United States Department of the Interior
National Park Service

National Register of Historic Places Multiple Property Documentation Form

This form is used for documenting property groups relating to one or several historic contexts. See instructions in National Register Bulletin *How to Complete the Multiple Property Documentation Form* (formerly 16B). Complete each item by entering the requested information.

__X_____ New Submission ________ Amended Submission

A. Name of Multiple Property Listing DRAFT

Pacific Gas and Electric Company Historic-Era Electrical Infrastructure

B. Associated Historic Contexts

(Name each associated historic context, identifying theme, geographical area, and chronological period for each.)

Context: Historic-era electrical infrastructure
Themes:

Origins of California's Electrical Industry	1849–1906
A Company Born from Many	1905
Transformative System Expansion	1906–1930
Depression and a Paradigm of Growth Tested	1930–1941
A Nation at War, an Industry Revived	1941–1945
The Post-War Era and California Unleashed	1945–1973
The Changing Face of Energy	1973–Present

Context: Architectural Styles of PG&E's Historic-Era Infrastructure
Themes:

Utilitarian Period	1899–1910
Pacific Service Period	1911–1930
Great Depression and World War II Period	1930–1945
Post-World War II and Mid-Twentieth Century Periods	1946–1974

Geographical Area: The State of California, which includes federal, tribal, city, and county geopolitical subdivisions of northern California (Del Norte, Siskiyou, Modoc Counties) bordering Oregon south to Kern and Santa Barbara Counties.

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D. Certification

As the designated authority under the National Historic Preservation Act of 1966, as amended, I hereby certify that this documentation form meets the National Register documentation standards and sets forth requirements for the listing of related properties consistent with the National Register criteria. This submission meets the procedural and professional requirements set forth in 36 CFR 60 and the Secretary of the Interior's Standards and Guidelines for Archeology and Historic Preservation.

Signature of certifying official Title Date

State or Federal Agency or Tribal government

I hereby certify that this multiple property documentation form has been approved by the National Register as a basis for evaluating related properties for listing in the National Register.

Signature of the Keeper Date of Action

Table of Contents for Written Narrative

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Provide narrative explanations for each of these sections on continuation sheets. In the header of each section, cite the letter, page number, and name of the multiple property listing. Refer to *How to Complete the Multiple Property Documentation Form* for additional guidance.

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E. Statement of Historic Contexts
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E.1 Introduction

This chapter outlines the history of Pacific Gas and Electric (PG&E)'s historic-era electrical infrastructure, covering both California's electrical industry development and PG&E's growth. It provides a framework for interpreting and assessing significant themes related to PG&E's historic-era electrical network.

The selected contexts are structured as a chronological summary of the origins and evolution of PG&E, including key mergers and predecessor companies, technological advancement, and the company's impacts on broader California's energy framework.

Because PG&E's development rests upon the merger of more than 500 distinct predecessor companies, these contexts do not present a complete portrait of all branches of the development tree. Instead, they present an overarching chronology that provides a contextual basis for the following four major narratives of significance under the criteria of the National Register of Historic Places (NRHP) and California Register of Historical Resources (CRHR).

- The role of corporate organization in facility development and expansion.
- The role of technological innovation in electrical development and consumption.
- The role of architectural treatment and design in facility development.
- The role of electrical development in California's community development.

The historic contexts situate the role of each major theme in PG&E's chronological development and present the ways in which the themes may be embodied in the company's extant historic-era electrical infrastructure.

E.2 1849–1906: Origins of California's Electrical Industry

The pursuit and mastery of energy production were defining preoccupations of California and its residents during the period of early statehood. The discovery of gold in the Sierra foothills in 1848 triggered rapid population growth, with population increasing from 92,597 in 1850 to nearly 400,000 only a decade later. By 1890, population had surpassed one million. During this period of rapid growth, cities and towns emerged across the state's key geographic locales. San Francisco, Sacramento, Los Angeles, Fresno, and Stockton emerged as commercial and transportation hubs, and smaller towns dotted the foothills and valley floors. Although this urban growth was initially fueled by the mineral riches emanating from California's mines, as the population of the state grew so too did the intricacy and demands of its economy, with a host of development sectors arising to satisfy burgeoning local demand. Thus, the California Gold Rush was the transformative backdrop for California's subsequent agricultural, industrial, commercial, and social growth—each of which required immense stores of energy.

In 1850, energy production consisted of a small number of established mechanisms and materials, all of which had played prevalent roles through centuries of western development. Many operations remained human-powered, with manual labor accounting for much of the energy expenditure behind agricultural and industrial tasks. The period was also characterized by the centrality of the domesticated animal, with mules, oxen, and horses serving as a mainstay of mechanical energy. Augmenting these age-old supplies, nineteenth-century energy production benefited from using materials including wood, coal, water, whale oil, and tallow, all of which played key roles in energy production for lighting, heating, and mechanical or motive needs.

California's particular geographic and geologic constraints repeatedly stymied energy production for California's earliest American residents and regional promoters. Supplies of wood were limited and expensive because most forest cover was in the mountains far from the growing population centers. The supplies that were locally available quickly diminished. The *California Culturist* lamented in 1860, "The trees which formerly stood on the hills of Contra Costa and Alameda, visible from the Bay, are to be seen no more [and] the magnificent oak groves of Oakland and Encinal have been so thinned and mutilated to furnish a supply of fuel." Adding to the energy paucity, California's coal supplies were few and generally of poor quality compared with much of the Eastern United States. Additionally, although the Sierra was awash with water, the lands near population centers were generally arid or defined by seasonal drought, precluding development of even small-scale water wheels in most localities and farms. Thus, even as California was heralded as a verdant land of plenty to an increasingly populous number of settlers, the state had few ready resources to address heat, light, and mechanical needs.[1]

Throughout the 1850s, a patchwork of energy development sought to shore up the energy imbalance that characterized the new state. In San Francisco, four whale oil refineries worked full tilt. By 1859, seven camphene refineries dotted the city, refining fuel oil from turpentine shipped around Cape Horn. During the same period, kerosene made its debut on the national market. Kerosene was commonly sold in California by 1860, and was readily adopted for domestic lighting, and to a lesser degree for heating and cooking. Distilled initially from coal and subsequently from increasing large supplies of newly discovered petroleum, kerosene offered a brilliant light that far surpassed the brightness of camphene. Additionally, kerosene proved far less combustible—a factor of great import during the era of wood-framed cities. By the 1880s, Californians were using millions of gallons of kerosene a year, with a host of domestic products developed to integrate kerosene into daily domestic life.[2]

E.2.1 Manufactured Gas

The most critical energy advancement to emerge during this period was the adoption and steady dispersal of urban manufactured gas. As early as the 1830s, eastern United States utilities had experimented with manufactured gas, deriving liquid fuel from a distillation of available organic substances, including fats, oils, coal, petroleum, rosin, and wood. By the 1840s, bituminous coal had emerged as the fuel source of choice for manufactured gas, with more than 50 coal-based manufactured gas plants operating in urban areas of the United States by 1850. In contrast to other traditional urban fuel sources, utilization of manufactured gas relied on substantial infrastructural planning and development as the gas was relayed from manufacturing plants to consumer via networks of buried street mains. In this sense, the introduction of manufactured gas became a broadly civic undertaking in a manner that far surpassed any efforts to date, with franchises granted by cities to private concerns and a substantial permanent urban infrastructure underlying development.[3]

California's first manufactured gas franchise emerged in San Francisco in 1852, when brothers Peter and James Donahue established the San Francisco Gas Company and developed a coal gas plant at First and Fremont Streets. The company initially laid mains in the central portions of the city, fueling approximately 100 city streetlights and select residential and commercial properties. The initial system was completed in 1854, heralded by a well-publicized celebratory banquet of lights at the Orient Hotel:

> Last evening, between six and seven o'clock, the streets of San Francisco were lighted with gas for the first time…A cheerfulness seemed to pervade the streets that has never been among us before. In travelling over the muddy sidewalks and in wading through the street crossings, there was a light ahead which showed the pedestrian how to pick his way, and seemed as sort of a guiding star through the mud. The lights burned very brilliantly, and it required only a larger number of them to render our streets as light as day. The good results from the introduction into the city are almost incalculable. Beside the greater accommodation, the safety of life and property will be very much increased, and when the streets are more generally lighted, the frequent midnight robberies and burglaries will materially decrease in number.[4]

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1 Firewood, *California Culturist,* July 1860, 19; James C. Williams, *Energy and the Making of Modern California*, 36–53; "Is There Good Coal in California?" *Daily Alta California,* December 14, 1858, 2.

2 James C. Williams, *Energy and the Making of Modern California*, 53-70; Richard Rhodes, *Energy: A Human History* (New York: Simon and Schuster, 2018), Chapter Nine; "Coal Oil Nuisances," *Daily Alta California,* June 10, 1886, 7.

3 Charles M. Coleman, PG&E of California: The Centennial Story of the Pacific Gas and Electric Company, 1852-1952 (New York: McGraw-Hill Book Company, 1952), 10-18; James C. Williams, Energy and the Making of Modern California, 53-70; "Early History of Wrought Iron Gas Pipe," The Gas Industry July 1921, Volume XXI,174.

4 "San Francisco by Gas-Light," *Daily Alta California*, February 12, 1854, 2.

Following this, San Francisco Gas Company continued to expand throughout the city, extending mains and bolstering capacity through the addition of multiple plants. From this beginning, San Francisco Gas Company would become one of the key corporate foundational antecedents of PG&E.

With San Francisco's successful integration of manufactured gas, virtually all of California's cities and regional centers followed suit. Sacramento Gas Company incorporated in 1854, with service initiated in 1855. In 1858, Marysville Coal Gas Company formed, followed by Stockton Gas Company and Nevada City Gas Works in 1859, San Jose Gas Company in 1860, Grass Valley Company in 1862, Oakland Gas Light Company and Vallejo Gas Light Company in 1866, Napa City Gas Light Company in 1867, San Rafael Gas Company in 1871, and Eureka Gas Works in 1878. Most manufacturers used coal, much of it shipped around Cape Horn, with several locales supplementing with locally available sources including pitch pine wood to minimize the high cost of production and coal shipping. Additionally, as early as 1864, Stockton was producing locally sourced natural gas, which was readily adopted and ultimately served to supplant manufactured gas during the first decades of the twentieth century.[5]

The importance of the manufactured gas boom in California was two-fold. First, it radically changed urban social expectations regarding energy infrastructure. Where the buried mains and glowing lights at first seemed a novelty, by the 1880s they were viewed as a vital component of California's urban locales—in both the street and, increasingly, the home. Across the state, manufactured gas lighting systems were credited with drops in crime, rising property values, and increased commerce and industry as the strictures of night were systematically dismantled by radiating energy networks. Essentially, the sophistication of manufactured gas created a market for, and expectation of, a heightened level of urban energy infrastructure—a demand that would grow exponentially during the ensuing decades as California's utilities, led by Pacific Gas and Electric Company (PG&E), introduced radical technological advancement in the field.[6]

The second critical legacy of manufactured gas in California was commercial and institutional. The manufactured gas plants that proliferated in the state's late-nineteenth-century cities were established by a slew of regional business and economic interests, with hundreds of firms vying for franchises across the state. As an example, while Peter and James Donahue's San Francisco Gas Company was the first to receive a franchise in San Francisco, almost immediately they were faced with a range of competitive advances from rival companies. As recorded in a somewhat scathing manner in the *Daily Alta* of 1852:

> The contract made by the select committee on gas of the Common Council with James Donahue and Company to light the city with gas was confirmed by the Board of Assistants last evening. It may now be considered as a law. Distressingly, the Assistants refused to entertain a proposition made by Messrs. V. Turner and Co. who offered to do the same work for 12 ½ cents cheaper for each light furnished. They thought it came a bit too late, notwithstanding it would save the city several thousand dollars per year. It is nothing more than might have been expected from that body.[7]

Even with early competition stifled at the starting gate in San Francisco, by 1857, a competing Aubin Patent Gas Company had built a gas plant in San Francisco. The company quickly failed; however, and all its holdings were purchased by the Donahue's San Francisco Gas Company, thus marking that institution's first merger. In 1863, Citizens Gas Company set up shop at King and Second Streets in San Francisco. This company was also promptly bought out by the Donahues, further enlarging San Francisco Gas Company. Next, City Gas Company emerged in San Francisco in 1870, bankrolled by several prominent figures including land speculators J.B. Haggin and Lloyd Tevis. The well-funded company laid competing mains, leading to a protracted war of attrition as both companies slashed prices and vied for market dominance. Ultimately, the two merged and formed San Francisco Gas Light Company in 1873, with a merged capital of 10 million dollars. As documented by historian Charles M. Coleman in *PG&E of*

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5 Charles M. Coleman, PG&E of California: The Centennial Story of the Pacific Gas and Electric Company, 1852–1952, 9–92; James C. Williams, Energy and the Making of Modern California, 53–70,115–168; "Auld Lang Syne," The Journal of Electricity, Power, and Gas, August 1904, Volume XIV, No.8, 287–298.

6 James C. Williams, Energy and the Making of Modern California, 53–70,115–168.

7 "Lighting the City with Gas," *Daily Alta California*, August 19, 1852, 1.

California: The Centennial Story of Pacific Gas and Electric Company, 1852–1952, "Ultimately Peter Donahue recognized that duplication in public utility service is costly—that two organizations, two plants, two lines of pipe in a single street, could not serve the customers on that street at as low rates as could one. Doubling the expense of service was not the way to rate reduction. Consolidation and efficiency were the answers." This operational vision of consolidation became central in the unfolding story of utility expansion in the decades that followed.[8]

During the period, a consistent pattern of competition and consolidation occurred across the state, with small-scale concerns vying for territorial acquisitions in nearly every service area. The result was the progressive consolidation of territory, financing, and technical expertise, as larger consolidated companies steadily emerged from the myriad jostling enterprises that characterized the early period of utility establishment. This concentration served to both increase the capital of the era's winners and allow for increasing technical advances, as engineers and developers of key systems gained increased territory and financial resources. This theme of concentration remained a defining characteristic of the utility industry as it emerged into the twentieth century and ultimately diversified from manufactured gas to widespread electrical development.[9]

E.2.2 The Advent of Electricity

Even as California's gas entrepreneurs jockeyed for position in an increasingly crowded field, the nascent utility industry was poised for transformation with the commercial advent of yet another technological advancement—electricity. Although several key innovators had developed an increasingly sophisticated understanding of the properties of electricity during the first half of the 1800s, applications of the technology remained largely abstract in the public imagination until the 1870s. Grandiose allusions to electricity's potential were coupled with the advancements, typified by this 1853 editorial in San Francisco's *Daily Alta*:

> If this electrical experiment should succeed, as we heartily hope it may, the age of steam will rapidly pass away, so easy of production would be motive power, that manual labor would be rendered almost unnecessary and electricity be applied to the most common purposes of life. Anything, from a locomotive to a sewing needle could be driven by it, and at a near nominal cost. In fact, should the experiment succeed, the dream of perpetual motive power would be almost realized, for when the machinery were once set in operation it need never stop.[10]

With the development of arc lamp lighting during the 1870s and Thomas Edison's successful commercial development of the incandescent bulb in 1879, electricity quickly evolved from abstraction to reality. Electric-generation schemes gained financing and market share across the nation. Again, San Francisco led in electrical development, emerging as the first city in the state to develop a central station for generating electricity. The newly formed California Electric Light Company constructed the station in 1879, which used two steam-driven turbines with a generating capacity to power 21 lights. The turbines, which had been developed by Philadelphian Charles F. Brush in 1878, produced direct current (DC) power, then the technological forefront of electrical generation and distribution. DC power produced a single-current voltage, distributed via conductor to load centers in a limited radius.[11]

Constructed at Fourth and Market Streets, the generating station was a rudimentary affair, essentially a wood-framed, sheet-iron-clad shed. As described by California Electric Light Company founder George H. Roe:

> Being unable to obtain any information regarding the business of electric lighting because no electric lighting had been done, we determined to ascertain whether the business of renting lights could be made profitable; and for the purpose built a station, if station it could be called, for the purpose of ascertaining; first, whether it was practical to

8 Charles M. Coleman, PG&E of California: The Centennial Story of the Pacific Gas and Electric Company, 1852–1952, 30.
9 "Benefits of Consolidation as Applied to Small Gas Companies," *The Journal of Electricity, Power, and Gas*, August 1904, Volume XIV, No. 8, 286-288; James C. Williams, *Energy and the Making of Modern California*, 53-70,115–168.
10 Electrical Motive Power," *Daily Alta California*, September 26, 1853, 2.
11 Thomas P. Hughes, Networks of Power: Electrification in Western Society, 1880-1930 (Baltimore, MD: The Johns Hopkins University Press, 1983), 262–285; Charles M. Coleman, PG&E of California: The Centennial Story of the Pacific Gas and Electric Company, 1852–1952, 51–71.

> distribute lights throughout the city; and second, whether the people would take these lights and pay a price for them that would show profit.[12]

Despite the largely experimental nature of the venture, California Electric Light proved profitable. By the mid-1880s, the company served a variety of businesses in the city's commercial core, including Hastings Department Store, the San Francisco Post Office, and Bush Street Theatre. In addition, the company situated prominent electric streetlights in several locales, most notably in front of City Hall. Early company literature was rife with pointed suggestions for use of electricity, with an 1879 circular touting its benefits for [including emphasis], "FACTORIES, MILLS, SHOPS, DEPOTS, PARKS, DOCKS, OPEN SPACES, CHURCHES, PUBLIC HALLS, THEATRES, STORES, etc., and also in LIGHTHOUSES and as HEADLIGHTS for STEAMERS, FERRY-BOATS and LOCOMOTIVES; also for projecting VIEWS, DIAGRAMS, etc. in Lectures upon Scientific and other subjects." Although the company initially operated Brush Dynamos (an early type of electrical generator that powered early street lighting systems), by 1888, it had diversified to incorporate use of Thomas Edison's incandescent lighting, a technology that was steadily supplanting the Brush system. In addition to its San Francisco utility services, California Electric Light Company acted as a marketer and distributor of electrical apparatuses, selling dynamos and lamps to private and municipal buyers across the West. In this manner, electrical technology steadily disseminated during the period, quickly becoming an entrenched utility rival to manufactured gas.[13]

Like the commercial development of manufactured gas, the implementation of early urban electrical systems was characterized by a complex framework of competition and consolidation. In San Francisco, a well-funded competitor, Electric Improvement Company, emerged in 1887 to rival California Electric Light. After several years of intense competition and rate cutting, California Electric Light prevailed, absorbing its competitor in 1892. Despite this victory, continued competition threatened the company's San Francisco dominance, with Edison General Electric Company of New York entering the San Francisco market soon after. Navigating this threat proved far more complex, as Edison General Electric Company was backed by the powerful eastern Wall Street financial interest of J.P. Morgan and Company and held the exclusive rights to Thomas Edison's electrical patents. Ultimately, California Electric Light was able to negotiate a peace with Edison: the two companies essentially merged in the San Francisco market to form a single unified Edison Light and Power Company in 1891. In the years following the merger, an ever more dominant Edison Light and Power Company continued to rebuff San Francisco competition, absorbing Mutual Electric Light Company, Western Light and Power Company, Harbor Light and Power Company, Central Light and Power Company, and Martell Power Company. This general pattern was repeated across the region, with electrical utilities springing up in towns and cities across Northern California and consolidating in rapid succession.[14]

Even as the gas and electrical utilities were undergoing internal economic and territorial consolidation, the two industries were also poised to clash with each other. As electricity gained market share and technological credibility, the industry's rapid growth threatened the more established gas industry, with the gas mains laid in the 1870s and 1880s undercut by the growing network of electrical distribution wires in the 1890s. Initially, the competitive threat of electricity inspired a colorful period of mutual aspersion, with a newly formed Pacific Coast Gas Association attacking the merits of electricity and the electrical industry loudly predicting the demise of gas. Although much of this lobbying was carried out in the technical press, the public seems to have followed developments as well, as relayed in a thoughtful 1879 reflection in the *Daily Alta California*:

> There are many people who for some considerable time past put their faith in Edison, believing that through him they would ere long be greatly enlightened and enlighted. They have been scarey of gas and hopeful of electricity. But Edison's light, like confidence, is of "slow growth." However, there may be something behind all that he has said and promised, or been reported to have said and promised. The best proof, however, would be a satisfactory

12 California Electric Light Company Circular, 1879; Charles M. Coleman, PG&E of California: The Centennial Story of the Pacific Gas and Electric Company, 1852–1952, 51-71.

13 California Electric Light Company Circular, 1879; Charles M. Coleman, PG&E of California: The Centennial Story of the Pacific Gas and Electric Company, 1852–1952, 51-71.

14 Charles M. Coleman, PG&E of California: The Centennial Story of the Pacific Gas and Electric Company, 1852–1952, 51–79; James C. Williams, Energy and the Making of Modern California, 115–168, 199-218.

> light, and so much cheaper or better than gas, that no doubt of its superiority should remain. Primitive settlers on this continent have depended more or less upon pitch-pine knots or splinters; then, as pigs and cattle increased, upon lard-lamps and oil. Then the poor whale was made to yield his blubber, and then coal, and next coal oil, were successively put under contribution, and then gas came to the front. But the pine knots and splinters have, to a considerable extent, disappeared; lard and tallow have ceased to answer the taste's demand; whales have become scarce, and Nantucket's hundred ships have dwindled to a small fleet. Then coal oil was converted to gas, and next old earth poured out its kerosene. But the world wants a substitute, and Edison has been promising much, and boasting a good deal; but as yet performing very little toward satisfying public demand. However, he is now reported as saying to a friend, who asked something as to his electrical light so long promised: "If you entertain particular vicious spite toward anyone, unload your gas stock on him, and be quick about it." That would intimate that he would soon give the public an opportunity to light up their houses and stores with electricity, and at a rate which would run gas out of use. Can he do it? Performance is better than promises.[15]

Despite the vying prognoses of the demise of gas and electricity's gimmickry, the physical infrastructure of gas and electricity continued to transform the urban landscape in tandem. As each industry continued to expand, it became increasingly clear to all parties that neither would suffer a decisive demise at the hands of the other. Electricity continued to make strides in performance and applicability, with public and domestic lighting and a limited network of electric streetcars prominently representing its success. At the same time, the increasing availability of natural gas to supplant manufactured gas bolstered gas service, and a host of domestic improvements in gas heating, cooking, and lighting enticed a growing number of consumers. By the mid-1890s, the two industries had reached a stage of general rapprochement, finding an uneasy truce of specialized service niches. An 1893 convening of the Civil and Mechanical Engineers Society reflects this trend with a paper on "Gas versus Electricity for Illuminating Purposes" that succinctly delineated a detailed comparison of the merits of each. Author S.A. Court's conclusion presented an even-handed accounting of future prospects, stating, "Electricity has a great and near future in providing the best form of illuminating agent; while gas will always be of great service for heating, cooking, and motive power …At no very distant date we might find gas companies supplying non-illuminating gas only for heating and cooking."[16]

As gas and electricity services seemed headed for peaceful coexistence, the established trends of consolidation in each industry made the next great leap, with leading firms in each field adopting an opportunistic ethic of "if you can't beat them, join them." One of the first mergers was of San Francisco Gas Light Company and Edison Light and Power Company. The two companies formed a consolidated San Francisco Gas and Electric Company in 1896 with a capital stock of 20 million dollars. Within 10 years, this consolidated entity would become Pacific Gas and Electric Company, today's PG&E. As recounted by PG&E Historian Charles M. Coleman, "Consolidation of gas and electric companies solved the problems of competition and affected economic savings by joint operation. Management began promoting the advantages of gas fuel for cooking and heating and the benefits of electricity for light and power. As time went on and appliances were improved and multiplied, gas and electricity each found its place."[17]

E.2.3 Electrical Potential of Water

While the nineteenth-century precursors of PG&E's twentieth-century physical and operational development were deeply rooted in the urban economic, technological, and consumer-based cultural landscape, the most transformative strand ultimately proved to emerge from deep within the state's hinterlands—specifically the towering mountains of the Sierra Nevada. Although far removed from technological advances in the urban realm, the Sierra Nevada became the locus for California's advancing energy industry, ultimately serving as the key factor in the state's transformative campaign of electrification.[18]

Although the fervor of the California Gold Rush had receded by the 1890s, the extensive mining campaign had transformed the Sierra Nevada, with an estimated 8,000 miles of ditches, tunnels, flumes, and canals that altered the

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15 "Edison, Gas, and Electricity," *Daily Alta California*, April 22, 1879.
16 "Gas versus Electricity for Illuminating Purposes," *Journal of Gas Lighting, Water Supply, &c.*, January 17, 1893, 101.
17 Charles M. Coleman, PG&E of California: The Centennial Story of the Pacific Gas and Electric Company, 1852-1952, 82.
18 James C. Williams, Energy and the Making of Modern California, 168–199.

natural hydrography of the region. Expertise developed during the mining era left a cohort of experienced engineers fluent in water conveyance and control, tunnel driving, and high-head water delivery. Thus, as electricity came to the fore, this cadre of experts and, in turn, financiers, saw the logic and potential of water-driven electrical systems as an alternative to available steam- and coal-powered systems. As early as 1879, Nevada County's Excelsior Water and Mining Company had successfully developed a water-driven turbine, lighting three 3,000-candlepower arc lamps. Although limited in scale, serving only the mine itself with DC current, the development served as a proof of concept—that the ready abundance of the Sierra Nevada's water *could* readily create electricity, if only for a limited local audience.[19]

At hydroelectricity's inception, these limitations were largely defined by the technological precepts of DC transmission, which only allowed small distances before significant energy loss precluded viability. As late as the 1880s, transmission was limited to an approximately 10-mile radius, with available DC technologies precluding reliable delivery outside of a limited radius. Solving the transmission puzzle became the defining electrical pursuit of the late-nineteenth century, leading to the adoption of alternating current (AC) systems, which phased and stepped power along the transmission corridor to maintain voltage levels over increasingly long distances. AC experimentation began in Europe during the 1870s, and by the 1890s, had proved to be far more viable than DC. By the early 1890s, three-phase AC electrical transmission had been implemented at a number of hydroelectric plants in California, including Redlands Electric Light and Power Company's Mill Creek Power Plant, the Sacramento Electric Power and Light Company's Folsom Powerhouse, and the San Joaquin Electric Company's Powerhouse No. 1 on the San Joaquin River. At Mill Creek, AC transmission sent 2,400 volts of power 7.5 miles to the Redlands; at Folsom, 2 years later, transmission length had jumped to 22 miles, with an output of 11,000 volts; the same year, the San Joaquin Powerhouse sent 11,000 volts 37 miles to Fresno. While these distances and voltages seem modest in scale related to modern applications, they proved revolutionary in establishing the commercial viability of AC transmission in California. Rapid development followed, and by 1904, 31 hydroelectric plants had been developed in California.[20]

In 1920, PG&E added Spaulding No. 2 Powerhouse, and in 1928, added Spaulding No. 3 Powerhouse. Spaulding No. 3 Powerhouse was the first partially automatically operated powerhouse in the PG&E system. Dutch Flat and Drum No. 2 Powerhouses followed in the 1940s and 1960s, with Wise No. 2 Powerhouse added to the system in the 1980s.[21]

Establishment of the Drum-Spaulding Project was of major importance to both PG&E's institutional ascendancy and Northern California development as a whole. As described by Frank G. Baum, Drum provided the foundation upon which decades of utility development would rest:

> The Company now has plans for power development carrying it up to the 1920s in a series of installations for which the foundation is laid and the most difficult work, financially and physically, is already done. The future of the company is therefore very encouraging and the Company no doubt will be a very large factor—if not the largest factor—in the uniform and stable development of Central California. For hydroelectric power is ideal power, and electricity is the ideal method of distribution; and it requires no prophet to predict that the future civilization of California will be largely influenced by electric power.[22]

The Drum-Spaulding development did more than affirm PG&E's market dominance in the Sacramento Valley and Bay Area. The system allowed PG&E to establish its commercial and institutional identity through a cohesive monumental built form. The design of the plants and Cordelia Substation was of a heightened and unified architectural expression intended to convey the company's growing civic role in California life. As described by PG&E lead architect Ivan C. Frickstad, who designed the first phases of construction:

> It is fitting and proper that the buildings comprising a system made up of a number of plants which are dependent upon one another for the perfect fulfilment of their specific mechanical functions should be made to express this

[19] Charles M. Coleman, PG&E of California: The Centennial Story of the Pacific Gas and Electric Company, 1852-1952, 92–127.
[20] "Hydroelectric Power Development and Transmission in California," *Association of Engineering Societies*, Volume XXXIV, No. 3, 8–98.
[21] National Register of Historic Places Evaluation, PG&E's Drum-Spaulding Hydroelectric Project; "Starting the Drum Plant," *Pacific Service Magazine*, December, 1913, 219; "The Robot in Hydroelectric Operation—Spaulding No. 3," *Pacific Service Magazine*, Volume XVII, No. 12, April 1930, 383.
[22] "Starting the Drum Plant [etc.]," *Pacific Service Magazine*, December 1913, 219-228.

> relationship by carrying a consistent architectural theme…While each has been given an individuality, they are architecturally related…in rendering 'Pacific Service' to the customer.[23]

By the mid-1910s, PG&E oversaw both an expanded territory, with a major new power source stemming from the South Yuba and Bear River waters, and a solidified system, with updated substations, transmission and distribution lines, and rehabilitated manufactured gas and steam facilities pulling disparate company facilities under the PG&E masthead. Company maps from the period attest to the steady progression, with both the density and expanded reach of service readily evident.

In addition to the legacy of hydraulic expertise developed during the mining era, the intricate pattern of water rights that emerged from the period served as a key building block for future growth. By the 1880s, a handful of powerful water companies controlled much of the Sierra's water rights and water storage and diversion facilities. This intricate system was designed to support mining, with a somewhat scattered side effect of agricultural irrigation and domestic water development for the numerous towns dotting the foothills and valley floor. With the decline of surface mining and the eventual legislative demise of hydraulic mining, the established ownership and control system served as a ready springboard for electricity development. Within this context, mining customers of the earlier era were replaced by a growing wave of electrical entrepreneurs who envisioned generation that could rival the riches of mining. The import of this transformation was not lost on period commentators, with PG&E employee A.H. Markwart noting in 1927, "The old saying, 'Coming events cast their shadows before,' is peculiarly applicable in the story of hydroelectric power in California. Few, even of those who live in this State, realize that the discovery of gold, an epochal event, while of direct political and economic importance at the time and subsequently, was but a precursor of even greater things."[24]

Thus, by the mid-1890s, hydroelectricity was increasingly viewed as a possible, even probable, alternative to urban-based electrical-generating plants and natural or manufactured gas. By 1900, the promise of the abundant watersheds of the Sierra Nevada had met the increasingly solidified technological and economic networks of the state's population centers, providing the foundation for extensive twentieth century growth and setting the stage for the key utilities that would define the market. Almost immediately, the burgeoning hydroelectric industry became a critical component of California's conception of future growth, with the San Francisco Call summarizing:

> A new kind of hustler has arisen within the past three or four months, he has been rapidly multiplying and filling the earth. He is the promoter of new electrical enterprises, and especially the promoter of schemes for the long-distance transmission of electric power. The air of the whole Pacific Coast has all at once been filled with talk about setting up water wheels in lonely mountain places and making them give light and cheaply turn other wheels in towns miles away.[25]

Within this early cohort of hydroelectric entrepreneurs, an evolving series of companies established by entrepreneurs Eugene J. de Sabla, Jr. and John Martin emerged as the most influential force in Northern California's hydroelectric development. Their projects served to link the hydroelectric facilities of the Sierra Nevada with the far-removed and increasingly populous urban consumer market. De Sabla hailed from a prominent mining family that had lost its fortune in the Panic of 1893, leading the young engineer to set his sights on the quickly ascending realm of hydroelectricity. In 1892, he established Nevada County Electric Power Company, securing funds from a host of San Francisco backers to complete the Nevada County "Rome" Powerhouse in 1896. The powerhouse had an initial installed capacity of 300 kilowatts (kW), with power relayed to the mines and businesses of Nevada City and Grass Valley in Nevada County's Sierra Nevada foothills. In the planning and construction of the Nevada County Powerhouse, de Sabla had aligned with John Martin, who at the time was a commercial seller of industrial pig iron for U.S. Cast Iron Pipe Company. Although the two initially convened to discuss industrial contracts for iron, they ultimately formed a transformative business partnership that went on to develop several major power plants during the

[23] Cordelia Substation from an Architectural Standpoint," Pacific Service Magazine, April 1914, 362.
[24] Charles M. Coleman, PG&E of California: The Centennial Story of the Pacific Gas and Electric Company, 1852–1952, 92–127.
[25] Darrell W. Heinrich, "Mill Creek No. 1: Pioneering Commercial Electric Power," *Hydro Review,* October 2002; *San Francisco Call* Article quoted in *Energy and the Making of Modern California,* 177.

period. Their developments from this period formed the basis of PG&E's hydroelectric portfolio at company inception in 1905.[26]

The next major de Sabla and Martin project was a hydroelectric plant in Browns Valley, developed in 1897 and 1898 under the auspices of Yuba Power Company to serve the valley floor town of Marysville. The power plant had a capacity of 1,080 kW and 18 miles of transmission lines transmitted at 16,700 volts. Even as this powerhouse came on-line, de Sabla and Martin were laying the groundwork for more infrastructure, looking to the urban market of Sacramento. A notable drought during 1897 and 1898 had served to idle the city's emerging electrical rail car system, which was energized by electricity from Sacramento Electric Power and Light Company's Folsom Power Plant on the American River. With the turbines largely stalled at that plant, de Sabla and Martin negotiated a contract with Sacramento Electric Gas and Railway Company and planned an additional powerhouse on the Yuba River that could supply Sacramento with power via a 61-mile-long transmission corridor. In support of this effort, the two established a satellite company—Yuba Electric Power Company, which developed the Colgate Powerhouse and its transmission line to Sacramento in 1899. The plant was named for financial backer Romulus Riggs (R.R.) Colgate, a key de Sabla and Martin investor, and had an initial capacity of 2,700 kW, with power transmitted at 22,000 volts to Sacramento. A secondary 30-mile transmission line extended to Oroville.[27]

With the completion of Colgate Powerhouse, de Sabla and Martin controlled a sprawling but discontiguous energy network, with discrete markets radiating from their three key regional projects. Although this portfolio was substantial for the period, they still operated far removed from the important Bay Area market, which was roundly considered the energy prize because of its population density and burgeoning commercial and industrial base. By 1900, however, de Sabla and Martin had contracted with Oakland Transit Company, forming Bay Counties Power Company, to service an electric streetcar in Oakland. Although the ostensible purpose of the company was to supply Oakland's streetcars with power, the new corporation effectively brought de Sabla and Martin to the Bay Area as a single entity by consolidating Nevada County Electric Power Company, Yuba Electric Power Company, and Yuba Power Company into a single commercial entity. The merger also served to increase the capital available, with the new Bay Counties Power Company valued at five million dollars and holding an additional three million dollars in secured bonds.[28]

Armed with increased capital, the new power company completed the groundbreaking Colgate to Oakland Transmission Line in 1901. The line extended the 1899 Colgate to Sacramento line, lengthening the transmission distance to a record-breaking 142 miles, which by 1903 ran at a record-breaking 60,000 volts. The line was celebrated for its AC engineering innovations, which included a challenging crossing of the Carquinez Strait. Yet its critical legacy lay in the affirmation of the basic principle of hydroelectric connectivity, proving that the distant hydropower supplies of the Sierra Nevada could be harnessed to serve the demands and economy of the city through long-distance transmission.[29]

Bay Counties Power Company continued to expand, purchasing Butte County Electric Lighting and Power Company in 1902, thereby acquiring that company's existing Centerville Plant, developed in 1900. In addition, the company purchased water supplies of Cherokee Mining Company, thus assuring supplies for operation. By 1903, Bay Counties Power Company had constructed an additional powerhouse on the bank of Butte Creek, directly above Centerville. Named for its founder, the de Sabla Powerhouse had a capacity of 13,000 kW and a noteworthy hydraulic head, with

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26 Calisphere Digital Archive, accessed at: https://calisphere.org/item/657c3371f8fa5b12cb78e23164993479/, and https://calisphere.org/item/189dc72df053b409a1cf581b7397b293/, August 14, 2018; "The Story of the Nevada Power Plant," *Journal of Electricity Power and Gas*, Volume XXIV, No. 13, March 26, 1910, 267–276.

