

Workforce Analysis of the Energy Handling Equipment Industry

Kofi A.B. Asare, Ph.D., M.ASCE; Somik Ghosh, Ph.D.; and Ben Bigelow, Ph.D.
Haskell and Irene Lemon Construction Science Division, Gibbs College of
Architecture,
The University of Oklahoma



Executive Summary

Energy handling equipment companies report that technician shortages are limiting their capacity to take on work. More than eight in ten respondents described their companies as understaffed, and nearly nine in ten identified difficulty finding qualified candidates as a reason for technician shortages. Many employers are training workers and using several recruitment channels, but filling positions can still take months, with increased pressure from competing with other industries for the talent pool. The business consequence is evident in respondents' assessments of the additional work they could perform. If workforce availability were not an issue, the most common response was that companies could take on 11-25% more installation or service work. This signals room for expansion that cannot be overlooked. While these are employers' estimates of additional capacity, rather than confirmed orders, they show why workforce availability matters to business growth in the energy handling equipment industry.

The workforce challenge extends across the installation, service, removal, and compliance activities. It also reaches beyond hiring new employees. Nearly half of respondents say they are unprepared to replace retiring technicians. Companies therefore face the combined task of meeting current needs, preparing new workers, and transferring experienced technicians' knowledge. This preliminary outlook, coupled with a forecast of underground storage tank (UST) installations from 2027-2031, offers little reason to put workforce development on the back burner. Installation activity across the 31 states studied, which hold about 64% of the nation's active USTs, is projected to remain broadly steady through 2031. This aligns with the Environmental Protection Agency's (EPA) national tank records, which show the same steady pattern with about 9,600 new tanks registered each year from 2023 to 2025. Even without rapid growth, companies will need technicians to complete new installations, care for existing equipment, and replace retiring workers.

Scaled to the roughly 526 PEI U.S. members in the service and construction membership category, the survey estimates a current technician shortfall of about 47% of the workforce members employ today. Retirements are expected to take away about 22% of that workforce over the next five years, or roughly 4.5% a year. Regular turnover is assumed to take another 20% each year. As a result, PEI members would need to hire the equivalent of about 72% of their current technician workforce to close the current gap and support business expansion.

Overall, the findings point to a practical agenda for PEI and its members: make careers in the industry more visible, connect recruitment to job-specific training, strengthen early career support for new hires, and prepare for retirements before they create vacancies. Existing training efforts provide a foundation for this work. Going forward, efforts must focus on understanding which approaches bring people into the industry and help them become capable, long-serving technicians.

Introduction

Energy handling equipment technicians are critical to installing fuel systems, keeping equipment operating, inspecting tanks, and carrying out removal and compliance work. The industry's workforce needs extend well beyond the completion of a construction project. An equipment problem or service requirement creates a need for technical attention even as new installations slow down.

The experience reported by energy handling equipment companies in this study is consistent with the wider competition for skilled field workers in the United States. The 2026 Associated General Contractors (AGC) and National Center for Construction Education and Research (NCCER) Workforce Survey reported that 87% of construction respondents have openings for hourly craft workers, with half indicating that available candidates lack essential skills or an appropriate certificate or license [1]. In the same study, 42% of respondents reported projected delays tied to shortages of their own or subcontractors' workers. Hiring difficulties persist even as conditions soften in parts of the construction industry. Similarly, the 2026 U.S. Energy and Employment Report [2] describes shortages in construction, installation, and repair occupations across the broader energy economy. Its coverage extends well beyond energy handling equipment, but it helps explain the wider setting in which energy handling equipment companies are recruiting technical staff.

Energy handling equipment shares construction's need for skilled entrants, practical training, and experienced field leadership. Its workload also includes continuing service and inspection needs at existing facilities. So, both new installations and existing facilities are important. This matters because a flat or declining installation outlook does not automatically negate the need for maintenance and replacement.

The PEI Industry overview [3] identified the talent challenge alongside economic pressures, consolidation, alternative fuels, and supply chain concerns as major issues the industry faces. The present study examines what that talent challenge means for the energy handling equipment industry and its ability to meet customer needs and business goals. This report empirically examines the industry's technician availability and shortfalls, their implications for companies' business capacity, how employers are recruiting and developing workers, and what projected tank installations from 2027-2031 mean for workforce planning. The core finding is that staffing pressures are projected to persist, even if installations do not increase.

Methods

The study brings together employers' experience, historical underground storage tank (UST) activity, and workforce literature from related industries. These sources provide a view of current staffing pressures and the work that companies may need to engage with over the next five years. The workforce survey collected information on staffing, recruitment, training, retirement expectations, and the crew needed for installation and service work from a sample in which the 51 respondents who reported their role were comprised of owners/principals (33/64.7%), executive/senior managers (11/21.6%), operations/project managers (4/7.8%), human resource persons (1/2%), senior field service technician (1/2%), and owner's chief of staff/vice president (1/2%). The analysis draws on 54 complete responses collected between July 31 and September 16, 2026. The recorded responses represent 4.9% of PEI's U.S. membership, which stood at 1,100 at the time of writing this report. About 526 (48%) of these members are in PEI's service

and construction membership category that employ field technicians. The national workforce estimates in this report are extrapolated from the sample to that group using an expansion factor.

Results use pairwise deletion, so each unit of analysis reflects the number of respondents who answered that question, and its base is reported with the ensuing result. The results are also compared across common business activities such as installation and service to identify shared challenges and differences. Because companies often perform several activities, the comparison groups may overlap. The findings presented in this report describe participating employers rather than a national workforce census. As such, results should be interpreted within the boundaries set forth in this report.

The tank installation outlook uses UST records from 31 states, with historical installation years from 2000 to 2023. The final data set reflects data quality checks, especially data completeness, rather than random selection. Forecasting combines patterns within individual states with installation and removal history across states. The main forecast target was to produce annual UST installation counts for each state, along with the year-on-year (YoY) change in installations, to show the expected direction and magnitude of future installation activity. The final dataset was drawn from AL, AR, AZ, CA, CO, CT, DE, FL, HI, ID, KS, LA, MD, NC, ND, NE, NH, NJ, NM, NV, NY, OH, OK, SD, TN, TX, UT, VA, WA, WV, WY. Together, these 31 states hold about 64% of the nation's active USTs, according to the EPA's end-of-year FY2025 UST performance measures. So, the forecast numbers in this report cover about two-thirds of national activity. Where a national figure is reported, the 31-state value is multiplied by 1.56, which is the ratio of active USTs in the 50 states and the District of Columbia to those in the 31 modeled states. This assumes that the remaining states follow the same installation trend. The EPA's records of newly registered tanks for FY 2023-2025 [4–7] support this, as the 31 states accounted for about 65% of new tanks registered in that period.

The forecast used an ensemble model that combined AutoETS and XGBoost models in a 50-50 mix. AutoETS modeled the historical installation level and time-series trend separately for each state and automatically chose an appropriate exponential-smoothing structure for the state's historical series. XGBoost used recent installation counts, lag features, rolling statistics, YoY trends, state, and forecast horizon to capture nonlinear relationships that a traditional time-series model alone would miss. Historical removals were used as model inputs, but the study did not produce removal forecasts. The performance of the forecast models was checked by comparing the predictions with recorded activity in later historical years (see Appendix B). The UST installation outlook covers 2027-2031 against an estimated 2025 baseline.

To connect the tank installation outlook to workforce planning, the study uses technician-to-project ratios estimated from the survey. Each company's reported average annual projects over the past five years (new installations; maintenance, inspection, and repair; and removal) were compared with its estimated technicians in the matching role. The ratios describe headcount relative to annual workload and do not represent labor hours or the number of technicians assigned to a single job. To compute the national workforce estimate, the study scaled the survey responses to PEI's U.S. service and construction membership. The workforce estimates are reported as lower, midpoint, and higher values that follow the survey's response bands. Appendix A provides the detailed data treatment assumptions, calculations, and sensitivity checks used in the workforce projections. All percentages reported from the survey are rounded to the nearest whole number.

Findings

Technician shortages are limiting business capacity

The survey shows that many participating companies are operating with fewer technicians than they believe they need (Figure 1). Of 54 respondents, 19 (35%) described their companies as severely understaffed and 26 (48%) as slightly understaffed. Only 8 (15%) reported adequate capacity, while 1 (2%) reported excess capacity. Respondents see room to do more work if they can secure the people to perform it. Of 51 installation respondents, 19 (37%) say they could take on 11-25% more work, and another 12 (24%) noted they could take on 26-50% more. Of 52 service respondents, 24 (46%) report potential for 11-25% more work and 13 (25%) report potential for 26-50% more. Compliance responses also point to additional capacity if workforce were not an issue, with 14 of 47 (30%) selecting 11-25% more work, 9 (19%) indicating 26-50% more, and 13 (28%) noting up to 10% more work.

