Understanding the Costs and Barriers of Residential Electrical Panel and Service Upgrades

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ABSTRACT

Upgrading electrical panels and services in U.S. homes represents a significant barrier to building modernization, imposing considerable costs, delays, and procedural uncertainties on homeowners, contractors, utilities, and building departments. Although cost databases document individual infrastructure activities, they rarely capture the integrated, whole-project perspective required to understand how electrical upgrades are planned, executed, and regulated. Existing research is often geographically constrained, narrowly scoped, or derived from limited samples, leaving significant knowledge gaps unaddressed. This study examines the timelines and costs associated with residential electrical panel and service upgrades using data from a national cross-sectional survey conducted in summer 2025. The survey captured responses from 140 stakeholders across 34 states, including building industry professionals, utility staff, and building department staff.

Findings indicate that project duration and cost increase substantially with building size though patterns vary by infrastructure type. Most single-family and small multifamily projects were completed within 30 days, whereas medium and large multifamily buildings show longer and less predictable timelines. Service rating increases modestly extend project duration, but building type and size were the primary determinants of delays. Cost patterns were similar: customer-side equipment and panel replacements scale predictably with building size, while utility-side costs are highly variable, often triggered by threshold-driven infrastructure upgrades such as transformer replacements. Permit fees vary considerably between jurisdictions but generally represent a minor proportion of total project costs.

These findings identify electrical upgrades as a significant barrier to residential building costs and highlight the need for improved stakeholder coordination, streamlined permitting, and strategies that reduce upgrade requirements while maintaining safety and code compliance.

Introduction

Residential electrical panel and service upgrades have emerged as a critical infrastructural bottleneck to adoption of energy and bill saving technologies and other home upgrades in the existing building stock. As households increase electric loads, the capacity of existing electrical infrastructure increasingly constrains both the feasibility and economic viability of electrical upgrades. Homes with insufficient panel amperage or service capacity frequently require panel replacements or full-service upgrades prior to installing new electrical loads, introducing substantial cost, complexity, and delay to otherwise routine building improvements. One indicator of the impact on the buildings industry of these additional project costs and delays is the development in recent years of new technologies and controls specifically to minimize added loads.

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Electricity is delivered to residential buildings through high-voltage transmission and distribution systems, entering the dwelling via service conductors and a utility meter before being distributed through the main electrical panel. The panel's amperage rating establishes the maximum allowable electrical load and provides overcurrent protection through circuit breakers. When anticipated household loads exceed panel or service capacity, this infrastructure needs to be replaced or upgraded to maintain safety and code compliance. Determining whether a replacement is necessary depends on load calculations and permitting processes, which vary across jurisdictions and utilities. Prior studies suggest that conservative assumptions, inconsistent application of load calculation methods, and differing utility or permitting requirements can influence upgrade determinations and associated costs (Gul and Meier 2025).

Prior research on residential retrofits has documented persistent affordability barriers across both single-family and multifamily buildings, encompassing high upfront costs, fragmented project coordination, and complex permitting requirements (Less et al. 2021; Walker et al. 2022; Casquero-Modrego et al. 2024). Several studies have explicitly identified electric infrastructure costs as a barrier (Deason et al. 2019; Aitchison et al. 2021; Casquero-Modrego et al. 2022; Walker et al. 2023; Satre-Meloy et al. 2024; Casquero-Modrego et al. 2025; Koli et al. 2025). The financial implications of residential electrical upgrades are considerable on homeowners and renters, particularly for older housing stock. Single-family homes comprise approximately 70% of the U.S. housing stock, and many were constructed under earlier electrical system requirements, retaining panels rated at 100 A or less (Meier and Gul 2024; Gul and Meier 2025). Beyond capacity constraints, safety concerns, including obsolete equipment, inadequate labeling, and non-compliant installations, can further necessitate panel replacement, expanding project scope and driving up costs (Zank et al. 2022; Montañés et al. 2025).

Effective load management strategies present a promising pathway to deferring or avoiding costly upgrades altogether. However, despite growing recognition of this potential, the conditions under which such strategies are applied, and their practical impact on upgrade rates and project costs, remain poorly understood at scale. There are also existing and emerging technological solutions to reduce the need for building and grid infrastructure costs (such as lower power appliances for hot water, cooking and clothes drying, as well as power management by circuit sharing, smart panels/breakers, among others), however, the baseline information on costs and timelines provided by this study is needed in order to prioritize and optimize changes in industry practice (Amruta et al. 2023; Anderson et al. 2024).

Our ability to reduce costs and other project barriers is limited due to a lack of comprehensive nationwide evidence on the costs, timelines, triggers, and barriers. Existing insights are largely derived from regional datasets or modeling efforts, such as *Pecan Street* in Texas, suggesting that while some upgrade measures can be accommodated within existing infrastructure, homes with sub-200 A panels face a higher likelihood of requiring significant electrical improvements (Gul and Meier 2025). Cost databases and estimating guides document discrete infrastructure tasks but rarely capture the integrated, whole-project perspective needed to understand how upgrades are planned and executed.

