Construction & Infrastructure

Figures current as of October 2026

How the world gets built: the industry and its 2026 split, the history from Roman concrete to China's boom, cement and the stone beneath it, the materials companies, steel, timber, and copper, the builders, the electrical trades that now lead the industry, the workforce, the productivity puzzle, the megaprojects, who pays, the world's build-out, and what to watch.

MODULE 1 — The Industry in 2026

Goal: Set the numbers and the structure.

Who builds what: owner, designers, general contractor, subcontractors, and suppliers; the three markets of housing, private building, and public works; the most fragmented large industry; and the 2026 split, with data centers up 73% on the year while factories and housing fall.

MODULE 2 — How the World Got Built

Goal: Trace the build from Rome to Shanghai.

Roman concrete and the Pantheon; Portland cement, cheap steel, reinforced concrete, and the safety elevator; the Erie Canal, Hoover Dam, the Empire State in 410 days, and the Interstates; China's boom; the long trend from fast and cheap to slow and dear.

MODULE 3 — Cement and Concrete

Goal: Understand the material the world stands on.

The kiln and the chemistry; concrete's recipe; why cement travels badly; the world's 3.8 billion tonnes and China's fall; aggregates, the largest mined material on earth; the emissions and the first capture plant; the haul-cost arithmetic, worked.

MODULE 4 — The Materials Companies

Goal: Follow the owners of the quarries and kilns.

Holcim, Amrize, Heidelberg Materials, CRH, Cemex, Vulcan, Martin Marietta, the Chinese and Indian giants, and Dangote; why a permitted quarry is a local monopoly; the reshuffle from the Amrize spin-off to CRH's $8.5 billion Arcosa deal; a quarry's value, worked.

MODULE 5 — Steel, Timber, and Everything Else

Goal: Read the other inputs and their prices, and weigh the tariffs on them.

Rebar and structural steel from electric furnaces; lumber and the Canadian duties; copper, asphalt, and diesel; the 50% metals tariffs and the Iran war's fuel shock; the cases for and against the tariffs on building materials; a steel-frame building's tariff bill, worked.

MODULE 6 — The Builders

Goal: Understand the contractor's business.

General contractors on thin margins, the subcontract chain, fixed price against cost-plus, bonds and retainage, and why contractors fail; the world's largest builders, from China State Construction to Vinci and Turner; the equipment makers; a contractor's job, worked.

MODULE 7 — The Electrical Build-Out

Goal: Follow the trades that now lead construction.

Why a data center is mostly electrical and mechanical work; Quanta, EMCOR, Comfort Systems, and their record backlogs; transformers and switchgear from the jobsite; the electrician as the scarce input; a 1-gigawatt campus's construction budget, worked.

MODULE 8 — The Workforce

Goal: Understand who builds and who is missing, and weigh the shortage.

8.4 million workers, their age, their pay, and their origins; unions and the open shop; apprenticeships and licensing; the immigration enforcement of 2025-26 and the 349,000 workers the industry says it needs, with the cases argued.

MODULE 9 — The Productivity Puzzle

Goal: Weigh why building got harder.

Output per construction worker below its 1970 level while the rest of the economy's doubled; the measurement case and its test; land-use rules, small firms, and the site as a factory that moves; prefabrication, Katerra's collapse, and a 19-day tower; the causes argued.

MODULE 10 — Megaprojects

Goal: Understand why big projects overrun, and weigh why America's overrun more.

Flyvbjerg's iron law; the Big Dig, Berlin's airport, Vogtle, California high-speed rail, and NEOM; America's subway costs against Madrid's; permitting, labor, owners, and politics argued as causes, with the permitting changes of 2025-26.

MODULE 11 — Paying for It

Goal: Follow the money to the public works, and weigh the federal role.

Who pays for infrastructure; the gas tax frozen since 1993 and the Highway Trust Fund; municipal bonds, tolls, and public-private partnerships; the 2021 infrastructure law, the stopgap that carried it past September 30, 2026, and the $580 billion House bill; the federal role argued.

MODULE 12 — The World's Build-Out

Goal: Read where the cranes are.

China after the boom; India's highways and cement; the Gulf's giga-projects cut back; Africa's cement race; Europe's slow build and Germany's €500 billion fund; cement per person, worked.

MODULE 13 — Where Things Stand, and What to Watch

Goal: Close with the trajectories, the thread through the arguments, and a dated watch list.

An industry leaning on one kind of building; rates, tariffs, and labor as the three constraints; what the course's five arguments share; a watch list from October 2026 on; and a last word.

A note on the sources: construction is measured badly, because its output is a one-off object on a particular site, the price indexes that turn spending into real output are contested, and the industry's own associations publish many of the figures the course relies on. Spending comes from the Census Bureau's monthly survey, materials from the US Geological Survey (USGS) and the producer price indexes (PPI) of the Bureau of Labor Statistics (BLS), employment from the BLS, and company figures from filings. Industry estimates, such as the contractor associations' labor models and the cost guides' prices per megawatt, are named as estimates where they appear. Where the field argues, over the tariffs on building materials, the labor shortage, why productivity stalled, why American projects cost more, and who should pay, 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
US construction spending	$2,203.1 billion at a seasonally adjusted annual rate, down 1.7% on the year: private residential $882.3 billion (down 4.8%), private nonresidential $773.0 billion (down 1.0%), and public $547.8 billion (up 2.5%)	August 2026	Census Bureau, *Construction Spending* (October 1, 2026)
Inside private building	Data centers about $85 billion, up 73%; power $165.9 billion, up 9.7%; manufacturing $168.2 billion, down 19.8%; offices other than data centers down 9.4%	August 2026	Census Bureau detail, via the contractor associations (October 1)
Data-center starts	$98.5 billion across 153 projects, 24% of all nonresidential building starts	January-August 2026	ConstructConnect (September 29, 2026)
Technology companies' capital spending	Over $400 billion in 2025; about $715 billion planned for 2026, mostly for artificial intelligence (AI)	2025-26	Company reports
Construction jobs and pay	8.36 million jobs, up 109,000 (1.3%) in a year; production workers paid $39.20 an hour, up 4.3%, against 3.3% across the private sector	September 2026	BLS, *Employment Situation* (October 2, 2026)
Materials prices	Inputs to nonresidential construction up 8.9%; diesel up 77.8%, aluminum mill shapes 27.3%, steel mill products 23.4%, and copper and brass mill shapes 20.9%	August 2025 to August 2026	BLS price indexes, via the Associated General Contractors (September 10)
Diesel at the pump	$6.20 a gallon, up $2.49 in a year	Week of October 5, 2026	US Energy Information Administration, weekly
Copper	$14,614.50 a tonne (three-month), near its record of $14,875 on September 10	October 8, 2026	London Metal Exchange
Interest rates	Federal funds target 3.75-4.00% after a quarter-point rise on September 16; ten-year Treasury 5.24%; 30-year mortgage 7.40%, highest since November 2023	September 16; October 8-9, 2026	Federal Reserve; Treasury market close (October 9); Freddie Mac (October 8)
Cement	United States: 84 million tonnes made and 110 million used, 21% imported, at an average mill value of $160 a tonne ($127 in 2021). World: about 3.8 billion tonnes, China 1.7 billion and India 470 million	2025	USGS, *Mineral Commodity Summaries 2026* (February 2026)
US aggregates	1.5 billion tonnes of crushed stone at $18.50 a tonne; 870 million tonnes of construction sand and gravel at $14.50	2025	USGS, *Mineral Commodity Summaries 2026*
Workers needed	349,000 net new workers in 2026 and 456,000 in 2027, on the contractors' model	2026-27	Associated Builders and Contractors (January 16, 2026)
The federal highway program	Authorities extended to December 11, 2026 by the stopgap signed on September 2; the 2021 law's advance appropriations lapsed on October 1; the federal gasoline tax 18.4 cents a gallon since 1993	October 2026	Continuing Appropriations and Extensions Act, 2027 (Public Law 119-103)
Highway Trust Fund	The transit account projected to run out in fiscal 2027 and the highway account in fiscal 2028	June 2026	Congressional Budget Office (CBO) baseline

A tonne is 1.10 US short tons. Dollars are US dollars; the euro is converted at $1.15, the yuan at 6.71, and the rupee at 95.5, the Federal Reserve's September 2026 averages; the Saudi riyal is pegged at 3.75.

Module 1 — The Industry in 2026

The Numbers and the Structure

Recommended Reading / Reference

Book: Tracy Kidder, *House* (1985), one house from the owners' first sketch to the last trim, and the clearest account of who does what on a job

Reference: The Census Bureau's monthly *Construction Spending* release (the Value of Construction Put in Place survey), the source for the spending figures throughout

1a. What Construction Is

Construction is the industry that turns money, land, and materials into things that stay where they are put: houses, offices, factories, warehouses, data centers, power plants, roads, bridges, pipes, and dams. It is one of the largest industries in every economy, about $13 trillion a year worldwide on industry estimates, roughly a tenth of world output. In the United States it ran at $2.2 trillion a year in August 2026, about 7% of the economy, with 8.4 million workers. It is also the least understood, because it has no single product, no national brand most people can name, and no factory: every project is a prototype, built once and outdoors on a site that did not exist in that form before.

Every project has the same cast: the **owner**, whether a family, a developer, a company, a utility, or a state highway department, decides to build and pays. The **designers**, architects for buildings and engineers for structures, systems, and roads, turn the owner's needs into drawings a builder can price and an inspector can approve. The **general contractor** takes responsibility for delivering the whole thing: it prices the job, schedules it, manages the site, and hires the **subcontractors** who do most of the physical work, the concrete, steel, electrical, mechanical, plumbing, drywall, and roofing firms and dozens of other specialists.

The **suppliers** sell the materials, from ready-mix concrete, rebar, and lumber to wire, pipe, glass, and the equipment that goes inside. Around them sit the lenders, the insurers and sureties who guarantee the contractor's work, the permitting authorities, and the inspectors, each of whom can stop a job.

The industry divides into three markets that move on different clocks: **residential** building (new homes and remodeling) follows mortgage rates and household formation. **Private nonresidential** building (offices, warehouses, factories, data centers, hospitals, and power plants) follows corporate investment and, in 2026, one kind of corporate investment above all. **Public** building (highways, schools, water systems, and transit) follows tax revenue and the federal programs that top it up. The three rarely boom together, which is why the total moves less than its parts and why a headline number can hide an industry moving in two directions at once.

It is also the most fragmented large industry in the economy: there are about 800,000 construction employers in the United States, four in five with fewer than ten employees, and the largest American builder, Turner, had revenue of $28 billion in 2025, about 1% of the country's construction. The reasons are structural and recur through the course: the product is heavy and local, so a builder's market is a metro area, and the work comes project by project, so firms grow and shrink with their backlog. The trades are separate skills with separate licenses, and every jurisdiction writes its own rules. A factory industry consolidates as it grows, but construction has stayed a network of small firms assembled for each job and dispersed at the end of it.

1b. The 2026 Numbers

Category	August 2026 (annual rate)	Change on the year	What drives it
Total construction spending	$2,203.1 billion	Down 1.7%; down 3.1% in January-August	The sum of a boom and a slump
Private residential	$882.3 billion	Down 4.8%	Rising mortgage rates; builders' unsold homes
Private nonresidential	$773.0 billion	Down 1.0%	Data centers and power up; factories, shops, and offices down
Data centers (counted inside 'office')	About $85 billion	Up 73%	The technology companies' AI build-out
Power	$165.9 billion	Up 9.7%	Generation and grid for the new load
Manufacturing	$168.2 billion	Down 19.8%; about a third below its September 2024 peak	The chip and battery plants finishing
Public construction	$547.8 billion	Up 2.5%	The last funded year of the 2021 infrastructure law
Highways and streets (public)	$150.6 billion	Up 4.4%	The largest single public category
Education (public)	$113.1 billion	Up 1.3%	Schools, the second-largest

Census Bureau, *Construction Spending*, released October 1, 2026; data centers from its detailed tables, as analyzed by the contractor associations.

1c. A Boom and a Bust in One Number

The August 2026 report is the industry's year in miniature: total spending ran at a $2,203 billion annual rate, 1.7% below a year earlier, and the first eight months were 3.1% below the same months of 2025. Private housing was down 4.8% on the year as builders worked through unsold homes. Factory construction was down a fifth on the year and a third from its September 2024 peak, as the semiconductor and battery plants funded by the laws of 2022 finished and too few new ones began. Offices other than data centers were down 9%, still falling after the remote-work vacancy wave.

Inside the same total, data-center construction ran at about $85 billion a year, up 73% on the year. Power construction, pulled by the same demand, rose 10% to $166 billion, nearly level with manufacturing, and together the two kept private nonresidential spending within 1% of a year earlier while almost every other part of it fell.

An industry economist's summary was that the office category, where the Census counts data centers, had become two businesses moving in opposite directions, and the aggregate was the average of a boom and a bust. The same is true of the whole industry, whose boom is concentrated in a few dozen campuses in Texas, Virginia, Ohio, Indiana, Georgia, Arkansas, and Arizona, built for the capital-spending plans of a handful of technology companies, which put their 2026 total at about $715 billion. The bust is spread across every metro area's housing and every region's factories.

The questions the rest of the course keeps returning to follow from that split. What happens to the contractors, the electricians, and the materials suppliers if the boom's buyers slow? Can the public side hold the floor now that its federal law runs on a stopgap? And can the industry's labor and materials serve the boom without starving everything else?

1d. The Vocabulary

Term	Meaning	Why it matters
Put in place	Spending counted as the work is done, month by month, not when the contract is signed	The Census measure; it lags starts by months
Starts and backlog	The value of projects beginning; the contracted work not yet built	The industry's forward indicators
Hard and soft costs	Construction itself; design, permits, financing, and fees	Soft costs are a fifth to a quarter of a budget
General contractor	The firm responsible for delivering the project	Manages the job and subcontracts most of the work
Specialty or trade contractor	Electrical, mechanical, concrete, steel, and other trades	Most of the labor and, in 2026, most of the growth
Mechanical, electrical, and plumbing (MEP)	The building's systems, as distinct from its structure	Most of the cost of a data center or hospital
Heavy civil	Roads, bridges, dams, tunnels, and pipelines	Public money and different contractors
Aggregates	Crushed stone, sand, and gravel	Most of concrete and asphalt by weight
Design-bid-build and design-build	Design first, then bid; or one contract for both	How risk is divided between owner and builder

Worked example — Where a Construction Dollar Goes

Take a $100 million project, a five-story laboratory and office building, excluding the land. Soft costs take about $22 million: design and engineering $8 million, permits and fees $3 million, financing during construction $6 million, and the owner's management, insurance, and contingency the rest. The hard cost is about $78 million, and it divides roughly into materials and equipment, $33 million, labor, $30 million, the subcontractors' and general contractor's overhead, $8 million, and profit, $7 million. Of the profit, the general contractor's own fee is about $3 million, under 4% of the hard cost, and the rest is spread across twenty or more subcontractors. Two things follow. The general contractor, which the public thinks of as 'the builder,' does perhaps a tenth of the physical work with its own crews and earns a thin fee for carrying the risk of the rest. And three of the main lines, materials, labor, and financing, are exactly the three that moved against the industry in 2025-26: tariffs and diesel raised the first, the labor shortage the second, and interest rates the third.

Module 1 Key Points

The Industry in 2026

• Construction is about $13 trillion a year worldwide and $2.2 trillion in the United States, about 7% of the economy.

• Every job has the same cast: owner, designers, general contractor, subcontractors, and suppliers; the subcontractors do most of the physical work.

• It is the most fragmented large industry: America's largest builder, Turner, does about 1% of the country's construction.

• In August 2026 total spending was down 1.7% on the year while data-center construction was up 73%.

• Housing, factories, and ordinary offices are falling; data centers, power, and public works are rising.