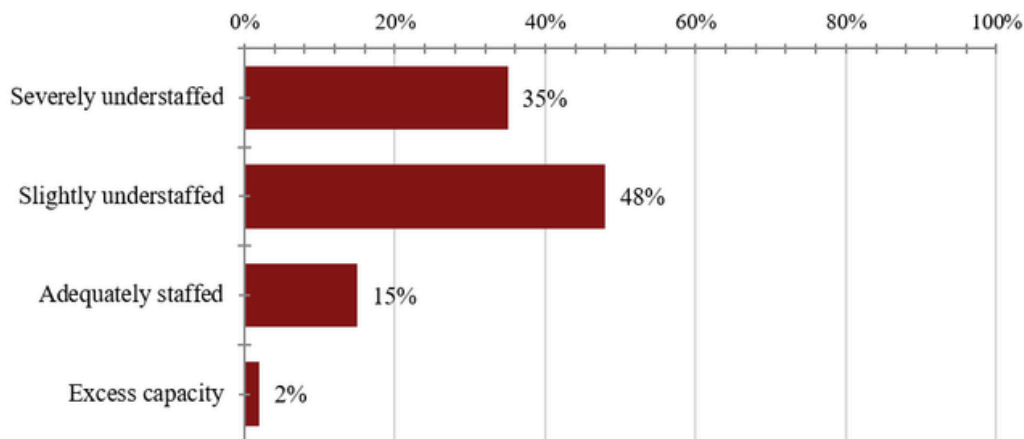


Figure 1. Reported technician staffing status (n = 54)

These responses describe what companies believe they could handle with sufficient technician staffing. They should not be read as a sales forecast or a measure of work already lost. They do, however, place the workforce challenge in business terms: technician availability affects the amount of work companies are prepared to accept and deliver. There are signs of pressure on existing operations as well. Reflecting on the past five years, 11 of 45 (24%) of respondents say they often operated below their ideal staffing level for typical UST inspection or maintenance activity, and 5 (11%) say they always did. Another 16 (36%) say this happened sometimes. About half (26 of 51, 51%) of those who answered a question on technician productivity reported a decline in technician productivity over that period. The survey did not investigate why productivity changed, but the responses reinforce the importance of looking beyond vacancy counts to how work is getting done. In the face of reduced technician productivity and staffing shortages, the business capacity of energy handling equipment companies is under serious strain.

Finding qualified people remains the main hiring obstacle

Difficulty finding qualified candidates was the most frequently selected reason for technician shortages, reported by 48 out of 54 (89%) respondents (Figure 2). Sixty-one percent (61%, 33/54) cited insufficient applicants, while 22 (41%) identified wage competition from other industries as a primary reason for the

technician shortage. The survey found that hiring often takes considerable time. Of 54 respondents, 19 (35%) reported that filling a technician position takes 3-6 months; 13 (24%) noted that it took more than 6 months; and 8 (15%) indicated they had been unable to fill any vacant positions. These timelines make advance planning important. A company cannot assume that a technician will be available as soon as workload increases or an experienced employee leaves.

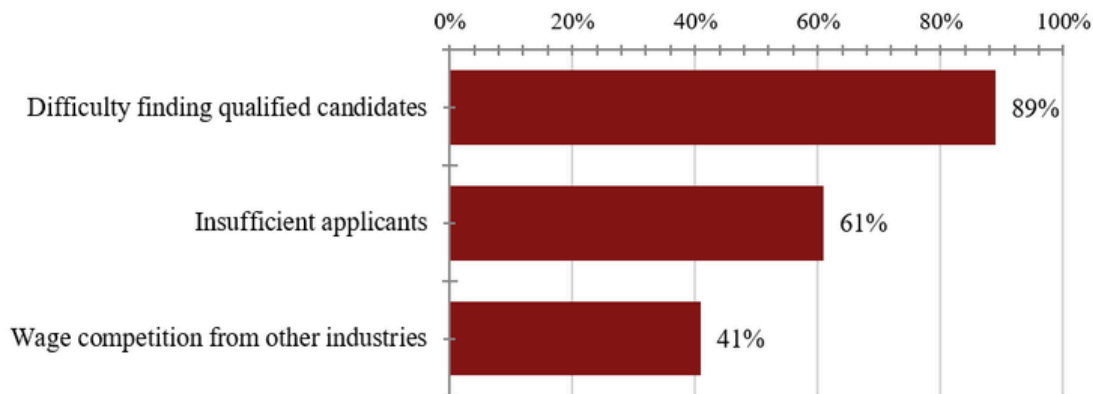


Figure 2. Leading reasons for technician shortages (n = 54)

The pressure is shared across the industry's main work units. Difficulty finding qualified candidates was reported by 41 of the 45 (91%) installation respondents, 39 of 43 (91%) service respondents, 26 of 29 (90%) removal respondents, and 28 of 31 (90%) compliance respondents. Understaffing is also widespread across all groups. Many responding businesses perform several types of work, so the findings describe a connected workforce challenge rather than separate shortages that can be added together.

Companies are investing in training and drawing on several recruitment channels

Most participating companies already provide formal training for technicians. Forty-six (46) of 51 respondents (90%) report training technicians during employment. Of these 51 respondents, 31 (61%) combine in-house training and external training, 10 (20%) provide in-house training only, and 5 (10%) use external training only. Only 5 (10%) reported not providing formal training.

Recruitment is similarly active (Figure 3): of 51 respondents, 37 (73%) selected online job boards, 36 (71%) selected industry referrals, and 34 (67%) selected internal training or promotion. Trade schools and community colleges were selected by 26 (51%); apprenticeship programs by 9 (18%); and military veteran programs by 6 (12%). Seven respondents (14%) indicated they recruited through their company website or through employee referrals. Respondents could select more than one method.

The pattern suggests that companies rely heavily on established hiring channels and on developing people already connected to the business. Among respondents involved in removal work, 26 of 29 (90%) noted that they used internal training or promotion. Trade schools or community colleges were cited by 23 of 45 (51%) installation respondents, 22 of 43 (51%) service respondents, and 12 of 31 (39%) compliance respondents. These figures show which approaches employers use, not which produce the most successful hires. Internal promotion can fill a role without adding someone to the workforce. Referrals may move experienced technicians between employers, and training can improve current employees' skills without

producing enough new entrants to fill vacancies. For workforce planning, each approach's outcome matters as much as its availability.

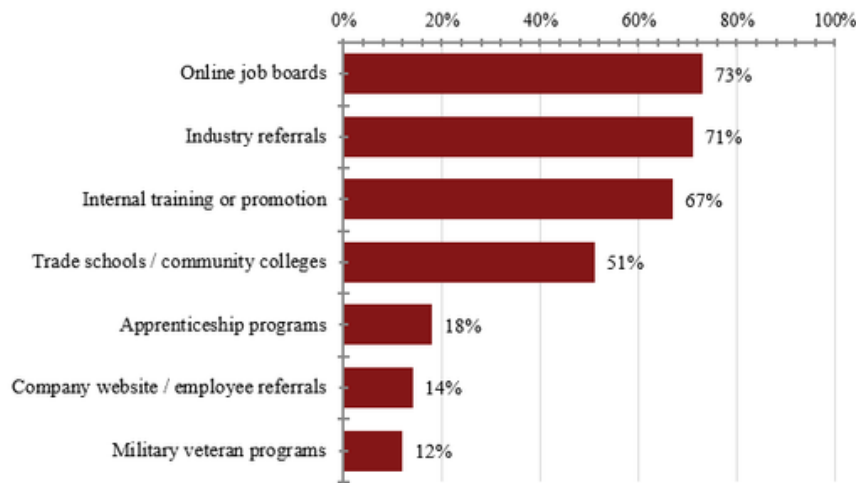


Figure 3. Recruitment channels used by participating companies (n = 51)

In the construction industry, for example, employers are also broadening their efforts. The AGC and NCCER describe employers increasing spending on training and professional development and strengthening engagement with high schools, colleges, and career and technical education institutions [1, 8]. While the questions they asked may differ from this study, the direction is relevant: employers are reaching further into education and career preparation to meet workforce needs. The Society for Human Resource Management (SHRM) [9] argues for closer employer involvement in education and training, including clearer links between learning and job requirements. NCCER research has found that most construction workers see industry credentials as valuable for getting hired and promoted, which makes education and training providers a practical recruitment channel [8]. As such, energy handling equipment companies should work with education stakeholders to create a clearer path from entry-level interest to demonstrated field skills.

Retirement pressures add urgency to developing the next generation of technicians

Hiring difficulties become more consequential as experienced technicians approach retirement. Across 51 respondents who provided technician age profiles, the average reported share of technicians aged 50 or older is 25%, with 25% aged 40-49 years. While these are average workforce shares and not percentages of respondents or exact technician counts, they make succession planning and knowledge transfer relevant to current workforce planning.

The 38 respondents who provided a retirement count expect an average of about 5 technician retirements per company over the next five years. Separately, the 35 respondents who supplied retirement percentages reported a median of 15% of their technician workforce retiring in the next 5 years. Weighted by company size, expected retirements equal about 22% of the technician workforce over the next five years (about

4.5% per year), because larger companies expect proportionally more retirements. Read alongside the age profiles, these figures signal the need to pay attention to succession planning, especially given current replacement readiness.

