

Residential Utility Service Upgrades for Electrification Retrofits: Costs and Recommendations

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ABSTRACT

As more jurisdictions and regulatory bodies implement decarbonization and electrification initiatives, aging infrastructure – both the utility and customer side of the meter – will be impacted by increased electrical load that require expensive panel and utility-side electrical service upgrades (Service Upgrades). A Service Upgrade is typically defined as an upgrade of utility-owned equipment from the utility pole to the residential meter to increase amperage capacity. Historically, there is a lack of knowledge of the cost to the customer and the process to complete a Service Upgrade. This paper presents the findings and recommendations of a recent “Residential Electric Service Upgrades for Electrification Retrofits” study that investigates the processes and costs required to upgrade electrical service capacity and make recommendations to address the challenges. The findings provide clarity on Service Upgrade triggers, the process indicate a provide insight into mitigating the need for a costly Service Upgrade. current barriers and opportunities for electric utilities to support residential customers during the Service Upgrade process.

Introduction

The State of California has set aggressive decarbonization goals in Senate Bills 32, 100, 1477 and Assembly Bill 3232. As described in the *Deep Decarbonization in a High Renewables Future* report (E3 2019), the pillars of decarbonization include “energy efficiency and conservation, electrification, low-carbon fuels (including electricity), and reducing non-combustion greenhouse gas (GHG) emissions.” Decarbonizing building energy end uses will be essential to achieve State GHG reduction targets. As a result, the California residential building market is rapidly shifting towards electrification and reductions in natural gas construction and appliances that have an impact on the utility customer and the California electric utility infrastructure.

Objectives

The “Residential Electric Service Upgrades for Electrification Retrofits” study set out to address three objectives.

1. **Map out the existing processes for completing Service Upgrades in residential retrofits in California with two activities.** Identify common scenarios when Service Upgrades are required to complete an electrification upgrade in residential retrofits and develop several representative examples. Identify current processes in place to complete a Service Upgrade and develop a process flow
2. **Understand the costs incurred by all parties when upgrading electrical service to residential sites with two activities.** Identify typical costs associated with increasing

electrical capacity for residential electrification retrofit projects and the parties responsible for these costs. Identify and explain factors that may impact these costs

3. **Make recommendations to the utilities and future program implementers to address challenges to integrating Service Upgrades into electrification projects with three activities.** Identify ways that utilities can improve Service Upgrade processes. Develop recommendations to potential program implementers on incorporating Service Upgrades into electrification programs. Identify future research needs

This paper is based on a California Investor Owned Utility (IOU) study co-funded by Pacific Gas & Electric (PG&E) and San Diego Gas & Electric (SDG&E), collectively (Utilities) and the study was conducted by a team lead by NV5.

Methodology

The study comprised of three methods for data collection primarily in the PG&E and SDG&E territories. Online surveys were conducted with homeowners who recently completed Service Upgrades with their utility and a follow-up call with homeowners that requested a call. In-depth interviews were conducted with contractors, utility subject matter experts (SMEs) and building department staff who were involved with Service Upgrades. The building department staff interviewed worked on building permits for residential Service Upgrades. California Public Utility Commission (CPUC) staffers were interviewed to gain additional knowledge on how the utility's tariff Rules are developed and reviewed for rate case approvals. The target audience survey and interviews are outlines in Table 1. In addition, a comprehensive literature review was conducted.

Table 1. Target Audience Surveys and Interviews

Research Method	Number	Target Audience
Online surveys	34	Homeowners
In-depth interviews	23	Contractors/trade professionals
	3	Building department staff
	3	CPUC staff
	6	Utility staff SMEs

STUDY RESULTS

A total of 34 homeowners from PG&E and SDG&E service territories responded to the survey out of the 136 homeowners contacted. Of the 136 total homeowners contacted, 58 homeowner contacts were provided in the PG&E data request response and 78 were provided in the SDG&E data request response. There were 23 contractors that completed interviews out of the 141 residential electrical contractor companies contacted. A total of 12 Utility, CPUC, and building department staff were surveyed or interviewed out of the 29 contacted. Three Building Department staff including two from PG&E service territory and one from SDG&E service

territory. There were three CPUC staff members and six Utility SMEs interviewed including three from PG&E and three from SDG&E.

Service Upgrade Triggers

A Service Upgrade is most often a direct result of a residential building increasing electric load requiring more service capacity and an electrical panel upgrade. The Utilities reported that the most common Service Upgrade triggers include solar photovoltaic (PV) installation (43%) and Level 2 Electric Vehicle (EV) Chargers (12%). The two leading triggers accounts for 55% of all Service Upgrades. The remaining Service Upgrades are noted as wiring upgrades which is assumed to be associated with home renovations and underground or overhead conversions. Contractors reported heating, ventilation, air conditioning (HVAC) upgrades, age of home, adding a pool or spa and home renovations as other common triggers as noted in Figure 1.