Module 1 Quiz

Check Your Understanding

1. What did the August 2026 construction spending report show for data-center construction?

A) Down about a fifth, like factory construction
B) Flat, as the technology companies paused orders
C) Up about 10%, in line with power-plant construction
D) Up 73% on the year

2. Who performs most of the physical work on a typical building project?

A) The general contractor
B) The architect and engineers, who also run the site
C) Specialty subcontractors
D) The owner's own construction department, on large jobs

3. Why does the module call the 2026 total 'the average of a boom and a bust'?

A) Data centers and power rose sharply while housing, factories, and ordinary offices fell
B) Spending boomed in the spring and then fell back sharply over the summer months
C) Public spending boomed while private spending collapsed
D) The Census Bureau changed its method and the series broke

4. About what share of American construction spending is public?

A) About half
B) About a quarter, $548 billion
C) About a tenth, $220 billion
D) Nearly all of it, through the states and the federal highway program

5. Why has construction stayed the most fragmented large industry?

A) Federal antitrust law has blocked most mergers among large builders since the 1990s
B) Its product is heavy and local, built project by project under each jurisdiction's rules
C) Owners prefer to split each job among many small builders
D) Most builders are family firms that refuse to sell

Module 2 — How the World Got Built

From Roman Concrete to the Chinese Boom

Recommended Reading / Reference

Book: Vaclav Smil, *How the World Really Works* (2022), the materials of modern life, cement and steel among them, in numbers

Reference: The USGS historical statistics for cement and steel; the Federal Highway Administration's history of the Interstate system

2a. Stone, Brick, and Roman Concrete

For most of history people built with what lay near the site, such as stone, mud brick, timber, and thatch, and built big things slowly, with enormous numbers of workers, because moving material was the whole problem. The Romans changed the material: their concrete mixed lime with volcanic ash from around Pozzuoli and rubble, set even under water, and could be poured into forms rather than cut and fitted.

With it they built harbors, aqueducts, vaults, and the Pantheon, whose unreinforced dome of 43 meters, finished around 125 AD, is still the largest of its kind. The builders graded the aggregate, with heavy basalt at the base and light pumice toward the top, and left the oculus open to lighten the crown. Recent work suggests that Roman concrete also healed its own cracks, as lumps of lime reacted with seeping water, one reason Roman harbor walls outlast modern ones. The technique was largely lost with the empire, and Europe built in stone and brick for a thousand years.

2b. The Industrial Materials

The modern industry rests on four inventions of the nineteenth century. In 1824 Joseph Aspdin, a Leeds bricklayer, patented Portland cement, limestone and clay burned together and ground, named for its resemblance to Portland stone, and hotter kilns later in the century produced the clinker-based cement still made today. In 1856 Henry Bessemer's converter made steel cheap enough to build with, and the open-hearth furnace soon made it cheaper still.

Joseph Monier's iron-reinforced flowerpots of 1867 led, through François Hennebique's system of the 1890s, to reinforced concrete, with steel to take tension and concrete to take compression, a composite that is now most of the built world. And Elisha Otis's safety elevator, demonstrated in 1854, made tall buildings usable, while the steel frame made them possible, first in Chicago's Home Insurance Building of 1885, where the walls hung on the skeleton instead of carrying the floors.

2c. The American Build

America's great projects came in waves, each tied to a new way of moving goods. The Erie Canal (1817-25), 363 miles dug largely by hand, cut the cost of freight from Buffalo to New York by about 90% and made New York the nation's port. The first transcontinental railroad (1863-69) was built by two companies racing from each end, one with thousands of Chinese laborers, on federal land grants and loans. The Brooklyn Bridge (1869-83) put steel wire into a suspension span and caisson disease, the bends, into the medical literature. The Panama Canal (1904-14), after France's failed attempt, succeeded when American engineers controlled the mosquitoes first and moved the dirt second.

Hoover Dam (1931-36) poured 3.25 million cubic yards of concrete in blocks cooled by embedded pipes and was finished two years ahead of schedule. The Empire State Building went up in 410 days in 1930-31 and came in under budget, and the Pentagon was built in about 16 months during the war.

The largest was the Interstate system: the Federal-Aid Highway Act of 1956 authorized 41,000 miles of limited-access highway, paid 90% of the cost from a new Highway Trust Fund fed by the gasoline tax, and set design standards the states had to meet. It took until 1992 to declare it complete, at a cost of about $114 billion, more than $500 billion in today's money. It rebuilt the country's geography: the suburbs, the trucking industry, and the logistics networks grew along it, and the downtowns it cut through declined. It was also the last American build of that scale, and the country has since maintained and widened what it built in the twentieth century far more than it has added to it.

2d. China's Build

The largest construction boom in history happened in China between the late 1990s and 2021. Vaclav Smil's comparison is the usual summary: China used more cement in the three years 2011-13, about 6.6 billion tonnes, than the United States used in the whole of the twentieth century, about 4.5 billion. It built the world's largest expressway network, hundreds of millions of apartments, and whole new districts, and its high-speed rail network reached 50,000 kilometers at the end of 2025. Its construction and real-estate sectors reached about a quarter of gross domestic product (GDP) on the widest measures.

The boom ran on local governments selling land and borrowing through financing vehicles, and on households buying apartments as savings. It ended when the property developers' debt broke in 2021. New construction starts in 2025, three-quarters of them housing, were 70% below 2021's, and they fell another quarter in the first eight months of 2026; cement output, 1.69 billion tonnes in 2025, the lowest since 2010, was a third below its 2014 peak. The world's largest builder is now working out what to do with the capacity the boom left.

2e. The Trend: Fast and Cheap, Then Slow and Dear

Project	Built	Time	Cost and outcome
Erie Canal	1817-25	8 years for 363 miles	Paid off its debt from tolls within a decade
Hoover Dam	1931-36	About 5 years	Two years early; a contract of about $49 million
Empire State Building	1930-31	410 days	About $41 million against a $50 million budget
The Pentagon	1941-43	About 16 months	6.5 million square feet
Interstate system	1956-92	36 years	About $114 billion; the last American build of its scale
Boston's Big Dig	1991-2007	16 years	Estimated at $2.8 billion in 1982; finished at $14.6 billion
Second Avenue Subway, phase 1	2007-17	10 years for 1.8 miles	$4.45 billion; among the costliest miles on earth
California high-speed rail	2015-	No track laid by September 2026	$33 billion in 2008; $231 billion for the first phase, San Francisco to Los Angeles and Anaheim, in the 2026 draft plan, and $35 billion for its first 171 miles, due in 2032

The pattern the course returns to in Modules 9 and 10: the twentieth century built big things faster and cheaper than the twenty-first builds comparable ones in the same country.

The table is not an argument that the past was better at everything. The Empire State's builders worked men at heights without harnesses, and Hoover Dam killed about a hundred workers. The Interstates were driven through neighborhoods whose residents had no say, and the transcontinental railroad made fortunes for its promoters through the Crédit Mobilier scandal. Some of the slowing is the price of things a society chose: safety, environmental review, and a voice for the people in the way.

But much of it is not, and the comparison with other countries today, where subways and rail lines still cost a fraction of the American figure, says that the difference is not all choice. Why a rich country with better tools builds more slowly and expensively than it once did is the question the course's second half takes up.

Worked example — The Empire State Schedule

The contract was signed in late 1929, and demolition of the old Waldorf-Astoria hotel began that autumn. Excavation started in January 1930, construction proper on March 17, and the steel frame in April; the building opened on May 1, 1931, 410 days after construction began. At the peak about 3,400 men were on site, and the frame rose four and a half floors a week, with one stretch of fourteen and a half floors in ten working days. The builders, Starrett Brothers and Eken, treated the site as an assembly line. Steel was fabricated in Pittsburgh, delivered piece by piece in the order it was needed, and hoisted within hours of arrival, because the streets of midtown had no room to store it. A narrow-gauge railway on each floor moved material from the hoists to the work, and the design was repetitive enough that the trades could follow each other up the building floor by floor. The whole building cost about $41 million including the land, under its $50 million budget, helped by the Depression's falling prices, and five workers died. The lesson the industry still draws is that the speed came from planning, a design fixed before the work began and a supply chain timed to the schedule, rather than from any machine the builders had and we lack.

Module 2 Key Points

How the World Got Built

• Roman concrete of lime and volcanic ash built the Pantheon's dome, still the largest unreinforced dome; the technique was then largely lost.

• Portland cement, cheap steel, reinforced concrete, and the safety elevator, all nineteenth-century inventions, made the modern built world.

• America's great builds followed new ways of moving goods: the canal, the railroad, and the 41,000-mile Interstate system.

• China used more cement in 2011-13 than America did in the whole twentieth century, in a boom that ended in 2021.

• The Empire State went up in 410 days, under budget; comparable American projects now take a decade and cost multiples of their estimates.

Module 2 Quiz

Check Your Understanding

1. What made the Pantheon's dome possible?

A) Roman concrete of lime and volcanic ash
B) Steel reinforcement bars set in the dome's concrete
C) Portland cement, which the Romans invented and later lost
D) Stone blocks cut to fit without mortar, as in Greek temples

2. How long did the Empire State Building take to build?

A) In 5 years
B) In about three years, on schedule
C) In 410 days
D) In about ten years, like the Second Avenue Subway

3. What did the Federal-Aid Highway Act of 1956 create?

A) The first federal gasoline tax
B) A federal toll-road authority
C) A national high-speed rail network linking the largest cities
D) The Interstate system and its trust fund

4. What does Vaclav Smil's comparison of Chinese and American cement show?

A) America used more per person in every decade
B) China used more in 2011-13 than America in the twentieth century
C) The two used about the same per person
D) China's use peaked in the 1990s, before its housing boom began in earnest

5. What trend does the module draw from its history?

A) Construction has grown faster each century as tools improved
B) Every era built more slowly than the one before, since Rome
C) Costs rose only where projects used new technology
D) Big things were once built faster and cheaper

Module 3 — Cement and Concrete

The Material the World Stands On

Recommended Reading / Reference

Book: Robert Courland, *Concrete Planet* (2011), the material's history from the first lime mortars to the modern ready-mix truck

Reference: The USGS *Mineral Commodity Summaries 2026* (February 2026), chapters on cement, crushed stone, and construction sand and gravel

3a. The Chemistry

Cement is made by heating crushed limestone with clay or shale in a rotating kiln, a steel tube several meters wide and up to a couple of hundred meters long, tilted slightly and turning slowly, to about 1,450°C (2,640°F). At that temperature the limestone (calcium carbonate) gives up carbon dioxide and becomes lime, and the lime fuses with the silica, alumina, and iron from the clay into marble-sized nodules called clinker. The clinker is cooled, ground with a few percent of gypsum to a powder finer than flour, and shipped as Portland cement. When water is added, the calcium silicates react to form a crystalline gel that binds whatever it is mixed with, and the reaction continues for years, which is why concrete keeps gaining strength long after it is poured.

The chemistry is also the industry's climate problem: driving carbon dioxide out of limestone releases about half a tonne of CO2 for every tonne of clinker, whatever fuel heats the kiln, and burning the coal, petroleum coke, or waste that supplies the heat adds most of the rest. A tonne of cement carries about 0.6 tonnes of CO2, and the industry as a whole about 7-8% of the world's emissions.

The main lever the industry has pulled is the clinker factor, the share of clinker in the finished cement, which it lowers by blending in blast-furnace slag, fly ash from coal plants, limestone powder, or calcined clay that do some of clinker's work without its emissions. The other levers are newer and costlier: carbon capture at the kiln, and new chemistries that avoid limestone altogether.

3b. Concrete

Cement is the glue, and concrete is the material. A typical cubic meter of concrete is about 10-15% cement, 60-75% aggregate (sand and crushed stone or gravel), and 15-20% water, with admixtures to adjust setting time, workability, or resistance to frost. Its strength depends on the ratio of water to cement, the quality of the aggregate, and how it is placed and cured. The world pours about 30 billion tonnes of concrete a year, roughly four tonnes for every person alive, more than any other manufactured material and second only to water among the substances people use.

Most of it is ready-mix, batched at a plant and delivered in a rotating drum truck that has about ninety minutes before the load begins to set. The rest is precast, cast in a factory into beams, panels, pipes, and blocks and trucked to the site. Nearly all structural concrete is reinforced with steel bar (rebar), because concrete is strong in compression and weak in tension, which ties the concrete business to the steel market of Module 5.

3c. Why Cement Travels Badly

American cement averaged $160 a tonne at the plant in 2025, and a tonne is a lot of weight for the money. Moving it by truck costs something like 15-25 cents a tonne-mile, so 200 miles of trucking adds a fifth to a third to the plant price, and a nearer plant wins. By rail the radius stretches, and by water, in ships and barges, cement can cross oceans. That is why the industry's map is a map of kilns near limestone and customers, why a cement plant on a navigable river or a port is worth more than one inland, and why import terminals ring the American coasts.

The United States made 84 million tonnes in 2025 and used 110 million, importing about a fifth, mostly from Turkey, Canada, Vietnam, and Greece. Aggregates are more local still: crushed stone averaged $18.50 a tonne at the quarry in 2025, more near the cities, and 45 miles of trucking adds about half to its price, so most of it travels less than 50 miles from where it is dug.

3d. The World's Cement

Country	2025 output (million tonnes)	Share of world	Note
China	1,700	About 45%	A third below its 2014 peak; losses, closures, and a planned capacity cut
India	470	About 12%	The growth market, up 7% on the year; highways and housing
Vietnam	100	About 3%	A major exporter of clinker and cement
Turkey	89	About 2%	The largest exporter to the United States
United States	84	About 2%	Imports about a fifth of what it uses
Iran	68	About 2%	Domestic building; sanctions limit exports
Brazil	67	About 2%	The largest in Latin America
Egypt	64	About 2%	Output up a fifth in 2025; the new capital and exports
Indonesia	64	About 2%	Overcapacity after the building of the 2010s
World	About 3,800	100%	Down from 3,900 in 2024

USGS, *Mineral Commodity Summaries 2026* (estimates, rounded); China's peak from its National Bureau of Statistics (2.48 billion tonnes in 2014).

The table has two stories, and the first is concentration: China alone makes nearly half the world's cement, and Asia about three-quarters. The second is decline at the top: China's output fell to 1.69 billion tonnes in 2025, the lowest since 2010, and another 9% in the first seven months of 2026, and its fall is larger than everyone else's growth, so world output is shrinking.

India is the large market growing fastest, with output up about 7% in 2025 on the highway and housing programs of Module 12, and Africa is where the next capacity is being built, largely by Chinese and African firms. The American market is small by volume but rich by price, with among the highest cement prices in the world, protected by the cost of freight.

3e. Aggregates: The Largest Mined Material

Sand, gravel, and crushed stone are the largest mined materials on earth by far. The United Nations Environment Programme estimates 40-50 billion tonnes a year, several times coal and iron ore combined. The United States alone produced about 2.4 billion tonnes in 2025, 1.5 billion of crushed stone from about

3,500 quarries and 870 million of sand and gravel from about 6,500 pits, most of it for concrete, asphalt, and road beds.

Not all sand will do: desert sand, rounded by wind, does not bind well in concrete, which is why the Gulf states import sand and why river sand is mined illegally in India and Southeast Asia. Singapore built much of its reclaimed land with imported sand until its neighbors banned exports. In the rich countries the constraint is not the rock but the permit, since a new quarry near a growing city is among the hardest industrial permits to obtain, and that is the source of the economics of Module 4.

3f. The Emissions, in Brief

Decarbonizing cement runs through the chemistry of 3a: blended cements have cut the clinker factor in the West toward 0.7 and can go lower with calcined clay; in the United States, blends made up 63% of shipments in 2025, nearly all of them portland-limestone cement. Alternative fuels replace some coal, and carbon capture takes what is left.

The first full-scale capture plant at a cement kiln, Heidelberg Materials' plant at Brevik in Norway, opened in June 2025 to capture about 400,000 tonnes of CO2 a year, roughly half the plant's emissions, for storage under the North Sea, at a cost that roughly doubles the cement's price before subsidy. The European Union's carbon border adjustment has covered imported cement since January 2026, with importers buying their first certificates in 2027, and China's national carbon market began covering cement in 2025. Elsewhere, the clinker factor and the kiln's fuel are the whole of the policy so far.