Of 51 respondents, 24 (47%) say they are somewhat or very unprepared to replace retiring technicians; 12 (24%) described themselves as prepared, while 15 (29%) were neutral (Figure 4). For companies already facing lengthy hiring timelines, waiting until a retirement occurs could leave little time to recruit and develop a replacement. The task is therefore broader than advertising a vacancy. Employers need to identify the work that depends on experienced staff, give developing technicians opportunities to learn it, and make the progression to independent responsibility is clear. Mentoring and documented task skills are practical approaches to consider.

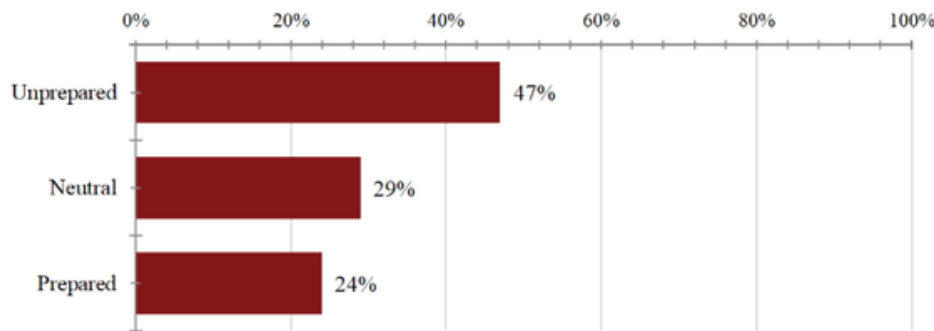


Figure 4. Readiness to replace retiring technicians over the five-year period, 2027–2031 (n = 51)

UST installation activity has settled below earlier levels

Analysis of historical UST records provides useful context for the workforce challenge. Across the 31-state dataset, recorded UST installations fell from 11,109 in 2000 to 5,214 in 2023, a decrease of 5,895 tanks (-53%). The longer trend shows a shift from higher installation volumes in the early 2000s to a lower, more stable level. Annual installations averaged about 7,340 during 2000-2009 and 5,323 during 2010-2019. The average for 2020-2023 was 5,570. The three-year moving average helps separate the underlying pattern from year-to-year fluctuations. As shown in Figure 5, recorded installations declined each year from 5,986 in 2019 to 5,214 in 2023, a 13% decrease, but the moving average smooths the dip and gives a big-picture view of the installation trend. Notably, these declines were gradual across those years, rather than a single-year interruption. The year-on-year change in UST installations from 2000-2023 is illustrated in Figure 6.

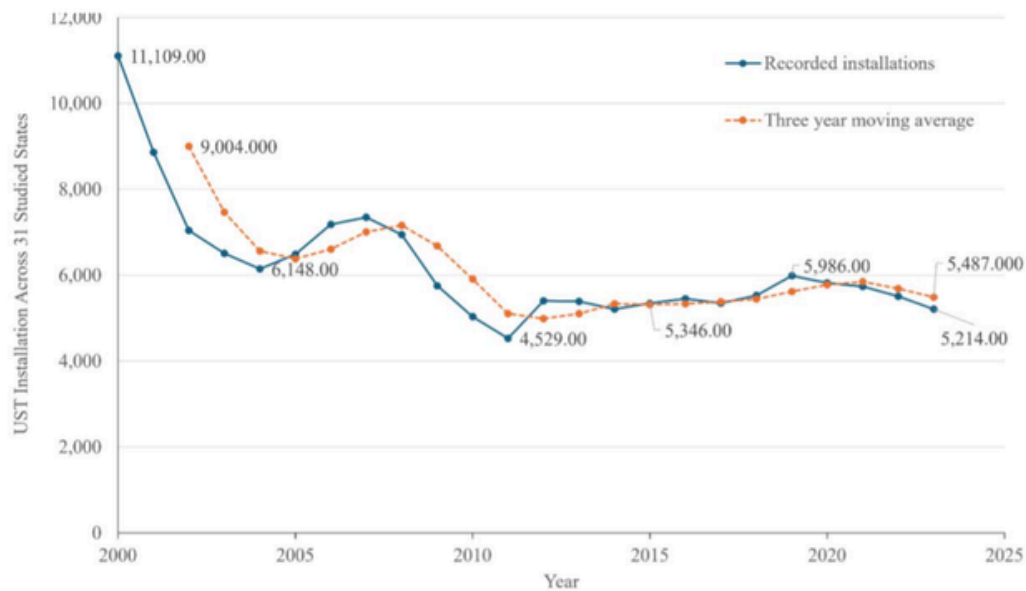


Figure 5. UST Installation Trend Across the 31 Studied States (2000 - 2023)

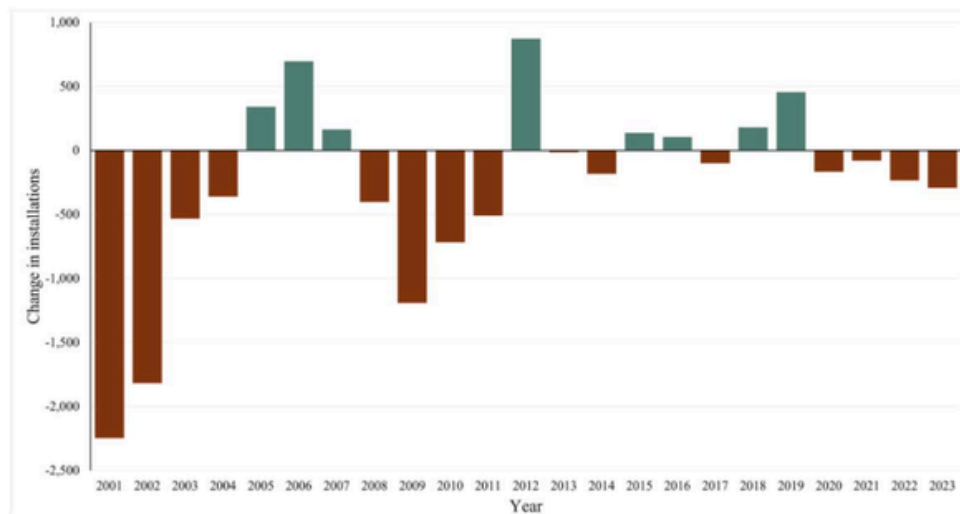


Figure 6. Historical YoY Change in UST Installations (2001 - 2023)

The outlook points to continuing work with a modest decline

The outlook points to continuing work with a modest decline The study's forecast model projects about 24,646 UST installations across the 31 states during 2027-2031 (Figure 7). Annual installations decrease from about 4,974 in 2027 to 4,896 in 2031. Relative to the estimated 2025 baseline of 5,041 installations, the 2031 projection is about 145 tanks lower (-2.9%).

Scaled to the nation, these figures are equivalent to about 7,750 installations in 2027 and 7,630 in 2031, totaling about 38,400 over the five-year period (Figure 8). This national equivalent estimate confirms the underlying trend, as the decline rate remains around 2.9%. The EPA's tank records were used as an independent check. Comparing the EPA's end-of-year tank counts for FY 2022-2025 implies about 9,600 new tanks registered each year in 2023- 2025 nationally, with about 6,200 of them in the 31 modeled states. The EPA records showed no marked decline in installations. These two data sources point in the same direction: installation activity remains generally steady. A larger base of installed tanks creates opportunities for more service and compliance work for PEI's members.

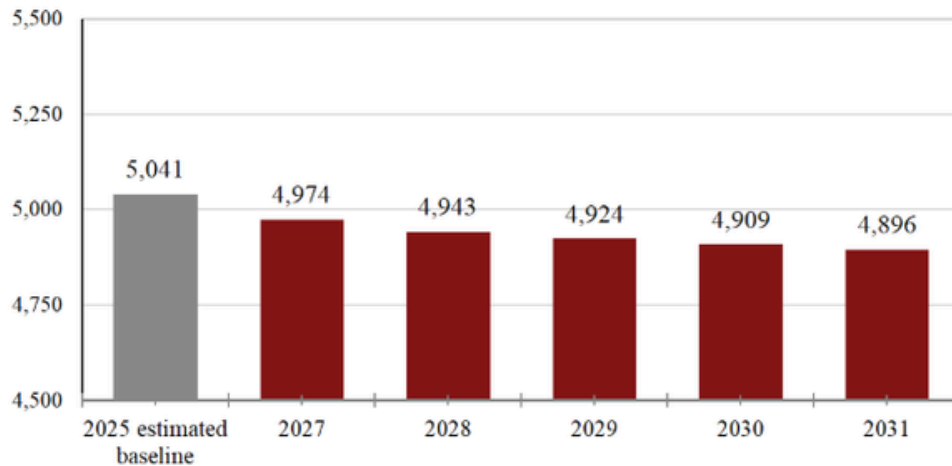


Figure 7. Projected UST Installations for 31 Studied States (2025 - 2031)

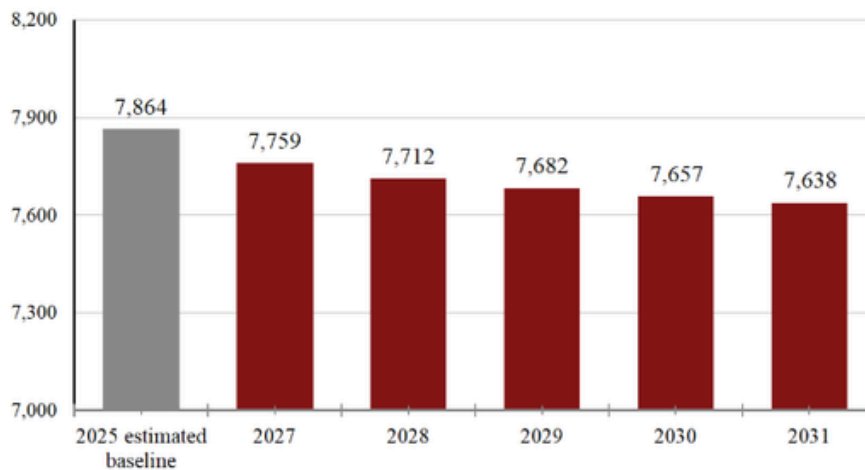


Figure 8. National equivalent five-year UST installation forecast, 2027–2031

For employers, the outlook suggests a continuing need for installation crews, even without a surge in new projects. Recruitment and training decisions must also account for the staffing gaps employers already face and the loss of experience through retirement. A modest decline in installations does not, by itself, show that those gaps will close.