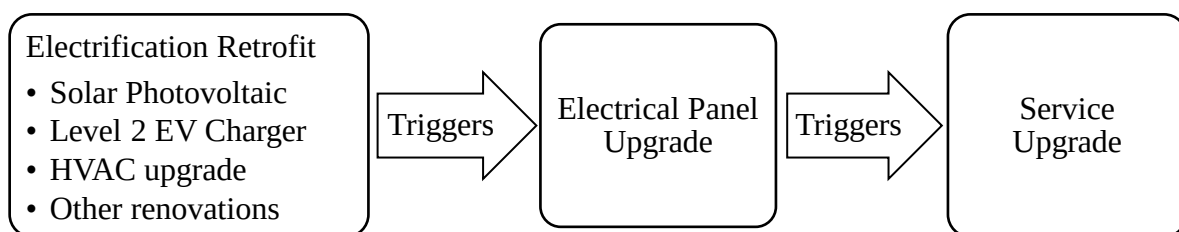


Figure 1. Service upgrade triggers reported by utilities, electricians, and customers.

Service Upgrade Process

SDG&E, PG&E and contractors from both service territories provided processes, responsible parties, and timelines from their perspective. There are many similarities and distinct differences.

San Diego Gas & Electric Company Process

SDG&E provided the following detailed process which is summarized below and illustrated in Figure 2. The process starts when the customer submits an application online or calling SDG&E. SDG&E creates a job package and assigns a fielding date. Over the next four to eight weeks, SDG&E fields the job and assigns the customer's final submittal date. SDG&E creates a service order which generates the Utility fees to complete the Service Upgrade and provides the job package to the customer in five to seven business days.

SDG&E contacts the customer over the next one to two days to verify they received the job package. The customer must pay the Utility fees and obtain a permit, if applicable. Contractors reported this step takes between one day and a week or more to complete. If a right-of-way is required, it must be obtained at this point in the process. Trenching is the customer's responsibility, so trench inspections are scheduled. SDG&E schedule crews and SDG&E completes the Service Upgrade work, the customer is energized, and the meter set is completed.

Figure 2 combines the information from SDG&E and the data gathered from contractors. Overall, the total Service Upgrade process is completed in up to ten months.