This study addresses these gaps by examining the costs, timelines and barriers associated with residential electrical panel and service upgrades in the U.S. across single- and multifamily buildings based on national survey data collected from the building industry professionals, electric utility staff, and building department staff. The findings are intended to inform strategies for reducing the costs and timelines for residential electrical upgrades while maintaining safety requirements. By comparing stakeholder-reported data across jurisdictions and project contexts, this study reveals how technical, institutional and procedural factors interact to shape the cost and time burden of residential electrical upgrades

Methodology

The survey was designed to characterize current practices, decision-making processes, and operational challenges associated with residential electrical panel and service upgrades in U.S. single- and multifamily buildings. The survey also explored perceptions of strategic approaches, including accurate load calculations and the adoption of load management technologies, which have the potential to mitigate upgrade requirements, manage peak demand, and improve affordability. Specifically, the survey addressed four primary objectives: (1) to identify common triggers for panel and service upgrades; (2) to document how electrical load calculations are applied and interpreted in practice; (3) to assess awareness and adoption of upgrade-avoidance strategies, such as load management and alternative circuiting approaches; and (4) to examine procedural, regulatory, and organizational constraints related to permitting, project timelines, and costs. By integrating perspectives from building industry professionals, utility staff, and building department staff, the study sought to elucidate the gap between the technical availability of upgrade avoidance strategies and their limited deployment in practice (Figure 1).

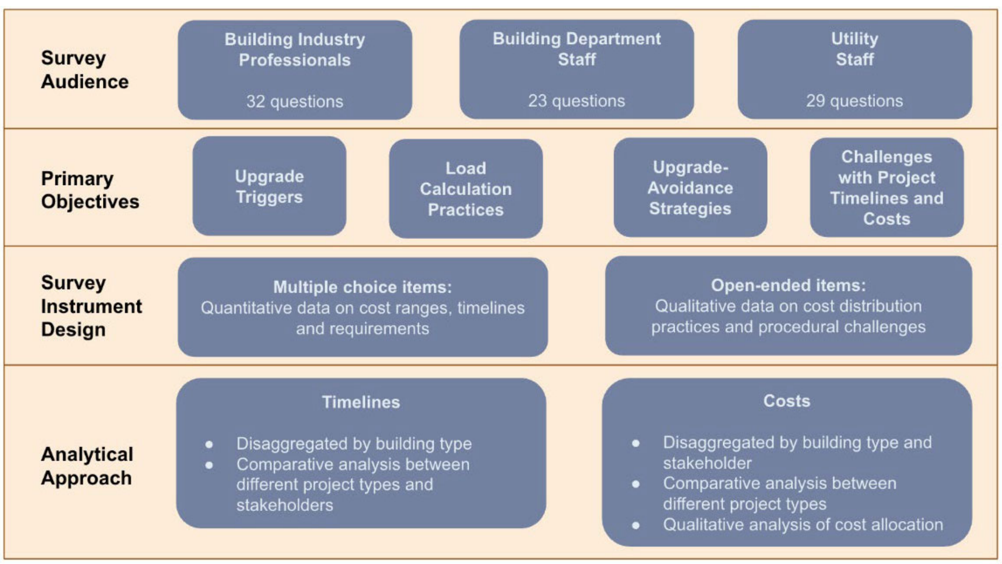

Figure 1. Survey design and cross-stakeholder analysis.

We conducted a 52-day cross-sectional survey during the summer of 2025. The survey targeted three stakeholder groups with direct involvement in residential upgrade projects: (1) *building industry professionals*, (2) *utility staff*, and (3) *building department staff*. Recruitment employed a nationwide, multi-channel strategy involving professional networks, industry organizations, utilities, building departments, and online platforms to achieve broad stakeholder coverage. Participants were compensated for their time to answer the survey questions with a $25 gift card.

We conducted the survey via Qualtrics, implementing safeguards to protect respondent anonymity, ensure data integrity, and comply with institutional ethics requirements. The survey

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comprised 84 questions in total, tailored to each stakeholder group: 32 for building industry professionals, 23 for utility staff, and 29 for building department staff. The survey design combined multiple-choice questions (capturing quantitative data on costs ranges, project timelines, and procedural requirements) with open-ended questions, providing qualitative insights into technical practices and operational challenges.

Table 1. Cross-stakeholder coverage of survey questions on project timelines and costs.

Cross-Stakeholder Mapping Questions			
	Building Industry Professionals	**Utility Staff**	**Building Department Staff**
Project Timelines			
Panel replacement timelines (without service rating increase)	Question C25	---	---
Panel replacement timelines (with service rating increase)	Question C26	Question U29	---
Project Costs			
Costs of electrical work and project types*	Questions C27-C32	Questions U27-U28	Question B23
Allocation of costs between utilities and customers	---	Questions U24-U25	---
*Includes panel replacements, service rating increases, transformer replacements, and permit fees.			

The analytical approach for this study centered on survey questions addressing *project timelines and costs*. To enable cross-stakeholder comparisons, questions that were either identical or conceptually aligned across stakeholder groups and project types were identified (e.g., panel replacement with and without a service rating increase). Where full alignment across all three groups was not feasible, comparisons were conducted between the two groups for which equivalent questions were available (Table 1). Stakeholder-specific questions were analyzed independently where they provided substantively relevant insights contributing to the broader interpretation of findings.

Results

This section presents findings from survey questions addressing two primary topics: (1) *project timelines*; and (2) *project costs*. The analysis is organized into two corresponding subsections. As outlined in the *Methodology* and summarized in Table 1, some questions were administered across multiple stakeholder groups, while others were specific to a single group. The cross-stakeholder mapping indicates which items were asked of building industry professionals, utility staff, and building department staff, and describes the distribution of questions across the timeline and cost topics, including questions on panel replacement timelines, service rating increase timelines, electrical project costs, and cost allocation between utilities and customers.

Respondents Characteristics

A total of 140 respondents completed all questions, comprising 60 building industry professionals (43%), 18 utility staff (13%), and 62 building department staff (44%), collectively representing 34 U.S. states (Figure 2). Responses were geographically concentrated, with building industry respondents clustered on the West Coast (41%) and East Coast/Mid-Atlantic (36%), and utility staff notably represented in the Midwest. New York and California were the most represented states across all three stakeholder groups. Participants reported experience across both single- and multifamily residential buildings, encompassing a wide range of building vintages, sizes, and project scales. Across all groups, respondents operated in diverse climate zones and community contexts. Figure 2 shows the number of respondents by state, with a higher number of respondents corresponding to a darker color.

