-2%; operating margin 6.3-7.3%	Guidance of January 29, 2026
Kia	2026	Revenue 122.3 trillion won ($91.7 billion); operating profit 10.2 trillion won ($7.6 billion), a margin of 8.3%	Guidance of January 28, 2026

Toyota: WardsAuto via Yahoo Finance, May 2026. Honda: RTTNews via Nasdaq and Reuters, May 14, 2026. Nissan: FilingReader, May 13, 2026. Hyundai and Kia: company releases. The 2025 margins are in Module 3.

Toyota changed its chief executive in 2026. On February 6 it named Kenta Kon, its chief financial officer, president and chief executive, and he took over on April 1, 2026 from Koji Sato, who became vice chairman.

Akio Toyoda, grandson of the founder, remains chairman. Kon said Toyota's staff needed to be more nimble, because they tend to resist changing systems they worked hard to build.

The group has also untangled its ownership. Toyota Industries, the loom maker from which the carmaker grew and now a maker of forklifts and engines, held shares in Toyota and in other group companies, which in turn held shares in it. In June 2025 a group company, Toyota Fudosan, with Toyota Motor, bid ¥16,300 a share to take it private. Elliott Management, an American activist fund, argued that the bid undervalued the company, and the price was raised twice, to ¥20,600. The offer succeeded on March 24, 2026, at about ¥5.9 trillion ($37.3 billion), one of Japan's largest buyouts, and Toyota Industries is leaving the stock exchange (Jiji Press). It is to sell its large stakes in other group companies, a step expected to speed a wider unwinding of Japan's cross-shareholdings (Automotive World, March 2, 2026).

7b. Honda and Nissan

Honda and Nissan, two of Japan's largest carmakers, nearly merged: in December 2024 they agreed to study combining under a joint holding company, and in February 2025 the talks collapsed. Honda then posted its first annual loss, for the year to March 2026, which it blamed on "EV-related losses as well as tariff impacts". It is writing off electric models it has cancelled (Module 3 has the margins and the amounts), and in March 2026 it also warned of ¥110-150 billion ($0.7-0.9 billion) of losses at its joint ventures in China (Automotive World). Its forecast is in the table.

Nissan's crisis is deeper. It lost ¥533.1 billion ($3.4 billion) in the year to March 2026, after a loss of ¥670.9 billion the year before, on global sales of 3.15 million vehicles. Its car business had negative free cash flow, the cash left after operating costs and investment, of ¥480.8 billion ($3.0 billion), though it was positive by ¥112 billion in the second half, and its liquidity, cash and available credit, stood at ¥3.6 trillion ($22.8 billion). Its recovery plan, Re:Nissan, announced in May 2025, cuts about 20,000 jobs, about 15% of its workforce, and its car plants from 17 to 10 by March 2028, so that its capacity falls from 3.5 million vehicles a year to 2.5 million. By May 2026 Nissan said it had reached agreements for all seven reductions.

Three plants show what the plan means. Oppama, near Yokohama, will stop building cars after March 2028, with its work moving to Kyushu and about 2,400 workers affected. Civac, in Morelos, Mexico, was to stop production by March 2026, with its models moving to Nissan's plant at Aguascalientes. In Britain, Sunderland, Nissan's European base since 1986, runs at about half its capacity and will merge its two lines into one, while seeking work from other makers, possibly Chery, and Nissan is cutting about 900 European jobs, about 10% of its staff there and about 500 of them in Spain (Automotive World, May 6, 2026).

7c. Korea

Hyundai Motor Group, which owns Hyundai, Kia, and Genesis, is the world's third-largest carmaker (Module 1). In 2025 Hyundai sold 4,138,389 vehicles to dealers and Kia a record 3,135,873 (company releases). The group builds cars in the United States at Hyundai's plant at Montgomery, Alabama, and Kia's at West Point, Georgia. Its newest plant, the Metaplant America at Ellabell, Georgia, near Savannah, built its first car on October 3, 2024 and opened formally on March 26, 2025. It can build 300,000 vehicles a year, rising to 500,000, and it began with the electric Ioniq 5 and Ioniq 9, can also build hybrids, and is to add its first Kia model in 2026. With battery joint ventures with LG Energy Solution and SK On, it is a $12.6 billion investment, the largest in Georgia's history (company).

In March 2025 the group pledged $21 billion of American investment for 2025-28, and on August 26, 2025 it raised the pledge to $26 billion. The money is to expand Hyundai's and Kia's American car output, build a

steel mill in Louisiana, and build a plant able to make 30,000 robots a year, with about 25,000 direct jobs (company).

On September 4, 2025, US immigration agents raided the battery plant that Hyundai and LG Energy Solution were building at the Ellabell site and detained 475 people, more than 300 of them South Korean citizens. The raid came while Korea was settling its tariff deal with the United States (Module 9). Hyundai and Kia both expect 2026 margins near or above their 2025 levels (table, section 7a, and Module 3).

7d. India

India is the world's fourth-largest vehicle producer (Module 1). Sales of passenger vehicles in India were 4.49 million in 2025, up 5.0%, and a record 4.643 million in the year to March 2026, up 7.9%, by the count of the Society of Indian Automobile Manufacturers (SIAM), which counts vehicles shipped from factories to dealers. Two-wheelers, the vehicle most Indians buy, passed 20 million in 2025, up 4.9%.

On September 22, 2025 the government cut the tax on small cars, as part of a reform of its goods and services tax (GST). Small cars are petrol cars with engines of up to 1,200 cc (cubic centimeters) and diesel cars of up to 1,500 cc, no more than 4 meters long. They had paid GST of 28% plus a compensation cess, a surcharge, of 1% for petrol and 3% for diesel, 29% or 31% in all, and now pay 18%. Larger cars, which paid 43-50%, now pay 40%. Passenger-vehicle sales rose 28.3% to 2.637 million in April-September 2026, the first half of India's fiscal year, against the same months of 2025. The tax cut "made vehicles more affordable and injected fresh momentum into the sector", said Shailesh Chandra, SIAM's president, in January 2026.

Maruti Suzuki, majority-owned by Japan's Suzuki, has led India's market since the 1980s. Its share fell to 39.26% in the year to March 2026, a 13-year low and its third annual fall in a row, as buyers moved to SUVs. The tax cut, which favored its small cars, reversed that: Maruti had 40.96% in April-September 2026, against 38.71% a year earlier. Tata Motors had 14.82%, Mahindra, known for its SUVs, 13.58%, and Hyundai 11.57%, down from 13.22%, while Toyota, which sells versions of Maruti's cars under its own badge, had 6.56% and Kia 6.40%. Japanese makers together sold 49.45% of India's passenger vehicles, Indian makers 28.47%, and Korean makers 17.97%. In the year to March 2026 Maruti sold 2,422,713 vehicles, its net sales rose 20.2% to 1.744 trillion rupees ($18.4 billion), its net profit was 144.5 billion rupees ($1.52 billion), and it ended the year with about 190,000 unfilled orders, nearly 130,000 of them for small cars (The Machine Maker, April 29, 2026).

India also exports cars: 905,000 passenger vehicles in the year to March 2026, up 17.5%, of which 447,774 were Maruti's. To attract makers of electric cars, it offers a 15% import duty, instead of up to 110%, on cars with an import value of at least $35,000. Makers qualify by investing at least 41.5 billion rupees ($437 million) and reaching 25% local content within three years and 50% within five, for up to 8,000 cars a year (guidelines of June 2, 2025).

7e. Mexico

Mexico builds cars mostly for other countries. It built 3,953,494 light vehicles in 2025, down 0.9%, and exported 3,385,785, or 86% of them, by the count of INEGI, its statistics institute. The United States took 2,653,897, 78.4% of the exports, Canada 11.1%, and Germany 3.1%. Most of the world's large makers build there, among them GM at Silao, Nissan at Aguascalientes, Volkswagen at Puebla, and Kia at Pesquería. INEGI's count leaves out heavy trucks and buses, which OICA's total includes (Module 1).

In January-September 2026 output fell 2.4% to 2,946,943 and exports 1.5% to 2,528,623, of which 76.4% went to the United States, 12.4% to Canada, 2.6% to Germany, and 1.7% to Brazil, and in September alone output fell 15.1% and exports 11.9%. Every investment decision in Mexico now depends on the US tariff on the non-American content of Mexican cars and on the review of the USMCA (Module 9).

Mexico's own market is smaller. Makers that report to INEGI sold 1,524,583 light vehicles there in 2025, up 1.3%, and 1,143,988 in January-September 2026, up 5.0%. The true totals are higher, because several brands, among them Tesla and the Chinese BYD, Geely, and GAC, do not report their sales to INEGI (Cluster Industrial, July 10, 2025). On Gasgoo's count, which includes them, Chinese brands had 17.2% of Mexico's light-vehicle sales in May 2026, up 2.8 points from a year earlier. Nissan, Chevrolet, and Toyota were the three best-selling brands that month, and BYD, seventh, led the Chinese brands. Mexico was the largest destination for China's vehicle exports in 2025 (Module 4) and raised its tariffs on Chinese cars from January 1, 2026 (Module 9).

7f. Brazil, Southeast Asia, Russia, and Turkey

Brazil, South America's largest car market and producer (Module 1), shows Chinese makers moving from exporting to assembling. Brazil was among the largest destinations for China's exports in 2025 and BYD now assembles cars at Camaçari (Module 4), while Brazil raised its tariff on imported electric cars in steps to 35% on July 1, 2026 (Module 9).

In Southeast Asia, Thailand is the largest producer (Module 1), and about 18 Chinese electric-car brands operate there under incentives tied to building cars locally (Rest of World, July 11, 2025). One of them, Neta, the second-best-selling electric brand in Thailand in 2023, closed showrooms amid more than 220 consumer complaints after its Chinese parent ran short of money (Module 4). In June 2025 Thailand's government proposed tighter rules for its electric-car subsidies. Indonesia, the region's most populous country, got BYD's newest plant in September 2026, and Chinese electric-car exports to both countries grew fast in 2025 (Module 4).

Russia is the clearest case of Chinese brands filling a gap. After Western makers left in 2022, following the invasion of Ukraine, Chinese brands' share of Russia's car sales rose from 6.9% in 2021 to 57.2% in 2025 (*The Guardian*, May 19, 2026). The market itself shrank 25% to 1.014 million in January-September 2025, when the central bank's policy rate was 21% (CarNewsChina, November 17, 2025). To protect its own makers Russia has raised its "recycling fee", a charge on each imported car nominally for its eventual disposal. It rose by about 70-85% on average on October 1, 2024, with increases of 10-20% every January 1 through 2030, and since December 1, 2025 it has risen with engine power, so powerful imports pay more.

Turkey, joined to the EU by a customs union for industrial goods since 1996, builds cars for European makers and courted BYD, whose plant at Manisa is on hold (Module 4). It has also raised its tariffs on Chinese cars (Module 9).

Across these markets the pattern repeats. Where tariffs were low, as in Mexico, or Western makers had left, as in Russia, Chinese brands took share quickly, and where governments tie incentives or tariffs to local assembly, as in Thailand, Brazil, and Indonesia, they have built plants. India is the exception among large markets. It has required government approval for investment from China since 2020, and makers from everywhere outside Japan, India, and Korea, Chinese and European alike, share only about 4% of its passenger-vehicle sales (section 7d).

Worked example — India’s Tax Cut on One Small Car

Take the cheapest version of Maruti Suzuki’s Alto K10, a small petrol car with a 1.0-liter engine, which cost about 423,000 rupees ($4,455) in Delhi before September 22, 2025, tax included. Small petrol cars then paid GST of 28% plus a 1% cess, 29% in all, so the price before tax was 423,000 ÷ 1.29 = 327,907 rupees and the tax was 95,093 rupees. Had Maruti kept its price before tax, the new 18% rate would have made the car 327,907 × 1.18 = 386,930 rupees, a cut of 36,070 rupees ($380), or 8.5%, the effect of the tax change alone. Maruti instead priced the car at 369,900 rupees ($3,895), a total cut of 53,100 rupees ($559), or 12.6%. Its price before tax is now 369,900 ÷ 1.18 = 313,475 rupees, so Maruti also cut its own price by 14,432 rupees, or 4.4%, which with tax saves the buyer another 17,030 rupees ($179). Of the buyer’s saving, 68% came from the government and 32% from Maruti. The government’s take on each car fell from 95,093 to 56,425 rupees, by 41%. If the car’s sales rose as fast as the market’s 28.3%, the government would collect 56,425 × 1.283 = 72,394 rupees for every 95,093 it collected before, 24% less. Maruti’s revenue before tax would rise 22.7%, from 327,907 rupees for one car to 313,475 × 1.283 = 402,188 rupees. Maruti cut deepest on its cheapest cars. On the S-Presso, whose price fell from about 427,000 to 349,900 rupees, its own cut was 10.4% of the price before tax, which made the S-Presso cheaper than the Alto, and on the Swift, a larger small car, it was 2.5%. The tax cut moved money from the state to buyers and raised the maker’s volume, and Maruti added cuts of its own to win share.

Module 7 Key Points

Japan, Korea, India, and the Rest

• Hybrids were 42% of Toyota- and Lexus-brand sales in 2025 and battery-electric cars 1.9%; Toyota forecasts ¥3.0 trillion operating income.

• Nissan lost ¥533.1 billion in the year to March 2026 and is cutting 20,000 jobs and seven of its 17 plants.

• Hyundai’s Georgia Metaplant opened on March 26, 2025; an immigration raid at its battery site on September 4, 2025 detained 475 people.

• India’s tax cut on small cars, from 29% to 18% on September 22, 2025, lifted sales 28.3% in April-September 2026.

• Mexico exported 86% of the 3,953,494 light vehicles it built in 2025, and 78.4% of the exports went to the United States.

• Chinese brands took 57.2% of Russia’s car sales in 2025, up from 6.9% in 2021.

Module 7 Quiz

Check Your Understanding

1. What share of Toyota- and Lexus-brand sales were hybrids in 2025?

A) 42%
B) 1.9%, the battery-electric share
C) About 10%, as in most markets
D) Over 60%, counting plug-in hybrids

2. What does Nissan’s recovery plan, Re:Nissan, do to its car plants?

A) It closes all of Nissan’s plants in Japan.
B) It cuts them from 17 to 10 by March 2028, so that Nissan’s capacity falls from 3.5 million to 2.5 million vehicles a year.
C) It moves Sunderland’s work to Mexico.
D) It adds three plants in the United States to avoid tariffs.