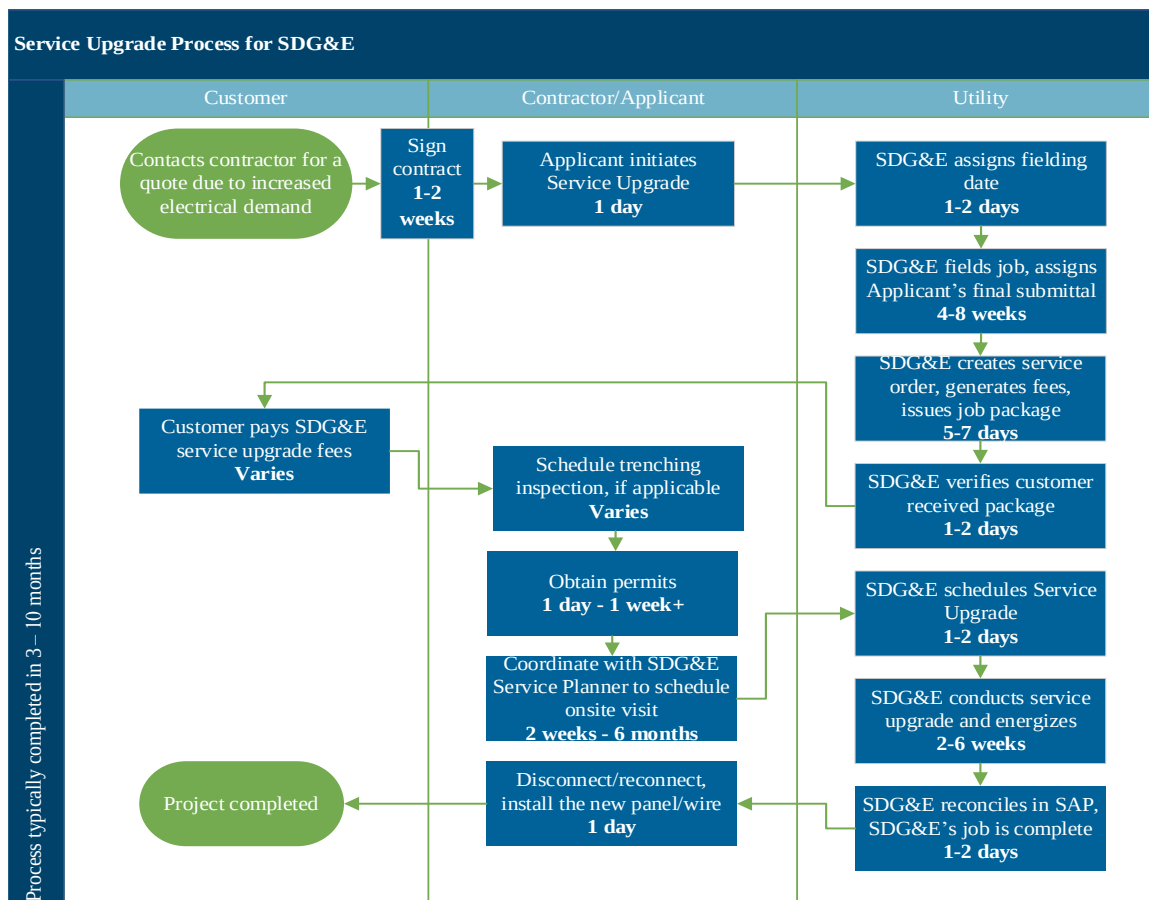


Figure 2. SDG&E Service Upgrade process reported by SDG&E utility staff and contractors.

Some customers describe the overall Service Upgrade process as confusing, and it took longer than expected, often exceeding six to nine months. Some customers stated there was a lengthy waiting period between the initial application and initial project estimate from the Utility.

Some Utility staff SMEs reported a perception that a lot of time is spent communicating with customers as opposed to reviewing and processing Service Upgrade applications. This may be due to a variety of issues including time spent addressing customer response accuracy, a lack of automated updates to customers through SAP, time needed to fully address customer questions and concerns, and time spent educating customers on the process.

Applications with missing or erroneous information may be voided by one Utility after 30 days of no applicant update, requiring a full application restart despite any work previously reviewed.

Some Utility staff and contractors reported they would benefit from customers and contractors having access to increased educational information on the process, requirements, and costs associated with Service Upgrades. There are manuals and guidance docs available such as Utility's Electric and Gas Service Requirements, but contractors were unaware of them.

SDG&E staff SMEs reported that it is common for solar photovoltaic sales teams to submit Service Upgrade applications for a batch of customers in a neighborhood that they canvass prior to signing an agreement. This results in Utility staff working on applications that typically never become projects. PG&E did not report this issue which may be due to the requirement to submit load calculations and onsite photos as part of the application.

Pacific Gas & Electric Company Process

PG&E also provided the following detailed process which is summarized below and shown in Figure 4 with the responsible parties and timeline. PG&E's Service Upgrade process is initiated when the customer submits a request online or over the phone. PG&E assigns a staff member (Job Owner) who has a conversation with the customer to understand the basic parameters of the project. The customer is then required to submit an engineering advance to begin PG&E's engineering reviews of the project to begin. An engineer develops an estimate, and the customer signs a contract with PG&E for the work. The customer completes any work on their end such as trenching that must be completed and then PG&E inspects. The last step reported by PG&E is completion of the Service Upgrade.

Contractors report the Service Upgrade process starting with the homeowner calling the contractor for a quote. Over the next one to two weeks, the contractor gathers information, and they sign a contract. The contractor takes photos and submits them to PG&E as part of the online Service Upgrade application. Contractors reported the ease of using the online system, the time and effort saved by PG&E requiring photos to be submitted with the application and the time necessary to complete the application which is only 15 to 30 minutes. The contractor waits to hear from the PG&E representative over the next three days. The lead time up to six months was reported by contractors because two site trips are required. The PG&E rep will then call the contractor with questions if more information is needed. PG&E confirms approval over the next two to seven days. The contractor obtains the permit from the authority having jurisdiction (AHJ) which is reported to take between one day and four weeks. The contractor schedules a disconnect with PG&E that will be over the next five days to eight weeks. After a field visit to complete the AHJ inspection and a disconnect/tear down, PG&E reconnects the electrical, and the installation is complete. From the contractor's perspective, the Service Upgrade process can be as little as two days and upwards of eight months from start to finish.

Figure 3 combines the information from PG&E on the Service Upgrade process along with the process and timeline data reported by contractor working in the PG&E service territory. Overall, the total Service Upgrade process is typically completed within ten to 30 days but projects up to eight months were reported.