Worked example — The Haul-Cost Arithmetic

A ready-mix producer outside a growing Sun Belt city needs 400,000 tonnes of crushed stone a year. The nearest quarry is 12 miles away and sells stone at $20 a tonne at the gate, and trucking at about 20 cents a tonne-mile adds $2.40, for a delivered cost of $22.40. The next-nearest quarry, 45 miles out, sells at $18, but trucking adds $9.00, for a delivered cost of $27.00, 20% more. Over a year the difference is about $1.8 million, which is the price protection the near quarry enjoys: it can raise its gate price by several dollars a tonne before any competitor can reach its customers. Now apply the same arithmetic to cement at $160 a tonne: a plant 60 miles from the customer pays about $12 a tonne in freight, 7-8% of the price, while a plant 300 miles away pays $60, more than a third, unless it ships by rail or barge. The industry's geography, with quarries ringing every city, cement plants on rivers and coasts, and import terminals at the ports, is this arithmetic drawn on a map.

Module 3 Key Points

Cement and Concrete

• Cement is limestone and clay burned at 1,450°C into clinker and ground; the limestone's chemistry releases CO2 whatever fuel heats the kiln.

• Concrete is mostly aggregate held together by cement; the world pours about 30 billion tonnes a year, more than any other manufactured material.

• Cement and stone are heavy and cheap, so freight sets their markets; crushed stone rarely travels more than 50 miles by truck.

• The world made about 3.8 billion tonnes of cement in 2025, nearly half in China, whose output is a third below its peak.

• Norway's Brevik plant became the first to capture a cement kiln's carbon at full scale, in 2025.

Module 3 Quiz

Check Your Understanding

1. Where do most of cement's carbon emissions come from?

A) The limestone's chemistry in the kiln
B) Trucking the cement
C) The electricity used to grind the clinker into powder
D) Mixing the concrete with water on the jobsite

2. Why is cement a local business?

A) Most countries ban cement imports to protect producers
B) Cement spoils within a day of leaving the kiln
C) It is heavy and cheap, so freight soon eats the price beyond a couple of hundred miles
D) Each country's building code requires its own recipe, so plants rarely export

3. What is the largest mined material on earth?

A) Sand, gravel, and crushed stone, at 40-50 billion tonnes a year
B) Coal
C) Iron ore
D) Limestone for cement kilns, about 4 billion tonnes a year

4. Which two countries produced the most cement in 2025?

A) China and Turkey
B) India and Iran
C) China, then India
D) The United States, then China

5. What is the clinker factor, and why does it matter?

A) The kiln's peak temperature
B) Clinker's share of cement; cutting it cuts emissions
C) The ratio of water to cement in concrete, which sets its strength
D) A charge on imported clinker that the European Union levies at its border

Module 4 — The Materials Companies

The Owners of the Quarries and the Kilns

Recommended Reading / Reference

Book: Ed Conway, *Material World* (2023), on sand, salt, iron, copper, oil, and lithium and the companies that dig them; its sand chapters are the best short account of aggregates

Reference: The companies' annual reports; Global Cement's annual Top 100 ranking of producers (November 2025)

4a. From Family Firms to Global Groups

For most of the twentieth century cement was a national business of family firms and, in much of the world, state companies, because freight kept each market local and governments treated cement as strategic. The industry globalized from the 1980s, as a handful of European and Mexican groups bought plants country by country, betting that scale in purchasing, engineering, and trading would beat local ownership.

Holderbank of Switzerland (later Holcim) and Lafarge of France built worldwide portfolios and merged in 2015. HeidelbergCement bought Hanson in Britain and, in 2016, Italcementi, and renamed itself Heidelberg Materials in 2022. Cemex of Mexico bought RMC, a British group, and then Australia's Rinker for about $15 billion in 2007, a year before the financial crisis nearly broke it under the debt. CRH of Ireland took a different route, buying hundreds of small American quarries, asphalt plants, and building-products firms. By the 2010s the Western majors had learned the lesson that shaped the reshuffle of 2025-26: cement is a cyclical, capital-heavy, carbon-exposed business, and the money is in the rock under it and the products made from it.

4b. The Majors

Company	Home	What it is in 2026	The recent moves
Holcim	Switzerland	Europe, Latin America, Asia, the Middle East, and Africa; a growing share of sales from roofing, insulation, and other building products	Spun off Amrize in June 2025; sold Lafarge Africa to China's Huaxin in 2025; completed its purchases of Xella and a majority of Cementos Pacasmayo in 2026
Amrize	United States (listed in New York)	Holcim's former North American business; the continent's largest cement producer	Independent since June 23, 2025
Heidelberg Materials	Germany	Europe, North America, Asia, and Africa; revenue €21.5 billion (about $25 billion) in 2025	Brevik, the first full-scale capture plant at a kiln; Padeswood in Britain next
CRH	Ireland (listed in New York)	The largest building-materials company in North America: aggregates, asphalt, cement, and products	Agreed on June 22, 2026 to buy Arcosa for about $8.5 billion; closing expected in early 2027
Cemex	Mexico	Mexico, the United States, and Europe; ready-mix and cement	Rebuilt after the 2008-09 debt crisis; asset sales to cut debt
Vulcan Materials	United States	The largest American aggregates producer	Prices up every year since 2021

Company	Home	What it is in 2026	The recent moves
Martin Marietta	United States	The second-largest American aggregates producer	Average price up 7% in 2025; traded its Texas cement plant to Quikrete for quarries
Quikrete	United States (private)	Bagged concrete, and now cement and aggregates	Bought Summit Materials for about $11.5 billion in 2025
China National Building Material (CNBM) and Anhui Conch	China	The world's largest cement groups, with 530 and 407 million tonnes of capacity	Losses, closures, and a push into aggregates and Africa
UltraTech	India	India's largest producer, above 200 million tonnes of capacity	Aims for 240 million tonnes by 2028; buying smaller rivals to hold share against Adani
Dangote Cement	Nigeria	Africa's largest producer	Plants in about ten African countries

Company reports; Global Cement Top 100 (November 2025) for capacities.

There were 1,256 companies making cement at the end of 2025, by Global Cement's count, and the ten largest controlled more than 1.9 billion tonnes a year of capacity, about two-fifths of the world's 4.6 billion. Four of the ten are mainland Chinese, and in any given region two or three producers usually supply most of the market, because a kiln's economic reach is a few hundred miles. That regional concentration is what antitrust authorities watch in every merger, and it allows the industry to raise prices when demand is strong: the average American price rose from $127 a tonne in 2021 to $160 in 2025, about a quarter.

4c. Why Aggregates Are the Best Business in the Industry

Crushed stone averaged $18.50 a tonne in 2025, yet a quarry is one of the most valuable industrial assets in America. The reasons are the freight arithmetic of Module 3 and the permit: a quarry within 20 miles of a growing city competes only with other quarries in the same radius, because stone from farther out cannot pay its freight. And new quarries near cities are nearly impossible to permit, because no neighborhood wants blasting, dust, and 300 trucks a day.

The existing quarries are therefore local monopolies or duopolies with decades of reserves in the ground, and they have raised prices every year for a generation, even in recessions, when volumes fall but prices rarely do. The two largest American producers, Vulcan and Martin Marietta, have raised their average prices faster than inflation in almost every year since 2010, and by 7-12% a year since 2021, while their volumes barely grew. Martin Marietta's average price rose 7% in 2025, to $23.30 a short ton, and it expected 4-6% more in 2026.

That is the business the Western majors have been moving toward: aggregates sit at the bottom of every road, foundation, and data-center slab, need no kiln, emit little carbon, and are protected by geography and the law.

4d. The Chinese and Indian Giants

The world's largest cement companies are Chinese, and they are in trouble: CNBM and Anhui Conch each have hundreds of millions of tonnes of capacity built for a boom that has ended. With national output a third below its peak, the industry ran at a loss in parts of 2024-25. The government has banned new capacity and ordered older plants retired, which the industry's federation expects to remove about 500 million tonnes of capacity, rather than let prices collapse.

The groups' responses mirror the Western majors' with a lag. Conch and Tianshan have become two of the world's largest aggregates producers, and Huaxin, which bought Lafarge Africa from Holcim in 2025, and others are buying and building plants in Africa, where Heidelberg Materials is their main Western rival. India's industry is the growth story: UltraTech, part of the Aditya Birla group, passed 200 million tonnes of capacity in 2026, and the Adani group's Ambuja and ACC are racing to add capacity for the highway and housing programs. Dangote, Nigeria's largest company, built Africa's biggest cement business on protected home demand and expanded across the continent.

4e. The Reshuffle of 2025-26

The pattern of the last two years is a turn toward North America and toward the rock. Holcim spun off its American business as Amrize in June 2025, arguing that it was too large and too different to run as a subsidiary and that an American listing would value it higher and give it a dollar stock to buy with. CRH had moved its primary listing to New York in 2023 for the same reasons. Quikrete, a private maker of bagged concrete, bought Summit Materials in 2025.

On June 22, 2026 CRH agreed to buy Arcosa for $150 a share, about $8.5 billion including debt. Arcosa brings 109 quarries and yards, about 35 million short tons of aggregates a year, and a business making the steel towers that carry transmission lines. The price is 11.5 times Arcosa's expected 2026 earnings before interest, taxes, depreciation, and amortization, counting $175 million of planned savings, and the deal is expected to close in the first quarter of 2027. Holcim, meanwhile, completed its purchases of Xella, a European maker of wall systems, and of control of Peru's Cementos Pacasmayo.

The logic across all of them is the same: the United States has the strongest construction demand among the rich countries, carbon pricing there is a distant prospect, and aggregates near growing cities are the scarcest asset in the business.

Worked example — What a Quarry Is Worth

Take a quarry near a Texas metro area that ships 3 million tonnes a year at $22 a tonne, $66 million of revenue. Its costs, for blasting, crushing, screening, equipment, labor, royalties to the landowner, and the reclamation it must eventually do, run about $14 a tonne, so it earns roughly $8 a tonne, $24 million a year before depreciation and tax. It holds 150 million tonnes of permitted reserves, fifty years at the current rate. If prices rise 5% a year and costs 3%, the margin widens from $8 to about $12 a tonne in five years and $17 in ten, with no new capital beyond replacing equipment. Pay 11.5 times the current $24 million, the multiple CRH agreed for Arcosa, and the buyer pays $276 million for a stream that, on those assumptions, earns about $51 million a year in ten years and still has forty years of stone. A buyer can pay that multiple because the one thing that could destroy the value, a competitor opening a new quarry nearby, is almost impossible near a growing city. The risk is the other side: volumes fall in a recession, and a quarry's value depends on the city around it continuing to grow.

Module 4 Key Points

The Materials Companies

• Holcim, Lafarge, Heidelberg, Cemex, and CRH globalized cement from the 1980s, buying local producers country by country.

• Permitted quarries near growing cities are local monopolies; Martin Marietta raised its average price 7% in 2025.

• The ten largest cement groups hold about two-fifths of the world's 4.6 billion tonnes of capacity; four are mainland Chinese.

• Holcim's 2025 Amrize spin-off and CRH's $8.5 billion Arcosa deal turn the industry toward North America and stone.

• China's cement giants are cutting capacity at home and building abroad, above all in Africa.

Module 4 Quiz

Check Your Understanding

1. What did Holcim do with its North American business in June 2025?

A) Sold it to CRH for cash and shares
B) Merged it with Cemex to form one group
C) Closed most of its kilns and imported instead
D) Spun it off as Amrize

2. Why does the module call aggregates the best business in the industry?

A) Stone is cheap to ship long distances
B) The highway program guarantees its prices
C) Permitted quarries near growing cities face little competition
D) Quarries are cheap to permit, so new ones open wherever stone prices rise

3. What did CRH agree to buy in June 2026?

A) Holcim, for $80 billion
B) Arcosa, for about $8.5 billion
C) Vulcan Materials, the largest American stone producer
D) A Chinese cement maker, its first deal in Asia

4. What is happening to China's cement giants?

A) They face losses as output falls, with capacity being cut and new plants built abroad
B) They are growing at 10% a year
C) They were merged into one state company
D) They import most of their clinker from Vietnam, having closed their own kilns

5. How much did the average price of American cement rise from 2021 to 2025?

A) It fell, as imports surged
B) It doubled, from $80 to $160 a tonne
C) About 5%, roughly in line with inflation
D) About a quarter

Module 5 — Steel, Timber, and Everything Else

The Other Inputs, Their Prices, and the Tariffs on Them

Recommended Reading / Reference

Book: Vaclav Smil, *Still the Iron Age* (2016), on steel's place in the modern economy, half of it in buildings and infrastructure

Paper: Aaron Flaaen and Justin Pierce, 'Disentangling the Effects of the 2018-2019 Tariffs on a Globally Connected U.S. Manufacturing Sector' (Federal Reserve Board, 2019)

Reference: The BLS producer price indexes for construction inputs, analyzed monthly by the Associated General Contractors of America (AGC) and Associated Builders and Contractors (ABC); the Commerce Department's Section 232 proclamations

5a. Steel

About half the world's steel goes into buildings and infrastructure: reinforcing bar in every concrete slab, column, and wall; structural shapes, the wide-flange beams and columns of a steel frame; plate for bridges and tanks; and pipe, studs, decking, and roofing. In the United States about 70% of steel is made in electric arc furnaces that melt scrap, and construction steel is almost all of that kind. Nucor, the largest American steelmaker, Steel Dynamics, and Commercial Metals, the largest maker of rebar, all run mini-mills near their markets.

The blast-furnace producers, Cleveland-Cliffs and U.S. Steel, sell mostly to carmakers and appliance makers; Nippon Steel bought U.S. Steel in June 2025 under an agreement that gave the federal government a 'golden share' with veto rights. A typical steel-frame office uses 10-15 pounds of structural steel per square foot, and a data center more, because its equipment and roof loads are heavy.

American steel is expensive by world standards and has been protected for decades. Antidumping duties cover rebar and other products from many countries, and in 2018 the government used Section 232 of the Trade Expansion Act of 1962, which lets the president restrict imports that threaten national security, to put tariffs of 25% on steel and 10% on aluminum. Both rose to 50% on June 4, 2025, and a 50% tariff on semi-finished copper followed on August 1.

Since April 6, 2026 the 50% rate has applied to the full value of goods made entirely or almost entirely of steel, aluminum, or copper, with 25% on products made substantially of them and 15% on certain metal-intensive grid and industrial equipment through 2027. Domestic producers raised their prices to just below the tariffed import price, as tariffs are designed to allow, and the producer price index for steel mill products was 23.4% higher in August 2026 than a year earlier.

5b. Timber

Wood frames most American houses and many low-rise apartments, and about a quarter to a third of the softwood lumber Americans use comes from Canada. The two countries have fought over it since the 1980s, with the United States arguing that Canadian provinces sell timber from public land too cheaply and Canada answering that American mills cannot compete, through five rounds of duties, settlements, and trade-panel rulings.

In the summer of 2025 the combined antidumping and countervailing duties on most Canadian softwood rose from about 14% to 35%, and a 10% Section 232 tariff on imported softwood lumber followed in October, so most Canadian lumber now pays about 45%. A review published in preliminary form in April 2026 would cut the duties to about 25%, but its final results were still pending in early October. Lumber prices are among the most volatile of all construction inputs, having tripled in 2020-21 and fallen back, and each $10,000 on the price of a house prices tens of thousands of households out of a mortgage. Mass timber, cross-laminated panels strong enough for mid-rise buildings, is a small but growing alternative to concrete and steel in Europe and the Pacific Northwest.

5c. Copper, Fuel, and the Rest

The rest of a building is a long list of commodities, each with its own market. Copper goes into wire, bus bars, transformers, motors, and plumbing, and the electrical build-out of Module 7 has made it one of the costliest lines in a data center; it set a record of $14,875 a tonne on the London Metal Exchange on September 10, 2026. Aluminum goes into windows, curtain walls, and cable, and glass, gypsum wallboard, insulation, and roofing are each made domestically by a handful of producers.

Asphalt, a refinery product, paves 94% of American roads, and diesel runs every excavator, loader, crane, and truck on a site. Both follow the oil price, which the Iran war and the closing of the Strait of Hormuz drove above $100 a barrel in 2026; Brent crude settled at $104.28 on October 8. Diesel at the refinery was 77.8% more expensive in August 2026 than a year earlier, and it cost $6.20 a gallon at the pump in early October, so the heavy-civil contractors who build roads, bridges, and utilities felt it first.