3. How many people did US immigration agents detain at the Hyundai-LG battery plant site in Georgia on September 4, 2025?

A) About 47, all American contractors
B) 475
C) More than 3,000, most of them Mexican
D) 300, all of them engineers flown in from Ulsan

4. In the worked example, how was the Alto K10’s price cut of 53,100 rupees divided?

A) About two-thirds came from the lower tax rate and about one-third from Maruti’s own cut in its price.
B) All of it came from the lower tax rate.
C) Maruti cut its own price by more than the tax cut saved.
D) Most came from Maruti, and the tax change added about 1%.

5. What share of Mexico’s light-vehicle exports went to the United States in 2025?

A) 95%
B) 86%, the share of its output that Mexico exported
C) 78.4%
D) About two-thirds, the share of its output bought by Americans

Module 8 — The Electric Transition

How Far, How Fast, and Where

Recommended Reading / Reference

Book: Levi Tillemann, *The Great Race: The Global Quest for the Car of the Future* (2015), a history of the race among America, Japan, and China to build the electric car, by a former adviser at the US Department of Energy

Reference: The IEA's *Global EV Outlook 2026* (May 20, 2026) for the world and its regions, and Rho Motion's monthly sales tracker for 2026 so far

8a. What Counts as Electric

Four kinds of car use a battery to drive the wheels. A **battery-electric vehicle (BEV)** runs on its battery alone and charges from the grid. A **plug-in hybrid (PHEV)** has a smaller battery that charges from the grid and a gasoline engine that takes over when the battery runs low. An **extended-range EV (EREV)** is a plug-in whose engine only charges the battery and never drives the wheels. A **hybrid (HEV)**, such as Toyota's Prius, cannot be plugged in: its small battery is charged by the engine and by braking, and it burns less fuel than a gasoline car of the same size while refueling the same way.

In this course, as in the counts of the IEA and of the research firm Rho Motion, an electric car means a BEV or a plug-in hybrid, with EREVs counted among the plug-ins and hybrids left out. The other measures differ in what they include and when they count a sale, and the differences are large enough to change a headline, so the table sets out the measures this course uses. Cox's American share, for one, counts only battery-electric cars, so it runs below any count that includes plug-in hybrids.

Source	What it counts as electric	Where	When a sale is counted
IEA	BEVs and plug-in hybrids, EREVs included; passenger cars only	World, by country	Sales to buyers, annual
Rho Motion	BEVs and plug-in hybrids; cars, vans, and other light commercial vehicles	World, by region	Sales to buyers, monthly
CAAM	New-energy vehicles: BEVs, plug-in hybrids, EREVs, and fuel-cell vehicles, trucks and buses included	China	Shipments from factories, exports included
CPCA	New-energy passenger cars	China	Retail sales in China
ACEA	Battery-electric and plug-in hybrid cars, reported separately	EU, EFTA, and UK	New registrations
Cox Automotive	Battery-electric cars only	United States	Sales estimates, quarterly
National Automobile Dealers Association (NADA)	Battery-electric, plug-in hybrid, and hybrid shares, each separately	United States	Sales, monthly

Definitions as each organization publishes them. Unless a sentence says otherwise, "electric car" in this course means a BEV or a plug-in hybrid.

8b. The World in 2025

More than 20 million electric cars were sold worldwide in 2025, 20% more than in 2024 and about a quarter of all new cars, by the IEA's count in its *Global EV Outlook 2026* (May 20, 2026). Battery-electric cars were 65% of them and plug-in hybrids about 35%, with EREVs under 7% of the total. Nearly 80 million electric cars were on the world's roads at the end of 2025, about 5% of all cars. The fleet changes far more slowly than sales, because each year's new cars replace only a small part of it.

China dominated every part of the business: it bought more than 13 million of the world's electric cars, about two-thirds, and built nearly three-quarters of the almost 22 million produced. Chinese makers supplied 60% of the electric cars sold worldwide, against about 15% each for European and North American makers. Outside China, Europe, and the United States, 55% of the electric cars sold were imports from China, up from under 5% five years earlier (IEA), and Module 4 covers China's own market.

In the United States, sales were about 1.5 million in 2025, slightly fewer than in 2024 and about 10% of new cars on the IEA's count, and they fell at the end of the year. Buyers rushed to buy before the federal credit ended on September 30, 2025 (Module 10), and fourth-quarter sales were 45% lower than a year earlier, a share of 6-7%. The table gives the IEA's figures for the other main markets.

Market	Electric cars sold, 2025	Share of new car sales
Europe	4.2 million	28%
Germany	850,000	About 30%
Norway	—	About 97%
Southeast Asia	More than 500,000	About 20%
Turkey	About 240,000	More than 20%
Brazil	180,000	9%
India	165,000	About 4%
South Korea	More than 200,000	11%
Japan	—	Under 3%

IEA, *Global EV Outlook 2026* (May 20, 2026); battery-electric and plug-in hybrid cars together. The EU's battery-electric share on ACEA's count is in Module 5, and China's share of its own market in Module 4. A dash means the IEA gives no count.

8c. 2026 So Far

In January-September 2026 the world bought 15.5 million electric cars and vans, 3% more than a year earlier, by Rho Motion's count (October 16). The total hides a split: China's sales fell 13% to 8.1 million after its purchase-tax exemption was halved (Module 4), and North America's fell 24% to 1.2 million. Europe's rose 30% to 3.9 million, and the rest of the world's rose 93% to 2.3 million. September alone, at 2.15 million, was 2% below September 2025.

The forecasts made in the spring were higher: the IEA expected about 23 million electric cars in 2026, about 28% of new cars, even after first-quarter sales fell 8% to about 3.9 million (May 2026). It expected high oil prices to push buyers toward electric cars after the war in the Middle East caused what its executive director since 2015, Fatih Birol, described as the largest oil supply shock in history (Module 6 covers the oil price). BNEF forecast more than 23 million in June, 11% more than in 2025 and 27% of sales. Rho Motion's count through September, up 3%, is running well below that pace.

The fastest growth is in markets that had few electric cars: Rho Motion's "rest of the world", everywhere outside China, Europe, and North America, bought 310,000 in September alone, 81% more than a year

earlier. Much of that growth is cheap Chinese cars, whose destinations Module 4 traces. Europe set a monthly record in September, about 600,000, 39% more than a year earlier.

The United States has fallen furthest among large markets, with battery-electric cars at 6.5% of US sales in the third quarter of 2026 by Cox's count: 266,630 cars, 7.7% more than in the second quarter but 38.6% fewer than in the rush of the third quarter of 2025. January-September sales were 729,869, down 29.9%, and Tesla sold about 54% of the third quarter's. Hybrids gained while electric cars fell, reaching 15.6% of US sales in January-September 2026, 3.1 points more than a year earlier, by NADA's count.

8d. What Batteries and Cars Cost

The battery is the costliest single part of an electric car, and BNEF's annual survey (December 9, 2025) put the average lithium-ion pack at $108 per kWh in 2025, 8% less than in 2024. Packs for battery-electric cars averaged $99, at which price a 60 kWh pack costs about $5,940. Packs built from lithium iron phosphate (LFP) cells, which store less energy for their weight but cost less and catch fire less readily, averaged $81. Packs built from nickel manganese cobalt (NMC) cells, which store more, averaged $128. Packs averaged $84 in China and cost 44% more in North America and 56% more in Europe.

LFP cells made up more than 55% of the electric-car batteries installed worldwide in 2025, up from nearly 50% in 2024, and China makes more than 80% of the world's battery cells (IEA). Two newer chemistries are coming, and the nearer is sodium-ion, which uses sodium in place of lithium. Changan's Nevo A06, which uses sodium-ion cells from the Chinese battery maker CATL, was unveiled on February 5, 2026 as the first such car for mass production, and CATL expected 10,000-20,000 cars to use its sodium-ion cells in 2026. Solid-state cells promise more energy per kilogram, but Toyota plans its first for 2027-28 (Module 7) and Samsung SDI for the second half of 2027.

Pack prices may not fall in 2026, because lithium prices more than doubled in the year to early 2026, though they stayed about 70% below their 2022 peak. Cobalt prices doubled after the Democratic Republic of the Congo, the largest producer, banned exports and then set quotas (IEA), and BNEF's survey for 2026 is expected in December.

Whether an electric car costs more than a gasoline one depends on where it is sold. In China it already costs less: battery-electric cars were cheaper on average than comparable gasoline cars in 2025 (BNEF), and 70% of those sold cost less than the average conventional car (IEA). In Germany, Italy, and the United Kingdom, BNEF found battery-electric cars about 17% dearer than comparable gasoline cars in 2025, down from 34%. Thailand has had parity for two years, and Indonesia's premium fell from more than 50% to about 40% (IEA).

In the United States the average transaction price, what buyers paid after discounts, was $55,879 for a battery-electric car in September 2026, 3% less than a year earlier, Cox found. That was 11% more than the average gasoline car, a premium that has held through 2026 and is down from about 18% on average in 2025. Discounts made up 11% of the electric price, against 14.2% a year earlier, so the gap narrowed with less discounting, not more.

8e. Charging

A buyer's next question is where to charge, and the United States had 76,236 public fast-charging ports on September 1, 2026, by the count of the Energy Department's Alternative Fuels Data Center (AFDC), of which Tesla ran 37,995, or 49.8%. Paren, a charging-data firm that counts differently, found 80,964 fast

ports at 14,614 sites at the end of September, with 4,106 added in the third quarter, 12% fewer than a year earlier. Counting the slower Level 2 chargers, which take hours to fill a battery, the country had 253,319 public ports on June 22, 2026. The IEA counted 33 electric cars per public charging point in the United States in 2025, against about 11 worldwide.

The question of the plug is settled, because most makers selling in North America have adopted Tesla's connector, standardized as the North American Charging Standard (NACS), and about 20 brands' cars can use Tesla's Superchargers. The $5 billion National Electric Vehicle Infrastructure (NEVI) program of 2021, which pays for chargers along highways, was frozen in February 2025 and restarted under new guidance in August 2025. About 550 fast-charging points paid for by it were working in 19 states in April 2026, with about 1,000 more awarded (IEA).

China has built far more, with 24.223 million charging points at the end of August 2026, 39.6% more than a year earlier: 5.16 million public and 19.06 million private, by the count of its National Energy Administration. Its public points are more than 65% of the world's, which numbered more than 7 million at the end of 2025 (IEA). The EU had 1.1 million public chargers at the end of 2025. Its Alternative Fuels Infrastructure Regulation (AFIR) requires fast-charging stations at least every 60 km along its main highways, and 79% of that network met the 2025 target in June 2026, by the count of the campaign group Transport & Environment.

Chinese makers now compete on charging speed, and BYD showed a 1,000-kilowatt (kW) charger in March 2025 that it said adds about 400 km of range in five minutes. In March 2026 it showed a battery that it said charges from 10% to 70% in about five minutes at up to 1,500 kW, and BYD said it planned 20,000 such stations in China in 2026, of which it had built 4,239 in January and February.

8f. Emissions over a Car's Life

Making an electric car emits more than making a gasoline car, mostly because of the battery, and the electric car repays that debt by emitting nothing from its tailpipe, at a pace that depends on the grid that charges it. The International Council on Clean Transportation (ICCT), a research group, compared medium-sized cars registered in 2021 over their lives (July 2021). Battery-electric cars' greenhouse emissions were 66-69% below a gasoline car's in Europe, 60-68% below in the United States, 37-45% below in China, and 19-34% below in India, where most power comes from coal.

The IEA reached similar results for cars sold in 2023 (*Global EV Outlook 2024*). Over 15 years and about 200,000 km, a medium battery-electric car emitted about half as much as a gasoline car, more than 40% less than a hybrid, and about 30% less than a plug-in hybrid. The gap against a gasoline car was about 65% in the United States, 40% in China, and 20% in India.

Electric vehicles of every kind, including two- and three-wheelers, buses, and trucks, displaced about 1.7 million barrels of oil a day in 2025, the IEA estimates, of which electric cars accounted for about 1.2 million, and it expects about 5 million barrels a day by 2030. The minerals run the other way: an electric car needs about six times the mineral inputs of a conventional car, not counting steel and aluminum (IEA, 2021). Recycling returns few of them yet, because most batteries recycled today are factory scrap and old car batteries become the main supply only in the mid-2030s. China has more than 85% of the world's recycling capacity (IEA).

8g. Is the Transition Stalling Outside China? The Cases as Their Advocates Make Them

The case that it is stalling: those who see a stall, BNEF among them, start with the United States, where sales fell in 2026 once the federal credit was gone (section 8c). BNEF expects US electric-car sales to fall 19% in 2026, and it cut its forecast of the electric share of US sales in 2040 from 71% to 57% (June 2026). The older makers have cancelled electric models and written down billions (Modules 3 and 6), so fewer new models are coming. Buyers who left gasoline cars chose hybrids, which need no chargers. With China's home market shrinking as well, world growth has all but stopped.

The case that it is not: the IEA and others argue that the slowdown is a pause in the two markets where governments withdrew support, not a turn. World sales still grew while those two shrank, and Europe and the emerging markets grew fastest (section 8c). American sales in the third quarter of 2026 were the highest of the year, the first full year without a federal credit, and the price premium has narrowed. Chinese exports are putting cheap electric cars into markets where almost none were sold five years ago. High oil prices add a push that the forecasts of 2025 did not include.

What the evidence says: sales fell where governments withdrew support and rose where rules tightened or fuel costs rose. On Rho Motion's rounded figures, sales outside China rose about 28% in January-September 2026, from about 5.8 million to 7.4 million. Leaving out North America too, they rose about 48%, from about 4.2 million to 6.2 million. The American fall followed the end of the credit and of the rules that made carmakers sell electric cars, while Europe's rise came as its fleet targets tightened (Module 10). Even BNEF, which cut its American outlook, still forecasts electric cars at 38% of the world's passenger-car sales in 2030.

The course's reading, stated once: outside China the transition is not stalling but splitting, with the United States the one large market going backward. The American stall follows a policy choice and could reverse with another, but as long as it lasts, the older makers will sell hybrids at home while Chinese makers sell electric cars in the fastest-growing markets. That is the course's larger question in one market: the time the American pause buys is useful to those makers only if they use it to make electric cars that can compete on cost.