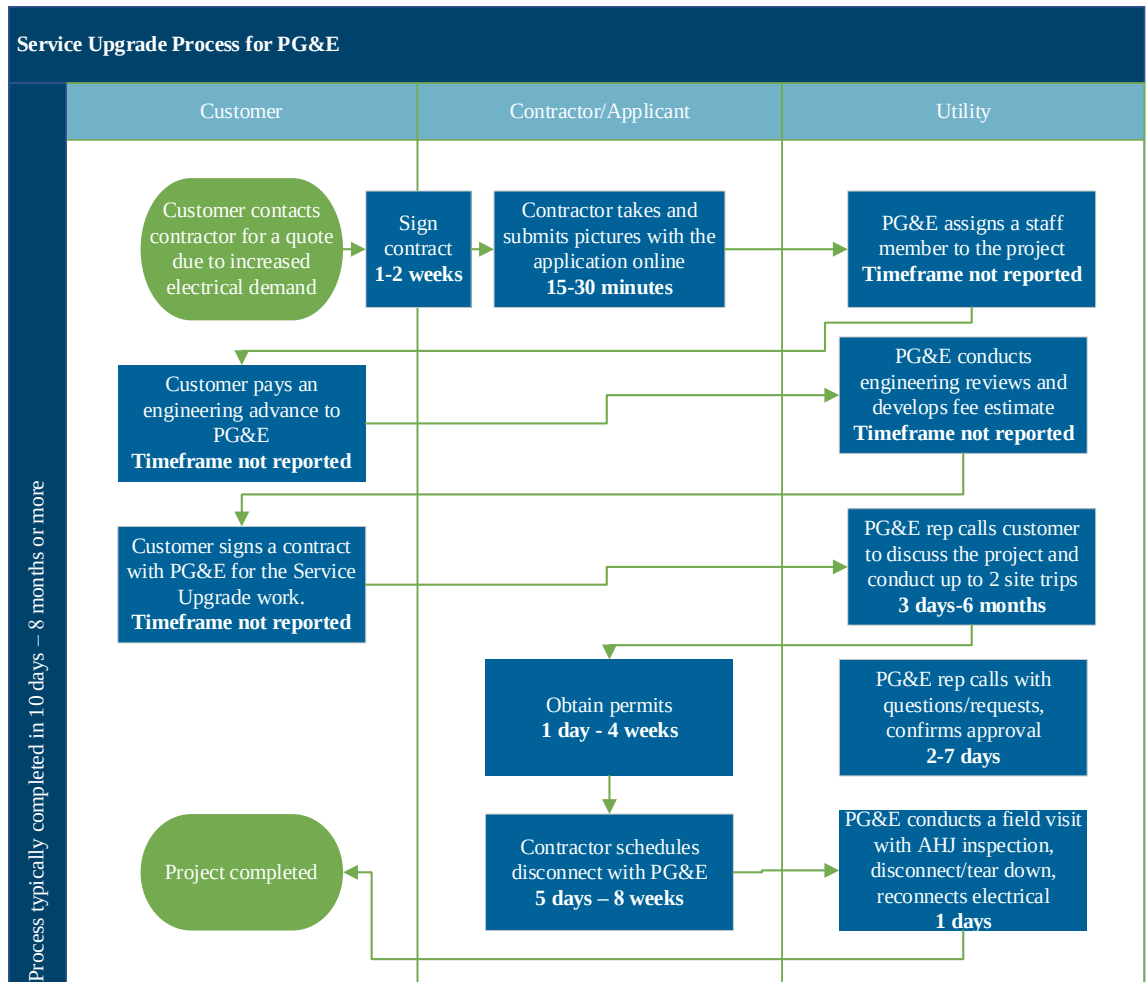


Figure 3. PG&E Service Upgrade process reported by PG&E utility staff and contractors.

Service Upgrade Costs

The typical costs associated with increasing electrical capacity in residential retrofits fall into three categories – Utility Service Upgrade costs, customer-owned equipment costs, and other miscellaneous project costs which may apply. The total cost for all three categories was reported to range between approximately \$2,000 to well over \$30,000 or more.

Utility Service Upgrade Costs

Rules 15¹ and 16² govern the allowance for Service Upgrades totaling \$2,154 for PG&E and \$3,241 for SDG&E shown in Table 2, which is the amount the utility initially covers on

¹ PG&E Website. "PG&E Rule 15". Accessed February 2022, https://www.pge.com/tariffs/assets/pdf/tariffbook/ELEC_RULES_15.pdf

SDG&E Website. "SDG&E Rule 15" Accessed February 2022 https://www.sdge.com/sites/default/files/elec_elec-rules_erule15.pdf

² PG&E Website. "PG&E Rule 16". Accessed February 2022: https://www.pge.com/tariffs/assets/pdf/tariffbook/ELEC_RULES_16.pdf

behalf of the customer, as filed in rate case proceedings. However, a Utility contractor reported that despite the Utility supplying the materials for service upgrades — wire, conduit, pole changeouts, and transformer upgrades, etc. potentially paid by the customer to the Utility — the cost the contractor would bill the Utility may still range between \$2,000 and \$30,000 for the labor, excluding any customer owned equipment.

