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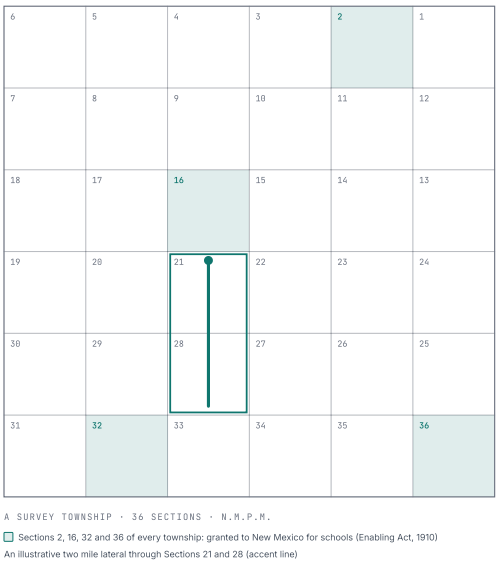
The Ledger

Land & energy, of record.

No. 004 Book 1 · Page 4

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Down and Across

How Americans learned to drill, lift and move oil on land, what a Permian well looks like in the autumn of 2026, and the robots, electric fleets and satellites promised next.

I · CHAIN OF TITLE

Sixty-nine feet

Drake's driven pipe, a cone bit that cut six times faster than the fishtail, and the rules that capture forced on every oil state.

II · OF RECORD

Two miles sideways

603 rigs, 5.6 wells a rig a quarter, a record month for New Mexico, and the law of a lateral that crosses eight tracts.

III · FUTURE INTERESTS

The well that runs itself

Two robotic rig floors, a frac job that ran itself, half of one major's rigs promised by 2028, and methane rules moving the other way.

A fourth entry, on one subject: how a well is made. Section I follows drilling from Drake's 69 feet to the first fractures, pipelines and conservation laws. Section II reads the record of October 2026, when a Permian well runs two miles sideways. Section III weighs what is promised next.

I · CHAIN OF TITLE LOOKING BACK

Sixty-nine feet

Edwin Drake drove an iron pipe to rock and found oil at 69 feet in 1859. In the hundred and twenty years that followed, the rotary rig, the cone bit, the blowout preventer, the log, the fracture and the pipeline made that hole an industry, and each left a rule an examiner still reads.

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On August 27, 1859, on Oil Creek near Titusville, Pennsylvania, Edwin L. Drake and his driller, William Smith, called Uncle Billy, found oil standing in a hole 69 feet deep [1], [2]. The method was a salt driller's. When the old way would take the hole no deeper than 16 feet, Drake drove an iron pipe down to the rock, a drive pipe he never patented, and Smith worked through rock and shale at an average of about three feet a day [1], [3]. The well gave a few dozen barrels a day: the American Society of Mechanical Engineers puts it at 1,000 gallons daily for three years, a Penn State history at an estimated 20 to 40 barrels [1], [3]. The Energy Information Administration's national series begins with that year, at 2 thousand barrels, and counts 500 thousand the next [4]. The Pennsylvania Historical and Museum Commission calls it the first successful commercial oil well [2]. Its backers had less faith in it than history does. The venture, renamed the Seneca Oil Company of Connecticut, had given up on Drake by the time of the strike and did not reimburse him for the well for four years. In October 1859 Smith set the well on fire inspecting the oil with an open lamp [3]. What followed was a century of machines for going deeper and of rules for sharing what they found.

The tools were older than the well. On the Kanawha River in western Virginia, where the Ruffner brothers built the first commercial salt furnace in 1808, saltmakers boring for brine devised well-drilling tools that petroleum drillers later adapted [5]. One of them is on record: on September 4, 1841, William Morris of Kanawha County received Patent No. 2,243 for a sliding connection between the auger and its heavy sinker, which let the bit and sinker fall and strike while it "relieves the poles above from the

jar" [6]. Drake's successors drilled with cable tools. A heavy bit on a cable was dropped on the bottom of the hole again and again, and every few strokes the crew stopped to haul the cuttings out, a start and stop that the landmark history puts at about 25 feet a day [7]. On April 25, 1865, E. A. L. Roberts patented a way to set off a charge of powder deep in a water-filled well, the well torpedo [8]. The power changed under the same rigs; the museum at Drake's site traces drilling from manual work to steam and then to gas engines [2].

MARGINAL NOTE

Cable tool and rotary

A cable tool rig pounds. Its bit is dropped on the bottom of the hole again and again, and every few strokes the crew stops to haul the cuttings out [7]. A rotary rig turns its bit and cuts without stopping. After Spindletop, the landmark history notes, steel derricks replaced wood and drilling mud and blowout preventers were developed [7]. The rotary still needed a bit for hard rock: the fishtail scraped, and the cone bit of 1909 chipped and crushed [7], [9].

The rotary rig made its name on the Gulf Coast. Anthony F. Lucas spudded a well at Spindletop, near Beaumont, on October 27, 1900, for Guffey and Galey of Pittsburgh, with Al and Curt Hamill of Corsicana, who drilled with a heavier rotary bit [10]. On January 10, 1901, at about 1,100 feet, mud and then oil came out of the hole, and the Lucas gusher flowed an estimated 100,000 barrels a day for nine days before it was capped [10], [11]. The field yielded 17,500,000 barrels in 1902 [10]. Many historians, the ASME history notes, date the cheap-oil era from that gusher and from the switch from the cable tool to the rotary rig [7].