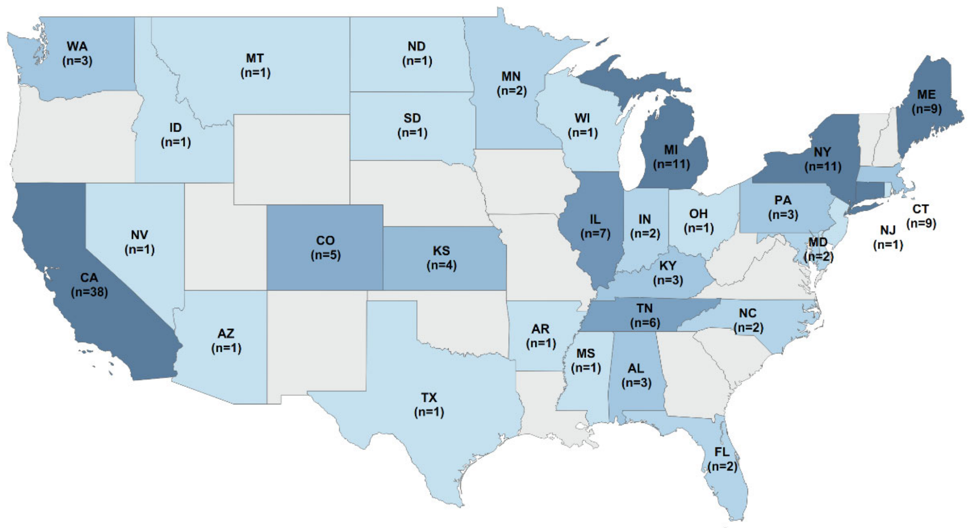

Figure 2. Geographic distribution of survey respondents.

Project Timelines

In this section, we report the findings from building industry professionals (contractors and engineers) regarding panel replacements without service rating increases, as well as responses from contractors, engineers, and utility staff concerning panel replacements that include service rating increases (Table 1).

Timelines for Service Rating Increases

Survey responses were obtained from building industry professionals (n=60) and utility staff (n=18) regarding the time from initial request or permit application to project completion across different building types (Table 1; Figure 3).

Completion rates within 30 days were highest for smaller building types and declined progressively with increasing building size. For single-family homes, 64% of building industry respondents and 80% of utility respondents reported project completion within 30 days. Small multifamily buildings (2-4 units) showed comparable timelines, with 63% and 64% of building industry and utility respondents, respectively, reporting completion within 30 days. These results suggest broadly consistent project durations across both stakeholder groups for buildings of this size.

For medium multifamily buildings (5-19 units), the share of projects completed within 30 days declined to 48% among building industry respondents and 54% among utility staff. Concurrently, 28% of building industry respondents indicated that timelines for this building type may extend beyond six months, while 38% of utility staff reported expected durations of more than three months, reflecting growing timeline variability as building complexity increases. This trend was most pronounced for large multifamily buildings (≥20 units), which recorded the lowest 30-day completion rates across all building types: 41% among building industry respondents and 42% among utility staff. Additionally, 36% of building industry respondents and 42% of utility respondents reported expected project durations exceeding three months, indicating that a substantial proportion of large multifamily service rating increase projects are subject to significant delays. Transformer-related projects, reported by utility staff only, were predominantly completed within 30 days (76%).

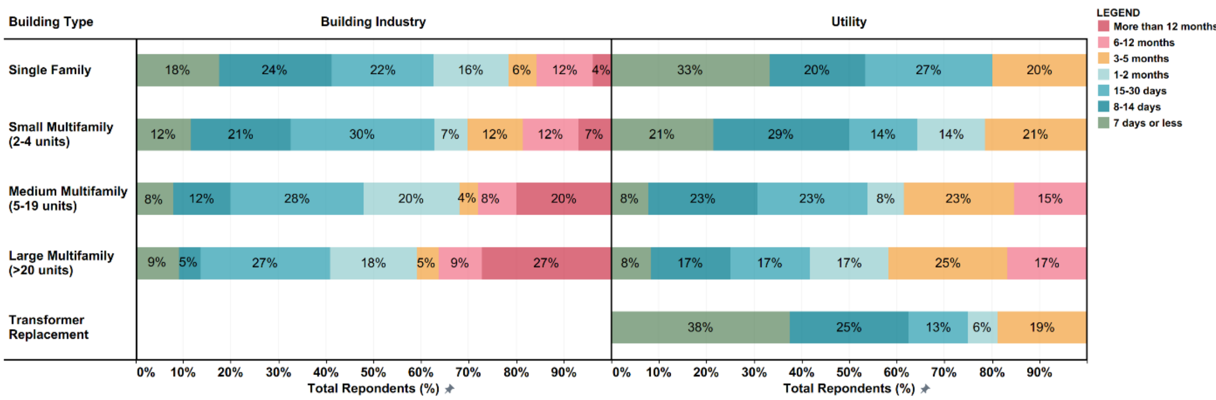

Figure 3. Project timelines associated with electrical service rating increases: (1) building industry professionals; (2) utility staff.

These findings reveal a consistent relationship between residential building size and service rating increase timelines, characterized by longer durations and greater uncertainty as building size increases. For single-family and small multifamily buildings, timeline uncertainty was low and broadly consistent across both stakeholder groups. As building size increased, however, uncertainty rose substantially, most notably among building industry professionals, who reported considerably lower confidence in expected timelines for medium and large multifamily projects than utility staff. Given the limited utility sample size (n=18), findings for this group should be interpreted with caution, particularly for larger building categories where response variability is high.

