SolvxAI
Data to Decision Powered by AI

The Economics of Engineering Capacity in Upstream Oil & Gas

A cited evidence review: talent replacement costs, the graduate-pipeline collapse, the engineering time drain, and the value of better reservoir decisions

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Contents

1. Executive summary

Upstream oil and gas faces a compounding capacity problem. The United States petroleum engineering graduate pipeline has collapsed by roughly three quarters from its 2017 peak [4]. Replacing an engineer costs real money and real time even by conservative all-industry benchmarks [2], while the compensation base being replaced is among the highest of any engineering profession [1]. Meanwhile, the closest credible measurements suggest technical professionals lose a large share of their week to data preparation and information retrieval rather than engineering judgment [5][6]. And the decisions that engineering capacity exists to serve are high-stakes and partially irreversible: primary field data from the Permian Basin shows that well-spacing decisions alone can swing recoverable volumes by double-digit percentages [7][8].

This review assembles the defensible, citable evidence behind each of those statements. It is deliberately conservative: every claim was checked against its primary source where available, graded for defensibility, and several widely repeated industry statistics were rejected because they did not survive verification (Section 8). Where no defensible number exists - for example, the dollar cost of knowledge lost to retirement - this review says so plainly rather than inventing one.

2. Methodology and evidence grading

The review was compiled from a structured multi-source search across industry bodies (SPE and its Journal of Petroleum Technology), professional-practice surveys (SHRM), primary technical literature (SPE conference proceedings), consultancy and analyst publications, and sector talent surveys, prioritising 2020-2026 material and reaching further back only where a series is canonical.

Each candidate claim was independently cross-checked against the primary document (survey report, conference paper, or original article) before inclusion. Claims were accepted only when the figure, its population, and its year could be verified; claims that failed this process are disclosed in Section 8 and are not used anywhere in this review or in SolvxAI's public materials.

Surviving evidence is graded on two tiers:

- **Primary - rock solid.** The figure comes from a primary survey or primary technical study, verified against the publisher's own document.
- **Directional - labeled.** The figure is credible and correctly attributed but transfers from an adjacent population, an older vintage, or analyst estimation. It is used only as context, always with its population and year stated.

3. What it costs to replace an engineer

3.1 The compensation base

The Society of Petroleum Engineers' 2019 Membership Salary Survey (n=4,037) reports worldwide mean total compensation for oil and gas professionals of $197,619, and a United States mean of $258,074 - mean base pay of $147,027 plus $50,811 in other compensation worldwide [1]. The 2021 edition - the

most recent covered by SPE's own journal as of this writing (verified July 2026) - reports worldwide average base salary of $118,996 plus $27,866 bonus ($146,861 combined), a narrower base-plus-bonus construct with no verifiable US mean [1]. This review therefore retains the 2019 US figure as the US anchor, clearly dated; both are self-reported member benchmarks.

3.2 Recruiting cost and vacancy time

SHRM's 2025 Talent Benchmarking - primary data from 2,371 US members surveyed January-March 2025 - puts average non-executive cost-per-hire at $5,475, with median time-to-fill of 44 calendar days for non-executive positions (45 for executive), measured from requisition to accepted offer [2]. The same benchmark series recorded $4,129 in fiscal 2015 and $4,683 in 2021 [3] - the floor keeps rising - and executive hires in the 2021 survey averaged $28,329, roughly six times that year's all-hire average, showing how steeply recruiting cost scales with seniority [3].

Two conservatisms matter here. First, these are all-industry figures: specialised petroleum engineering roles drawn from a shrinking talent pool (Section 4) plausibly cost more and take longer. Second, cost-per-hire excludes the largest components of real replacement cost - vacancy coverage, onboarding, and the months before a new hire reaches full productivity. No defensible oil-and-gas-specific figure for total turnover cost as a percentage of salary survived verification, so this review reports the components and leaves the aggregation to the reader's own assumptions.

4. The pipeline collapse and the knowledge that walks out the door

4.1 The graduate pipeline

The canonical longitudinal dataset on US petroleum engineering education - Lloyd Heinze's annual survey of petroleum engineering programs (Texas Tech University), as reported in SPE's Journal of Petroleum Technology - shows bachelor's degrees granted peaking at approximately 2,615 in 2017 (the highest since tracking began in 1956), then falling to 894 in 2022, 655 expected in 2023, and roughly 500 projected for 2024: a decline of about 75 percent or more from peak [4]. Undergraduate enrollment fell 28 percent in a single year between fall 2016 (8,712) and fall 2017 (6,263) [4].