Spindletop's soft sands suited the rotary; hard rock did not. The rig then used one bit, the fishtail, which scraped and stalled in hard formations [7]. In 1908 Howard R. Hughes and Walter Sharp built a model of a roller bit with two cone-shaped cutters, each with 166 cutting edges, that chipped and crushed rock instead of scraping it, and Hughes's Patent No. 930,758 was granted on August 10, 1909 [7], [9]. They tested the bit at Goose Creek, Texas, in 1908: on the first try the pipe twisted off, and on the second, by the Hughes Tool biography the landmark history quotes, Hughes drilled fourteen feet of hard rock in eleven hours and found the Goose Creek field. The partners founded the Sharp-Hughes Tool Company in 1909, in a rented shop twenty by forty feet [7]. The landmark history gives a case from the House No. 1 well of the Producers' Oil Co. at Humble, Texas: below 1,819 feet a fishtail bit made 38 feet in 19 days, and the cone bit 72 feet in 6, six times the rate at a quarter of the cost per foot [7]. Hughes Tool commercialized the three-cone Tricone bit in 1933, and the three-cone patent of Floyd L. Scott and Lewis E. Garfield issued on December 4, 1934 [7], [12]. During the seventeen years of that patent, Hughes Tool's share of the market approached 100 percent [7].



FIG. 1 Feet drilled a day through the same hard rock at the House No. 1 well, Humble, Texas: the fishtail bit against the Hughes two-cone bit, as the ASME landmark history reports the case, with the cable tool's general rate for scale [7].

Deeper holes met higher pressures. In 1922 James S. Abercrombie, a wildcatter, and Harry S. Cameron, a machinist, worked out a ram-type blowout preventer at Cameron's shop in Humble; the design held up to 3,000 psi, was marketed in January 1924 and was patented on January 12, 1926 [13]. Seeing underground came next. On June 4, 1921, on a farm north of Oklahoma City, Karcher, Ohern, Haseman and Irving Perrine showed that a reflection seismograph could map structure below the surface, and in December 1928 Amerada struck oil near Seminole in the first well drilled on a structure the method had found [14]. On September 5, 1927, a team led by Henri Doll ran the first electrical well log, in a 500-meter well at Pechelbronn in Alsace, and the company now called SLB began surveys in the United States on August 17, 1929 [15].

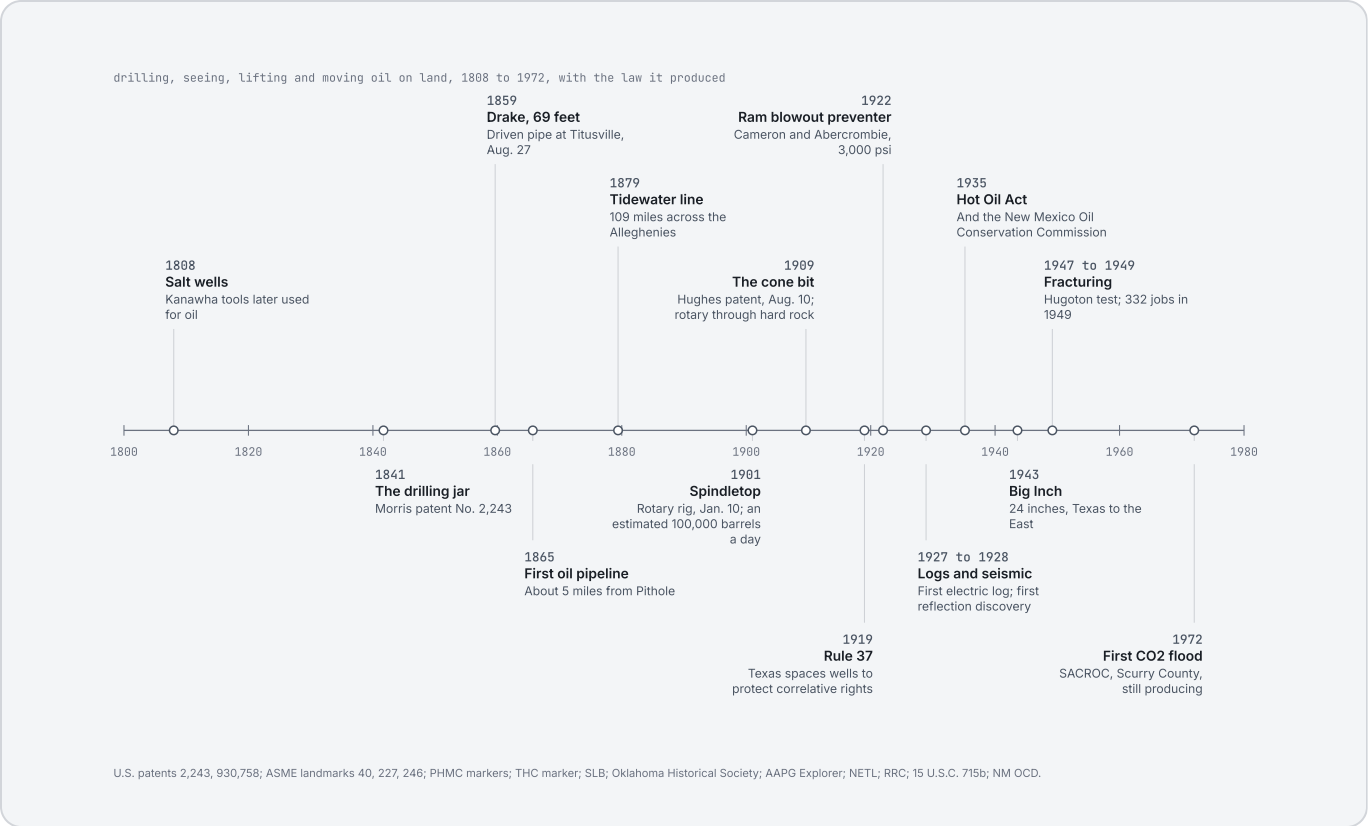


FIG. 2 Drilling, seeing, lifting and moving oil on land, 1808 to 1972, with the rules the industry produced. Dates from patents, landmark histories, state markers, agency histories and statutes [1], [5], [6], [9], [11], [13], [14], [15], [16], [17], [18], [19], [20], [21], [22], [23].