Table 2. Rules 15 and 16 Allowances

	PG&E	SDG&E
Allowance*	\$2,154	\$3,241
Cost of Service Factor**	14.64%	14.63%

* Allowances are set as the distribution line and service extension portion of the (Utility Net Revenue) divided by the (Cost of Service Factor). Defined in Rule 15 Section C.3

** The Cost of Service Factor includes depreciation, return, income taxes, property taxes, Operating and Maintenance (O&M), Administrative and General (A&G), Franchise Fees and Uncollectible Expenses (FF&U) and replacement of facilities for 60 years at no additional cost to customer. Defined in Rule 15 Section J for SDG&E and Rule 2 Section 1.3.b for PG&E

Those material costs may also be passed onto the customer in certain circumstances, such as in the case of a transformer replacement. Utility SMEs and data request responses reported that if the transformer needs to be replaced and upgraded, the homeowner bears:

- 100% of the cost if they are the only home on the transformer
- 50% of the cost if the transformer is shared with another property
- 0% of the cost if it is shared between three or more properties. In this case the Utility bears 100% of the transformer upgrade cost.

The average costs reported by the contractors is shown in Table 3 below. However, as the Utilities did not provide their actual contractual Service Upgrade costs due to privacy reasons, these costs were reported by electrical contractors who have performed work on behalf of the utilities in the past.

SDG&E Website. "SDG&E Rule 16" Accessed February 2022:
https://www.sdge.com/sites/default/files/elec_elec-rules_erule16.pdf

Table 3: Utility Service Upgrade Costs for Utility/Public Right-of-Way Property

Cost Description	Average cost	Transaction			
Transformer Upgrade	\$6,000 - \$8,000		Homeowner	→	Utility 
Pole Replacement	\$9,000 - \$11,000		Homeowner	→	Utility 
Total New or Upgraded Utility Equipment Service	\$10,000 - \$30,000		Utility	→	Contractor 
Overhead line, service line only	\$2,850 - \$4,500 (Utility supplies materials)		Utility	→	Contractor 
Overhead line with a new Utility pole	\$11,000 - \$13,000 (Utility supplies materials)		Utility	→	Contractor 
Overhead to underground conversion	\$13,000 - \$18,000 (Utility supplies materials)		Utility	→	Contractor 
Trenching for underground upgrades	\$180 to \$200 per llinear foot (Utility/Public Property)		Utility	→	Contractor 

Customer-owned Equipment Costs

Customers are responsible for electrical panel upgrades with costs ranging between \$2,000 and \$4,500 with an average cost of \$2,780 as reported by electricians. This cost does not include additional customer costs incurred if they are responsible for any portion of Utility infrastructure — pole changeouts, transformer upgrades, conduit replacement — or other costs such as sub-panels, excessive run distances, new breakers, trenching, etc. All together, these costs can range from \$3,000 to more than \$18,000.

Overhead to underground conversions or panel relocations on the homeowner's property typically resulted in costs ranging between \$3,000 and \$10,000 on average, compared with the average overhead service upgrade cost range between \$2,000 and \$4,500.