Timelines for Electrical Projects With and Without Service Rating Increases

Survey responses from the building industry (n=60) indicate that timelines generally increase when a service rating increase is involved (Table 1; Figure 3).

For single-family homes, projects without service rating increases were typically completed within 30 days according to 70% of responses (26% ≤7 days, 22% 8-14 days, 22% 15-30 days), compared with 64% for projects that included a service rating increase (18%, 24%, 22%, respectively). Small multifamily buildings (2-4 units) showed a similar trend; 62% of projects without service rating increases were completed within 30 days, compared with 63% of those with service rating increases. For medium buildings, 34% of projects without service rating increases were completed within 30 days, compared with 48% for those with service rating increases. For large buildings, the corresponding timelines within 30 days were 56% and 41% respectively.

Building industry reported timelines show that service rating increases modestly extend project duration and uncertainty, particularly for smaller building types. For single-family homes, the proportion of “don’t know/not sure” responses increased from 10% to 15% when a service rating increase was involved. Medium and large multifamily buildings showed high uncertainty regardless of whether a service rating increase was required (55-63%), suggesting that building size and type are the primary drivers of timeline variability.

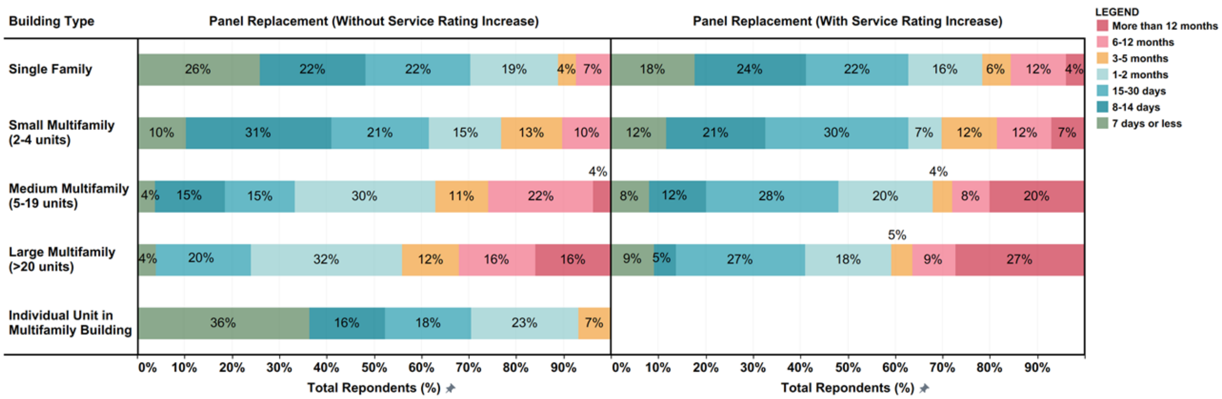

Figure 4. Project timelines associated with and without service rating increases.

These findings reveal a consistent relationship between residential building size and service rating increase timelines, characterized by longer durations and greater uncertainty as building size increases. Most single-family and small multifamily projects are completed within a time period of one month. Medium and larger multifamily buildings consistently showed longer and less predictable timelines, a pattern acknowledged by both building industry and utility stakeholders. Given the limited utility sample size (n=18), findings for this group should be interpreted with caution, particularly for larger building categories where response variability is high.

Project Costs

Respondents were asked to provide cost estimates for various types of residential electrical work, including panel replacements, service rating increases, transformer replacements, and permit fees, for different building types and project scales. Building industry professionals, utility staff, and building department staff reported on these costs, while utility staff additionally provided open-ended responses on how costs are allocated between the utility and the customer. These items allowed cross-stakeholder cost comparisons across project types, as well as assessment of utilities' cost distribution practices. (Table 1).

Unless otherwise noted, in this analysis quartiles have been calculated using linear interpolation in the data visualization software (Tableau). Small sample sizes in medium and large multifamily categories (n<10) constrain statistical precision, and results for these segments should be interpreted as indicative rather than definitive. Cost distributions were right-skewed across multiple categories, with mean values exceeding medians, reflecting the influence of high-cost outliers. Accordingly, median values and interquartile ranges (IQR) are reported as the primary measures of central tendency throughout this section.

Building Industry Cost Estimates

Cost estimates in ($) reported by building industry professionals (n=60) increased with building size across most project types. Single-family and small multifamily projects showed relatively narrow cost distributions, whereas medium and larger multifamily categories showed greater variation.

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Service rating increase ($) (utility-side costs passed to the customer): Reported utility-side costs showed heterogeneity and did not scale linearly with building size (Figure 5). For single-family buildings (n=19), the median cost was $3,500 (IQR: $1,650-$7,000; mean: $5,040). Small multifamily buildings (2-4 units; n=12) showed a median of $4,350 (IQR: $1,500-$6,000; mean: $6,861). Medium multifamily buildings (5-19 units; n=5) showed a lower median of $2,000 but markedly wider dispersion (IQR: $1,500-$10,000; mean: $5,800). Large multifamily buildings (≥20 units; n=3) showed the highest central tendency and variability, with ($7,500; $5,000; $37,500; mean of $16,667). Overall, the pattern suggests that utility-side costs reflect threshold-driven infrastructure interventions rather than proportional scaling with building size. We assume that when load additions exceed existing transformer capacity, potentially high-cost infrastructure upgrades are triggered, leading to the increased magnitude and uncertainty observed in larger multifamily buildings.