Lifting oil was mechanized in the same years. W. C. Trout developed a pumping unit for Humble Oil in the 1920s, perfected in the Goose Creek field; pumping units carried Lufkin through the Depression, and by 1973 it had built more than 100,000 of them [24]. The first fracture was an experiment in Kansas. In 1947 Stanolind fractured the Klepper No. 1 in the Hugoton field, Grant County, at 2,400 feet, with a thousand gallons of a napalm mix of palm oil, naphthenic acid and gasoline and sand from the Arkansas River [22]. Halliburton, its licensee, ran the first two commercial jobs in March 1949, near Duncan, Oklahoma, for $900 and at Holliday, Texas, for $1,000, and did 332 that first year; by 2013, the AAPG history reports, the Department of Energy estimated that at least two million oil and gas wells had been fractured [22]. In 1972 carbon dioxide injection began at the SACROC Unit in Scurry County, Texas, now the oldest CO2 enhanced recovery operation in the United States [23].

Oil also had to be moved. In the fall of 1865 a pipeline about five miles long pumped oil from Pithole to the railhead at Miller Farm, and its trench is still visible [16]. On May 28, 1879, the Tidewater Pipe Co., an early rival of Standard Oil, began pumping 109 miles across the Alleghenies to Williamsport [17]. The law then sorted pipe from production. The Hepburn Act of June 29, 1906 made those who carried oil by pipe line common carriers under the Interstate Commerce Act, excepting water and natural or artificial gas, and Texas declared its pipelines common carriers under its Railroad Commission in 1917, by the Pipeline Petroleum Law, Senate Bill 68 [18], [25]. The Natural Gas Act of June 21, 1938

reached interstate transport and sales of gas for resale, but not “the production or gathering of natural gas” [26].

The largest lines of the era were built for a war. Work on the 24-inch Big Inch began on August 3, 1942, and it was finished by August 14, 1943, from Longview, Texas, toward Phoenixville, Pennsylvania; with the 20-inch Little Big Inch, completed in March 1944, it carried over 350 million barrels east before May 1945 [21]. Texas Eastern bought both lines for natural gas for $143,127,000, final on November 14, 1947 [21]. The country had produced 63.6 million barrels in 1900 and 898 million in 1930, and 1,974 million in 1950, on its way to 3,517 million in 1970, computed by *The Ledger* from EIA’s series [4].



FIG. 3 United States crude oil production every tenth year, 1860 to 1980, in million barrels a year, computed by *The Ledger* from the Energy Information Administration’s annual series; output peaked in 1970 [4].

Each of these machines raised the same question of property. Owners above a common pool raced each other to it, and the Supreme Court answered in *Ohio Oil Co. v. Indiana* on April 9, 1900 that each surface owner held “a coequal right in them all to take from a common source of supply,” which a state could protect against waste [27]. Texas gave its Railroad Commission jurisdiction over production in 1919, and the Commission’s Rule 37 set minimum distances between wells to protect field pressure and correlative rights [18], [28]. When the East Texas field flooded the market in the early 1930s, the Commission began to set the rate at which every well in the state could produce, the practice called proration [28]. The Commission’s reach grew with the industry: rates for gas utilities in 1920, the odorization of gas after the New London school explosion of 1937, liquefied petroleum in 1939, and in the 1960s a place as the model for OPEC [18]. The Connally Hot Oil Act of February 22, 1935 made oil produced above a state’s limits contraband in interstate commerce [19]. New Mexico’s Oil and Gas Act of the same year created the three-member Oil Conservation Commission, and the state’s pooling statute, now NMSA 1978 70-2-17, lets the Division pool owners who have not agreed, allocate production by surface acreage and charge a nonconsenting owner up to 200 percent for risk [20], [29].

MARGINAL NOTE

Correlative rights

Correlative rights is the name for what *Ohio Oil Co. v. Indiana* described in 1900: each owner above a common pool has a coequal right to take from it, and the state may protect that right and prevent waste [27]. The doctrine is why spacing rules exist (Texas's Rule 37 states it as its purpose) and why a pooling order allocates production by acreage [18], [29]. In a title file it appears as a spacing exception, a proration order or a pooling order, each a public record of the agency that issued it.

The machines left two kinds of record. One is on paper: spacing exceptions, proration and pooling orders in the agencies' files, and pipeline grants and easements in the county records, each the product of a rule that drilling made necessary [18], [29]. The other is in the ground. Texas plugged a record 2,022 orphaned wells in fiscal 2026, at a cost of $125,643,478 [30]. The question Drake's well first raised is the one a two-mile lateral asks in 2026: when oil moves to a well, whose oil is it?

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Two miles sideways

A new Permian well runs about two miles sideways, and the first four-mile laterals were drilled in 2026. Rigs are back to 603 across the country, each drilling more wells than in early 2025, while the gas waits on new pipe and a lateral that crosses eight tracts asks the law who shares the oil.

On August 5, 2026, Permian Resources reported that it had drilled its first four-mile laterals, horizontal sections of about 21,120 feet, computed by *The Ledger* [31]. It expects to bring about 250 wells online in 2026 at an average lateral of about 11,000 feet [31]. On August 19, 2026, the Energy Information Administration put numbers on the change: the average new horizontal well in the Permian Basin ran 6,149 feet sideways in 2015 and 10,867 feet in 2025, 77 percent longer, and super-laterals over 15,000 feet, almost unknown before 2020, were 15 percent of the basin's new completions [32]. Wells under 5,000 feet fell from 43 percent of completions to 4 [32].

The horizontal well is older than the boom. In 1975 the Department of Energy's National Energy Technology Laboratory worked with industry on the first horizontal shale well with seven separately fractured intervals, and in 1985 it mapped fractures in real time with microseismic sensors in Colorado [33]. On September 25, 1987, Meridian Oil completed the first horizontal well in North Dakota's Bakken for 258 barrels a day; its lateral ran 2,603 feet, and it took 57 days and $2 million to drill and complete [34]. What turned the technique into an industry was cheap fracturing. A Mitchell Energy shale well fractured with sand, water and chemicals "hit big in 1997," and Devon Energy bought the company in 2002 for $3.5 billion [35]. From 2010 to 2021, the laboratory notes, citing EIA, about 81 percent of completions were horizontal or directional, and U.S. crude output more than doubled while gas withdrawals rose 55 percent with 66 percent fewer wells completed [33]. Crude production, 1,829,880 thousand barrels in 2008, passed the 1970 record by 2019 and reached 4,986,606 thousand in 2025 [36].