Using historical data available through 2023, the study's 2027-2031 outlook extends four to eight years ahead. As such, these figures are best used as a planning reference that must be updated as newer installation records become available. Applying the survey's ratio for new installations (about 2.9 installations per installation technician per year) to the 31-state forecast gives an installation workload equal to about 1,691 installation technicians in 2027, easing to about 1,664 by 2031 (About 2,638 and 2,596 nationally), based on the midpoint of the survey response bands. The change over the period is fewer than 30 technicians, which is too small to offset the staffing gaps and retirements described in the next section. Because the ratio comes from companies that are already understaffed, and installation technicians may also carry out removals and do other work, these figures describe relative workload rather than a count of distinct employees.

Closing technician staffing gaps and replacing retirees requires substantial hiring

This planning case shows the current unmet technician workforce gaps, impending retirements, and ordinary turnover combine to create hiring needs even as UST activity declines slightly. Each component of the analysis uses the respondents who answered the relevant question; the bases and assumptions are listed in Appendix A. Table 1 and Figure 9 summarize the results.

Current Workforce

Participating companies reported an average of about 23.5 technicians each at the band midpoint with a range of 17.5 – 29.5 technicians. This includes full-time, part-time, and subcontracted roles. Scaled to PEI's service and construction membership, this projects to about 12,361 technicians working for member companies. The projected current workforce ranges from 9,205 to 15,517. Full-time service technicians make up the largest share (40%), followed by full-time installation technicians (25%), subcontracted technicians (14%), and full-time compliance technicians (13%); part-time roles account for the remaining 7%.

Current Shortfall

Companies were asked how many technicians they need to meet their existing workload and backlog for new installations and for service calls. Treating these answers as technicians needed in addition to current staff, the midpoint shortfall is about 2,887 installation technicians, 2,963 service technicians, or about 5,850 technicians in total. That equals about 47% of the midpoint workforce, in line with the widespread understaffing reported earlier. No comparable data was collected for compliance work, so compliance need is not included.

Retirements

Applying the company size-weighted five-year retirement rate of about 22% to the workforce estimate yields about 2,750 expected retirements over the next five years, or about 550 a year, within a range of 410-6914. Table 1 uses the annual figure.

Turnover

Technicians may leave for reasons other than retirement. In an interview with one survey respondent, they noted that people leave the industry because of “work-life balance” and wanting to be “a part of their children’s lives”. As such, the planning case assumes that 20% of the workforce leaves each year through quits and layoffs. This number draws on construction industry turnover reported in the July 2026 Bureau of Labor Statistics Job Openings and Labor Turnover Survey (JOLTS) released on September 1, 2026 [10]. The 20% is about half of the construction rate reported and is based on the assumption that the seasonality of general construction drives the rate up in a way that is materially different from the energy handling equipment industry. At the midpoint workforce projection, this means replacing about 2,472 technicians a year. Some of these departures move between member companies rather than leaving the industry. Others also move into conventional construction trades such as plumbing and electrical work, as noted by a PEI member the study team interviewed. This part of the analysis is more relevant to hiring demand at the company level than to new entrants the industry must attract as a whole.

Table 1. Technician workforce planning estimate for PEI member companies in service and construction

Planning Component	Lower Estimate	Midpoint Estimate	Higher Estimate
Current technician workforce	9,205	12,361	15,517
Current installation technician shortfall	1,982	2,887	3,792
Current service technician shortfall	1,954	2,963	3,972
Expected retirements per year	410	550	691
Annual turnover replacement at 20%	1,841	2,472	3,103
Total Workforce Needed	15,391	21,233	27,075

Note: The study did not directly measure the shortfall for compliance technicians. As such, the study reports no shortfall estimates for that category.

The recommended planning projection is about 21,233 technicians at the midpoint, with a range of 15,391-27,075, representing the current workforce plus the reported shortfall and one year of retirements and turnover replacement. At the midpoint, about 8,872 are hires beyond the current workforce. The survey data may overlap. For example, a company’s reported shortfall may already reflect an expected retirement. As such, these numbers are reported as a planning reference and not a precise count. Because retirements and turnover recur every year, members across the industry are likely to need about 3,022 replacement hires at the midpoint.

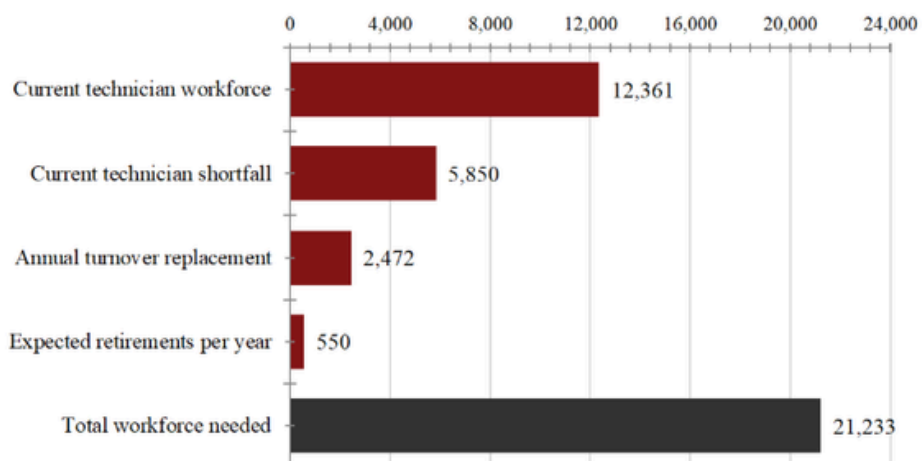


Figure 9. Midpoint technician workforce planning estimate

Additional Capacity

The study asked how much more installation and service work companies could take on if workforce availability were not a constraint. Assuming technician needs rise in proportion to workload, covering that work would require about 1,852 more technicians at the midpoint (range, 885 – 3,147). This represents a growth opportunity rather than a current shortfall and was not included in the planning requirements above.

Workload per technician

Participating companies completed about 2.9 new installations per technician and about 71 maintenance, inspection, or repair jobs per service or compliance technician. A small number of companies with very high reported job counts influenced the maintenance figure. These ratios are factors that can be used to update the future workforce need estimates as newer installation records become available.

Implications for PEI and Its Members

Make careers in the industry more visible: With 89% of respondents citing difficulty finding qualified candidates and 61% citing too few applicants, the first constraint appears to be the size of the applicant pool. PEI can help members present energy handling equipment work as a skilled career with competitive pay and career progression, using shared marketing materials and its communications apparatus that small companies could not produce on their own.

Build pathways with education and training providers: Only about half of respondents recruit through trade schools or community colleges. Fewer than one in five use apprenticeship programs. Partnerships with career and technical education programs, community colleges, and veteran programs could widen the entry points into the industry and connect training directly to field tasks. Expected retirees could be engaged to teach in some of these programs to pass on their accumulated wisdom.

Define a progression from entry level to field leadership: A recognized pathway from helper to technician to foreman, with the skills and benefits expected at each step, would give new entrants a reason to stay and give employers a shared training standard. An industry credential program built around that progression is an intervention PEI could make.

Support new hires through their early years: For about three in four respondents, filling a technician vacancy takes about three months or longer, or has been impossible. As such, losing a technician is costly. Structured onboarding, mentoring, and clear expectations during the first year help protect that investment.

Track workforce data over time: Carrying out a technician census at regular intervals would let PEI and its members see whether shortages are easing and which recruitment and training approaches produce lasting hires.

Conclusion

This study set out to investigate if the energy handling equipment industry has enough technicians to do the work available to its members, and if the direction of the UST installation activity from 2027-2031 will impact the industry's workforce needs. What stands out across the findings is where the pressure originates. The pressure appears to come from too few people knowing that such technician occupations exist or arriving in the industry prepared and ready to do them. The expected retirement rate also poses some stress as experienced technicians are likely to leave with knowledge that has not been properly documented for transfer to newer generations, who are not even in the industry now. While some companies have responded through formal training of the people they employ, the underlying problem still resides in how people find their way into the trade in the first place. This poses an entirely different question for PEI and its members.