27 Charles M. Coleman, *PG&E of California: The Centennial Story of the Pacific Gas and Electric Company, 1852–1952*, 128-143; "History of Hydroelectric and Gas Development in Central California," *Progressive Age,* October 15, 1907, 580-587; Frederick Hall Fowler, *Hydroelectric Power Systems of California and their extensions into Oregon and Nevada* (Washington DC: United States Government Printing Office, 1923), 114.

28 Charles M. Coleman, PG&E of California: The Centennial Story of the Pacific Gas and Electric Company, 1852–1952, 128–143; James C. Williams, Energy and the Making of Modern California, 181.

29 "Hydroelectric Power Plants," *The California Journal of Technology*, 1907, 1-15; "Hydroelectric Power in California," *Page's Weekly*, June 2, 1905, 1191–1192; Historic American Engineering Record (HAER), Colgate-Oakland Transmission Line (HAER CA-190 and CA-191), PAR Environmental Services, Inc. on behalf of PG&E, submitted to the National Park Service February 1998. "The Bay Counties, California Electrical Transmission System, Colgate Plant," *Electrical World and Engineer* Volume XXXVIII, No. 13, October 12, 1901, 583-586.

the penstock dropping 1,531 vertical feet for delivery to the plant. Additionally, with its location directly adjacent to Centerville, the new de Sabla plant was an early representative of the integrated "Chain of Power" hydroelectric systems of the twentieth century, with flows continuing from one powerhouse seamlessly to efficient use at the next.[30]

With extensive supplies of hydroelectric power, de Sabla and Martin turned to consolidating the electric distribution system. Rather than continue to contract wholesale power with myriad small regional concerns, the two sought ownership of generation, transmission *and* the lucrative consumer distribution. In 1901, the two men formed California Central Gas and Electric Company and rapidly acquired small town utilities and distribution systems, purchasing 12 systems during the first year alone. As recounted by historian Charles M. Coleman, "The development was historically important. The magnet of centralized utility operation was beginning to draw the small particles together into a pattern. The result, accomplished at first somewhat haphazardly, was to be the PG&E integrated system."[31]

The fruition of this integrated system was further realized when Bay Counties Power Company and California Central Gas and Electric Company merged under single corporate ownership, forming California Gas and Electric Company on December 6, 1901. The new company was initially capitalized at 30 million dollars, a substantial sum that reflected both the extensive holdings of the combined companies and its assumed commercial promise as a unified entity. In an important sense, the merger reflected far more than simple corporate efficiency, as it served to weave together critical strands of the energy fabric: urban markets with rural generation areas, established gas networks with rapidly expanding hydroelectric supplies, and long-distance transmission corridors with a dense and lucrative distribution market. By 1902, the company's holdings represented the backbone of Northern California's energy framework. The company's transmission lines originating in Yuba and Nevada Counties coursed across the Sacramento Valley to Oakland, and a radiating network of distribution systems reached North Bay. Notably absent from this solidifying network, however, was a substantial footing in Northern California's most prized consumer market: the City of San Francisco. Addressing this gap became the primary impetus behind the creation of PG&E in 1905.[32]

In 1904, California Gas and Electricity came one step closer to realizing its Bay Area ambitions with the acquisition of yet another completed hydroelectric project—Standard Electric Company's Electra Powerhouse. The powerhouse was constructed in 1902 with a 100-mile-long transmission line that ran from the powerhouse's Mokelumne River site in Amador County to Oakland, San Jose, and San Francisco via a South Bay path that traversed and supplied suburban towns on the peninsula. While the 10,000-kW power plant was the first to supply hydroelectric power to San Francisco, its effect was muted because San Francisco Gas and Electric Company's regional dominance and aggressive protective maneuvering precluded distribution of the Electra Powerhouse's power in San Francisco. Thus, although the power supply was available, Standard Electric Company lacked contracts to distribute it in the city.

Despite the lack of a San Francisco market, the Electra Powerhouse's power gained a steady foothold along the peninsula. Standard Electric Company's founders, W.H. Crocker and European nobleman Prince Andre Poniatowski, had recognized the potential of this regional market early, acquiring multiple small-scale systems on the peninsula and supplanting these existing steam and gas facilities with the Electra Powerhouse's long-distance hydroelectric power. Thus, when the Electra Powerhouse came on-line, Crocker and Poniatowski purchased the systems and markets of San Mateo Electric Company, San Mateo Gas Light Company, Peninsula Lighting Company, Redwood City Electric Company, San Jose Light and Power Company, and Electric Improvement Company of San Jose. These peninsula acquisitions ensured a growing market of truck farms, residential subdivisions, and Bay Area industry for Electra Powerhouse's long-distance power.

When de Sabla and Martin's California Gas and Electric Company acquired Electra Powerhouse and the Bay Area holdings of Crocker and Poniatowski in 1904, the purchase further cemented California Gas and Electric's dominance.

30 Historic American Engineering Record (HAER), Centerville Hydroelectric System, Powerhouse (HAER CA-127A), PAR Environmental Services, Inc. on behalf of PG&E, submitted to the National Park Service February 1993.
31 Charles M. Coleman, PG&E of California: The Centennial Story of the Pacific Gas and Electric Company, 1852–1952, 154.
32 Charles M. Coleman, PG&E of California: The Centennial Story of the Pacific Gas and Electric Company, 1852–1952, 154.

Through the acquisition, they had eliminated a competitor and now controlled the peninsula and South Bay market from San Jose to San Bruno. From this vantage, the company held a far stronger position as it eyed the landlocked holdings of San Francisco Gas and Electric Company in the City of San Francisco.

In addition to solidifying its Bay Area market and moving incrementally closer to San Francisco, California Gas and Electric Company had substantially bolstered its hydroelectric capacity and water supply by early 1905. The company purchased the holdings of South Yuba Water Company, which included three power plants as well as an intricate 450-mile network of water canals, diversions, and 20 storage reservoirs in Nevada and Placer Counties. Although the power plants (including the 1896 Newcastle Plant, 1898 Auburn Plant, and 1902 Alta Plant) were an important component of the purchase, the most meaningful legacy of the acquisition was the substantial water rights acquired by the company. The ditches, canals, and reservoirs of the South Yuba Water Company provided a hydraulic foundation for California Gas and Electric Company's urban hydroelectric vision, which required more hydroelectric powerhouses fueled by Sierra Nevada water. This vision culminated in the formation of PG&E in the first years of the twentieth century.

E.2.4 Unifying Energy Strands

While PG&E did not emerge until the first years of the twentieth century as a consolidated commercial entity, the foundations of the company arose from a complex interweaving of nineteenth-century economic, technological, and environmental factors—all of which are intimately related to California's distinct development narrative. Most importantly, the company was born of a nascent California's statewide response to energy scarcity. With a rapidly expanding population and limited traditional energy supplies, California became an important proving ground for new technologies, readily adopting and adapting the series of innovations that characterized the period. Second, the company developed from concurrent strands of innovation, with the innovators and entrepreneurs of manufactured and natural gas, early steam-based electrical dynamos, and hydroelectric development operating in largely discontiguous and often combative spheres that ultimately coalesced to form the cohesive whole of PG&E. Third, the company was born of steady and transformative consolidation, a hallmark of the nineteenth-century utility industry and one of the driving forces behind PG&E's ultimate 1905 formation. Lastly, within this largely technological and economic sphere, California's particular geography and geology were vital and provided the last great vault to twentieth-century energy development with the advance of high-head hydroelectric power and AC electrical transmission. As summarized by California energy historian James C. Williams, "In California, prior to the twentieth century, electric power meant hydroelectricity, and the interplay between the environment and technology played a crucial role in shaping the region's electric power industry." Within this overall energy context, PG&E's twentieth-century physical and operational development stands as one of the state's most illustrative representatives of the physical legacy of this complex interplay.

E.3 1905: A Company Born from Many

PG&E was formally incorporated on October 10, 1905. The 1905 establishment represented the merger of two of California's most influential utility concerns: San Francisco Gas and Electric Company and California Gas and Electric Company. The impetus behind this merger was decidedly pragmatic, with both companies recognizing key limitations that precluded further independent growth. When the holdings of the two companies were formally merged, the combined service area of the new PG&E company was approximately 40,000 square miles spanning much of Northern California. Its gas, steam, and hydroelectric facilities served San Francisco, Oakland, Sacramento, Fresno, and Stockton, as well as a significant concentration of smaller towns in the Bay Area and Sacramento Valley.

As discussed in Section E.1, *1849–1906: Origins of California's Electrical Industry*, San Francisco Gas and Electric had evolved from its 1852 manufactured gas origins into the key market force in San Francisco. It owned extensive gas facilities and steam-based urban electrical-generating plants that dominated the energy-hungry San Francisco market. Despite this local dominance, the company lacked hydroelectric holdings, which by 1900, were widely acknowledged as the key to California's energy future. Thus, the most valuable component of San Francisco Gas and

Electric's holdings was access to the San Francisco urban market itself, with the quickly expanding city and surrounding North and South Bay environs representing a major market prize for the utility industry. In contrast to the compact market of San Francisco Gas and Electric Company, the holdings of California Gas and Electric Company were geographically sprawling, and, most importantly, well-supplied with hydroelectric capacity. By the time it was absorbed by PG&E in 1905, the company operated a transmission and distribution system that included hydroelectric plants in Nevada, Butte, Yuba, and Amador Counties, as well as a loose network of regional gas and steam plants. Despite this market dominance, California Gas and Electric lacked distribution outlets in San Francisco and sufficient urban steam plants in the Bay Area to ride out the summer dry spells that often interrupted reliable delivery of hydroelectricity. The merger of the two neatly solved each company's institutional limitations, yielding a San Francisco market for California Gas and Electric and supplying San Francisco Gas and Electric with one of the state's most robust hydroelectric networks. Additionally, the merger greatly increased the capital valuation of each company as the two became a larger and more efficient system, an important building block for the future capital and institutional growth envisioned by the company's founders.

E.3.1 Significant Figures in Formation of PG&E

Initial leadership within PG&E skewed heavily toward the intimate cadre of utility managers, businessmen, and engineers that had come of age within the orbit of de Sabla and Martin's California Gas and Electric Company. Both de Sabla and Martin held prominent positions on PG&E's Board of Directors and maintained active roles in the company through 1914, when they both retired their official roles with the company. Executive leadership of the company included key figures hand-picked by de Sabla and Martin. This early leadership cohort would remain central to PG&E's identity through the first decades of growth, with a number of founding early figures remaining at their posts through the 1920s. Following this initial period, the scale and the size of the company reflected a more corporate identity, with the lean, personality-driven identity of the early years replaced with an increasingly complex bureaucratic corporation of professional engineers and managers.[33]

Elected in October 1905, John A. Britton served as PG&E's first president until 1907, when he transitioned to vice president and general manager. He held the latter position until his death in 1923. Britton had moved to San Francisco in 1868, with his first foray in the utility industry as a laborer for Oakland Gas Light Company, where he quickly ascended to bookkeeper. As electricity eclipsed gas in the public imagination, Britton became an early student of the technology, attending night school in electrical engineering. By 1900, he was president of the Oakland Gas Light and Heat Company. In 1901, John Martin selected Britton to head California Central Gas and Electric Company, the distribution arm of California Gas and Electric Company. By the time of his appointment to president of PG&E in 1905, Britton was a prominent fixture in the industry, a role he would retain for nearly two decades as PG&E matured into an established company. Within this context, Britton served as a notable administrator, leading the consolidation of the satellite of discrete facilities in the company's early organizational years. He was also a high-profile industry spokesman, touting both electricity and gas in consumer life and PG&E's instrumental civic role as a "public service corporation".[34]

Frank G. Drum served as PG&E's first vice president. By July 1907, he had become president of the company, remaining in this position until 1920. Drum came to PG&E from California Gas and Electric Company, where he had been a major stockholder after purchasing the holdings of early financial backer R.R. Colgate in 1903. Drum was an Oakland native and heavily immersed in California land and business development prior to his affiliation with the utility industry. At the outset of his career, he served with Oakland Bank of Savings, moving on to the office of prominent land speculators J.B. Haggin and Lloyd Tevis and becoming manager of their sprawling California property holdings. In 1899, Drum served as one of the organizers of Mercantile Trust Company of San Francisco, further

33 "Officials for Light and Power Companies," San Francisco Chronicle, March 2, 1906; "List of Gas and Electric Companies and Their Officials," *Report of California Railroad Commission*, 1919, 320.

34 "Britton Speaks Before Ad Club," *San Francisco Chronicle*, February 21, 1913, 5; "The History of Gas Lighting in Oakland," *Pacific Gas and Electric Magazine*, September 1909, 125–129.

solidifying his credentials for, and exposure to, California's highest echelon of business and development dealings. Thus, when Drum became a major shareholder of the California Gas and Electric Company in 1903, he was well versed in finance, land speculation, and utility development—management skills that ultimately served to chart the course of PG&E's development for the first two decades of its existence.

Rather than being a utility promoter in the vein of John Britton, Drum was largely recognized as a behind-the-scenes developer, aligning the capital and institutional frameworks that allowed for the company's initial physical expansion.[35]

A third key figure in PG&E's formation was New York banker Noah Wetmore (N.W.) Halsey. Halsey served as the architect and financier behind the company's acquisition of San Francisco Gas and Electric Company and California Gas and Electric Company holdings in 1906 and chaired the PG&E Board of Directors from 1906 to 1908. Halsey had established his namesake firm, N.W. Halsey and Co., in 1900, specializing in municipal, railroad, and public utility bonds. In 1905, de Sabla and Martin engaged Halsey's firm to draw up the financial framework of PG&E. As chairman of the board, Halsey remained active in the financial affairs of the company as it navigated its first years, guiding bond sales and stock offerings that supplied the company with a much-needed cash flow for system integration and new development in the years following 1906. Following Halsey's death in 1911, N.W. Halsey and Co. continued to be central to PG&E's financial identity, underwriting major bond issues that supported PG&E's 1910s development, most notably the Drum-Spaulding Project. N.W Halsey and Co. also served as the architect of PG&E's groundbreaking "Customer Ownership Plan," which sold stock directly to the small-scale individual consumer in addition to traditional brokerage houses. In essence, a pragmatic way to wring more money for development, the small investor-centric model was the first of its kind in the utility industry. It became an important component of PG&E's identity during its first decades of development, enabling the company to tout its role as a company owned by and for Californians.[36]

Thus, in its early years, PG&E was guided by a tight-knit cohort of industrial, financial, and utility leaders, virtually all of whom were steeped in the intricate, regionally based utility development of the nineteenth and early twentieth centuries. Because the company was formed from many Northern California utilities, lower-level company staff included ranks of experienced gas and electrical engineers, with most heads of engineering and regional superintendents pulled from predecessor companies. PG&E continued this hiring preference as it expanded, leveraging decades of experience and applied knowledge. As recorded by period commentators, this organizational merger represented a pivotal transition in California's utility development, with the growing company considered to "assume a prominence and importance in gas and electric affairs exceeding that of any other contemplated on the Pacific Coast." PG&E, for its part, emerged from the formation bullish, declaring in March 1906 that it was "ready for business—with the first order to increase power for California."[37]

E.4 1906–1930: Transformative System Expansion

E.4.1 The Earthquake of 1906: A City Undone

The formation of PG&E was predicated upon years of precise operational calculations on the part of de Sabla, Martin, and their cadre of executives. However, San Francisco's ruinous earthquake of April 1906 presented an entirely unexpected challenge to the young company. The quake and ensuing fire destroyed much of the central city and much of the utility system that had been laid by San Francisco Gas and Electric. The earthquake and fire gutted what only months before had been the prized utility market of the West, with the city's business blocks, residential streets, and

35 "Frank Drum, S.F. Capitalist, Dead," *San Francisco Chronicle*, August 29, 1923; Charles M. Coleman, *PG&E of California: The Centennial Story of the Pacific Gas and Electric Company, 1852–1952*, 173-174; "Biographical Sketch of John Alexander Britton," *Pacific Gas and Electric Magazine*, September 1909, Volume 1, No. 4,150.

36 Charles M. Coleman, *PG&E of California: The Centennial Story of the Pacific Gas and Electric Company, 1852-1952*, 229-232; William Richard Cutter, *New England Families, Genealogical* and Memorial, (New York: Lewis Historical Publishing Company, 1913), 632.

37 "John A. Britton Will Head the Gas Combine," *San Francisco Chronicle*, January 4, 1906, 14; "PG&E is Ready for Business and Will Increase Power," *San Francisco Chronicle*, March 2, 1906.

commerce transformed from a lucrative urban realm to a catastrophic disaster zone. "San Francisco seems doomed to entire destruction," predicted a combined issue of the *San Francisco Call*, *Chronicle*, and *Examiner*, published the day following the quake, "the city is a mass of smoldering ruins." An evocative image from April 19, 1906, conveys the magnitude of the disaster, with a lone soldier standing guard at the Mechanics Monument, erected in 1901 in commemoration of San Francisco Gas Company's founder Peter Donahue, now remaining as one of the few standing structures on Market Street.[38]

PG&E's new San Francisco holdings lay in ruin, with broken and exploding gas mains, downed electrical lines, and most of its portfolio of electrical and gas plants badly damaged or destroyed. Only the Potrero Generating Plant, Station A, survived largely intact. On April 30, 1906, the *San Francisco Chronicle* declared the utility realm bleak: "A careful study of the lighting situation in San Francisco has been made by company officials, and the situation can hardly be regarded as encouraging, San Francisco Gas and Electric [PG&E] has suffered immense loss…Just how long it will take to get in working order again, it has not been determined."[39]

The years immediately following the disaster were lean and perilous, defined by a scramble for cash to shore up a badly damaged system, and a devastated urban consumer market. In addition to millions of dollars in damage, "losses in revenue were severe. Street lighting revenue dropped. A total of about a half million dollars evaporated in uncollectible accounts…the gigantic shuffling of a whole city's population, many of whom were left penniless, resulted in heavy loss to the gas and electric company."[40] To staunch the loss, the young company resorted to heavy borrowing, with funds fronted by Halsey and other banks as well as personally from executives themselves. By 1907, the company faced 10 million dollars in debts and was forced to leverage fees on its stock to cover operations and rehabilitation. With efforts focused upon system triage, momentum behind system expansion and capacity growth sagged.[41]

E.4.2 Incremental Growth and Facility Refinement

PG&E's operational and financial foundations stabilized and strengthened by 1910, as the immediate 1906 devastation of San Francisco yielded to a prolonged campaign of rebuilding and regional growth throughout Northern California. Industrial, residential, and commercial construction in the Bay Area created strong utility demand, as did corresponding growth in Northern California as agricultural and regional development transformed the Sacramento and Northern San Joaquin Valleys into increasingly settled population areas. From 1900 to 1910, California's population jumped by 60 percent, with much of this growth in PG&E's service territory. Thus, even as company officials scrambled to secure sufficient funding for system rehabilitation and improvement, they also plotted continued growth, with several incremental expansions occurring during the period.[42]

Importantly, PG&E continued to absorb new corporate holdings, steadily acquiring several rivals. In 1906, just before the earthquake, PG&E had gained control of Mutual Electric Light Company, one of the few remaining rivals in San Francisco. The purchase removed a competitor from the field and yielded an additional urban generating station, located at Spear and Folsom Streets. Additional small purchases prior to the earthquake included Big Creek Power Company, which operated power plants and transmission and distribution facilities in Santa Cruz County.

In 1910, PG&E acquired the extensive regional holdings of E.D.M. Lehe, who operated electric plants and irrigation pumping facilities in Wheatland, Lincoln, Davis, Roseville, Cordelia, Elmira, Winters, Dixon, Rio Vista, and Benicia. As reported in period press, with the purchase it was understood that "PG&E intended to extend its service in the Northern part of the state, dealing especially with irrigated districts and supplying electricity in rural districts." In 1911, PG&E removed another small rival from San Francisco, acquiring Metropolitan Light and Power Company,

38 "Earthquake and Fire: San Francisco in Ruins," *San Francisco Call / Chronicle/Examiner*, April 19, 1906.
39 "Little Light for Weeks to Come," *San Francisco Chronicle*, April 30, 1906; "The History of Gas Lighting in San Francisco," *Journal of Electricity, Power, and Gas*, June 11, 1910, Volume XXIV, No. 24, 542.
40 Charles M. Coleman, PG&E of California: The Centennial Story of the Pacific Gas and Electric Company, 1852-1952, 241.
41 Charles M. Coleman, PG&E of California: The Centennial Story of the Pacific Gas and Electric Company, 1852-1952, 241.
42 United States Census Records, California Census Data 1900 and 1910 accessed at California Department of Finance.

which operated a small urban generation plant. That year, PG&E also purchased several other Northern California concerns, including Sebastopol Light, Power, and Water Company, Hayward Electric Light Company, and Live Oak and Encinal Light and Power Company. In 1912, PG&E further bolstered its peninsula holdings by purchasing South San Francisco Light and Power Company, which included a South San Francisco power plant that catered to adjacent industrial facilities and had distribution lines extending to Millbrae.[43]

In addition to this steady organizational expansion, PG&E initiated improvements to existing components of the system, rehabilitating existing electric plants and gas works, adding new substations, and rebuilding and expanding transmission and distribution lines. In San Francisco and Oakland, steam plants were upgraded and improved, with new steam turbines, generators, switchboards, and distribution facilities being added to the existing facilities at San Francisco Station A and Oakland Stations A, B, and C. Across the service territory, PG&E added new "permanent" substations to increase distribution capacity from the existing high-voltage corridors and replace rudimentary and functionally obsolete facilities. As recorded by PG&E Electrical Engineer C.F. Adams, improvement of the approximately 200 substations the company owned was of particular import. "The old substations are objects of much concern. Electrically they are outgrown. Mechanically and as a fire risk, they are hazardous. Their replacement has become a necessity…and these old type structures have been gradually superseded by a new and permanent type of structure." Within this context of substation improvement through permanent construction, PG&E began to develop a characteristic classical architectural tone that characterized much of the company's development prior to World War II.[44]

To accompany the improved generating and substation facilities, PG&E initiated a campaign of distribution improvement during the period, developing new lines across the service territory to serve new areas and replace outdated networks. As recorded in company periodicals, the work was incremental and comprehensive, with additions and improvements of varying scales documented in detailed monthly company tabulations that serve as both a detailed accounting of system improvements and a cogent reflection of regional growth. For example, the May 1912 *Pacific Gas and Electric Magazine* notes several distribution line developments, new substation construction, and several additions to the company's fledgling automobile fleet—a prized and noteworthy operational status symbol of the period.[45]

Against this backdrop of ongoing system improvement, the first 5 years following PG&E organization were decidedly quiet in the hydroelectric realm, with only one small 5,500 kW plant constructed during that time. Deer Creek Powerhouse, located in Nevada County, utilized the extant ditches of South Yuba Water Company, which were purchased by de Sabla and Martin in 1905. The concrete powerhouse contained a single turbine, with power transmitted to Sacramento at 60,000 volts. The small project had been contemplated prior to the earthquake and delayed for lack of funds through 1907 before coming on-line on May 6, 1908. Although diminutive in size and reach, the Deer Creek Powerhouse was noteworthy as the first hydroelectric powerhouse developed by PG&E after company formation.[46]

With the addition of Deer Creek Powerhouse in 1908, PG&E owned 11 hydroelectric power plants, three steam-driven electrical power plants, and 18 gas works, with a combined output of approximately 150,000 kW. Upward of 200 substations and hundreds of miles of transmission and newly improved distribution lines supplied power from these generating facilities. By 1911, the company served 204 towns with electricity and 54 with gas service. Approximately two-thirds of California's population was within the PG&E service territory. In promotional literature, the utility boasted a diverse and expanding customer base, including burgeoning residential, commercial, industrial, and

[43] "Big Creek Power Plant is Sold," *San Francisco Chronicle*, March 10, 1906, 3; "Deal for Mutual Light Stock Closed," *San Francisco Chronicle*, March 23, 1906, 9; "Light Trust Has Control of Field," *San Francisco Chronicle*, March 7, 1906; "Lehe Sells All Of His Power Holdings," *San Francisco Chronicle*, May 18, 1910, 5; "San Mateo County Power Plant Sold," *San Francisco Chronicle*, March 12, 1912, 8; Charles M. Coleman, *PG&E of California: The Centennial Story of the Pacific Gas and Electric Company, 1852–1952*, 251–256.

[44] "Building New Substations," *Pacific Gas and Electric Magazine*, 171–173, October, 1910, Volume II, No. 5; "Fireproof Substations," *Pacific Gas and Electric Magazine*, January, 1911, Volume II, No. 8.

[45] See "Authorized Additions and Improvements, *Pacific Gas and Electric Magazine*, 1909–1914 for representative improvements presented by the company.

[46] "The Story of the Deer Creek Power Plant," *Pacific Gas and Electric Magazine*, August, 1910, Volume II, No. 3.

agricultural sectors that were increasingly specialized in function, along with a growing array of business afforded by electricity including amusement parks, breweries, can factories, dental motors, foundries, glove factories, mattress factories, planing mills, safe factories, oil-refining plants, shoe factories, slaughter houses, and terra cotta works.[47]

E.4.3 Drum-Spaulding Hydroelectric Project

In 1912, PG&E embarked on the company's first major new development: construction of the Drum-Spaulding Hydroelectric Project, an ambitious phased hydroelectric project situated on the west slope of the Sierra Nevada along the South Yuba River, Bear River, North Fork of the North Fork American River, and tributaries of the Sacramento River watershed in Nevada and Placer Counties, California. The project utilized the abundant waters once held by South Yuba Water Company and other water companies serving mining needs in the vicinity. The project had been under consideration for some years, stymied by the tumultuous early years of company organization.

The Drum-Spaulding Hydroelectric Project is a power generation and water supply system consisting of numerous components, including powerhouses, on-stream dams with reservoirs, off-stream impoundments, diversion dams, associated canals, tunnels, ditches, penstocks, an overhead transmission line, and other features. Numerous mining ditch companies have been involved with the evolution of portions of the water delivery and storage system, beginning in the 1850s. The Drum-Spaulding Hydroelectric Project reflects a design conceived, surveyed, and engineered by PG&E in the 1910s and enhanced in the 1920s, 1940s, 1960s, and 1980s. Throughout the last 150 years, PG&E has updated and modified the project's powerhouses, dams, and other water control and conveyance features as economic and technological considerations have allowed. The Drum-Spaulding Hydroelectric Project uses diversions along tributary creeks and regulatory reservoirs combined with conveyance features, such as tunnels, flumes, and ditches. Minor elements, such as weirs and gauges, are numerous and occur ubiquitously throughout the project area.

The Drum-Spaulding Hydroelectric Project is a phased system of 10 developments: Spaulding No. 3; Spaulding No. 1 and No. 2; Drum No. 1 and No. 2; Dutch Flat No. 1; Halsey; Wise; Newcastle; Deer Creek; Alta; and Wise No. 2. In the 10 developments there are 29 reservoirs with a combined capacity of 154,388-acre-feet, six major water conduits, 12 powerhouses with associated switchyards with a combined capacity of 192.5 megawatts (MW), transmission lines, and associated facilities and structures, including recreational facilities.

As summarized by John A. Britton in 1912, the project represented (and continues to represent) both a triumph for PG&E and, equally importantly, a triumph for the primacy of hydroelectricity:

> It has been our experience in operating hydroelectric plants in this state that developments made were rapidly absorbed. While at first the market was not visible, the presence of cheap power has resulted in the establishment of many new industries…Tied in, as it will be, with the present existing eleven powerhouses of the company, the new development will give a guarantee of service at such a minimum cost to compel the utilization of electric energy in all industries and for all agricultural purposes wherever power can be employed.[48]

Initial facility development included the 24,000 kW Drum Powerhouse; Lake Spaulding, a massive concrete dam and storage reservoir; associated water conveyance tunnels and canals; and a 110-mile 110 kV transmission line (referred to as the Drum–Cordelia line) to PG&E's new Bay Area electrical load center, Cordelia Substation. The transmission line was the highest voltage line of the PG&E system. Assistant General Manager and PG&E Chief Engineer James H. Wise, who had begun his career with work on the 1903 de Sabla Powerhouse, oversaw engineering and design. In 1912, however, at the age of 32 and during project construction, Wise was killed in an auto accident. Electrical Engineer Frank G. Baum replaced Wise as chief engineer. Baum was a peer and associate of Wise and had played a role in some of California's earliest hydroelectric engineering, consulting on the development of the Electra Powerhouse and de Sabla Powerhouse in the early 1900s. As chief engineer of PG&E through the 1910s and 1920s, Baum remained at the vanguard of electrical engineering research and hydroelectric design and development. His

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47 "Industries Supplied from Hydroelectric Plants," *Pacific Gas and Electric Magazine*, September, 1909, Volume I, No. 4, 152; "The Pacific Gas and Electric Company Supplies Heat, Light, and Power To," *Pacific Gas and Electric Magazine*, Volume III, No. 5, Back Cover.

48 "$10,000,000 Power Plants to Improve Service Here," *Pacific Gas and Electric Magazine*, August 1912, 92.

capstone work on the 1920s Pit Hydroelectric Project is discussed in Section E.3.5, *Pit Hydroelectric Project and Pit River Developments*, Baum remained with PG&E until his death in 1932.[49]

Drum Powerhouse came on-line November 26, 1913, with Vice President Britton sending a dispatch from the powerhouse succinctly stating, "Drum synchronized with Pacific Service at 10:56 today. Everything from Spaulding to Cordelia in perfect harmony." By 1916, PG&E had raised the dam at Lake Spaulding for more storage and completed an additional 14,000 kW powerhouse named Halsey Powerhouse in honor of PG&E's early financier N.W. Halsey. Wise Powerhouse, of approximately the same capacity, followed in 1917, along with the lower-capacity Adit Powerhouse, located below Spaulding Dam, which was subsequently reconstructed in 1928 as Spaulding No. 1 Powerhouse.