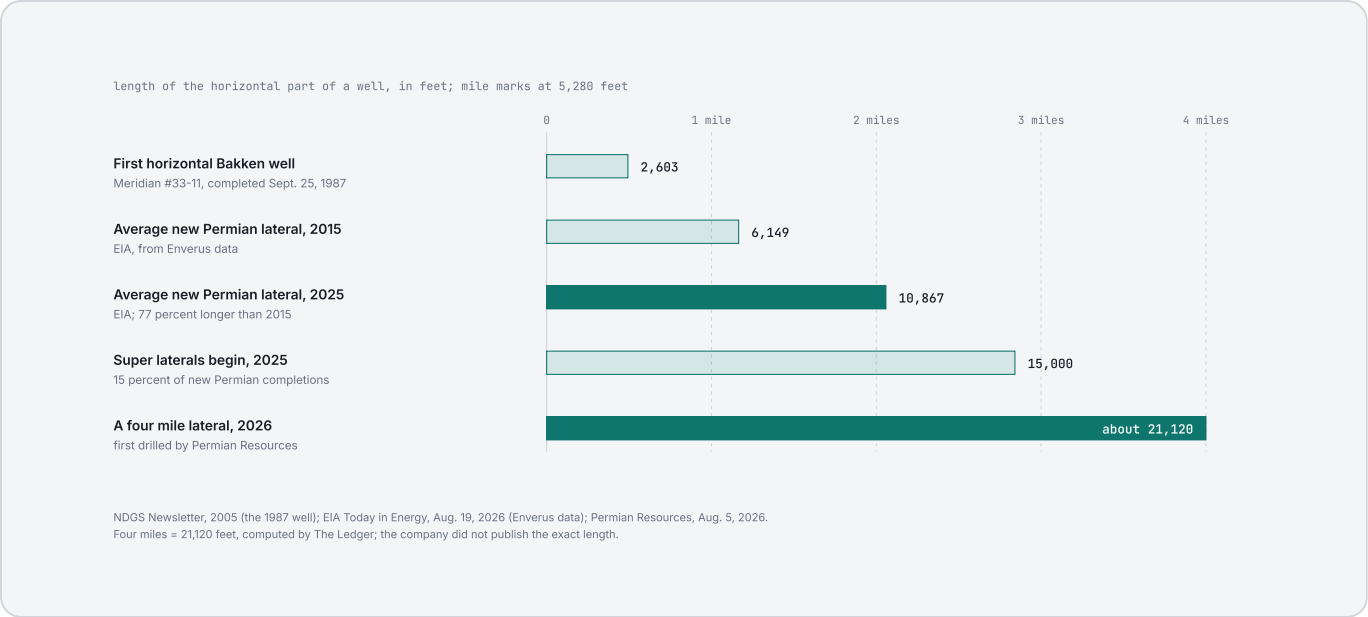


FIG. 4 How far a well runs sideways: the first horizontal Bakken well (1987), the average new Permian lateral in 2015 and 2025, the super-lateral threshold and a four-mile lateral of 2026, whose length is computed by *The Ledger* [31], [32], [34].

The rigs came back in 2026. On October 30, 2026, Baker Hughes counted 603 active rigs in the United States, 57 more than on October 31, 2025: 588 on land, 527 drilling horizontally, 462 aimed at oil [37]. The Permian had 272, against 251 in October 2025; Texas had 275 and New Mexico 99 [37]. The Railroad Commission of Texas issued 759 original drilling permits in September 2026, after 693 in July and 695 in August, and its Midland district alone accounted for 323 new holes; the Commission processed 961 oil and 280 gas completions that month [38], [39]. The prices behind the count are 2026's: EIA expects Brent to average $96 a barrel in 2026 after the closure of the Strait of Hormuz [40].

Each rig now does more. EIA's Short-Term Energy Outlook of October 6, 2026 counts 302 Permian rigs in the first quarter of 2025 and 264 in the third quarter of 2026, with the wells each rig drilled in a quarter rising from 4.8 to 5.6; the 264 rigs drilled 1,490 new wells, more than the 1,440 drilled by 302 [40]. The basin needs every one. In EIA's one-year trend for the third quarter, new Permian wells added about 477 thousand barrels a day while existing wells lost about 479 thousand, and the stock of wells drilled but not yet completed fell from 1,295 to 844 [40].

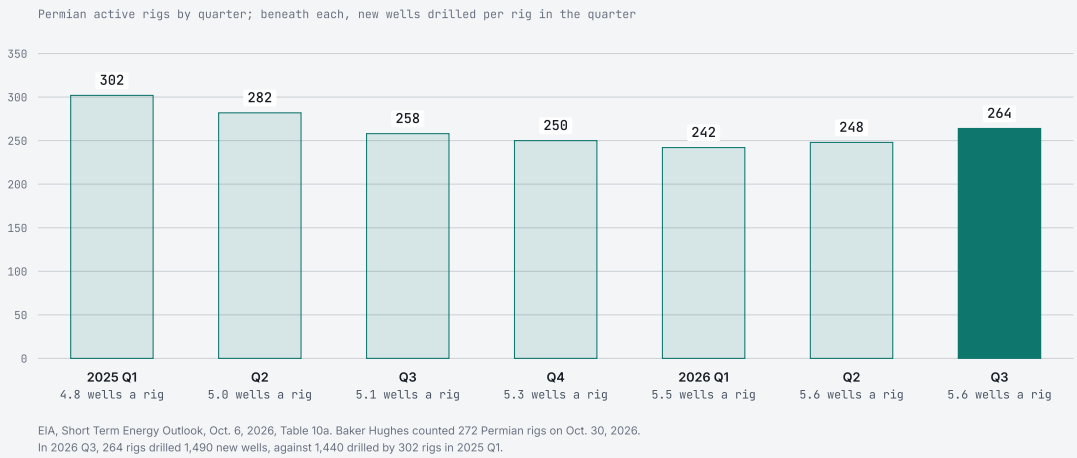


FIG. 5 Permian active rigs by quarter, 2025 to the third quarter of 2026, with the new wells drilled per rig in each quarter, from EIA's Short-Term Energy Outlook of October 6, 2026 [40].