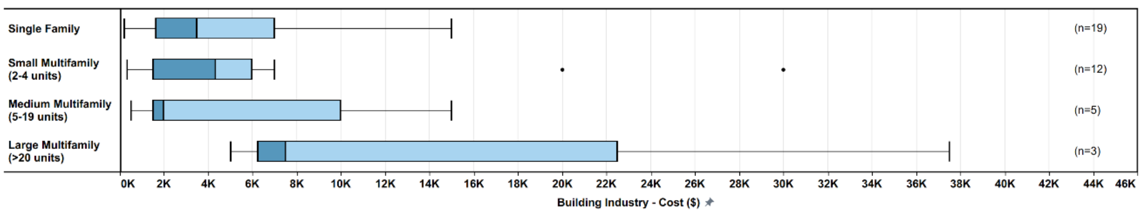

Figure 5. Service rating increase ($): Utility-side costs passed on to the building owner.

Service rating increase ($) (customer-side equipment): In contrast to the utility-side costs, customer equipment costs increased with building size (Figure 6). For single-family homes (n=22), the median cost was $2,800 (IQR: $2,000-$5,000; mean: $3,409). Small multifamily buildings (2-4 units; n=11) showed a median of $5,000 (IQR: $2,550-$10,000; mean: $7,509). A pronounced cost escalation was observed for medium multifamily buildings (5-19 units; n=4), with a median of $18,750 (IQR: $8,000-$28,750; mean: $18,375), increasing further to ($5,000; $25,000; $45,500; mean: $25,167) for large multifamily buildings (≥20 units; n=3). Interquartile ranges widened with building size, indicating greater cost dispersion in larger buildings. However, mean and median values remained relatively aligned in the medium and large categories. These results indicate that customer-side upgrade costs increase in a relatively systematic manner with building size, with a marked escalation in the 5-19-unit range.

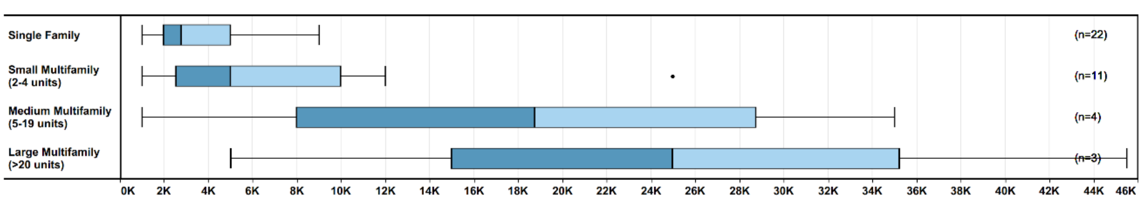

Figure 6. Service rating increase ($): Customer-side equipment costs.

Main service panel replacement ($): Reported costs for main service panel replacement increased with building size (Figure 6). For single-family homes (n=34), the median cost was $3,500 (IQR: $2,100-$5,000; mean: $3,931), rising slightly to $4,125 (IQR: $2,200-$6,750; mean: $4,966) for small multifamily buildings (2-4 units; n=20). A pronounced increase was observed for medium multifamily buildings (5-19 units; n=6), with a median of $11,750 (IQR: $5,000-$15,000; mean: $10,500), and remained elevated in large multifamily buildings (≥20

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units; n=4), where the median was $11,500 (IQR: $5,000-$24,000; mean: $14,500). The wider interquartile ranges (despite the small sample size) and higher mean values in larger building types indicate substantial variability, likely due to the high cost of individual incremental infrastructure upgrades that may be triggered, such as transformer replacement.

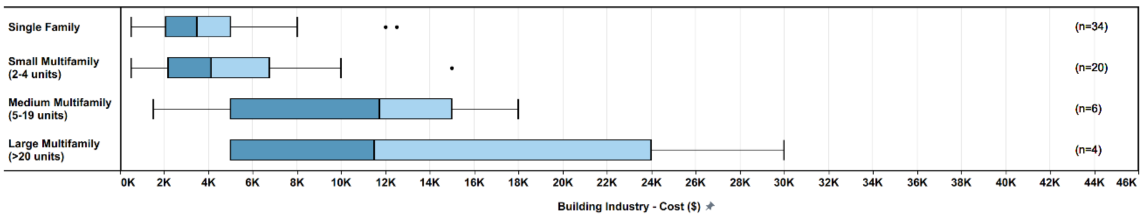

Figure 7. Main service panel replacement ($).

Individual subpanel replacement ($ per home): Reported per-home costs showed a modest increase with building size (Figure 8). For single-family homes (n=31), the median cost was $1,500 (IQR: $775-$2,500; mean: $1,879), rising slightly to $2,000 (IQR: $1,750-$2,950; mean: $2,380) for small multifamily buildings (2-4 units; n=15). Medium multifamily buildings (5–19 units; n=6) had a median of $2,500 (IQR: $2,500-$3,500; mean: $3,233), while large multifamily buildings (≥20 units; n=4) showed a median of $2,875 (IQR: $2,000-$3,375; mean: $2,688). The substantial overlap in interquartile ranges across building types indicates that per-home subpanel replacement costs ($) remain relatively consistent regardless of building size, suggesting that these upgrades are driven more by home-level conditions and installation characteristics than by overall building size.