5d. The Prices

Input	Change, August 2025 to August 2026	The driver
Inputs to new nonresidential construction	+8.9%	Tariffs and the Iran war's fuel shock
Diesel fuel (wholesale)	+77.8%	The Hormuz closure and crude above $100
Aluminum mill shapes	+27.3%	The 50% Section 232 tariff
Steel mill products	+23.4%	The 50% tariff and domestic price-following
Copper and brass mill shapes	+20.9%	The copper tariff and record prices
Liquid asphalt	+16.4%	The oil price
Construction wages (production workers)	+5.0% (+4.3% in September)	The labor shortage; the private sector +3.3%
Projects canceled, postponed, or scaled back in six months	55% of surveyed firms	A third blamed rising costs

AGC's analysis of the BLS producer price indexes (September 10, 2026) and its survey with the National Center for Construction Education and Research (NCCER) in July-August 2026.

Materials inflation this sharp changes behavior in three ways. Owners cancel or shrink projects whose bids come in over budget, which is why 55% of surveyed contractors reported a canceled, postponed, or scaled-back project in the six months to August: a third blamed rising costs, 10% changes in demand caused by tariffs, and 6% the war in the Middle East. Contractors write price-escalation clauses into contracts and buy materials early, tying up cash. And the projects that proceed are the ones whose owners care least about price, the data centers, whose buyers are racing each other for capacity, which widens the split of Module 1.

5e. Tariffs on Building Materials: The Cases as Their Advocates Make Them

Who pays first: a tariff on an imported material is paid first by the importer, but its cost lands wherever the contracts put it. On a fixed-price job signed before the tariff, the contractor absorbs it unless the contract has an escalation clause; a standard form for one, ConsensusDocs 200.1, has become common in bids since 2025. On a cost-plus job the owner pays, and on the next job everyone prices it in, so the owner, whether a developer, a school district, or a state transportation department, pays or builds less. Meanwhile the domestic producers collect the difference between the old price and the new one without paying any tariff at all.

The case for the tariffs: the steel industry, its unions, and the administration argue that a country that cannot make its own steel, aluminum, and lumber depends on its rivals for its defense and its infrastructure. They point to subsidized Chinese mills whose surplus flooded world markets, to the electric-furnace mills built in America since 2018, to Nippon Steel's commitment of about $11 billion of new investment in U.S. Steel by 2028, and to the jobs those mills support. The lumber duties, on this view, answer a real subsidy in the low fees Canadian provinces charge for public timber, and every tariff also raises revenue.

The case against: builders, contractors, and most economists argue that the tariffs tax many to protect a few. Far more Americans work in industries that use steel than in making it, and domestic producers raise their prices to just below the tariffed import price, so buyers pay more even for American metal. Every input taxed raises the cost of the roads, schools, and homes the country says it needs, and the home builders argue that the lumber duties add to the price of every new house.

What the evidence says: the Federal Reserve Board's study of the 2018 tariffs found them associated with higher producer prices and with lower manufacturing employment overall, because higher input costs and foreign retaliation outweighed the protection they gave. In 2025-26 prices moved the same way: steel mill products rose 23% in the year to August 2026, aluminum 27%, and copper 21%, and a third of the contractors reporting cancellations blamed rising costs. On the other side, new mills have been built and the U.S. Steel investment is committed, so the strategic case holds for a few products, but the duties fall on every supplier, friendly or not, and on derivative goods far from any mill.

The course's reading, stated once: the tariffs do what their advocates intended for the producers, keeping mills open and prices high, but for construction they are a tax that falls hardest on the projects with the least room to pay, the schools, roads, and houses, while the data centers absorb it. A narrower tool aimed at subsidized imports would protect the strategic capacity at a fraction of the cost to builders.

Worked example — A Steel-Frame Building's Tariff Bill

A 250,000-square-foot distribution center with a two-story office block uses about 1,700 tons of structural steel (joists, girders, columns, and deck) and 600 tons of rebar in its slab and footings, plus about 40 tons of copper in its electrical service. At prices of a year earlier the steel package cost roughly $3,400 a ton installed for the structural steel and $1,600 for the rebar, about $6.7 million, and the copper about $0.6 million, $7.3 million in all. With steel mill prices up 23% and copper up 21% in a year, and fabrication and erection labor up 5%, the same package costs about $8.2 million, an increase of about $0.9 million on a building whose total hard cost is about $38 million, more than 2%. That is far less than the headline tariff rate, because the metals are a fraction of the building, but it would eat more than half of the general contractor's fee on the job. Whoever the contract names absorbs it, and if the owner does, the project's return falls by about the same share and the marginal warehouse is not built.

Module 5 Key Points

Steel, Timber, and Everything Else

• About half the world's steel goes into construction; American construction steel comes mostly from scrap-melting electric furnaces.

• Steel and aluminum tariffs reached 50% in June 2025; steel mill prices were 23% higher in August 2026 than a year earlier.

• Most Canadian softwood lumber pays about 45%: 35% in duties since mid-2025 plus a 10% tariff since October 2025.

• Diesel at the refinery rose 78% in the year to August 2026, hitting road, bridge, and utility builders first.

• A Federal Reserve study found the 2018 tariffs cost manufacturing jobs overall, as input costs and retaliation outweighed protection.

Module 5 Quiz

Check Your Understanding

1. Which steelmaking route makes most American construction steel?

A) Blast furnaces
B) Imports from China, about half of rebar and beams
C) Open-hearth furnaces, still the standard since the 1950s
D) Electric arc furnaces melting scrap

2. What do most Canadian softwood lumber imports pay at the American border in 2026?

A) No duty, under the North American agreement
B) About 45% in all
C) About 14%, the rate before 2025
D) About 10%, the new security tariff alone

3. Why did diesel and asphalt prices jump in 2026?

A) Refiners switched to jet fuel
B) Asphalt was added to the steel tariffs
C) The Iran war closed the Strait of Hormuz and drove crude oil above $100 a barrel
D) A federal rule banned older diesel engines on public road and bridge projects

4. Who absorbs a tariff-driven price rise on a fixed-price contract signed before the tariff?

A) The contractor, unless it has an escalation clause
B) The owner, automatically
C) The federal government
D) The supplier, which must hold its quoted price for the life of the job

5. What is the course's reading of the tariffs on building materials?

A) They cost builders almost nothing
B) They should be raised to cover all inputs
C) They have cut prices by spurring new domestic competition among the steel mills
D) They keep strategic capacity open but tax every project, hardest those with the least room to pay

Module 6 — The Builders

The Contractor's Business and the Firms That Do It

Recommended Reading / Reference

Book: Carol Willis, ed., *Building the Empire State* (1998), the builders' own notebook of the job, day by day, and the best record of how a general contractor manages a site

Reference: Engineering News-Record (ENR), the annual Top 400 Contractors (May 2026) and Top 250 Global Contractors rankings; the companies' 2025 annual reports

6a. The General Contractor's Business

A general contractor sells a promise: to deliver a building or a road for a price, by a date, to the drawings. Its assets are its people (estimators, project managers, and superintendents), its relationships with subcontractors and owners, its bonding capacity, and its record. It owns little equipment and does perhaps a tenth of the physical work with its own crews. Its revenue is large and its margin small: a typical American general contractor earns 2-4% of revenue before tax in a good year, and a specialty subcontractor 5-10%.

The business is really two businesses, the first of them risk management: pricing work correctly, choosing which risks to accept, and controlling the thousands of decisions that decide whether the job makes money. The other is cash management: the owner pays monthly for the work done, less retainage of 5-10% held back until completion, and the contractor pays its subcontractors when it is paid; in between it holds the float, which in a healthy firm is a large share of its profit.

6b. Who Carries the Risk

Contract or delivery method	How it works	Who carries the cost risk
Lump sum (fixed price)	The contractor agrees to build the drawings for a set price	The contractor, except for the owner's changes
Cost-plus with a guaranteed maximum price (GMP)	The owner pays actual cost plus a fee, up to a cap	The owner below the cap; the contractor above it
Unit price	Payment per quantity, such as per ton of asphalt or per cubic yard of earth	Shared: the owner carries quantities, the contractor unit costs
Design-bid-build	The owner's designer completes the drawings, contractors bid, and the low bid wins	Design errors fall on the owner; price risk on the contractor
Design-build	One contract for both design and construction	Mostly the design-builder; faster, with less owner control
Construction manager at risk	A contractor joins during design and later commits to a GMP	Shared; the common method for complex buildings
Engineer-procure-construct (EPC)	One firm delivers a working plant, such as a refinery or power station, for a price	The EPC contractor; the source of its largest losses
Alliance or integrated delivery	Owner, designer, and builder share a pool of profit and risk	Shared; used for megaprojects in Australia and Britain

The allocation matters because construction's risks are large and hard to foresee: ground conditions no survey found, a design that does not fit, a price that moves between bid and purchase, a delayed permit, or a subcontractor that fails. Every contract is a choice about who absorbs them, and every dispute is a fight about whether a cost was inside or outside that choice. That is why change orders, the priced adjustments

for work the owner adds or alters, are where many jobs make or lose their money, and why the industry supports a large profession of claims consultants and construction lawyers.

6c. Bonds, Retainage, and Why Contractors Fail

Because a contractor's promise is only as good as its balance sheet, public owners and most large private ones require surety bonds. Under a performance bond, an insurer guarantees the job will be finished if the contractor fails, and a payment bond guarantees that the subcontractors and suppliers are paid. The federal Miller Act of 1935 requires both on federal contracts above $150,000, and the states have copies. The surety underwrites the contractor like a lender, and a firm's bonding capacity caps how much work it can take on.

The bonds exist because contractors fail more often than most businesses: margins of a few percent on fixed prices mean that one bad job, a 10% overrun on a contract as large as a year's revenue, can erase years of profit. The failures come in waves with the cycle and with fixed-price megaprojects: Britain's Carillion collapsed in 2018 with 43,000 employees, and Fluor lost more than a billion dollars on lump-sum projects and stopped bidding them in 2019. Backlog itself can vanish: when Saudi Arabia cut back NEOM in 2026, Italy's Webuild lost its $4.7 billion contract for the Trojena dams in March and a €1.4 billion ($1.6 billion) rail contract in May.

6d. The World's Largest Builders

Company	Home	Revenue, 2025	What it builds
China State Construction Engineering (CSCEC)	China (state)	¥2.08 trillion (about $310 billion)	Most of China's supertall towers; housing; Belt and Road projects
China Railway Group	China (state)	¥1.09 trillion (about $163 billion)	Railways, bridges, tunnels, and metros
China Railway Construction	China (state)	¥1.03 trillion (about $153 billion)	High-speed rail and highways
China Communications Construction	China (state)	¥731 billion (about $109 billion)	Ports, dredging, bridges, and roads abroad
Vinci	France	€74.6 billion (about $86 billion)	Contracting, energy work, and concessions such as motorways and airports
Bouygues	France	€56.9 billion (about $65 billion)	Building, roads (Colas), and telecoms
ACS	Spain	€49.8 billion (about $57 billion)	Controls Hochtief, which owns Turner and Australia's CIMIC
Turner	United States (part of ACS)	$28.3 billion	Buildings, above all data centers, hospitals, and stadiums
Bechtel	United States (private)	$19.5 billion	Liquefied natural gas plants, mines, nuclear plants, and megaprojects
Kiewit	United States (employee-owned)	$15.3 billion	Heavy civil, power, water, and mining

Company reports, converted at the Federal Reserve's September 2026 averages; ENR's 2026 Top 400 for Turner, Bechtel, and Kiewit. The Chinese groups' revenue includes property development and other businesses.

Chinese state firms hold the top four places, with combined revenue of about $735 billion in 2025. They grew with China's boom and now depend on the state's infrastructure spending at home and on work

abroad: China State Construction's overseas contracts rose 15% in 2025 while its building contracts were flat, and in February 2026 it joined a consortium for the high-speed line between Abu Dhabi and Dubai.

The Western firms that remain large combine contracting with something steadier: Vinci earns much of its profit from concessions, owning and operating motorways and airports for decades. ACS, through Hochtief, owns Turner, whose revenue grew 34% in 2025 on data centers, hospitals, and stadiums, and Bechtel and Kiewit are private and take on the largest American engineering and heavy-civil work. In the United States the largest general contractors, Turner, Bechtel, STO Building Group, Kiewit, Whiting-Turner, and DPR, each hold about 1% of the market or less.

6e. The Machines

Construction's equipment is made by a concentrated industry: Caterpillar, with $67.6 billion of sales and revenues in 2025, is the largest, Komatsu of Japan is second, and then come Sany and XCMG of China, Deere, Volvo, Liebherr, and Hitachi. Chinese makers dominate excavator sales in China and are pushing abroad on price. Much of the equipment on an American site is rented rather than owned, because a contractor's needs change with each job, and United Rentals and Sunbelt, the largest rental companies, have fleets worth tens of billions of dollars. The machines are more capable than those of 1970 by every measure, which is one of the puzzles of Module 9: better tools have not made the industry more productive.

Worked example — A Contractor's Job

A regional general contractor wins a $100 million lump-sum contract for a hospital wing. It budgets $97 million of cost, $80 million in subcontracts, $12 million in its own general conditions (site management, temporary facilities, insurance, and its own crews), and $5 million of contingency, and expects a $3 million fee. Over the two-year job the owner pays monthly, holding 5% retainage, so by the end $5 million sits with the owner until close-out. Now three things go wrong, each ordinary: the structural steel subcontractor's price rises $1.2 million under the new tariffs, and its contract lets it pass the increase through. A buried utility line no survey showed costs $0.8 million, and the owner disputes that it is a change. And the mechanical subcontractor falls behind, so the contractor pays $1.5 million of overtime to hold the schedule. These three use $3.5 million of the $5 million contingency, leaving $1.5 million against everything that has not yet gone wrong. Another $4.5 million of trouble, a little more than the first three together, and the contractor earns nothing for two years of work; any more and it loses money. That is why contractors fight over change orders, why sureties watch the quality of a backlog more than its size, and why in 2026 few contractors bid a fixed price without an escalation clause.

Module 6 Key Points

The Builders

• A general contractor sells a promise to deliver for a price, earns 2-4% of revenue, and profits from managing risk and cash.

• Every contract type, from fixed price to guaranteed maximum and design-build, decides who absorbs construction's unforeseen costs.

• Surety bonds guarantee completion and payment because contractors fail often: one bad fixed-price job can erase years of profit.

• Chinese state firms are the four largest builders; China State Construction alone took in about $310 billion in 2025.

• Caterpillar leads a concentrated equipment industry, and much of the American fleet is rented rather than owned.

Module 6 Quiz

Check Your Understanding

1. What pretax margin does a typical American general contractor earn in a good year?

A) About 20%
B) Roughly 12%
C) About 2-4% of revenue
D) About 10%, close to the average for manufacturers

2. What does a payment bond guarantee?

A) That the contractor finishes the job even if it goes bankrupt
B) That subcontractors and suppliers get paid
C) That the owner repays the construction loan on schedule
D) That the government pays the contractor on time, with interest

3. Why do contractors fail more often than most businesses?

A) Thin margins on fixed-price jobs
B) They carry no insurance
C) Owners pay them in advance and the cash runs out
D) Unions set their prices above what owners will pay

4. Which company had the most construction revenue in the world in 2025?

A) Vinci of France
B) Bechtel
C) China State Construction
D) Caterpillar, if machinery sales are counted as construction

5. Under a cost-plus contract with a guaranteed maximum price, who pays for costs above the cap?

A) The owner, as with any cost-plus job
B) The architect, if the design caused them
C) The subcontractors, shared equally among them
D) The contractor

Module 7 — The Electrical Build-Out

The Trades That Now Lead Construction

Recommended Reading / Reference

Book: Gretchen Bakke, *The Grid* (2016), on the American electrical system and the people who build and repair it

Reference: The quarterly filings of Quanta Services, EMCOR, and Comfort Systems; Cushman & Wakefield's *2026 Data Center Development Cost Guide* (August 2026); ConstructConnect's monthly data-center reports

7a. Why a Data Center Is an Electrical Project

From the outside a data center is a large, windowless warehouse, and its cost is inside. An AI data hall packs racks that draw 100 kilowatts or more each, ten times a conventional server rack, and every watt must be delivered without interruption and removed as heat. That requires a chain of equipment from the utility's substation to the chip: high-voltage switchgear and transformers that step the power down, uninterruptible power supplies and batteries that carry the load for the seconds before the backup generators start, and the generators themselves, or increasingly on-site gas turbines. Busways and cable distribute the power to each row, and a cooling system of chillers, pumps, and cooling towers or dry coolers, with liquid loops to the racks for the newest chips, removes the heat.

