APPENDIX A

Affordability Metrics Framework

Staff Proposal

R.18-07-006

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1. Introduction

a. Background

In establishing this proceeding, the California Public Utilities Commission (Commission or CPUC) stated that "water, energy, and telecommunications services should be affordable" for residential ratepayers.[1,2] The Commission formed a working group comprised of staff from the Water, Energy, and Communications Divisions, with the goal of developing a framework that would allow the Commission to assess the affordability of public utility rates across utility types and services.

In developing this framework, staff aims to adhere to the following principles, as laid out by the order instituting rulemaking. The Commission finds that the framework should:

- address the affordability of *essential* (not discretionary) utility service
- account for California's geographic and economic diversity
- assess affordability across utilities and over time
- be feasible for staff to implement and maintain
- be usable by and relevant to Commission decision-makers

The Commission has an obligation to ensure that utility rates in California are "just and reasonable."[3] However, some ratepayers may face difficulty paying utility bills under rates that have been determined "just and reasonable." Our preliminary work has revealed the vast variance in affordability that lies *within* each utility's service territory, even in the presence of clear differences in rates *among* utilities. In other words, every utility serves some households under extreme hardship, but many more for whom essential service charges do not place a severe financial burden. Thus, the affordability metrics reveal underlying socioeconomic disparity in a given utility service territory, which territory-wide or county-wide averages do not convey.

Staff observes that affordability is not just a function of household expenses, but the ability to pay for those expenses. As such, an effective framework for measuring affordability must consider essential service utility charges[4] alongside a household's income and other essential expenses such as housing costs in order to highlight the tradeoffs that occur if a household is not "making ends meet." The more that a household's essential utility service charges reduce a household's ability to pay for other nondiscretionary needs, the less affordable the essential utility services.

Staff develops this affordability framework to enable spatial and temporal comparisons of affordability. This framework does not directly evaluate actual utility bills paid by residential ratepayers. Instead, it develops a method for calculating the affordability of a pre-determined *essential service quantity* to determine the impact of utility rates on a household. We also do not set

[1] Order Instituting Rulemaking (OIR) 18-07-006, p.2

[2] A later scoping memo clarified that broadband and other communications services are also included within these goals. For the purposes of this staff proposal, we are including providers of broadband, and other communications services are public utilities.

[3] California Public Utilities Code §451.

[4] Essential service utility charges will be reflected on a household's utility bill.

forth criteria to determine in absolute terms whether essential utility service charges are affordable or not. Instead, the proposed metrics may be used to describe, for example, the degree to which essential utility services become more or less affordable due to a proposed rate change, how much the affordability of essential utility service charges has changed over time, and the degree to which essential utility services are more or less affordable in particular geographies. As utilities are unique in providing essential services, comparing changes to the essential service charges to the consumer price index or inflation does not reflect the vast disparity in quality of life for someone living with or without affordable utility service. An affordability framework will help the Commission better contextualize rates in the experiences of households.

b. Summary of Changes

This document revises the original proposal offered by staff on August 20, 2019. Many of the changes consist of refinements to the methods for calculating the affordability metrics. Also, in response to party comments, staff has switched from using the Ability to Pay index (API) to a composite socioeconomic vulnerability index (SEVI) as our preferred measure of socioeconomic vulnerability.

2. Definitions and Data Sources

a. Affordability

Affordability is central to provision of utility services, though it is a challenging concept to quantitatively reflect and operationalize in decision-making. To our knowledge, few public utility commissions have attempted to quantify or directly include affordability in their decision-making processes. Affordability is fundamentally linked to some conception of basic need, or essential service, and the normative goal that people should be able to pay for a quantity of essential service necessary for their household to function. To measure affordability requires defining an essential service quantity, knowing the charges for that quantity and comparing that essential service charge to a household or individual's ability to pay for it.