The question is no longer how to staff up to do more work or for the next busy season. It is about making energy handling equipment technician work a visible, understood, and deliberately chosen career. That is a bigger problem than a single company can solve, because the benefits of building a talent pipeline are shared by every employer who later hires from it. This is an urgent call to action for PEI and its membership. The broader labor market makes this more pressing. Construction and the wider energy economy are drawing on the same pool of skilled field workers, so does a small specialized industry have something distinctive to offer? It can offer steady work tied to maintaining existing facilities, regardless of macroeconomic dynamics. That stability may be an underused recruiting message.

The findings and conclusions presented in this paper rely on a modest, self-selected sample of member companies and on survey questions that captured ranges rather than exact counts. So, its estimates describe the scale of the challenge rather than a precise count of the people needed. Its projections rest on stated assumptions, including how respondents interpreted questions about staffing needs and a turnover rate drawn from the broader construction industry, and its future installation outlook is modeled on 31 states that hold about 64% of the nation's tanks, with national equivalent estimates. The figures in this report should therefore be treated as a planning reference. This does not discount the weight of the study's findings. The study's central finding lies in the consistency of the evidence: across hiring, training, retirement, and business capacity, every measure points in the same direction, i.e., the industry has untapped business capacity which is due to not having the talent it takes to do business.

The most useful next steps would extend beyond this analysis of workforce needs to understanding what is required to resolve it. The industry knows little about which recruitment channels and training models produce technicians who stay, and following new entrants through their first few years would provide evidence for technician retention. Measuring turnover and productivity within the industry would also help sharpen future estimates of workforce needs. Extending the tank analysis to all states and to the installed tank base would clarify where service demand will concentrate. Finally, conversations with employers and technicians could explain what the current evidence does not cover in terms of how to effectively draw people into the trade and keep them. Such efforts could explore technicians' paths into the industry and why they have remained to identify factors that boost retention.

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Appendix A – Assumptions

Response bases

All survey records that contained answers are included in the analysis, and all results use pairwise deletion. Each figure uses the respondents who answered that question, and the base is reported with it. The workforce planning estimate in Table 1 uses the following bases: technician headcount, 50 responses; installation technicians needed, 43; service technicians needed, 49; retirement count, 37; retirement percentage, 34; additional installation work, 47; additional service work, 48; and annual projects, 49.

Band values

Table A1. Values assigned to banded survey responses

Survey item and band	Lower	Midpoint	Higher
Technician headcount: 1–5	1	3	5
Technician headcount: 6–10	6	8	10
Technician headcount: 11–15	11	13	15
Technician headcount: 16–20	16	18	20
Technician headcount: 21+	21	23	25
Technicians needed: 0	0	0	0
Technicians needed: 1–5	1	3	5
Technicians needed: 6–10	6	8	10
Technicians needed: 11–15	11	13	15
Technicians needed: 16+	16	18	20
Additional work: up to 10%	0%	5%	10%
Additional work: 11–25%	11%	18%	25%
Additional work: 26–50%	26%	38%	50%
Additional work: more than 50%	51%	63%	75%

The top bands (21+, 16+, and more than 50%) have no stated upper limit. The values used for them are assumed caps, so the higher scenario is not a true maximum.

Assumptions

Scaling to PEI membership. National figures equal the average per responding company multiplied by the roughly 526 PEI U.S. members in the service and construction membership category (48% of 1,100 U.S. members). Manufacturers, distributors, and other members that do not employ field technicians are excluded from the scaling base. Each item uses its own base, so expansion factors differ slightly (for example, 10.5 for technician headcount, 12.2 for installation need, and 10.7 for service need). No weighting or nonresponse adjustment is applied. The estimate assumes responding companies resemble service and construction members in size and workforce mix.

Workforce mix. The share of each technician category is the pooled midpoint share across all responses, and the same mix is applied to the lower, midpoint, and higher totals. Subcontracted, part-time, and full-time roles are summed, so totals are headcounts, not full-time equivalents.

Technicians needed (current shortfall). The survey asked how many technicians the company “currently needs to meet the existing workload and backlog” for new installations and for service calls. These answers are treated as technicians needed in addition to current staff. If some respondents reported their total requirement instead, the shortfall is overstated.

Retirements. The five-year retirement rate (22.25%) weights each company’s reported retirement percentage by its midpoint technician headcount (34 responses). Annual retirements equal the five-year total divided by five (4.45% a year). The unweighted median of company percentages is 15%.

Turnover. An annual turnover rate of 20% is assumed, drawing on construction-industry quits and layoffs reported in the BLS Job Openings and Labor Turnover Survey. Table 1 includes one year of turnover replacement and one year of retirements. Replacement hires per year equal annual retirements plus annual turnover.

Additional capacity. Technician needs are assumed to rise in proportion to workload, so 10% more work requires 10% more technicians. This ignores overtime, utilization, technology, and subcontracting. The result measures a growth opportunity and is not added to the planning requirement.

Compliance workforce. The current compliance workforce is estimated as the remainder after service, installation, and subcontracted technicians. No compliance-specific shortfall is estimated because the survey did not ask for one.

Workload ratios. New installations and removals are compared with installation technicians; maintenance, inspection, and repair are compared with service and compliance technicians combined. Subcontracted technicians are excluded because the survey does not assign them to project types. The installation and removal ratios share the same technician pool and should not be added together.

Tank forecast. The forecast is applied to the 31 modeled states as reported and is not extrapolated to other states. A survey “project” is assumed to be comparable to one tank. Removal activity was not forecast but the trend carries forward the year-on-year changes from 2000-2024, which integrates removals. Appendix B describes the forecasting method and its validation. National equivalents presented in the whitepaper multiply the forecast results by a factor of 1.56, which is the ratio of active USTs in the 50 states and the District of Columbia (527,819) to those in the 31 modeled states (338,573). These numbers were obtained from the EPA’s FY2025 UST performance measures records. The scaling assumes that the remaining states install new tanks at the same rate per existing tank as the modeled states.

**Appendix B - FORECASTING NEW UST INSTALLATIONS FOR THE NEXT FIVE YEARS
(2027-2031)**

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FORECASTING NEW UST INSTALLATIONS FOR THE NEXT FIVE YEARS

1. Forecasting Objective

The purpose of the forecasting analysis is to estimate future annual Underground Storage Tank (UST) installation activity at the State $\times$ Year level using historical state-level installation patterns.

The finalized historical dataset contains reliable installation data from 1999 through 2023, with 2023 serving as the last observed year for model training. The forecasting approach models both the annual number of new UST installations and the year-on-year (YoY) change in installation counts to understand how installation activity is expected to increase or decrease over time.

The finalized historical dataset contains reliable installation information through 2023. Therefore, forecasts are generated annually from 2024 through 2031. The forecast through 2031 provides estimates covering the current five-year planning horizon through 2031.

The main forecasting target is the annual UST installation count for each State $\times$ Year, accompanied by the corresponding YoY change in installations to show the expected direction and magnitude of changes in future installation activity.

2. Forecasting Dataset Construction and Final Modeling Panel

2.1 Data Preparation

The forecasting dataset was developed from cleaned and standardized state Underground Storage Tank (UST) records. After source standardization, date cleaning, duplicate handling, and physical-tank reconstruction, the consolidated dataset contained approximately:

- 1.62 million physical tank records
- 1.40 million tanks with usable installation-year information

The usable tank records were aggregated at the:

State $\times$ Installation Year

level to calculate the annual number of new UST installations in each state.

2.2 State Selection and Data-Quality Screening

Before constructing the final State-Year forecasting panel, each state was evaluated based on:

- Source-file availability
- Successful data extraction
- Tank-level data quality
- Installation-year reliability
- Historical data coverage
- Recent data coverage
- Installation-year conflict rates

The state-selection process reduced the original dataset as follows:

Stage	States/Territories Remaining	Reason for Reduction
Raw source folders	55	Initial state and territory datasets
Usable mapping entries	53	Guam and Iowa had no usable source file identified
Sources selected for extraction	40	13 states/territories were judged unusable during inventory and source review
Successful extraction	39	Michigan failed extraction due to a missing expected worksheet
Passed tank-quality gate	37	Kentucky and Mississippi failed tank-level quality checks
Final strict modeling panel	31	6 excluded at the final panel gate

Table 1: Data-reduction and state-selection stages

The 13 datasets removed during the source-selection stage were:

AK, CNMI, GA, ME, MA, MO, MT, OR, PA, PR, RI, SC, WI

2.3 Final Panel Inclusion Criteria

The remaining states were evaluated using historical coverage and installation-year reliability. A state was excluded from the strict forecasting panel when any of the following conditions applied:

- 1999-2019 coverage < 80%
- 2020-2023 coverage < 75%
- Installation-year conflict rate $\geq 20\%$

2.4 Final Panel-Gate Decisions

Of the 37 states reaching the final decision stage:

- 31 states were included
- 6 states were excluded

State	Decision	Main Reason
Vermont (VT)	Excluded	Large historical coverage gaps and no usable 2020–2023 data
Virgin Islands (VI)	Excluded	No 2020–2023 data
Minnesota (MN)	Excluded	Installation-year conflict rate of approximately 31.4%
District of Columbia (DC)	Excluded	Historical coverage below the preferred threshold
Illinois (IL)	Excluded	Installation-year usability below the strict inclusion threshold
Indiana (IN)	Excluded	Installation-year usability below the strict inclusion threshold

Table 2: Final panel decisions

2.5 Final Modeling States

The final forecasting panel contains 31 states:

AL, AR, AZ, CA, CO, CT, DE, FL, HI, ID, KS, LA, MD, NC, ND, NE, NH, NJ, NM, NV, NY, OH, OK, SD, TN, TX, UT, VA, WA, WV, WY

2.6 Historical Installation Trends, 2000-2023

Historical UST installation activity across the 31 modeling states was examined from 2000 through 2023 to identify the patterns present in the observed data before forecasting. The annual installation series

shows substantial variation over time, including periods of both increase and decline. The three-year moving average was used to smooth short-term fluctuations and provide a clearer view of the underlying historical direction.