MARGINAL NOTE

Drilled but not completed

A well can be drilled and left waiting for its fracture treatment. EIA counts these wells as a stock, drilled but uncompleted, and the Permian's fell from 1,295 in the first quarter of 2025 to 844 in the third quarter of 2026 as crews completed more wells than rigs drilled [40]. For a lessor the stock matters because a drilled hole is not yet a producing well: the lease clause that measures what holds the lease may treat the two very differently.

Production set records anyway. EIA's monthly series, released October 30, 2026, puts U.S. crude at 13,965 thousand barrels a day in August, Texas at 5,710 thousand and New Mexico at 2,442 thousand, the highest month in a state series that begins at 203 thousand in January 1981 [41], [42]. EIA forecasts U.S. output of 13.9 million barrels a day in 2026 and 14.3 million in 2027, with the Permian at 6.81 million and 7.14 million [40]. The oldest technique in the basin is still at work: at SACROC, the Scurry County unit where carbon dioxide injection began in 1972, Kinder Morgan's net oil rose 11 percent to 20.05 thousand barrels a day in the third quarter of 2026, out of 27.07 thousand from all its CO2 fields [43]. The mood in the field is cooler than the counts. In the Dallas Fed Energy Survey released on September 30, 2026, the business activity index fell to 38.8 from 46.1 while the oil production index rose to 20.7, and executives expected West Texas Intermediate at $88 at the end of 2026 [44].

Gas is the constraint. EIA puts Permian marketed gas at 27.6 billion cubic feet a day in 2025, 29.5 in 2026 and 32.0 in 2027, all of it needing gathering, processing and pipe out of the basin [40]. Energy Transfer said on August 4, 2026 that its Hugh Brinson Pipeline was in commercial service and expected to carry its full first-phase 1.5 billion cubic feet a day by September 1; it had placed the 275 million cubic feet a day Mustang Draw I processing plant in service in the Midland Basin in June and added more than 90,000 barrels a day of Permian natural gas liquids capacity on Lone Star Express [45]. Enbridge reported on August 6, 2026 that Blackcomb, built to move up to 2.5

billion cubic feet a day to Agua Dulce, had begun commissioning beside the operating 580-mile Matterhorn Express, also 2.5 [46]. Energy Transfer had also finished a 14-mile lateral off Hugh Brinson at Abilene [45]. On October 2, 2026, EIA reported record U.S. gross withdrawals of 137 billion cubic feet a day in July, with Texas and New Mexico up 1.7 billion from June as new pipelines eased the bottleneck [47].

The commitments run years ahead. On August 17, 2026, Targa Resources signed 20-year agreements with ExxonMobil running through 2046, covering gathering, processing, treating, NGL transport and fractionation, and announced three Delaware Basin processing plants of about 825 million cubic feet a day, with a 70-mile residue line to Waha, for the first half of 2028 [48]. Enbridge listed the Eiger Express, up to 3.7 billion cubic feet a day, for mid-2028 and a sanctioned Bay Runner Twin of up to 2.6 billion toward Rio Grande LNG [46]. On October 21, 2026, Kinder Morgan announced a final investment decision on Permian Link, about 2.8 billion cubic feet a day on about 434 miles of new pipe, for 2030, at about $4.2 billion [43].

A lateral that long is a title event. New Mexico builds standard horizontal spacing units from governmental quarter-quarter sections of 40 acres, so a two-mile lateral down the middle of a two-section unit crosses eight of them, computed by *The Ledger* [49]. Before the permit, the state requires the consent of at least one working interest or unleased mineral owner in every tract the completed interval penetrates, or a compulsory pooling order [49]. Its Division pools owners who have not agreed, allocates production by surface acres, and may charge a nonconsenting owner up to 200 percent of that owner’s share of the cost for risk [50]. Texas does not require pooling for every horizontal well that crosses a property line. In *Railroad Commission of Texas v. Opiela*, decided June 30, 2023, the Austin court of appeals held that “production through a PSA well is not the same as pooling,” even under a 1955 lease that barred pooling, yet it sent the permit back because the Commission erred in finding a good-faith claim to drill. The parties then settled, and on January 31, 2025 the Supreme Court of Texas, without considering the merits, granted review, vacated the court of appeals’ judgment and returned the case to the trial court; under the appellate rules such an order does not vacate the court of appeals’ opinion unless it says so, and this one does not [51], [52], [53].

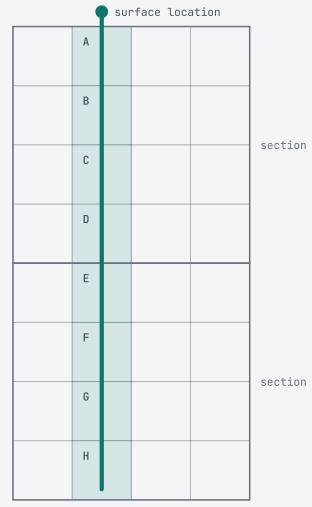


FIG. 6 An illustrative two-mile lateral across a 1,280-acre unit of two sections, with what New Mexico and Texas require of it. The tract letters are fictional; the rules are the agencies' and the courts' [49], [50], [51], [52].