Affordability is discussed in California Public Utilities Code in the context of energy[5], water[6], and communications[7] service. Existing notions of affordability within the CPUC have historically been tied to a specific level of service, but the Commission has never defined or quantified affordability or what service is considered essential.[8] This proposal defines affordability as: **the impact of essential utility service charges on a household's ability to pay for non-discretionary expenses.** This "impact" can be characterized in terms of a representative household or a collection of households in a given geographic area. We depict this impact in three ways in the following sections.

b. Affordability Metrics

An affordability analysis, in essence, relates two numbers: (1) the cost of essential utility service and (2) the economic standing of the households paying for the service. Quantifying either of these quantities alone requires a careful selection of assumptions and acceptance of data limitations. As such, we propose three metrics that depict the components of affordability independently and in relation to one another. The three metrics also address distinct yet related questions about the

[5] California Public Utilities Code §739(d)(2): In establishing residential electric and gas rates, including baseline rates, the commission shall ensure that the rates are sufficient to enable the electrical corporation or gas corporation to recover a just and reasonable amount of revenue from residential customers as a class, while observing the principle that electricity and gas services are necessities, for which a low affordable rate is desirable and while observing the principle that conservation is desirable in order to maintain an affordable bill.

[6] California Public Utilities Code §739.8(a): Access to an adequate supply of healthful water is a basic necessity of human life, and shall be made available to all residents of California at an affordable cost.

[7] California Public Utilities Code §871.5. (a) The offering of high-quality basic telephone service at affordable rates to the greatest number of citizens has been a longstanding goal of the state. (d) The furnishing of lifeline telephone service is in the public interest and should be supported fairly and equitably by every telephone corporation, and the commission, in administering the lifeline telephone service program, should implement the program in a way that is equitable, nondiscriminatory, and without competitive consequences for the telecommunications industry in California.

[8] The 1976 Warren-Miller Lifeline Act enacted Public Utilities Code Section 739.b, which defines energy baseline rates in terms of "a significant portion of the reasonable energy needs of the average residential customer." Section 739.8(e) has provided for "an adequate supply of healthful water… at an affordable cost" since 1993.

ability of households to afford essential utility service, and the economic vulnerability of communities and households to an increase in the cost of essential utility service.

Hours at Minimum Wage (HM) describes essential service bills in terms of worked hours required to pay for them. It provides a clear illustration of the impact on daily lives of low-wage ratepayers compared to the dollar amount alone.

The **Vulnerability Index** describes the relative socioeconomic characteristics of communities—in terms of poverty, unemployment, educational attainment, linguistic isolation, and percent of income spent on housing—to quantify how the same rate impact may affect one community's ability to pay more than another's.

The **Affordability Ratio (AR)** describes the impact an essential service bill has on a household budget; that is, the percent of income that is spent on each type of essential utility service after housing and the remaining essential utility services are considered.

The Metrics and Methods section discusses in more detail how these metrics are computed.

c. Essential Utility Service

As noted, affordability at the CPUC has never been explicitly defined but has historically been tied in statute to the concept of essential service. Tiered rate structures common in both the water and energy spaces further reflect the concept of an essential quantity of service, and the CPUC already considers local voice service to be essential. Still, the notion of essential service can differ greatly across utilities, in part due to differing assumptions of what is adequate or reasonable to meet essential needs.

For the purposes of this proposal, staff distinguishes the concepts of essential *service* and essential *use* or *usage*. Public utilities sell services to their ratepayer for a price. The amount of service that the ratepayer purchases from the utility determines the charges that the ratepayer pays to the utility.[9]

Since utility use and utility service are dependent on a household's specific needs, the first step in determining essential service for each industry is to determine what needs can reasonably be considered *essential*. From there, this proposal determines a specific level of *essential service* that must be supplied by a utility to meet those needs. This level may vary within and between utility service territories for a given industry depending on how those needs vary geographically. That level of essential service will correspond to an *essential service quantity* in units appropriate to the industry. An *essential service charge* for each industry multiplies utility rates by that utility's essential service quantity, with the addition of any fixed (i.e. quantity-independent) charges intrinsic to the bill.[10] Over time, ratepayer needs will evolve, as will the amount of utility service required, and staff intends for this framework to be flexible enough to accommodate future changes in essential service quantities.