Cushman & Wakefield's 2026 cost guide puts an all-in greenfield campus at $8.9 million to $23.3 million per megawatt of information technology (IT) capacity in American and Canadian markets, before the chips, up 21% on average since its late-2024 edition. In the guide's breakdown, the power infrastructure that brings electricity onto the site is about a fifth of an all-in budget on its own, more than the core, shell, and sitework that look like the building, at about a sixth.

That is why the construction boom of 2025-26 has been, above all, a boom for the electrical and mechanical trades and the firms that employ them. A general contractor still manages the site, but the specialty contractors who install the switchgear, pull the cable, set the generators, and pipe the chillers hold most of the contract value and most of the scarce labor. The same is true, in smaller measure, of the semiconductor plants, battery plants, and hospitals of the last five years: the more technical the building, the larger the share that is mechanical, electrical, and plumbing work. Data-center starts reached $98.5 billion in the first eight months of 2026, 24% of all nonresidential building starts, by ConstructConnect's count.

7b. The Specialty Contractors

Company	What it does	Contracted work, June 2026	The 2026 story
Quanta Services	Utility, transmission, and substation construction; electrical work for large campuses	Backlog $53.4 billion, of which $33.6 billion is remaining performance obligations	2026 revenue outlook raised to about $39.5 billion; the grid's largest contractor
EMCOR	Electrical and mechanical construction and building services	$17.14 billion of remaining performance obligations, up 44%	2026 revenue guidance raised to $20.0-20.5 billion

Company	What it does	Contracted work, June 2026	The 2026 story
Comfort Systems USA	Mechanical and electrical contracting; modular assemblies	Backlog $14.1 billion, up 73%	Technology work 58% of first-half revenue; gross margin 25.9%; bought Hunt Electric
MYR Group	Transmission lines and commercial electrical work	Record backlog	The lineworker shortage
Sterling Infrastructure	Site preparation for data centers and factories	Backlog $4.33 billion, up 116%	Data centers, factories, and chip plants 92% of its site-work backlog

Company reports for the second quarter of 2026, released July 24-August 3, 2026.

The specialty contractors' results read unlike anything else in construction: EMCOR's remaining performance obligations, the contracted work not yet done, reached $17.14 billion at the end of June 2026, up 43.9% on the year. Quanta's reached $33.6 billion within a total backlog of $53.4 billion, against $35.8 billion a year earlier. Comfort Systems' backlog hit a record $14.1 billion, up 73%, with technology work 58% of its revenue in the first half and a gross margin of 25.9%, where a general contractor's is in single digits.

Their executives say the same thing each quarter: the limit on their growth is supply, the skilled people and the equipment, rather than demand. That is also the risk, because these firms are staffed and priced for a boom that depends on a handful of buyers' capital budgets.

7c. The Equipment From the Jobsite

The utility's view of the transformer shortage is a grid that cannot connect new load; the builder's view is a schedule that depends on a delivery date years away. Large power transformers, custom-built for each substation, can take up to four years to arrive, and the medium-voltage switchgear, distribution transformers, and generators a data center needs take one to two. Transformer prices have risen about 80% in five years, and since April 2026 a 15% tariff has applied to certain metal-intensive grid equipment.

Contractors have responded by buying equipment before designs are final, by reserving factory slots years ahead, and by prefabricating. Comfort Systems and others assemble electrical rooms and mechanical skids in factories and truck them to the site, which saves field labor and time. The owners who win the race are the ones with the balance sheets to order early, another way the boom favors the largest buyers.

7d. The Electrician

The scarcest input on a data-center site is a licensed electrician: the country had about 819,000 electrician jobs in 2024, and the median electrician earned $63,190 in May 2025, by the BLS's counts. Becoming one takes a four- or five-year apprenticeship of about 8,000 hours on the job plus classroom training, and a license issued state by state, so the supply cannot rise quickly. A single large campus can need 1,000-2,000 electricians at its peak, drawn from the same regional labor pool as every hospital, school, and factory within commuting range.

In the AGC's 2026 survey, 28% of contractors had worked on a data center in the past year, and of those, 58% said the projects had increased competition for skilled workers and 49% reported more pressure on wages. The shortage is the constraint that turns a boom in one kind of building into higher costs and delays for all the others, the channel through which the AI build-out reaches the price of a school.

7e. The Wires Between

The electrical build-out does not stop at the campus fence: each gigawatt of new load needs substations, transmission lines, and often new generation, and building those is a boom of its own. Quanta's crews string high-voltage lines and build substations for utilities across the country, lineworkers are as scarce as electricians, and the steel lattice towers and poles the lines hang from are a growth business; Arcosa's business making them was part of what CRH agreed to buy.

Power construction rose 9.7% in the year to August 2026, to a $165.9 billion annual rate, nearly level with manufacturing in the Census series. The grid's own economics, who pays for the lines, how long interconnection takes, and what the capacity markets pay, are a subject of their own; for the builder, they set when the power arrives and therefore when the building can be used.

Worked example — A 1-Gigawatt Campus's Construction Budget

A technology company plans a campus with 1 gigawatt of IT load in the Midwest, in eight buildings built over four years. At about $12 million per megawatt, near the low end of the cost guide's range, the buildings and their systems cost about $12 billion, before the servers and networking, which cost three to four times as much again. The construction dollars divide roughly as follows. Electrical systems (the power infrastructure, switchgear, transformers, uninterruptible power supplies and batteries, generators, busway, cable, and their installation) take $5-5.5 billion, and mechanical and cooling $2.2-2.7 billion. The structure and shell (foundations, steel, precast walls, and roofing) take $1.5 billion, site work, roads, and utilities $0.5 billion, and design, the general contractor's fee and general conditions, and contingency the rest. At the peak about 4,000-6,000 workers are on site, 1,500 or more of them electricians. The electrical labor alone, 1,500 electricians for three years at a fully burdened $95 an hour, comes to about $850 million, and a 10% raise to attract them adds about $85 million. A transformer delivered six months late idles a building whose servers would earn hundreds of millions of dollars a year. That arithmetic is why the technology companies pay premiums for schedule certainty, and why the specialty contractors' margins have risen while the general contractors' have not.

Module 7 Key Points

The Electrical Build-Out

• A data center's cost is mostly in its power and cooling systems; the shell and site work are about a sixth of the budget.

• The specialty contractors carry record backlogs: Quanta's reached $53.4 billion and Comfort Systems' $14.1 billion, up 73%.

• Large transformers can take up to four years to arrive, so contractors order before designs are final and prefabricate.

• Licensed electricians take four to five years to train, and a single campus can need 1,000-2,000 of them at its peak.

• The same electricians serve every hospital and school nearby, which is how the AI build-out raises the cost of other buildings.

Module 7 Quiz

Check Your Understanding

1. Why is a modern data center mostly an electrical and mechanical project?

A) Its servers are counted as construction
B) Power and cooling equipment dominate its cost
C) Electricians install the servers, so their work is counted as building
D) Census rules count its steel shell as electrical work for the survey

2. What did Comfort Systems' backlog reach at the end of June 2026?

A) A record $14.1 billion, up 73%, with technology work 58% of revenue
B) About $1.4 billion
C) $14.1 billion, down from a year earlier
D) About $41 billion, the largest backlog in the whole industry

3. What do the specialty contractors say limits their growth?

A) Demand from owners other than the technology companies
B) Supply, not demand
C) Interest rates on their borrowing, the highest since 2007
D) Competition from general contractors entering their trades

4. How long can a large power transformer take to arrive in 2026?

A) A few weeks
B) Six months
C) About a year, the same as before 2020
D) Up to four years

5. How does the AI build-out raise the cost of a new school?

A) Campuses draw electricians from the same regional pool, so wages and delays spread to other jobs
B) Schools must now meet data-center electrical codes
C) Data centers use up a region's ready-mix concrete supply
D) New schools must now install backup generators as large as a data center's

Module 8 — The Workforce

Who Builds, and Who Is Missing

Recommended Reading / Reference

Book: Matthew Crawford, *Shop Class as Soulcraft* (2009), the case for skilled manual work and why a society stopped training for it

Reference: The BLS construction employment and earnings series; the AGC and NCCER *2026 Workforce Survey* (September 3, 2026); ABC's workforce model (January 16, 2026); the Congressional Research Service on project labor agreements (August 12, 2026)

8a. Who Builds

About 8.4 million people work in American construction: carpenters, laborers, electricians, plumbers and pipefitters, operators of heavy equipment, ironworkers, roofers, drywall installers, concrete finishers, supervisors, estimators, and managers. Employment rose 109,000 in the year to September 2026: the nonresidential specialty trades added 142,000 jobs while the residential trades shed 33,000. The workforce is older than the economy's, with an average age of about 42, and overwhelmingly male, since about one worker in ten is a woman.

It is also heavily immigrant: a record 26% of construction workers were born abroad in 2024, by the home builders' count of government data, and more than half in drywall, plastering, roofing, and painting, most from Mexico and Central America; a large minority of them are unauthorized. And it is dangerous: workers in construction and extraction occupations suffered 1,032 of the 5,070 fatal work injuries in 2024, about a fifth, 370 of them from falls, slips, and trips.

The work divides into trades with separate skills, pay, and paths in. The licensed trades, electricians, plumbers, and in many states the mechanics who install heating, ventilation, and air conditioning (HVAC), require an apprenticeship and a state license. The structural and finishing trades, carpenters, ironworkers, concrete workers, and drywall hangers, are learned on the job or in union apprenticeships, without a license in most states. The equipment operators run excavators, cranes, and pavers, and the management layer, the superintendents and project managers who run the sites, is drawn increasingly from construction-management degree programs rather than from the trades, a change that has thinned the path from apprentice to boss.

8b. Pay

Construction pays better than its reputation: production and nonsupervisory workers averaged $39.20 an hour in September 2026, 20% above the private-sector average, and their pay rose 4.3% in a year against 3.3% across the private sector. The median electrician earned $63,190 in May 2025 before overtime, and union journeymen in large cities earn $50-70 an hour plus benefits. Pay varies more than in most industries, by trade, by region, by union status, and with the cycle. The work is also seasonal and irregular, since a worker is employed by the project and between projects may not be, which is one reason fewer young Americans choose it despite the pay.

8c. Unions and the Open Shop

About 11% of construction workers belonged to a union in 2025, nearly double the private-sector rate of 5.9% but a fraction of the mid-century share. The building-trades unions, the electricians of the International Brotherhood of Electrical Workers and the carpenters, operating engineers, laborers, plumbers and pipefitters, and ironworkers, are strongest in the Northeast, the Midwest, and California, and on large public, industrial, and utility work. The open-shop contractors, represented by ABC, dominate housing and the Sun Belt.

Two federal policies sit on the line between them. The Davis-Bacon Act of 1931 requires locally prevailing wages, often the union scale, on federally funded construction; unions defend it as preventing a race to the bottom, and critics say it raises public costs by several percent. Project labor agreements, pre-hire agreements that set union terms for a whole project, have been required on federal projects of $35 million or more by a 2022 executive order that remains in force. Open-shop contractors have challenged it, and in April 2026 a federal appeals court upheld the refusal to block it while their case continues. The unions also run most of the country's registered apprenticeship programs, which gives them a large role in training even where their members are a minority.

8d. Training

The industry's pipeline narrowed for a generation: high schools cut vocational programs as the college track became the default, the crash of 2008-11 drove a large share of the workforce out of the industry, many for good, and the workers who stayed are aging toward retirement. The responses are slow by nature: registered apprenticeships take four or five years, and in the AGC's 2026 survey 36% of firms had started or increased spending on training, while some states have expanded pre-apprenticeship programs in high schools. Prefabrication, which moves work from the site to a factory, lets less experienced workers do more under supervision. None of it produces a journeyman electrician before 2030 who is not already in training today.

8e. The Shortage and the Border: The Cases as Their Advocates Make Them

The industry's case: the contractor associations say the industry is short of workers at any plausible level of demand and that enforcement is making it worse. ABC estimates that the industry must attract 349,000 net new workers in 2026 and 456,000 in 2027 just to keep supply and demand in balance. In the AGC's 2026 survey, 29% of firms reported an effect from immigration enforcement in the previous six months: 6% had agents visit a site, 12% saw workers stay away, and 16% saw subcontractors lose crews, with 42% affected in the South. The Census Bureau counts net immigration halving, from 2.7 million to 1.3 million, in the year to July 2025, and projects about 321,000 for 2026 if trends continue. The associations' prescription is a temporary work visa for construction and more lawful pathways, alongside training.

The enforcement case: the administration and its supporters argue that the industry's reliance on unauthorized labor is the problem, not the remedy. On this view it has held down wages for citizens and legal immigrants, discouraged investment in training and labor-saving methods, and left workers without protection against unsafe sites. Removing it will raise wages until Americans take the jobs, as they did in earlier decades, and push contractors toward prefabrication and machinery, and a temporary shortage is the transition cost of a labor market that follows the law.

What the evidence says: both sides describe something real. Construction wages are rising faster than the economy's, which is what a shortage and a wage response look like; construction job openings were 18% higher in August 2026 than a year earlier, while the rate of hiring fell to the lowest for any August in the series' 26 years. The higher pay has not yet drawn enough native-born entrants to offset retirements and departures, and training takes years. About 71% of firms reported no direct effect from enforcement, so the effect is concentrated in particular regions and trades, the finishing and concrete trades of the Sun Belt where the immigrant share is highest, rather than in the licensed electrical work where the boom's shortage is sharpest.

The course's reading, stated once: the shortage is real and was building before 2025 from demographics and a generation of neglected training. Enforcement adds to it in the trades and regions most dependent on immigrant labor and raises costs there, and higher pay will draw workers in over years, not quarters, so the buildings that must be finished soon, like data centers, will outbid the rest for the workers there are.

Worked example — The Price of a Crew

A mechanical contractor needs a crew of 40 pipefitters for 18 months on a hospital. A journeyman's base wage is $48 an hour, benefits (health, pension, and training) add $24, and payroll taxes and insurance add another $10, for a fully burdened $82 an hour. At 2,000 hours a year for a year and a half, the crew costs about $9.8 million. If the contractor must pay 10% more to hold the crew against a data-center job across the county, the crew costs about $1 million more, roughly the contractor's whole profit on a $15 million subcontract. If it cannot hold the crew and the job slips two months, the general contractor's site costs, the owner's financing, and the hospital's delayed revenue add several million more. That is why labor shortages show up less as unfilled jobs than as higher bids, longer schedules, and projects that do not start.

Module 8 Key Points

The Workforce

• A record 26% of America's 8.4 million construction workers were born abroad, and more than half of those in drywall and roofing.

• Construction pay rose 4.3% in the year to September 2026, faster than the private sector's 3.3%, the signature of a shortage.

• About 11% of construction workers are unionized; prevailing wages and project labor agreements divide union and open-shop builders.

• The contractors say the industry needs 349,000 more workers in 2026 just to keep supply and demand in balance.

• Construction job openings were 18% higher in August 2026 than a year earlier, while the hiring rate fell to a record August low.