Other Miscellaneous Costs

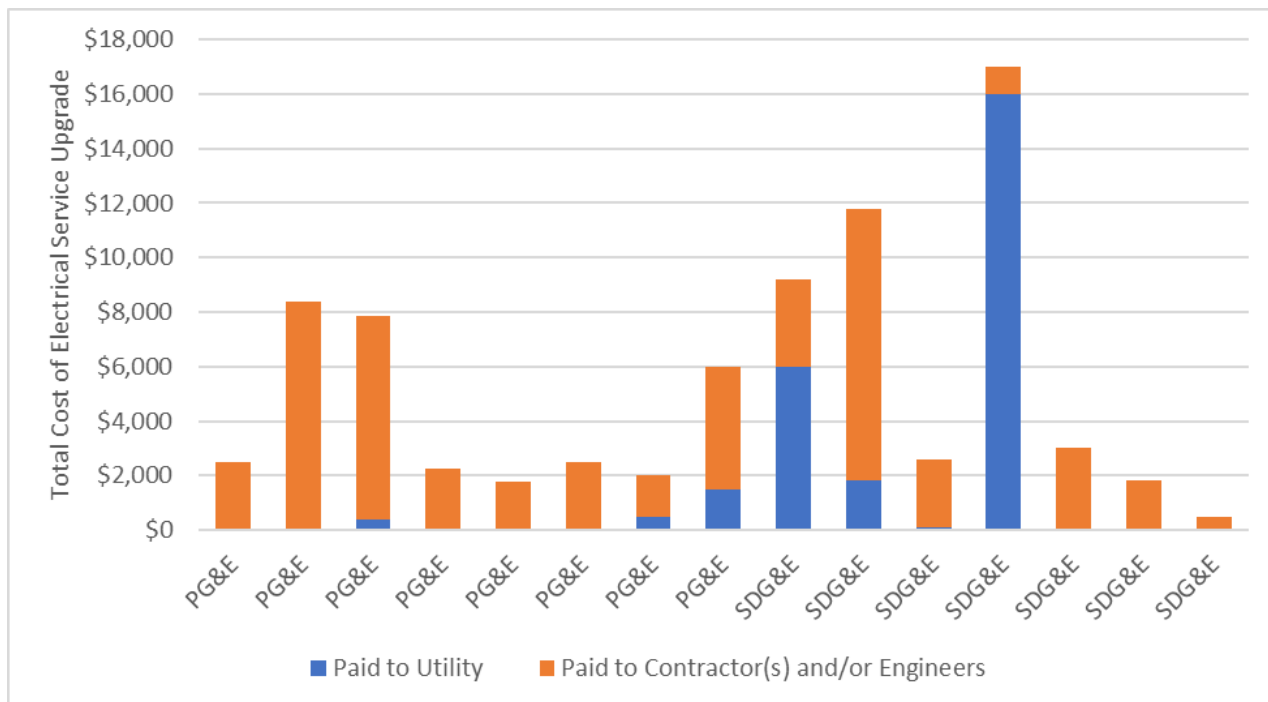
Other Service Upgrade related costs the customer may typically be responsible for, but not limited to, include trenching, permits, easement costs, conduit replacements, grounding, taxes, and other design or application fees. Additionally, costs may be incurred due to errors in the process, as reported by one homeowner who was instructed to relocate the gas meter, then once that was paid for, was told that it had to be moved to yet a different location, resulting in more expenses incurred.

Table 4: Miscellaneous Service Upgrade Costs

Cost Description	Average cost	Transaction
Permit Costs	PG&E Territory: \$125 - \$500 Arcata, CA: \$129 Humboldt County: \$132 Other Northern Counties: \$125 - \$140 SDG&E Territory: City \$128, County \$136	 Homeowner → Contractor  — OR —  Homeowner → City/County 
	Contractor "Bundled" Fee: \$500 (All Permit + Labor Fees in one)	 Homeowner → City/County 
Upgrade/New Branch Circuits	\$250 - \$700 per circuit	 Homeowner → Contractor 
Trenching & Conduit	\$5 - \$15 per linear foot (Homeowner Property)	 Homeowner → Contractor 

The total cost for a Service Upgrade as reported by homeowners in the survey results is shown in **Error! Reference source not found.**5 below.

Table 5. Total Cost of Service Upgrades as Reported by PG&E and SDG&E Homeowners



The outlying respondent in Table 5 that reported a \$16,000 total cost for the Service Upgrade had the following statement about the major challenges faced during the Service Upgrade: “Inspection prior to start by SDGE was flawed. She told me I had to move the gas line prior to being able to upgrade my power panel. I paid \$1,002 dollars to move the gas line and when she came back, she said there was another issue with the gas line, and it would have to be moved again. She had a person with her who was 'in training' and she was supposed to be the trainer? Completely unnecessary and additional cost on the project (along with delays)”

Service Upgrade Alternatives

Most customers and contractors are unaware of available options to mitigate the need for a panel upgrade that would trigger a Service Upgrade. A leading driver for Service Upgrades in California is solar PV and driven by a customer’s desire for a certain amount of energy offset, available roof space and shape. Although the average residential solar installation size in California is 5 kW DC, cost-effective energy efficiency measures can help reduce the overall size of a customer’s PV offset. That in turn may allow more customers to size a PV system under the code limits of their existing panel, from 3.8 kW for 100-amp busbars, up to a maximum of 13.4 kW for 225-amp service busbars with a 200A main breaker. Section 705 of the electrical code prescribes that when a customer’s busbar rating is higher than their main panel rating, they can install more solar than if the panel rating and busbar rating were matched. Additionally, some solar inverters enable more PV capacity than the inverter outputs to the grid, meaning more

capacity is available across the day. This is known in the industry as “clipping” and may reduce the AC nameplate size needed.