Worked example — Eight Years of an Electric Car, a Hybrid, and a Gasoline Car

Take three versions of a compact crossover, each driven 12,000 miles a year for eight years, 96,000 miles in all. Every input is an illustrative assumption unless a source is named. The gasoline version costs $35,000 and gets 30 miles per gallon, and the hybrid costs $37,000 and gets 45. The battery-electric version costs $38,850, 11% more than the gasoline car, the US premium of September 2026 (section 8d), with no federal credit. It uses 0.30 kWh per mile at the plug, charging losses included. It takes 80% of its charge at home at 18.2 cents per kWh, the EIA's forecast of the average US residential price for 2026 (October 6, 2026), and 20% at public fast chargers at 48 cents, for a blended 24.16 cents. After eight years the gasoline car keeps 30% of its price, the hybrid 33%, and the electric car 22%, and insurance, maintenance, and financing are left out. At $4.50 a gallon, the gasoline car loses $24,500 of value and burns 3,200 gallons costing $14,400, for $38,900 in all, or 40.5 cents a mile. The hybrid loses $24,790 and burns 2,133 gallons costing $9,600, for $34,390, or 35.8 cents a mile. The electric car loses $30,303 and uses 28,800 kWh costing $6,958, for $37,261, or 38.8 cents a mile. It beats the gasoline car by $1,639 but loses to the hybrid by $2,871. The break-even prices follow from the gallons: the electric car matches the gasoline car when 3,200 gallons cost $12,761 ($37,261 less $24,500), a price of $3.99 a gallon. It matches the hybrid only when 2,133 gallons cost $12,471 ($37,261 less $24,790), a price of $5.85. The hybrid beats the gasoline car at any price above 27 cents. Charging only at home lowers the electric car's break-even against the hybrid to $5.04. If the electric car kept 30% of its value like the gasoline car, it would cost $34,153 and beat the hybrid at any price above $4.39. Eight points of resale value, worth $3,108, move the result more than a $1 rise in gasoline, which adds $2,133 to the hybrid's fuel bill.

Module 8 Key Points

The Electric Transition

• More than 20 million electric cars were sold in 2025, about a quarter of new cars, and China bought about two-thirds of them.

• In January-September 2026 world sales rose 3%: Europe up 30%, the rest of the world up 93%, China down 13%, North America down 24%.

• Battery-electric cars were 6.5% of US sales in the third quarter of 2026 (Cox), and hybrids 15.6% of January-September sales (NADA).

• Battery packs averaged $108 per kWh in 2025; electric cars cost less than gasoline ones in China and 11% more in America.

• Over its life a battery-electric car emits 60-69% less than a gasoline car in Europe and America, and 19-45% less in China and India.

• Outside China, sales rose about 28% in January-September 2026; the stall is American and follows the end of federal support.

Module 8 Quiz

Check Your Understanding

1. How did electric-car sales change in January-September 2026, by Rho Motion's count?

A) World sales fell 8%, with every region lower

B) They rose 3% in every region

C) China rose 13%, Europe fell 30%, North America rose 24%, and the rest of the world rose 93% as exports surged

D) World +3%: China -13%, North America -24%, Europe +30%, and the rest +93%

2. What did BNEF's survey of December 2025 find for battery packs?

A) $128 per kWh

B) Packs for every use averaged $99, the same in China, Europe, and North America

C) An average of $108 per kWh, 8% less than in 2024

D) An average of $84 per kWh worldwide, because cheap Chinese LFP packs pulled North American and European prices down to China's level

3. Why does Cox's US electric-car share run below a count like the IEA's for the same market?

A) Cox counts only cars assembled in the United States and leaves out every import from Korea, Japan, and Europe, which the IEA includes

B) Cox measures registrations, not sales

C) Cox leaves out Tesla's direct sales

D) It leaves out plug-in hybrids

4. In the worked example, what decides whether the electric car beats the hybrid at $4.50 gasoline?

A) Resale value: if the electric car kept 30% of its price, it would beat the hybrid.

B) The cost of electricity, which would have to fall below zero.

C) The hybrid's fuel economy, which is too low to matter.

D) The federal tax credit, which still pays $7,500 to buyers of electric cars assembled in North America and closes the gap.

5. What is the course's reading of whether the electric transition is stalling outside China?

A) It is stalling everywhere, because world sales rose only 3% in 2026.

B) It is not stalling but splitting: sales outside China rose about 28%, and the stall is an American one that follows the end of federal support.

C) It is stalling in Europe, where sales fell 30% in 2026.

D) It has stopped in China, which now exports most of the electric cars it builds.

Module 9 — Tariffs and Trade

The Walls Around the World's Car Markets

Recommended Reading / Reference

Book: Douglas A. Irwin, *Clashing over Commerce: A History of US Trade Policy* (2017), the standard history of American tariffs from 1789, and of the arguments over protection that the car tariffs of 2025-26 revive

Reference: The Office of the US Trade Representative's *2026 USMCA Autos Report to Congress* (July 1, 2026), and the proclamations and notices in the *Federal Register*, the sources for the rules and rates here

9a. Where America's Cars Come From

About three-quarters of the light vehicles Americans buy are built in North America. The import count of the Bureau of Economic Analysis (BEA), vehicles built outside the US, Canada, and Mexico, was 22.0% of sales in September 2025 and 23.5% in November 2025, against a high of 26.3% in November 2023 (Haver Analytics, from BEA data). BEA does not separate the three North American countries, whose factories work as one system under the USMCA of 2020.

Inside that system parts cross the borders several times, and the American share of them has fallen. In the count of the Office of the US Trade Representative (USTR), US content in Mexican-built vehicles fell from over 60% to 35%, and in Canadian-built vehicles from 85% in 2017 to 50% in 2024 (July 1, 2026). The US ran an auto trade deficit with Mexico of $131.6 billion in 2025, against $138.2 billion in 2024, and USTR found that 24% of 961 checks of whether vehicles met the agreement's origin rules failed. To qualify under the agreement, a vehicle must be 75% North American by value, and 40% of a car's value, 45% of a light truck's, must come from plants that pay production workers an average of at least $16 an hour. Module 7 covers Mexico's industry.

9b. The Section 232 Tariffs

Section 232 of the Trade Expansion Act of 1962 lets the President restrict imports that the Commerce Department finds threaten national security. On March 26, 2025 President Trump used it, on the strength of a Commerce report of February 17, 2019, to put a 25% tariff on imported cars and light trucks from April 3, 2025 and on their parts from May 3, 2025. The tariff comes on top of the most-favored-nation (MFN) duty, the rate for countries without a better deal, which is 2.5% for cars, so a car that paid 2.5% before April 2025 paid 27.5% after.

Vehicles that qualify under USMCA pay the 25% only on the value of their non-US content, once the government approves the maker's accounting of that content. Qualifying parts have stayed tariff-free, because the Commerce Department had not set up a way to charge them by July 1, 2026, and 70.9% of parts imports claimed USMCA treatment in 2025. To soften the parts tariff for cars assembled in America, an order of April 29, 2025 created an offset. A maker may credit up to 3.75% of the sticker price, the manufacturer's suggested retail price (MSRP), of the vehicles it assembles in the US against the tariffs on its imported parts, and a companion order the same day stopped the car tariffs from stacking on top of the steel and aluminum tariffs. On October 17, 2025 the President kept the offset at 3.75% to April 30, 2030, where it had been due to fall to 2.5% in May 2026.

Four trading partners bought lower rates, which the table lists. Japan's came with a pledge of $550 billion of investment in the US. Korea, which pledged $350 billion, was threatened with a return to 25% in late January 2026, when President Trump said its parliament had not passed the law behind its pledge, and the parliament passed it on March 12, 2026 by 226 votes to 8.

Where the vehicle comes from	US tariff	In force from	Legal basis
Japan	15%, all duties included	September 16, 2025	Executive order of September 4, 2025
European Union	15%, or the MFN rate if higher	August 1, 2025, applied from September 25	Federal Register notice of September 25, 2025
South Korea	15%, all duties included	November 1, 2025, applied from December 4	Federal Register notice of December 4, 2025
United Kingdom	10% for 100,000 cars a year; 25% above the quota	June 2025	Executive order of June 2025
Medium and heavy trucks, from anywhere	25%, and 10% on buses; USMCA trucks pay on non-US content	November 1, 2025	Proclamation of October 17, 2025

Rates in force on October 22, 2026; the general rate and the USMCA rule are in the text. Federal Register; Butzel; Thomson Reuters. Chinese cars face further tariffs (section 9f).

9c. The Courts and the Deals

The tariffs that fell in court were different ones. In 2025 the President also imposed tariffs under the International Emergency Economic Powers Act (IEEPA) of 1977, among them a 25% tariff on Canadian and Mexican goods that did not qualify under USMCA. On February 20, 2026, in *Learning Resources, Inc. v. Trump*, the Supreme Court ruled by 6 votes to 3 that "IEEPA does not authorize the President to impose tariffs." The Section 232 tariffs and the deals that adjust them were untouched. Importers got refunds: Ford recorded $1.3 billion in the first quarter of 2026, Stellantis €400 million ($449 million at October 16, 2026 exchange rates, the rates used throughout this module), and GM a gain of about $500 million.

A 10% surcharge under Section 122 of the Trade Act of 1974 filled the gap from February 24 to July 24, 2026. Tariffs of 10% to 12.5% by country then replaced it under Section 301 of the same act, which lets USTR act against foreign practices that burden American commerce. Section 232 goods are generally exempt from them, as are qualifying USMCA goods.

The agreement's first joint review, on July 1, 2026, ended without renewal. USTR said "the United States did not agree to renew the USMCA in its current form," so the agreement now gets a review every year, with no date yet set for the next one, and it expires on July 1, 2036 unless the three governments extend it. Washington wants 50% US content in vehicles for preferential access, which Mexico has called a non-starter. A US-Mexico deal under negotiation in October 2026 would cut the rate on Mexican light vehicles to 15% on their non-US content, but it was not final (Mexico Business News, October 1).

With Canada the dispute escalated. On July 20, 2026 the President used Section 338 of the Tariff Act of 1930 to impose tariffs for the first time, adding 50% to about $20 billion of Canadian goods from August 22, whether or not they qualify under USMCA. The duties exclude every good under Section 232, so Canadian vehicles and parts are not covered (C.H. Robinson, August 22). The list called "motor vehicles" is named for the Canadian practice it answers, a 25% surtax on US-built vehicles, and contains no vehicles. On August 24 President Trump posted that tariffs on Canadian cars, trucks, parts, and steel would rise to 50% on January 1, 2027, with US-built vehicles exempt. As of October 22, 2026 no proclamation had followed the post.

The truce between Washington and Beijing, agreed on October 30, 2025, was extended in late September 2026 from November 10, 2026 to January 10, 2027, keeping the tariff relief in place. Whether China's pause on its wider rare-earth controls was extended with it has not been confirmed in writing (Module 2). It leaves the 100% tariff on Chinese electric cars in place (section 9f).

9d. The Bills

Carmakers report what the tariffs cost them, each on its own basis. *Automotive News* counted “at least $35.4 billion since 2025” across the industry, with BMW, Honda, Hyundai-Kia, Mazda, Mercedes, Nissan, Subaru, and Volkswagen each above $1 billion (March 16, 2026). The table sets the largest makers’ own figures side by side.

Maker	Tariff cost	Period	What the figure counts
GM	$3.1 billion	2025	The year’s cost, as GM reported it in January 2026
GM	$2.5-3.5 billion	2026, guidance of April 2026	Gross cost, cut from $3-4 billion; about $900 million in the second quarter
Ford	$1.0 billion	2025, forecast in October 2025	Net cost after offsets, in Ford’s own release
Ford	About $2 billion	2025, stated in February 2026	The finance chief’s figure, after the offset was limited
Stellantis	€1.0-1.2 billion ($1.12-1.35 billion)	2026, guidance	Net cost; €300 million in the first half, after the refund
Toyota	¥1.38 trillion ($8.73 billion)	Year to March 2026	Toyota’s estimate of the cost to its operating profit
Hyundai	4.1 trillion won ($3.07 billion)	2025	Hyundai Motor alone; 7.2 trillion won ($5.40 billion) with Kia
Volkswagen	€2.9 billion ($3.26 billion)	2025	The direct charge in its annual report
Volkswagen	“Some 5 billion euros” ($5.62 billion)	2025	The chief executive’s figure, direct and indirect

Company releases and statements; Bloomberg Law (February 11, 2026); GCN (August 13, 2026); Quartz (May 8, 2026); Korea Times (January 29, 2026).

The figures measure different things, and the gaps between them are the lesson. Ford’s lower figure came before December 23, 2025, when Ford learned that it could apply the expanded offset only back to November, not to May, which added about $900 million to its 2025 bill (Bloomberg Law). Volkswagen’s 2025 operating margin was 4.6% before special items and 5.5% before special items and tariffs. Oliver Blume, its chief executive since September 2022, counted direct and indirect effects when he gave his larger figure in March 2026.

9e. What the Tariffs Did

Forecasts of the effect on prices were large. The Yale Budget Lab estimated in March 2025 that the 25% tariffs would raise vehicle prices 13.5% on average, about $6,400 on an average 2024 new car. After the offsets, Anderson Economic Group, a Michigan consultancy, estimated $2,000-3,000 for US-assembled models with the fewest imported parts, and $10,000-15,000 for full-size SUVs and cars assembled in Europe and Asia (May 2025). Goldman Sachs expected $2,000-4,000 within six to twelve months (April 2025).

Measured prices rose much less. Kelley Blue Book's average transaction price, the average that buyers actually paid, rose 2.5% from March to April 2025, against a typical April rise of about 1.1%, and passed $50,000 for the first time in September 2025, at $50,080. Over 2025 the CPI for new vehicles rose only 0.3%, by the count of the Bureau of Labor Statistics (BLS). Section 9g weighs who has paid the difference between the forecasts and the outcome. Module 12 has today's prices.

The tariffs' purpose is to move production, and the makers have announced American investments with dates. Hyundai Motor Group raised its pledge for 2025-28 to $26 billion in August 2025 (Module 7). Stellantis announced $13 billion over four years on October 14, 2025, the largest in its 100-year US history, to raise its US output 50% and reopen its Belvidere, Illinois plant in 2027 with about 3,300 jobs. GM said in June 2025 that it would spend about $4 billion over two years to build more gasoline vehicles in three US plants from 2027 (Module 6). Toyota announced up to $10 billion more over five years on November 12, 2025.