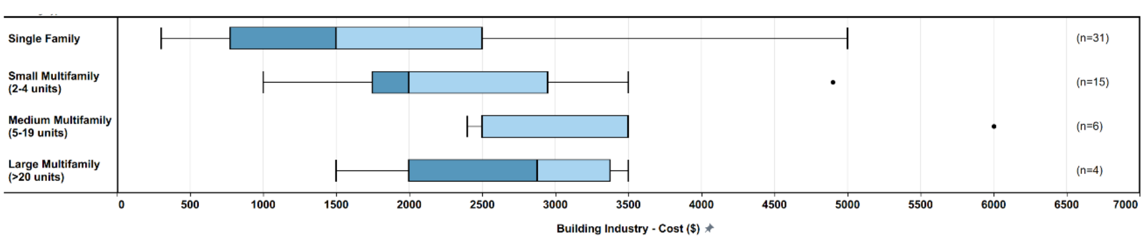

Figure 8. Individual Subpanel replacement ($ per home).

Distribution panel replacement (total project cost $): Distribution panel replacement (total project cost $): Reported total costs for distribution panel replacement in multifamily buildings increased with building size (Figure 9). For small multifamily buildings (2-4 units; n=12), the median cost was $4,250 (IQR: $2,500-$6,250; mean: $4,935). Medium multifamily buildings (5-19 units; n=4) showed a median of $5,500 (IQR: $1,500-$9,000; mean: $5,250), while large multifamily buildings (≥20 units; n=3) had ($5,000; $9,000; $22,500; mean: $12,167). These results indicate that total distribution panel replacement costs ($) per project escalate with building size, with greater variability observed in larger buildings, consistent with the larger range of electrical infrastructure characteristics of larger multifamily buildings.

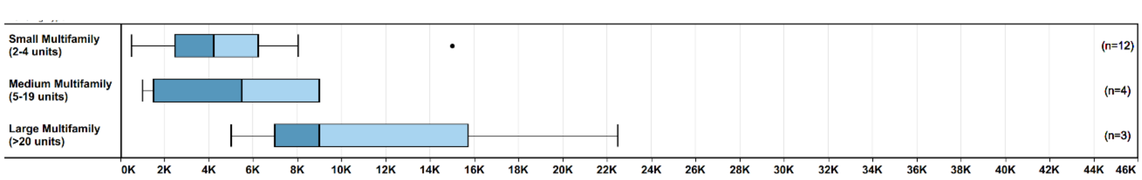

Figure 9. Distribution panel replacement (total $).

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Rewiring (replacing hazardous or undersized conductors) ($ per home): Reported per-home rewiring costs showed variable patterns across building types and did not follow a consistent trend with building size (Figure 10). For single-family homes (n=21), the median cost was $5,000 (IQR: $1,000-$7,500; mean: $7,021). Small multifamily buildings (2-4 units; n=10) had a lower median of $1,500 (IQR: $1,000-$3,000; mean: $2,340). Medium multifamily buildings (5-19 units; n=3) showed ($3,000; $5,500; mean: $3,833), while large multifamily buildings (≥20 units; n=3) we had ($1,500; $5,500; $15,000; mean: $7,333). The absence of a clear monotonic relationship between rewiring costs and building size likely reflects project-specific variability in existing wiring conditions, the extent of partial versus full conductor replacement, and differences in overall project complexity.

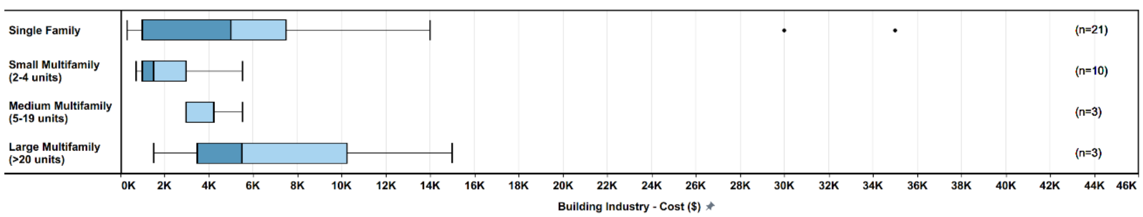

Figure 10. Rewiring (replacing hazardous or undersized conductors) ($ per home).

The cost findings on electrical upgrades in this section reveal several patterns. A pronounced cost escalation occurs at the medium multifamily threshold (5-19 units), consistent with the transition from residential-scale electrical infrastructure to more complex distribution systems. Utility-side costs are highly variable and appear to be threshold-driven, likely occurring when additional load exceeds existing transformer capacity. The large range in reported costs makes utility-side costs difficult to predict, especially for larger buildings. In contrast, customer-side equipment costs show consistent increases with building size, and can therefore be anticipated with greater reliability. Medium and large multifamily buildings face substantially higher upgrade costs than single-family or small multifamily buildings, sometimes by an order of magnitude. Rewiring costs show no clear relationship with building size and instead appear to depend on building-specific conditions. Finally, wide interquartile ranges across categories indicate substantial cost variability, reflecting differences in local labor markets, existing infrastructure, and project scope, which complicates cost predictions and analysis.

Utility Costs of Electrical Service Installation and Upgrades

A total of 18 utility staff respondents participated in the survey. However, fewer than 10 responses were available for the analyses presented in this section. This limited sample size limits conclusions that can be drawn, and the results should therefore be interpreted as indicative rather than definitive.

New Service Project: Reported costs for new service and service upgrade projects increased clearly with building size (Table 2). For single-family homes (n=7), the median cost was $2,000 (IQR: $660-$2,500; mean: $1,760), rising to $2,750 (IQR: $1,350-$4,250; mean: $2,900) for small multifamily buildings (2-4 units; n=8). Medium multifamily buildings (5-19 units; n=8) showed a median of $8,250 (IQR: $2,550-$17,000; mean: $9,700), while large multifamily buildings (≥20 units; n=7) reached a median of $20,000 (IQR: $6,300-$30,000; mean: $18,157). Overall, costs were highly variable and escalated sharply in larger buildings, likely reflecting threshold-driven

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utility requirements where load additions exceed existing service capacity. For projects involving new transformer installation (n=9), median costs were $2,500 (IQR: $2,500-$6,500; mean: $4,155), suggesting that transformer installations for new service are lower in cost compared to transformer replacements associated with service upgrade projects, as discussed below.