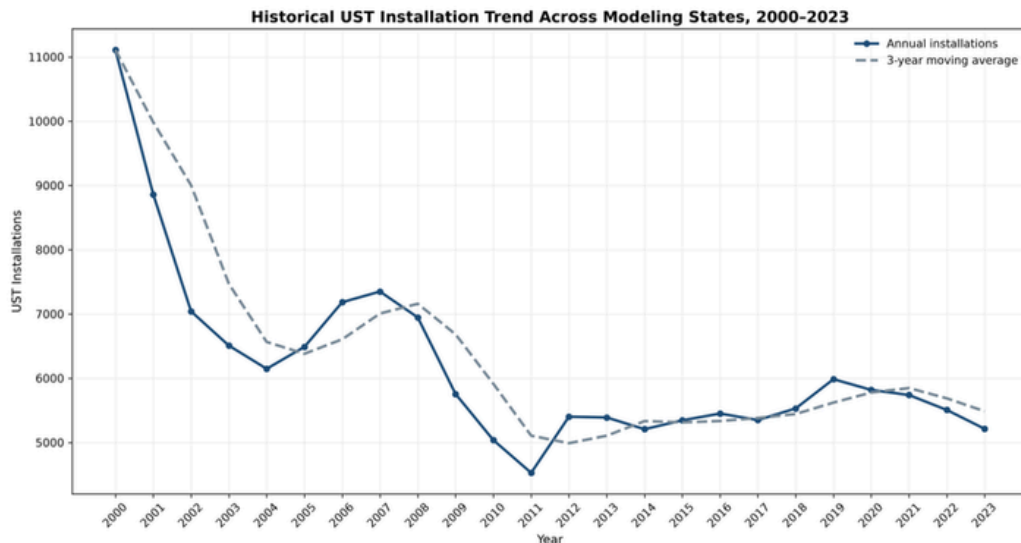


Figure 1: UST installation trend across modelling states, 2000-2023

The recent historical period shows a clear downward pattern after 2019. Aggregate installations decreased from approximately 5,986 installations in 2019 to 5,214 installations in 2023, a reduction of 772 installations, or approximately 12.9%. The three-year moving average also begins to move downward during this period, indicating that the decline is visible not only in individual annual observations but also in the smoothed recent trend.

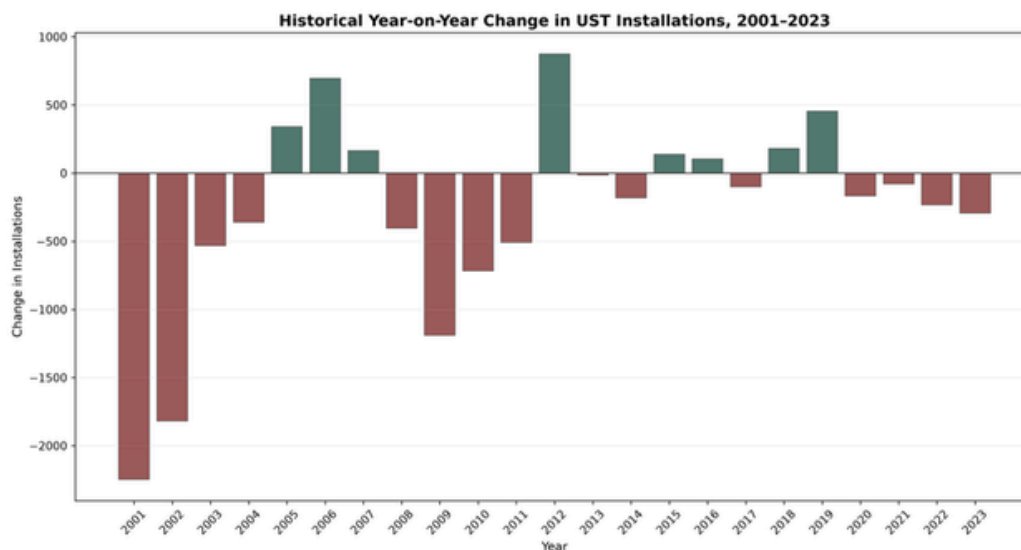


Figure 2: Historical YoY Change in UST installations, 2001-2023

The year-on-year analysis confirms that UST installation activity has experienced both positive and negative changes over the historical period. However, the most recent period shows a consistent sequence of negative annual changes. From 2019 onward, installations decreased in each subsequent year through 2023. This recent sequence of negative YoY changes provides an important historical signal for the forecasting model.

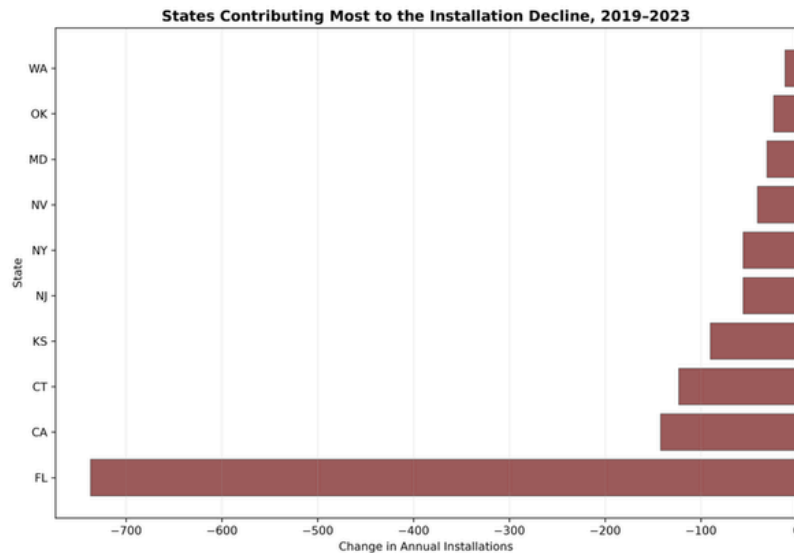


Figure 3: States Contributing most to the installation decline, 2019-2023

The aggregate decline between 2019 and 2023 was not distributed equally across all modeling states. The state-level comparison shows that Florida contributed the largest reduction in annual installations, followed by notable declines in states including California, Connecticut, Kansas, New Jersey, New York, Nevada, Maryland, Oklahoma, and Washington. This indicates that the recent aggregate decline was strongly influenced by reductions in several states rather than by an identical downward pattern across every state.

Overall, the historical analysis identifies a recent pattern of declining UST installation activity before the forecast period. The reduction from 2019 through 2023, the sequence of negative year-on-year changes, and the decline observed in several higher-volume states are all consistent with the downward direction of the future forecasts. These historical patterns are represented in the forecasting model through recent installation counts, lagged installation values, three-year rolling statistics, year-on-year changes, state identity, and historical removal activity.

3. Forecasting Features and Prediction Structure

The forecasting model uses historical information available up to the forecast-origin year to predict future annual UST installations for each state. For the production forecast, 2023 is the forecast origin, and predictions are generated for 2024 through 2031.

The features are designed to describe four important aspects of UST activity: the recent level of installations, the direction of installation activity, tank-removal and replacement activity, and differences among states and forecast horizons.

Feature Group	Feature	Description
Forecast Position	Horizon	Number of years ahead being predicted. For example, Horizon = 1 predicts 2024 from the 2023 origin, while Horizon = 8 predicts 2031.
Forecast Position	Origin_Time_Index	Represents the position of the forecast-origin year in the historical time series.
Historical Installations	UST_Origin	Number of UST installations in the forecast-origin year.
	UST_Origin_lag1	Installation count one year before the forecast origin.
	UST_Origin_lag2	Installation count two years before the forecast origin.
	UST_Origin_Rolling3_Mean	Average installation activity during the three years ending at the forecast origin.
	UST_Origin_Rolling3_Std	Variation in installation activity during the same three-year period.
Installation Trend	UST_Origin_YoY_Change	Absolute year-on-year change in installations entering the forecast-origin year.
	UST_Origin_YoY_Pct_Change	Percentage year-on-year change in installations entering the forecast-origin year.