Electricians reported that installing a 240-volt EV charger is a common reason for a panel upgrade and a resulting Service Upgrade. It is also one of the most avoidable. Customers who travel less than 20,000 miles per year in their commute can charge effectively from a 120-volt charger with the electrical outlets already found in the customer’s garage.³ A 240-volt Level-2 EV charger that requires a new 240-volt circuit is generally unnecessary and alleviates the need for a panel upgrade. If a customer drives over 20,000 miles per year and a 240-volt Level 2 EV charger is necessary, there are several smart circuit and power sharing devices available today. These devices share power between an EV and another device on the panel including the NeoCharge Smart Splitter, the SimpleSwitch 24-volt Circuit Switch, and the EVduty Smart Current Sensor, which are all Underwriters Laboratory (UL) Listed. If the EV is the trigger for the upgrade, selecting one of these options would be much less expensive for customers than upgrading their service panel that triggers a Service Upgrade. Figure 4 provides three smart circuit products and pricing.

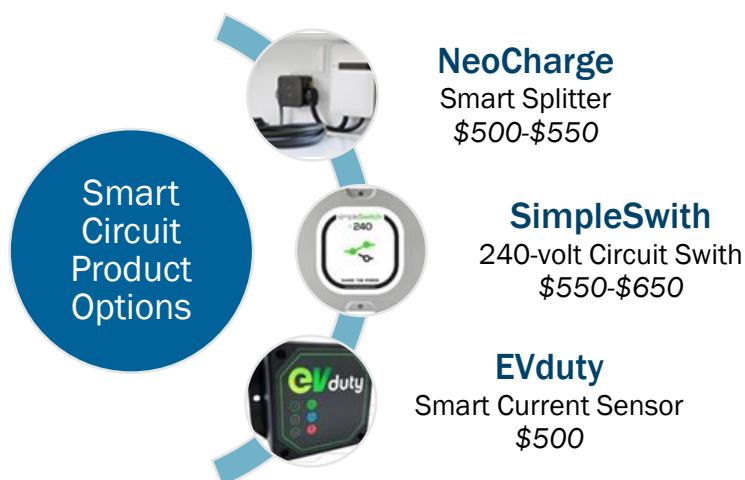


Figure 4. Smart Circuit Products and Sharing Devices

Since most homes built after 1968 have 100-amp service, a panel upgrade can be avoided in many cases. From 1965 to 1967, single family homes in California began to be required 100-amp electrical service, regardless of load calculations required. This means that there is a subset of older homes on less than 100-amp service, but there is also a high level of confidence that a home built after 1968 has at least 100-amp service already. Approximately 71% of homes should have at least 100-amp panels based on the year the home was built and should not need a panel upgrade that triggers a Service Upgrade. Of the remaining 29% of older homes, any that added air conditioning would have since upgraded to 100A and should not require a panel upgrade. Figure 2 illustrates the relative age of the owner-occupied housing stock in California.

³ U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy.
https://afdc.energy.gov/files/u/publication/electric_vehicles.pdf

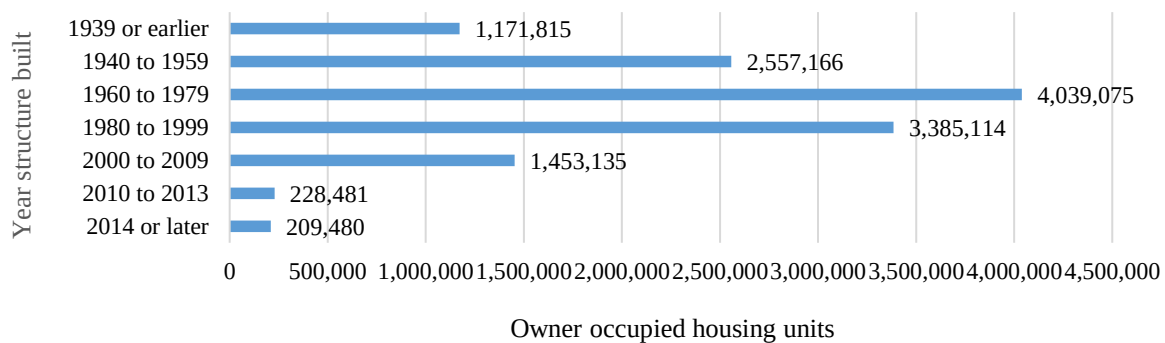


Figure 2. 2020 US census data on the age of housing stock in California. *Source:* US Census Bureau

Most gas water heaters currently have a 120-volt circuit to the appliance, and this can either be upgraded to 240-volts or it can be kept on a 120-volt circuit to avoid some Service Upgrades due to insufficient breaker space. Almost all heat pump water heaters on the market are currently 240/208 volts, but manufacturers like Rheem and Haier are bringing 120-volt water heaters to the market. These 120-volt standalone units are intended to be a near drop-in replacement for a standard gas-fired storage tank water heater, without requiring expensive 240-volt circuit upgrades from the currently available heat pump water heaters.