Upgrade or Replacement Service Project: Costs for upgrade or replacement service projects followed a similar pattern with building size (Table 2). Single-family homes have relatively low and predictable costs, with a median of $1,500 (IQR: $750-$2,250), while small multifamily buildings (2-4 units) rise modestly to $3,500 (IQR: $1,750-$4,500). Medium multifamily buildings (5-19 units) show further escalation, with a median of $4,875 (IQR: $3,250-$10,375) and a mean higher than the median, reflecting occasional high-cost outliers. Large multifamily buildings (≥20 units) exhibit the highest costs at the top end ($15,000; IQR: $12,500-$17,500), indicating substantial expenses for major service upgrades. Overall, these results indicate that smaller buildings face relatively predictable and modest costs, while medium and large multifamily projects are both more expensive and more variable, highlighting the importance of site-specific planning and budgeting for high-capacity electrical service interventions.

Table 2. Utility costs ($) Associated with new electrical service installation and upgrade projects.

Utilities					
	Single-family Homes Median (IQR)	**Small Multifamily (2-4 units) Median (IQR)**	**Medium Multifamily (5-19 units) Median (IQR)**	**Large Multifamily (>20 units) Median (IQR)**	**New or Replacement Transformer Median (IQR)**
New service project	Respondents (n=7) $2,000 ($660-$2,500) Mean: $1,760	Respondents (n=8) $2,750 ($1,350-$4,250) Mean: $2,900	Respondents (n=8) $8,250 ($2,550-$17,000) Mean: $9,700	Respondents (n=7) $20,000 ($6,300-$30,000) Mean: $18,157	Respondents (n=9) $2,500 ($2,500-$6,500) Mean: $4,155
Upgrade or replacement service project	Respondents (n=4) $1,500 ($750-$2,250) Mean: $1,500	Respondents (n=4) $3,500 ($1,750-$4,500) Mean: $3,125	Respondents (n=4) $4,875 ($3,250-$10,375) Mean: $6,813	Respondents (n=3) ($10,000; $15,000; $20,000) Mean: $15,000	Respondents (n=6) $4,000 ($2,750-$12,500) Mean: $6,375

Allocation of Costs Between Utilities and Customers: Utility respondents provided qualitative insights into the cost allowances and cost distribution practices for various electrical service and upgrade projects, including overhead and underground configurations for single-family and multifamily buildings, as well as secondary transformer upgrades or replacements. Reported allowances were minimal or nonexistent across all categories, indicating that these data are better interpreted qualitatively rather than quantitatively.

For service rating increases, nearly all utility respondents who provided allowance data (n=11) reported no utility allowance, with only a single respondent indicating a non-zero amount of $2,100. Similarly, for new service installations, most respondents (n=8) also reported a $0 allowance, though a small number (n=4) indicated their utility provides modest allowances ranging from $100-$2,218 (for overhead single-family or multifamily buildings) and from $750-$2,218 (for underground single-family or multifamily buildings). Secondary transformer upgrades or replacements followed the same pattern, with nearly all 12 respondents reporting no allowance and one respondent reporting $2,100.

When asked about the conditions under which customers bear responsibility for utility-side upgrade costs, respondents described a range of practices. While four respondents reported that customers are responsible for all utility-side material and labor costs beyond any standard allowances, most highlighted that a range of project-specific factors affect cost distribution. The most common responses (n=8) indicated that customers pay for specific project types or when projects exceed certain thresholds, such as for underground connections, longer service runs, higher added loads, or lower payback periods. A few (n=4) noted that responsibility can depend on other factors outside the project scope, with costs covered by the utility for addressing internal equipment safety issues, or for specific customer classes, such as residential or low-income customers. In one reported case, instead of charging upgrade costs directly, the utility recovers them through increased rates applied to all customers.

These findings indicate that, in general, utilities do not tend to provide direct monetary support for service rating increases, new service installations, or secondary transformer upgrades, suggesting that such costs are typically borne by the customer. Where they do cover upgrade costs, the amount of coverage depends on both project-specific and utility-specific factors, with significant variation from utility to utility.

Building Department Permit Fees for Residential Upgrades

Building department respondents (n=33) reported permit fees across eight residential work categories for single-family homes (Figure 11). Fees were generally modest, with most categories clustering near a $100 median. Solar PV installation was the notable exception, yielding the highest median ($200; IQR: $80-$315) and mean ($209), likely reflecting its greater technical complexity, multi-trade coordination requirements, and grid-interconnection review process. Home rewiring also carried a comparatively higher permit fee (median: $129; IQR: $61-$250; mean: $183), consistent with its labor-intensive scope. The remaining categories (i.e., EV charger installation, panel replacement (with and without service rating increase), home battery installation, plumbing, and HVAC), were tightly grouped, with medians at or near $100 and means ranging from $134 to $152. Several respondents (n=11) reported the same fees across all permit types they filled out. In addition to the wide interquartile ranges across all categories this indicates considerable variability in fees across jurisdictions, despite similar central tendencies. Open-ended responses identified additional sources of variability, including fees tied to job valuation (n=5), square footage (n=1), or jurisdiction (n=2).

These findings suggest local governments set their permit fees differently which can lead to different costs for homeowners and contractors depending on where they live. Fees appear to vary more based on jurisdiction than project type, suggesting that the type of technology or installation work itself plays a relatively minor role compared to differences in local fee-setting practices.