Factory jobs have not yet followed. *Automotive News* counted about 11,000 fewer jobs at vehicle and parts plants in July 2026 than in March 2025, the month before the tariffs took effect, a fall of about 1% (Module 2 has the levels). Most of the announced production starts in 2027-29.

9f. The Walls Against China

The highest wall is America's. Under Section 301 the US has charged 100% on Chinese electric cars since September 27, 2024, and 25% on their batteries, on top of the other tariffs. A rule of the Commerce Department's Bureau of Industry and Security (BIS), final on January 14, 2025, bans Chinese and Russian software for connecting and driving cars from model year 2027 and hardware from model year 2030. It also bars any maker with a "sufficient nexus" to China or Russia from selling new connected cars in the US from model year 2027, "even if the vehicle was made in the United States." Since nearly every new car connects to a network, the rule keeps Chinese brands out of the US whatever the tariff.

Others have built lower walls, some with gates. Mexico raised its tariff on cars from countries without a trade agreement with it, China among them, from 20% to as much as 50% on January 1, 2026 (*Automotive Logistics*). Canada, which put a 100% tariff on Chinese electric cars in 2024, cut it to 6.1% for up to 49,000 vehicles a year in January 2026, in a deal in which China agreed to cut its combined tariff on Canadian canola seed from about 84% to about 15% by March 1 (CBC, January 16, 2026).

Brazil has restored its import tax on electric cars in steps, from 10% in January 2024 to 35% from July 1, 2026. Kits for local assembly reach the same 35% by January 2027, and a duty-free quota of $463 million for kits from July to December 2026 serves BYD's plant in Camaçari (Agência Brasil, June 24, 2026; Module 4 has the plant). Turkey added 40% to the duty on Chinese electric cars in March 2023 and extended that extra duty to Chinese gasoline and hybrid cars in June 2024 (Yicai, June 11, 2024). It raised the extra duty on those to 50% on January 1, 2025, on top of a 10% standard duty, with BYD exempted for its planned plant (AGBI, January 2025). Europe's anti-subsidy duties are in Module 5, and Russia's recycling fee in Module 7.

9g. Do the Tariffs Protect American Manufacturing or Tax American Buyers? The Cases as Their Advocates Make Them

The case that the tariffs protect American manufacturing: USTR argues in its report of July 1, 2026 that the old rules let American content drain away, as the falling US shares of Mexican-built and Canadian-built

vehicles, the failed origin checks, and the deficit with Mexico show (section 9a). The 2.5% MFN duty, USTR says, is “too low to sufficiently incentivize changes to product sourcing.” Supporters point to the investments the tariffs have drawn from Hyundai, Stellantis, GM, and Toyota (section 9e) and to the pledges from Japan and Korea (section 9b). A tariff that stays in place, they argue, makes building in America cheaper than importing, which no subsidy has done.

The case that the tariffs tax American buyers: The Detroit Three told the White House in March 2025 that tariffs on Canada and Mexico would hurt American companies more than their foreign rivals, because their supply chains run through both countries, and won a pause for USMCA vehicles. Commenters told USTR that the 15% deals let a Japanese, Korean, or European car with no American content pay as little as a Mexican-built car with some (worked example). The tariff on parts raises the cost of cars built in America too, and economists such as those at the Yale Budget Lab expected the tariffs to raise prices by 13.5% on average (section 9e). On this view the money comes out of buyers’ pockets and makers’ investment budgets, and plants planned on rates that change by proclamation or post may never be built.

What the evidence says: eighteen months after the tariffs began, both sides can point to something. The makers have paid tens of billions of dollars (section 9d), while new-car prices rose far less than the forecasts (section 9e), so the cost has so far fallen mostly on the companies and their shareholders. Part of it reaches buyers in ways a price index misses, such as smaller discounts and fewer cheap models (Module 12). The announced investments are real decisions with dates, but most of their output is still to come, and employment in vehicle and parts plants has fallen slightly (section 9e). USTR’s latest measure of US content is for 2024, before the tariffs.

The course’s reading, stated once: so far the car tariffs have worked more as a tax than as protection. The tax has fallen mostly on the carmakers, foreign and American alike, and is reaching buyers slowly, while the protection exists mostly as plants still to open. The tariffs can still protect American manufacturing, but only if those plants are built and the rates stay stable enough to plan around, which rates set and changed by proclamation, deal, and post in 2025-26 have not been. A structure that charges a Mexican-built car with American parts as much as a Japanese car with none works against its own stated aim.

Worked example — Three Imported Cars and a Threat

Take three cars, each with a customs value, the price declared at the border, of $30,000, an illustrative figure. The first is built in Japan and pays the deal rate of 15% on its full value, $4,500. The second is built in Mexico, qualifies under USMCA, and has an assumed 40% US content, so it pays 25% on the other 60%: 25% of $18,000, or $4,500, an effective 15%. At USTR’s average US content for Mexican-built vehicles, 35%, it would pay 25% of $19,500, or $4,875. The third is built in Canada, qualifies, and has 50% US content, USTR’s 2024 average for Canadian-built vehicles, so it pays 25% of $15,000, or $3,750, an effective 12.5%. Compare a car assembled in the US with $8,000 of imported parts that do not qualify under USMCA, which pay 25%, or $2,000. If it carries a $40,000 sticker price, the offset lets its maker credit 3.75% of that, $1,500, against its parts tariffs, so the net tariff is $500, or 1.25% of the sticker price. Now apply the threatened 50% to the Canadian car. If it applies to the non-US content, as the 25% does now, the bill doubles to $7,500, an effective 25%. If it applies to the full value, the bill is $15,000, four times today’s. The post of August 24, 2026 did not say which.

Module 9 Key Points

Tariffs and Trade

• The 25% Section 232 tariff on imported cars began on April 3, 2025; Japan, the EU, and Korea pay 15%.

• USMCA cars pay 25% only on non-US content, and US-assembled cars earn an offset of 3.75% of sticker price until April 30, 2030.

• The Section 338 duties of August 22, 2026 exclude Canadian vehicles; the threatened 50% from January 1, 2027 had no proclamation.

• Carmakers reported at least $35.4 billion of tariff costs by March 2026; Toyota’s was ¥1.38 trillion in its year to March 2026.

• The US charges 100% on Chinese electric cars and bars makers with Chinese ties from connected-car sales from model year 2027.

• So far the tariffs have worked more as a tax, paid mostly by carmakers, than as protection; most announced plants open from 2027.

Module 9 Quiz

Check Your Understanding

1. Why do the Section 338 duties that took effect on August 22, 2026 leave Canadian cars and parts untouched?

A) Because the duties apply only to goods that fail to qualify under USMCA, and nearly all Canadian cars qualify

B) Because they exclude every good already covered by the Section 232 tariffs, and their “motor vehicles” list contains no vehicles

C) A court blocked them

D) Canada paid a settlement

2. What does a Mexican-built car that qualifies under USMCA pay under the Section 232 tariff?

A) It pays 25% on the value of its non-US content.

B) It pays nothing, because USMCA cars are exempt from Section 232.

C) It pays 15% on its full value.

D) It pays 25% on its full value, plus the 2.5% duty charged on all imported cars.

3. What did the Supreme Court decide on February 20, 2026?

A) It struck down the Section 232 car tariffs and ordered refunds to every importer.

B) It ruled that tariffs under the Tariff Act of 1930 need a vote of Congress.

C) It let the President impose emergency tariffs for 150 days without a vote of Congress.

D) IEEPA does not let the President impose tariffs.

4. In the worked example, why does the Japanese car pay the same tariff as a Mexican-built car with 40% US content?

A) The Japanese car pays nothing under the 2025 deal.

B) Both pay 25% on their full value.

C) Japan's 15% applies to the whole car, while the Mexican car pays 25% on the 60% that is not American.

D) The Mexican car pays the 2.5% duty on top of 25%, while Japan's deal waived every duty on its cars in return for $550 billion of investment.

5. What is the course's reading of the car tariffs as of October 2026?

A) Pure protection

B) A tax paid by foreign carmakers alone

C) Protection that has added plant jobs

D) More tax than protection, so far

Module 10 — The Rules

Emissions, Fuel Economy, and Safety

Recommended Reading / Reference

Book: Ralph Nader, *Unsafe at Any Speed: The Designed-In Dangers of the American Automobile* (1965), the attack on the industry's neglect of crash safety that helped bring the first federal car-safety law in 1966

Reference: NHTSA's final fuel-economy rule (*Federal Register*, September 30, 2026), the EU's carbon dioxide rules for cars (Regulation (EU) 2019/631, as amended), and NHTSA's Crash Stats publications on deaths on the roads

10a. Why and How Cars Are Regulated

Governments regulate cars for three reasons: the pollution they emit, the oil they burn, and the deaths and injuries in crashes. Much of the cost of the first two falls on people other than the buyer, and no buyer can test a car's crash protection before buying it. In the United States each concern has its own agency. The EPA limits tailpipe pollution under the Clean Air Act of 1970, and from 2010 it also set greenhouse-gas standards for cars, resting on its finding of 2009, the **endangerment finding**, that greenhouse gases endanger public health and welfare. NHTSA sets the CAFE fuel-economy standards under a law of 1975 passed after the Arab oil embargo, and safety standards under the safety law of 1966.

California holds a special place. Because it set its own limits before the federal law existed, the Clean Air Act lets it adopt stricter standards if the EPA grants it a waiver, and lets other states copy them. Its Advanced Clean Cars II (ACC II) rules, granted a waiver in December 2024, required a rising share of zero-emission cars, reaching all new cars in model year 2035. Twelve states had adopted them by April 2026, covering 40.7% of new light-vehicle registrations.

Most of these rules set an average for a maker's whole fleet, not a limit for each car, and that lets makers trade. A maker that beats its target earns **regulatory credits**, which it can bank or sell to a maker that misses, and in Europe makers can instead form a **pool** that is judged as one fleet. A maker of electric cars can therefore earn money from its rivals' gasoline cars (section 10c). Safety rules, by contrast, apply to each car.

10b. America's Reversal

Between July 2025 and September 2026 the United States removed most of what had pushed makers to sell electric cars. The tax law signed on July 4, 2025 (Public Law 119-21, which its sponsors called the One Big Beautiful Bill Act) ended the federal credits of up to $7,500 for a new electric car and $4,000 for a used one after September 30, 2025. It also set the civil penalty for missing a CAFE standard at $0, so the standards stayed on the books but could no longer be enforced with fines.

NHTSA then rewrote the standards. In June 2025 it ruled that the 1975 law bars it from counting electric cars when it sets the "maximum feasible" standard. Its final rule, which it calls SAFE III and which covers model years 2022-2031, was published on September 30, 2026 and takes effect on November 30, 2026. It requires an industry average of about 34.9 miles per gallon in model year 2031, in the test values CAFE uses, which run above window-sticker figures. The rule of June 2024 had required about 50.4 for that year. From model year 2028 makers may no longer trade fuel-economy credits with each other. NHTSA itself

estimates that the new rule will raise fuel use by more than 121 billion gallons through 2050. Twenty-one states, the District of Columbia, and five cities have sued in the federal appeals court in Boston, and the Environmental Defense Fund has filed a parallel challenge.

The EPA went further. On February 12, 2026 it rescinded the endangerment finding and with it every federal greenhouse-gas standard for cars and trucks, leaving its limits on smog-forming and other traditional pollutants in place. It argued that the Clean Air Act does not authorize vehicle standards aimed at global climate change, and that its standards could not affect the climate materially in any case. Seventeen health and environmental groups sued in the federal appeals court in Washington on February 18, 2026, and states led by New York, Massachusetts, California, and Connecticut followed on March 19.

Congress revoked California's three newest waivers, including the one for ACC II, under the Congressional Review Act (CRA), a 1996 law that lets Congress overturn an agency's rules by a simple majority. President Trump signed the resolutions on June 12, 2025, and California and 10 other states sued the same day, a case with no ruling on its merits by September 2026. When the EPA sent four older waivers to Congress in June 2026, California sued again. On September 2, 2026 a federal judge in Washington kept those four older waivers in force while the case proceeds, holding that a waiver is not the kind of rule the CRA covers. Several states that adopted ACC II have stopped enforcing its sales quotas for some model years from 2026 to 2028.

10c. The Credit Markets

Credits turned the rules into income for makers of electric cars, and Tesla's figures show how much. Its revenue from regulatory credits reached a record $2.76 billion in 2024 and fell 28% in 2025, to about $2.0 billion. In the third quarter of 2026 it was $113 million, against $417 million a year earlier (Tesla's quarterly reports, with its other results in Module 6). Its buyers had been makers that sold too many trucks and SUVs to meet American fuel-economy and greenhouse targets, or California's quotas, on their own.

The credits lost their American buyers when the penalties went. With the CAFE fine at $0 from July 2025 and the EPA's greenhouse standards rescinded in February 2026, a maker selling many pickups no longer had any reason to buy credits in the United States. Tesla's annual report for 2025 said that government actions, the 2025 tax law among them, had "restricted certain regulatory credit programs".

In Europe credits change hands through pools. For 2025 Tesla's pool took in Stellantis, Toyota, Ford, Mazda, and Subaru, joined later by Leapmotor, Honda, and Suzuki, while Mercedes-Benz pooled with Volvo Cars, Polestar, and Smart, and Nissan with BYD (Reuters). The prices paid are not disclosed, and the worked example shows what the credits are worth. The pools were expected to be renewed for 2026 and 2027, the years that are judged together with 2025 (section 10d).

10d. Europe's and Britain's Targets

The EU's fleet law, which limits the carbon dioxide (CO_2) that new cars emit per kilometer, tightens in steps. After the target for 2025-29 in the table, the cut from the 2021 level is 55% in 2030 and 100% from 2035, a level that only battery-electric and fuel-cell cars can meet. Each maker's own target is adjusted for the average mass of its cars, so a maker of heavier cars gets a higher one. The table compares the fleet rules of Europe, Britain, and China.