To help prevent the need for some panel upgrades, a helpful tool is the “Watt Diet” Calculator⁴ which determines the size of a home’s electrical panel according to the code requirements. It does the load calculations that an electrician would do, with the goal to reduce the required panel size. An all-electric home with an EV charger can be as big as 2,000 square feet in most of California, fit on a 100-amp panel, and alleviate the need for a Service Upgrade.

Key Recommendations

Service Upgrade Triggers

Service upgrades are triggered by electrical panel upgrades that are often avoidable due to a lack of contractor education and incentives.

1. Leverage Workforce, Education, & Training (WE&T) programs to integrate education on the options to mitigate the need for a panel upgrade. Electricians drive the decision to upgrade in the face of the cost. Increase contractor awareness of the existing Utility Electric and Gas Requirements Manual.
2. Incentives to avoid panel upgrade. Consider nonfinancial and financial program incentives that encourage mitigating the need for upgrading a customer’s electrical panel that will trigger a Service Upgrade. Consider the Peninsula Clean Energy’s rebate structure which financially incentivizes everyone to have 100-amp service but reduces the existing incentive available for upgrading to 200-amp at a progressively

4 Redwood Energy Website. “Watt Diet Calculator.” Accessed February 2022. <https://redwoodenergy.net/watt-diet-calculator/>

- decreasing level based on customer income, while increasing customer education about “power efficient” appliances, load balancing devices and smart panels for 240-volt appliances.⁵
3. Require inspectors to assess the need for a panel upgrade and provide a report to the customer. In addition to contractor education, Utility and Building Department inspectors should be trained to assess the need for a panel upgrade and provide the customer with a panel report and a leave-behind pamphlet explaining options to avoid the need for a panel upgrade and potential cost savings. This recommendation also supports decreasing the Service Upgrade cost category below.

Service Upgrade Process

To improve the Service Upgrade process, the Utilities must improve the timeline, improve communication with the customer, and right-size resources to meet the customer’s increasing demands.

1. Expand existing software platform for Service Upgrades to reduce customer confusion, set timeline expectations, and reduce time spent by Utility staff communicating with customers. Improve upon and expand the Utilities’ existing customer-facing software platform to enhance the customer experience and “at will” information exchange. The system should focus on the timeline and cost expectations, frequently asked questions, and provide customers and contractors with automated status updates with important notifications to understand steps completed and upcoming requirements. The system must identify and track issues with applications reported by Utility SMEs during any stage of the application to reduce the administrative burden on Utility staff. It must allow more detailed customer project tracking than currently available.
2. Develop a system for Utility staff to visualize capacity constraint. Utilities should consider tracking the location of Service Upgrades on a neighborhood or multi-group level and flag those areas as potentially requiring more extensive distribution level upgrades as electrification adoption increases.
3. Leverage existing resources. Consider leveraging internal Utility continuous process improvement resources that will assess and report on the Service Upgrade timeline, process automation and system upgrades.
4. Develop and share Utility-specific best practices. There are differences between the PG&E and SDG&E Service Upgrade process. The Utilities will benefit from sharing best practices and lessons learned for processes and customer application intake, requirements, and scheduling.

Service Upgrade Costs

The customer pays a contractor for the home upgrades but, in addition, must pay the Utility up to \$30,000 or more to upgrade the Utility’s infrastructure from the customer’s meter to the pole. The key recommendations that will decrease Service Upgrade costs.

⁵ Peninsula Clean Energy. “Heat Pump Water Heater Rebates.” Accessed April 2022.
<https://www.peninsulacleanenergy.com/heat-pump-water-heater/>

1. Leverage industry best practices to conduct education and training for contractors and inspectors on the options to mitigate the need for a Service Upgrade, the process, and all costs associated with a panel upgrade and Service Upgrade.
2. Increase the Rule 16 allowances to reduce the cost burden on the customer. Identify other incentive mechanisms to offer incentives to customers to further reduce the cost burden of the Service Upgrade, particularly during electrification retrofits. These incentives could be included in parallel to statewide decarbonization, demand response, energy efficiency third-party, EV charging, or self-generation incentive programs.

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