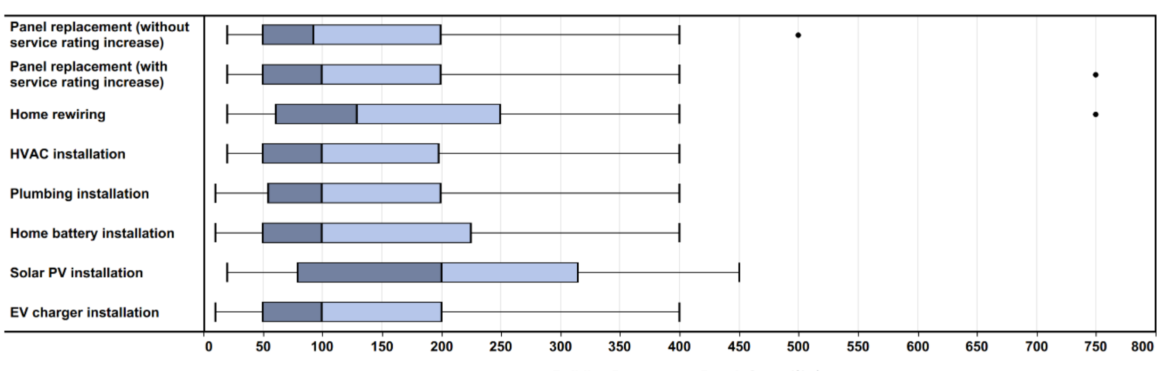

Figure 11. Typical permit fees ($) for residential electrical, plumbing, and HVAC projects.

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Discussion

This study provides a nationwide empirical perspective on the timelines and costs associated with residential electrical panel and service upgrades across single- and multifamily buildings in the U.S. Drawing on survey data from 140 respondents across 34 states, comprising building industry professionals, electric utility staff and building department staff, the analysis characterizes how building size, infrastructure complexity, and institutions factors collectively shape upgrade outcomes. Both project timelines and costs are consistently influenced by building size. Single-family and small multifamily buildings projects generally experience predictable timelines, with most projects completed within 30 days, and moderate, relatively consistent costs. By contrast, medium (5-19 units) and large (≥20 units) multifamily buildings face longer, more variable timelines and substantially higher costs, reflecting the transition from residential-scale upgrades to more complex distribution infrastructure. Customer-side equipment costs escalate sharply with building size, whereas utility-side costs are threshold-driven and highly variable, typically triggered when added load exceeds existing transformer capacity. Rewiring costs, in contrast, are largely project-specific, reflecting the condition of existing conductors rather than building size.

Reported utility-provided allowances for electrical service projects were minimal or not offered, suggesting that customers bear most upgrade costs. The amount the customer pays, however, can depend on a wide range of factors, including the size, scope, purpose, and location of the upgrades. Certain utilities have specific approaches to protecting affordability, such as covering all costs for low-income customers, or spreading costs across all customers. These approaches vary significantly between utilities. Permit fees, though modest compared to overall electrical project costs, also vary across jurisdictions, introducing additional uncertainty. These financial and procedural barriers raise particular affordability concerns for multifamily housing projects, which often serves lower-income populations and renters.

Limitations

The analysis relies on self-reported survey data, which may be subject to bias, differences in respondent interpretation, and variation in how costs and timelines are defined across jurisdictions and project contexts. Sample sizes were particularly limited for medium and large multifamily building categories (less than 10 in several analyses), which constrains statistical precision and limits the generalizability of findings for these segments; results for these categories should therefore be interpreted as indicative rather than definitive. Future work could add to these small samples to give more definitive results. Geographic clustering of respondents, with building industry professionals concentrated on the West Coast and East Coast/Mid-Atlantic, may introduce regional bias, as electrical upgrade costs, permitting requirements, and utility practices vary considerably across states, jurisdictions, and utility service territories. The limited utility sample (n=18) further constrains the robustness of utility-side cost and timeline estimates. The associations identified may be influenced by factors not captured in the survey, such as regional differences in labor costs, local code requirements, or utility infrastructure capacity.

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Conclusions

The need for residential electrical panel and service upgrades is a key obstacle to scaling panel replacement avoidance strategies. Our findings indicate that:

- Medium and large multifamily buildings are the most constrained by both cost and systemic complexity.
- Projects that require service rating increases (as opposed to only main panel replacements) face higher cost and time burdens due to additional coordination and infrastructure upgrades needed on the utility side.
- Project timelines and uncertainty escalate with building size, particularly for medium and large multifamily buildings, reflecting systemic complexity in coordination, permitting, and utility involvement.
- Costs scale with building size, with medium multifamily buildings showing a structural cost escalation and large multifamily buildings facing the highest and most variable expenditures. Customer-side equipment costs increase predictably, whereas utility-side costs are threshold-driven and highly variable.
- Financial support from utilities is minimal, indicating that the burden of electrical upgrades is predominantly borne by customers. Both utility-side cost distribution and building department fee-setting practices are variable between jurisdictions.
- Affordability concerns are significant, and multifamily housing faces higher upgrade costs and longer timelines.

Together, these results highlight that reducing costs and time delays for residential electric work will require integrated strategies, including adoption of load management technologies to avoid costly infrastructure upgrades, improved coordination among stakeholders, and targeted financial incentives to offset customer costs. Such interventions could reduce project timelines and improve cost predictability, while maintaining safety and code compliance. Interventions are particularly critical for multifamily housing, where infrastructure complexity and cost escalation present substantial barriers to affordable upgrades. Future research should examine the effectiveness of specific intervention strategies, including the potential for lower power and load management technologies to reduce upgrade requirements, and the impacts of alternative utility cost-allocation mechanisms.

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