E.4.4 Defining Territory: Mounting Utility Competition

One of the defining characteristics of PG&E's foundational growth was the steady acquisition of market share and territory, with the dominant paradigm from the 1850s to the 1910s guided by a relentless strategy of purchase and merger. PG&E and its primary predecessor companies, San Francisco Gas and Electric and California Gas and Electric, substantially outmatched the bulk of their competition, with the much larger PG&E subsuming small, regional entities across the northern and central reaches of the state. With each small acquisition, the company emerged in a stronger position for the next, thus perpetuating a cycle of Northern California consolidation. As early as 1906, the company's utility hegemony seemed a point of fact for period commentators, with the *San Francisco Chronicle* surmising, "To all intents and purposes every substantial opposition to the Pacific light and power monopoly has been stifled."[50]

Despite its market dominance in Northern and Central California, PG&E faced both territory constriction and mounting competition during the 1910s from two notable rival utilities: San Joaquin Light and Power Company and Great Western Power Company. In the same manner as PG&E, each utility sought to build its own large-scale utility networks in the state. The resulting maneuvering between the companies played out through the 1910s and 1920s, with a complicated institutional thrust and parry that ultimately shaped PG&E's current service area and facility portfolio. While a detailed narrative of each of these companies is beyond the scope of this narrative, their overall institutional framework and facility development during the period is presented herein—as PG&E ultimately absorbed each company—and their substantial historical portfolios are reflected in PG&E's historic-era infrastructure.

E.4.4.1 San Joaquin Light and Power Company

San Joaquin Light and Power Company originated in 1895. Its first powerhouse, San Joaquin No. 1, was completed in 1896. Located on the North Fork of the San Joaquin River, the powerhouse transmitted electricity to Fresno via an 11,000-volt transmission line, a well-publicized operational record at the time. The company was initially established as San Joaquin Electric Company and was the brainchild of John S. Eastwood, a civil engineer who later would play a definitive role in California's hydroelectric development with his key engineering role in the Pacific Light and Power Company Big Creek Hydroelectric Project in Fresno County. Despite his engineering acumen, Eastwood was less adept in the realm of institutional maneuvering and finance. After a series of mechanical setbacks at San Joaquin No. 1 Powerhouse, a pernicious drought that undermined operations, and heavy financial losses, the young San Joaquin Electric Company was forced into bankruptcy and receivership by 1899.[51]

In 1902, Southern California lumber baron and utility entrepreneur W.G. Kerckhoff and electrical engineer A.C. Balch purchased the holdings of San Joaquin Electric, renaming it San Joaquin Power Company. The two hired San Joaquin

49 National Register of Historic Places Evaluation, PG&E's Drum-Spaulding Hydroelectric Project, FERC No. 2310, Nevada and Placer Counties, California, 2011 (authored by PAR Environmental Service, Inc. on behalf of PG&E).
50 "Light Trust Has Control of Field," *San Francisco Chronicle*, March 7, 1906, 7.
51 Hydroelectric Power Development and Transmission in California," *Association of Engineering Societies*, Volume XXXIV, No. 3, 79-80; Allen, et al. National Register of Historic Places Nomination Form: Big Creek Hydroelectric System Historic District, California, 2016.

County civil engineer Albert G. Wishon as general manager the same year. As a founding member of Mount Whitney Power Company, Wishon had been the guiding force behind the initial development of the 1890s Kaweah Hydroelectric System in Tulare County. In addition to his notable hydroelectric engineering expertise, Wishon had a deep interest in the agricultural development of the arid lands of the San Joaquin Valley, viewing hydroelectric development and electrical pump irrigation as the central driver of California's rural economic development. This perspective came to define the development of San Joaquin Light and Power Company from the early twentieth century through its 1930 absorption by PG&E. As summarized by Wishon, "The towns grow in proportion to the development of the back country, and it shall always be the policy of the San Joaquin to look carefully after the back country so that the industrial business of the towns will keep pace." This rural-based development ethic did much to shape physical development of the company, leaving a physical legacy of rural electrical infrastructure and accompanying agricultural markets that PG&E brought into its system in 1930.[52]

Much like PG&E, San Joaquin Power Company's early years were characterized by shrewd territorial expansion and system development. By 1905, the company had been renamed San Joaquin Light and Power Company and had initiated a campaign of capital development that resulted in the completion of San Joaquin No. 3 Powerhouse, located upstream from San Joaquin No. 1. The project also included a second transmission line to Fresno to serve the town and surrounding agricultural enclaves. In 1910, the company purchased Merced Falls Gas and Electric Company, which drew in an expanded service area that included Merced, Madera, and Athlone. At the same time, extensions from the Fresno line brought electrical power across the San Joaquin Valley, with lines to Corcoran, Coalinga, Selma, Dinuba, Sanger, Reedley, Kerman, and the Kings River Area. Also in 1910, the company expanded south with the purchase of Bakersfield's Power Transit and Light Company, owned by Kern County Land Company. To link the Bakersfield market with the existing northern facilities, a transmission line was constructed along the east side of the San Joaquin Valley, thereby connecting the increasingly sprawling service territory. With the Bakersfield Power Transit and Light purchase, San Joaquin Light and Power Company acquired the Kern Canyon Plant, which supplied Bakersfield and its environs. Additionally, San Joaquin Light and Power built two natural gas steam plants in 1921 for standby use in Bakersfield, one in central Bakersfield in 1910 and one in Buttonwillow, at the present site of PG&E's Midway Substation. As the company expanded in Kern County, it developed an additional electrical pumping market in the burgeoning oil and natural gas fields. In 1912, San Joaquin Light and Power Company made its final substantive territorial leap, purchasing Midland Counties Gas and Electric Company, Paso Robles Light and Water Company, and Russell Robison Water and Electric Company, and formed a combined Midland Counties Public Service Corporation with the acquired holdings. The purchases added a large swath of the Central Coast from Monterey County to Santa Barbara County to the company's service area. [53]

In addition to territorial acquisition, San Joaquin Light and Power rehabilitated existing facilities and constructed a series of new powerhouses through the 1910s and 1920s. In 1910, the original 1896 San Joaquin No. 1 Powerhouse was entirely reconstructed and renamed Wishon Powerhouse in commemoration of Albert G. Wishon. San Joaquin Light and Power Company constructed Tule Powerhouse in 1914, followed by Crane Valley Powerhouse in 1919, Kerckhoff Powerhouse in 1920, and Balch Powerhouse in 1927. Ultimately, San Joaquin Light and Power Company held 11 powerhouses, with transmission and distribution lines connecting much of the San Joaquin Valley and Central Coast. The import of this electrical framework was profound, with electrical pumping transforming largely unsettled cattle and dry farming lands into a patchwork of diverse, irrigated farms. The population of San Joaquin County tripled between 1900 and 1930, afforded by the increased settlement opportunities derived from irrigation and accompanying processing and industry. The pages of company publication *San Joaquin Light and Power Magazine* reflect the steady evolution of the San Joaquin Valley from desert to Eden, with "Valley Development Progress" recorded as a tale of intensive agricultural and

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52 "Hydroelectric Power Development and Transmission in California," *Association of Engineering Societies*, March, 1905, Volume XXXIV, No. 3, 86-88; Albert G. Wishon, "California's Water Problem, *San Joaquin Light and Power Magazine*, Volume III, No. 11, 583-586; Charles M. Coleman, *PG&E of California: The Centennial Story of the Pacific Gas and Electric Company, 1852*–1952, 181–200.

53 Charles M. Coleman, *PG&E of California: The Centennial Story of the Pacific Gas and Electric Company, 1852–1952*, 181–200; "San Joaquin Light and Power Earns Seven and a Half on its Preferred," *San Francisco Chronicle*, May 28, 1916; "The New Pacific Service Merger," *Pacific Service Magazine*, Volume XVIII, Number 1, 3–26.

civic development through electrification.[54] Although San Joaquin Light and Power's territorial reach extended west and south from Fresno, an early détente was reached with PG&E and its predecessor company California Gas and Electric that created a clear dividing line between the territories of each company and precluded any development by San Joaquin Light and Power north of the Fresno market. In 1903, just after Kerckhoff and Balch had acquired the foundering San Joaquin Power Company, California Gas and Electric had made a foray into the Fresno utility market, purchasing Fresno Gas and Electric Company. Rather than initiate a rate war, the rival companies established an elegant and lasting agreement that successfully defined relations through 1930. For its part, California Gas and Electric, and subsequently PG&E, agreed not to enter the electricity market in the region. On their end, San Joaquin Light and Power Company yielded the Fresno gas market, agreeing not to manufacture or distribute gas in Fresno and its environs. Thus, a territorial peace was established, with San Joaquin Light and Power controlling the areas south of Santa Cruz, Santa Clara, Stanislaus, Tuolumne, and Mono Counties and PG&E retaining all markets north. This basic construct lasted through 1930, when San Joaquin Light and Power ultimately was purchased by PG&E and was absorbed into an expanded and consolidated PG&E service territory.[55]

E.4.4.2 Great Western Power Company

In contrast to the clear-cut geographic truce that allowed PG&E and San Joaquin Light and Power Company to develop largely in parallel, the relationship between PG&E and its second major utility rival, Great Western Power Company, proved far more acrimonious. At the center of the protracted struggle between the two companies lay the Bay Area market, which each sought to make its own through high-voltage hydroelectric transmission lines from rival hydroelectric systems. Although Great Western Power Company ultimately ceded and was purchased by PG&E in 1930, the company's developments became key building blocks in PG&E's facility portfolio.

While PG&E's hydroelectric system fanned out across a number of watersheds in Northern California, the origins of Great Western Power Company lay entirely in the North Fork of the Feather River. The company initially formed in 1902 as Western Power Company, with a development plan that included an ambitious multi-component Feather River hydroelectric generation scheme composed of multiple power plants, a massive storage reservoir, and a transmission line to the Bay Area. Company founders included Southern California citrus magnate and newspaper publisher Edwin T. Earl; his brother, Oakland lawyer Guy C. Earl; and two hydraulic engineers, Julius M. Howells and James D. Schuyler. The origins of the development plan dated to the 1880s, when a young Howells surveyed the Big Meadows area of Plumas County as part of a geologic expedition and noted the site's tremendous potential for water storage. By 1900, as rapid advances in hydroelectric development were altering the energy landscape of California, Howells returned to the idea and resurveyed the Big Meadows area in extensive detail, supported by funding from the Earl brothers. Based on Howell's survey, the Earls quickly moved to secure land and water rights in Big Meadows and posted formal notice at the proposed dam site on April 8, 1902.[56]

Howells's initial plan called for a number of powerhouses along the upper stretches of the Feather River, with proposed phased powerhouses at Caribou, Butt Creek, and Mosquito Creek. The first powerhouse the company completed was at Big Bend, a wide oxbow in the lower stretches of the North Fork approximately 16 miles northeast of Oroville. At Big Bend, the company controlled the remnants of a failed nineteenth-century mining operation that included a large tunnel bored through the neck of the bend to divert water and expose the riverbed. Using this existing facility saved money and time, which in turn freed up the needed finances to develop proposed upstream facilities, including the large storage dam at Big Meadows. Construction of the powerhouse was initiated in 1906 and completed in 1908. At the time of its completion, the 10,000-kW powerhouse held the distinction of having the longest and highest voltage transmission line, with a 100-kilovolt (kV) steel tower alignment extending 155 miles from Big Bend

54 *San Joaquin Light and Power Magazine*, Volume III, (31, 142, 202, 256, 319, 373, 605, 662).
55 Charles M. Coleman, PG&E of California: The Centennial Story of the Pacific Gas and Electric Company, 1852–1952:181–200.
56 Jackson Research Projects, "Great Western Power Company: Hydroelectric Power Development on the North Fork of the Feather River, 1902–1930", developed on behalf of PG&E, 1986; "The Big Meadows Dam," *Journal of Electricity, Power, and Gas*, Volume XXVII, Number 14, September 30, 1911.

to Oakland. As more generation units were added, the operating capacity of Big Bend reached 70,000 kW, making it the largest plant in California.[57]

By 1909, Great Western Power Company had also completed a steam plant on the shores of San Francisco Bay in Oakland. The plant was a key hedge against the dry season, a backstop to keep urban supplies available when hydroelectric turbines slowed. Initially, the power generated was sold wholesale to PG&E because Great Western lacked franchises and an urban distribution system. By 1911, however, Great Western had solved the shortcoming by purchasing San Francisco's City Electric Company, thereby accessing an existing San Francisco distribution system. With distribution assured, Great Western initiated the final stroke, completing the first underwater transbay cable from Oakland to San Francisco in 1912, followed by additional cables in 1915 and 1916. With the cables in place, Great Western Power had arrived in San Francisco.[58]

With both Great Western Power Company and PG&E serving San Francisco, the two companies fell into a heated battle for primacy in the Bay Area. As early as 1906, rumors swirled that the two would merge, with the *San Francisco Chronicle* regularly reporting that one would absorb the other. When mergers failed to come to fruition, the two engaged in a protracted rate war, with Great Western slashing rates to attract PG&E customers. By 1911, relations between the companies had devolved to the point that a terse PG&E President Britton informed the *Chronicle*, "Not only has Pacific Gas and Electric not bought the Great Western, there are no negotiations and nothing but a fight between us".[59]

By 1912, the two companies were engaged in a legal battle before the State Railroad Commission, predecessor of the California Public Utilities Commission. PG&E argued that Great Western's incursions into PG&E territory represented unwarranted competition for an area already well served. In June 1912, however, the State Railroad Commission ruled that Great Western's competition was in keeping with the public good. With this victory, Great Western continued its path of expansion. In 1914, the company completed the long-planned dam at Big Meadows, creating Lake Almanor with a 72-foot-high hydraulic-fill dam designed by Julius M. Howells. The dam was subsequently enlarged by Great Western Power between 1925 and 1927, increasing the capacity of the reservoir to 1,308,000 acre-feet, the largest in the state at the time. In 1916, the company built an additional steam plant in San Francisco on Bush Street, further buffering against vagaries of drought and water supply. This was supplemented in 1924 by an additional steam plant in Oakland on 20th Street. In 1921, Great Western completed Caribou Powerhouse, its first Upper North Fork Feather River powerhouse, and built a 186-mile 165 kV transmission line through the Feather River Canyon to a new substation in Oakland.

In 1928, Great Western Power Company funded the development of Bucks Creek Powerhouse, initially begun by Feather River Power Company and acquired by Great Western prior to completion. Thus, by the late 1920s, Great Western was an entrenched adversary to PG&E in the Bay Area. Although the holdings of the company were concentrated within a single watershed, the North Fork of the Feather River system included three powerhouses and the state's largest storage reservoir, all of which linked to the state's populous Bay Area market and 15 Northern California counties. While PG&E contested this steady Great Western advancement into the Bay Area, ultimately Great Western's power facilities became core components of PG&E's electrical infrastructure, forming the basis of PG&E's twentieth century Feather River "Stairway of Power."[60]

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57 Jackson Research Projects, "Great Western Power Company: Hydroelectric Power Development on the North Fork of the Feather River, 1902-1930; Charles M. Coleman, *PG&E of California: The Centennial Story of the Pacific Gas and Electric Company, 1852–1952*, 211-224.

58 Jackson Research Projects, "Great Western Power Company: Hydroelectric Power Development on the North Fork of the Feather River, 1902–1930.

59 "Stock Dividend Step to Merger," *San Francisco Chronicle*, November 24, 1911; "Great Western Invades Oakland," *San Francisco Chronicle*, November 7, 1911; "Will Not Merge Power Companies," *San Francisco Chronicle*, December 26, 1911; "Western Power Wants Permit," *San Francisco Chronicle*, May 8, 1912; "Power Companies Continue Battle," *San Francisco Chronicle*, May 11, 1912; "Rate Board Hearing on Power Company's Fight," *San Francisco Chronicle*, June 3, 1912; "Light and Power Companies Fight," *San Francisco Chronicle*, June 6, 1912; "Big Deal in Power Companies Pending," *San Francisco Chronicle*, October 27, 1910; "Big Light Firms Likely to Merge," *San Francisco Chronicle*, January 16, 1907.

60 "Rate Board Hearing on Power Company's Fight," *San Francisco Chronicle*, June 3, 1912; "Light and Power Companies Fight," *San Francisco Chronicle*, June 6, 1912; "Power War Ended by State Rate Commission," *San Francisco Chronicle*, June 20, 1912; "Feather River Power Company Builds Highest Head Hydroelectric Project in North America," *Western Pipe and Steel News*, Volume V, March 1928; "Caribou 165,000 Volt Development," *Electrical World*, September 23, 1922, 649; Jackson Research Projects, "Great Western Power Company: Hydroelectric Power Development on the North Fork of the

E.4.5 Pit Hydroelectric Project and Pit River Developments

By the close of the 1910s, PG&E had continued to integrate holdings inherited at formation and embarked on ambitious development schemes, with the initial 1910s Drum-Spaulding construction serving as the company's largest area of expansion. Additionally, the company continued to purchase smaller entities to both increase market share and network potential. Although this continuous growth ensured the company's position as Northern California's preeminent utility, PG&E faced intense competition and limitations to growth, with the southern wall of San Joaquin Light and Power Company and the intermixed trunk service corridor of Great Western Power Company creating a limiting framework that preoccupied company officials and financial backers. PG&E also faced a series of external challenges, including the industrial demands and material limitations of World War I and back-to-back drought years during the late 1910s and early 1920s that slowed hydroelectric production. Within this context, PG&E was forced to initiate energy rationing just as the company was seeking to grow its consumer base.[61]

By 1920, the population of the PG&E service area was more than 1.8 million, more than half of the population of the state. Additionally, because of extensive advertising regarding the merits of electricity and an increasing array of domestic, commercial, and industrial electrical products, adoption and consumption rates had skyrocketed. In 1920, 83 percent of California households were wired for electricity, compared with a far lower national average of 35 percent. Similarly, although the country only consumed 372 kW hours per capita annually, Californians on average consumed 1,085 kW hours each. Within this broadening consumer context, the utility found the energy shortage particularly acute. As summarized by *Pacific Service Magazine* in January 1920:

> Today it is an accepted fact that our Golden State of California possesses limitless possibilities in the way of agriculture, industrial, and every other kind of development and that the one thing needed to enable her people to realize their fondest hopes is continuous cheap electric power. By cheap electric power it is meant power that can be manufactured and distributed at such a price as to bring it within the range of the "little fellow." It is not the one great spectacular industrial establishment, with its daily consumption of so many thousand kilowatt hours that establishes the prosperity of a community: it is rather the aggregate of small users. To bring this prosperity about we must have power at our disposal and plenty of it—hydroelectric power. We must look for the energy that will place California where she belongs by right of her extraordinary natural advantages…Our Sierra peaks stand ready to furnish at the word of command.[62]

Despite the inherent plenty of the Sierra Nevada, a period company report lamented, "In the past ten years there has been practically no transmission capacity added, with the exception of the Drum–Cordelia line, and no capacity into San Francisco has been added…The need of the system now is for more transmission line capacity."[63]

Within this context of demand and scarcity, PG&E embarked on its second major hydroelectric project, constructing a series of powerhouses on the Pit River, located more than 200 miles from the Bay Area in Northern California's rugged Shasta County. The project was groundbreaking in scale and design, with the initial generation output of 69 megawatts (MW) and transmission voltage of 220-kV serving as operational milestones in hydroelectric development.

The Pit River had long been considered an ideal location for generation, with engineers surveying the river's potential in the early days of hydroelectric growth. However, the site's remote Cascade Mountains location had long precluded development in the early years of hydroelectric engineering, with the hundreds of miles separating the river from population centers forming a technical and economic barrier. Beginning in 1909, several companies had initiated hydroelectric schemes on the Pit River to no avail, with Mount Shasta Power Company and Northern California Power

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Feather River, 1902-1930; *Report of California Railroad Commission From January 1, 1911 to June 30, 1912*, "Certificate of Public Convenience and Necessity" (Sacramento: California State Printing Office), 110.

61 "To All Patriotic Citizens," *San Francisco Chronicle*, July 22, 1918, 2; "Pacific Service to its Electric Power Consumers," *San Francisco Chronicle*, August 25, 1920, 7; Frank G. Baum, "Report on Pacific Gas and Electric Company Transmission Changes and Report on Pacific Gas and Electric Company 200 Mile, 220,000 volt, 300,000 kW Transmission Line, San Francisco, November 10, 1919.

62 "Power Development in California," *Pacific Service Magazine*, Volume XI, No. 8, January 1920, 245; "Electrical Men of the Coast Send out a Stirring Message," *Pacific Service Magazine*, Volume XIV, Number 1, June 1922, 10.

63 Cardno. 2020. Pacific Gas and Electric Company Historic-Era Electrical Infrastructure Management Plan. Prepared for Pacific Gas & Electric Company. April:3-56.

Company each initiating plans only to have them collapse in the face of the site's remote nature. By the mid-1910s, however, PG&E engineers, led by Chief Engineer Frank Baum, eyed the river as an ideal site for extensive large-scale, multiphase power. The ambitious scheme mirrored Julius M. Howells's plans for the North Fork of the Feather River, with a planned series of powerhouses that could be developed in an integrated fashion in response to demand. As summarized by Baum in the preface to a company report on the Pit River, "I feel certain [with Pit] no company in California and probably no company in this country is so favored with the conditions for its future power supply. Coupled with the unusual water supply, physical conditions are extremely favorable, and developments can be made in such steps as required, results being obtainable as development proceeds." Based on this theory of expansive phased construction, PG&E purchased the necessary holdings and water rights of Mount Shasta Power Company in 1917 and secured those of the Northern California Power Company in 1919.[64]

The complexity and remote nature of the proposed system allowed PG&E to test many of the most advanced theories in hydroelectric generation and transmission. The first powerhouse completed was Pit No.1, located at the head of the Pit River canyon below Fall River Mills. As designed, the plant had an installed capacity of 69,000 kW, the largest of the PG&E system at the time. The treatment of the powerhouse and its associated system components mirrored the advanced engineering, with an architectural treatment that was conceived and designed by PG&E lead architect Ivan C. Frickstad to convey the aspirations of PG&E as a dominant civic force in California social and economic life.

As described by PG&E upon operation in September 1922:

> Of course, the giant powerhouse was the center of observation. It stood there in its resting place at the bottom of the slope, in its Gothic design looking for all the world like some border castle of the long ago. One might almost have compelled the imagination to depict a grim, mail-clad warrior patrolling the battlements, the glint of sunlight upon his armor, as the warder's bugle sounded the call to arms.[65]

The 220-kV transmission line that connected the Pit Project to the associated Vaca-Dixon Substation represented the most advanced transmission design during the period, running at the highest commercial voltage developed to date and the one of the longest distances—202 miles. This voltage standard remained the high-voltage technological standard through the 1960s until the development of 500-kV transmission capabilities.

Although Pit No. 1 helped relieve the critical energy shortage of the Bay, continued drought plagued California during the winters of 1923 and 1924. By 1925, PG&E had brought an additional Pit powerhouse on-line. Pit No. 3, located downstream from Pit No. 1, added 70,000 kW capacity to the system. Like Powerhouse No. 1, Pit No. 3 was engineered by Frank Baum and designed by Ivan Frickstad, with an architectural expression that was stylistically subservient to, but expressive of, the revival design themes of Pit No. 1 and the associated Vaca-Dixon Substation.

PG&E's Shasta County expansion during the period also included construction of two smaller powerhouses, Hat Creek Nos. 1 and 2, located along a small tributary of the Pit River. The powerhouses had a combined output of 20,000 kW and supported lumber operations in Shasta County. Although the small powerhouses stood in marked contrast to the unprecedented scale of Pit No. 1 and Pit No. 3, they reflected PG&E's continued integration into the northern watersheds of California and of the company's period design ethos, with Ivan C. Frickstad's heightened classical vision evident in their design.

PG&E's 1920s expansion on the Pit River was a key step in the development of multiphased hydroelectric generation. Although it was not until the 1940s that further expansion of the system occurred, with the completion of Pit No. 5 in 1944 followed by Pit Nos. 4, 6, and 7 by 1965, the 1920s development led by Baum, Frickstad, and others exists as a singular moment of expansion for the company that laid the operational foundation for long-term twentieth century growth.

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[64] Frank G. Baum, "Report on Pacific Gas and Electric Company Transmission Changes and Report on Pacific Gas and Electric Company 200 Mile, 220,000 volt, 300,000 kW Transmission Line, San Francisco, November 10, 1919; Charles M. Coleman, *PG&E of California: The Centennial Story of the Pacific Gas and Electric Company, 1852–1952*, 284–290.

[65] "Representative Gathering at Pit No. 1 Witnesses the Great Plant Put in Operation," *Pacific Service Magazine*, Volume XIV, No. 5, 135.

Although water rights and development potential for the Pit River was the real prize of PG&E's 1919 purchase of Northern California Power Company Consolidated Powerhouse, the addition of the small utility company also brought six additional previously constructed hydroelectric power plants into the PG&E portfolio. The plants had a 30,000-kW combined output and a distribution area of 5,000 square miles in six northern counties. Although dwarfed by PG&E's larger holdings, the facilities represented both an increase in PG&E's service area and promising sites for future operational efficiencies under PG&E's integrated system. As summarized by PG&E, "At the present time the Northern is producing about 30,000 horsepower of electric energy but it should be needless to inform our readers that under the ownership of 'Pacific Service' these properties will be developed to the fullest extent possible. It will be seen then that with a larger market for its power the Northern can be made of far greater value than is possible under current operating conditions."[66]

The Northern California Consolidated powerhouses included the 1901 Volta Powerhouse, 1904 Kilarc Powerhouse, 1907 Cow Creek Powerhouse, 1910 Inskip and South Powerhouses, and 1911 Coleman Powerhouse. The service area included regional centers such as Red Bluff, Redding, Corning, Orland, Willows, and Williams, as well as dispersed agricultural and mining customers. In particular, the system catered to the numerous copper mines proliferating in the region, which produced copper supplies that were critical for transmission conductors and other burgeoning industrial uses.

The acquisition of Northern California Consolidated Powerhouse also brought a noteworthy element to PG&E's portfolio: the first interstate transmission connection with a 60 kV line that carried power from Oregon's California–Oregon Power Company into PG&E's service territory. The interstate tie, completed in 1918, was the first of several developed during later decades in the twentieth century as high-voltage interstate interties became key components of mid-century growth. As noted by PG&E construction engineer E.H. Steele regarding the 1918 interconnection:

> Not that the consummation of this agreement carried with it at the time any construction plan which would involve the transmission of electric energy at any higher voltages, or the direct delivery of power over any greater distances than was being accomplished at that time; but the interconnection of these trunk lines between these three important companies, serving the greater part of Northern and North-Central California, must bring about a condition that will stimulate the desire to harness the hitherto undeveloped sources of hydroelectric energy to the centers of population where demand is growing year by year.[67]

The former Northern California Consolidated Powerhouse holdings today remain an operating component of the PG&E system; however, all generating facilities but Kilarc and Cow Creek were demolished and replaced by PG&E with new facilities during the 1980s.[68]

E.4.6 Continued 1920s Utility Absorption and Market Growth

Although the early 1920s planning and development of the Pit Hydroelectric Project was PG&E's most transformative new construction during the period, a series of additional mergers and smaller-scale developments coalesced to form a more expansive and materially complex system. These ongoing 1920s additions served as an institutional mortar, absorbing new systems and targeting construction to fill holes and weaknesses in PG&E's service area while steadily adding to the customer base and distribution system. The system expansion in this period increasingly built on existing nexus points, as PG&E absorbed a number of the small-scale utilities that were adjacent to, and even physically connected to, existing PG&E infrastructure.

The company purchased the holdings of California Telephone and Light Company in April 1923. The purchase included facilities in Sonoma and Lake Counties, northern Napa County, and southern Mendocino County, as well as a pool of slightly more than 6,000 mostly agricultural customers. California Telephone and Light Company itself was

[66] "Editorial," *Pacific Service Magazine*, Volume XI, No. 1, June, 1919, 24–25.
[67] "Editorial," *Pacific Service Magazine*, Volume XI, No. 1, June, 1919, 24–25
[68] "Good Engineering, Poor Management: The Battle Creek Hydroelectric System and the Demise of the Northern California Power Company," *The Journal of the Society for Industrial Archaeology*, Volume 21, No. 2, 1995, 5–24.

the product of multiple small-scale regional acquisitions comprising former holdings of Sonoma Valley Light and Power Company, Russian River Light and Power Company, Clear Lake Consolidated Telephone and Telegraph Company, Northwestern Electric Company, Healdsburg Telephone Company, Cloverdale Light and Power Company, Calistoga Electric Company, and Mt. Konocti Light and Power Company. California Telephone and Light Company was primarily a distribution system, purchasing all power wholesale from neighboring companies including PG&E and the smaller Snow Mountain Power Company, which operated a single powerhouse, Potter Valley Powerhouse, on the Eel River. As summarized by the State Railroad Commission in 1920, the company was, "a consolidation of separate systems, each of which was built to supply the need for telephone and electric service in communities which the large utility companies had not found it profitable to enter. The territory in which it operates is widely scattered and, from a public utility standpoint, relatively unremunerative." Despite this somewhat dour prognosis from the State Railroad Commission, PG&E viewed the purchase as one of strategic growth, noting that, "This territory is still only partially developed, particularly as regards the utilization of electric energy on farms and in poultry incubating establishments, but with the greater resources of PG&E there will soon be afforded an attractive and constantly growing market for the sale of electricity." Thus, PG&E viewed the scattered and relatively low-capacity system of California Telephone and Light Company as an area ripe for growth, with the influx of PG&E's power and capital laying the foundation for regional agricultural and community development.[69]

If the California Telephone and Light Company purchase primarily reflected the purchase of market *potential*; subsequent purchases in 1927 and 1928 were of more immediate regional importance. During 1927 and 1928, PG&E acquired Sierra and San Francisco Power Company, Western States Gas and Electric Company, and Coast Valley Gas and Electric Company. All of the properties were jointly owned and managed by Chicago utility investment firm H.M. Byllesby & Company, which held them under the national corporate umbrella of Standard Gas and Electric Company. None of the companies acquired in the purchase had been direct competitors to PG&E. However, because the service areas of each largely paralleled that of PG&E, company officials touted the move as a logical expansive step in solidifying PG&E control in Northern and Central California. As announced by PG&E President Wigginton E. Creed:

> The merger of these important Byllesby properties under the control and management of the Pacific Gas and Electric Company is both a logical and constructive move in the future development of the electric power service in Northern and Central California. The territories served by the three merged companies are immediately adjacent to that of the Pacific Gas and Electric Company and, in some instances, extend within the exterior boundaries. All three companies are substantially interconnected with the Pacific Gas and Electric system and their addition to the latter involves no more than the absorption of contiguous territory and the operation and development under one management of companies already economically and physically joined with the Pacific Gas and Electric Company.[70]

Sierra and San Francisco Power Company operated in 10 counties including San Francisco County and had a lucrative street railroad contract in San Francisco that was slated to extend through 1953. Although the company was not formally purchased until 1928, its facilities had been leased and operated by PG&E since 1920. Thus, Sierra and San Francisco Power Company system components were already largely integrated into PG&E's service network when PG&E acquired the company. Additionally, under the lease period, PG&E and Sierra and San Francisco Power had collaboratively developed key components of the Sierra and San Francisco network, constructing Spring Gap Powerhouse and Melones Powerhouse, in 1921 and 1927, respectively, as part of what was then termed the Sierra System of Pacific Gas and Electric Company. Spring Gap Powerhouse was located on the Middle Fork of the Stanislaus River with a capacity of 7,500 kW. Although modest in scale, the plant was noteworthy for its vertical hydraulic head, which was the highest of the PG&E system at the time with a drop of 1,864 feet. Melones Powerhouse was a 26,000-kW facility located downstream from Spring Gap on the Stanislaus River. PG&E and Sierra and San

[69] "Editorial," *Pacific Service Magazine*, Volume XIV, No. 12, May 1923, 394; *Decisions of the Railroad Commission of the State of California Volume XVIII*, (Sacramento: California State Printing Office, 1923), Decision No. 8006, 673; "400,000 Purchase Price of Local Telephone Line," Healdsburg Enterprise, Volume XLIV, No. 22, November 25, 1926; 2.

[70] "Editorial," *Pacific Service Magazine*, Volume XVII, No. 1, July, 1927,1.