The demand side has not softened in proportion: JPT's 2023 coverage reports more than 90 percent of graduates placed before graduation, with program heads reporting companies missing their hiring goals [4]. Employers are bidding for a shrinking cohort.

4.2 The knowledge attrition problem

A rigorous, quantified study of what it costs when a senior engineer retires - the value of field-specific judgment, decision history, and context accumulated over decades - does not, to this review's knowledge, exist in citable form. That absence is itself the finding: the knowledge in question was rarely written down, so its loss has never been measured. Organisations experience it as longer studies, repeated analysis, and decisions re-litigated from scratch. The structural remedy is to capture engineering decisions and their rationale as durable, queryable institutional assets while the people who made them are still in the building.

5. The engineering time drain

How much of an engineer's week goes to assembling, cleaning, and hunting for information rather than engineering? For petroleum engineers specifically, no defensible measurement survived verification - including the widely repeated claim that they spend more than half their time on data, which this review rejects (Section 8). The closest credible measurements come from adjacent technical professions:

- Data professionals reported spending approximately 45 percent of their time on data loading (19%) and cleansing (26%) combined - Anaconda, State of Data Science 2020, n=1,099 [5]. The 2021 edition of the same survey found a lower share (~39%), so the figure is year-specific.
- Knowledge workers were estimated to spend nearly 20 percent of the workweek searching for internal information or tracking down colleagues - McKinsey Global Institute, 2012 [6]. This is a fourteen-year-old estimate for generic interaction workers and is cited as context, not as a current measurement.

Both figures transfer imperfectly to petroleum engineering - and are labeled accordingly wherever SolvxAI uses them. The directional conclusion they support is modest and robust: a material fraction of highly compensated technical time [1] is routinely consumed by work below the license.

6. The decision stakes: what better engineering is worth

Labor efficiency is the smaller half of the value case. The larger half is decision quality, because development decisions are partially irreversible and move volumes that dwarf payroll.

Primary evidence: SPE-194310-MS (2019 SPE Hydraulic Fracturing Technology Conference), analysing Midland and Delaware basin wells from 2012-2018, found that normalized production from child (infill) wells is systematically lower than from parent wells, with production parity in general only when spacing exceeds roughly 800 ft (800-1,200 ft described as a transition zone, first-12-months basis) [7]. Thresholds are bench- and depletion-dependent; the finding is spacing-conditional, not a universal constant.

Analyst quantification: a 2019 Tudor, Pickering, Holt & Co. analysis, as reported by Bloomberg and World Oil, estimated that Permian operators drilling parent-child wells too close together risk losing 15-20 percent of ultimately recoverable crude from those wells, with child-well recovery 20-30 percent below parents across much of the basin [8]. This is sell-side analyst estimation via journalism - graded directional - but it is consistent in direction with the primary SPE study.

For scale on the cost of renting judgment instead: the 2026 Global Energy Talent Index reports an average North American oil and gas contractor day rate of $776, blended across roles and seniority [9]; specialised petroleum engineering consultants command materially more.

7. The evidence register

Every figure used in this review and on SolvxAI's public value page, with its grade:

#	Source (year)	Figure(s) used	Grade
1	SPE Membership Salary Survey (2019; 2021 edition noted)	US mean total comp $258,074 (2019); worldwide $197,619 (2019); worldwide base+bonus $146,861 (2021)	Primary
2	SHRM 2025 Talent Benchmarking	Non-executive cost-per-hire $5,475 avg; median time-to-fill 44 days (n=2,371)	Primary
3	SHRM benchmarking series (FY2015; 2021)	Cost-per-hire $4,129 (FY2015) -> $4,683 (2021); executive $28,329 (2021) - trend anchors	Primary
4	Heinze survey via SPE JPT (data 2016-2024; reported 2018-2023)	PE degrees ~2,615 (2017) -> 894 (2022) -> 655 (2023) -> ~500 projected (2024); enrollment 8,712 -> 6,263; 90%+ placed	Primary
5	Anaconda State of Data Science (2020)	~45% of data professionals' time on loading + cleansing	Directional
6	McKinsey Global Institute (2012)	~20% of workweek searching for information	Directional
7	SPE-194310-MS (2019)	Child wells underproduce parents; parity generally > ~800 ft spacing	Primary
8	Tudor Pickering Holt via Bloomberg/World Oil (2019)	15-20% of recoverable crude at risk; child recovery 20-30% below parents	Directional
9	Global Energy Talent Index (2026)	North America oil & gas contractor day rate ~$776 (blended)	Directional