Rule	What it limits	Requirement in 2026	Penalty for missing	How makers trade
EU fleet CO2 standard	Average CO2 per km of each maker's new cars, adjusted for mass	93.6 grams per km fleet-wide for 2025-29, judged on the 2025-27 average	€95 per gram over target, on every car registered	Pools of makers judged as one fleet
Britain's zero-emission vehicle (ZEV) mandate	Share of each maker's new cars with no tailpipe emissions	33% of new cars	£12,000 per car short (£15,000 before April 2025)	Allowances traded between makers and moved between years
China's dual-credit system	Fuel consumption, and new-energy-vehicle credits as a share of conventional output	NEV credits equal to 48% of conventional output	Credits must be bought; new models that miss the fuel target can be refused approval	Credits sold between makers

European Commission and Autovista24 (EU); Motorway's guide to the ZEV mandate and *Car* magazine (Britain); China's Ministry of Industry and Information Technology, via Shanghai Metals Market, November 11, 2025 (China).

The 2025 step alarmed the industry. Renault's chief executive at the time, Luca de Meo, warned in January 2025 that the rules could cost European makers €15 billion. The EU answered with Regulation 2025/1214 of June 17, 2025, which judges each maker, and each pool, on its average over 2025, 2026, and 2027 instead of year by year, so a maker that misses in 2025 can make up the gap later.

On December 16, 2025 the European Commission proposed turning the 2035 requirement into a 90% cut, about 11 grams per kilometer. Makers could cover the remaining 10% with credits for low-carbon steel made in the EU and for renewable fuels, capped at 7% and 3% of the 2021 level. The 2030 target would be judged on a 2030-32 average, and small electric cars made in the EU would earn extra credit until 2034.

The votes are still under way. A Council report of June 15, 2026 found the member states' positions far apart, with some governments wanting to keep the 100% target. In the Parliament, the center-right European People's Party, the Socialists and Democrats, and the liberal Renew Europe agreed in October 2026, according to *Der Spiegel*, on an 87.5% cut by 2035, less than the Commission proposed. The environment committee, which leads on the file with Massimiliano Salini of the European People's Party as rapporteur, the member who drafts its position, was expected to vote in early November, after votes in the transport and industry committees set for October 22. The full Parliament's vote had an indicative date of November 23, 2026, which *Der Spiegel* expected to slip to December (Brussels Morning and electrive, October 20, 2026).

Britain sets a quota instead of a fleet average. Its ZEV mandate raises the required share of zero-emission cars from 28% in 2025 to 80% in 2030 and all new cars from 2035. In April 2025 the government allowed full hybrids to be sold until 2035, cut the fine, and extended the makers' flexibilities to 2029. On August 14, 2026 it opened a review of whether the annual targets remain appropriate, which closes on October 23, 2026.

10e. China's Rules

China's main tool is the dual-credit system, in force since 2018 and run by the Ministry of Industry and Information Technology (MIIT). Each maker must meet a corporate average fuel consumption (CAFC) target for its cars, and must also earn new-energy-vehicle credits equal to a set share of the conventional cars it makes or imports, each NEV earning credits by its type and range. A maker short of either kind must buy NEV credits from makers with a surplus. The required share rises steeply, to 58% in 2027 (Shanghai Metals Market, November 11, 2025). Module 4 covers the purchase tax and trade-in subsidies, China's other levers.

China has also tightened its design rules for electric cars. Since July 1, 2026, its battery standard, GB 38031-2025, has required that a battery not catch fire or explode after a single cell overheats and fails, where the old rule required only five minutes' warning for the occupants. New tests cover blows to the car's underside and repeated fast charging, and a companion vehicle standard requires a hardware switch that cuts the high-voltage circuit within one second, independent of the car's software.

10f. Safety

Every new car sold in the United States must meet the Federal Motor Vehicle Safety Standards (FMVSS), which the maker certifies itself, without approval in advance. NHTSA tests for compliance afterward, and its New Car Assessment Program (NCAP) rates cars from one to five stars in its own crash tests. The Insurance Institute for Highway Safety (IIHS), funded by insurers, runs separate tests of its own. Europe and China, by contrast, approve each new model before it can be sold.

Deaths per mile on American roads have fallen by two-thirds since the federal count began in 1975, but not steadily. That year 44,525 people died, 3.35 per 100 million vehicle miles traveled (VMT). Deaths reached 51,093 in 1979 and a low of 32,479 in 2011, then rose to 42,939 in 2021, after the pandemic began (IIHS). NHTSA counted 39,254 deaths in 2024, 1.19 per 100 million VMT, and estimates 36,640 for 2025, 6.7% fewer, at a rate of 1.10. Its estimate for the first quarter of 2026, 7,770 deaths, was 4.3% below a year earlier.

A recall obliges a maker to fix a safety defect at no cost to the owner, and 2025 set a record. Ford issued 153 recalls, about twice the previous record of 77, set by GM in 2014, and more than Toyota, Stellantis, Honda, Hyundai, and GM together (KXAN, March 3, 2026, from NHTSA's database; Automotive World, June 11, 2026). Recall Masters, a recall-data firm, counts differently, finding 146 Ford campaigns covering 12.9 million vehicles and more than 28 million vehicles recalled across the industry.

The largest new safety rule is on hold. NHTSA's standard for automatic emergency braking (AEB), FMVSS No. 127, published on May 9, 2024, requires every new light vehicle from September 1, 2029 to avoid hitting a car ahead at up to 62 mph and to brake for pedestrians by day and night. The industry's trade group, the Alliance for Automotive Innovation, asked a federal appeals court to review it in January 2025. The case has been paused since February 2025, and on March 23, 2026 the Transportation Department told the court it was preparing a proposal to give makers two more years.

Repair is the other fight. In 2020 Massachusetts voters, 74.97% in favor, required makers to give independent repair shops access to the data their cars send. A federal judge dismissed the industry's last challenges in February 2025, and after the appeal was argued on February 3, 2026 the two sides paused it to discuss a settlement. Subaru has switched off its cars' data links in Massachusetts rather than comply. In Congress, a House committee voted 48-1 on May 21, 2026 for a bill that would write the industry's voluntary repair agreements of 2014 and 2015 into law, without the wider data access that independent shops seek.

10g. Should the Emissions Rules Be Loosened? The Cases as Their Advocates Make Them

The case for loosening them: Lee Zeldin, the EPA's administrator since January 2025, called the repeal the largest deregulatory action in American history when he proposed it in July 2025, and the EPA put its savings at more than $1.3 trillion in vehicle costs. Its supporters argue that the standards forced makers to build electric cars that buyers did not want, at losses recovered through higher prices on other cars. They

argue that the Clean Air Act never gave the EPA power over the global climate, and that the 1975 fuel-economy law bars counting electric cars at all. In Europe, makers warned of billions of euros in fines (section 10d) and argued that money paid in fines cannot be spent on new models while Chinese rivals gain ground. Cheaper new cars, they add, replace older and less safe ones sooner.

The case for keeping them: states, health groups, and environmental groups such as the Environmental Defense Fund argue that the rules are what cut fuel use and emissions, and that the government's own figures show it, starting with NHTSA's estimate of the extra fuel its new rule will burn (section 10b). They argue that the science behind the endangerment finding has only grown stronger. A federal court in Massachusetts ruled on January 30, 2026 that the Energy Department's climate working group, whose report supported the repeal, had been set up in breach of the federal law on advisory committees. Stable rules, they argue, let makers plan plants and batteries that take years to build, and dropping them hands the electric market to China's makers.

What the evidence says: the rules cut fuel use, by the government's own reckoning, but they are an expensive way to do it. The standard studies, by David Austin and Terry Dinan (2005) and by Mark Jacobsen (2013), found that fuel-economy standards cost more per gallon saved than a fuel tax achieving the same saving. Standards do nothing to reduce driving, and by raising the price of new cars they keep old ones on the road longer. The rules also shape what is sold: after the American credit and penalties ended, the battery-electric share of US sales fell (Module 8), while Europe's rose as its targets tightened (Module 5). Credit trading lowered the cost of meeting the targets by letting makers that missed them pay those that beat them, which is what Tesla's credit income measured.

The course's reading, stated once: the evidence supports easing the rules' timetable but not removing them. Because standards cost more than a fuel tax, giving makers more time where the targets bite, as the EU did with its three-year average, buys real savings for a small loss. America went further, and by its own estimate it will burn more fuel for decades while removing the home demand that the older makers' electric plants were built to serve. The relief lets those makers earn more on trucks now, but it does nothing to lower what it costs them to build an electric car that can compete with China's, which is the test the time they have been given must pass.

Worked example — How an EU Fleet Fine Works, and Why Carmakers Paid Tesla to Pool

Take a maker, here called A, that registers 1,000,000 new cars in the EU in a year, with a target of 95 grams of CO2 per kilometer after the adjustment for its cars' mass and a fleet average of 104 grams. These figures are illustrative. Its excess is 9 grams, and the fine is €95 for each gram of excess on each car registered: 9 × €95 × 1,000,000 = €855 million, or €855 a car. Under the 2025-27 averaging, A owes nothing if it cuts its average to 89 grams in 2026 and 92 in 2027, because (104 + 89 + 92) ÷ 3 = 95.0. If it cannot, it can pool. Suppose Tesla registers 150,000 cars, all battery-electric at 0 grams, with a target of 100 grams, higher than A's because its cars are heavier. The pool's target is the members' targets weighted by their cars: (1,000,000 × 95 + 150,000 × 100) ÷ 1,150,000 = 95.65 grams. Its average emissions are (1,000,000 × 104 + 150,000 × 0) ÷ 1,150,000 = 90.43 grams, 5.22 grams under the target, so the pool owes nothing. Count the surplus in gram-cars, one gram under target on one car. Tesla brings 15 million (100 grams × 150,000 cars), and A needs 9 million of them (9 grams × 1,000,000 cars). A is better off paying Tesla any sum below €855 million than paying the fine, and Tesla's other 6 million gram-cars, worth up to €570 million at the fine's rate, can cover other members. The price is negotiated in private. That is why pools form around makers that sell only electric cars, and why a rule meant to cut emissions also moves money from the makers of gasoline cars to their electric rivals.

Module 10 Key Points

The Rules

• The 2025 tax law ended federal EV credits after September 30, 2025, and set the CAFE penalty to $0.

• NHTSA’s new rule lowers the 2031 standard to about 34.9 mpg; the EPA rescinded the endangerment finding on February 12, 2026.

• Tesla’s regulatory-credit revenue fell from $417 million to $113 million in a year as American buyers of credits disappeared.

• The EU fines €95 per gram per car over target; 2025-27 is averaged, and 2035 may be softened to a cut of 87.5% or 90%.

• China requires NEV credits equal to 48% of conventional output in 2026 and, since July 2026, batteries that do not burn.

• US road deaths were an estimated 36,640 in 2025, down 6.7%; deaths per mile are two-thirds below 1975’s.

Module 10 Quiz

Check Your Understanding

1. What did the tax law of July 4, 2025 do to the CAFE fuel-economy standards?

A) It set the penalty for missing them to $0.
B) It repealed the standards outright and moved fuel economy from NHTSA to the EPA.
C) It doubled the penalty to pay for ending the electric-car credits.
D) It froze the standards at their 2025 level, leaving the penalty unchanged.

2. Why did Tesla's regulatory-credit revenue fall to $113 million in the third quarter of 2026?

A) Because Tesla stopped selling credits to concentrate on robotaxis.
B) Because, with the CAFE fine at $0 and the EPA's greenhouse standards rescinded, rival makers no longer needed to buy credits in the United States.
C) Because the EU banned pooling with Tesla in 2026.
D) Because Tesla's sales fell below the level that earns credits.

3. Under the EU's rules, what does a maker pay if its fleet misses its CO2 target?

A) A flat €1 million fine
B) €15 billion, shared by all makers
C) €95 per gram over target, on every car registered
D) Carbon permits in the EU's emissions trading system, bought for every tonne its cars will emit over their lives, in place of a cash fine

4. What has China's battery standard GB 38031-2025 required since July 1, 2026?

A) Sodium-ion cells
B) Five minutes' warning to the occupants before a battery fire
C) Solid-state cells in every new car sold from 2027
D) No fire or explosion after a cell fails

5. What is the course's reading on loosening the emissions rules?

A) Loosen them everywhere, because the rules have no measurable effect on fuel use or emissions.
B) Reverse every change at once, because standards are the cheapest way to cut emissions.
C) Ease the timetable, but do not remove the rules.
D) Replace the rules with a fuel tax, as Congress agreed to do in 2025.

Module 11 — Software and Autonomy

The Computer on Wheels and the Car Without a Driver

Recommended Reading / Reference

Book: Lawrence D. Burns with Christopher Shulgan, *Autonomy: The Quest to Build the Driverless Car—and How It Will Reshape Our World* (2018), by GM's former head of research, later an adviser to Google's self-driving car project, the origin of Waymo

Reference: Waymo's Safety Impact data (through June 2026), the Insurance Institute for Highway Safety's study of July 23, 2026, and NHTSA's Standing General Order crash reports

11a. The Computer on Wheels

A car of the 2010s ran on dozens of electronic control units (ECUs), small computers each bought from a supplier with its own software: one for the brakes, another for the windows, another for the engine. Newer cars replace most of them with a few central computers linked to "zonal" controllers that gather the wiring for each part of the car, a design that Tesla and the Chinese electric-car makers adopted first. The payoff is the **over-the-air update**, new software sent over the mobile network that can fix defects, add features, or sell subscriptions long after the car is sold. A car built this way is called a **software-defined vehicle**.

The car is also becoming a data center. Micron, a memory maker, puts the memory in an average car at about 90 gigabytes (GB) in 2026, heading toward about 278 GB as driver assistance spreads (April 2026), and Module 2 covers the 2026 shortage of memory chips. Nvidia's automotive revenue reached a record $2.3 billion in its fiscal year to January 2026, 39% more than a year earlier. In China, Horizon Robotics shipped more than 4 million of its Journey driver-assistance chips in 2025 and held 44.2% of the market for advanced driver assistance in cars priced under 200,000 yuan (about $29,900 at October 16, 2026 exchange rates). GlobalFoundries, a chipmaker, expects the chips in an average car to be worth more than $3,000 by 2030.

Software has been the older makers' hardest problem. Volkswagen's own software unit, Cariad, fell behind, and its delays held back electric models at Porsche and Audi, so in 2024 Volkswagen turned to Rivian. Their joint venture, worth up to $5.8 billion to Rivian, is to supply the electronics and software for Volkswagen's future cars. Volkswagen released about $1 billion more on March 27, 2026, after the ID.EVERY1, the first car to use the system, passed winter testing, on top of a little more than $3 billion already invested. Chinese makers, which develop new cars far faster (Module 2), buy much of their driver-assistance technology from local suppliers such as Horizon Robotics and Huawei, whose car alliance Module 4 describes.