MARGINAL NOTE

Allocation and PSA wells

The *Opiela* opinion gives the working definitions [51]. An allocation well is a horizontal well that crosses leases that have not been pooled, with no agreement among the royalty owners on sharing; absent agreement, production belongs to the tract where the wellbore captured it. Under a production sharing agreement, the owners of the tracts agree how the well's production is shared, wherever its take points are. In *Opiela* the Commission had permitted a PSA well on a showing that at least 65 percent of the interest owners had agreed.

New Mexico's gas rule adds a date: operators must capture at least 98 percent of the gas they produce, in each of two reporting areas, by December 31, 2026 [54]. That is a beginning, not an end. Each new lateral leaves a pooling order or a production sharing agreement behind it, each new plant a long dedication and a line of easements, and an examiner will meet them in the record before the next well is drilled.

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The well that runs itself

Two rig floors in the Permian now run on robots, a fracturing job has run itself, and one major has promised half its shale rigs to automation by 2028. What is proven, what is promised, and what each change does to a lease, a surface and a royalty.

On October 7, 2026, Helmerich & Payne said that two of its FlexRobotics systems were doing the repetitive work of the rig floor on rigs drilling for ExxonMobil, keeping crews out of the higher-risk tasks, and that it expected to deploy seven more within twelve months [55]. On October 26, 2026, ExxonMobil said it plans to automate more than half of its unconventional drilling rigs by the end of 2028, estimated that automation could eliminate roughly a third of high-consequence drilling incidents, and said it expects to keep similar staffing; it counted 1,000 horizontal wells drilled in the New Mexico Delaware Basin since 2017 in a December 2024 item [56]. Two systems are in service. The rest is a plan and an estimate.

Automation has reached the frac spread as well. Halliburton says its ZEUS IQ platform ran a fracturing job in Colorado's DJ Basin in March 2025 that adjusted its own pumping schedules, volumes and rates from surface and subsurface data, without human intervention [57]. The company's account gives no measured results. Software that steers the bit is older than the robots. SLB said in September 2022 that its Neuro autonomous directional drilling had been deployed on more than 50 rigs in 10 countries and had drilled 612,000 feet in 131 customer wells; on one Middle East well it cut the commands sent down to the tool by 33 percent and raised the rate of penetration 13 percent against wells drilled by hand [58].

what has happened, and what is promised, as of Oct. 31, 2026

	Has happened	Is promised
ROBOTS ON THE RIG FLOOR	Two H&P FlexRobotics systems working for ExxonMobil (Oct. 7, 2026).	Seven more within a year (H&P); half of ExxonMobil's unconventional rigs automated by the end of 2028.
AUTONOMOUS FRACTURING	One job run without hands on the controls, DJ Basin, March 2025 (Halliburton).	No fleet-wide figure published.
FOUR MILE LATERALS	Drilled by Permian Resources (2026) and Chord, whose first five-well four mile pad came on in 2026 Q1.	Chord: about 40 percent of its 2026 wells, 60 percent of spuds.
GAS AND NGL INJECTION	One Bakken pilot: cumulative oil up about 253 percent over five months (EERC, 2026).	Since July 4, 2025, the 45Q credit pays the same for EOR as for storage.
ELECTRIC FRAC FLEETS	Over half of Halliburton's North American fleet in 2025.	Liberty: about 3 GW of power projects by 2029.
A GRID FOR THE PERMIAN	765 kV import paths recommended by PUCT staff, April 2025: $10,114 million.	Permian load of 26,400 MW in 2038 (ERCOT study).
CARBON CAPTURE	First Texas Class VI permits, three Ector County wells (EPA, Apr. 7, 2025).	STRATOS operating in 2027 (Occidental, Aug. 2026).
METHANE FROM ORBIT	Tanager-1: 14,400 methane plumes published by Aug. 16, 2026.	Three more Tanager satellites (Carbon Mapper).

Company releases and filings (H&P, ExxonMobil, Halliburton, Permian Resources, Chord, Liberty, Occidental); EERC; 26 U.S.C. 45Q; PUCT; ERCOT; EPA; Carbon Mapper.

FIG. 7 Eight technologies, what has happened and what is promised as of October 31, 2026, from company releases and filings, the research center, the statute, Commission staff, ERCOT, EPA and Carbon Mapper [55], [56], [57], [59], [60], [61], [62], [63], [64], [65], [66], [67], [68], [69].

The well is getting longer. Permian Resources drilled its first four-mile laterals in 2026, and Chord Energy brought its first full four-mile spacing unit online in the Williston Basin in the first quarter, a five-well pad drilled mostly in single runs; Chord plans about 40 percent of its 2026 wells, and 60 percent of its spuds, as four-mile laterals [59], [60]. Its outlook for 2026 has 135 to 165 wells brought online, about 40 percent of them three-mile laterals and about 40 percent four-mile [60]. It reported the pad's capital costs in line with expectations, helped by fracturing more than one well at a time [60]. Old wells are getting second fractures. ConocoPhillips reported more than 50 mechanically isolated refracs in the Eagle Ford by August 2021, which it said added on average 75 percent more reserve recovery at a fraction of a new well's cost [70]. A Department of Energy field test in the Midland Basin, reported in 2023, found that adding fracturing stages "does not always correlate with a commensurate increase in production," and tested refracturing through a new liner [71].

For a lessor the question is what keeps a lease alive while a four-mile program or a refrac is under way, and the answer is in the lease. In *Sundown Energy v. HJSA No. 3*, decided in 2021, the Supreme Court of Texas held that under the lease's own definition of drilling operations, work other than spudding a new well could hold non-producing tracts in a continuous drilling program [72].

Most of the oil stays in the rock. EIA's 2013 assessment put shale oil recovery at typically 3 to 7 percent of the oil in place [73]. Injection is the attempt on the rest. The Energy & Environmental Research Center reported in June 2026 that a single cycle of natural gas liquids injected into a Chord well unit in the Middle Bakken raised daily oil rates by up to 470

percent and cumulative oil by about 253 percent over five months [61]. Federal tax law now pays the same for carbon dioxide used in enhanced recovery as for carbon dioxide stored: since July 4, 2025, Section 45Q gives both a base of $17 a metric ton, where enhanced recovery had earned $12; carbon captured from the air by a plant placed in service after 2022 earns a base of $36 [62].