Francisco Power Company developed it in collaboration with the Oakdale and South San Joaquin Irrigation Districts as a joint power and irrigation control project. As described by PG&E upon construction:

> The Project is of immense importance to the agricultural development of a large section of the San Joaquin Valley. The lack of sufficient impounded water to encourage proper agricultural expansion has long been a serious handicap to the territory supported by the Stanislaus River watershed. Concurrent with the need for storage of water for irrigation purposes, the development of the hydraulic energy of the project became an important issue, for rural electrification is playing a more and more important part every day in the development of the great tracts of valley lands that stretch from north to south of our Golden State. Here it was that Pacific Service came in with a proposal to make common cause with the irrigation districts for the general good…In other words, the parties entered into a combined irrigation and power project.[71]

In addition to ensuring PG&E ownership of these newly built generating facilities, the Sierra and San Francisco Power acquisition included the sizeable 1908 Stanislaus Powerhouse, located 25 miles north of Sonora on the Stanislaus River. The "commodious corrugated iron and steel frame structure" had a generating capacity of 39,000 kW. PG&E also gained the small Phoenix, Knights Ferry, and La Grange Powerhouses through the purchase, all nineteenth- and early twentieth-century power plants with miniscule generating capacity. Importantly, the purchase also included a 104 kV transmission line from Stanislaus Powerhouse to San Francisco, which served the Market Street Railway. An additional 60 kV line extended from Santa Clara County off the San Francisco trunk line to service Monterey County. In addition to this core transmission system, an array of lower voltage distribution lines radiated throughout the overall service area of the newly acquired PG&E territory.[72]

The integration of the Sierra and San Francisco Power Company facilities created the foundation for PG&E's twentieth century development on the Stanislaus and Tuolumne Rivers. Although the small Phoenix, Knights Ferry, and La Grange Powerhouses were obsolete and soon removed, Spring Gap Powerhouse remains in operation today. Stanislaus Powerhouse remained in use for decades but was decommissioned and sold for scrap in 1963. PG&E constructed a new outdoor Stanislaus Powerhouse immediately adjacent to the old powerhouse site. Melones Powerhouse was operated for much of the twentieth century but decommissioned and replaced with the New Melones Dam and Powerhouse in 1978, although the former powerhouse still stands on site.

The second Byllesby company that PG&E acquired, Western States Gas and Electric Company, served eight counties in Central California. Western States had a network that included the city of Stockton, San Joaquin and Sacramento Valley agricultural lands between Stockton and Sacramento, and areas of El Dorado, Amador, Calaveras, Contra Costa, and Humboldt Counties. The company was established in 1910 as a consolidation of Humboldt Gas and Electric Company, Stockton Gas and Electric Corporation, Richmond Light and Power Company, American River Electric Company, Arcata Light and Power Company, Fortuna Lighting Company, and Ferndale Electric Light Company. The hydroelectric workhorses of the Western States system included two power plants on the American River: the 1904 American River Powerhouse, located 6 miles above Placerville and rated at 5,600 kW; and the much larger 1924 El Dorado Powerhouse, which operated at 24,600 kW and was located 21 miles above Placerville. In a discontiguous extension to the north, the company also operated the small 1905 Junction City Powerhouse on the Trinity River in Humboldt County, with an operating capacity of a mere 2,400 kW. In addition, key components of the company included steam-electric plants in Stockton and Eureka for standby reserve use and a large gas plant in Stockton. In addition to these generation facilities, the company held several hundred miles in 60 kV transmission lines and extensive distribution networks and gas mains in its service area.[73]

PG&E operated El Dorado Powerhouse until the 1990s, when it was sold to El Dorado Irrigation District and substantially rehabilitated. American River Powerhouse was operated until the 1960s when PG&E redeveloped its

71 "Pacific Service as a Cooperative Enterprise—Melones Power Project," *Pacific Service Magazine*, Volume XV1, No. 9, July, 1926, 295.
72 "Editorial," *Pacific Service Magazine*, Volume XVII, No. 1, July, 1927,1.
73 *Moodys Manual of Railroads and Corporation Securities, 1920: Public Utility* Section (New York: Poor's Publishing Company, 1920), 1291; "Editorial," *Pacific Service Magazine*, Volume XVII, No. 1, July, 1927,1.

American River holdings and constructed the Chili Bar Hydroelectric Project. Although the major generating facilities have been removed, the physical legacy of the Western States service area remains as part of PG&E's territory.

The third Byllesby acquisition, Coast Valleys Gas and Electric Company, was the smallest of the three firms. Coast Valleys had no hydroelectric capacity and only limited generation capacity from three small steam-electric plants in Salinas, Monterey, and King City and two small gas plants in Monterey and Salinas. The company provided no gains in generation; however, it offered an ideal conduit for market expansion. At the time of the PG&E purchase, Coast Valleys operated 110 and 60 kV transmission lines that linked Salinas with the power supplies of Sierra and San Francisco Power Company's Stanislaus Powerhouse. At Salinas, this supply was distributed across the Monterey Peninsula, with Monterey, Carmel, Soledad, King City, and San Ardo all served from Stanislaus. Upon purchase, PG&E quickly moved to supplant and improve the existing transmission system with its own extensive power supplies, noting, "The newly acquired territory is a region noted for its scenic beauty, its splendid natural resources, and its many points of historical interest…Needless to say, that with the agricultural, industrial, and other development of this territory the growth of demand for electric power has been very rapid. There is need for additional service." By 1928, PG&E was planning and initiating construction of a new 110 kV double-circuit steel tower line to service the newly acquired territory on the Monterey Peninsula. The line extended from the 1920 Newark Substation, which served as PG&E's primary period substation for Central California, to link power supplies from Drum, Stanislaus, and Electra Powerhouses. Thus, in less than 1 year, PG&E linked the new service territory of the Monterey Peninsula to its multifaceted power supply.[74]

E.4.7 Pacific Service Merger: A Modern PG&E Emerges

By 1929, PG&E had a gross revenue of 65 million dollars, surpassing earnings from any other year. Sales of electricity also reached a new high, with kW hours surging by 38 percent from 1928. The company's connected load was 1,864 MW, also a record-breaking number, and customer count surpassed one million, with 1,300,000 customer households in 38 counties and 362 cities and towns across Northern and Central California. Beneath these numbers lay an impressive array of company statistics: annual reporting boasted 400 million dollars invested in capital improvements, 61,000 square miles of territory, 159,000 acres of land owned, 20 million dollars in annual wages, and 7 million dollars in taxes paid. Company facilities included 34 hydroelectric power plants and eight electric steam plants with a combined operating capacity of 685 MW, as well as 18 gas plants that processed and sold 22 billion cubic feet of gas in the year. Lastly, PG&E maintained 18,488 miles of transmission and distribution lines, a figure proudly noted by the company as equivalent to "three-quarters of the distance around the earth."[75]

The steady drumbeat of progress in 1929 continued. In September, PG&E purchased Snow Mountain Power Company, which operated Potter Valley Powerhouse on the Eel River and held transmission lines that extended into Mendocino, Lake, Sonoma, and Napa Counties. The purchase complemented PG&E's earlier acquisition of California Telephone and Light Company, which had purchased and distributed Snow Mountain's power in California Telephone and Light Company territory. With an 8,000-kW capacity, Potter Valley Powerhouse was a small component of PG&E's system. In a separate purchase, the company acquired a powerhouse and dam at Bullards Bar on the North Yuba River, adding another 8,000 kW to the network, as well as a 60 kV connection to the existing Colgate transmission line. The company also continued to lay the groundwork for new facilities with a late 1920s construction campaign on the Mokelumne River to supplant the existing early twentieth-century capacity of the 1902 Electra Powerhouse. Although the Salt Springs and Tiger Creek Powerhouses would not be completed until 1931, planning and construction began in 1926, as PG&E planned for a growth curve that would stretch into the 1930s.[76]

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74 "Pacific Service in New Territory: Our Newark-Salinas Tower Line," *Pacific Service Magazine*, Volume XVII, No. 3, January, 1928, 84–87; "An Important Link in the Service Chain: Additions to Newark Substation," *Pacific Service Magazine*, Volume XIII, No. 8, January, 1922, 252.

75 *Pacific Service Magazine*, Volume XVII, No. 9, July 1929; *Pacific Service Magazine*, Volume XVII, No. 12, April, 1930, 393.

76 "Our Newly Acquired Properties—Snow Mountain Water and Power Company," *Pacific Service Magazine*, Volume XVII, No.11, 343; "Salt Springs Development Underway," *Pacific Service Magazine*, Volume XVI, No. 9, July 1926.

In addition to PG&E's substantial electrical growth, 1929 was a major year in gas expansion. By the mid-1920s, natural gas surpassed manufactured gas, with increasing availability of natural gas through improved pumping methods expanding the market. By 1929, PG&E had converted much of its manufactured gas market to natural gas. In preparation for this, the company constructed an extensive gas pipeline system that connected the burgeoning Kern County oil field with PG&E service territory. During this period, many of the existing manufactured gas plants were retired, often existing as remnant features on PG&E's electric substation sites.[77]

As PG&E emerged into the 1930s, the company had every reason to feel bullish on future prospects, both regarding the company itself and the surrounding state of California. The bullishness of the company was mirrored by leaders at the time. Then-United States Secretary of Commerce and future President Herbert Hoover, ally of the industry, surmised at a meeting of the National Electric Light Association, "By the 1930s, the stations of the country will probably need an additional capacity of fully 30 percent, carrying them up to nearly 36 million horsepower and involving some 5 billion dollars in investment…This enormous expansion might awaken some anxiety in the public mind…But you can't buy a 100 horsepower at a ten-cent store".[78]

Against this backdrop, the March 29, 1930 merger of PG&E with long-time rivals Great Western Power Company and San Joaquin Light and Power Company served as a definitive masterstroke, representing a "Pacific Service Merger" that secured PG&E a role as one of the largest utilities in not only the state, but the nation. The merger brought to PG&E Great Western Power Company's three large Feather River hydroelectric power plants—Big Bend (1908), Caribou (1921), and Bucks Creek (1928)—Great Western's two associated high-voltage transmission lines and associated transmission substations, and five urban steam-operated power plants in Oakland and San Francisco—an aggregate generating capacity of approximately 250,000 kW. Additionally, PG&E acquired Great Western's extensive water storage facilities, most importantly Lake Almanor with its 1,300,000 acre-feet stored at the headwaters of the North Fork Feather River. Eventually, this water storage played a key role in PG&E's extensive mid-century development of this watershed.[79]

Although Great Western Power Company was the biggest prize because of both its scale and the fierce competition that had long defined relations between the companies, the holdings of San Joaquin Light and Power Company also proved transformative. In this acquisition, PG&E bolstered generation capacity by 165,000 kW from 11 hydroelectric power plants: Crane Valley (1919), San Joaquin Powerhouse No. 1 (1910), San Joaquin No. 1-A (1919), San Joaquin No. 2 (1917), San Joaquin No. 3 (1906), Kerckhoff (1920), Balch (1927), Tule River (1914), Kern Canyon (1921), Merced Falls (1930), and Mountain King (1922). Three steam plants provided additional supply: a large plant at Midway in Buttonwillow, a plant in Bakersfield, and the Betteravia steam plant in Santa Barbara County. Transmission and distribution infrastructure included 523 miles of 110 kV transmission line, 996 miles of 70 kV transmission line, and 7,300 miles of 11 kV distribution line. In addition to the transmission and distribution held directly by San Joaquin Light and Power Company, PG&E absorbed the operationally affiliated Central Coast holdings of the Midland Counties Public Service Corporation, which included 12 substations and nearly 200 miles of 60 kV transmission line radiating from southern Monterey County to Santa Barbara County. This purchase secured another piece of the territory puzzle, fitting seamlessly with the 1928 purchase of the Coast Valleys Gas and Electric Company territory in Monterey.[80]

E.5 1930–1941: Depression and a Paradigm of Growth Tested

Through 1930, PG&E assimilated its massively expanded service area and facility infrastructure, including all or portions of 46 counties, 63 hydroelectric plants, 15 steam plants, and 24 gas plants. Through the year, however, the broad economic foundations of the state and country grew increasingly weak. The 1930 malaise incited by the stock market crash of 1929 threatened to overtake industrial, commercial, and civic growth. By the close of 1930, the

77 "How Natural Gas is Transmitted from Valley Oil Fields to the Bay," *Pacific Service Magazine*, Volume XVII, No. 12, April 1930, 367.
78 "How the NELA Came to San Francisco," *Pacific Service Magazine*, Volume XVI, Number 5, July, 1925, 162.
79 "The New Pacific Service Merger," *Pacific Service Magazine*, Volume XVII, No. 1, July, 1930, 1–25.
80 "The New Pacific Service Merger," *Pacific Service Magazine*, Volume XVII, No. 1, July, 1930, 1-25

ramifications of economic decline were evident, as summarized in PG&E's Twenty-Fifth Annual Report of 1930: "The Company's activities during the past twelve months were prosecuted in the teeth of a general business depression of marked severity and duration." Initially, the company put an opportunistic spin on the mounting panic, even using the chaos of the stock market as fodder for selling more PG&E consumer bonds. It continued to develop new facilities, confirming its commitment to growth as it proceeded with construction with Tiger Creek and Salt Springs Powerhouses on the Mokelumne River and made a variety of other system improvements totaling 50 million dollars in 1930 alone. The justification behind the capital improvements seemed to be aimed squarely at the growing specter of depression:

> This [growth] is strictly in line with our company's policies of building ahead and addressing the constant increase in population and by the general expansion of agricultural, industrial, and other fields of human activity which has been in process since the fertile brain of man conceived practical ways and means of enabling the people of California to profitably avail themselves of the natural resources with which this state is endowed, to a greater and more diversified extent, perhaps, than any other state in the Union. It was no small task to undertake expenditures of this magnitude in the face of a general business depression of unusual severity at a time when there was a slowing up of industrial and commercial enterprise, when retrenchment, rather than advancement was the order of the day. But the Pacific Gas and Electric Company is a public service corporation and as such it is its bounden duty to provide continuous, adequate, and dependable service and any and all circumstances. It may not take shelter behind stress of conditions. [81]

As the declines of 1930 extended through 1931 and 1932, however, the outlook became bleak. Gross revenues fell for the first time in company history. Paying customer load for 1932 was three million dollars short of 1931 and continued to decline during 1933 and 1934. In 1933, the company had furloughed 81 percent of its personnel, noting, "While curtailed demand has necessarily resulted in the postponement of important construction projects the California Gas and Electric utilities have cooperated in efforts to reduce unemployment by spreading available work among as many employees as possible. [PG&E] alone, by this means has succeeded in giving work to 1,700 employees, or 19 percent of its present personnel." By this time, even the company's journal, *Pacific Service Magazine*, long a sunny and detailed bastion of PG&E's expansion program, had become a victim of what was now an undisputed and devastating economic depression, with the last issue published in January 1933. The final page of the issue sounded a grim tone: "Through the pages of this magazine may be traced, step by step, every major construction project, every addition to the company's corporate holdings, every expansion of its territory, every notable extension and improvement of its service facilities…But, as already stated, the general policy of today is one of retrenchment in all directions, so with the present issue, *Pacific Service Magazine* passes…We express the hope that the day is not far distant when the conditions that have brought about this suspension will be but an unpleasant memory.".[82]

Against this societal backdrop of upheaval and insecurity, the capital campaigns of the 1930s stood in marked contrast to the boom years of the 1910s and 1920s. Although PG&E did construct new facilities and maintain its sprawling system, the scale of efforts was greatly reduced, consisting primarily of the completion or fine-tuning of projects that had been planned or developed prior to the Great Depression. Thus, the Great Depression is a clear dividing line in the trajectory of PG&E, as the foundational aspirations and societal underpinnings of the initial decades of development collided with a faltering economic reality that undid many of the company's assumptions regarding California's statewide economic prospects. PG&E would again play a central role in the state's economic growth, but not until World War II.

E.5.1 A Diminished Period of Capital Expansion and Improvement

From 1931 to 1936, PG&E's infrastructural campaigns were limited to all but the barest necessities, with virtually all construction put on indeterminate hiatus. Notable exceptions were two projects that had been under contemplation and construction during the boom period in the late 1920s and 1930: the Mokelumne River hydroelectric expansion and

[81] "The Pacific Service Record for 1930," *Pacific Service Magazine*, Volume XVIII, No. 4, April 1931; "Editorial," *Pacific Service Magazine*, Volume XVIII, No. 11, January, 1933.

[82] "Notice To Our Readers," *Pacific Service Magazine*, Volume XVIII, No. 11, April, 1933, 356.

modernization of San Francisco's largest and oldest steam-electric plant, Station A, to accommodate the utility transition to natural gas. After completion of these two large projects in 1931, PG&E infrastructure improvement efforts went largely dormant, succumbing to the much maligned "retrenchment," during which PG&E initiated only scattered facility improvements and new construction.

PG&E had acquired the Mokelumne holdings from Standard Electric Company, which had been absorbed by California Gas and Electric Company in 1904 and subsequently merged into PG&E upon formation. Until the late-1920s expansion, the sole operating powerhouse in the watershed was the 1902 Electra Powerhouse. By the mid-1920s, as demand grew and drought conditions tested available hydroelectric generation, PG&E planners and engineers formulated an expansion plan for the Mokelumne holdings. PG&E proposed a "first unit of development" that included two powerhouses, Salt Springs and Tiger Creek, as well as an associated 220-kV transmission line connecting to Newark Substation, the central interconnection point for the company's central Sierra Nevada projects. This was intended to be the first phase of a larger development that was ultimately planned to include the construction of an additional powerhouse at West Point, an additional generating unit in Tiger Creek Powerhouse, and the replacement and upgrade of Electra Powerhouse. Although none of these later-phase components were undertaken during the 1930s, all were eventually added during the 1940s. Construction of the "first unit" began in 1926 and continued through 1931, with Tiger Creek and Salt Springs Powerhouses coming on-line July 12, 1931. At initial construction, the project brought nearly 71,000 kW to PG&E's transmission system, much of which was funneled south to the former San Joaquin Light and Power Company's territory via a newly constructed 220-kV substation at Herndon.[83]

As the Great Depression intensified, the scale of the project was a notable beacon of productivity in an otherwise dismal industrial landscape. The project also served as a key source of work for PG&E's increasingly beleaguered staff. As pointedly noted by company officials, the project was key in its industrial supply demands, with PG&E management touting that, "A 'Buy at Home Policy' was steadfastly adhered to by [the] company in this, as indeed, in all its major construction achievements of recent years. Whenever possible, all machinery and supplies were purchased from California corporations and firms, so that, to say nothing of labor on the ground, employment in the manufacture of the finished product from the raw material was provided for many thousands of workers in Northern California industries."[84]

The aesthetic treatment of Tiger Creek and Salt Springs Powerhouses stood in contrast to the company's earlier large-scale powerhouse construction. The powerhouses conveyed little of the fanciful classical allusions of earlier development, most notably that of the Drum and Pit projects. Although the powerhouses retained a subtle monumental aesthetic, with rhythmic fenestration and massing, the style was largely devoid of ornamentation and conveyed something of a muted Art Deco form. Describing Salt Springs Powerhouse, officials were succinct, noting simply that the facility was, "of modern construction, tall and roomy." The quoining and battlements of PG&E's earlier hydroelectric plants ceded to a sparer form that would increasingly define utility construction by the middle of the twentieth century.

In addition to its ongoing work expanding the Mokelumne infrastructure, PG&E initiated refurbishment of San Francisco's Station A, a steam-electric power plant located in the Potrero District. Construction of the plant began in 1928, and the facility was in operation in 1930. The plant had initially been constructed in 1901 by Clause Spreckels' Independent Power and Light Company, a rival to San Francisco Gas and Electric. In 1903, Independent Power and Light Company and its holdings were absorbed by San Francisco Gas and Electric, ultimately becoming part of PG&E in 1906. The plant was the lone steam-generating plant to survive the earthquake of 1906 and had been a vital component of San Francisco's standby generation capacity since. The 1931 work expanded the plant and adapted it for use as a natural gas plant. Expansion included four additional steam-generation units, which served to rate the plant as the largest steam-generating station in the world at a capacity of 130,000-kW. In keeping with the ethos of efficiency

[83] "Mokelumne River Project Officially Placed in Service," *Pacific Service Magazine*, Volume XVIII, No. 5, July, 1931.
[84] "Mokelumne River Project Officially Placed in Service," *Pacific Service Magazine*, Volume XVIII, No. 5, July,1931.

and thrift, the architectural designs were modest, with PG&E noting, "The old building at Station A is of brick and had to be altered but little to house the turbines and boilers and their related auxiliaries…Although the original building presented a rather plain appearance, it has been possible by refacing its fronts in red brick and properly placing the windows and doorways to produce an inexpensive architectural effect which is very pleasing."[85]

As construction of projects planned during the 1920s closed, PG&E fell into a period of marked quiet, with very little new construction across the system and no major expansion projects. Period records include a variety of small maintenance projects and the ongoing construction of new substations, as market demands and obsolescence affected this vital link in the energy supply chain. Overall, construction was focused on rebuilding or constructing small distribution substations rather than the more complex class of interconnected transmission step-down stations. Small substation improvements included Del Monte and Carmel Substations in 1931, Los Coches, and Sunnyvale Naval Air Station, Crystal Springs, Lodi, Bolinas, and Vallejo Substations in 1932. PG&E also completed a smattering of other substation improvements across the service area. Like the powerhouses, the new breed of substation stood in marked contrast to earlier substations that included a stylized "permanent" control building or attendant facility. Substation design became decidedly utilitarian in form, reflecting advances in outdoor distribution equipment, economy, and the growing ubiquity of the small substation as a common and widely developed physical type. During this period, PG&E and other utilities moved to a new paradigm of largely outdoor and unattended substations, which ultimately streamlined and simplified construction and operation. Although exceptions to this general trajectory remained, particularly in urban areas that required interior distribution facilities, on the whole PG&E's substations shifted to outdoor distribution and transmission apparatus and became largely devoid of a self-conscious or developed architectural form.[86]

In addition to ongoing system maintenance and small-scale upgrades, PG&E touted the company's continued links to California's admittedly muted industrial progress. In 1933, the company highlighted its role in dredging for the Port of Stockton, with PG&E current supplying the deep-water dredgers. In 1934, during construction of the San Francisco-Oakland Bay Bridge, PG&E ran 25,000 feet of electrical cable across the construction site, noting, "The San Francisco-Oakland Bay Bridge, superlatively great structure, is being built with superlatively modern facilities. Employed to complete it by 1937 is electric power—PG&E power." Thus, even as the company experienced a period of relatively stagnant facility growth, its existing power grid continued to play a well-integrated role in the industrial, commercial, civic, and domestic life of the state. Additionally, the company continued to see reason for tempered future optimism, noting, "Estimates of the future electric power requirement of any area, small or vast, are most frequently predicated upon future population. Even the present economic disorganization has not served to greatly affect the rate of immigration into the Western states. To the contrary, the fact that the west has fared better during the past three years than have other regions, may invite more rapid immigration."[87]

By 1936, PG&E saw a slight uptick in gas and electric sales, a product of a slackening economic depression in the state and increased population and consumption rates. By 1939, plans for more power coalesced, with a focus on urban oil-fueled steam plants. Years of drought during the first half of the 1920s had unsettled the industry, exposing the fact that despite intensive watershed development, hydroelectricity would always be at the whim of nature and rainfall. Technical advances in steam generation had also enabled higher capacity plants as natural gas replaced the laborious and expensive manufactured gas process. In addition, gas plants could be developed and operated more economically than hydroelectric plants because gas plants could be located closer to population centers, required less infrastructural planning and overhead, and could be automated more than the hydroelectric plants of the period. PG&E's early 1930s refurbishment of Station A in San Francisco was indicative of this pivot from hydroelectric primacy, firmly establishing urban generation as a viable area of future growth. As steam generation was primed to expand, PG&E

[85] "Reconstruction of Station A: First of New Turbines Installed," *Pacific Service Magazine*, Volume XVIII, No. 2, October 1930; "Station A Reconstruction Completed—High Pressure Units Now In Operation," *Pacific Service Magazine*, Volume XVIII, No. 6, October, 1931, 163–171.

[86] "The Substation Feature of the Electric Distribution Problem," *Pacific Service Magazine*, Volume XVIII, No. 10, October 1932, 307-313; "Reconstructed Substation is Typical of Modern Design," *Pacific Service Magazine*, Volume XVIII, No. 11, January, 1933, 335–339.

[87] Power in the West, Its Past, Its Present, and Its Future," *Pacific Service Magazine*, Volume XVIII, No. 11, January, 1933, 328.

engineer and future PG&E president A.H. Markwart noted in 1930, "Under the circumstances which now prevail it is natural to question the future of hydro power in California."[88]

By the late 1930s, with improved economic conditions and the specter of war on the horizon, plans for three new power plants were under way, all of which were sited adjacent to San Pablo Bay oil refineries in Contra Costa County. The siting was intended to introduce a number of industrial efficiencies, with all utilizing waste fuels from the refineries and exchanging steam, water, and power between the plants and adjacent refineries to save operating costs. Avon Power Plant was brought on-line in 1940, adjoining Tidewater Associated Oil Company. Next came the Martinez Power Plant in 1941, located at the Shell Oil Company. Last, Oleum Power Plant was completed in 1942, operating at Union Oil Company. Combined, the three plants brought 137,000 kW of power to the Bay Area, just as the outbreak of the war initiated a rapid period of industrial demand. Thus, the plants launched PG&E from the fading pall of the Depression to the industrial throes of the war effort.[89]

E.6 1941–1945: A Nation at War, an Industry Revived

Although the bombing of Pearl Harbor proved the ultimate catalyst for America's entry into World War II, the country had steadily escalated wartime readiness in the months and years prior as the nation witnessed the growing dissolution of its European allies in the face of expanding Axis powers. As the European conflict intensified during 1940, the United States initiated a broad defense campaign designed to bolster industrial capacity in support of European allies and to ready America itself for military conflict. PG&E played a key role in the California effort, and as the state's largest utility assumed the identity of an "Arsenal of Fuel and Power," for an unprecedented and all-encompassing national defense campaign. As early as 1940, the company noted a substantial uptick in energy consumption and sales, with a 10 percent increase in gas sales and a 6 percent increase in electricity consumption over 1939 levels. The company resumed system expansion with "expenditures for additions and betterments to the company properties exceeding those of any year since 1930, with a comprehensive construction program designed to meet all possible demands upon its system resulting from load growth in this territory during the next few years."[90]

By mid-1941, the United States military had spearheaded a comprehensive campaign to address a "National Defense Emergency." In California, this campaign translated to more than one billion dollars in military construction, with the West Coast increasingly seen as a vulnerable flank fronting a hostile Pacific Rim. Within this context of public expansion, private industry played a critical role as the production of iron, steel, and other commodities boomed to keep pace with the ballooning military needs. PG&E played a central role, with then-President James Black even leading "Industrial Defense Clinics" to coordinate industrial production and strategizing. As relayed by Black in April 1941:

> All other matters are either subordinate to or related to defense. It is necessary to have a complete understanding of the tremendous responsibility which has been placed on industry in preparing the implements of national defense with emergency speed. There has been no armament industry in America. As a result, the great forces of American production must be speedily and effectively converted to defense production, meaning everything from a toothpick to a battleship.[91]

That energy production and power served as the common denominator between a toothpick and a battleship was not lost on Black. Throughout 1941, as production soared, PG&E repeatedly assured a worried public and military of the company's ample power supplies. As summarized by Vice President and General Manager Paul M. Downing in 1941, "Northern California will have ample electric power to meet any anticipated increased consumption arising from the national defense program…Supplies are ten to twelve percent in excess of demand, and PG&E has under construction

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88 James C. Williams, Energy and the Making of Modern California, 278–281.
89 James C. Williams, Energy and the Making of Modern California, 278-281.
90 "Pacific Gas and Electric Company Annual Earnings Equal to $2.68 Share," *San Francisco Chronicle*, March 25, 1941.
91 "A Clinic for Defense Problems," *San Francisco Chronicle*, April 11, 1941.

new power plants which will considerably add to its capacity." Closing firmly, Downing declared, "We do not anticipate any power shortage here."[92]

E.6.1 Wartime Construction

PG&E's three steam plants in Contra Costa County, Avon, Martinez, and Oleum were the first major links in the escalated wartime energy supply chain, infusing the Bay Area industrial corridor with additional capacity and a backstop against the vagaries of drought. In addition, the company plotted a series of watershed expansions through 1940 and 1941 to increase hydroelectric capacity. Despite the impetus of a nation increasingly focused on war, siting of the plants was stymied by regulatory complexities. PG&E initially pursued development of two powerhouses on the Feather River, only to be ensnared in Federal Power Commission licensing conditions that caused the company to abruptly shift course and abandon its Feather River plans altogether in mid-1941. Instead, the company focused on construction of several smaller powerhouses: the 2,000 kW Phoenix Powerhouse, located on the Stanislaus River and replacing an earlier powerhouse of the same name; the 12,000 kW Narrows Powerhouse, located on the Yuba River in Nevada County; and the 22,000 kW Dutch Flat Powerhouse, located downstream from Drum Powerhouse on the Bear River in Placer County. Phoenix was completed first, coming on-line in 1940, with Narrows active in 1942, and Dutch Flat operational in March 1943. Reflecting both the spare design ethos evident in the 1930s Tiger Creek development and the exigencies of wartime construction, the powerhouses were modest in form and design, with stripped down concrete exteriors and little heightened ornamentation defining their industrial form.[93]

In addition to the incremental capacity increase afforded by Phoenix, Narrows, and Dutch Flat Powerhouses, PG&E constructed Pit No. 5 Powerhouse, adding to the Pit River chain of development. The powerhouse was constructed between July 1941 and April 1944 and was considered a key element of Northern California's wartime energy security—so much so that it escaped the tightening supply strictures of industrial wartime rationing. With its 151,000-kW capacity, Pit No. 5 was the largest hydroelectric powerhouse built to date in the PG&E system, with a concurrently constructed 220-kV transmission line that ran parallel to the system's original 1920s transmission line to Vaca-Dixon Substation and on to the interconnected grid of the Bay Area. Upon completion, the powerhouse was feted by high-ranking military officers and California Governor Earl Warren, who praised PG&E for "keeping pace with a constantly mounting demand for electricity for war production and for the domestic, business, and agricultural needs of more than one million customers". Pit No. 5 Powerhouse proved the capstone of the war effort, with its massive scale and hastened construction defining the era's efficiency and readiness paradigm. Additionally, the project was an emphatic affirmation of the initial precepts of the 1920s Pit River development, confirming the immense multiphased potential of the watershed.[94]

PG&E's readiness campaign also included general distribution-related construction, adding capacity to serve new industrial facilities and military cantonments. In advertising, PG&E noted that its distribution facilities fed "cantonments at Fort Ord, Camp San Luis Obispo, Camp Roberts, Camp Bradley, the Presidio of San Francisco and Neighboring Forts…Hamilton, Moffat, and Mather Air Fields, Airports of Stockton, Fresno, and Salinas…Naval Air Station Alameda, the Naval Supply Depot and Fleet Supply Base in Oakland, Hunter's Point Dry Dock, and the Naval Reserve Aviation Base in Oakland…Housing Projects in the neighborhoods of army and naval establishments….served as rapidly as they are being completed." In this manner, the basic distribution capacity of the company was linked to wartime expansion, with the industrial pulse of the era fed by a growing array of utilitarian

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92 "Civilian Defense: Luncheon Speakers Give SF Clearer Picture of Emergency," *San Francisco Chronicle*, May 30, 1941; "A Clinic for Defense Problems," *San Francisco Chronicle*, April 11, 1941; "California Will Not Suffer an Electric Shortage," *San Francisco Chronicle*, June 3, 1941.

93 "PG&E Projects: Firms Asks Speedy Ruling," *San Francisco Chronicle*, April 30, 1941; "Power Dam: PG&E Change Plan, Moves to Pit River," *San Francisco Chronicle*, July 2, 1941; "Work to Start on PG&E Yuba Plant," *San Francisco Chronicle*, July 15, 1941.

94 Charles M. Coleman, PG&E of California: The Centennial Story of the Pacific Gas and Electric Company, 1852-1952, 316–319; "Pit 5: California's Greatest Hydroelectric Plant, San Francisco Chronicle, May 1, 1944.

PG&E distribution lines. PG&E likened its company to a domestic army "ensuring electric power when and where needed".[95]

E.6.2 PG&E in the Readiness Era

While PG&E's physical expansion during World War II era reflects the era's immense industrial demands, other aspects of the company's operations convey the tone of the period. The primacy of industry led to the nation's industrial giants assuming an outsized, and often self-promotional, role in the prosecution of war. As Northern and Central California's preeminent utility, PG&E embraced this high-profile role, with extensive public service campaigns and preparedness partnerships that were often cloaked with more than a touch of advertising.