11b. Driver Assistance

Driver assistance is graded from Level 0 to Level 5 on the scale of SAE International, the engineers' standards body. At Level 2 the car steers, brakes, and accelerates, but the driver must watch the road at all times and is responsible for what happens. At Level 3 the driver may look away in the conditions the maker specifies, its **operational design domain**, and the car is responsible until it asks the driver to take over. Levels 4 and 5 need no driver at all, Level 4 within a defined domain and Level 5 anywhere. Nearly every system on sale to private buyers is Level 2.

Tesla's Full Self-Driving (Supervised), or FSD, a Level 2 system despite its name, steers in cities as well as on highways. Tesla reported 1.74 million active subscriptions in the third quarter of 2026, against 1.04

million a year earlier. The Dutch vehicle authority approved it in April 2026 under a temporary national exemption, and Tesla says it is available in nine EU countries with more than 100,000 customers there. Approval across the EU needs the support of 15 of the 27 states with 65% of the population, and a vote is possible in December 2026 at the earliest. China has not approved it.

GM's Super Cruise and Ford's BlueCruise let drivers take their hands off the wheel on mapped highways while a camera checks that their eyes are on the road. Super Cruise was fitted to about 750,000 vehicles across 23 models, which had driven 1 billion hands-free miles by May 1, 2026, and GM plans to let drivers of the Cadillac Escalade IQ take their eyes off the road in 2028. BlueCruise was fitted to 1.22 million vehicles worldwide at the end of 2025, which drove 264 million hands-free miles that year.

Level 3 has proved hard to sell. Mercedes-Benz's Drive Pilot, the first Level 3 system certified in the United States, let drivers look away at up to 40 mph on certain highways in California and Nevada, in daylight and good weather, for $2,500 a year. Mercedes paused it in January 2026, leaving it out of the updated S-Class, and said a more capable system would follow within two or three years. BMW is dropping its own Level 3 system with the updated 7 Series.

Regulators have tightened their oversight. China acted after a Xiaomi SU7 using its driver-assistance system crashed in March 2025, killing three people. From April 2025 its makers needed approval for over-the-air updates to driver-assistance software, could no longer test it on customers as public "beta" versions, and could not advertise it in misleading terms. In December 2025 its industry ministry approved China's first Level 3 cars, Changan's Deepal SL03 and BAIC's Arcfox Alpha S, for pilots in single lanes of designated expressways in Chongqing at up to 50 km/h and in Beijing at up to 80 km/h. In the United States, NHTSA has been examining since March 2026 whether FSD detects glare, fog, and dust in time to warn drivers, in an engineering analysis covering about 3.2 million vehicles. It opened a separate investigation in October 2025 into whether FSD runs red lights and drives into opposing lanes, covering about 2.88 million.

11c. Robotaxis and Driverless Trucks

A **robotaxi** carries paying passengers with no one at the wheel, inside its operational design domain. Waymo, which began as Google's self-driving project, opened its first fully driverless public service in Phoenix in 2020 and remains far ahead in the United States, as the table shows. It raised $16 billion of equity in February 2026 at a valuation of $126 billion, and $5 billion of debt on October 8, 2026. Tekedra Mawakana, its co-chief executive since 2021, set a goal in February 2026 of more than 1 million paid rides a week by the end of the year, about twice its pace in September. Riders in Austin and Atlanta book Waymo through Uber, under a contract that runs to May 2028.

Operator (owner)	Where it carries the public	Vehicles	Rides or miles
Waymo (Alphabet)	15 US metros, from Phoenix and San Francisco to Atlanta and Miami	More than 4,000 (September 2026)	About 500,000 paid rides a week; 271.3 million miles with no driver through June 2026
Tesla	Austin, Dallas, Houston, Miami, Orlando, and Tampa with no safety driver; the San Francisco Bay Area with one	Not disclosed; about 169 Cybercabs registered in Texas in early October 2026	Not disclosed; about 700,000 paid miles in the second quarter of 2026
Zoox (Amazon)	Las Vegas	Up to 2,500 a year under its federal exemption	Not disclosed

Operator (owner)	Where it carries the public	Vehicles	Rides or miles
Apollo Go (Baidu)	27 cities worldwide, most in China (May 2026)	Not disclosed	3.2 million driverless rides in the first quarter of 2026, up more than 120%; more than 22 million in all by April
Pony.ai	Guangzhou, Shenzhen, and other Chinese cities; Singapore	1,975 (June 30, 2026); more than 3,500 targeted by the end of 2026	Robotaxi revenue of $12.1 million in the second quarter of 2026, up 691%

Waymo via TechCrunch (September 1 and 24, 2026) and Waymo (September 24, 2026); Tesla's second-quarter 2026 update, TechCrunch (July 23, 2026), and Texas registration data via Not a Tesla App (October 4, 2026); NHTSA via Automotive World (July 30, 2026); Baidu via CnEVPost (July 28, 2026); Pony.ai's results (August 18, 2026).

Tesla is taking a different path, with cameras alone instead of the lidar (laser-ranging) sensors and detailed maps that Waymo uses, and a purpose-built car. The Cybercab, which has no steering wheel or pedals, first came off the line at Tesla's Texas plant in February 2026 and entered production in April, with installed capacity of more than 125,000 a year, the company says. Public rides in Cybercabs began in parts of Austin on September 3, 2026. Because Tesla discloses neither its fleet nor its rides, outsiders count registrations, which showed 45 Cybercabs in Texas on September 2 (Reuters), while Tesla's robotaxi account claimed more than 300 in Austin on October 9-10. Tesla reported nearly 2 million cumulative miles with no one supervising by the end of September, about eight times the total three months earlier, while its paid robotaxi miles fell 36% between the first and second quarters of 2026.

China's operators are expanding abroad. Baidu began testing Apollo Go in London in July 2026 with Freenow, a taxi app owned by Lyft, and aims to carry the public there in 2027 if regulators approve. Pony.ai says its service in China's largest cities has positive unit economics, meaning each car covers its own operating costs, though it gives no figures, and WeRide runs robotaxis in Abu Dhabi as well as in China. Ride-hailing companies, which once built driverless cars of their own, now partner with the makers: Uber agreed in July 2025 with Lucid and Nuro to deploy more than 20,000 Lucid Gravity robotaxis over six years, starting in 2026.

Trucks may pay sooner than taxis, because long highway runs are simpler to automate than city streets. Aurora Innovation began hauling freight with no driver between Dallas and Houston in May 2025, and its trucks had driven nearly 440,000 driverless miles by the end of June 2026, when it introduced its second-generation hardware. It aims to have more than 200 driverless trucks working by the end of 2026, against the 20-25 it expected to have running at the end of September, and it forecast revenue of $14-16 million for 2026.

11d. The Rules for Driverless Cars

No federal law governs driverless cars. The Federal Motor Vehicle Safety Standards (FMVSS) assume a human driver with a steering wheel and pedals, so a car without them needs an exemption. NHTSA's framework of April 24, 2025 set out to make exemptions easier. It opened its exemption program to American-built vehicles and simplified the Standing General Order (SGO), its rule requiring companies to report crashes involving automated systems, to a single five-day deadline. On July 30, 2026 it granted Zoox the first exemption for a commercial robotaxi without manual controls. In June 2026 it proposed letting such vehicles drop the brake pedal that its braking standard requires, and it aims to write permanent rules by about 2028.

The states license the services. California requires permits from its Department of Motor Vehicles and from its Public Utilities Commission, which by August 2026 let Waymo serve the nine-county Bay Area,

Sacramento, and Southern California from Thousand Oaks to the Mexican border. In February 2026 Waymo asked the Senate Commerce Committee for uniform national standards, citing competition from China. In Europe a United Nations regulation adopted by the EU has allowed Level 3 lane-keeping at up to 130 km/h since 2022, and the EU's decision on FSD is pending (section 11b). The American ban on Chinese software in connected cars is in Module 9.

11e. Security

Software opens cars and the plants that build them to attack. The costliest case so far hit Jaguar Land Rover (JLR), Britain's largest carmaker, owned by India's Tata group. A cyberattack on August 31, 2025 forced JLR to shut down its systems and halt its factories. It disclosed the attack on September 2 and began a phased restart on October 8, 2025. JLR put its direct costs at £196 million, and in the quarter to September its revenue fell 24% to £4.9 billion, with a pre-tax loss of £485 million (November 14, 2025). The Cyber Monitoring Centre, an independent British body that rates cyber events, put the cost to Britain's economy at about £1.9 billion (about $2.5 billion), the costliest cyber event in the country's history.

The cars themselves are exposed through their connections. In January 2025 researchers showed that a flaw in Subaru's connected-car service let them start, unlock, and track cars, with a year of location history, from nothing more than a license plate, and a similar flaw had been found in Kia's dealer portal in September 2024. Since July 2024 every new car registered in the EU must come from a maker with a certified system for managing cyber risks, under a United Nations regulation.

11f. Are Robotaxis Safe Enough to Scale? The Cases as Their Advocates Make Them

The case that they are: Waymo argues that its record already shows a large gain. Through June 2026, over 271.3 million miles, its cars had 82% fewer crashes causing injury than human drivers on the same roads, about 841 fewer, and 95% fewer causing serious injury or worse, with 93% fewer injury crashes involving pedestrians and 86% fewer involving cyclists (September 24, 2026). Its benchmark comes from human crash data in the same cities, adjusted upward for crashes that people do not report. Supporters add that a robotaxi is never drunk, tired, or distracted, which they say are behind most of the deaths on American roads, an estimated 36,640 in 2025 (Module 10), so each year of delay costs lives.

The case that they are not yet: critics, among them safety advocates and some researchers, argue that the figures are Waymo's own, measured against benchmarks Waymo builds, in cities and weather it chose. Robotaxis also fail in ways people do not. NHTSA opened an inquiry after Waymo cars passed stopped school buses, which led to a recall in December 2025, and another after one struck a child near a school in January 2026. Waymo paused its freeway rides from May to July 2026 and recalled 3,791 cars over how they handled flooded roads. Expanding into snow, freeways, and new cities multiplies the situations a system has never met. Other operators publish far less: Tesla filed 22 crash reports in its trial's first year, and the news site Electrek's own calculation (April 2026) found one crash for every 57,000 supervised robotaxi miles against one for every 229,000 miles driven by people.

What the evidence says: the best independent check is by the Insurance Institute for Highway Safety (IIHS), whose researchers compared Waymo with human drivers in the same places and years (July 23, 2026). Counting only the kind of crash people report to the police, over about 50 million driverless miles in San Francisco, Phoenix, Los Angeles, and Austin in 2021-24, Waymo's cars were in 68% fewer crashes and 81% fewer injury crashes. The gains varied, from 76% fewer crashes in Phoenix and 71% in Los Angeles to

35% in San Francisco, and Austin, where the sample was small, showed 4% more. IIHS warned that its data could not track a large expansion, and since only Waymo reports its mileage, no other operator's crash rate can be calculated. Deaths are too rare to judge yet: at the 2025 national rate of 1.10 per 100 million miles (Module 10), human drivers would be expected to cause about three deaths in 271.3 million miles.

The course's reading, stated once: Waymo's record, checked independently, is strong enough to support scaling its service in cities and conditions like those it has measured, with every crash reported as now. It cannot yet show fewer deaths, and it says nothing about other operators, Tesla above all, which have not published the data that would allow the same test. The case for scaling has been made for one company's system on the roads it knows, and it has still to be made for the rest.

Worked example — The Cost of a Robotaxi Mile Against a Ride-Hail Mile

No operator publishes its costs, so every input here is an illustrative assumption except one. A robotaxi with its sensors costs $120,000 and lasts five years at about 68,000 miles a year, the 110,000 km that BNEF estimated each Waymo car covered a year in December 2025, for 340,000 miles in all. Its costs per mile are 35.3 cents for the vehicle ($120,000 ÷ 340,000), 4.5 cents for electricity (0.30 kWh at 15 cents), 15 cents for maintenance, tires, and cleaning, 10 cents for insurance, and 30 cents for remote assistance, depots, mapping, and overhead: 94.8 cents a mile in all. Only some miles carry a paying rider, the rest being trips to pick-ups, depots, and chargers. If 55% are paid, each paid mile costs 94.8 ÷ 0.55 = $1.72. A ride-hail driver who earns $24 an hour, out of which the driver pays for the car, and carries riders 12 miles an hour, costs $24 ÷ 12 = $2.00 per paid mile before the platform's fee. The robotaxi is 14% cheaper. At the Cybercab cost Tesla is aiming for, under $30,000, the vehicle's share falls to 8.8 cents a mile, the total to 68.3 cents, and the paid mile to $1.24, 38% below the driver. If 65% of miles were paid, the two robotaxi costs would fall to $1.46 and $1.05. With the cheaper car, remote support and overhead become the largest cost, 44% of the total, and they fall only as fleets grow. The arithmetic explains the race: the cheaper the car and the busier the fleet, the wider the margin over a human driver.

Module 11 Key Points

Software and Autonomy

• Cars are moving to a few central computers updated over the air; memory per car is heading from about 90 GB toward 278 GB.

• Tesla had 1.74 million FSD (Supervised) subscriptions in the third quarter of 2026; every such system still needs a watching driver.

• Mercedes paused its Level 3 system in January 2026; China approved its first Level 3 cars in December 2025.

• Waymo gives about 500,000 paid rides a week with more than 4,000 vehicles in 15 US metros.

• IIHS found Waymo in 68% fewer police-reportable crashes than human drivers; deaths are still too rare to compare.

• A robotaxi beats a human driver’s $2.00 a paid mile by a wide margin only when the car is cheap and the fleet busy.