MARGINAL NOTE

Huff and puff

In a huff and puff, one well is both injector and producer. Gas, natural gas liquids or carbon dioxide is pushed down a producing well, the well is left to soak, and then it is produced again, in one cycle or several. The Chord pilot in the Bakken was a single cycle in one horizontal spacing unit [61]. The Department of Energy's Midland Basin test site evaluated the method with field gas [71]. What many cycles recover over many years is not yet of record.

An electric frac fleet runs its pumps on electric power instead of diesel engines. Halliburton says more than half of its North American fleet was electric in 2025 and that electric fleets powered more than half of its delivered horsepower [63]. Liberty, which began generating power for its electric fleet in 2021 and in 2023 launched Liberty Power Innovations as an integrated fuel and power provider, plans about 3 gigawatts of power projects by 2029 [64]. The grid is being planned to follow. ERCOT told a Texas legislator on August 12, 2026 that its Permian Basin Reliability Plan, published in July 2024, studied a Permian load of 23,659 megawatts in 2030 and 26,400 in 2038, and that 765-kilovolt lines are needed by 2030 [66]. Commission staff recommended those lines in April 2025, at a transmission providers' estimate of $10,114 million and 1,255 new miles, 22 percent more than the 345-kilovolt option [65]. ERCOT says each of its three studies found 765-kilovolt lines needed from 2030, driven mainly by the effect of House Bill 5066 on its load forecast, and that more than 600 utility studies would be invalidated if the lines were delayed or denied [66]. Outside ERCOT, the Southwest Power Pool awarded Southwestern Public Service the first 765-kilovolt project in Texas in its 2025 plan, Commission staff noted [65].

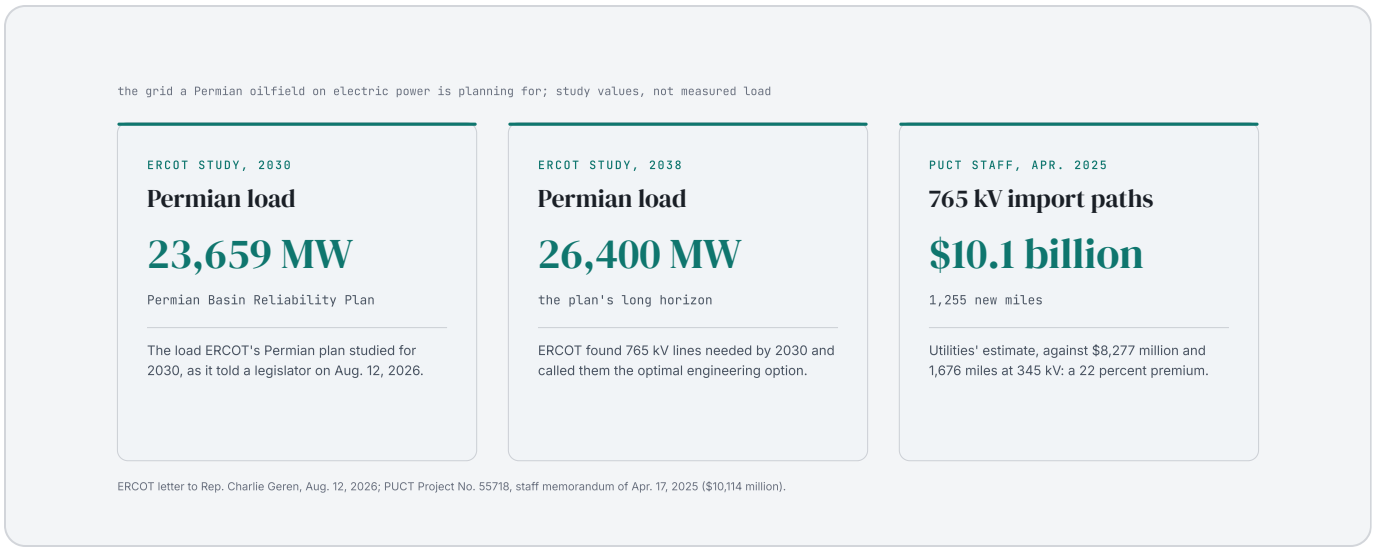


FIG. 8 The grid the Permian is planning for: ERCOT's study loads for 2030 and 2038 and the 765-kilovolt import paths as estimated by the transmission providers and reported by Commission staff. Study values, not measured load [65], [66].

Carbon capture tied to production has its permits and its delays. On April 7, 2025, EPA issued the first Class VI permits in Texas, to Oxy Low Carbon Ventures for three wells in Ector County, on former ranch land about 14 miles from Odessa, that would store about 722,000 metric tons of carbon dioxide a year at about 4,400 feet [67]. Texas took over Class VI permitting on December 15, 2025, so the Railroad Commission now issues those permits [74]. Occidental said in August 2026 that full commissioning of STRATOS, its direct air capture plant in Ector County, designed to capture up to 500,000 metric tons of carbon dioxide a year, should begin around the end of 2026, with operations in 2027, when about $400 million of capital for its low carbon business rolls off [68], [75].

MARGINAL NOTE

Pore space

Pore space is the empty space in rock where carbon dioxide would be stored. New Mexico answered who owns it in 2025: absent contrary language in a severing instrument, “the surface estate includes the pore space” [76]. Texas assigned the permits rather than the title, taking Class VI primacy for its Railroad Commission on December 15, 2025 [74]. A storage project therefore needs a surface title search, and not only a mineral one.