8. Limitations, and claims this review rejects

8.1 Limitations

- Vintage: several load-bearing figures predate 2020 (SPE compensation 2019; McKinsey 2012; the SPE spacing study and TPH estimate 2019). Each is dated explicitly wherever used, and fresher successors should supersede them as they become verifiable.
- Population transfer: the time-drain figures measure data professionals and generic knowledge workers, not petroleum engineers. The SHRM benchmarks are all-industry. In both cases the transfer is conservative for the argument being made, and is always labeled.
- Gaps this review declines to fill: no defensible figure exists for total turnover cost as a percentage of salary in oil and gas, for time-to-full-productivity of an engineering hire, for the dollar value of knowledge lost to retirement, or for incumbent engineering-software seat pricing. Where SolvxAI's interactive estimator touches these quantities, the inputs are user-set assumptions and labeled as such.

8.2 Claims that failed verification (and are not used)

- “Petroleum engineers and geoscientists spend more than 50 percent of their time searching for and assembling data.” The attribution chain behind this widely repeated figure does not withstand scrutiny; it is not used.
- “Knowledge workers spend 28 percent of the workweek on email.” Failed verification against the cited source; not used.
- The dramatic 2018-2019 projections of the petroleum-engineering pipeline collapsing to a few hundred graduates on specific timelines. The specific projected trajectories did not materialise as stated; only realised graduation figures are used here, plus the single clearly-labeled 2024 projection from the same primary survey series.

9. Implications

Read together, the verified evidence describes a sector where engineering capacity is scarce, expensive to replace, partly consumed by work below the license, and applied to decisions whose value dwarfs the cost of the people making them. Any credible response operates on all three margins at once:

- **Capacity** - return the hours lost to data preparation, retrieval, and assembly to engineering judgment.
- **Continuity** - convert individual experience into durable, queryable institutional knowledge before it retires, so each departure stops resetting the organisation's memory.
- **Decision quality** - put every relevant discipline at the table for the irreversible decisions - spacing, completion design, acquisition - where single-digit percentage improvements move more value than entire payrolls.

SolvxAI is built for exactly these three margins. The interactive estimator at solvxai.app/value lets readers apply their own assumptions to the benchmarks in this review, with every dial traceable to the register in Section 7.

10. References

[1] Society of Petroleum Engineers, “2019 Membership Salary Survey - Highlight Report” (2019). https://www.spe.org/media/filer_public/ee/ff/eeffeeec-/2019_salary_survey_highlight_report.pdf ; see also JPT, “Industry Salaries Continue to Inch Up”, https://jpt.spe.org/industry-salaries-continue-inch ; and JPT, “2021 SPE Salary Survey Offers New Benefits Analysis” (January 2022), https://jpt.spe.org/2021-spe-salary-survey-offers-new-benefits-analysis

[2] SHRM, “2025 Talent Benchmarking” (press release, 15 October 2025; recruiting benchmarking report). https://www.shrm.org/about/press-room/shrm-releases-2025-benchmarking-reports--how-does-your-organizat ; https://www.shrm.org/content/dam/en/shrm/research/2025-recruiting-benchmarking-report.pdf

[3] SHRM benchmarking series: “Talent Access Report” (2021), https://www.shrm.org/content/dam/en/shrm/research/benchmarking/Talent%20Access%20Report-TOTAL.pdf ; “SHRM Benchmarking Report: $4,129 Average Cost-per-Hire” (FY2015 data, published 2016), https://www.shrm.org/topics-tools/news/shrm-benchmarking-report-4129-average-cost-per-hire

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[5] Anaconda, “The State of Data Science 2020” (n=1,099). https://know.anaconda.com/rs/387-XNW-688/images/Anaconda-SODS-Report-2020-Final.pdf

[6] McKinsey Global Institute, “The Social Economy: Unlocking Value and Productivity Through Social Technologies” (July 2012). https://www.mckinsey.com/industries/technology-media-and-telecommunications/our-insights/the-social-economy

[7] SPE-194310-MS, “Parent-Child Well Performance...”, SPE Hydraulic Fracturing Technology Conference (2019). https://onepetro.org/SPEHFTC/proceedings-abstract/19HFTC/19HFTC/D021S004R004/217839

[8] World Oil (Bloomberg), “Permian child wells may cut oil recovery up to 20%, bank says” (20 September 2019), reporting Tudor, Pickering, Holt & Co. analysis. https://www.worldoil.com/news/2019/9/20/permian-child-wells-may-cut-oil-recovery-up-to-20-bank-says

[9] Airswift / Energy Jobline, “Global Energy Talent Index (GETI) 2026”. https://www.airswift.com/blog/what-energy-jobs-pay

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