Historical Removals	Removal_Origin	Number of tanks removed during the forecast-origin year.
	Removal_Origin_lag1	Number of removals one year before the forecast origin.
	Removal_Origin_lag2	Number of removals two years before the forecast origin.
	Removal_Origin_Rolling3_Mean	Average removal activity over the three years ending at the forecast origin.
	Removal_Origin_Rolling3_Std	Variation in recent removal activity.
	Removal_to_Install_Origin	Ratio of removals to installations in the forecast-origin year, providing information about tank turnover or potential replacement activity.
State Identity	State_Code	Identifies the state so the machine-learning model can learn differences in historical UST activity among states.

Table 3: Final Forecasting features

4. Model Development and Validation

The forecasting model was selected through a two-stage evaluation process. First, a broad set of statistical and machine-learning forecasting methods was compared using historical rolling-origin validation. Second, the strongest baseline model was re-evaluated after incorporating historical tank-removal information. This approach was used instead of relying on a single train/test split so that model performance could be evaluated across multiple historical periods and different forecasting conditions.

4.1 Candidate Models

The initial comparison evaluated the following forecasting approaches:

- Naive forecast
- AutoETS
- Holt Damped Trend
- Theta
- Local Linear Trend
- AutoARIMA

- YoY Damped Growth
- XGBoost
- LightGBM
- AutoETS + XGBoost Ensemble

The purpose of this step was to compare different forecasting approaches under rolling-origin historical validation, rather than depending on a single train/test period. The model-development code explicitly calculates MAE, RMSE, R^2 , and sMAPE for this comparison.

The final evaluation used:

- 31 states
- 10 historical forecast origins: 2009-2018
- 5 forecast horizons per origin
- 1,550 out-of-sample predictions per model

Because $31 \times 10 \times 5 = 1550$

4.2 Rolling-Origin Historical Validation

Rather than evaluating the models using only one train/test period, the comparison used rolling-origin historical validation.

At first stage, each candidate model was repeatedly retrained at 10 historical forecast origins from 2009 through 2018. At each origin:

1. Only information available up to that historical year was used for training.
2. The model produced forecasts for the following years.
3. Those predictions were compared with the actual installation counts that subsequently occurred.

This process evaluates how consistently a forecasting method performs across different historical conditions rather than judging it from a single period.

4.3 First stage Model Comparison

Model	Mean-Origin RMSE
AutoETS + XGBoost Ensemble	100.8
Naive	102.6

YoY Damped Growth	109.7
XGBoost Baseline	116.4
Theta	124.1
AutoETS	125.4
LightGBM	128.4
Holt	131.1
Local Linear Trend	176.6
AutoARIMA	192.5

Table 4: Stage 1 mean-origin model comparison

The AutoETS + XGBoost ensemble produced the lowest average error across the historical forecast origins and was therefore carried forward to the next stage of model development.

Why the Ensemble Was Useful?

The two components capture different aspects of the historical data:

AutoETS

- Models the historical installation level and time-series trend separately for each state.
- Automatically chooses an appropriate exponential-smoothing structure for each state's historical series.

XGBoost

- Uses recent installation counts, lag features, rolling statistics, YoY trends, state identity, and forecast horizon.
- Can capture nonlinear relationships that are not represented by a traditional time-series model alone.

The initial ensemble combined the two forecasts as:

Forecast = $0.5 \times \text{AutoETS} + 0.5 \times \text{XGBoost}$

4.4 Overall Pooled Performance

Model	N	MAE	RMSE	R ²	sMAPE
AutoETS + XGBoost Ensemble	1,550	53.154	102.673	0.85	38.049
YoY Damped Growth	1,550	55.699	117.255	0.805	42.262
Naive	1,550	47.389	118.623	0.8	32.298
XGBoost Baseline	1,550	57.713	122.724	0.786	38.53
AutoETS	1,550	61.702	132.599	0.751	45.195
LightGBM Baseline	1,550	59.672	138.385	0.728	37.601
Holt Damped	1,550	63.437	138.629	0.727	44.819
Theta	1,550	61.771	139.141	0.725	46.737
Local Linear Trend	1,550	95.121	185.55	0.512	84.556
AutoARIMA	1,550	83.601	200.588	0.429	52.45

Table 5: Overall Pooled performance

The AutoETS + XGBoost ensemble produced the:

- lowest pooled RMSE: 102.673
- highest pooled R²: 0.850

among the broad model candidates.

This indicated that combining time-series behavior with machine-learning information provided a strong overall forecast.

4.5 Performance across Historical origins

The models were evaluated repeatedly at different historical forecast origins.

This is important because performance can vary depending on the period from which the forecast begins.

For example, at the 2009 origin, AutoETS slightly outperformed the ensemble, while at the 2010 origin the ensemble substantially outperformed the other models. This variation demonstrates why model selection was based on performance across all historical forecast origins.

A second important result was the average performance across the 10 historical origins.

Model	Mean-origin MAE	Mean-origin RMSE	Median-origin RMSE	Mean-origin R ²
AutoETS + XGB Ensemble	53.154	100.791	96.48	0.842
Naive	47.389	102.612	76.415	0.786
YoY Damped Growth	55.699	109.746	97.723	0.798
XGB Baseline	57.713	116.403	98.016	0.763
Theta	61.771	124.078	103.501	0.707
AutoETS	61.702	125.405	104.261	0.727
LightGBM	59.672	128.419	98.478	0.689
Holt Damped	63.437	131.158	124.222	0.701
Local Linear Trend	95.121	176.619	165.763	0.47
AutoARIMA	83.601	192.518	172.038	0.367

Table 6: Mean rolling-origin performance

The AutoETS + XGBoost ensemble had the lowest mean-origin RMSE, which was the main selection criterion.

The final model-selection table in the notebook ranked models using:

1. Mean-Origin RMSE
2. Overall RMSE
3. Mean State RMSE
4. Aggregate RMSE across modeling states

This is why the ensemble was selected even though a simple Naive forecast performed well under some individual diagnostics.

4.6 Forecast performance by Horizon

The ensemble was also evaluated separately for each forecast horizon

Years ahead	MAE	RMSE	R ²	sMAPE
1	34.619	67.157	0.937	26.805

2	48.046	93.746	0.871	35.334
3	56.308	102.298	0.852	39.166
4	62.023	117.298	0.806	42.871
5	64.774	123.235	0.787	46.071

Table 7: AutoETS + XGBoost ensemble by forecast horizon

This shows the expected pattern that forecasting error increases as the forecast horizon becomes longer.

However, the model maintains a positive R^2 even at the five-year horizon: $R^2 = 0.787$

which shows that the model continued to explain substantial variation in installation activity at longer forecast horizons.

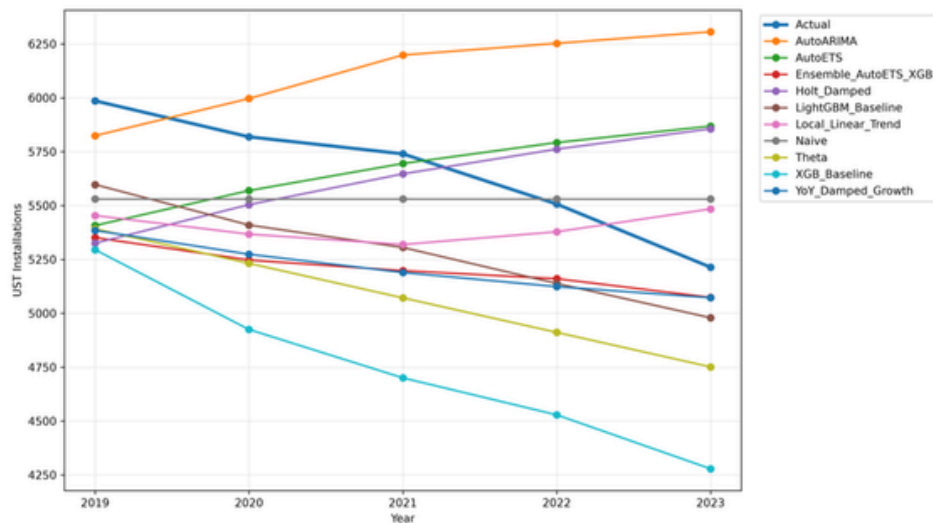


Figure 4: Aggregate Five-Year Historical Forecast Across Modeling States

4.7 Incorporating Historical Tank Removals

After the initial AutoETS + XGBoost ensemble was selected, the forecasting analysis was extended to determine whether historical tank-removal activity could improve future installation forecasts.

Three approaches were compared:

1. Current Baseline Ensemble

AutoETS + XGBoost without removal-history features.

2. Direct Removal Ensemble

Removal information from the observed forecast-origin period is included directly in the XGBoost features for each forecast horizon.

3. Recursive Removal Ensemble

Future removal activity is first forecast and then fed recursively into the installation forecasting process. The same rolling-origin validation framework was used so that the removal-aware approaches could be compared fairly with the original baseline.

The same rolling-origin validation framework was used so that the removal-aware approaches could be compared fairly with the original baseline.

4.8 Removal-Aware Model Comparison

Model	MAE	RMSE	R ²	sMAPE	Mean-Origin RMSE
Current Baseline Ensemble	53.154	102.673	0.85	38.05%	100.791
Direct Removal Ensemble	51.768	103.768	0.847	37.21%	99.238
Recursive Removal Ensemble	52.499	104.129	0.846	37.05%	101.04

Table 8: Removal-aware model comparison

The Direct Removal Ensemble was selected for the forecast.