[9] In the case of water and energy, service and usage are generally equivalent: the utility provides exactly what the customer uses. In the case of communications services, the carrier may supply more than what is actually used by the consumer (oversubscription).

[10] Essential service charges exclude taxes. Surcharges and other non-volumetric charges are also generally excluded, but are addressed specifically in each industry's essential service section.

This section defines the range of utility service providers—Commission-jurisdictional and otherwise— that were considered as part of this overall affordability analysis, and how essential service quantities are defined for each utility type. Although the CPUC does not have rate regulation authority over many utility service providers in California, those service providers' rates still have an impact on residential utility affordability. Therefore, where possible, staff have included data sources relevant to *all* forms of utility service provision. For geographies relevant to each industry, we: 1) define a basis for quantifying essential service; 2) distinguish between those utilities whose rates may be directly evaluated in affordability metrics and those whose rates will be indirectly incorporated to provide estimates of nondiscretionary expenses; and 3) detail data sources for rates and service territory boundaries.

i. Electric and Gas Service

"Electrical Corporation" and "Gas Corporation" are used in statute to characterize every corporation or person operating a non-private property electric or gas plant for compensation.[11] These terms are used alternatingly in statute with "Investor-Owned" electrical and gas corporations to with respect to CPUC-regulated energy utilities.[12]

A data request was issued for Geographic Information System (GIS) shapefiles of all baseline territory boundaries within electric and gas IOU service territories.[13] GIS shapefiles for non CPUC-regulated municipal utility service territories were obtained through the California Energy Commission's public website.[14,15] The data sources were combined to create two overall service territory boundaries, one for gas and another for electricity.

[11] *See* California Public Utilities Code §218 and §220. Certain exceptions exist; see statute for these exceptions.
[12] Other retail suppliers in California of electricity or gas such as publicly owned electric utilities, community choice aggregators (CCA), electric service providers (ESP), and core transport agents (CTA) are not regulated by the CPUC .
[13] Includes Small Multi-Jurisdictional Utilities (SMJUs) .
[14] California Energy Commission: Electric Public Owned Utilities. Nov 2017. https://ww2.energy.ca.gov/maps/serviceareas/CA_Electric_Public_Owned_Utilities_POUs.html .
[15] California Energy Commission: Natural Gas Utility Service Areas Map. June 2018. https://ww2.energy.ca.gov/maps/serviceareas/naturalgas_service_areas.html.

Figure 1 below shows the service territory and climate zone boundaries for electricity service in the state of California.