PG&E was central to California's readiness campaigns from the outset of the war. In addition to the company's vital links to power supply, the company played an important role in power consumption—both defining and being defined by government regulation of power usage. By 1942, as the Civilian Defense Office initiated mandatory blackout periods, PG&E was providing technical oversight, both ensuring adequate compliance and providing consumer-based suggestions for maintaining creature comforts. The company also navigated War Production Board restrictions on natural gas usage, complying with restrictions on natural gas for heating purposes while continuing to promote gas consumption for a range of residential uses.[96]

PG&E also developed public-private readiness plans. In a number of cities, PG&E developed back-up generator capacity to provide key sources of power in the event that transmission lines were bombed or cut by saboteurs. In collaboration with defense officials, the company planned "Blinking Blackouts" whereby communities could warn of incursions. In a move that can be interpreted as both intimate and opportunistic, the company made its way into the kitchen, beseeching war wives to maintain optimal efficiency and nutrition standards atop their PG&E-fueled kitchen appliances.[97]

In a dark chapter of the domestic wartime landscape, PG&E found itself at the center of the country's punishing treatment of its own Japanese citizens and residents. As hysteria over domestic insecurity reached its zenith following the bombing of Pearl Harbor, the United States military initiated a series of calculations regarding its Japanese residents, leading to the forced internment of thousands of innocent American citizens and residents. Relocation was based on a series of military zones, many of which were defined by their relationship to powerhouses, substations, and key transmission lines. Concluding that "Jap residents live virtually next door to every important airfield, military camp, naval base, railroad center, war factory, and strategic public utility," in 1942 the United States government, abetted by its private industry and citizens, initiated a rapid and largely uncontested campaign of removal that remains one of the most painful and morally repugnant legacies of the World War II era.[98]

E.7 1945–1973: The Post-War Era and California Unleashed

By the time the Allied Powers declared victory over Japan in August 1945, California's population had surged from just shy of seven million in 1940 to nearly ten million, an astounding trajectory that surpassed all other eras in the scope of growth. By 1960, nearly 16 million residents filled the state. As population surged, California's populace, indeed the nation's, was defined by increasing consumer sophistication, including heightened expectations regarding domestic consumption after years of war and the Great Depression. Surveys initiated by the United States Chamber of Commerce confirmed this growing pulse of demand, with more than half of the mid-1940s adult population actively

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95 "All Clear" *San Francisco Chronicle*, May 14, 1943.
96 "Control Sky Glow", *San Francisco Chronicle*, August 17, 1942; "Important Facts," *San Francisco Chronicle*, March 20, 1942
97 "They Can't Invade Santa Cruz," *San Francisco Chronicle*, July 20, 1941; "Fresno Studies Methods of Broadcasting the Blackout," *San Francisco Chronicle*, January 4, 1942; "Air Raid Shelters: These Facilities Approved," *San Francisco Chronicle*, December 23, 1941; "Food on the Homefront" *San Francisco Chronicle*, February 20, 1942.
98 "Pacific Coast: A Military Zone, *San Francisco Chronicle*, March 4, 1942; "Jap Residents Encircle Vital State Areas," *San Francisco Chronicle*, March 5, 1942.

seeking durable goods—most notably cars and a widening range of home appliances. The era of the consumer had begun.[99]

Within this increasingly dominant consumer-focused framework, PG&E seamlessly pivoted from the industrial mandates of war to a peacetime economy, initiating another period of rampant expansion that largely built upon existing facilities developed during the first decades of the twentieth century. While the war had introduced a number of privations, including material and consumer-related restrictions and an escalated wartime tax structure, industrial demand had supported a number of record years of revenue during the mid-1940s, leaving PG&E flush and confident for capital expansion. Additionally, the readiness rhetoric of the war provided a continuing language and tenor of efficiency across the company. PG&E executives confronted the challenge of a booming post-war population in much the same way as they had ramped up capacity for war. As reported by R.E. Fisher, then vice president of PG&E, the company was "sizing up the problem of post-war conditions…with success in planning based on strategic independent action." Energy historian James C. Williams notes that such expansive rhetoric was a hallmark of the utility industry during the period: "A subtle, almost permanent wartime atmosphere enveloped people everywhere in Cold War America and cloaked the industry's rapid expansion in an air of incontestability…Expansion [language] emphasized power companies heroically meeting the energy demands stirred by national security needs and by a rising standard of living."[100]

E.7.1 A Billion Dollar Campaign

By 1946, PG&E had announced a 3-year, 160-million-dollar facility campaign. "PG&E is busy on the largest construction program in its history," declared company publication *PG&E Progress*. "The purpose, of course, is to provide facilities to anticipate the growth of Northern and Central California and to restore normal system reserves depleted under wartime restrictions." This campaign had nearly quadrupled to 800 million dollars by 1951 and would rise over the billion dollar mark before 1960. Explaining the work, PG&E President James Black noted:

> We observed that the war served to accelerate an already significant westward movement of population and industry. It is now even more apparent that much of the wartime growth is of a permanent character, and that the industrial, commercial and agricultural development of this region will continue on a far higher plane of activity than before the war. Some measure of the magnitude and diversified character of this growth is afforded by the statement that in 1946 alone, more than 1200 industries announced plans for new or expanded facilities in the Company's service area.[101]

A good deal of this expenditure was on relatively prosaic projects, with tens of thousands of miles of distribution line and more than 200 associated small-scale substations constructed from 1946 through the 1960s. By 1951, PG&E held 58,000 miles of transmission and distribution line, a number that would more than double by the close of the twentieth century. As substations proliferated to respond to increased demand and development, they followed the utilitarian maxims that had arisen in the Great Depression era, with predominately standardized outdoor facilities replicated widely across urban, rural, industrial, and suburban landscapes.

PG&E's first post-war powerhouse, a retrofitted wartime tanker ship turned steam plant, is likely one of the most novel to be developed in the company's history, although none of the facility remains. Damaged in World War II, the SS Donbass was sold by the federal government at public auction. PG&E purchased the ship for $110,000 and repurposed the stern section with steam boilers, a turbine, and generators. The piecemeal powerhouse was moored in Humboldt County on the industrial shores of Eureka, adding 5,400 kW to the local distribution system and providing critical support for the city's booming sawmills. The SS Donbass remained in operation for nearly 10 years until it was replaced by Humboldt Bay Power Plant in 1956. Upon retirement, the ship was sold to a Los Angeles firm and

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99 James C. Williams, Energy and the Making of Modern California, 280.

100 "PG&E Gross Revenue Gain Highest," *San Francisco Chronicle*, April 14, 1943; "Electric Capacity," *San Francisco Chronicle*, June 10, 1943; James C. Williams, *Energy and the Making of Modern California*, 283–284.

101 "$300,000,000 Building Program," *PG&E Progress*, February, 1947.

scrapped. In a sense, the small plant harkened back to PG&E's mid-nineteenth-century foundations, where early electrical pioneers operated in a relatively ad hoc material landscape defined by unorthodox experimentation.[102]

By 1948, PG&E had completed three additional powerhouses consisting of two new hydroelectric facilities on the Mokelumne River and the large Kern County Steam Plant. The hydroelectric plants, Electra Powerhouse and West Point Powerhouse, had been envisioned decades earlier as part of PG&E's late 1920s and early 1930s Mokelumne River construction campaign. The Electra Powerhouse replaced the 1902 powerhouse of the same name and increased the capacity fourfold to 80,000 kW. West Point Powerhouse added a relatively small 15,000 kW to the Mokelumne system, rounding out the developable capacity of the watershed. The Kern County Steam Plant was the centerpiece of the late-1940s campaign, with a 75,000-kW turbogenerator that represented the vanguard of operational efficiency for the PG&E system. As relayed by historian Charles M. Coleman, steam-based generation plants were a central focus in the post-war period:

> During Post-War expansion a marked change was brought about in the planning of new installations. Since pioneer days California had turned to water power for production of electricity because of the lower cost of operation on the streams of the Sierra. Steam-operated powerhouses were built and maintained chiefly for stand-by service during period of short water supply, peak loads, and emergency. In recent years, engineers have planned more and larger steam-operated stations. The primary reasons being that generations by steam plants was becoming more efficient and could be established economically in centers of populations and industry; also that available sites for hydro projects were diminishing in number.[103]

Thus, the Kern Power Plant represented a new breed of steam plant that would come to take on a greater share of PG&E's energy load during the second half of the twentieth century. Other major plants of the period included the 1950 Moss Landing Plant in Monterey County, the 1951 Contra Costa and 1954 Pittsburg power plants in Contra Costa County, and the 1956 Humboldt Bay Power Plant in Eureka, along with expansion and modernization of older facilities including those at Hunters Point in San Francisco. Before 1940, steam provided 25 to 40 percent of output, with hydroelectricity accounting for the remainder. By the 1960s, steam plants accounted for upward of 60 percent of system output. As concluded by PG&E Vice President Walter Dryer in 1957, "For economic reasons nearly all future hydro development in Northern California will be designed to supply peaking power; consequently, the role of thermal-electric plants will be to supply power at high capacity factor, except during periods of heavy run-off." While many of this era's fossil-fuel steam-generation plants would eventually be phased out of operation because of higher fuel prices and rising environmental concerns about greenhouse gases, by the mid-twentieth century fossil-fuel-generated steam had ascended to an equal—if not greater—footing as California's vaunted hydroelectric system. As noted by energy historian James C. Williams, the shift was profound in a professional engineering culture that had come to maturity in a hydroelectric framework: "Hydroelectricity [had been] a significant part of the culture of California's electric power industry. Top utility leaders, particularly in PG&E, had cut their teeth on hydro power, fought for it as sound policy, and believed in it."[104]

Reflecting this fundamental hydroelectric faith even in the face of improved steam capabilities, PG&E continued to refine its established hydroelectric systems. The company returned to the North Fork of the Feather River, where early twentieth-century rival Great Western Power initially developed hydroelectric power and constructed the first PG&E-built powerhouses on the river. Cresta Powerhouse came on-line in 1949 and added 75,000-kW to the existing capacity of the Feather River facilities. Rock Creek Powerhouse came on-line in 1950 and generated 126,000-kW. Both were connected by a new 220-kV transmission alignment that supplemented the 1920s line built by Great Western Power Company. In contrast to Great Western's classically inspired powerhouses, which reflected the early

[102] Floating Electric Plant of Russian Ship Put Into Operation Here to Augment Local PG&E Service, *Eureka Times-Standard*, December 28, 1946
[103] Charles M. Coleman, *PG&E of California: The Centennial Story of the Pacific Gas and Electric Company, 1852*–1952, 332–335.; "160 Millions for New Facilities," *PG&E Progress*, Volume XXIII, No. 12, November, 1946.
[104] James C. Williams, *Energy and the Making of Modern California*, 280-283; "PGE Continues Expansion to Meet Growth of State," *Healdsburg Tribune*, March 29, 1951.

twentieth-century utility industry preoccupation with civic stature, the two PG&E powerhouses exuded a monolithic and understated design, with limited fenestration defined by a solid and utilitarian concrete massing.[105]

Through the 1950s and 1960s, PG&E continued to add to the Feather River "Stairway of Power," constructing three additional powerhouses by 1958: Poe Powerhouse, Butt Valley Powerhouse, and Caribou No. 2 Powerhouse, standing adjacent to the 1921 Great Western Power Caribou Powerhouse. Belden Powerhouse was added in 1969. Notably, all of the powerhouses reflected a new era of operational design, with outdoor plans that lacked the framing super structure of earlier powerhouses. The design was largely predicated upon cost and construction efficiency, with turbines and generators recessed in utilitarian concrete enclosures that introduced substantial savings in material and labor. This design was replicated across PG&E's watersheds, as well as those of other utilities during the period. The last powerhouse to join the Feather River network, Grizzly Powerhouse, was added to the Bucks Creek system in 1993, and also used a semi-outdoor design.

The North Fork of the Feather River continues to generate more than 800 MW of hydroelectric power, making it one of the most productive watersheds in the state. Additionally, the watershed is one of the most representative examples of the evolution of the hydroelectric industry. The early twentieth century holdings of Great Western Power Company intermix with ongoing twentieth-century development by PG&E, reflecting a century-long tale of corporate assimilation and technological and stylistic evolution.[106]

In addition to bolstering the Feather River as a core hydroelectric system, PG&E returned to the Pit River watershed, completing a series of powerhouses between 1955 and 1965. Pit No. 4 Powerhouse came on-line in 1956 and was of the traditional above-ground enclosed variety, with a generating capacity of 84,000-kW. James B. Black, Pit No. 6, and Pit No. 7 Powerhouses were completed during the mid-1960s, integrating flows from the McCloud and Pit Rivers. Pit No. 6 and Pit No. 7 Powerhouses were developed as below-grade structures situated at the base of their respective dams, running at 80-MW and 112-MW, respectively. James B. Black Powerhouse was an above-grade, semi-outdoor structure with a monolithic concrete form and a generating capacity of 172-MW from two units. As an assemblage, the operating facilities of the Pit and McCloud Rivers were designed to generate approximately 800-MW of power. Like the facilities of the Feather River, the plants represent multiple generations of development and design, albeit entirely of PG&E origin.

While the Feather and Pit Rivers formed the epicenter of hydroelectric capacity for PG&E, the post-war period included widely dispersed expansion and reconstruction on other watersheds. Expansion of the former San Joaquin Light and Power Company's development on the Kings River watershed included the construction of the innovative subterranean Haas Powerhouse, buried 427 feet below grade. Rated at 128,000-kW, Haas Powerhouse had a subterranean tailrace that conveyed water for delivery to a newly upgraded Balch Powerhouse. The company also constructed a second Balch Powerhouse in 1959, with the semi-outdoor Kings River Powerhouse added in 1962. Following the work, PG&E noted, "The tumbling Kings River has been harnessed to produce power for the benefit of Northern and Central California homes, farms, and industries," with more than 300-MW of power added to the watershed, far-surpassing its small-scale, early twentieth-century San Joaquin Light and Power Company origins. Further development did not occur until the late 1970s, when PG&E initiated construction of the Helms Pumped Storage Facility, which was completed in 1984 with a capacity of more than 1,000-MW, making it the largest single hydroelectric storage project in the state.[107]

Additional 1960s projects included the redevelopment of Stanislaus Powerhouse, constructed by predecessor company Sierra and San Francisco Power in 1908. The new Stanislaus Powerhouse supplemented the capacity available from PG&E's existing 1940 Phoenix Powerhouse and the 1920s Spring Gap Powerhouse. A telling photograph from the

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105 "Stairway of Power on the Feather River," PG&E, (Company Brochure, on file at the Plumas County Museum).

106 "162 Millions More for Expansion," *PG&E Progress*, Volume XXIX, No. 4, March 1952; "Stairway of Power on the Feather River," PG&E, (Company Brochure, on file at the Plumas County Museum); "Planning and Design of Hydroelectric Power Plants," CED Engineering, 1995, accessed: https://www.cedengineering.com/userfiles/Design%20of%20Hydroelectric%20Power%20Plants.pdf; United States Army Corps of Engineers, Planning and Design of Hydroelectric Power Plant Structures, United States Government Printing Office, 1960.

107 "Powerhouse Inside Mountain Has Six-Mile Waterfall," *Popular Mechanics*, March, 1959, 101; "Sierra milestone," *PG&E Life*, May, 1959, 8–9.

construction period illustrates the wide technological and stylistic gulf between the 1908 Stanislaus and its 1963 namesake, with the squat 1960s outdoor facility generating almost double the amount of electricity as the sprawling original. Upon completion of the new facility, the original Stanislaus Powerhouse was torn down and sold for scrap, severing one of the earliest links to the foundations of hydroelectric generation on the Stanislaus River.

An additional system alteration was the 1963 replacement of the original early twentieth century de Sabla Powerhouse on Butte Creek in Butte County with a semi-outdoor facility. The replacement is another example of the changing face of PG&E's infrastructure, as the "Billion Dollar Campaign" fine-tuned and expanded nearly a century of facility growth across PG&E's service area. This sweeping campaign served to markedly expand the generation capacity and breadth of the service network, while leaving a defining mid-century stamp on PG&E's facility infrastructure, as the modern era of both steam and hydroelectric plants intermixed with, and at times effaced, the system's earlier construction and predecessor company lineage.

E.7.2 The Energy of the Future: Nuclear and Geothermal Energy

Although much of PG&E's post-war expansion was characterized by network continuity, with the established precepts of hydroelectricity and fossil-fuel-based steam generation remaining intact even as they were continuously refined in form and function, the era was also one of radical energy innovation. Some wondered whether nuclear and geothermal energy technologies would render PG&E's existing power generation assets obsolete.

> **Q.** Will Atomic Energy Make Conventional Steam and Hydroelectric Plants Obsolete?
>
> **A.** No. Existing conventional plants will take their normal position in the system in the same manner as they do now when a new and more efficient conventional plant is added. As we see it, nuclear power is an eventual "must" for the industry; but we expect to continue building hydroelectric and conventional steam plants for those situations where they will be the most economic source of power. In a hydro-steam system such as ours, there should be no difficulty in integrating economically competitive nuclear plants and using them to help meet tomorrow's power requirements.[108]

During the period, a previously unimaginable generation source assumed center stage in both utility planning and public discourse: nuclear energy. The rise, and ultimate stumble, of nuclear power as a "must" for future energy needs was a defining moment in PG&E's post-war development, introducing a revolutionary new energy source and ushering in an era of increasing conflict over the societal repercussions and costs of energy consumption.

Less than 10 years after the detonation of atomic bombs over Hiroshima and Nagasaki, peacetime applications of nuclear energy had assumed an increasingly vivid role in energy planning, taking on the mantle of "energy of the future." By 1954, Atomic Energy Commission (AEC) Chairman Lewis L. Strauss predicted "that our children will enjoy electrical energy too cheap to meter." Within this "atomic age" context, California was ideally situated as a proving ground for domestic nuclear energy development. The state's active involvement in wartime defense programs gave it a leading role in continued peacetime research, with University of California, Stanford, and California Institute of Technology housing extensive applied atomic research and programs. Additionally, the state's already sprawling utilities, led by PG&E, were particularly suited to the institutional needs of atomic development, with existing robust transmission networks ideally suited for the centralized structure of nuclear generation. Lastly, the state was booming and hungry for power. California was becoming the most populous state in the nation and required continuous adaptation and capital expenditure to keep pace with energy demand. In this context, PG&E was an early proponent of nuclear power. PG&E Vice President Walter Dreyer declared the imperative to "make atomic energy the servant and not the master of mankind."[109]

[108] "Reason Behind Our Building Boom," *PG&E Life*, December, 1958, 16-17.
[109] "The Atom and Our Future," *PG&E Life*, February, 1959, 17–18.

By the early 1950s, the AEC had initiated a program to promote the study and development of nuclear reactors, summoning the nation's electric power industry to collaborate with government researchers. PG&E was an early participant in this process, and by 1954 the company had teamed with General Electric Company (GE) to construct a licensed commercial nuclear test plant at Vallecitos, near Livermore. The 5,000-kW plant became operational in 1957 and served as a pilot facility to test operations, materials, and protocol. By 1958, PG&E had begun planning the nation's first commercial nuclear power plant in Humboldt County, adjacent to the existing 1950s Humboldt Bay Steam Plant. The 60,000-kW nuclear plant came on-line in 1963, with the nuclear reactor sited alongside two existing steam turbines. Upon commission, a telegram from the John F. Kennedy White House lauded the achievement, noting, "In this and the nation's other nuclear generating plants, the peaceful atom adds new dimensions to our natural resources, assuring adequate supplies of electricity for our continued national growth and progress."[110]

Even before Humboldt Bay's reactor was operational, the company moved to secure additional nuclear capability, announcing plans in 1961 for a large nuclear power plant in rural Sonoma County at Bodega Bay. Almost immediately, however, a vocal opposition contested the siting, coalescing to a broad-based movement protesting the industrial intrusion on the California coastline. After failing to halt the project on any aesthetic or environmental grounds, the protest came to hinge on seismic safety, with the proposed plant's site adjacent to the San Andreas fault becoming a key area of debate. While a series of hearings before the AEC attempted to delineate a path for approval, a devastating 9.2 coastal Alaska earthquake presented an emphatic verdict. After surveying the damage, the AEC, and the public, extrapolated, "Bodega Head [was] not a suitable location for the proposed plant." The denial was not only a blow to PG&E but a blow to California's whole nuclear program, as the public became increasingly ambivalent about nuclear energy and its risks. Additionally, the protests surrounding the Bodega plant served as a harbinger, with environmentally based activism at the fore while California grappled with both increased population and increased energy consumption.[111]

Ultimately, nuclear generation did not become California's or the country's energy of the future. In response to continued seismic analysis, the lauded Humboldt Bay Nuclear Power Plant was inactive by 1976 and decommissioned in 1983. Despite the combative climate, PG&E was able to construct an additional nuclear power plant at Diablo Canyon in San Luis Obispo County in 1973, with the plant commissioned in 1985. The plant remains in operation, although it has been consistently mired in public protest over safety and societal impacts as well as lingering doubt over its ability to withstand seismic hazards. The plant is scheduled for decommissioning by 2025. Thus, although the atomic age began with premises of abundant power to a grateful, consuming public, in California the technology largely floundered on a sea of negative public opinion, with the environmental risk outweighing the promised reward.

E.7.2.1 Alternative Energy Sources

While pursuing nuclear power, PG&E also explored other alternative energy sources to supplement its existing steam- and hydroelectric-based system. By the mid-1950s, the company had its eye on geothermal development, with which roiling "volcanic steam" from deep below the ground might be utilized to power turbines. The technology was not wholly new, as technological antecedents dated to the early twentieth century. However, PG&E's vigorous pursuit of geothermal commercial exploitation served as California's, and the nation's first large-scale commercial foray into geothermal generation. In 1958, the company contracted with two small exploratory power companies, Magma Power Company and Thermal Power Company, to build a generating plant in the geothermally active Mayacamas Mountains north of San Francisco, creating the Geysers Geothermal Power Complex. PG&E Unit 1 came on-line in 1960, running at 12,000-kW. Three years later the company opened a second unit, running at 14,000-kW. By the late 1960s, two more units were added, with each running at 28,000-kW. By 1989, the sprawling geothermal field held 23 units and generated more than 2,000-MW of power, making the site one of the most substantial single sources of non-fossil-

110 "White House Lauds PG&E Nuclear Power Plant," *PG&E Progress*, Volume XL, No. 11, November 1963,3; Garret Root and Rand Herbert, From Sawdust to Uranium: *The History of Electrical Power Generation in Humboldt County and Pacific Gas and Electric Company's Humboldt Bay Power Plant 1883-2019*, developed on behalf of PG&E, 2013.
111 James C. Williams, Energy and the Making of Modern California, 305.

fuel-based energy in the state. The success of Geysers Geothermal Power Complex encouraged other utilities to develop additional geothermal resources across the state. Southern California Edison, Sacramento Municipal Utility District, and Northern California Power Authority have all developed geothermal capability.[112]

Despite the promise of geothermal energy production, doubts around the longevity of the technology clouded operations at the Geysers site, as a decline in steam pressure led to substantial losses of capacity. By 1992, the generation capacity of Geysers had dropped to slightly more than 1,000-MW, only half of its 1989 high. PG&E began divesting from the site, retiring many wells and selling Geyser holdings. At present, the company owns none of the generating units. As summarized by energy historian James C. Williams, although geothermal exploration existed as an important technological milestone in California's energy framework, ultimately the technology served to "remind energy planners that, in their arena, the give-and-take between technology and the environment included a myriad of ever-changing factors," that dictated ultimate technological success or failure.[113]

E.7.3 Energy's Amazing High Road: 500-kV Transmission

As PG&E continued diversifying its energy supplies with more powerful hydroelectric and gas plants and newly developed geothermal and nuclear supplies, the company developed the first major advance in California transmission technology since the incorporation of 220-kV in the 1920s. As demand for electrical power across urban and rural areas expanded into the mid-twentieth century, regional efforts to meet this demand led to cooperative, and at times conflicting, efforts by public and private utility organizations to meet this demand. The Bonneville Power Administration (BPA)—in hopes of addressing 1958 budget shortfalls caused by temporary declining demand and surplus supply of energy developed along the Columbia River's Bonneville Dam complex—began planning for the creation of a relatively short extra-high-voltage (EHV) intertie to the California state lines with the aim of connecting to and selling surplus power to population centers within PG&E's network.[114]

By 1961, BPA had developed an initial federal framework that positioned its proposed publicly owned system well in contrast with California utilities' desire for a privately owned and operated system within California borders. BPA's position of strength, influenced by strong federal support in the interests of national security, caused the California's private utility companies to develop the California Power Pool, a collective voice that combined the resources of PG&E, San Diego Gas and Electric, California Electric Power, and Southern California Edison (SCE) to lobby for construction of a privately owned and operated intertie.[115]

In PG&E's 1961 Annual Report, the company announced, "PG&E and other members of the California Power Pool have jointly offered to construct a line of not less than 500,000 volts from Shasta County to Southern California, making Northwest power supplies available on terms which will make construction of the line economically feasible." The announcement was notable in two respects. First, development of 500-kV electrical transmission as a standard for long distances would more than double the standard transmission capability utilized to date, representing a great stride in transmission efficiency. Second, successful development of the wider Pacific Intertie program would be the first of several major interconnected campaigns in the latter decades of the twentieth century that sought to stabilize and bolster California's energy supplies with power generated from the hydro supplies of the Pacific Northwest.[116]

Successful development of the mid-twentieth century western EHV power grid relied on the success of three separate arenas of negotiation during this period.[117]

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112 James C. Williams, *Energy and the Making of Modern California*, 288–289, 340-345; "Among Ourselves," *PG&E Life*, 16–17.
113 James C. Williams, *Energy and the Making of Modern California*, 288–289, 340-345; Geysers Geothermal Plant History, accessed at: http://geysers.com/history11.
114 Binus, Joshua D. 2008. *Bonneville Power Administration and the Creation of the Pacific Intertie, 1958-1964.* Portland, Oregon: Portland State University:viii.
115 Binus 2008:19, 24.
116 "EHV—Electricity's Seven League Boots," *PG&E Life*, May, 1962.
117 Binus 2008: vi, 102.

- The successful planning and construction of the Pacific Intertie System, spearheaded by BPA and its cooperative relationships with the California Power Pool and multiple agencies across varying geographies.
- The passage of federal legislation under the Kennedy and Johnson administrations and Congress to enact limits on the export of electricity to safeguard available power for the generating regions in the Pacific Northwest and Canada and provide federal funding for the Pacific Intertie system. This would include the Pacific Northwest Consumer Power Preference Act (1964) and the Public Works Appropriation Bill of 1965 (1965).
- The full ratification of the Columbia River Treaty (1961), an agreement between Canada and the United States that proposed international cooperative agreements between British Columbia generation facilities and public and private utility providers and agencies in Washington State, Oregon, and California.

While 500-kV transmission operated on the same general AC precepts established decades earlier, with phased power stepped up and down from generation to distribution, the transmission structures designed by PG&E engineers and other energy developers departed in several respects from the established 220-kV transmission design. The tower itself was an imposing lattice steel H-frame designed to provide the necessary clearance between conductor strands and have the torsion strength to hold the far heavier conductor and insulators. The design of the conductor itself also differed from earlier construction, with bundled strands of conductor wound together rather than single polyphase conductor strands. As summarized by PG&E engineers, "Up to now, with each increase in transmission voltage the Company has used larger diameter conductor…But to double voltage you must double diameter of conductor, this means an expensive, heavy, and hard to work with conductor. To get around this, [we have determined] that two or more smaller conductors may be used close together. More and more of this bundled conductor will be used in the future to hold down the number of new lines needed while supplying the greatly increased requirements of our service area."[118]

As agency negotiations surrounding the wider system continued through 1964, California's Congressional delegation contested the Pacific Intertie's proposed DC leg through Nevada (without any tie-lines to Northern or Central California), because the proposal insufficiently supported the needs of the Central Valley Project (CVP) and the California State Water Project (SWP). This led to calls for the Bureau of Reclamation to construct two additional lines: a new 500-kV line from the California–Oregon border to PG&E's Round Mountain, which would extend the already-proposed 500k V line from John Day Dam (Oregon) to the California–Oregon border, and a new 230-kV line from Round Mountain to the Cottonwood station, where the line would tie into five existing 230-kV lines supporting the CVP.[119]

Once negotiations ended, with public and private entities largely satisfied with the result, President Johnson signed the Pacific Northwest Consumer Power Preference Act on August 31, 1964, which defined BPA's Pacific Northwest service area and authorized the sale of federal Columbia River hydroelectric power over the Pacific Intertie to the Southwest once Pacific Northwest energy needs were met, and the Public Works Appropriation Bill of 1965, which provided federal funding to support its construction.[120]

Construction of early PG&E components of the Pacific Intertie system began in 1962 with a 94.4-mile 230-kV transmission alignment from Pacific Power and Light's Malin station to PG&E's Round Mountain Substation, energized and upgraded to 500-kV by 1965.[121] By 1968, PG&E had completed the company's 500-kV transmission backbone within the broader intertie system, with a transmission corridor extending from Northern California to an interconnection with Southern California Edison at Midway Substation in Kern County. Construction involved 1,025 miles of transmission corridor and substantial upgrades to the company's existing substation network, with seven

118 "More Change is in the Air," *PG&E Life*, January 6–9, 1963.
119 Binus 2008:98-100.
120 Binus 2008, 102.
121 Cardno. 2020. Pacific Gas and Electric Company Historic-Era Electrical Infrastructure Management Plan. Prepared for Pacific Gas & Electric Company. April. A.3A-1.

substations either rehabilitated or newly constructed and designated as EHV stations: Round Mountain, Table Mountain, Vaca-Dixon, Tesla, Metcalf, Los Banos, and Midway. In addition to housing the larger circuit breakers, transformers, and switching equipment necessary to relay and convert the 500-kV power, each substation was upgraded with leading-edge computer technology for monitoring and regulation. As noted by PG&E engineers:

> PG&E will be the first electric company to use "on-line" computers in substations to aid in operating a transmission line. The compact devices will be placed in each of the seven EHV substations and keep hourly logs of load conditions, print out alarms in case system conditions go above or below tolerable conditions, and perfume sequence-of-events recording—that is keep records that will show the operator and system dispatcher what conditions were before, during, and after any malfunction of equipment. It will make for speedy analysis and tracing of troubles. The computers are a major contribution to the modernity of the Northwest-Southwest Intertie.[122]

In the decades that followed additional interconnected corridors have been developed outside of the PG&E service area by other public and private utilities. At present, 500-kV remains the highest standard for transmission capacity in PG&E's service area.

E.8 1973–Present: The Changing Face of Energy

Although there is no definitive dividing line that marked the end of California's and PG&E's heady days of expansive post-war growth, by the early 1970s, a complex array of environmental, economic, and social factors had altered the landscape of energy development. While the 1940s, 1950s, and 1960s were generally characterized by a tacit social compact that took for granted the benefits of continuously growing energy consumption, this overarching assumption came to be questioned by the close of the 1960s and into the 1970s and beyond.

At a basic level, the furor over nuclear generation elicited a substantial backlash against the societal costs of energy, with utilities, most notably PG&E, put on the defensive against a growing cohort of opposition. By 1967, as PG&E continued to pursue the construction of Diablo Canyon Nuclear Power Plant in the face of stiff opposition, the company sounded cautionary tones that stood in stark contrast to the grand language of expansion in earlier eras. In a public leaflet titled "Diablo Canyon: The Story from the Beginning," PG&E defended its nuclear program as one of duty-bound necessity [original emphasis]:

> First of all, environment is our concern at PG&E. As more people require more power and make heavier demands on open space, our company bends every effort to ensure that our vital facilities conform to the best land use. But we must build: A growing California has growing energy needs. Few people realize their magnitude: when we say we must build to meet these needs, we are talking about a doubling of demand for power within the next ten years![123]

As documented in the public statements, the language had shifted so that rather than being a hallmark of progress, increased energy consumption was framed as something of a cost of progress. From the mid-1960s into the 1970s, this growing environmental awareness was not limited to the nuclear arena. Growing citizen activism against offshore oil drilling and air pollution merged to create a large environmental movement. Although many of these initiatives began at a decidedly local level, environmental activism ultimately led to the passage of key local, state, and federal legislation that sought to navigate the growing rift between energy consumption and environmental preservation. As early as 1959, the California Legislature had passed the nation's first anti-smog law, limiting fossil-fuel emissions. The federal Clean Air Act followed in 1963, providing the basis for federal clean air standards. In 1969, a devastating oil well blow-out off the coast of Santa Barbara further catalyzed the public to articulate environmental values in the face of consumption, with the 800-mile coastal oil slick a painful and pressing reminder of the costs of progress. In response to this and other environmental disasters, key legislation of the period included the 1969 National

[122] "EHV," *PG&E Life*, May, 1967.
[123] "Special Report on Diablo Canyon," *PG&E Life*, June, 1967.

Environmental Policy Act (NEPA) as well as the 1970 California Environmental Quality Act (CEQA), which introduced environmental concerns as an integral component of utility planning and permitting.[124]

In addition to looming environmental concerns, the 1973 oil embargo and domestic energy crisis served to alert an increasingly wary public to the dangers of dependence on fossil fuels. With fuel shortages and spiking prices, the state's oil dependent electrical generation facilities saw sharp increases in cost, and utility bills rose accordingly. The crisis further illustrated that ascending rates of consumption were unsustainable both environmentally and economically. As concluded by California State Comptroller Houston Flournoy in 1973, "Energy companies cannot continue to satisfy our ravenous and growing appetites for energy at prices we can live with." While ultimately the embargo subsided, it underscored the need for continued portfolio diversity in energy generation. During the 1970s, PG&E diversified by increasing reliance on hydroelectricity and pursuing geothermal generation. During the 1980s, 1990s, and into the twenty-first century, PG&E expanded its portfolio to include solar, wind, and other alternative energy sources, which have now become crucial areas of growth for the industry at large. Within this overall framework of energy diversity, the environmental stakes have continued to rise, with the effects of climate change driving decisions for the next century of energy growth.[125]

California's population has doubled since the 1970s. Consequently, PG&E's network has continued to expand and modernize to address ongoing demand, although the pace of new generation has slowed. There has been little new hydroelectric development and only isolated, yet important, natural-gas steam-plant upgrades. The company has made notable forays into alternative solar siting, a process which will likely expand in the future. Additionally, the company has expanded its intersystem links, with an integrated transmission grid that pools power from a variety of non-PG&E sources within and outside of California. Thus, the overall energy network has continued to evolve, with expansion, repair, and retooling creating a constantly evolving energy grid that reflects both the company's early twentieth century foundations and its evolving utility role.