Module 8 Quiz

Check Your Understanding

1. How many net new workers does Associated Builders and Contractors say the industry needs in 2026?

A) About 34,000
B) About 3.5 million, nearly half the workforce
C) About 349,000
D) About 1 million, mostly in electrical work

2. What does the Davis-Bacon Act require?

A) Locally prevailing wages, often the union scale, on federally funded construction
B) Union membership on federal jobs
C) A state license for every electrician
D) American steel and iron on every federally funded construction project

3. What share of American construction workers belonged to a union in 2025?

A) 5.9%
B) About 11%
C) About a third, the highest of any industry
D) About half, concentrated in the Sun Belt

4. What share of firms in the AGC's 2026 survey reported an effect from immigration enforcement?

A) About 6%
B) About 90%
C) About 29%, rising to 42% in the South
D) Every firm that worked on a federal project, and almost no others

5. What is the course's reading of the labor question?

A) Wages will fall as the boom ends and workers return from other industries
B) Robots and prefabrication will replace most site trades before 2030
C) Enforcement has had no effect, since few builders hire immigrants
D) The shortage is real, and enforcement deepens it

Module 9 — The Productivity Puzzle

Why Building Got Harder

Recommended Reading / Reference

Paper: Austan Goolsbee and Chad Syverson, 'The Strange and Awful Path of Productivity in the U.S. Construction Sector' (National Bureau of Economic Research, 2023), the case that the decline is real

Paper: Daniel Garcia and Raven Molloy, 'Reexamining Lackluster Productivity Growth in Construction' (Federal Reserve Board, revised 2025), the measurement question tested

Paper: Leonardo D'Amico, Edward Glaeser, Joseph Gyourko, William Kerr, and Giacomo Ponzetto, 'Why Has Construction Productivity Stagnated? The Role of Land-Use Regulation' (National Bureau of Economic Research, 2024)

9a. The Numbers

Every major industry in the American economy produces more per worker than it did fifty years ago, except one. On the Commerce Department's data, construction's value added per worker was about 40% lower in 2020 than in 1970, while output per worker across the economy more than doubled, and construction is the only major industry to have registered negative average productivity growth since 1987.

The effect is not small: construction averaged about 4.3% of GDP between 1950 and 2020, so a half-century of decline in it has subtracted measurably from the country's growth, and it shows up directly in the price of every house, school, and road. Before about 1970 construction was more productive than the economy as a whole and improving. The break came then and has not reversed, through computers, better machines, new materials, and every management fashion since.

Measure	Construction	The economy	Source or note
Value added per worker, 2020 against 1970	About 40% lower	More than twice as high	Goolsbee and Syverson, from Bureau of Economic Analysis data
Average productivity growth since 1987	Negative	Positive in every other major industry	Garcia and Molloy
Physical output in housing (square feet or units per worker)	Falling or flat for decades	Not applicable	Goolsbee and Syverson
Share of GDP, 1950-2020 average	About 4.3%	Not applicable	The weight of the drag on growth
Capital investment rate	About the economy's	Not applicable	The decline is not for lack of equipment

9b. The Measurement Case, and Its Test

The first explanation economists reached for was that the numbers are wrong, because construction's real output is measured by deflating spending with price indexes for a 'constant-quality' structure. If buildings have improved in ways the indexes miss, with better insulation, safer wiring, sprinklers, accessibility, stricter seismic and energy codes, and more of everything a modern building has that a 1970 building did not, then prices have been overstated and real output and productivity understated. The argument is plausible, and the industry's defenders make it: a house of 2025 is a better product than a house of 1970, square foot for square foot.

It has been tested, and it does not explain the decline: Goolsbee and Syverson measured productivity in physical terms that need no price index, square feet of housing and numbers of units per worker, and found it falling or at best flat for decades. Garcia and Molloy at the Federal Reserve estimated how large the quality bias could be under generous assumptions and concluded that it was not large enough to alter the view that productivity growth has been weak. Measurement may explain part of the decline, but not most of it.

9c. The Causes: The Cases as Their Advocates Make Them

Regulation and the small firm: the first case runs through firm size. Construction firms are small, and small firms are less productive in every industry, because they cannot spread the costs of equipment, engineering, and process improvement over much output. Edward Glaeser, Joseph Gyourko, and their coauthors have argued, with data across American metro areas, that strict local land-use regulation keeps homebuilders small. Where every project needs its own discretionary approvals from its own jurisdiction, firms cannot build at the scale that pays for mass-production methods, and the most productive builders cannot expand into the most regulated markets.

The industry's structure: a second case blames the chain of Module 1. Each project assembles a new team of owner, designer, general contractor, and twenty subcontractors, who split the work and the risk by contract and rarely work together again, so no one in the chain captures the gains from improving the whole process and no one invests in it. Design is separated from building, so buildings are designed in ways that are hard to build, and fixed-price bidding rewards the lowest price for today's method rather than investment in a better one.

The site: a third case says the problem is physical, since a construction site is a factory that moves, is rebuilt for each product, works outdoors in the weather, and makes a prototype every time. Manufacturing's productivity came from repetition, standardization, and controlled conditions, and a building on a particular lot, to a particular code, for a particular owner, gets little of any of them.

Labor and its price: a fourth case, argued from both directions, is about workers. Critics of immigration argue that an ample supply of cheap labor from the 1980s on let contractors hire hands rather than buy machines, so the industry never had to mechanize. Critics of the unions argue the opposite problem: work rules and craft jurisdictions, which reserve each task to one trade, froze methods in place and turned every new technique into a dispute over whose work it was.

9d. The Attempts to Industrialize

The obvious answer, to build in factories, has been tried for a century, and its record is mixed. Sweden builds most of its detached houses from factory-made panels, and Japan's Sekisui House has made millions of factory-built homes, both behind standardized codes and long-lived firms. China's Broad Group put up a 57-story tower of steel modules in Changsha in 19 working days in 2015.

In the United States the most ambitious attempt, Katerra, raised about $2 billion from SoftBank and others from 2015 to integrate design, factory production, and construction under one roof. It built factories before it had the steady volume to fill them, took on projects it could not deliver at its promised costs, and went bankrupt in June 2021. The lesson most in the industry drew is that the factory needs a pipeline of repeated designs, which the American market, fragmented by jurisdiction, owner, and code, rarely provides.

Where the volume exists, prefabrication is winning: the electrical rooms and mechanical skids of data centers (Module 7), hotel bathrooms, and hospital headwalls are increasingly built in factories. Robots now lay out walls, tie rebar, and hang drywall on some sites, and 3D-printed concrete houses have been built in Texas, but none of it has yet changed the national numbers.

9e. What the Evidence Says, and the Course's Reading

What the evidence says: the physical measures of 9b rule out a statistical illusion. The regulation case has the most direct support: stricter land-use rules go with smaller builders across metro areas, and Goolsbee and Syverson found that states with more productive construction sectors do not gain market share, as productive firms and places do in other industries; if anything they lose it. The structure case fits where productivity has grown, in repeated designs built by the same owners and teams, such as the data-center campuses and the factory modules of 9d.

The site's physics sets limits, but it cannot explain why the United States does worse than it did in 1970, or worse than countries building with the same physics today. And neither labor case explains why the decline appears in regions and trades where its premise does not hold.

The course's reading, stated once: the decline is real, not an artifact, and the best-supported cause is the combination of the first two cases: rules that make every project a negotiation with its own jurisdiction, and an industry of small firms assembled for each job, which together prevent the scale and repetition that make other industries more productive. The way out runs through standardized products, repeated designs, factory-built components, and owners who build the same building many times, with rules that allow repetition as the precondition.

Worked example — What a 40% Gap Costs

Suppose a building needed 100,000 hours of construction labor in 1970. If construction productivity had tracked the economy's, roughly doubling, the same building would need about 45,000-50,000 hours today; on the measured decline it needs about 165,000. At a burdened $80 an hour, the difference is between about $3.8 million and $13.2 million of labor, more than three times as much for the same building. Labor is about a third of a building's hard cost, so the difference in the total is smaller but still large. On the rough shares of Module 1, a building that costs $100 million today would cost perhaps $75-80 million had construction kept pace, and less still once the shorter schedule cut the financing and site costs. Across $2.2 trillion a year of American construction, the gap is several hundred billion dollars a year, which is why economists who study housing costs, infrastructure costs, and slow growth keep arriving at the same industry.

Module 9 Key Points

The Productivity Puzzle

• Construction's value added per worker was about 40% lower in 2020 than in 1970, while the economy's more than doubled.

• The measurement defense was tested: physical output per worker was flat or falling, and plausible quality bias is too small to explain it.

• Strict local land-use rules keep builders small, Glaeser, Gyourko, and coauthors argue, and small firms are less productive in every industry.

• Factory building works where volume repeats, as in Sweden, Japan, and data-center modules, and failed at Katerra, bankrupt in 2021.

• Goolsbee and Syverson found that states with more productive builders do not gain construction market share, unlike in other industries.

Module 9 Quiz

Check Your Understanding

1. How did construction's value added per worker in 2020 compare with 1970?

A) About twice as high
B) About the same, after quality corrections
C) About 10% higher, the slowest of any industry
D) About 40% lower, while the whole economy's more than doubled

2. What did Garcia and Molloy conclude about the measurement explanation?

A) Quality bias is too small to explain it
B) It explains all of it
C) The Census Bureau has double-counted construction workers since 1987
D) Productivity actually doubled once quality was measured properly

3. What link do Glaeser, Gyourko, and their coauthors draw?

A) Unions raise costs
B) Strict land-use rules keep builders small
C) Interest rates cut starts
D) Steel tariffs have slowed every builder's schedule since 2018

4. What happened to Katerra?

A) It became America's largest homebuilder
B) Bechtel bought it to build its factories
C) It went bankrupt in 2021
D) It moved its factories to China to build towers for export

5. What is the course's reading of the productivity puzzle?

A) It is a statistical artifact
B) The decline is real, rooted in rules and small firms
C) Unions alone caused it
D) Robots will solve it within the decade, as the startups have promised

Module 10 — Megaprojects

Why Big Projects Overrun, and Why America's Overrun More

Recommended Reading / Reference

Book: Bent Flyvbjerg and Dan Gardner, *How Big Things Get Done* (2023), the iron law of megaprojects from a database of 16,000 projects, and what the exceptions did

Reference: The Transit Costs Project at New York University's Marron Institute (final report, 2023), the comparative data on rail construction costs; the California High-Speed Rail Authority's draft *2026 Business Plan* (February 2026)

10a. The Iron Law

Bent Flyvbjerg has built the largest database of large projects, more than 16,000 dams, bridges, rail lines, tunnels, buildings, power plants, IT systems, and Olympic Games across 136 countries. He calls his main finding the iron law of megaprojects: over budget, over time, under benefits, over and over again. Fewer than half his projects came in on budget, 8.5% came in on budget and on time, and 0.5%, one in two hundred, came in on budget, on time, and with the benefits promised. The overruns are not spread evenly around a modest average; they have fat tails, so a meaningful share overrun by 100% or more. The risk is highest for nuclear power, the Olympics, IT systems, and large water and rail projects, and lowest for solar, wind, transmission, and roads.

His explanation has two parts, the first of them psychology: planners are optimistic, treat their project as unique, and ignore the base rate of how similar projects actually turned out. The second is politics and money: promoters understate costs and overstate benefits to win approval, because an honest estimate would not be funded, which Flyvbjerg bluntly calls strategic misrepresentation.

His prescription follows: plan slowly and build fast. Spend years getting the design and the plan right, because delay during construction is where risk compounds; use the record of past projects of the same kind to forecast; and make the project modular, built of repeated, tested units that improve as they are repeated. That is why solar and wind farms beat nuclear plants, and why the Empire State went up in 410 days.

10b. The Cases

Project	The plan	What happened
Boston's Big Dig	About $2.8 billion (1982 estimate) to bury the Central Artery	Finished in 2007 at about $14.6 billion; a fatal ceiling collapse in 2006
Berlin Brandenburg Airport	Open in 2011 for about €2 billion	Opened in October 2020, nine years late, at about €7 billion; its fire-safety system rebuilt
Plant Vogtle units 3 and 4	About $14 billion, online in 2016-17	Online in 2023-24, seven years late, at more than $30 billion
California high-speed rail	$33 billion (2008) for San Francisco to Los Angeles by 2020	$231 billion for the first phase in the 2026 draft plan; $35 billion for its first 171 miles, due in 2032; no track laid by September 2026; $4 billion of federal funds withdrawn in July 2025

Project	The plan	What happened
NEOM's The Line (Saudi Arabia)	A 170-km linear city for 9 million people	Suspended in September 2025 with about 2.4 km of foundations; halted until after 2030; about $16 billion of payments to contractors expected
Guggenheim Museum Bilbao	About $100 million, 1997	On time and on budget; the design fixed before construction
China's high-speed rail	50,000 km since 2008	Built at roughly $17-21 million per km, about two-thirds of the cost elsewhere
Madrid Metro expansions	More than 100 km of new lines, 1995-2011	Among the cheapest subway construction in the world

Flyvbjerg and Gardner; the project authorities; the World Bank (2019) for China's rail costs; Semafor (May and June 2026) for NEOM.

The failures share features the iron law predicts: first-of-a-kind technology or design (Vogtle's AP1000 reactors, Berlin's smoke-extraction system), designs that changed after construction began (Berlin, California), political promises made before the engineering (California's 2008 ballot, NEOM's renderings), and a sponsor that could not say no. The successes share the reverse: a design fixed before the first shovel, standardized components, experienced in-house owners, and repetition. Madrid's metro was built by a small, stable team of public engineers who reused station designs and contracts, and China's rail program built the same viaducts and stations by the thousand.

10c. America's Transit Costs

The comparison that has most shaped the American debate is the cost of a kilometer of subway. New York's Second Avenue Subway cost about $4.45 billion for the 1.8 miles of its first phase, opened in 2017, and its second phase has been estimated at more than twice as much per mile, well over $1 billion per kilometer, against $200-300 million in Madrid, Istanbul, Rome, and Stockholm. The Transit Costs Project at New York University, which compared projects across dozens of countries, found that the difference is not the tunnel boring machines or the geology.

It is the stations, which in New York were dug as cavernous mezzanines far larger than the traffic required. It is the staffing, with labor rules requiring several times the workers per task of comparable European projects. And it is the procurement, by transit agencies that had lost their in-house engineers and relied on consultants and on contracts that shifted risk onto bidders, who priced it in. Other rail and highway projects show the same pattern in different proportions.

10d. Why American Projects Cost More: The Cases as Their Advocates Make Them

The permitting case: one school, associated with the 'abundance' argument of Ezra Klein and Derek Thompson and with reformers in both parties, puts process first. Environmental review under the National Environmental Policy Act (NEPA) averaged more than four years for a full impact statement before Congress set deadlines and page limits in 2023. On top come the lawsuits any opponent can bring, the historic-preservation, endangered-species, and local reviews, and the requirement that every affected party be consulted and accommodated. Each step adds time, time is the risk that compounds costs, and the process pushes designs toward whatever offends the fewest objectors rather than whatever costs least.

The labor case: a second school points to the workforce: prevailing-wage rules, union staffing agreements that require more workers per task than peer countries use, and craft jurisdictions that prevent workers from

doing adjacent tasks. In the Transit Costs Project's New York case studies, labor was the largest single source of the gap with peer cities.

The state-capacity case: a third school blames the owners: public agencies that cut their engineering staffs, outsourced design and management to consultants, and became unable to act as knowledgeable clients. So they over-specify, change designs late, and write contracts that make bidders price in the risk of dealing with them, and on this view the same labor and the same laws would produce cheaper projects under an owner that knew what it wanted and kept to it.

The political case: a fourth school blames the politics of approval: projects promised before they are designed, scope expanded to win votes along the route, stations placed to satisfy constituencies, and no official rewarded for saying no.

What the evidence says: the causes are not rivals, and their weights differ by type of project. For subways, the comparative evidence gives the most weight to station design, staffing, and weak in-house capacity, with environmental review a smaller share of the gap. For highways, transmission lines, and new energy projects, permitting delay and litigation weigh more, because the projects cross more land and more jurisdictions, and for first-of-a-kind projects like Vogtle and California's railway, the iron law's design risk dominates.