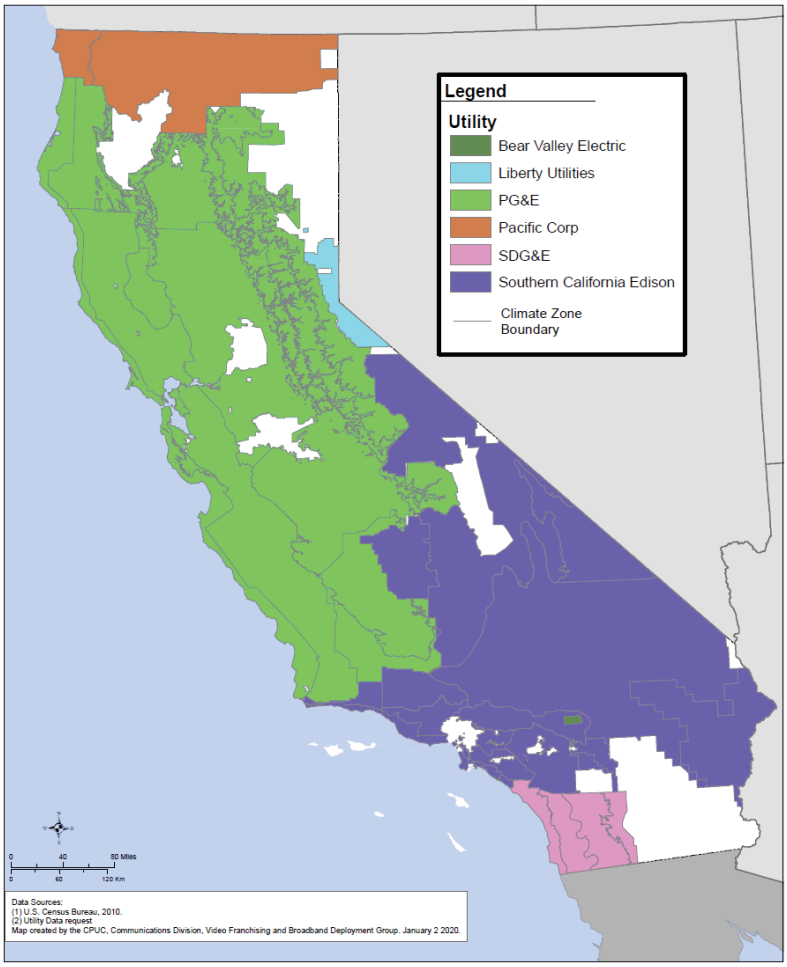

Figure 1: Electric Utility Service Territories and Climate Zone Boundaries

Figure 2 below shows the service territory and climate zone boundaries for gas service in the state of California. It is worth noting that there remain some questions as to which portions of the displayed gas service territories actually have gas service available. For areas where there is no gas service available, we assess those households as "all-electric" customers, which has implications for the households' Tier 1 electricity usage quantity.