E.9 Architectural Styles

The designs of PG&E's infrastructure evolved as a response to three factors: changing engineering requirements; property settings in urban and rural environments; and the company's decision to convey the identity and importance of infrastructure through design. The architectural styles of PG&E's historic-era infrastructure can be divided into four periods of design described below. While outliers were constructed during every period, the corresponding dates capture most of the properties that reflect each period.[126] The first period was engineering-driven, resulting in properties that were utilitarian and not distinguished by decorative features or forms conveying an architectural style. The second period, the Pacific Service period, corresponds to a time when architectural design was a component of infrastructure design and not solely a response to engineering-driven needs. This period correlates with the career of Ivan C. Frickstad, PG&E's architectural assistant to the civil and hydraulic engineer and the period spans the major building campaigns of the 1910s and 1920s. This Pacific Service period was the most architecturally distinguished. The third period of design was defined by a simplified aesthetic influenced by the Great Depression, a period of economic downturn, and a preference for less fanciful styles in favor of function. The final period began following World War II and continued through the twentieth century with a return to engineering-driven designs that conveyed function and exhibited minimal ornamentation or style.

E.9.1 Utilitarian Period, 1899–1910

The earliest buildings and structures of PG&E and the power companies it later acquired were constructed mostly between 1899 and 1910. These properties were defined aesthetically by form, function and available materials more than architectural style. During this period, all power companies prioritized functionality and the ability to deliver

[124] James C. Williams, Energy and the Making of Modern California, 288–289, 340–345.
[125] James C. Williams, Energy and the Making of Modern California, 293–319.
[126] For example, some powerhouses of the 1920s reflect the simplicity of the Utilitarian period more than the Pacific Service period.

reliable service above developing distinctive architectural buildings.[127] Generating stations exhibited typical characteristics of industrial, single-story buildings of the time. These properties resembled barns and were often situated over water. Most exhibited large one-story rectangular volumes with monitor windows along the gabled roofline that served as a natural light source. Fenestration along the elevations was spaced at regular intervals with single, narrow windows sometimes featuring segmental arches. Examples of utilitarian period buildings include Colgate Powerhouse (circa 1899). Within urban areas, substations appeared to be windowless masonry boxes, occasionally distinguished by decorative surrounds framing a single entrance. Decorative surrounds would become a common feature during the Pacific Service period.

The style of the Utilitarian period is distinguished by the following character-defining features.

- Rectangular single-story volumes.
- Moderately pitched front-gabled roofs with shallow eaves, often clad in shingles or metal; may include central monitors.
- Fenestration along elevations spaced at regular intervals.
- Tall multi-light windows, including double-hung sash windows, transom windows, and fixed windows sometimes featuring segmental arches; monitor windows along the gable roofline.
- Brick or concrete construction.
- Brick, metal, or masonry exterior cladding.
- Limited ornament restricted to primary entrance and window surrounds, including arched lintels over doors and windows and hinged wood doors.
- Multiple outlets for water to exit the building.
- High ceilings and large, open interior spaces.

E.9.2 Pacific Service Period, 1911–1930

By the early 1910s, the form and style of properties within the PG&E portfolio began to convey monumentality through elaborate architectural forms. This new emphasis on style can be attributed to Ivan C. Frickstad, who began his role as the "architectural assistant to the civil and hydraulic engineer of the Pacific Gas and Electric Company of San Francisco" in 1911 and retired in 1948.[128] The shift toward high-style buildings began with the Drum-Spaulding Hydroelectric Project in 1912.

Little is known about Frickstad's formal architectural training. He appears to have embraced the City Beautiful movement with its emphasis on historicist styles that influenced the civic and public works building campaigns across the United States in the early twentieth century. Frickstad recognized that architectural style was a form of branding and referencing historical forms conveyed the importance and monumentality of PG&E's buildings. Connected projects "should be made to express this relationship by carrying throughout the system a consistent architectural theme which fulfills all mechanical requirements while establishing a distinctive character..."[129] Writing in 1916,

[127] Ivan Frickstad. 1915. Some Sub-Stations of the Pacific Gas & Electric Co. (*The Architect and Engineer: Architect and Enginee*r, XLII: 54–68) 55.
[128] Ivan Frickstad. 1915. "Some Sub-Stations of the Pacific Gas & Electric Co." (*The Architect and Engineer: Architect and Enginee*r, XLII: 54–68) 55; Ivan C. Frickstad. 1916. "The Development of 'Pacific Service' Architecture as Exemplified in its Modern Powerhouses and Substations." *Pacific Service Magazine*, VIII:6: 204–216.
[129] Frickstad. 1916: 205.
[130] Ibid.

Frickstad described the architectural style of PG&E's buildings as "Pacific Service;" however, the buildings and structures display characteristics of the styles that defined the City Beautiful movement.[130]

The City Beautiful movement, developed from the Chicago World's Columbian Exposition of 1893, generally applied to large-scale urban planning projects, championing a philosophy that beauty created moral and civic virtue. From individual buildings to entire urban plans, buildings and landscapes were designed with a heavy emphasis on European historical influences. Public works became monumental by directly referencing monuments of past civilizations with designs that mimicked forms and ornaments found on classical temples and monuments, Gothic religious buildings, as well as Renaissance palaces and religious buildings, thereby incorporating by association the grandeur and greatness associated with the earlier periods and civilizations from which these iconic styles emerged and are inherently identified.

Architects of the City Beautiful movement typically learned the architectural language of classicism at the École des Beaux-Arts in Paris, the French school of architecture. From broad Beaux-Arts classicism, more nuanced variations emerged, including Neoclassical and Italian Renaissance Revival architectural styles. Architectural design within the City Beautiful movement also incorporated the general revival of older European architectural styles Gothic Revival, Mediterranean Revival, and Spanish Colonial Revival.

The Drum-Spaulding and Pit projects exemplify the application of City Beautiful architectural styles to power infrastructure, and the Cordelia Substation in particular is an excellent example of Beaux-Arts classicism. The building features a triumphal-arch inspired monumental tripartite entrance with arches framed by pilasters, light-colored cladding material reminiscent of marble, mullions separating bands of fenestration, elaborate cornice, and a distinctive height difference between the primary and secondary levels. The Wise No. 1 and Halsey Powerhouses, also from this era, were more Italian Renaissance Revival in character. Pit No. 1, completed in 1922, was a Late Gothic Revival-style structure with engaged towers anchoring the generator building like a medieval bridge.[131] The buildings were constructed with quoining and battlements along their elevations. Pit No. 3 and Hat Creek were more Neoclassical and less elaborate. The design of these systems was not dictated by setting. The buildings seem to be embracing the monumentality and design trends of the era more than their urban or mountain contexts.

Frickstad believed that substations designed by PG&E should adhere to design types appropriate to urban contexts. These were the "City" type used in urban environments and the "Out-of-Town" type used in smaller city centers.[132] The City type was a windowless building with only one main entrance. This created insulation against the noise of station machinery. Lighting came primarily from skylights and venting through ductwork in the ceiling and floor. These buildings had large, unbroken wall surfaces that were often treated with plaster over concrete structures.[133] Architectural style was usually expressed in applied details, such as plaster and terra cotta cornices, pilasters, cartouches, and friezes over a building's single entrance. Entrances could be paired doors executed in stamped metal. Frickstad was not solely responsible for the design of PG&E's buildings during his career. Willis Polk Company, an affiliate of Chicago World's Columbian Exposition-designer D.H. Burnham & Co., and Frederick H. Meyer designed several substations in San Francisco. The first City-type substation was Station G at Ellis and Broderick Streets in San Francisco. It was designed by Willis Polk & Co. Station D, a Renaissance Revival-style substation, was also designed by Willis Polk & Co. Station J, also Renaissance Revival in style, was designed by Frederick H. Meyer. The Out-of-Town type was used for substations and in smaller city centers.[134] Frickstad did not write about what defined the Out-of-Town type, though it appears to have less ornament and unembellished materials.

[130] Ibid.
[131] "Representative Gathering at Pit No. 1 Witnesses the Great Plant Put in Operation," *Pacific Service Magazine*, Volume XIV, No. 5: 135.
[131] "Representative Gathering at Pit No. 1 Witnesses the Great Plant Put in Operation," *Pacific Service Magazine*, Volume XIV, No. 5: 135.
[132] Frickstad. 1916: 206-7
[133] Frickstad. 1915: 56, 63.
[134] Frickstad. 1915: 56.

The architectural styles of the Pacific Service period are generally distinguished by the character-defining features presented in Table 2-1.[135] While Beaux-Arts classicism is the broadest type, the other three most common styles of the period—Neoclassicism, Italian Renaissance Revival, and Gothic Revival—are distinguished by specific character-defining features listed in Table 2-1. This list is not exhaustive, and additional property-specific features may be identified during future evaluations.

E.9.3 Great Depression and World War II Period, 1930–1945

By the beginning of the 1930s, the era of fanciful designs was ending. The aesthetic treatment of the Pit No. 5, Tiger Creek, and Salt Springs Powerhouses stood in contrast to the company's earlier large-scale powerhouse construction. Frickstad did not celebrate these projects in writing. These projects were spare in form and lacking embellishment, setting a trend for utility construction that would become standard by the middle of the twentieth century. When stations required upgrading, simple materials such as red brick were retained, and additional ornament was not added.[136]

The Tiger Creek and Salt Springs Powerhouses were not City Beautiful monuments. Their style followed a simplified form with rhythmic fenestration and massing, largely devoid of ornamentation. This type of design in utility buildings is sometimes classified as Art Deco or Public Works Administration (PWA) Moderne. Art Deco is mostly associated with the skyscrapers and glamorous urban buildings of the 1920s and 1930s. As a style, it abstracted many elements of Gothic Revival design into pure geometric forms while simultaneously taking influence from the art of Maya, Japan, and ancient Egypt. Art Deco emphasized verticality and the elimination of superfluous ornament and classical references, such as columns with classical order capitals. PWA Moderne was initially associated with New Deal-funded projects constructed through the PWA and Works Progress Administration (WPA) but came to be used for infrastructure projects constructed by utility companies. The stripped classicism of the style blended the formality of the Pacific Service period with Art Deco's modernism; however, the style exhibited even less ornament than Art Deco. PWA Moderne buildings were often distinguished by fluted pilasters extending the length of the façade. Signage was incorporated into the cladding material.

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[135] Marcus Whiffen. American Architecture Since 1780: A Guide to the Styles. Cambridge, MA: MIT Press, 1992; GPA Consulting. 2018. "Context: Architecture and Engineering, 1850–1980; Theme: Beaux Arts Classicism, Neoclassical, and Italian Renaissance Revival Architecture, 1895–1940." In *SurveyLA: Los Angeles Citywide Historic Context Statement.* Prepared for City of Los Angeles Department of City Planning, Office of Historic Resources. July.

[136] "Reconstruction of Station A: First of New Turbines Installed," *Pacific Service Magazine*, Volume XVIII, No. 2, October 1930; "Station A Reconstruction Completed—High Pressure Units Now In Operation," *Pacific Service Magazine*, Volume XVIII, No. 6, October, 1931, 163–171.

Table E-1. Character-Defining Features of Pacific Service Period Architectural Styles

Beaux-Arts Classicism	Neoclassical	Italian Renaissance Revival	Gothic Revival
• Arched or linteled openings • Cladding materials consisting of cast concrete, plaster, or light-colored brick sheathing (stone is rare) • Paired columns or pilasters • Elaborate cornice or active roofline with roof-top sculpture or decorative elements • Monumental entrance • Symmetrical design • Tripartite (base-shaft-capital) vertical arrangement • Tripartite (larger center with flanking wings) horizontal arrangement • Wall planes that advance and recede	• Formal arrangement of architectural elements, particularly columns • Monumental in scale, often with pedimented porticos • Parapets incorporating balustrades • Smooth masonry exteriors or plaster executed to appear as masonry • Decorative, protruding lintels over windows and doors • Single volumes	• Arcading on ground floor • Arched, linteled, or pedimented window openings • Parapets incorporating balustrades • Brick, stucco, or plaster cladding, on ground or lower floors sometimes finished to appear as rusticated masonry • Classical columns or pilasters supporting an architrave • Elaborate cornice directly on top of architrave • Monumental arched entrance • Projecting balconies with balustrades • Renaissance ornament, such as broken pediments, dentils, modillions, quoins, scrolls, statuary, and cartouches • Deep overhang with corbeling • String courses of brick or stone between stories • Symmetrical design • Tripartite (base-shaft-capital) vertical arrangement • Tripartite (larger center with flanking wings) horizontal arrangement	• Concrete or brick construction • Corbeled or crenellated gable ends • Emphasis on verticality • Steeply pitched front or cross-gable roof with finials, pinnacles, towers and spires • Windows and doors set in pointed arched openings

The architectural styles of the Great Depression and World War II period are distinguished by the following character-defining features.[137]

- Art Deco:
  - Emphasis on verticality
  - Smooth wall surfaces finished with stucco
  - Flat roof, at times with shaped parapets, vertical projections or towers, emphasizing verticality
  - Zigzags, chevrons and other stylized and geometric motifs as decorative elements on façade
  - Metal windows, often fixed sash and casement
- PWA Moderne/Stripped Classicism:
  - Emphasis on verticality
  - Flat roofs
  - Formal symmetry and massing as a single volume or tripartite volume with flanking wings
  - Smooth wall surfaces, typically stucco over masonry
  - Windows arranged in vertical recessed bays defined by fluted pilasters
  - Minimal ornamentation, including some zigzags, medallions, or plaster reliefs

E.9.4 Post-World War II and Mid-Twentieth Century Periods, 1946–1974

PG&E's infrastructure in the Post-World War II and Mid-Twentieth Century period is characterized as functional. Project designers were not trying to convey a message through design or making aesthetic choices as much as seeking engineering-driven solutions. During World War II, powerhouses were modest in form and design, with stripped-down concrete exteriors and little ornamentation. These buildings were not monumental. After World War II, PG&E's substations shifted to outdoor distribution and transmission apparatuses and became largely devoid of a self-conscious or developed architectural form.[138] By 1948, Frickstad retired, and the design of PG&E's infrastructure was no longer distinguished by style. Cresta and Rock Creek Powerhouses, both dating to the late 1940s after the war, had a monolithic and understated design with a solid and utilitarian concrete massing. While they somewhat referenced the PWA Moderne massing and fenestration patterns, these buildings are devoid of ornament and lack architectural style.

Nuclear power plants, which emerged in the Post-World War II period, were an entirely new type of energy generation with unique containment dome design requirements; however, the designs were guided by engineers. The first nuclear power plant in the system was Vallecitos, near Livermore. The 5,000-kW plant became operational in 1957 and served as a pilot facility to test operations, materials, and protocol. By 1958, PG&E had begun planning the nation's first commercial nuclear power plant in Humboldt County, adjacent to the existing 1950s Humboldt Bay Steam Plant. PG&E's engineering department, under the management of Jim Schuyler, completed the main design of the Humboldt Bay plant, with input from GE researchers. Nuclear reactors were built on the ground floor of a plant and covered with containment domes, large steel and concrete domes built over the reactor. These domes were large and highly visible

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137 Whiffen, Marcus. American Architecture Since 1780: A Guide to the Styles. Cambridge, MA: MIT Press, 1992. Architectural Resources Group, ICF International, Mitzi Mogul. 2021. "Context: Architecture and Engineering, 1850–1980; Sub-context: L.A. Modernism, 1919–1980; Theme: Related Responses to Modernism 1924–1970." In SurveyLA: Los Angeles Citywide Historic Context Statement. Prepared for City of Los Angeles Department of City Planning, Office of Historic Resources. August.

138 "The Substation Feature of the Electric Distribution Problem," *Pacific Service Magazine*, Volume XVIII, No. 10, October 1932, 307-313; "Reconstructed Substation is Typical of Modern Design," *Pacific Service Magazine*, Volume XVIII, No. 11, January, 1933, 335–339.

and were a signature of a nuclear facility. They were also extremely expensive to construct and, because of their seams, potentially could leak radiation if an accident occurred.[139]

While not distinguished by the architectural style, properties of the Post-World War II and Mid-Twentieth Century periods of significance are distinguished by the following character-defining features reflecting technological advances.

- Concrete or metal materials.
- An exposed structural and mechanical system, such as a lattice tower, with no cladding.
- Concrete or metal enclosures designed to protect specific machinery.
- Simplified massing prioritizing structural stability.
- Forms and shapes that respond to internal function (such as a dome over a reactor) without reference to historical design precedents.

F. Associated Property Types

(Provide description, significance, and registration requirements.)

F.1 Introduction

This chapter presents three categories of historic-era infrastructure properties within Pacific Gas and Electric Company (PG&E)'s network that reflect the significance of the periods of development described in Chapter 2, *Statement of Historic Contexts*. Categories are based on three functions in the system of power infrastructure: generation, transmission/distribution of power, and substations. Within each of these categories, property subtypes are defined. The chapter focuses on subtypes and requirements each must meet to be eligible for listing in the National Register of Historic Places (NRHP).

Properties evaluated under the three identified categories may be significant in the areas of architecture, community planning and development, engineering, or industry. Individual properties and historic districts may have different areas of significance for each criterion under which they are eligible.[140] Properties significant in the areas of architecture will reflect the character-defining features of styles described in Chapter 2, Section 2.9, *Architectural Styles*.

Associated property types for PG&E's historic-era infrastructure generally meet one or both of the following registration requirements.

- Properties must be proven to be significant in the development of PG&E's infrastructure across Northern and Central California and fit into identified thematic frameworks.
- Properties must reflect either technological innovation, significant design, or a development milestone or period in the progression of PG&E's infrastructure in California, or they must be an early, innovative, or rare surviving example of its subtype.

Property types are identified by distinct character-defining features, and they must meet specific registration requirements to convey significance and be eligible for listing in the NRHP. Each property type identified below includes a table of specific registration requirements organized as eligibility standards by NRHP criteria, integrity considerations, associated context(s) and periods of significance, and geographic location.

[139] PAR Environmental Services, Inc. 2003. Cultural Resources Study for the PG&E Humboldt Bay Power Plant, ISFSI Licensing Project, Humboldt County, California. Final. August. Sacramento, CA. (Prepared for: Pacific Gas and Electric, San Francisco, CA) 19.

[140] National Park Service [NPS]. 1997. National Register Bulletin [NRB] 16A: How to Complete the National Register Registration Form. Available: https://www.nps.gov/subjects/nationalregister/upload/NRB16A-Complete.pdf. Accessed March 4, 2025:38-40.

Properties may be eligible as individual resources or as historic districts. An NRHP-eligible historic district is an area that "possesses a significant concentration, linkage, or continuity of sites, buildings, structures, or objects united historically or aesthetically by plan or physical development."[141] A district may be a single geographic area of contiguous historic properties, but it may also be non-contiguous: "composed of two or more definable significant areas separated by nonsignificant areas."[142] For PG&E, historic districts may include a collection of buildings, structures, objects, or sites that tell a story of the development of a particular power system, for example, including its establishment and transformations through time. Contributing resources within such a district may be geographically dispersed. Many such systems, including hydroelectric power systems, comprise multiple elements that spread over many miles of terrain and are connected by humanmade infrastructure and natural features. Districts must also retain sufficient integrity to convey their significance, meaning that most of the contributing resources that comprise the historic character, and the relationships among these resources, must have integrity as described in Section 3.1.2, *Integrity*.[143]

F.1.1 Relevant Criteria for Evaluation

NRHP criteria define, for the nation as a whole, the scope and nature of historic and archaeological properties that are to be considered eligible for listing in the register. The National Register Criteria for Evaluation describe how properties are significant for their association with important events or persons, for their importance in design or construction, or for their information potential.[144]

Criteria A and C are relevant to the evaluation of property types that reflect significance in the development of PG&E's infrastructure. Criteria B and D are not considered further for reasons as described in Section 3.1.1.2, *Criterion B*, and Section 3.1.1.4, *Criterion D*.

Historic-era infrastructure within the PG&E network can convey significance under the following themes identified in the historic context.

- 1849–1906: Origins of California's Electrical Industry
- 1905: A Company Born from Many
- 1906–1930: Transformative System Expansion
- 1930–1941: Depression and a Paradigm of Growth Tested
- 1945–1973: The Post-War Era and California Unleashed
- 1973–Present: The Changing Face of Energy
- Architectural Styles

F.1.1.1 Criterion A

Properties can be eligible for the National Register if they are associated with events that have made a significant contribution to the broad patterns of our history.[145]

[141] National Park Service [NPS]. 1995. National Register Bulletin [NRB] 15: How to Apply the National Register Criteria for Evaluation. Available: https://home.nps.gov/subjects/nationalregister/upload/NRB-15_web508.pdf:5.
[142] NPS. 1995:6.
[143] NPS. 1995:46.
[144] NPS. 1995: 11
[145] NPS. 1995:12.

Under Criterion A, an eligible power property must convey a direct physical and operational association with one or more of the following.

- A key project sponsored by a predecessor company or PG&E that demonstrably shaped the territory and service breadth of the predecessor company and/or PG&E in the period of significance.
- A key technological innovation or period of innovation that shaped commercial, geographic, and structural patterns of electrical generation and consumption.
- A key event, pattern of events, or historic trend that mandated the particular design and engineering response of the property.

The historic context describing these key projects, technological innovations, and events in the development of PG&E's infrastructure is described in Chapter 2, *Statement of Historic Contexts*.

F.1.1.2 Criterion B

Properties may be eligible for the National Register if they are associated with the lives of persons significant in our past.[146]

Under Criterion B, a property must convey a direct and demonstratable physical and operational association to the significant activities of a person or people significant in local, state, or national history. Such associations are rare for infrastructure property types and cannot derive from general operational associations. Infrastructure resources rarely qualify under Criterion B because most lack sufficient association with an important person's productive life. Examples of properties commonly found significant under Criterion B include the home of an important individual, the studio of a significant artist, or the business headquarters of an important industrialist.[147] Infrastructure properties rarely embody such connections to important figures. The contributions of important figures to important events or patterns of events significant to history are best evaluated under Criterion A. Innovations in technology or associations with an expert engineer, builder, or designer are best evaluated under Criterion C. As such, no infrastructure properties would have significance under Criterion B and this criterion does not require further consideration.

F.1.1.3 Criterion C

Properties may be eligible for the National Register if they embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction.[148]

Under Criterion C, infrastructure properties may have significance for their design, construction, and engineering qualities. Specifically, they may embody distinctive characteristics of a type, period, or method of construction; represent the work of a master; or possess high artistic value.

A property that is an excellent example of a specific architectural style, type, period, or construction method should be "conceived, designed, or fabricated by a people or culture in past periods of history."[149] Architectural styles of PG&E infrastructure are described in Chapter 2, Section 2.9, *Architectural Styles*. A property may include a few applied elements of a specific architectural style. However, if these elements were added outside of the historic context of the style and without consideration for the overall principles or defining characteristics of the style, the property is unlikely to be an excellent example. Within the context of PG&E's network, qualifying resources under Criterion C may include resources expressing novel, innovative, or transitional technologies or architecturally innovative buildings

146 NPS. 1995:14.
147 NPS. 1995:14.
148 NPS. 1995:17.
149 NPS. 1995:17.

related to power generation and transmission infrastructure (e.g., powerhouses, transmission lines, hydroelectric infrastructure, nuclear power plants). These elements may individually qualify on their own merits or may not be significant individually but be part of a larger historic district to which they may contribute significance.

F.1.1.4 Criterion D

Properties may be eligible for the National Register if they have yielded, or may be likely to yield, information important in prehistory or history.[150]

Under Criterion D, a property would need to have the potential to illustrate significant informational facets of PG&E's organizational development, architectural or technological innovations, or thematic impacts through its material construction and design. As built environment resources, PG&E facilities are well-represented in the historical record through company design plans, engineering schematics, and primary and secondary research materials. As such, infrastructure property types would not have potential to have yielded, or be likely to yield, new information important to history not already captured in the historical record. The archaeological potential for these properties is not considered in this analysis.

F.1.2 Integrity

Properties must convey sufficient integrity with specific considerations for each aspect of integrity depending on the property and its significance. Properties should retain most or all of the following seven aspects of integrity to convey their significance within the historic context(s).

- **Association.** Association is the direct link between an important historic event or person and a historic property.
- **Location.** Location is the place where the historic property was constructed or the place where the historic event occurred.
- **Setting.** Setting is the physical environment of a historic property.
- **Feeling.** Feeling is a property's expression of the aesthetic or historic sense of a particular period of time.
- **Design.** Design is the combination of elements that create the form, plan, space, structure, and style of a property.
- **Workmanship.** Workmanship is the physical evidence of the crafts of a particular culture or people during any given period in history.
- **Materials.** Materials are the physical elements that were combined or deposited during a particular period of time and in a particular pattern or configuration to form a historic property.[151]

For buildings, minor additions, alterations, or structural modifications that are compatible in size and scale or are generally in-kind with the original style may not undermine integrity if the overall operation and alignment of a property are retained. For historic properties that are components of existing energy infrastructure, it is key that properties retain function and alignment, so changes to some aspects of design, workmanship, and materials will be necessary to continue ongoing functions. Continued operation, through integrity of association and feeling, are key aspects of integrity for historic-era infrastructure. Maintaining the alignment, through integrity of location and setting, are also key aspects of integrity.

[150] NPS. 1995:21.
[151] NPS. 1995. NRB 15: How to Apply the National Register Criteria for Evaluation. Available: https://www.nps.gov/subjects/nationalregister/upload/NRB-15_web508.pdf. Accessed March 4, 2025:44-45.

Registration requirements under each category below specify essential aspects of integrity a property requires to convey significance.

F.1.3 Historic-Era Electrical Infrastructure Facility Inventory and Summary of Past Evaluation Efforts

PG&E's historic-era electrical generation, transmission, and substation facilities are summarized in the tables in Appendix A, *Historic-Era Electrical Infrastructure Facility Inventory and Previous Determinations of Eligibility.* The tables are organized by facility type as follows.

- Table A-1A addresses PG&E generation facilities.
- Table A-1B addresses PG&E dams.
- Table A-2 addresses substation facilities.
- Table A-3A addresses 500 kilovolt (kV) transmission lines.
- Table A-3B addresses 230 kV transmission lines.
- Table A-3C addresses 115 kV transmission lines.
- Table A-3D addresses 60 kV transmission lines.

The purpose of the tables is to catalogue facilities managed under this plan and provide an informational baseline for project planning. It is anticipated that PG&E Cultural Resource Specialist (CRS) and any contracted consultants will use the tables to obtain basic biographical data regarding facilities and information regarding previous cultural resource documentation.

The tables include baseline documentary information regarding the facilities to aid in management under the *Historic-Era Electrical Infrastructure Management Plan* (HEIMP). Data types include the following elements.

- **Facility name.**
- **Federal Energy Regulatory Commission (FERC) license number.** Applicable for hydrogeneration facilities.
- **City and county.** For transmission lines, data include the originating and terminating county.
- **In-service date.** In-service data provided for all facilities where such data could be obtained from desktop review using PG&E engineering data sources.
- **Miles (transmission facilities).** Includes the length of alignment.
- **Number of towers (transmission facilities).** Includes the number of tower structures associated with alignment.
- **Voltage (transmission facilities).** Operating voltage levels.
- **Original line name (transmission facilities).** As discussed in Section 3.3, *Transmission/Distribution of Power*, transmission lines have been segmented and renamed over time, as PG&E has updated transmission management practices. This field includes the name of the original transmission line as constructed, if known, to aid cultural resource managers in identifying all segments of a historical alignment.
- **Predecessor information:** For facilities developed by PG&E predecessor companies.
- **Building type.** For generation facilities and substation facilities, this includes information regarding facility style and architectural design. For generation, this information focuses on the main generating powerhouse. For substations, this information focuses on any enclosed control/operations buildings for substations with enclosed

facilities. When there are no identifiable stylized elements or design features associated with a facility, the table notes "Utilitarian," which generally encompasses two structural types: prefabricated metal storage buildings and concrete or Cement Masonry Unit storage or utility structures.

- **NRHP/California Register of Historical Resources (CRHR) evaluation.** Identifies any previous evaluations that have addressed the facility.
- **Documentation.** Includes the citation for previous documentation efforts.
- **Concurrence.** Includes information, if known, regarding the status of State Historic Preservation Officer (SHPO) concurrence on facility eligibility.

These tables were first developed during the creation of the HEIMP. The development of the facility lists in Appendix A, *Historic-Era Electrical Infrastructure Facility Inventory and Previous Determinations of Eligibility*, relied on available PG&E asset data sources. Although the analysis included fact-checking of built dates and other key data attributes through review and comparison of multiple desktop data sources, the attribute data in facility tables will require informational screening and field verification as part of project review. In particular, information regarding *facility age* must be fact-checked at the inception of all project review, as PG&E asset databases commonly contain incomplete age information. Fact-checking may include field review and/or review of additional engineering records obtained from ERIMS® to corroborate facility information found in the tables. Fact-checking of *concurrence* information is also important, because a records review suggests that this field is likely incomplete in PG&E's asset management data. The collective CRS staff at PG&E updated the NRHP/CRHR eligibility data from June through August 2025.

An additional note, for a 60 kV transmission, this classification can include voltage of 70 kV, which is generally classified within the 60 kV property type as it is a minor variant to this overall type.

F.2 Generation

Power generation infrastructure is the centralized facility type required for capturing energy from natural resources and transforming it into electricity for transmission and distribution. Historically, power generation facilities designs have been based on the specific natural energy source that a facility uses to create electricity, including water, natural gas and steam, or nuclear power. For instance, available water flow energy from Sierra Nevadan rivers has driven development of hydroelectric facilities with the water intakes, turbines, and forebays that are essential to manage and use water flow energy to produce electricity.

Generation properties are divided into three subtypes based on the resource type used to generate electricity: Hydroelectric Power Generation (water), Natural Gas/Steam Power Generation (gas/steam), and Nuclear Power Generation (atomic fission).

F.2.1 Hydroelectric Power Generation

Hydroelectric power is generated by harnessing the energy of moving water. Therefore, these systems are commonly situated on or near waterways, including the Feather River, Yuba River, and Pit River, and many are within the Sierra Nevada. Water from these sources is captured in a storage reservoir created by a dam. Canals, flumes, tunnels, or even natural waterways convey the water through header boxes or valve houses and into penstocks leading to the powerhouses. As water enters the powerhouses, it turns turbines, which produces an electric current in a generator. This energy flows from the powerhouse to transmission lines and into the electric grid.

PG&E's hydroelectric power system was established in the early twentieth century and continues to develop and expand today. As of 2025, PG&E owns 67 hydroelectric powerhouses dating from 1900 to 1993, and more than 100 reservoirs are connected to the system.[152] PG&E's hydroelectric facilities are in Amador, Butte, El Dorado, Fresno, Kern, Madera, Mendocino, Merced, Nevada, Placer, Plumas, Shasta, Tehama, Tulare, and Tuolumne Counties.[153]

PG&E's hydroelectric power generation resources from the period of early development in the region (1900–1930) include many resources constructed by predecessor power companies, such as Great Western Power Company, and that were purchased by PG&E and incorporated into its growing system. The earliest extant powerhouses were built small; were clad in metal, brick, or masonry; and reflected a less ornamented architectural design. Many of these systems integrated extant ditches from mining and other previous uses rather than building entirely new water conveyance systems.

By the 1920s, PG&E was developing its brand identity through building campaigns, and hydroelectric power generation resources, particularly the powerhouses, were symbols of the company's growing dominance. Powerhouses incorporated a variety of period revival architectural styles or elements, including Greek Revival and Italianate styles, and utilized reinforced concrete for the buildings and associated dams. These dams created reservoirs that fed systems of turbines and generators inside the spacious powerhouses. During this period, hydroelectric power expanded into rapidly growing cities and towns. The style and design of the elements of hydroelectric systems conveyed their importance as civic structures.

Development of hydroelectric systems in California slowed during the Great Depression (1930–1941) and only began to accelerate again during World War II (1941–1945). Resources developed during the former period were small, utilitarian, and lacking in ornamentation. During World War II, developments continued to be small with minimal architectural detailing, apart from Pit No. 5 Powerhouse, as described in Chapter 2, Section 2.6.1, *Wartime Construction*.

The modern period of PG&E hydroelectric development (1945–1973) is characterized by the incorporation of modern technological innovations in power generation and transmission systems. Building programs during this period continued with understated architectural design for utilitarian structures and buildings. From the 1950s onward, there was a shift away from enclosed facilities, with more outdoor or semi-outdoor construction. Turbines, generators, and electrical switching equipment were set outside along with other standalone equipment that did not require a building enclosure.