Methane can now be seen from orbit. Carbon Mapper’s Tanager-1, launched on August 16, 2024, spotted a leaking pipeline in the Texas Permian on October 9, 2024, and the operator fixed it; by August 16, 2026 the project had published 14,400 methane plumes, and three more satellites are planned [69]. The federal duty to act on what is seen is shrinking. EPA’s 2024 methane rule had its deadlines extended in July 2025 and was amended in April 2026, and on October 29, 2026 EPA proposed to rescind its Super Emitter Program, among other changes, with comments due December 16 [77]. That program let certified third parties report releases of 100 kilograms of methane an hour or more, measured with approved remote sensing, and its start had already been put off to January 22, 2027 [78]. Congress voided EPA’s rule for the methane Waste Emissions Charge in March 2025, and Public Law 119-21 moved the charge to emissions reported for 2034 [79], [80].

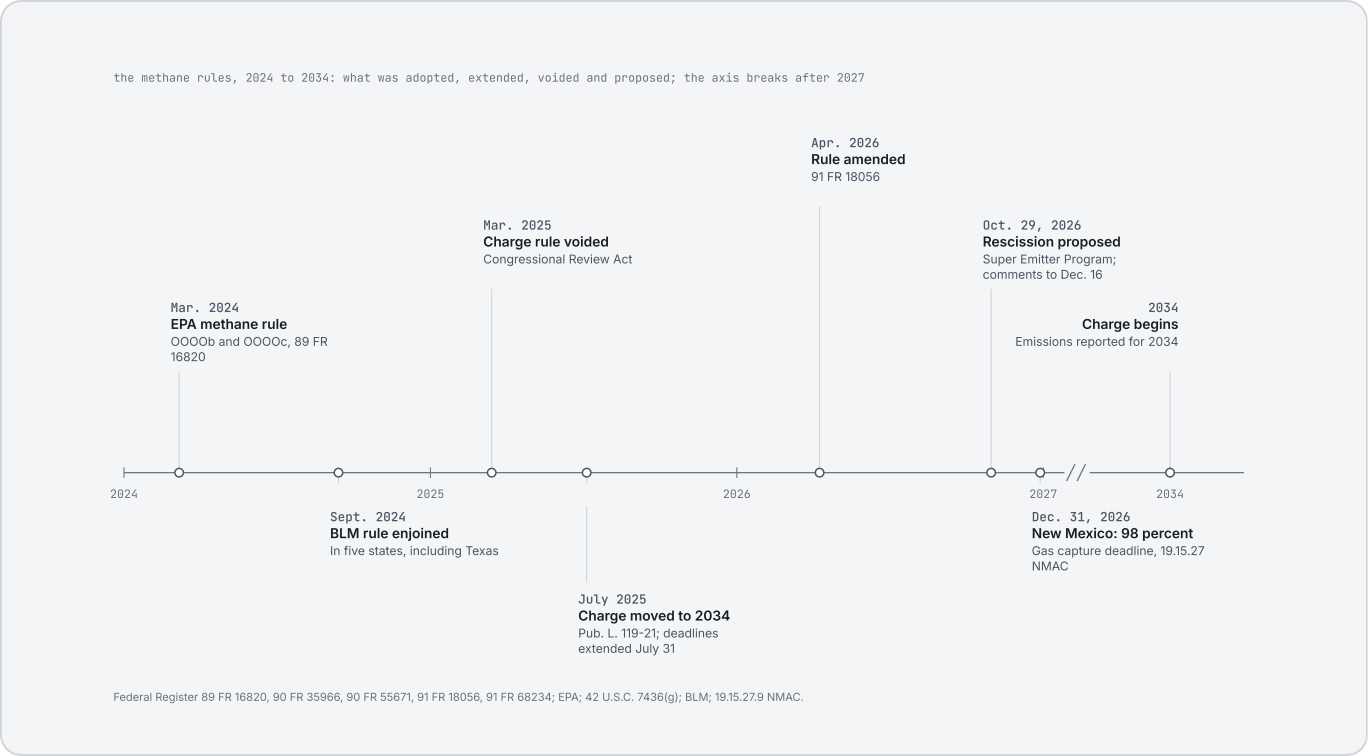


FIG. 9 The methane rules for onshore oil and gas, 2024 to 2034, from the Federal Register, EPA, the U.S. Code, the Bureau of Land Management and the New Mexico Administrative Code [77], [79], [80], [81], [82].

The Bureau of Land Management's 2024 rule charging royalty on gas avoidably lost from federal leases was enjoined on September 12, 2024 in North Dakota, Texas, Montana, Wyoming and Utah, in North Dakota v. Department of the Interior, where it cannot be enforced while the case goes on; elsewhere BLM enforces it, and two of its deadlines will not be enforced before December 10, 2026 [81]. New Mexico moves the other way: by December 31, 2026, its operators must capture at least 98 percent of the gas they produce [82]. The state counts it each year as the gas produced less the gas lost, divided by the gas produced; gas that is sold, used beneficially or flared in an emergency is not lost gas [82].

Much of this is a promise with a date on it. STRATOS, with its well permits since April 2025, now expects operations in 2027 [68], [75]. ERCOT's 765-kilovolt lines wait on route applications still before the Commission in August 2026, and on load forecasts for 2030 and 2038 [66]. ExxonMobil's half by 2028 is a target and its one-third an estimate, and Halliburton's autonomous frac is one job [56], [57]. The Bakken injection result is one unit over five months [61]. What is of record is narrower: two robots on rig floors, the first four-mile wells, half of one company's frac fleet electric, three permitted injection wells, and a satellite that found a leak.

Each of these technologies brings a title question with it. A refrac or a four-mile program asks what words in the lease hold it [72]. Storage asks whose pore space it is, and in New Mexico the answer starts with the surface owner [76]. An electric oilfield needs easements for generators, substations and the 1,255 miles of new line its grid plan calls for [65]. And a satellite that sees a leak raises the question a royalty owner will ask next: who pays for the gas that was lost?

The record is clear.

Archive builds title from the record: an automated title examination platform for the Permian Basin, beginning with Eddy and Lea counties, New Mexico. *The Ledger* is published at archiveledger.com.

COLOPHON

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