The permitting ground moved in 2025-26: in May 2025 the Supreme Court's decision in the *Seven County* case told courts to defer to agencies on the scope of their reviews, and the White House Council on Environmental Quality withdrew its government-wide rules for NEPA reviews. The House passed a reform bill, the Standardizing Permitting and Expediting Economic Development (SPEED) Act, in December 2025, and on September 30, 2026 four senators of both parties introduced their own, which would give opponents 150 days to sue and protect permits once issued; its vote is expected after the November elections. Whether faster reviews lower costs will show first in transmission and energy projects, where permitting weighs most.

The course's reading, stated once: America's high costs are several failures compounding, slow process, heavy staffing, over-built designs, and owners without the capacity to control any of them. The countries that build cheaply fix the last one first, because a capable owner is the one who can resist the other three.

Worked example — A Kilometer of Subway

Take two cities building 5 kilometers of tunneled subway with four stations: in a Spanish-style program the cost runs about $250 million a kilometer, $1.25 billion in all. The tunnel, bored by a machine at a similar cost in both cities, is about a third; the four stations, built to a standard design at the size the traffic needs, about 40%; and systems, design, and management the rest. In the American program the tunnel costs perhaps 50% more, because of labor rules and utility relocation, but the stations cost six to eight times as much, each dug as a large cavern with full-length mezzanines, excavated from the surface under crowded streets, designed by consultants, and changed during construction. The soft costs of design, management, and insurance run to a third of the total rather than a tenth. The result is well over $1 billion a kilometer, $6-7 billion for the same five kilometers. At those prices a city can afford one line where the other builds five, which is why the cost of a kilometer, more than any single project, decides how much transit a country ends up with.

Module 10 Key Points

Megaprojects

• Flyvbjerg's iron law: only 8.5% of large projects come in on budget and on time, and 0.5% also deliver their promised benefits.

• Overruns have fat tails, worst for nuclear, rail, IT systems, and the Olympics, best for modular solar, wind, and transmission.

• California's high-speed line grew from $33 billion in 2008 to $231 billion for its first phase in the 2026 draft plan.

• New York's subways cost well over $1 billion a kilometer against $200-300 million in Madrid or Istanbul, mostly from stations, staffing, and procurement.

• In 2025-26 the Supreme Court narrowed environmental reviews, the House passed a permitting bill, and senators introduced another.

Module 10 Quiz

Check Your Understanding

1. What does Flyvbjerg's iron law say about large projects?

A) Most come in on budget
B) They cost what planners estimate, give or take a tenth
C) Over budget, over time, under benefits
D) Big projects run faster than small ones, drawing better contractors

2. What happened to NEOM's The Line?

A) Work stopped with 2.4 km of foundations
B) Its first 20 km opened to residents in 2025
C) It was cut to a 20-km first phase, now under construction
D) A Chinese developer bought it to build the full 170 km by 2030

3. What did the Transit Costs Project find drives New York's subway costs?

A) Tunnel boring machines
B) The price of steel
C) Harder rock and deeper groundwater than any other city's subway builders have faced
D) Oversized stations, heavy staffing, and procurement through consultants by agencies that lost their engineers

4. What happened to California high-speed rail's federal funding in 2025?

A) It was doubled to finish the line by 2030
B) It became a low-interest loan from the Transportation Department
C) The grants continued on schedule for the first segment
D) About $4 billion was withdrawn

5. What changed for federal environmental review in 2025-26?

A) Congress set a one-year deadline for all reviews
B) A Supreme Court ruling narrowed reviews, the House passed a reform bill, and senators wrote another
C) Every federal project now needs two reviews
D) A law signed in 2026 ended federal environmental reviews for energy, road, and rail projects

Module 11 — Paying for It

The Money Behind the Public Works

Recommended Reading / Reference

Book: Henry Petroski, *The Road Taken* (2016), an engineer's history of American roads and bridges and the argument over who pays to keep them up

Reference: CBO's Highway Trust Fund projections (June 2026) and its estimate for the House bill (July 2026); the American Association of State Highway and Transportation Officials on the stopgap (September 3, 2026); the American Society of Civil Engineers' *2025 Report Card for America's Infrastructure*

11a. Who Pays

Public construction ran at $548 billion a year in August 2026, about a quarter of American construction, and most of it is not federal. States and localities own nearly all the roads, bridges, water systems, schools, and transit lines, and pay about three-quarters of the cost of building and maintaining them from fuel taxes, sales and property taxes, tolls, fares, water bills, and borrowing. The federal government pays the rest, mostly as grants for highways, transit, airports, and water.

The main borrowing tool is the municipal bond: states, cities, and authorities owe about $4 trillion, much of it for infrastructure, at interest rates lowered by the exemption of municipal interest from federal income tax, which the 2025 tax law left in place. Issuance set a record in 2024 and another in 2025, at $580 billion, as the federal money of the 2021 law needed local matches.

11b. The Gas Tax and the Trust Fund

The federal highway and transit programs were built to pay for themselves: the Highway Trust Fund, created with the Interstates in 1956, receives the federal fuel taxes, 18.4 cents a gallon on gasoline and 24.4 on diesel, and spends them on grants to the states. The taxes have not been raised since 1993: inflation has cut their real value by more than half, and more efficient cars and electric vehicles pay less or nothing. Since 2008 Congress has covered the shortfall by transferring general revenue, more than $275 billion in all.

CBO's June 2026 projections show the fund's transit account running out in fiscal 2027 and its highway account in fiscal 2028; in 2026 the highway account took in $41.6 billion and paid out $62.2 billion. Raising the gas tax is unpopular in both parties. The proposals that have advanced are fees on electric and hybrid vehicles, which the House's 2026 bill would impose and which CBO expects to raise about $17 billion through 2036, and, in the longer run, a charge per mile driven, which several states have piloted.

11c. The 2021 Law

The Infrastructure Investment and Jobs Act of November 2021 was the largest federal infrastructure measure since the Interstates: about $1.2 trillion over five years, including about $550 billion of new spending above the baseline for roads and bridges, public transit, passenger rail, water pipes and lead-line replacement, broadband, ports, airports, the grid, and electric-vehicle chargers. It raised the core surface-transportation programs by about a third and added advance appropriations from the general fund,

just over $36 billion a year at the Transportation Department alone, many of them competitive grants open directly to cities and counties.

By January 2025 the outgoing administration counted $591 billion announced for more than 72,000 projects. The law's results are real, in bridges replaced, water systems rebuilt, and broadband extended, but also smaller than its headline, because construction costs rose sharply after 2021 and ate much of its purchasing power, as the state transportation departments themselves acknowledge.

11d. The Stopgap

The law's surface-transportation authorities were due to expire on September 30, 2026. Without a new law or an extension, the Transportation Department could not have committed new highway and transit money from October 1. Congress chose a stopgap: the House passed a continuing resolution running to December 4 on July 21, and the Senate passed its own, running to December 11, on August 8 by 90 votes to 6. The House accepted the Senate's version on September 1 by 370 to 48, and the President signed the Continuing Appropriations and Extensions Act, 2027 on September 2, so the highway and transit authorities did not lapse and the government did not shut down on October 1.

The stopgap funds the government and extends the highway and transit programs through December 11 at prorated 2026 levels, and it keeps unspent balances of some grant programs available into 2027. It does not continue the 2021 law's advance appropriations, which ended with fiscal 2026, so from October 1 there was no new money for the bridge formula program, the electric-vehicle charger program, or the intercity passenger-rail grants. The American Public Transportation Association put the loss at about a fifth of federal transit funding and four-fifths of passenger-rail funding. Full-year appropriations for fiscal 2027 are unresolved, and December 11 is the next deadline.

The replacement is still in Congress: the House Transportation and Infrastructure Committee approved the BUILD (Building Unrivaled Infrastructure and Long-term Development) America 250 Act on May 22, 2026, by 62 votes to 2. It would authorize $580 billion over fiscal 2027-31, impose fees on electric and hybrid vehicles for the trust fund, speed environmental review, and repeal the 2021 law's carbon-reduction, electric-vehicle charger, and resilience programs, and CBO estimates it would deepen the trust fund's shortfall by nearly $150 billion. By early October it had not reached the House floor, and the Senate's committees had not released a bill of their own, though the Speaker said he meant to finish it this year. For contractors and state transportation departments, the work under way is funded, and the next year's lettings depend on what Congress does by December 11 and in the session that follows.

Item	Figure	Note
The 2021 law, total	About $1.2 trillion over five years	About $550 billion above the baseline
Advance appropriations	Just over $36 billion a year at the Transportation Department, fiscal 2022-26	Lapsed on October 1, 2026; not continued by the stopgap
Announced by January 2025	$591 billion for 72,000-plus projects	The outgoing administration's count
The stopgap	Highway and transit programs extended to December 11, 2026 at prorated 2026 levels	Public Law 119-103, signed September 2, 2026
The House's BUILD America 250 Act	$580 billion, fiscal 2027-31	Committee vote 62-2 on May 22, 2026; no floor vote by early October
Fees on electric and hybrid vehicles	About $17 billion through 2036 ($12 billion net of lost income-tax revenue)	CBO's estimate; the first new trust-fund revenue in decades

Item	Figure	Note
Federal gas tax	18.4 cents a gallon since 1993	Diesel 24.4 cents
General-fund transfers to the trust fund	More than $275 billion since 2008	The gas tax no longer pays for the program
Trust fund exhaustion	Transit account in fiscal 2027; highway account in fiscal 2028	CBO, June 2026
Infrastructure grade (civil engineers' report card, 2025)	C	Up from C-minus in 2021; the best since the report card began in 1998

11e. Tolls, Partnerships, and Their Record

The alternatives to tax-funded building are old and uneven: tolls pay for many bridges, tunnels, and turnpikes and, as express lanes priced by congestion, for new capacity in Texas, Virginia, and California. Public-private partnerships hand a private consortium the design, construction, financing, and often decades of operation of a project, in exchange for tolls or annual availability payments from the government. They transfer some risk and add private discipline, and they also add financing costs and long contracts that are hard to change.

Maryland's Purple Line light rail shows the risk: signed as a partnership in 2016, it lost its builder in 2020 over delays and cost disputes, was rebid, and now costs close to $10 billion, with service due in the winter of 2027. Chicago's 2008 lease of its parking meters for 75 years, sold for about $1.15 billion, became the standard example of a city selling a future revenue stream too cheaply. Asset recycling, leasing an existing road or port to fund new ones, has worked better in Australia and India, where the National Highways Authority of India (NHAI) raised about 280 billion rupees (about $2.9 billion) in 2025-26 by selling toll rights on completed roads.

11f. The Federal Role: The Cases as Their Advocates Make Them

The case for a large federal role: infrastructure is a national network whose benefits cross state lines, so states acting alone underinvest in it, and federal money in the Interstates built the modern economy. The civil engineers' estimate of a $3.7 trillion ten-year investment gap is a measure of neglect, and the 2021 law, whatever inflation took, repaired thousands of bridges and water systems that local budgets had deferred for decades. Letting its programs lapse, as the advance appropriations did on October 1, or cutting its climate and resilience programs leaves the next storm's damage to be paid for later at a higher price.

The case for a smaller one: federal money raises the cost of what it buys, through prevailing-wage rules, Buy America requirements, federal environmental review, and grant conditions, so a dollar spent through Washington builds less than a dollar spent by a state. The 2021 law's surge coincided with and fed the cost inflation that ate its purchasing power, and its competitive grants and climate programs steered money toward federal priorities rather than the most-used roads. The trust fund's insolvency shows a program that has outgrown the tax meant to pay for it, and on this view Washington should fund the national networks, cut the conditions, and let states raise and spend the rest.

What the evidence says: the 2021 law's bridges and pipes are real, and so is the inflation, since public construction spending rose strongly in dollars and much less in real terms. The strongest points on each side are compatible: the national networks need a federal funder, and the federal conditions raise costs. That is the bargain the House bill strikes, a large authorization with faster reviews and fewer programs, though CBO finds that even with its new fees it would deepen the trust fund's shortfall.

The course's reading, stated once: the unresolved problem is revenue, not authorization. Until the trust fund has a tax base that keeps pace with cost, every highway bill is a transfer from the general fund dressed as a user-paid program, and the deadlines will keep arriving.

Worked example — What the Gas Tax Still Buys

A driver of a car that gets 25 miles a gallon and goes 12,000 miles a year buys 480 gallons and pays about $88 a year in federal gas tax. Had the 1993 rate of 18.4 cents been indexed to consumer prices, it would be about 43 cents in 2026, and the same driver would pay about $205. Meanwhile the cost of what the tax buys has risen faster than prices in general: highway construction costs roughly doubled between 2003 and 2024. So the real federal contribution per mile driven has fallen by well over half since 1993, while an electric vehicle, heavier than its gasoline equivalent, pays nothing at all. Multiply by more than 3 trillion vehicle-miles a year and the trust fund's shortfall follows: about $32 billion in 2026 on CBO's figures, $20.6 billion for highways and $11.2 billion for transit. A fee on electric vehicles of the size the House proposes closes little more than a billion dollars a year of it; a per-mile charge could close all of it, and is the political fight of the highway bill after next.

Module 11 Key Points

Paying for It

• States and localities pay about three-quarters of public works, borrowing through municipal bonds, a record $580 billion in 2025.

• The federal gas tax has been 18.4 cents a gallon since 1993; the trust fund's highway account runs dry in fiscal 2028.

• A stopgap signed September 2 extended the 2021 law's programs to December 11, but its advance appropriations lapsed October 1.

• The House's $580 billion bill cleared committee 62-2 in May but had no floor vote by October, and the Senate had no text.

• CBO finds the House bill would deepen the trust fund's shortfall by nearly $150 billion despite its new vehicle fees.

Module 11 Quiz

Check Your Understanding

1. When was the federal gasoline tax last raised?

A) In 1993, to 18.4 cents
B) In 2021
C) Every year since 2008, indexed to inflation
D) In 2025, as part of the July tax law

2. What happened to the federal highway program at the September 30, 2026 deadline?

A) It lapsed for a month
B) A five-year law passed
C) A stopgap extended it to December 11
D) The 2021 law was extended in full for two more years, advance appropriations included

3. What does the stopgap signed on September 2, 2026 leave out?

A) The trust fund's core highway formula programs
B) The 2021 law's advance appropriations, such as the bridge formula and passenger-rail grants
C) All transit programs
D) Operating funds for the Federal Highway Administration's own offices and staff

4. What does the House's BUILD America 250 Act propose?

A) A gas-tax holiday
B) A $1 trillion national infrastructure bank replacing the formula programs
C) $580 billion over five years
D) Doubling the 2021 law's climate and charger programs

5. What went wrong with Maryland's Purple Line partnership?

A) Its builder quit in 2020, and the cost neared $10 billion
B) Its trains were recalled for defects
C) It was cancelled before construction began
D) The private partner went bankrupt and the federal government took ownership of the line

Module 12 — The World's Build-Out

Where the Cranes Are

Recommended Reading / Reference

Book: Jonathan Hillman, *The Emperor's New Road* (2020), China's Belt and Road as a construction program, from the ports to the railways

Reference: China's National Bureau of Statistics (monthly real-estate releases); NHAI and India's road ministry; Saudi Arabia's Ministry of Finance (quarterly budget reports); Euroconstruct (June 2026); the USGS country cement data

12a. China After the Boom

China remains the largest construction market on earth, and it is shrinking. New construction starts in 2025, 588 million square meters (6.3 billion square feet) of floor space, about three-quarters of it housing, were 70% below 2021's, and they fell another 25% in the first eight months of 2026; property investment fell 17% in 2025 and 20% in January-August 2026. Cement output is a third below its 2014 peak, and parts of the cement and steel industries run at a loss.

The state has tried to fill the gap with infrastructure: special local-government bonds for roads, water, the grid, and urban renewal, and in late 2024 a ¥10 trillion (about $1.5 trillion) program to swap the hidden debts of local financing vehicles for official bonds. But infrastructure spending has grown slowly, because the local governments that did most of it lost their land-sale revenue with the property market and are under orders to cut debt. The builders have looked abroad: China State Construction's overseas contracts rose 15% in 2025, and in February 2026 it joined the consortium building the Abu Dhabi end of the high-speed line to Dubai. The Chinese contractors, equipment makers, and cement groups built for a domestic boom are now the world's most aggressive exporters of construction.