F.2.1.1 Associated Property Types

Hydroelectric power facilities are, by their nature, sited close to waterways. In California, PG&E's hydroelectric facilities are largely situated along river basins, many of which are in the north and central Sierra Nevada. To function effectively, plants use the natural steep terrain of these areas and the winding waterways to funnel water into the powerhouses that generate electricity. Therefore, the hydroelectric generation historic property generally consists of the following: dams and their associated reservoirs or impoundments; water conveyance features, including intakes, flowlines, tunnels, siphons, surge tanks, and outlets; and powerhouses, including penstocks, valve houses, and ancillary infrastructure. These components may be individually significant historic properties, and an intact system of these components may constitute a Historic District of Hydroelectric Generation and Transmission Property Types.

Hydroelectric power facilities may be eligible for listing in the NRHP under Criteria A and/or C. Under Criterion A, these properties may be associated with a specific event or pattern of events or historic trends related to the development or expansion of power distribution in a community, the state of California, or the nation. Under Criterion C, these properties may have significance for their design, construction, and engineering qualities. Specifically, they may embody distinctive characteristics of a type, period, or method of construction, represent the work of a master, or possess high artistic value.

[152] "Hydroelectric system." https://www.pge.com/en/about/pge-systems/hydroelectric-system.html.
[153] "United States Electricity Industry," Office of Electricity Delivery and Energy Reliability, United States Department of Energy, DOE/OE-0017, July 2015.

The following sections describe the associated property subtypes within the category of hydroelectric generation. These include individual properties and hydroelectric generation and transmission historic districts. Each associated property type is defined, along with its character-defining features; the historic significance of each type is described, and eligibility thresholds are provided.

Associated Property Subtype: Dams

Dams were constructed to channel water and produce power more efficiently. They typically served two functions: water storage and water diversion, but there are also examples of dams being used to create plunge pools in afterbays, which are reservoirs into which the water empties. Larger dams are used to create reservoirs that feed the turbines in a hydroelectric system. Smaller dams may be used for water diversion. The earliest subtypes of dams in the PG&E hydroelectric systems were constructed from earth fill, masonry, or concrete.

Dams include common elements, such as spillway and overtopping protection systems. Overtopping protection systems can be constructed from concrete, timber cribs, sheet piles, riprap and gabions, reinforced earth, minimum energy loss weirs, embankment overflow stepped spillways, and precast concrete blocks. Dams also include a recorder or control house.

Types of Dams

The following types of dams are associated with PG&E's hydroelectric systems.

- **Embankment dams.** Embankment dams constructed of natural materials or industrial waste materials, and may include earth fill, rock fill, or hydraulic fill. Some examples may include a gunite or concrete facing.
- **Masonry dams (non-concrete).** Masonry dams were generally small and shorter than later reinforced concrete examples. Common features include cut masonry blocks (stone, brick, or concrete) joined with a binder, such as mortar; abutments; a crest or top ridge; an upstream slope or face; an outlet or outfall; and a spillway. Typically, these are gravity dams with a straight or arched form. Arched form dams include a curved upstream configuration that transmits the water load to the abutments; this curved upstream configuration is also found in concrete examples.
- **Reinforced concrete dams.** In the early twentieth century, PG&E constructed multiple reinforced concrete dams to create storage reservoirs for new hydroelectric systems, including in the Sierra Nevada. These concrete dams included:
  - *Gravity dams*: Also built-in masonry, this type of concrete dam holds back water using only the weight of the construction material and its resistance against the foundation.
  - *Flat slab and buttress dams*: A type of dam consisting of a flat reinforced concrete slab inclined downstream from the reservoir that transmits load from the reservoir and slab to the buttress and foundation.
  - *Ambursen dams*: A type of flat slab and buttress dam in which the slab is simply supported at the buttress.
  - *Arch dams*: A type of dam that has a curved profile in the form of a horizontal arch with its convex side upstream; the dam typically abuts the walls of a gorge or humanmade ridge.
- **Other dam types.** Less common types of dams associated with PG&E's hydroelectric systems include wood board or timber crib dams, steel frame timber face dams, and steel-reinforced rockfill dams.

Character-Defining Features of All Dam Types
▪ Placement and orientation to waterway and powerhouse or other facilities in the hydroelectric system.
▪ Utilitarian function of storing or diverting water.

- Physical and functional relationship to water intake and outlet systems, which may include spillways, tunnels, pipes, gates, etc.
- Massing as designed by the engineer.
- Abutments.
- Recorder or control house, which is typically a small building set on or adjacent to the dam structure.

Associated Property Subtype: Storage Reservoirs

Storage reservoirs are generally open-air with an associated embankment or dam that spans a river or stream and contains the reservoir. They include one or more inflow canals and an outflow.

Character-Defining Features of Storage Reservoirs

- Storage capacity.
- Functional and physical relationships to connecting infrastructure, including water conveyance systems.
- Impounding structures, including dams.
- Setting and location related to waterways and hydroelectric facilities.

Associated Property Subtype: Water Conveyance Resources

Water conveyance resources include systems of intakes, flowlines, tunnels, siphons, penstocks, surge tanks, flumes, canals, water towers, and outlets. Functional, small-scale components like weirs, gauges, and pipes, are not character-defining features to these types of resources.

Character-Defining Features of Water Conveyance Resources

- Operational alignment and functional and physical relationships to dams, reservoirs and powerhouses and their penstocks.
- Associated water control features, including gates, gatehouses, pipelines, and valve houses.
- Associated infrastructure supporting water conveyance function may be character-defining in its functional role within the system (e.g., intakes, flowlines, tunnels, siphons, penstocks, flumes, surge tanks,, canals, water towers, and outlets).

Associated Property Subtype: Powerhouses

Powerhouses are the heart of the hydroelectric facility. Housed inside are mechanical systems that produce the electrical power that is then transmitted out to the grid. They are generally located along a waterway, either natural or humanmade, and usually altered for the purpose of conveying water efficiently into the powerhouse through water conveyance systems. Powerhouses enclose the mechanical systems, including generators, turbines, and switching equipment, that work together to generate power from the water flowing through the system. PG&E’s hydroelectric powerhouses were constructed during several distinct periods of development throughout the twentieth century.

In addition to specific elements that reflect eras of development described here, the historical significance of all types of powerhouses is conveyed through the following features.

Character-Defining Features of All Powerhouse Types

- Operational, functional, and physical relationships to dams, reservoirs, water conveyance systems, and transmission and distribution systems.
- Large interior space, including a generating room consisting of turbines, governors, and generators as well as other mechanical systems for power generation.

- Functional fenestration.
- Applied ornamentation on a utilitarian design or architectural design.

Types of Powerhouses

PG&E's hydroelectric systems included Utilitarian and Pacific Service Period style powerhouses and powerhouses associated with the Great Depression and World War II, post-World War II and the mid-twentieth century, and recent development.

- **Utilitarian powerhouses.** The earliest extant powerhouses were small and had minimal architectural designs or details.

Character-Defining Features of Utilitarian Powerhouses

- Rectangular massing.
- Metal, concrete, brick, or stone cladding.
- Medium-pitched gable roofs with shallow eaves; may include central monitors.
- Tall multi-light windows, including double-hung sash windows, transom windows, and fixed windows.
- Hinged wood doors.
- Minimal architectural detailing, including arched lintels over doors and windows.
- Multiple outlets for water to exit the building.
- High ceilings and large, open interior spaces.

- **Pacific Service powerhouses.** By the 1910s and 1920s, there was a new focus on powerhouses as civic structures.[154] As a result, many PG&E powerhouses constructed in this era exhibit elaborate architectural styles, including Greek Revival, Italian Renaissance Revival, Gothic Revival, Beaux Arts, and Mission Revival styles, or employed classical detailing. Reinforced concrete as the primary construction and cladding material also became more common, though masonry powerhouses were still constructed.

Character-Defining Features of Pacific Service Powerhouses

- Rectangular massing.
- High ceilings and large, open interior spaces.
- Concrete or masonry unit construction or cladding.
- Medium-pitched gabled roofs with shallow eaves or parapet or flat roofs (particularly for Mission Revival-style buildings), often clad in shingles or metal.
- Tall multi-light windows, including double-hung sash windows, awning windows, and fixed windows.
- Reflecting detailing or ornate architectural styles: Greek Revival, Italian Renaissance Revival, Gothic Revival, Mission Revival, Public Works Administration Moderne/Stripped Classicism.

- **Great Depression and World War II powerhouses.** Hydroelectric generation facility construction during the Great Depression focused on existing system upgrades and maintenance.

Character-Defining Features of Great Depression and World War II Powerhouses

- Smaller, utilitarian structures, except for Pit River #5 Powerhouse.
- Rectangular, concrete massing.
- Minimal architectural details, such as parapets and incised ornamentation.

[154] See Chapter 2, Section 2.4, *Transformative System Expansion*, for additional details.

  - Symmetrical fenestration consisted of fixed or awning multi-light, tall windows.

- **Post-World War II and Mid-Twentieth-Century powerhouses**. From the 1950s onward, there was a shift to more outdoor or semi-outdoor construction.
- **Recent Development powerhouses (1973–2024).** Twelve hydroelectric generation powerhouses were constructed within the PG&E system between 1973 and 2024.

Character-Defining Features of Recent Development Powerhouses

- Utilitarian, simple design with industrial, reinforced concrete massing.
- Occasional presence of subterranean chambers.
- New or replacement powerhouses added to existing generation systems.

Associated Property Subtype: Residential (Housing and Camps)

This subtype includes workers' camps, villages, and other buildings that served as support for construction, operations, and maintenance of hydroelectric generation systems. Camps were intended to house workers for only short periods of time, usually less than a year, and consisted of canvas tents or portable frame bunkhouses by the 1920s. Other structures included cook houses, recreation halls, bathhouses, commissaries, offices, barns, warehouses, and various storage sheds. Permanent foundations were used for machinery and other construction elements.

By the 1920s, some camps were supplied with electricity from the nearby powerhouses, and water pipes supplied kitchens and large bunkhouses. More permanent camps or villages consisted of timber-framed housing along with hospitals, schools, food processing facilities, lumber yards, railroad infrastructure (e.g., tracks, mills, blacksmith shops, water tanks), and trams for delivery and transportation of construction and maintenance materials, or other buildings that served the residents. Many of these camps were dismantled after construction, burned down intentionally to reduce liability, or abandoned over time, but remnants of foundations may still exist to mark these areas.[155]

Character-Defining Features of Workers' Camps

- Wood-framed residential and communal/recreational buildings typically executed in vernacular styles with wood or canvas tent siding and steel, wood shingle, or canvas roofs. Canvas was used in lower elevation areas, while lumber siding was more common at elevations with harsher winter conditions. Sited close to known construction areas and components of the hydroelectric generation system which they served.

Associated Property Subtype: Historic Districts of Hydroelectric Generation and Transmission Property Types

Connected hydroelectric facilities, also called "chains of power," consist of a series of dams and reservoirs, water conveyance systems, powerhouses, and transmission lines that move power seamlessly downriver and into various connected electrical grids. The district boundary typically includes the discreet hydroelectric system adopted, created, and/or developed by PG&E consisting of contributing dams, reservoirs, water conveyance systems, powerhouses, transmission lines, and other resources.

Other resources that may be associated with hydroelectric generation and transmission historic districts include supporting structures and systems that contribute to the ability of the system to generate power.

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155 Linda Pollack, Polly Allen, and Joshua Peabody. "Big Creek Hydroelectric System Historic District," National Register of Historic Places Nomination Form (Washington, DC: U.S. Department of the Interior, National Park Service, 2015), Section 7: 10, 116–121. PAR Environmental Services, Inc. 2024. "The Camp at Sand Bar Dam." http://www.parenvironmental.com/articles/sandbardam.php. Accessed September 9, 2024.

Features like stream gauges which are installed throughout watersheds to feed hydroelectric generation systems to record stream flow and reservoir levels and to provide baseline data for operational purposes, do not contribute to hydroelectric generation and transmission historic districts. Stream gauges generally include the "small recorder's houses with associated gauging equipment; small concrete weirs that stabilize the water service for measurement purposes; access features, including metal handrails and dirt or wood plank/metal frame walkways or cables; and miscellaneous modern equipment including solar panels for power and operation and other associated monitoring infrastructure."[156] These are relatively minor support resources that have been altered substantially over time to accommodate new monitoring equipment and features. As such, these resources are not individually eligible for listing in the NRHP nor would they be contributing features to hydroelectric generation and transmission historic districts.

Character-Defining Features of Historic Districts of Hydroelectric Generation and Transmission Property Types

- Engineering design, construction, and functional linkage: operation connecting the dams, reservoirs, water conveyance systems, and powerhouses together to generate power at multiple locations in a watershed.
- Worker's camps: a concentration of wood-framed residential and communal/recreational buildings typically executed in vernacular styles with wood or canvas tent siding and steel, wood shingle, or canvas roofs. Canvas was used in lower elevation areas, while lumber siding was more common at elevations with harsher winter conditions. Sited close to known construction areas and components of the hydroelectric generation system which they served.

F.2.1.2 Registration Requirements for Individual Property Types Under Hydroelectric Power Generation

Eligibility Standards	**Criterion A** Across all periods of significance, a hydroelectric power property eligible under Criterion A must convey a direct physical and operational association with one or more of the following. • A key project sponsored by a predecessor company or PG&E that demonstrably shaped the territory and service breadth of the predecessor company and/or PG&E in the period of significance. • A key technological innovation or period of innovation that shaped commercial, geographic, and structural patterns of electrical generation and consumption. • A key event, pattern of events, or historic trend that mandated the particular design and engineering response of the property. **Criterion B** Individual hydroelectric power properties would not reflect significance under Criterion B. **Criterion C** To be eligible under Criterion C, a hydroelectric power property must exhibit one or more of the following. • Utility engineering and design that reflect consolidation and corporate organization in the period of significance. • Utility engineering and design that reflect significant technological advances in the appropriate period of significance. • The distinctive characteristics of a type, period, or method of construction, reflecting an architectural style of the Utilitarian, Pacific Service, Great Depression and World War II, or Post-World War II and Mid-Twentieth-Century periods. **Criterion D** As a built environment resource, individual hydroelectric power properties would not reflect significance under Criterion D.
Integrity Considerations	The essential aspects of integrity for a hydroelectric power property to convey its significance are location, design, materials, feeling, workmanship, and association from a period of significance.

[156] Linda Pollack, Polly Allen, and Joshua Peabody. "Big Creek Hydroelectric System Historic District," National Register of Historic Places Nomination Form (Washington, DC: U.S. Department of the Interior, National Park Service, 2015), Section 7, 56.

	• **Location**: The resource must retain integrity of location and should not be moved from its original location along waterways or in mountainous regions.
	• **Design, Materials, Feeling, Workmanship, Association**: The resource's original materials and design features must remain intact and visible, including architectural features (e.g., wall cladding, windows, fenestration pattern, roof features, dam materials and design, water impoundment, and other details) and functional features (e.g., orientation and physical connection to water conveyance systems within and around the system and the relationship of the functional components), such that it represents its association with a specific context or contexts in PG&E's history and expresses a particular time. The resource should retain sufficient integrity of workmanship to exhibit original construction techniques.
	• **Setting**: The setting may be compromised by nearby construction that post-dates the period of significance.
	• **Alterations**: Limited alterations may not compromise these aspects of integrity such that the resource no longer conveys significance.
	  o Limited door and window replacements may be acceptable if they are located on secondary elevations, do not change the original fenestration pattern, and are compatible with the original design of the resource.
	  o If a resource is a rare surviving example of its type and/or period of significance, a greater degree of alterations that have already occurred may be acceptable.
	  o Original power-generation machinery mechanisms may have been replaced.
	  o Original operational features, such as spillways and overtopping systems, intakes, penstocks, transmission lines, may have been replaced or modified.

Associated Context(s) and Periods of Significance	• 1849–1906: Origins of California's Electrical Industry • 1905: A Company Born from Many • 1906–1930: Transformative System Expansion • 1930–1941: Depression and a Paradigm of Growth Tested • 1945–1973: The Post-War Era and California Unleashed • 1973–Present: The Changing Face of Energy
Geographic Location	An eligible hydroelectric power property must be located along waterways, such as rivers and feeder streams, including on-stream and off-stream for impoundments or in mountainous regions, such as the Sierra Nevada.

F.2.1.3 Registration Requirements for Historic Districts Under Hydroelectric Power Generation

Eligibility Standards	**Criterion A** Across all periods of significance, a hydroelectric power historic district eligible under Criterion A must convey a direct physical and operational association with one or more of the following. • A key project sponsored by a predecessor company or PG&E that demonstrably shaped the territory and service breadth of the predecessor company and/or PG&E in the period of significance. • A key technological innovation or period of innovation that shaped commercial, geographic, and structural patterns of electrical generation and consumption. • A key event, pattern of events, or historic trend that mandated the particular design and engineering response of the property. **Criterion B** Hydroelectric power historic districts would not reflect significance under Criterion B. **Criterion C** To be eligible under Criterion C, a hydroelectric power historic district must exhibit a significant concentration, linkage, or continuity of sites, buildings, structures, or objects united historically or aesthetically by plan or physical development and one or more of the following. • Utility engineering and design that reflect consolidation and corporate organization in the period of significance. • Utility engineering and design that reflect significant technological advances in the appropriate period of significance.

	• The distinctive characteristics of a type, period, or method of construction, reflecting an architectural style of the Utilitarian, Pacific Service, Great Depression and World War II, or Post-World War II and Mid-Twentieth-Century periods. **Criterion D** As a built environment resource, hydroelectric power historic districts would not reflect significance under Criterion D.

Integrity Considerations	The essential aspects of integrity for a hydroelectric power historic district to convey its significance are location, design, materials, feeling, workmanship, and association from a period of significance.
	• **Location**: The resource must retain integrity of location and should not be moved from its original location along waterways or in mountainous regions.
	• **Design, Materials, Feeling, Workmanship, Association**: The resource's original materials and design features must remain intact and visible, including architectural features (e.g., wall cladding, windows, fenestration pattern, roof features, dam materials and design, water impoundment, and other details) and functional features (e.g., orientation and physical connection to water conveyance systems within and around the system and the relationship of the functional components), such that it represents its association with a specific context or contexts in PG&E's history and expresses a particular time. The resource should retain sufficient integrity of workmanship to exhibit original construction techniques.
	• **Setting:** The setting may be compromised by nearby construction that post-dates the period of significance.
	• **Alterations:** Limited alterations may not compromise these aspects of integrity such that the resource no longer conveys significance.
	  ○ Limited door and window replacements may be acceptable if they are located on secondary elevations, do not change the original fenestration pattern, and are compatible with the original design of the resource.
	  ○ If a resource is a rare surviving example of its type and/or period of significance, a greater degree of alterations that have already occurred may be acceptable.
	  ○ Original power-generation machinery mechanisms, water conveyance systems, and power transmission features may have been replaced.
	  ○ Original operational features, such as spillways and overtopping systems, intakes, penstocks, transmission lines, may have been replaced or modified.

Associated Context(s) and Periods of Significance	• 1849–1906: Origins of California's Electrical Industry • 1905: A Company Born from Many • 1906–1930: Transformative System Expansion • 1930–1941: Depression and a Paradigm of Growth Tested • 1945–1973: The Post-War Era and California Unleashed • 1973–Present: The Changing Face of Energy
Geographic Location	• An eligible hydroelectric power historic district must be located along waterways, such as rivers and feeder streams, including on-stream and off-stream for impoundments or in mountainous regions, such as the Sierra Nevada. • For the worker's camps subtype, the geographic location must be sited close to known construction areas and components of the hydroelectric generation system which they served. • Eligible districts may be a single geographic area of contiguous historic properties or may be composed of two or more definable significant areas separated by nonsignificant areas.[157]

F.2.2 Natural Gas/Steam Power Generation

Natural gas and steam generation were electricity-generating systems employed from 1879 through 1960. Steam generation relies on a fuel source to generate steam to spin turbines, which provides the mechanical energy that is converted to alternating current (AC) electricity through electrical generators. Transformers then step up the energy for transmission from the steam-generation plant. Although PG&E operated several large fossil fuel-based steam plants as

[157] NPS. 1995:6.

part of its twentieth-century energy portfolio, all of PG&E's twentieth-century fossil fuel steam plants were either divested or decommissioned and are no longer under PG&E ownership or management. The only PG&E steam plants held by the company at present are Modern-era facilities, specifically the 2009 Gateway Generating Station (Antioch), 2010 Colusa Generating Station (Stonyford), and 2010 Humboldt Bay Generating Station (Eureka).

Plants reflecting the period of Establishment of Urban Electrical Generation Capacity (1879–1893) are associated with the period when steam generation was established. During this period, steam-operated powerhouses were built and maintained chiefly for stand-by service during periods of short water supply, peak loads, and emergencies. The first plant was California Electric Light Company's San Francisco Generating Station. By 1893, the state's primary energy supply shifted away from steam with the introduction of long-distance hydroelectric transmission.

Plants reflecting the period of Steam Generation Refinement and the Incorporation of Natural Gas (1925–1931) are associated with the period when steam generation was revived as PG&E began a concerted development of statewide natural gas pipelines and the accompanying development of natural gas steam plants.

Plants reflecting the period of Efficiency and Modernization (1945–1960) are associated with the period following World War II when new steam plant construction and refurbishment of increasingly large and efficient steam-generation plants supplanted hydroelectric plants in system capacity and dominance as available sites for hydro projects were diminishing in number.

A summary of past inventory and evaluation efforts for natural gas/steam power generation is included in Appendix A, Table 1A, *PG&E's Power Generation Facilities and NRHP Eligibility Information*.

F.2.2.1 Associated Property Type: Natural Steam/Gas Plants

Natural gas and steam-generation plants were developed during three distinct periods. Between 1873 and 1893, plants reflected the establishment of urban electrical generation capacity. These smaller plants typically had only one steam-generation unit and were constructed in modest architectural designs executed in brick. The second period of development was the incorporation of natural gas and occurred between 1925 and 1931. During this period, existing plants were expanded and adapted for use as natural gas plants. There was typically more than one steam-generation unit. Designs were still modest and executed in brick but included muted Art Deco designs and rhythmic fenestration. The final phase of steam generation focused on efficiency and modernization. Between 1945 and 1960, plants were large facilities of four or more steam-generation units powered by fossil fuels. Designs were utilitarian and did not exhibit styles or patterns of material consistency.

Natural steam/gas plants are parts of the power generation system and reflect this in their form, design, function, and materials. Natural gas steam plants with turbines constructed after 1925 incorporate natural gas pipelines. Plant designs and components vary depending on their period of construction. There are three distinct periods of Natural Steam/Gas Plant development with the following typologies.

Natural steam/gas plants may be eligible for listing in the NRHP under Criteria A and/or C. Under Criterion A, these properties may be associated with a specific event or pattern of events or historic trends related to the development or expansion of power distribution in a community, the state of California, or the nation. Under Criterion C, these properties may have significance for their design, construction, and engineering qualities. Specifically, they may embody distinctive characteristics of a type, period, or method of construction, represent the work of a master, or possess high artistic value.

There are no known known previously evaluated steam facilities in PG&E system.

The following sections describe the associated property subtypes within the category of Natural Gas/Steam Plants. Each associated property type is defined, along with its character-defining features.

Types of Natural Steam/Gas Plants

PG&E's natural steam/gas plants systems included Utilitarian and Pacific Service plants and plants associated with the Great Depression and World War II and post-World War II and the mid-twentieth-century.

- **Utilitarian plants.** Natural steam/gas plants were constructed during the establishment of urban electrical generation in the late nineteenth century. The first plant was California Electric Light Company's San Francisco Generating Station. By 1893, the state's primary energy supply shifted away from steam with the introduction of long-distance hydroelectric transmission. Steam-operated plants were built and maintained chiefly for stand-by service during periods of short water supply, peak loads, and emergencies.

Character-Defining Features of Utilitarian Natural Steam/Gas Plants
▪ Smaller, typically with only one steam-generation unit.
▪ Modest architectural designs typically executed in brick.
▪ Set in urban environment.

- **Pacific Service plants.** Pacific Service types of natural steam/gas plants evolved during a period of steam-generation refinement: when natural gas was incorporated into the production of steam. This occurred mostly between 1925 and 1931 as existing plants were expanded and adapted for use as natural gas plants. Steam generation was revived as PG&E began a concerted development of statewide natural gas pipelines and the accompanying development of natural gas steam plants.

Character-Defining Features of Utilitarian Natural Steam/Gas Plants
▪ Additional (more than one) steam-generation units.
▪ Modest architectural designs executed in brick, with muted Art Deco designs, and rhythmic fenestration.
▪ Set in urban environment.

- **Post-World War II and Mid-Twentieth-Century period plants.** During this period, natural steam/gas plants were updated to increase efficiency. This period began at the end of 1945 and continued into 1960. New steam plant construction and refurbishment of increasingly large and efficient steam-generation plants supplanted hydroelectric plants in system capacity and dominance as available sites for hydro projects were diminishing in number.

Character-Defining Features of Post-World War II and Mid-Twentieth-Century Period
▪ Large, industrial-scale facilities of four or more steam-generation units.
▪ Support buildings express utilitarian, rectangular forms with minimal architectural embellishment.
▪ Utilitarian materials like corrugated metal, concrete, and brick.
▪ Powered by fossil fuels.
▪ Set in urban environment.

F.2.2.2 Registration Requirements for Individual Properties Under Natural Gas/Steam Power Generation

Eligibility Standards	**Criterion A** Across all periods of significance, a natural gas/steam power property eligible under Criterion A must convey a direct physical and operational association with one or more of the following. • A key project sponsored by a predecessor company or PG&E that demonstrably shaped the territory and service breadth of the predecessor company and/or PG&E in the period of significance.

<table>
<tr><td></td><td>

A key technological innovation or period of innovation that shaped commercial, geographic, and structural patterns of electrical generation and consumption.
A key event, pattern of events, or historic trend that mandated the particular design and engineering response of the property.

Criterion B
Individual natural gas/steam power properties would not reflect significance under Criterion B.
Criterion C
To be eligible under Criterion C, a natural gas/steam power property must exhibit one or more of the following.

Utility engineering and design that reflect consolidation and corporate organization in the period of significance.
Utility engineering and design that reflect significant technological advances in the appropriate period of significance.
The distinctive characteristics of a type, period, or method of construction, reflecting an architectural style of the Utilitarian, Pacific Service, Great Depression and World War II, or Post-World War II and Mid-Twentieth-Century periods.

Criterion D
Individual natural gas/steam power properties would not reflect significance under Criterion D.
</td></tr>
<tr><td>Integrity Considerations</td><td>
The essential aspects of integrity for a natural gas/steam power property to convey its significance are location, design, materials, feeling, workmanship, and association from a period of significance.

Location: The resource must retain integrity of location and should not be moved from its original location typically close or within urban population centers.
Design, Materials, Feeling, Workmanship, Association: The resource's original materials and design features must remain intact and visible, including architectural features (e.g., wall cladding, windows, fenestration pattern, roof features, and other details) and functional features (e.g., open interior space used for machinery and turbines or generators, etc.), such that it represents its association with a specific context or contexts in PG&E's history and expresses a particular time. The resource should retain sufficient integrity of workmanship to exhibit original construction techniques.
Setting: The setting may be compromised by nearby construction that post-dates the period of significance.
Alterations: Limited alterations may not compromise these aspects of integrity such that the resource no longer conveys significance.

Limited door and window replacements may be acceptable if they are located on secondary elevations, do not change the original fenestration pattern, and are compatible with the original design of the resource.
If a resource is a rare surviving example of its type and/or period of significance, a greater degree of alterations that have already occurred may be acceptable.
Original power-generation machinery mechanisms may have been replaced.

</td></tr>
<tr><td>Associated Context(s) and Periods of Significance</td><td>

1849–1906: Origins of California's Electrical Industry
1906–1930: Transformative System Expansion
1930–1941: Depression and a Paradigm of Growth Tested
1945–1973: The Post-War Era and California Unleashed

</td></tr>
<tr><td>Geographic Location</td><td>

Siting is typically urban and is not dependent on natural features such as waterways.
Typically located close or within population centers.

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F.2.3 Nuclear Power Generation

Although PG&E continued developing and expanding its conventional natural steam/gas generation systems through 1960, the 1950s saw investigations into peacetime applications of nuclear energy that resulted in the creation of nuclear power plants. Nuclear power plants rely on nuclear fission to generate heat and steam to spin turbines that provide mechanical energy, which is then converted to AC electricity through electrical generators. Transformers then step up the energy for transmission from the nuclear power plant. California's extant, sprawling energy grid, coupled with hosting exceptional wartime research and development institutions at the University of California, Stanford, and California Institute of Technology (Caltech) uniquely positioned the state to continue exploring nuclear energy expansion following World War II.[158]

Cooperative relationships between PG&E and General Electric Company (GE) led to the construction of the first licensed commercial nuclear test plant at Vallecitos, near Livermore, which hosted an operational boiling water reactor 30-megwatt plant by 1957. By 1958, PG&E began planning the nation's first commercial nuclear power plant, which would be located adjacent to the existing Humbolt Bay Steam Plant in northern California. This 60,000-kilowatt (kW) plant came online in 1963. Pressurized Water Reactor plants were standard for facilities in California after the 1960s. Studies into seismic activity along the California coastline, coupled with increasingly critical public opinion turning against nuclear power, stunted nuclear power plant construction and generation expansion by the mid-1970s. California utilities built six nuclear power plants during this 20-year construction window.

At present, PG&E's network includes one operational Pressurized Water Reactor nuclear power plant, Diablo Canyon (1973), in San Luis Obispo County, which is tentatively planned for decommissioning in the next 20 years.[159]

A summary of past inventory and evaluation efforts for nuclear power generation is included in Appendix A, Table 1A, *PG&E's Power Generation Facilities and NRHP Eligibility Information*.

F.2.3.1 Associated Property Type: Nuclear Power Plants

All nuclear power plants host one or more nuclear reactors that share common components: a fuel source, moderator, coolant, control rods, pressure vessels or tubes, and a containment structure. Reactor vessels are housed inside large, cylindrical, domed structures called containment buildings. Separate buildings, commonly utilitarian, house the support infrastructure including turbines, generators, condensers, pumps, and other water and electrical generation systems near the containment building. To date, one decommissioned nuclear power plant at Rancho Seco, southeast of Sacramento, featured cooling towers since its design did not have access to a large body of water to induce cooling.[160]

Development of nuclear power plants in California occurred between 1954 and 1985, reflecting the earliest experimental facilities at Santa Susana Field Laboratory near Simi Valley and the Vallecitos Nuclear Power Plant near Sunol and ending with completion of the last components at Diablo Canyon Power Plant, the last active commercial nuclear power plant in California.[161]

Components of nuclear power generation work together to produce controlled nuclear fission that fuels energy production. Nuclear fission generates heat and steam that spins turbines that provide mechanical energy. This mechanical energy is then converted into AC electricity through electrical generators. Transformers then step up the energy for transmission.

Building blocks of this process include the system's cooling tower(s) or other cooling systems, containment structures, turbines, electric generators, piping and steam line infrastructure, and transmission lines radiating from the facility.[162] Diablo Canyon Power Plant, the sole operational nuclear power plant within PG&E's California network, operates

[158] Cardno 2020:4-8.
[159] Cardno 2020:3-109-113; Page & Turnbull 2022:56-57.
[160] Page & Turnbull. 2022. Diablo Canyon Power Plant Decommissioning Project Historic Built Environment Evaluation. Prepared for Aspen Environmental Group. April:53-57.
[161] Page & Turnbull 2022:56-57; Cardno 2020:5-8.
[162] Cardno 2020:4-8; Department of Energy. 2019. *Infographic: How does a pressurized water reactor work?* Available: https://www.energy.gov/ne/articles/infographic-how-does-pressurized-water-reactor-work. Accessed: February 26, 2025.

using a once-through cooling system, which bypasses use of a cooling tower by discharging a portion of the warmed water back into an adjacent body of water after it passes through the condenser.[163]

Nuclear power plants may be eligible for listing in the NRHP under Criteria A and/or C. Under Criterion A, these properties may be associated with a specific event or pattern of events or historic trends related to the development or expansion of power distribution in a community, the state of California, or the nation. Under Criterion C, these properties may have significance for their design, construction, and engineering qualities. Specifically, they may embody distinctive characteristics of a type, period, or method of construction, represent the work of a master, or possess high artistic value.

The following section describes the character-defining features and registration requirements for extant nuclear power plants within PG&E's network.

Character-Defining Features of Nuclear Power Plants

- Functional components of the nuclear power generation system date to the period of significance.
- Maintains its original function and physical connection to its nuclear power source.
- Maintains its connection to its transmission source.
- Existence of key operating systems such as turbines and generators.
- Industrial scale.
- Keeps the key components of nuclear power generation system. Nuclear power generation components including mechanical systems (generators, turbines, etc.) and nuclear waste storage facilities.
- Construction materials, such as concrete, used for nuclear containment. The presence and function of the materials is more important than original materials for integrity consideration.
- Location alongside a body of water and/or distant from population centers with a substantive buffer zone between public and private areas.