Although the original baseline retained slightly better pooled RMSE and R², the Direct Removal Ensemble provided:

- the lowest MAE: 51.768
- the lowest Mean-Origin RMSE: 99.238
- lower typical forecast-origin error

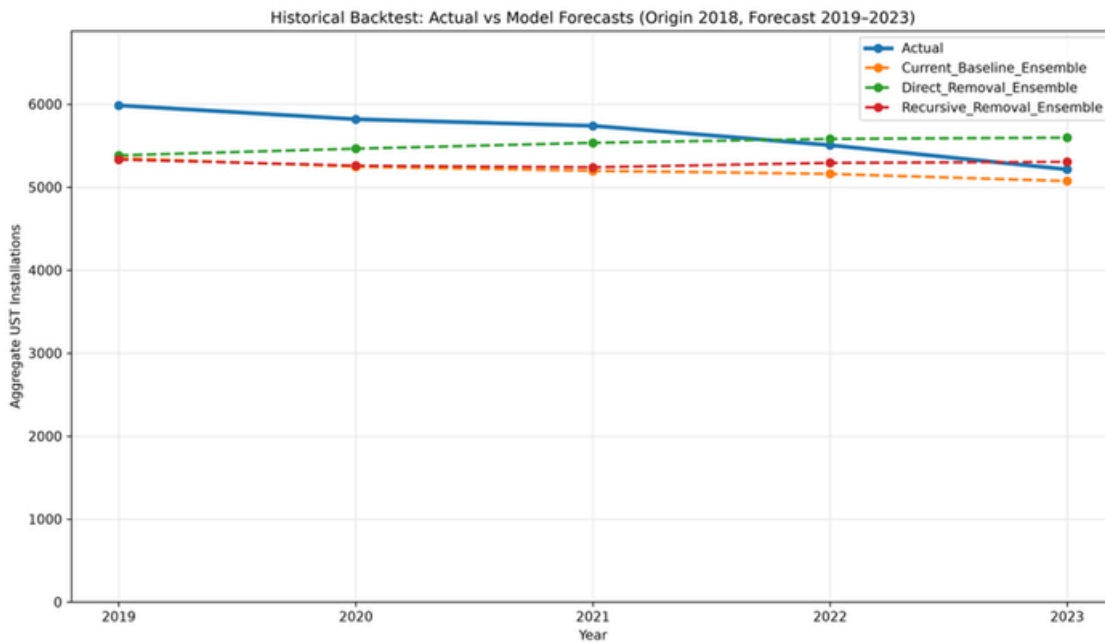


Figure 5: Actual vs Model Forecasts

4.9 Final Selected Forecasting Model

The final production forecasting model is therefore:

$$\text{Direct Removal Ensemble} = 0.5 \times \text{AutoETS} + 0.5 \times \text{Direct XGBoost}$$

For the production forecast:

- AutoETS models state-specific historical level and trend.
- Direct XGBoost uses the origin-based forecasting features, including historical installations, installation trends, historical removals, state identity, and forecast horizon.
- All future horizons are predicted directly from information available at the forecast origin.

For the 2023 production origin, this means forecasts for 2024 through 2031 are all generated from the fixed historical information available through 2023.

This combination was selected because it integrates traditional state-level time-series behavior with installation and removal-based machine learning information while maintaining stable performance across multiple historical forecast periods.

5. Final Model Training and Results

After model selection, the final model was trained using the complete finalized historical panel through 2023.

Final Step data checks were:

Check	Result
States	31
Historical period	1999-2023
Historical State-Year rows	775
Removal information availability	92.26%
XGBoost training examples	4,340
Final state forecast rows	248
Missing final forecasts	0
Negative final forecasts	0

Table 9: Final Model training checks

The 248 final forecast rows correspond to:

31 states x 8 forecast years = 248

5.1 Final Forecast Results

The aggregate observed installation count across the 31 modeling states in 2023 was 5214

Year	Forecast installations	Rounded installations	YoY change	YoY change(%)
2024	5,088.58	5,089	-125.42	-2.41%
2025	5,040.79	5,041	- 47.78	-0.94%
2026	5,003.14	5,003	-37.66	-0.75%
2027	4,973.96	4,974	-29.18	-0.58%
2028	4,943.37	4,943	-30.59	-0.61%
2029	4,924.17	4,924	-19.19	-0.39%
2030	4,908.50	4,909	-15.67	-0.32%
2031	4,895.97	4,896	-12.54	-0.26%

Table 10: Final annual forecasts, 2024-2031

These are the final aggregate forecasts from the selected Direct Removal Ensemble.

Because the historical dataset ends in 2023, the forecast series begins in 2024. For the current five-year workforce-planning period, particular attention can be given to 2027-2031.

5.2 Five-Year Planning Result: 2027-2031

For the current five-year planning period:

Year	Forecast new installations
2027	4,974
2028	4,943
2029	4,924
2030	4,909
2031	4,896

Table 11: Five-year planning

forecasts, 2027-2031

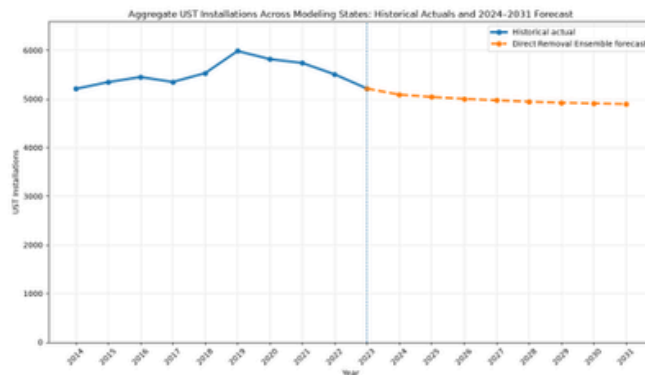


Figure 6: Aggregate UST Installations

5.3 Forecast Year-on-Year Changes

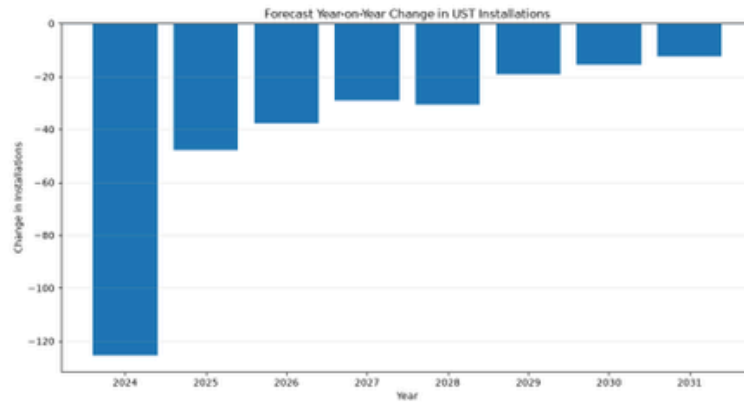


Figure 7: Forecast YoY on changes

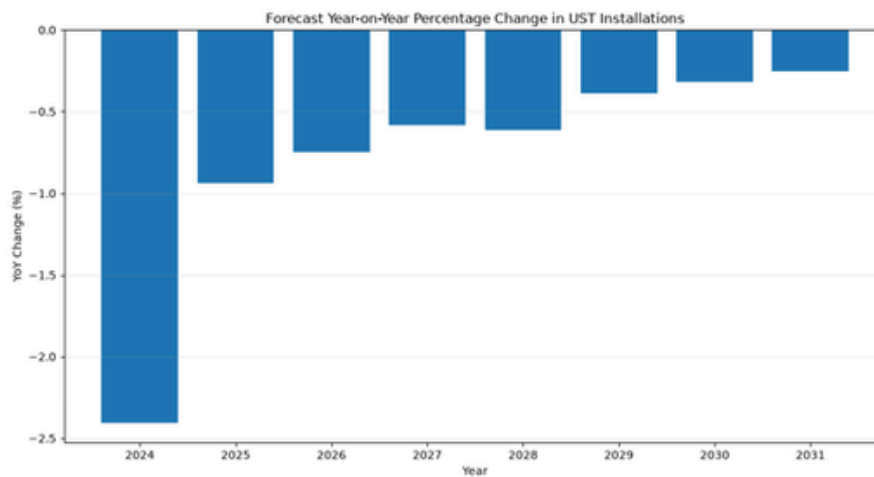


Figure 8: YoY Changes (%)

6 Limitations

The forecasting analysis is based on 31 states that satisfied the final historical coverage and installation-year reliability requirements. State UST datasets differ in structure, reporting practices, and completeness. Historical records also contained missing, conflicting, and placeholder installation dates that required quality screening. Removal information was available for approximately 92.26% of the final State-Year observations, with coverage varying among states. The model is based on historical installation and removal patterns through 2023; therefore, future regulatory, economic, infrastructure, or market changes not represented in the historical data may affect actual installation activity. Forecast uncertainty also increases as the prediction horizon extends further from the last observed year.