Module 11 Quiz

Check Your Understanding

1. How many active FSD (Supervised) subscriptions did Tesla report for the third quarter of 2026?

A) 1.74 million, against 1.04 million a year earlier
B) 1.48 million
C) About 500,000
D) 750,000

2. What did the IIHS study of Waymo published in July 2026 count?

A) Deaths per mile
B) Police-reportable crashes: 68% fewer than human drivers
C) Insurance claims paid out
D) Every crash Waymo itself reported, including minor scrapes, over 271.3 million miles in five cities

3. What did NHTSA grant Zoox on July 30, 2026?

A) A Level 3 permit for highways
B) A $5 million research grant
C) The first exemption for a commercial robotaxi without manual controls
D) Approval to sell to private buyers

4. Why can Waymo's 271.3 million miles not yet show whether robotaxis cause fewer deaths?

A) Because Waymo stopped counting crashes in Texas, where most of its miles are driven.
B) Because human drivers would cause only about three deaths in that distance.
C) Because NHTSA forbids companies to publish fatality data.
D) Because its cars drive mostly on freeways, where deaths are rare and no human benchmark can be built.

5. What happened to Mercedes-Benz's Level 3 Drive Pilot in January 2026?

A) It was approved for eyes-off driving at up to 80 mph in every US state
B) It was recalled after a fatal crash in Nevada
C) It became standard on every new Mercedes
D) Mercedes paused it

Module 12 — The Buyer

Price, Credit, Insurance, and the Used Car

Recommended Reading / Reference

Book: Lendol Calder, *Financing the American Dream: A Cultural History of Consumer Credit* (1999), how installment credit, led by the car loan of the 1920s, became an ordinary part of American life

Reference: The Federal Reserve Bank of New York's quarterly *Household Debt and Credit Report*, Kelley Blue Book's monthly transaction-price reports, and Edmunds' quarterly financing data, the sources for most figures here

12a. What a New Car Costs

The average new vehicle sold for $50,562 in September 2026, by the measure of Kelley Blue Book, a pricing guide owned by Cox Automotive, which tracks the prices buyers actually paid (October 13). That was 0.7% more than a year earlier and $52 below the record of $50,614 set in December 2025. The average sticker price, the manufacturer's suggested retail price (MSRP), was $52,342. Incentives, the makers' discounts and cheap-loan offers, averaged $3,359, or 6.6% of the price, against 7.3% a year earlier. J.D. Power, a data firm that counts only sales to households, put its average at $45,915. The National Automobile Dealers Association (NADA) put the average retail price at franchised dealers at $48,205 in 2025, 35.4% above the $35,608 of 2018.

The consumer price index tracks the price of the same vehicle over time, so it leaves out the shift to bigger vehicles. On that measure new vehicles cost 0.6% more in September 2026 than a year earlier and used cars 1.5% less, while all prices rose 3.7%, by the count of the Bureau of Labor Statistics (BLS) on October 14. The average price paid rose by less than inflation, so in real terms, after inflation, the average new vehicle got about 3% cheaper over the year.

Cheap new cars have become scarce. The average compact car sold for $27,977 in September, against $37,614 for a compact SUV and $67,573 for a full-size pickup (Kelley Blue Book). Makers have dropped most small cars because they earn little on them (Module 3), and buyers have moved to SUVs and pickups (Module 6). The cheap models that remain are scarce: in August 2026 dealers had 54 days' supply of vehicles under $30,000, against more than 90 days of those over $60,000 (Cox).

The price also includes the dealer's fees and add-ons. The Federal Trade Commission (FTC) issued its Combating Auto Retail Scams (CARS) Rule in December 2023. It would have required dealers to quote a full price, barred charges for add-ons of no benefit to the buyer, and required express consent for every charge. Its effective date of July 2024 was stayed, and on January 27, 2025 the US Court of Appeals for the Fifth Circuit vacated it by 2 votes to 1, on a challenge by NADA and the Texas Automobile Dealers Association, because the FTC had skipped a required advance notice of the rulemaking.

12b. Paying for It

Most new cars are bought on credit, and the loans keep growing. In the third quarter of 2026 the average new-car loan was a record $44,664 at an annual percentage rate (APR) of 7.0%, with a down payment of $5,554, by Edmunds' count. The average monthly payment was a record $787, against $756 a year earlier, and the average buyer will pay $9,938 of interest over the life of the loan. A record 25.5% of new loans ran 84 months or more, against 21.8% a year earlier, and a record 21.2% of buyers paid $1,000 or more a

month, against 19.1%. Of those paying $1,000 or more, 69% had taken terms of 72 months or longer, and even among used-car buyers 6.5% paid that much. J.D. Power, on a base it does not state, puts loans of 84 months or more at 13.9%.

Other sources measure other periods. Experian, a credit bureau, found an average new-car payment of $765 at 6.35% over 69.5 months in the second quarter of 2026, with the rate down from 6.79% a year earlier, and a used-car payment of $542 at 11.19%. Borrowers with the weakest credit pay far more, 16.11% on new cars and 21.62% on used ones (Experian). J.D. Power put September's average new-car payment at $821, a record for the month.

Loan rates follow the cost of money. The Fed raised its target for the federal funds rate, the rate banks charge each other overnight, by a quarter point to 3.75-4.00% on September 16, 2026, by 12 votes to 0, its first rise since July 2023. Kevin Warsh has chaired it since May 22, 2026. The ten-year Treasury yield, which moves the cost of longer loans, was 5.19% on October 14. Leasing, in which the driver pays for the car's expected loss of value over two to four years instead of its full price, is recovering slowly. Leases were 23.75% of new-vehicle financing in the second quarter (Experian), and Cox expects about 3.0 million leases in 2026, 23% of retail sales.

The tax law signed on July 4, 2025 lets buyers deduct up to $10,000 a year of interest on a loan for a new vehicle assembled in the US and bought for personal use in 2025-28. Leases and used cars do not qualify, and the deduction phases out for single filers with incomes between $100,000 and $150,000 and for couples between $200,000 and $250,000. In the first filing season, 1.4 million filers claimed $2.6 billion, about $1,860 each, by the Internal Revenue Service's (IRS) figures to mid-May 2026 (CDG News, May 22, 2026). Cox had estimated that about 4 million of some 13.4 million new cars sold in a year would qualify. Final rules take effect on November 9, 2026, and interest on negative equity rolled into a loan does not qualify.

12c. Credit and Its Strains

Americans owed $1.713 trillion on auto loans at the end of June 2026, $58 billion more than a year earlier, out of $18.771 trillion of household debt. Lenders made a nominal record of $211 billion of new auto loans in the second quarter (Federal Reserve Bank of New York, August 11). Balances were moving into serious delinquency, 90 days or more behind, at an annual rate of 3.00%, against 2.93% a year earlier, the highest since 2010 (CBT News).

The strain is concentrated among subprime borrowers, those with low credit scores. In Fitch Ratings' index of subprime auto loans held in asset-backed securities, bonds backed by pools of car loans, a record 6.90% were at least 60 days behind in January 2026. The rate eased to 6.13% in July and 5.98% in August, while the rate on prime borrowers' loans stayed near 0.5%. Lenders kept lending: Dealertrack's credit availability index reached 105 in July, its highest since November 2015, with 74% of applications approved. Subprime borrowers made up 11.2% of September's retail sales, 2.2 points more than a year earlier (J.D. Power), but only about 15% of outstanding auto loans were subprime when they were made, against about 20% before the pandemic (Experian). Cox counted 1.73 million repossessions in 2024, near 2009's 1.77 million, and estimates for 2025 vary widely by method.

Two collapses in September 2025 showed what car credit can hide. Tricolor, a Texas used-car dealer and subprime lender, closed more than 60 locations and filed for bankruptcy. Prosecutors say it pledged the same loans to more than one bank and, a month before the filing, told lenders it held $2.2 billion of collateral when it held $1.4 billion. JPMorgan Chase wrote off $170 million. Tricolor's founder, Daniel Chu, charged in December 2025, has pleaded not guilty, and its chief operating officer pleaded guilty on June 24, 2026, the day prosecutors added a charge against Chu that carries a minimum sentence of ten years. First Brands, a

maker of replacement parts such as FRAM filters, filed for bankruptcy with more than $9 billion of liabilities after its borrowing against unpaid customer invoices, kept off its balance sheet, unraveled. Its founder, Patrick James, and his brother Edward were indicted in January 2026 and have pleaded not guilty, and a judge converted the company's case to a liquidation on August 24, 2026. Both had borrowed from lenders that could not see the whole of their debts.

12d. The Used Car and the Aging Fleet

Used cars are dear because the supply was cut years ago. New-car sales in 2020-23 fell about 10.1 million short of the 2016-19 pace of 17.2 million a year, by the figures of the Bureau of Economic Analysis (BEA), so fewer cars are now reaching the age at which most are resold. Leasing, which returns three-year-old cars to dealers, fell from nearly 30% of retail sales in 2015-19 (Cox) to 18% of new sales in 2022 (Edmunds). Cox expects off-lease supply at wholesale to rise 23% in 2026.

The Manheim Used Vehicle Value Index, which tracks wholesale prices at Cox's auctions adjusted for mileage, mix, and season, stood at 205.9 in September 2026, 0.6% lower than a year earlier, and Cox cut its forecast for the index's rise over 2026 to about 0.2%, from 2% (Cox, October 7). Retail asking prices moved the other way: the average used listing was $27,235 in September, the highest since December 2022 and nearly 6% more than a year earlier, and listings under $15,000 fell 16.2% in a year, to 15.7% of inventory from 19.4% (Cox, October 16). Americans bought about 20.4 million used cars at retail in 2025, and Cox expects 20.5 million in 2026.

Negative equity, owing more on a loan than the car is worth, follows from long loans. Edmunds found that 29% of trade-ins in the fourth quarter of 2025 were underwater by a record $7,214 on average, and more than a quarter of those owed $10,000 or more. In the second quarter of 2026 the share was nearly 30%, at $6,884 on average, and J.D. Power put it at 29.4% in September. The usual remedy, rolling the debt into the next loan, makes the next loan larger (worked example).

Americans keep their cars longer: the average light vehicle on the road was a record 12.8 years old in 2025, by the count of S&P Global Mobility, now Mobility Global, of 289 million vehicles in operation, with cars at 14.5 years and light trucks at 11.9. Only 4.5% of the fleet was scrapped in the year. The Auto Care Association, the trade group of the parts and repair business, put the average at a record 12.9 years in its factbook of June 2026.

12e. Insurance, Repair, and Theft

Running a car has cost much more since 2021. In the consumer price index, motor vehicle insurance rose 49.8% from August 2021 to August 2026, and maintenance and repair 50.8% from January 2021 to September 2026 (BLS). Insurance then turned down: August 2026 brought its first annual decline since 2021, and in September it was 5.0% cheaper than a year earlier, while repair cost 5.8% more and body work 6.0% more. Insurify, an insurance-comparison site, put the average full-coverage premium at $2,237 a year in mid-2026, up 1% in the first half after a 6% fall in 2025. The average household spent $1,993 on vehicle insurance in 2024, 12.3% more than in 2023 (BLS).

Repairs cost more because cars carry more to repair. Cameras, radar, and other sensors for driver assistance sit in bumpers, mirrors, and windshields, and they must be recalibrated after a crash. The American Property Casualty Insurance Association (APCIA), the insurers' trade group, found that the average paid claim for vehicle damage rose 42.3% from 2020 to the year to September 2025, while the

number of claims rose 1.4%. Labor costs more too: franchised dealers charged customers an average of $192 an hour in the first half of 2026 and employed 272,624 technicians (NADA).

Theft has fallen fast, and the National Insurance Crime Bureau (NICB) counted 659,880 vehicle thefts in 2025, 23% fewer than in 2024, after a peak of more than 1 million in 2023. Thefts in the first half of 2026 were 268,415, down another 21% (*Insurance Business*, October 1, 2026).

12f. Are Cars Unaffordable, and Why? The Cases as Their Advocates Make Them

The case that cars have become unaffordable: Mobility Global, an automotive forecaster, calls affordability "the single biggest challenge" and expects American sales of only 16.4 million in 2030, below their pace before the pandemic (September 28, 2026). Consumer advocates and Edmunds' analysts point to record payments and seven-year loans (section 12b), insurance and repair prices up about half since 2021 (section 12e), the shrinking supply of cheap used cars, and the share of trade-ins underwater (section 12d). They blame the industry's shift to trucks and SUVs and its retreat from small cars, the lost production of 2020-23, higher interest rates, tariffs, and cars that cost more to fix.

The case that buyers are coping: Cox and Edmunds' Jessica Caldwell, who says "consumers are adapting," note that sales are near 16 million a year (Module 6). The average price rose by less than inflation over the year to September 2026 (section 12a), insurance is getting cheaper (section 12e), and loan rates have eased (section 12b), with 24% of new loans at 3.99% or less (Edmunds). Credit is the most available since 2015 (section 12c), and auto debt is 7.17% of disposable income, the lowest since 2014 apart from early 2021 (Wolf Street). Buyers, on this view, are adjusting by choosing cheaper models, keeping cars longer, and leasing again.

What the evidence says: the averages hide a split between buyers. Cox's own explanation of the market's strength is that "strong fleet sales, wealthier vehicle buyers, and more access to credit are all keeping this market relatively strong" (September 24, 2026). The signs of strain are concentrated among buyers with less income or weaker credit: subprime delinquency near its record while prime borrowers stay current, $1,000 payments, seven-year loans, and rolled-over debt. The cheapest choices are disappearing at both ends of the market, with few new cars under $30,000 and fewer used ones under $15,000. Off-lease returns are rising, the first sign that the used-car shortage is easing (section 12d).

The course's reading, stated once: cars are affordable for the buyers who sustain the market and increasingly unaffordable for those at its bottom. The average price has stopped outrunning inflation, but the market has lost its cheap new cars and much of its supply of cheap used ones, and the buyers left at the low end carry long loans, rolled-over debt, and insurance and repair bills that rose about half in five years. The main causes are on the supply side, the makers' shift to trucks and SUVs and the lost production of 2020-23, while the tariffs have so far been mostly absorbed by the makers (Module 9). Relief depends on returning off-lease cars and on whether the makers bring back cheaper models.