12b. India's Build

India's build-out is still growing quickly. The National Highways Authority, which builds about half of the national-highway kilometers built each year, built 5,313 kilometers (3,300 miles) of national highway in 2025-26, 15% above its target and about 14.6 kilometers a day, with capital spending of 2.44 trillion rupees (about $26 billion), on a national network now more than 146,000 kilometers long. The road ministry's budget for 2026-27 is a record 3.09 trillion rupees (about $32 billion), with capital spending up 9%. Dedicated freight corridors, a high-speed line from Mumbai to Ahmedabad built with Japanese finance, metro systems in more than twenty cities, new airports, and a national housing program add to it, and cement output rose about 7% in 2025.

The limits are visible too: awards of new highway contracts slowed in 2025-26. The ministry built 10,660 kilometers of national highway in 2024-25, and the rating agency ICRA estimated 9,500-10,000 for 2025-26 and expects 9,000-9,500 in 2026-27. Land acquisition remains the slowest step in most Indian projects.

12c. The Gulf

The Gulf states spent the 2010s and early 2020s on the most ambitious construction programs in the world, and 2025-26 is the time of retrenchment. Saudi Arabia's giga-projects, NEOM, the Red Sea resorts, Qiddiya, Diriyah, New Murabba, and the housing developer Roshn, were reviewed from 2024 as costs rose and oil revenue fell. NEOM's The Line, planned as a 170-kilometer city, was suspended in September 2025 with about 2.4 kilometers of foundations and is halted until after 2030.

In March 2026 NEOM terminated Webuild's $4.7 billion contract for the dams of its Trojena mountain resort, along with a tunnel contract for The Line, and in May a €1.4 billion (about $1.6 billion) rail contract, and Semafor reported that the kingdom expects to pay about $16 billion to contractors for cancelled work over five years. The 2029 Asian Winter Games, planned for Trojena, moved to Kazakhstan, and in October 2026 Reuters reported that the NEOM stadium planned for the 2034 World Cup had been shelved indefinitely.

The kingdom budgeted a 2026 deficit of about 165 billion riyals ($44 billion), and the first half's deficit alone reached 160 billion riyals, all of it borrowed, as spending rose faster than revenue. It is reprioritizing toward deadlines it cannot move, Expo 2030 in Riyadh and the 2034 World Cup. The United Arab Emirates (UAE) and Qatar continue at a steadier pace, with contracts for the $8 billion-plus high-speed line between Abu Dhabi and Dubai awarded in February 2026. For the international contractors that followed the money to the Gulf, the lesson is the one of Module 6: a large backlog in a sovereign's giga-project is a claim on a budget, not a certainty.

12d. Africa's Cement Race

Africa has the world's fastest-growing cities and some of its lowest cement use per person, often 100-200 kilograms a year against a world average near 470, and cement prices among the highest, because much of it is imported or made in a few protected plants. That combination has made the continent the industry's contested growth market: Nigeria's Dangote built the largest African producer behind import restrictions at home and now operates across about ten countries. Chinese firms, led by Huaxin, which bought Lafarge Africa from Holcim in 2025, are buying and building plants in East and West Africa, and Heidelberg Materials is the largest Western rival.

Chinese contractors build a large share of the continent's major roads, railways, ports, and dams, often with Chinese financing, alongside Turkish, European, and a growing number of African firms. The binding constraints are finance and power: most African governments are heavily indebted, and a cement kiln needs a reliable grid.

12e. Europe's Slow Build

Europe's construction has been weak since the interest-rate rises of 2022-23, with housing starts down sharply in Germany, France, and Scandinavia and infrastructure spending held back by budget rules. Output in the 19 countries Euroconstruct tracks grew 0.2% in 2025, and it forecast growth of 2.0% in 2026 and 2.2% in 2027, led by civil engineering. Germany amended its constitution in 2025 to create a €500 billion (about $575 billion) special fund for infrastructure over twelve years, for railways, bridges, schools, and the grid, after a decade in which Deutsche Bahn's punctuality and the autobahn bridges became symbols of neglect. It has been slow to spend: €24 billion went out in 2025 against €37 billion budgeted, and by the end of April 2026 only 28% of the year's €40 billion had been spent.

The European Union's carbon border adjustment, covering imported cement and steel since January 2026, protects Europe's decarbonizing producers while raising their costs. Britain cut its High Speed 2 rail line to its first leg in 2023 after costs soared, and is trying to reform planning to build more housing and grid. Europe's constraint is the one of Module 10: it builds slowly, with Madrid's metro, Copenhagen's, and Scandinavia's tunnels as the exceptions.

Region	2026 direction	The driver	The constraint
United States	Total down 1.7%; data centers and power up	The technology companies' capital spending; the 2021 law's last funded year	Rates, tariffs, and labor
China	Down; new starts down a quarter again	The property collapse	Local-government debt
India	Up	Highways, housing, metros, and cement	Land; slower highway awards
Saudi Arabia and the Gulf	Saudi cut back; UAE steady	The giga-project review; the war	Oil revenue and the budget
Sub-Saharan Africa	Up from a low base	Urbanization	Finance, power, and imported inputs
Europe	Up about 2%; Germany slowly turning up	The €500 billion fund; the carbon border charge	Rates, budgets, and permitting

Census Bureau; China's National Bureau of Statistics; ICRA; Saudi Ministry of Finance; Euroconstruct (June 2026).

Worked example — Cement per Person

Divide each country's cement by its people and the stage of its build-out appears. China makes about 1.7 billion tonnes for 1.42 billion people, about 1.2 tonnes a person a year, down from about 1.8 at its 2014 peak. The United States uses about 110 million tonnes for 347 million people, about a third of a tonne, the use of a mature economy maintaining what it built. India makes about 470 million tonnes for 1.46 billion people, also about a third of a tonne, but it is building rather than maintaining, and its use per person is rising, while Nigeria uses about a tenth of a tonne a person. If India's use per person rose to China's peak, India would need about 2.6 billion tonnes a year, more than five times its current output and well above what China makes today. Even half of that path is the largest growth opportunity the cement industry has, which is why UltraTech and Adani are buying capacity and why the world's cement map will move toward South Asia and Africa as China's shrinks. Populations are the United Nations' *World Population Prospects 2024* estimates for 2025.

Module 12 Key Points

The World's Build-Out

• China's construction starts in 2025 were 70% below 2021's, and they fell another quarter in January-August 2026.

• India's highway authority built 5,313 kilometers in 2025-26, 15% above target, though new awards are slowing.

• The Gulf is cutting back: The Line is halted until after 2030, and NEOM may owe contractors $16 billion.

• Africa is the contested cement market: fast-growing cities, low use per person, and Chinese, European, and Nigerian producers.

• Germany's €500 billion infrastructure fund is spending slowly: €24 billion went out in 2025 against €37 billion budgeted.

Module 12 Quiz

Check Your Understanding

1. What happened to China's construction starts after 2021?

A) They doubled as the state built social housing
B) They held steady while exports of cement fell
C) They rose in 2025 after the ¥10 trillion debt swap
D) They fell about 70% by 2025

2. About how many kilometers of national highway did India's highway authority build in 2025-26?

A) About 530 km
B) About 53,000 km, more than all other countries
C) About 10,700 km, double its target for the year
D) About 5,300 km

3. What did Germany create in 2025 for its infrastructure?

A) A €500 billion special fund
B) A sale of Deutsche Bahn and the autobahns to investors
C) A ban on new roads in favor of rail and cycling
D) A carbon tax to pay for every new bridge

4. Why is Africa the contested growth market for cement?

A) Cement is cheap there
B) Its governments ban imports
C) Fast-growing cities with low use per person
D) European groups have left, leaving Chinese firms the only bidders

5. How much cement would India need if it matched China's peak use per person?

A) About the same as today
B) About 2.6 billion tonnes a year, more than five times today's output
C) Less than today, as it builds more with steel and timber
D) About 1 billion tonnes, double today's

Module 13 — Where Things Stand, and What to Watch

The Trajectories and the Dates

Recommended Reading / Reference

Book: Ezra Klein and Derek Thompson, *Abundance* (2025), the argument that America's scarcities of housing, energy, and infrastructure are failures to build, and the debate it started

Reference: The Census Bureau's monthly *Construction Spending* release; the AGC's monthly analysis of materials prices and employment; ConstructConnect's monthly data-center reports

13a. An Industry Leaning on One Kind of Building

The American construction industry enters the autumn of 2026 moving in two directions at once. Data-center construction ran at about $85 billion a year in August, up 73% on the year, and data-center starts reached $98.5 billion in the first eight months of 2026, about a quarter of all nonresidential building starts. Power construction is nearly level with factory construction, and the specialty contractors that do the electrical and mechanical work carry the largest backlogs in their histories.

Everything else is falling or growing slowly: housing, under mortgage rates that reached 7.4% in October; factories, after the chip and battery plants; ordinary offices; and a public sector, up 2.5% on the year, whose federal law runs on a stopgap to December 11. The industry's growth, in other words, depends on the capital budgets of a handful of technology companies and of the utilities building to serve them.

That concentration is the first thing to watch, and the technology companies' plans for 2027 come with their third-quarter results in late October and their fourth-quarter results in late January. If they show another large increase, the boom continues, and the shortages of labor and equipment with it. If they flatten, or if one large buyer cuts, the effect would fall first and hardest on the firms and workers that have grown to serve the boom. Those are the electrical and mechanical contractors, such as Comfort Systems, where technology work was 58% of first-half revenue, the electricians who moved to the campuses, and the copper and switchgear suppliers. The rest of the industry would see the other side, with labor and equipment freed for the hospitals, schools, and factories that have been outbid.

13b. The Three Constraints

Constraint	Where it stands	What would change it
Rates	The Fed raised its target to 3.75-4.00% on September 16; the ten-year Treasury yield was 5.24% and the 30-year mortgage rate 7.40% in early October	Inflation easing as the oil shock fades; the Fed's next moves
Materials and tariffs	Inputs up 8.9% in a year; the metals tariffs at 50%; diesel up 78% at the refinery and $6.20 a gallon at the pump	The war's course; tariff exemptions or deals; the price of copper
Labor	349,000 workers needed in 2026 and 456,000 in 2027 on the contractors' model; pay up 4.3%	Training pipelines; immigration policy; a slowdown in data centers

The three constraints compound: higher rates cut the projects whose owners borrow, housing and speculative commercial building, the most; the tariffs and fuel raise the cost of the projects that proceed; and the labor shortage lets the projects with the richest owners outbid the rest. The result is the split of Module 1

made structural: the industry builds what the richest buyers want, at rising cost, and builds less of everything else. The quickest relief would come from rates, if the oil shock fades and the Fed stops raising them, and the slowest from labor, which will take years whatever policy does.

13c. What the Arguments Share

The course has argued five questions, each after making the opposing cases: the tariffs on building materials (Module 5), the labor shortage (Module 8), productivity (Module 9), the cost of American projects (Module 10), and the federal role (Module 11). The thread through them is that the constraints on building in the United States are mostly institutional, how projects are approved, owned, staffed, priced, and paid for, rather than technical. The tools to build faster and cheaper exist, and they are used where the institutions allow it: on the data-center campuses, in Madrid's metro, and in the factories that make modular electrical rooms.

13d. What to Watch

When	What	Why it matters
October 27-28, 2026	The Federal Reserve's meeting	Whether a second rise follows September's; mortgage and bond rates
Late October	The technology companies' third-quarter results and 2027 spending plans; the specialty contractors' third-quarter backlogs	The largest single source of construction growth
November 2	September construction spending (Census Bureau)	Whether data centers keep offsetting the declines elsewhere
November 3	The midterm elections and state transportation ballot measures	The Congress that finishes the highway bill; state funding
November-December	The Senate's bipartisan permitting bill, introduced September 30, and the House's BUILD America 250 Act	Faster reviews and the next five-year highway program
December 11	The stopgap ends: fiscal 2027 appropriations and the highway program's next extension	Whether the advance appropriations return and the programs are extended again
First quarter of 2027	CRH's purchase of Arcosa expected to close	Consolidation in American aggregates
Fiscal 2027	CBO's projected exhaustion of the trust fund's transit account, with the highway account following in fiscal 2028	The revenue question every extension postpones
2027	456,000 workers needed on the contractors' model; India's highway construction expected to ease to 9,000-9,500 km	Whether labor or demand becomes the binding constraint
Through 2027	The 15% tariff on metal-intensive grid equipment	Transformer and switchgear prices
2030	The first phase of the Abu Dhabi-Dubai high-speed line; Expo 2030 in Riyadh; The Line halted until after 2030	The Gulf's giga-projects after the retrenchment
2032	California high-speed rail's Merced-Bakersfield segment due	The largest American megaproject's next test
2034	Saudi Arabia's World Cup, without the NEOM stadium	With Expo 2030, a deadline the kingdom cannot move
Monthly	Materials prices, construction employment, copper, and diesel	The costs of building, in real time

13e. The Last Word

The throughline of thirteen modules is that building is heavy, local, and political. It is heavy, so its materials, cement, stone, and steel, are made near where they are used, and freight shapes the industry's map and its monopolies. It is local, so its firms are small, its markets are metro areas, and every project is a prototype on its own site under its own rules. And it is political, because nearly everything built needs permission, much of it needs public money, and all of it changes a place other people live in.

The history of the industry is the history of societies that learned to organize those three facts, the Romans with their concrete, the builders of the Empire State with their schedule, and China with its state-directed boom. The American question of 2026 is whether a country that once built faster than anyone can relearn how. The data centers show it still can when the owner is capable, the design repeats, and the money is ample; the subways and high-speed lines show what happens when none of the three holds.

Worked example — The Concentration Arithmetic

Private nonresidential construction ran at about $773 billion a year in August 2026, and data centers at about $85 billion of it, about a ninth. But data centers were up about $36 billion on the year while the category as a whole fell by about $8 billion, so the rest of it fell by about $44 billion: without data centers, private nonresidential spending would have been down about 6% on the year rather than 1%. Now suppose the technology companies' plans for 2027 are flat and data-center construction levels off at $85 billion. The industry loses its largest source of growth, and the total follows the rest of the market down. Suppose instead it falls by a third, to about $57 billion: private nonresidential spending falls another 3.6%, and specialty contractors such as Comfort Systems, for which technology work was 58% of revenue in the first half of 2026, lose much of their growth. The electricians, the switchgear, and the copper that moved to the campuses would move back to the hospitals and factories, slowly and at lower prices. That is the risk the backlogs do not show.

Module 13 Key Points

Where Things Stand, and What to Watch

• Data-center starts reached $98.5 billion in the first eight months of 2026, a quarter of nonresidential building starts, while most else fell.

• The technology companies' 2027 spending plans, due from late October, are the largest single variable for the industry.

• Rates, tariffs, and labor compound: the richest owners keep building at rising cost, and everyone else builds less.

• The highway program runs on a stopgap to December 11; the midterms and the session's end decide the next bill.

• The throughline: building is heavy, local, and political, and America's constraints are mostly institutional, not technical.

Module 13 Quiz

Check Your Understanding

1. What is the concentration risk the module describes?

A) Growth rests on a few data-center buyers
B) Too many small builders compete for the same public jobs
C) Public spending has grown too large for states to sustain
D) China and India make most cement and could cut exports

2. When does the stopgap funding the federal highway program end?

A) June 2027
B) December 11, 2026
C) September 30, 2026, with no extension
D) In 2028, when the trust fund's highway account runs dry

3. Which three constraints does the module name for 2026-27?

A) Land, permits, and cash
B) Steel, wood, and wire
C) Weather, permits, and the supply of cement and steel
D) Rates, tariffs, and labor

4. What share of Comfort Systems' revenue came from technology work in the first half of 2026?

A) About 5%
B) About 90%
C) About 58%, more than half of it
D) About a fifth, in hospitals

5. What is the course's throughline?

A) Building is heavy, local, and political, and America's limits are mostly institutional
B) Cement prices decide everything else
C) Factories will replace construction sites within a decade
D) America builds faster and cheaper than the other rich countries it competes with

Answer Sheet

Answers to every module's Check Your Understanding quiz.

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