[163] California State Water Board. 2023. *Board adopts amendment extending once-through-cooling operations at four coastal plants*. Available: https://www.waterboards.ca.gov/press_room/press_releases/2023/otc-press-release-8.17.2023.pdf. Accessed: February 26, 2025:2.

F.2.3.2 Registration Requirements for Individual Properties Under Nuclear Power Generation

Eligibility Standards

Criterion A

Across all periods, a nuclear property eligible under Criterion A must convey a direct physical and operational association with one or more of the following.

- A key project sponsored by PG&E that demonstrably shaped the territory and service breadth of PG&E and placed in service during the period of significance for nuclear energy (1957–1973).
- A key technological innovation or period of innovation that shaped commercial, geographic, and structural patterns of electrical generation and consumption.
- A key event, pattern of events, or historic trend that mandated the particular design and engineering response of the property.

Criterion B

Nuclear generation and transmission facilities would not reflect significance under Criterion B.

Criterion C

To be eligible under Criterion C, a nuclear power generation property must exhibit one or more of the following.

- Utility engineering and design that reflect significant technological advances in the nuclear power generation.
- Utility engineering and design that reflect notable innovations in PG&E's power generation infrastructure design, function, or capacity.
- The distinctive characteristics of a type, period, or method of construction, reflecting an architectural style of the Post-World War II and Mid-Twentieth-Century period.

Criterion D

As a built environment resource, nuclear generation and transmission facilities would not reflect significance under Criterion D.

Integrity Considerations

The essential aspects of integrity for a nuclear power generation property to convey its significance are location, design, feeling, and association from the period of significance.

- **Location**: The resource must retain integrity of location and should not be moved from its original location, typically distant from major population centers.
- **Design, Feeling, Association**: The resource's original design features must remain intact and visible. For nuclear power generation properties, the property should retain spatial relationships between components of nuclear power generation and transmission as originally designed. The property should contains all the essential components for nuclear power generation as originally connected to each other in order to convey integrity of feeling and association.
- **Materials and Workmanship**: Integrity of materials and workmanship are not essential aspects of integrity to convey the significance of nuclear power generation properties.
- **Setting:** The setting may be compromised by nearby construction that post-dates the period of significance.
- **Alterations:** Limited alterations may not compromise these aspects of integrity such that the resource no longer conveys significance.
  - Limited material replacement with like or compatible materials to those used during the period of significance.
  - If a resource is a rare surviving example of its type and/or period of significance, a greater degree of alterations that have already occurred may be acceptable.
  - Original power-generation machinery mechanisms may have been replaced.

Associated Context(s) and Period of Significance

1945–1973: The Post-War Era and California Unleashed, The Energy of the Future: Nuclear and Geothermal Energy.

Geographic Location

- Distant from major population centers.
- Known examples located in: San Luis Obispo County, Livermore, and Eureka.

F.3 Transmission/Distribution of Power

Transmission and distribution infrastructure carries electricity from the generating source to the consumer. Within the Transmission/Distribution of Power category, transmission carries electricity from the generating source at high voltages, acting as the bulk electricity supplier. The transmitted electricity is then stepped down at step-down substations and disseminated to end users via lower voltage distribution lines and distribution substations.

PG&E's network consists of more than 19,000 circuit miles of transmission lines and 100,000 miles of electric distribution lines throughout its service network. As such, the distribution infrastructure property type is PG&E's most ubiquitous and standardized component. Because of their ubiquity, standardization, and lack of significance under any evaluative criteria, distribution facilities (those lines carrying 50 kV or less) are only described and characterized in this section.

F.3.1 Transmission Facilities

PG&E transmission facilities encompass those infrastructure components designed to carry electrical voltages of 51 to 500 kV from generation facilities to substations, where distribution lines (<50-kV lines often mounted to wood poles) send power to end users. As defined by PG&E, transmission lines have the following three qualities.

- Carry electricity across the state.
- Transport bulk electricity at high voltages above 50 kV to 500 kV using three-phase AC circuits.
- Are usually carried on tall metal towers, and less commonly wood poles.

For technological innovation, transmission facilities fall within two broad periods of significance, corresponding to the steep rise in voltages carried within the lines. For 60 to 220-kV lines the period of significance is 1901 to 1931. Examples include the 60-kV Colgate-Oakland Transmission Line (1901, Bay Counties Power Company; AC engineering innovations, record-breaking 142 miles, early 60-kV voltage) and the 100-kV Big Bend to Oakland Transmission Line (1908–1909, Great Western Power Company). This period closes with the erection of multiple 220-kV transmission lines up to and in 1931 (pre-1931), such as PG&E's Pit Hydroelectric Project (1922).

The next period of significance concerns the establishment of 500-kV lines and infrastructure as the standard for long-distance energy transmission. The thematic period of significance for 500 kV development is 1963 to 1968, when technological adaptations and increased demand led to development and standardization of extra high-voltage (EHV) transmission infrastructure.

Development of the modern western power grid, and its interconnectedness across state and national borders, emerged during the post-World War II expansion of communities and the concurrent energy demands to support these populations. Planning and construction of the intended scale required multi-agency negotiations between the Bonneville Power Administration (BPA) and members of the California Power Pool (PG&E, Southern California Edison, San Diego Gas and Electric, California Electric Power), ratification of the Columbia River Treaty (1961) between the United States and Canada, and federal government financing under the Kennedy and Johnson Administrations.[164]

The Pacific Intertie System, an expansive network of power generation, EHV transmission, and distribution facilities with AC and direct current (DC) components, dates to between 1965 and 1970. This system became the first international public–private, interregional, interagency power-sharing system exchanging, storing, and transmitting 500-kV electrical power from parts of the Pacific Northwest and Canada to and from Southern California, Arizona, and Nevada. Additionally, the system established an efficient method for seasonal power-sharing relationships during periods of the year where system geographies experience opposite energy use patterns.

164 Binus 2008:vi, 102.

To carry 500-kV power, PG&E and other agencies needed to develop new tower and conductor methods. Such innovations included engineered towers to sustain both the added weight and distances needed for EHV transmission, as well as braided conductor that would not overburden the new towers.

The 1963–1968 period of significance for 500-kV transmission facilities includes the following highlights.

- **1962–1963**. As conception of the Pacific Intertie gained traction, PG&E erected the first 100-mile EHV link between a Pacific Power & Light generation facility in Oregon and PG&E Round Mountain in Shasta County (initially rated at 230 kV, then upgraded to 500 kV in 1965).
- **1964.** PG&E designed and engineered new H-frame towers without guy wires outside the structures placed on round concrete footings to secure the tower and minimize footprints in areas of limited spaces, such as agricultural lands.[165]
- **1965.** Table Mountain and Round Mountain energized at 500 kV.
- **1965–1968.** PG&E continues to erect 500-kV transmission lines within its network.
- **1968.** PG&E completed and energized most of the company's 500-kV backbone.

The summary of past inventory and evaluation efforts for power transmission is included in Appendix A, Table 2A, *PG&E's 500 kV Transmission Facilities and NRHP Eligibility Information*; Table 2B, *PG&E's 230 kV Transmission Facilities and NRHP Eligibility Information*; Table 2C, *PG&E's 115 kV Transmission Facilities and NRHP Eligibility Information*; and Table 2D, *PG&E's 60 kV Transmission Facilities and NRHP Eligibility Information*.

F.3.1.1 Associated Property Type: Transmission Structures

Primary physical and operational components common to all transmission lines within PG&E's network include the transmission structure or tower, conductors that ferry the electrical current along the alignments, and insulators that confine the current to the conductors. These are the components of a transmission line, rather than individual property types.

Tower structures may consist of lattice steel overhead structures or, less commonly, wood poles. Wood poles date to the earliest periods of electrical transmission while lattice steel overhead structures date to circa 1901 to present to address higher voltages, conductor weights, and durability requirements. Wood poles have an approximately 50-year lifespan, are regularly replaced, and carry lower voltages, generally below 100 kV.

Lattice steel overhead structures derived from windmill designs and can carry more weight than wood poles, and come in various designs depending on terrain and environmental factors. Suspension towers are the most common and carry standard, straight segments of an alignment. Angle towers are stronger support structures present when there is a change in direction in alignment and the longitudinal forces are unbalanced. Dead-end towers are employed at key transition points, such as large deviations in alignment, or when the alignment reaches a terminus or substation. Transposition towers are placed at regular intervals to transpose (switch) position of conductors to help reduce system loss and balance conductor voltage along the alignment. Voltages at 500 kV or above required additional support structures and designs to accommodate the added distances and conductor weights.

EHV transmission structures whose early designs date to 1963 feature an H-frame form without guy wires beyond the tower footprint (some used narrow tower bases within agricultural landscapes) to accommodate the increased weight of a 500-kV conductor, insulators, and necessary clearances needed for the higher voltage. Some alignments feature newly installed tubular steel poles and light duty steel poles, which consist of a single, slender tapered steel body with

[165] PG&E Life. "New 500-KV Tower Design To Be Used In Farmlands." July–August 1964:24.

cross-arms. Such modern replacements of original lattice towers appear interspersed within older historic-period alignments across PG&E's transmission network.

A transmission conductor is attached to transmission structures to carry electrical current from generating sources to step-down substations and, ultimately, the end user. Conductors typically have a lifespan of 30 to 50 years and lines are often reconductored. The earliest transmission lines were made from copper and are often replaced with bundled strands of aluminum surrounding a steel core for structural stability. Three-phase AC transmission groups conductor in threes, single circuits have three total lines, double circuit has six total lines.

Transmission insulators block the flow of electrical current from escaping the conductor into the transmission support structures and the ground. Insulators have a 20- to 30-year lifespan and are regularly replaced. Insulator materials include porcelain, glass, or polymer plastic strung in disks and joined together by metal ball and sockets on insulator strings. Four to six insulators per joining are common on 60 kV transmission lines while 12 or more insulators are seen on 220 kV+ lines.

Different alignment and transmission structure types feature different types of insulators depending on the needs of the alignment. Suspension insulators are the most common type and are strung vertically and suspended from the support structure. Strain insulators appear on dead-end and angle towers and are strung horizontally to absorb longitudinal forces. Finally, post insulators appear on lower voltage transmission lines, which act in lieu of cross-arms to rigidly form the support structure for the overhead conductor.

Transmission facilities may be eligible for listing in the NRHP under Criteria A and/or C. Under Criterion A, these properties may be associated with a specific event or pattern of events or historic trends related to the development or expansion of power distribution in a community, the state of California, or the nation. Under Criterion C, these properties may have significance for their design, construction, and engineering qualities. Specifically, they may embody distinctive characteristics of a type, period, or method of construction, represent the work of a master, or possess high artistic value.

The technological and structural evolution of PG&E's historic-era transmission alignments was punctuated by discrete periods of important technological advancement that led to greater system capacity and reliability. After these periods (1901–1931 for 230 kV and below, 1961–1970 for 500 kV), the technological and structural components of the transmission property type reflected a largely static configuration and design, with only few localized variations on standardized plans and tower types. Because of this iterative and repetitive type, only those transmission properties developed during the identified transmission-related technological periods of significance are subject to review.

Character-Defining Features of Transmission Facilities

- Location and spatial alignment.
- Relationship to its generation source and consumption source.
- Relationship of features, e.g., long alignments of utility towers, conductors, and insulators.
- Utilitarian form of transmission structure.
- Industrial scale.

F.3.2 Registration Requirements for Individual Properties or Historic Districts Under Transmission Facilities

Eligibility Standards	**Criterion A**
	• Across all periods, transmission facilities eligible under Criterion A must convey a direct physical and operational association with one or more of the following.
	• A key project sponsored by PG&E that demonstrably shaped the territory and service breadth of PG&E and placed in service during the period of significance for the specific voltage type.
	  o 1901–1931 for 51–220kV.
	  o 1963–1968 for 500-kV.
	• A key technological innovation or period of innovation that shaped commercial, geographic, and structural patterns of electrical generation and consumption.
	• A key event, pattern of events, or historic trend that mandated the particular design and engineering response of the property
	• First or foremost example of electrical transmission that resulted in a notable change in population or economic activity in a community because of electrification.
	Criterion B
	Transmission facilities would not reflect significance under Criterion B.
	Criterion C
	To be eligible under Criterion C, a transmission power property or historic district must exhibit a significant concentration, linkage, or continuity of sites, buildings, structures, or objects united historically or aesthetically by plan or physical development *and* one or more of the following.
	• Utility engineering and design that reflect significant technological advances in the transmission of electricity.
	• Utility engineering and design that reflect notable innovations in PG&E's power generation infrastructure design, function, or capacity (including voltage regulation, voltage level, or transmission distance).
	• The distinctive characteristics of a tower frame type or bound conduction type.
	Criterion D
	As a built environment resource, transmission facilities would not reflect significance under Criterion D.

Integrity Considerations	• The essential aspects of integrity for a transmission facility property to convey its significance are location, design, feeling, and association from a period of significance. • **Location**: The resource must retain integrity of location and should not be moved from its original location. The transmission facility must retain its original alignment with the same beginning and end points and largely the same corridor as in the period of significance. • **Design, Feeling, Association**: The resource's original tower design must remain intact and retain original functional features. For integrity of feeling and association to be intact, the majority of a transmission line must retain a long straight alignment across flat topographies. • New substation interconnections and branch lines may exist and do not undermine integrity as long as the core historical alignment remains intact. To convey significance, associative features must retains their original functions as a transmission lines. • **Materials and Workmanship:** While tower structures must retain integrity of design, materials and workmanship may have been changed over time as the result of routine maintenance for the system's function (insulators, conductors, minor additive features like spark arrestors or bird control features). • **Setting:** The setting may be compromised by nearby construction that post-dates the period of significance. • **Alterations*:*** Alterations may not compromise these aspects of integrity such that the resource no longer conveys significance. o New substation interconnections • New branch lines

Associated Context(s) and Periods of Significance	• 1849–1906: Origins of California's Electrical Industry • 1906–1930: Transformative System Expansion • 1930–1941: Depression and a Paradigm of Growth Tested • 1945–1973: The Post-War Era and California Unleashed
Geographic Location	• Long straight alignments across flat topographies, including sparsely populated desert climates and modified agricultural regions, such as the California Central Valley. • Across mountainous regions and forested areas with diverse topographies, such as the Sierra Nevada.

F.3.3 Distribution Facilities

Distribution facilities are those transmission infrastructure facilities designed and erected to transmit 50 kV or less. These facilities often emerge from a regional substation and distribute power to end users in the immediate vicinity. According to PG&E, distribution facilities deliver electricity to neighborhoods and communities over a shorter distance than transmission lines. They are the final stage of electricity delivery to homes and businesses. The distribution lines are generally supported by wood poles.

PG&E manages and operates more than 100,000 circuit miles of distribution facilities in its service area, making this property type the most physically expansive and ubiquitous component within PG&E's electrical infrastructure.

Most distribution lines are carried on standardized wood poles, derived from telegraph transmission technology, with estimated life spans of less than 50 years. Wood poles are commonly cedar, yellow pine, or Douglas fir treated in creosote and measuring 30 to 40 feet high with 5 to 6 feet of the pole buried for structural integrity. Wood poles are regularly replaced across PG&E's network. Conductors are often made of aluminum or copper, and insulators are often ceramic, glass, or polymer. Distribution lines' associated infrastructural components (conductor, insulators, and transformers) are replaced on an ongoing basis.

The technological components of distribution facilities date to the earliest stages of PG&E's development, with minimal engineering modifications since their standardization in the late 19th century. Functional utilitarian structures that do not incorporate innovative technology are not specifically associated with any contexts of importance in PG&E's history or the history of energy infrastructure. Distribution facilities are utilitarian in form and materials and do reflect significance from PG&E's foundational period. Therefore, there is no potential for this type of property to convey significance under any historic context or evaluative theme, such as EHV transmission, architectural innovations, or novel technologies.

There are no previously identified NRHP-eligible associated property types under this category. There is no potential for this property type to have significance under any context. Because of this overall lack of significance, PG&E's electrical distribution system below 50 kV and all its appurtenant features, including wood poles, would not be significant under any evaluation criteria. As such, this description serves to explain this infrastructure type, and does not include associated property types or registration requirements. Because there is no potential for significance, no registration requirements were developed for distribution lines.

F.4 Substations

Substations typically serve as the start- and endpoint of named transmission lines. Functionally, the primary purpose of most substations is to modulate line voltage, stepping it up or down, depending upon the need. All substations include switching mechanisms or circuit breakers that allow line segments to be energized or switched off for maintenance or, automatically, as the result of a fault. A substation can increase or moderate distribution from high-voltage corridors, though sub-70 kV substations are the most common in the PG&E system. Substations have been an integral part of power transmission and distribution since the late nineteenth century. Since that time, they have taken many forms, from utilitarian sheds to monumental buildings to enclosed yards.

Construction of substations has been an ongoing constant throughout PG&E's history. Even during periods of limited development for generation and transmission facilities, new substations were constructed to replace obsolete older substations. Subtypes of substations roughly correspond to four periods: pre-1910, 1910 to 1930, 1930 to 1945, and after 1945. The earliest substations were utilitarian and no known examples from the pre-1910 period are extant. By 1912, many early substations were obsolete and dangerous, leading to a campaign to replace rudimentary early stations with permanent, safe enclosure buildings.

The substations constructed between 1910 and 1930 reflect a distinct period of growth for PG&E when large-scale systems with monumental architectural designs were constructed as PG&E established its commercial and institutional identity through a cohesive monumental built form. This was the Pacific Service period. Substation control houses of this period used a City Beautiful-influenced architectural vocabulary. The plants and Cordelia Substation associated with the Drum-Spaulding development system reflect this period. The design was of a heightened and unified architectural design intended to convey the company's growing civic role in California life. The Beaux Arts architectural style of the Cordelia Substation conveys monumentality, using the same architectural language of great civic buildings of the 1910s. Transmission and distribution infrastructure was contained in a switchyard secondary to the monumental building.

By the early 1930s, the projects planned during the 1910s and 1920s neared completion. Projects planned and constructed during the 1930s were rebuilding or constructing small distribution substations rather than the more complex class of interconnected transmission step-down stations. These new substations met market demands and replaced obsolete facilities that affected a vital link in the energy supply chain. Small substation improvements included Del Monte and Carmel Substations in 1931, and Los Coches, Sunnyvale Naval Air Station, Crystal Springs, Lodi, Bolinas, and Vallejo Substations in 1932. PG&E also completed a smattering of other substation improvements across the service area.

Substations constructed after 1930 were primarily outdoor switchyard-type design. Like the powerhouses, the new breed of substation in the 1930s stood in marked contrast to earlier substations that included a stylized "permanent" control building or attendant facility. Substation design became decidedly utilitarian in form, and the growing ubiquity of the small, unmanned substation as a common and widely developed type of infrastructure reflected the rising need for outdoor distribution equipment. During this period, PG&E and other utilities moved to a new model of largely outdoor and unattended substations, which ultimately streamlined and simplified construction and operation. Although exceptions to this general trajectory remained, particularly in urban areas that required interior distribution facilities, on the whole PG&E's substations shifted to outdoor distribution and transmission apparatus without buildings that reflect an architectural style.[166]

After World War II, yard-type substation design continued to be the default form of the property type. As higher voltage capacity was introduced into the system, seven existing substations were rehabilitated or newly constructed as EHV line stations: Round Mountain, Table Mountain, Vaca-Dixon, Tesla, Metcalf, Los Banos, and Midway.

The summary of past inventory and evaluation efforts for power transmission is included in Appendix A, Table 2D, *PG&E's Substation Facilities and NRHP Eligibility Information.*

F.4.1 Associated Property Type: Substations

Substations vary greatly but generally include a switchyard and control house. Substations may also include storage facilities.

Substations may be eligible for listing in the NRHP under Criteria A and/or C. Under Criterion A, these properties may be associated with a specific event or pattern of events or historic trends related to the development or expansion

[166] "The Substation Feature of the Electric Distribution Problem," *Pacific Service Magazine*, Volume XVIII, No. 10, October 1932, 307-313; "Reconstructed Substation is Typical of Modern Design," *Pacific Service Magazine*, Volume XVIII, No. 11, January 1933, 335–339.

of power distribution in a community, the state of California, or the nation. Under Criterion C, these properties may have significance for their design, construction, and engineering qualities. Specifically, they may embody distinctive characteristics of a type, period, or method of construction, represent the work of a master, or possess high artistic value.

There are three main subtypes of substations: single building, switchyard, and multiple buildings. Post-1930s unenclosed substations with standardized utilitarian features and no buildings do not convey significance. This typically includes switchyards or facilities without purpose-designed buildings (e.g., enclosed yards). This type of substation typically dates to all periods following the Pacific Service period.

F.4.1.1 Associated Property Subtype: Single Building

- **Single building.** This type of substation was part of the Pacific Service building program completed between 1911 and 1930.

Character-Defining Features of Single-Building Substations

- A cohesive monumental built form.
- Monumental architectural style, such as Beaux Arts, Classical Revival, or PWA Moderne.
- Building may contain administrative functions.
- Transmission and distribution infrastructure contained in a switchyard secondary to the monumental building.
- Each named line (or circuit) consists of multiple conductors that arrive at the site as one transmission line terminates and another begins.
- Bushings, capacitors, and other electrical equipment are installed within the substation (either within a building or outside) to modulate or control power flow.

F.4.1.2 Associated Property Subtype Associated Property Subtype: Multiple Building

- **Multiple building.** For this type of substation, multiple uses are combined within one site. Some of these uses may not include substation functions.

Character-Defining Features of Multiple-Building Substations

- Often house additional functions that include a wide array of specialized buildings.
- Often occurs in tandem with regional or district administrative and maintenance uses, requiring additional specialized structures.
- Expanded to encompass other uses.
- Many “substations” have become larger nodes of operation beyond their primary transmission function, providing a variety of control and support services that enable the management.
- Each named line (or circuit) consists of multiple conductors that arrive at the site as one transmission line terminates and another begins.
- Bushings, capacitors, and other electrical equipment are installed within the substation (either within a building or outside) to modulate or control power flow.

F.4.1.3 Registration Requirements for Individual Properties Under Substations

Eligibility Standards

Criterion A

Across all periods of significance, a substation eligible under Criterion A must convey a direct physical and operational association with one or more of the following.

- A key project sponsored by a predecessor company or PG&E that demonstrably shaped the territory and service breadth of the predecessor company and/or PG&E in the period of significance.
- A key technological innovation or period of innovation that shaped commercial, geographic, and structural patterns of electrical generation and consumption.
- A key event, pattern of events, or historic trend that mandated the particular design and engineering response of the property.

Criterion B

Individual hydroelectric power properties would not reflect significance under Criterion B.

Criterion C

To be eligible under Criterion C, a substation must exhibit one or more of the following.

- Utility engineering and design that reflect consolidation and corporate organization in the period of significance.
- Utility engineering and design that reflect significant technological advances in the appropriate period of significance.
- The distinctive characteristics of a type, period, or method of construction, reflecting an architectural style of the Utilitarian, Pacific Service, Great Depression and World War II, or Post-World War II and Mid-Twentieth-Century periods.

Criterion D

As a built environment resource, individual hydroelectric power properties would not reflect significance under D.

Integrity Considerations

Multiple-building substations may contain a single building that is eligible, while the entire "yard" is not.

The essential aspects of integrity for a substation property to convey its significance are location, design, materials, feeling, workmanship, and association from a period of significance.

- **Location**: The resource must retain integrity of location and should not be moved from its original location.
- **Design, Materials, Feeling, Workmanship, Association**: The resource's original materials and design features must remain intact and visible, including architectural features (e.g., wall cladding, windows, fenestration pattern, roof features, and other details) and functional features (e.g., presence of a switchyard, orientation and physical connection to named transmission lines), such that it represents its association with a specific context or contexts in PG&E's history and expresses a particular time. The resource should retain sufficient integrity of workmanship to exhibit original construction techniques. To convey integrity of feeling and association, the property's original function related to the transmission of electricity should remain apparent even if it is functionally offline.
- **Setting:** The setting may be compromised by nearby construction that post-dates the period of significance.
- **Alterations*:*** Limited alterations may not compromise these aspects of integrity such that the resource no longer conveys significance.
  - Limited door and window replacements may be acceptable if they are located on secondary elevations, do not change the original fenestration pattern, and are compatible with the original design of the resource.
  - If a resource is a rare surviving example of its type and/or period of significance, a greater degree of alterations that have already occurred may be acceptable.
  - Original power transmission equipment may have been replaced.

Associated Context(s) and Periods of Significance	• Single-Building Subtype
	  ○ 1906–1930: Transformative System Expansion
	• Multiple-Building Subtype
	  ○ 1930–1941: Depression and a Paradigm of Growth Tested
	  ○ 1941–1945: A Nation at War, an Industry Revived
	  ○ 1945–1973: The Post-War Era and California Unleashed

Geographic Location	• Start- and endpoint of named transmission lines. • Throughout PG&E's service area (urban, rural, and all terrains).

G. Geographical Data

The PG&E power generation and transmission network crisscrosses portions of northern and central California, with resources located in incorporated cities and towns, unincorporated public and private, federal, and tribal lands. Although some resources, such as substations, occupy specific parcels with dedicated addresses, much of PG&E's network, particularly transmission lines and hydroelectric facilities, span tens or hundreds of miles and cross multiple local, county, and regional jurisdictions. As such, the geographical area covered by this Multiple Property Documentation Form (MPDF) includes the following: The State of California, which includes federal, tribal, city, and county geopolitical subdivisions of northern California (Del Norte, Siskiyou, Modoc Counties) bordering Oregon south to Kern and Santa Barbara Counties.

H. Summary of Identification and Evaluation Methods

(Discuss the methods used in developing the multiple property listing.)

In 2019, Pacific Gas and Electric Company (PG&E) developed the *Historic-Era Electrical Infrastructure Management Plan* (HEIMP). The development of the HEIMP was supported by a comprehensive research program based on review of a wide array of both PG&E and contextual sources. This Multiple Property Documentation (MPD) builds on the HEIMP with a framework for evaluating eligibility. The following sources were reviewed for the development of the historic context and evaluation criteria.

PG&E Facility Data Sources

PG&E facility informational sources formed a core component of the research program. These sources provided detailed documentary information about PG&E facilities, property types, and system growth and evolution. It is important to note that the majority of these informational sources are restricted and only accessible with PG&E authorization and access credentials. The following PG&E sources were consulted:

- ***PG&E Facility Inventory Data:*** PG&E holds asset inventories of generation, transmission/distribution, and substation facilities. This data can provide basic real property characteristics of facilities, including facility name, location, operational type, and age.
- ***PG&E Map Guide and Electric Transmission Geographic Information System:*** PG&E manages digital data platforms that provide spatial and structural information on PG&E facilities. The data platforms also support detailed searches for digitized structural data, drawings, and real property information about PG&E facilities. In order to access these platforms, researchers must hold appropriate PG&E credentials.
- ***PG&E Engineering Record Information Management System (ERIMS):*** PG&E holds an extensive archived records repository of PG&E engineering data, collectively managed and maintained under the ERIMS. Data under the system are accessed by means of facility key word and generally include engineering drawings and plans, work orders, photographs, construction and alteration documents, permitting documents, and other related facility data. It is important to note that because of the volume of data held by ERIMS, records searches can be lengthy and include review of high volumes of records. Additionally, while records are available through key word search, the retrieval system is of a generalized nature that requires extensive review and winnowing to obtain relevant records.

- ***PG&E Photographic and Journal Archives:*** PG&E houses a company archive of facility photographs at its San Francisco headquarters. The photographs are organized by facility or hydroelectric project name and provide original and construction-era photographs as well as photographs over time. In addition, this repository houses PG&E company journals including PG&E's *Pacific Service Magazine*, *PG&E Progress*, and *PG&E Life*, all of which provide information about company development. Note, *Pacific Service Magazine*, (published 1909–1933) is also presently available digitally to the public at archive.org.[167] These periodicals provide important physical and contextual background regarding company development.
- ***PG&E of California, The Centennial Story of Pacific Gas and Electric Company 1852–1952 (Charles M. Coleman):*** PG&E sponsored a centennial corporate history that remains an important informational touchstone documenting the first century of PG&E facility development. The work discusses key early figures and projects of the company and details a number of predecessor utility companies that ultimately formed PG&E.

H.1 Contextual Sources

In general, this contextual material falls into two basic classes: (1) period journals and publications and, (2) academic technological and cultural analyses.

H.1.1 Period Journals and Publications

The late-nineteenth and early-twentieth century proliferation of electrical technology was well documented in technical and general commercial publications, which closely covered facility development, technological milestones, and electrical consumption trends. As a class of informational resources, these periodicals situate PG&E's facility development within a larger commercial and technological context. In general, select runs of these periodicals are available at Northern California repositories, including the California State Library, San Francisco Public Library, and Oakland Public Library, as well as the libraries of University of California (UC) Davis, UC Berkeley, and Stanford University (for comprehensive holdings, see search engine Worldcat.org or other). Additionally, select issues of some periodicals can be accessed digitally via the Google Books search engine, although digital holdings are incomplete. The following is a list of *major* technical period publications that guided research of PG&E facilities:

- Electrical West
- Electrical World
- Journal of the American Institute of Electrical Engineers
- Journal of Electricity and Western Industry
- Journal of Gas, Lighting, Water Supply, and Sanitary Improvement
- Pacific Rural Press
- San Joaquin Light and Power Company Magazine
- The California Journal of Technology
- The Electrical Journal
- The Journal of Electricity
- The Journal of Electricity, Power and Gas

In addition to these technical journals, general periodicals, most notably the *Daily Alta California* and the *San Francisco Chronicle*, provided a wealth of information regarding PG&E's San Francisco-based corporate antecedents

[167] Accessed at https://archive.org/search.php?query=creator%3A%22Pacific+Gas+and+Electric+Company%22, September 24, 2019.

and physical and commercial identity. Both are available digitally; the *Daily Alta California* (1849–1891) is archived as part of the California Digital Newspaper Collection and the *San Francisco Chronicle* (1865–present) was accessed through the digital collections of the San Francisco Public Library. While this list includes a major body of knowledge relating to electrical development, it is not exhaustive and vital sources of information may be found across broad categories of period resources from the early electrical development period.

H.1.2 Technological and Cultural Analyses

Research included review of key academic and technical secondary source publications addressing pertinent energy and utility frameworks. Although this list is not an exhaustive accounting of *all* sources available, it represents an informational foundation for energy-related development themes, both in California and the nation as a whole. The sources also provide contextual information regarding California's statewide growth patterns.

- California: A History (Kevin Starr, 2015)
- Electrifying America: Social Meanings of a New Technology (David E. Nye, 1990)
- Energy: A Human History (Richard Rhodes, 2018)
- Energy and the Making of Modern California (James C. Williams, 1997)
- Golden Dreams: California in an Age of Abundance (Kevin Starr, 2009)
- High Tension Line Practice: Materials and Methods (Ernest V. Pannell, 1925)
- Infrastructure: A Guide to the Industrial Landscape (Brian Hayes, 2014)
- Networks of Power: Electrification in Western Society, 1880-1930 (Thomas P. Hughes, 1983)
- Technology and Transformation in the American Electric Utility Industry (Richard F. Hirsh, 1989)
- The California Energy Crisis: Lessons for a Deregulating Industry (Will McNamara, 2002)
- Transforming California: A Political History of Land Use and Development (Stephanie S. Pincetl, 1999)

H.2 Previous PG&E Cultural Studies

In 2019, the HEIMP Project team assembled and reviewed all identified PG&E facility cultural resource documentation on file with PG&E related to generation, transmission, and substation facilities and reviewed the California Office of Historic Preservation's Built Environment Resource Directory (BERD) for all previous cultural resource determinations related to PG&E facilities. This documentation provided information on previous cultural resource determinations for NRHP and CRHR eligibility and provided valuable facility-specific context and themes of significance that were incorporated into the contextual and evaluative analysis of the HEIMP.

The majority of previous cultural resource documentation of PG&E infrastructure dates from the 1980s to the present, with much of the documentation developed as part of Federal Energy Regulatory Commission (FERC) relicensing documentation for specific PG&E hydroelectric facilities. Consequently, documentation for FERC hydroelectric generation projects is far more extensive than it is for PG&E transmission and substation facilities outside of the FERC regulatory nexus. The documentation of PG&E's transmission and substation infrastructure generally stems from a range of federal and state regulatory frameworks, including those of the United States Army Corps of Engineers, the California Public Utilities Commission (CPUC), and CEQA compliance.

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Tier 2: 120 hours (generally individual nominations by paid consultants)
Tier 3: 230 hours (generally new district nominations by paid consultants)
Tier 4: 280 hours (generally newly proposed MPS cover documents by paid consultants).

The above estimates include time for reviewing instructions, gathering and maintaining data, and preparing and transmitting reports. Send comments regarding these estimates or any other aspect of the requirement(s) to the Service Information Information Collection Clearance Officer, National Park Service, 1201 Oakridge Drive Fort Collins, CO 80525.