Worked example — A $50,000 Car on a Seven-Year Loan

Take a $50,000 new car, close to the average price, bought with an assumed 6% sales tax ($3,000), $1,000 of registration and dealer fees, and Edmunds' average down payment of $5,554. The buyer borrows $48,446 for 84 months at Edmunds' average rate of 7.0%. The monthly payment is $731.18, and over seven years the interest totals $12,973. Add insurance at Insurify's average of $2,237 a year, or $186 a month. Add gasoline for 12,000 miles a year at 25 miles a gallon and the October 19, 2026 price of $4.284 (Module 6), or $171 a month. With an assumed $100 a month for maintenance and repairs, the car costs $1,189 a month, of which the loan is 61%. If the car was assembled in the US and the buyer's income qualifies, the first year's $3,215 of interest is deductible, which is worth $707 to a buyer in the 22% tax bracket, about $59 a month. Now trade the car in after three years, when it is assumed to be worth 55% of its price, or $27,500. After 36 payments the buyer still owes $30,534, so the negative equity is $3,034. On a five-year loan at the same rate the payment would be $959.29, but after 36 payments the balance would be $21,426, leaving $6,074 of equity. Roll the $3,034 into an identical new loan and its payment rises from $731 to $777. The seven-year loan buys a lower payment at the price of $3,862 more interest and a car worth less than its loan at trade-in.

Module 12 Key Points

The Buyer

• Kelley Blue Book’s average new-vehicle price was $50,562 in September 2026, up 0.7% in a year, less than 3.7% inflation.

• Edmunds’ average new-car payment hit a record $787 in the third quarter of 2026, and 25.5% of new loans ran 84 months or more.

• Auto loans totaled $1.713 trillion; subprime delinquency hit a record 6.90% in January 2026, then eased to 5.98% by August.

• Insurance and repair prices rose about 50% from 2021; insurance fell 5.0% in the year to September 2026, while repair rose 5.8%.

• Nearly 30% of trade-ins carry negative equity; the worked example’s seven-year loan leaves the buyer $3,034 underwater after three years.

• The course’s reading: cars stay affordable for the buyers who sustain the market and are strained at the bottom, mainly because cheap cars disappeared.

Module 12 Quiz

Check Your Understanding

1. What was Kelley Blue Book's average transaction price for a new vehicle in September 2026?

A) $50,562, near the record
B) $45,915
C) $52,342 MSRP
D) $50,614, a new record high

2. What share of new-car loans ran 84 months or longer in the third quarter of 2026, by Edmunds' count?

A) 13.9%
B) About half of all new-car loans, as lenders stretched terms to hold payments under $700
C) 25.5%, a record
D) 21.8%, the same as a year earlier

3. What did Fitch's measure of subprime auto-loan delinquency do in 2026?

A) It fell below 1%
B) It hit a record 6.90% in January, then eased to 5.98% by August
C) It reached 8.42% in July
D) It rose every month to a record above 7%, the highest since the series began, as repossessions passed 3 million

4. Why are used cars scarce and dear in 2026?

A) Because new-car sales in 2020-23 fell about 10 million short of their 2016-19 pace and leasing collapsed, so fewer cars are reaching resale age
B) Because of tariffs on used imports
C) Because scrappage doubled
D) Because rental companies stopped selling their fleets after 2023 and now keep each car twice as long as before

5. What is the course's reading on whether cars have become unaffordable?

A) They are affordable for nearly everyone, because real prices fell in 2026.
B) They are unaffordable for every buyer, because prices have doubled since 2020.
C) Tariffs alone made cars unaffordable, by raising every new car's price 13.5%.
D) The strain falls on buyers at the bottom.

Module 13 — Where Things Stand, and What to Watch

The Argument, the Contradictions, and the Calendar

Recommended Reading / Reference

Book: Tim Higgins, *Power Play: Tesla, Elon Musk, and the Bet of the Century* (2021), a *Wall Street Journal* reporter's account of how a start-up forced the older makers into the electric turn this course follows

Reference: The monthly figures that date the watch list below: CPCA's weekly and CAAM's monthly counts for China, ACEA's registrations for Europe, Rho Motion's electric-car tracker, and the carmakers' results calendars

13a. The Argument on One Page

The course has made one argument from twelve directions. The center of the car industry has moved to China. China built more than a third of the world's vehicles in 2025 and has been the largest exporter since 2023 (Module 1). It sells most of the world's electric cars and makes most of their batteries, and its largest maker sold more battery-electric cars than Tesla (Modules 4 and 8). It got there through two decades of state support and a home market that turned electric faster than any other. It now has far more plants than its buyers need (Module 4).

The older makers earn their profits in a narrow band: pickups and large SUVs in North America, Toyota's hybrids, and luxury cars, which are losing ground in China (Modules 3, 5, 6, and 7). Their electric programs lost money, Ford's about $27,000 on each car in 2025. In 2025-26 they wrote off tens of billions of dollars and turned plants built for electric cars to gasoline trucks, batteries for the grid, and range extenders (Modules 3 and 6).

Governments built walls around them. America taxes imported cars at 25% and Chinese electric cars at 100%, and Europe, Mexico, Brazil, and Turkey have raised duties of their own, while Canada has let a quota of Chinese electric cars back in at 6.1% (Modules 5 and 9). America also loosened its rules, ending the credits and penalties that pushed its makers toward electric cars (Module 10). The walls buy time, but they do not lower costs. So far the American tariffs have worked more as a tax, paid mostly by the makers, than as protection, and most of the plants announced under them open from 2027 (Module 9).

The decade's question is what the older makers do with the time: close the cost gap with China, through cheaper batteries and platforms, fewer models and plants, and partnerships with Chinese firms, or keep selling what already pays (Modules 3, 5, and 8). Outside the walls the electric car keeps spreading, in Europe, which legislated it, and in the emerging markets, where Chinese cars arrive cheap (Modules 5, 7, and 8). Investors have placed their largest bet on the car's software and the driverless car it may become, although robotaxis remain a small business so far (Modules 3 and 11).

13b. Five Contradictions

Each module states its own findings. Read together, they produce tensions that no single module states.

The electric car won in China; its makers did not. New-energy vehicles took a record share of China's retail sales in 2026, while the industry's margin fell to a record low and sales at home fell (Module 4). The

policy produced the cars, and the price war took the profit. Exports became the outlet, and the walls of Modules 5 and 9 went up against them.

Europe's electric sales rise while its makers shrink. Battery-electric cars took a growing share of EU sales in 2026 while Volkswagen cut its margin forecast and planned 100,000 job cuts (Module 5). The transition Europe legislated is increasingly supplied by Chinese brands, and by their plug-in hybrids above all, which the duties on Chinese battery-electric cars do not reach (Modules 5 and 10).

America's walls raise the cost of building cars in America. The parts tariffs add to the cost of cars assembled in the United States, which is why the government added an offset for them (Module 9). Toyota's North American business lost money in its last fiscal year (Module 7). The electric supply chain that the federal credits were meant to build was cut back or converted after the credits ended (Modules 6 and 10).

The rules loosened as fuel got dearer. America zeroed its fuel-economy penalties in July 2025, rescinded its greenhouse standards for vehicles in February 2026, and loosened its fuel-economy standards in September 2026, in the year gasoline passed $4.50 a gallon and buyers turned to hybrids (Modules 6, 8, and 10). Buyers moved toward efficiency without the rules, while the rules moved the other way.

Strong sales, strained buyers. American sales were near their best since 2019 while monthly payments, loan terms, and subprime delinquencies set records (Modules 6 and 12). Longer loans to stretched buyers are part of what keeps sales high, so the market's strength and the buyer's strain are partly the same fact. And the most valuable carmaker earned a thinner margin in its latest quarter than most of the makers it is worth more than; its price rests on software and robotaxis yet to be proved at scale (Modules 3, 6, and 11).

13c. What to Watch

The dates below are the ones that would confirm or overturn the course's readings. Each entry says what the event would show, not what the course has already reported about it.

When	What	Why it matters
October 27-28, 2026	The Fed's rate-setting meeting	Car loans are priced off the Fed's rate; a further rise would lift the payments already straining buyers at the bottom (Module 12)
October 28, 2026	Ford's and Stellantis's third-quarter results	Whether Ford's raised guidance survives its supply problems and its electric reset, and whether Stellantis's return to profit holds as its American sales fall (Modules 3, 5, and 6)
November 3, 2026	The US midterm elections	Control of Congress decides whether the tariffs, the credits, or the emissions rules change by law rather than by proclamation and rule (Modules 9 and 10)
Early November 2026	Toyota's, Honda's, and Nissan's results for April-September	What the tariffs cost the Japanese makers, and whether Honda's and Nissan's recoveries hold (Modules 7 and 9)
November 10, 2026	The original end of China's pause on its wider rare-earth export controls, which the truce's extension did not explicitly cover	Whether those controls return, and with them the magnet shortages that stopped lines in 2025 (Module 2)
Mid-November 2026	China's October sales	Whether the fall at home deepens while exports keep rising (Module 4)

When	What	Why it matters
November 23, 2026 (indicative; may slip to December)	The European Parliament's vote on the car CO2 rules	Whether the 2035 end of new combustion cars is softened to the Commission's 90% cut or to the 87.5% the main groups reportedly agreed (Module 10)
November 30, 2026	NHTSA's new fuel-economy rule takes effect, with states suing	Whether the looser standards take hold while 21 states, the District of Columbia, and five cities ask the appeals court in Boston to overturn them (Module 10)
As soon as December 1, 2026 (proposed)	An EU safeguard cap on imported hybrids and plug-in hybrids	Whether Europe closes the gap in its duties that Chinese plug-in hybrids came through (Module 5)
Fourth quarter of 2026	BYD's plant at Szeged, Hungary, begins series production	The first passenger-car plant a Chinese maker has built inside the EU, and a test of the case for inviting them (Modules 4 and 5)
End of 2026	Waymo's goal of a million paid rides a week	Whether Waymo can double its September pace by the year's end and keep its safety record (Module 11)
January 1, 2027	The threatened 50% US tariff on Canadian cars and parts	Whether a tariff announced in a post becomes a proclamation, hitting cars made under the North American trade pact (Module 9)
January 10, 2027	The extended US-China truce ends	Whether the tariff cuts agreed in 2025 continue, and with them any extended pause on China's wider rare-earth controls (Modules 2 and 9)
April 1, 2027	China cuts its export tax rebate on new-energy vehicles from 13% to 9%	A cost on the exports that became China's outlet as sales at home fell (Module 4)
2027	The next annual review of the North American trade pact; the first of the plants announced under the tariffs open	Whether the pact is renewed, and whether the tariffs bring the plants they were meant to (Module 9)
December 31, 2027	China's half-rate purchase tax on new-energy vehicles ends	The end of China's purchase-tax relief for buyers at home, and a test of demand without it (Module 4)
April 30, 2028	The UAW's contracts with GM, Ford, and Stellantis expire	The next national test of labor costs at the Detroit Three (Module 2)
April 30, 2030	The tariff offset for American-assembled cars ends; in the same year Volkswagen's 100,000 job cuts are due to be complete	Whether American assembly pays without the offset, and how much smaller Europe's largest maker has become (Modules 5 and 9)

Dates are as announced by October 22, 2026. Toyota's, Honda's, and Nissan's results dates, and the timing of China's October figures, are expected, not confirmed.

13d. The Last Word

The course began with 96 million vehicles and ends with a question of time. For most of the twentieth century the industry's center moved slowly, from Detroit to Europe and Japan, and the makers that led it were the ones that built good cars most cheaply at scale. In the 2020s it moved in a decade, to China, on the strength of the battery. The tariffs and rule changes of 2025-26 slow that movement where they apply. They do not reverse it.

The reader who follows the industry from here will learn more from costs than from announcements: the price of a battery pack, the profit on each vehicle, the share of each plant's capacity in use, and what buyers pay each month. Plans for robotaxis, plants, and electric models are claims until they show up in those numbers. The course's figures are current as of October 2026, and the watch list above is where they will next change.

Module 13 Key Points

Where Things Stand, and What to Watch

• China built 36% of the world's vehicles in 2025 and sells most electric cars, but its price war left its makers record-low margins.

• The older makers earn their profits on pickups, SUVs, hybrids, and luxury cars, and wrote off tens of billions on electric plans.

• Tariffs and looser rules buy the older makers time; so far the American tariffs have acted more as a tax than as protection.

• American sales stay near 16 million on longer loans, with record payments and record subprime delinquency in January 2026.

• The course's thread: the walls buy time, and the decade's question is whether the older makers use it to close the cost gap.

Module 13 Quiz

Check Your Understanding

1. Why, in the course's reading, did the walls against Chinese cars go up in 2024-26?

A) Chinese cars failed safety tests abroad
B) Exports became the outlet for an overbuilt industry
C) China stopped exporting batteries
D) Chinese makers sold their cars abroad for less than half their price at home, as the duties were set to show

2. What does the module conclude the American tariffs have mainly been so far?

A) A tax, paid mostly by the makers
B) A spur to new American plants, most of them already open
C) A cut in prices for American buyers as imports fell
D) A collapse in imports from Japan, Korea, and Europe in 2025 and 2026

3. Which contradiction does the module draw from America's rules?

A) The rules tightened as gasoline got cheaper, so buyers turned away from hybrids
B) Tariffs cut import prices
C) The rules loosened as fuel got dearer
D) Congress restored California's waivers

4. What does the module say the tariffs and looser rules do for the older makers?

A) They have made the older makers cheaper to run than the Chinese makers.
B) They have ended the electric transition in every market.
C) They let the makers stop spending on new models.
D) They buy the older makers time but do not lower their costs, so the result depends on what the makers do with that time.

5. What is the course's thread?

A) Electric cars have failed
B) Tariffs will bring the industry back to America
C) China will own every car market by 2030
D) Walls buy time; will it be used?

Answer Sheet

Answers to every module's Check Your Understanding quiz.

Module	Answers
Module 1 Quiz	1. C 2. B 3. D 4. A 5. C
Module 2 Quiz	1. B 2. D 3. A 4. B 5. D
Module 3 Quiz	1. A 2. C 3. B 4. D 5. A
Module 4 Quiz	1. C 2. C 3. A 4. D 5. B
Module 5 Quiz	1. D 2. C 3. B 4. A 5. B
Module 6 Quiz	1. D 2. C 3. A 4. C 5. D
Module 7 Quiz	1. A 2. B 3. B 4. A 5. C
Module 8 Quiz	1. D 2. C 3. D 4. A 5. B
Module 9 Quiz	1. B 2. A 3. D 4. C 5. D
Module 10 Quiz	1. A 2. B 3. C 4. D 5. C
Module 11 Quiz	1. A 2. B 3. C 4. B 5. D
Module 12 Quiz	1. A 2. C 3. B 4. A 5. D
Module 13 Quiz	1. B 2. A 3. C 4. D 5. D