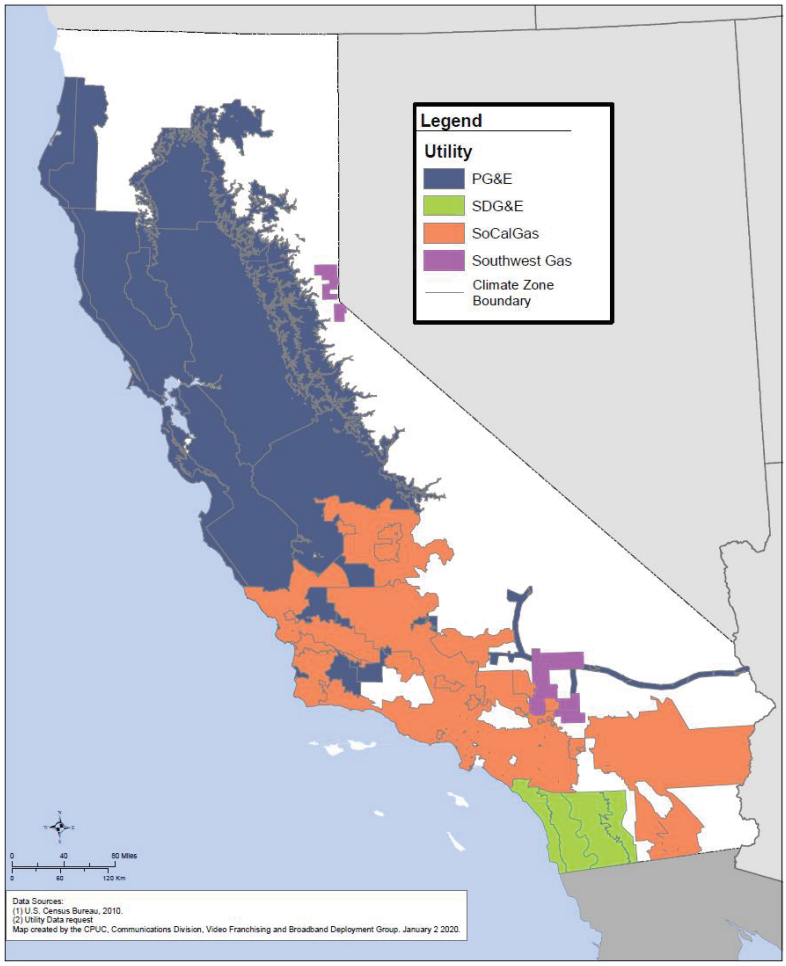

Figure 2: Gas Utility Service Territories and Climate Zone Boundaries

1) Energy Essential Service: Baseline Quantity

Staff proposes that electric and gas baseline quantity definitions and methods[16] established in Public Utilities Code Section 739 be used for essential service quantities pending more robust determinations of these quantities by the large Investor-Owned Utilities (IOU)[17] as part of the essential use studies (discussed below). Staff further proposes that for other energy utilities[18] currently not required to participate in the essential use studies, electric and gas baseline quantities continue to be used for essential service quantities pending Commission consideration of the need for such studies.

a) Baseline Quantities as a Proxy for Essential Service Quantity

Electrical and gas corporations regulated by the Commission[19] are required by statute to file a schedule of rates and charges providing baseline rates.[20] Residential tiered electricity and gas rates have an inclining block structure, as shown below in Figure 3, wherein monthly usage is broken into tiers by quantity of usage. Usage in the lower tiers is charged lower rates than usage in the higher tiers.

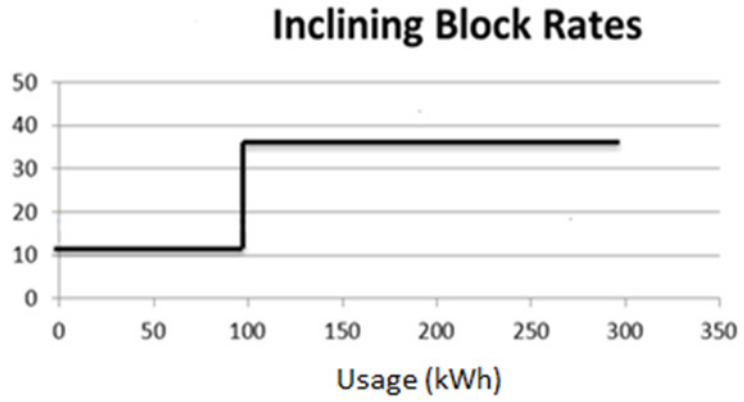

Figure 3: Inclining Block Rates[21]

[16] Public Utilities Code Section 739 defines baseline quantity for an average residential customer and mandates that the CPUC establish these quantities, with the methodology for establishing these quantities to take into account different levels of usage due to climatic and seasonal variation and the availability of gas service.
[17] The large IOUs include: Pacific Gas and Electric Company (PG&E), Southern California Edison Company (SCE), San Diego Gas and Electric Company (SDG&E) and Southern California Gas (SCG).
[18] Other energy utilities are the Small and Multi-Jurisdictional Utilities (SMJU): Southwest Gas Corporation (Southwest Gas), Liberty Utilities (CalPeco Electric) LLC, Bear Valley Electric Service (BVES), and PacifiCorp.
[19] These electrical and gas corporations include the large electric and gas IOUs as well as the SMJUs.
[20] California Public Utilities §739(d)(1): The commission shall require that every electrical and gas corporation file a schedule of rates and charges providing baseline rates.
[21] Time-of-use (TOU) rates, for which the rate goes up for peak hours and goes down for non-peak hours, may also have Tier 1 usage, which is billed as a credit across the various time periods.

The first tier of usage, or "baseline quantity," is defined by statute as a quantity "necessary to supply a significant portion of the reasonable energy needs of the average residential customer." Statute defines baseline quantity for residential customers as follows:

- Electric**:** 50% to 60% of average residential electricity use.[22]
- All-Electric: 60% to 70% of average residential electricity use during the winter heating season.[23]
- Gas: 60% to 70% of average residential gas use during the winter heating season.

While baseline quantities are intended to represent the reasonable energy needs of the average residential ratepayer in each baseline territory, current baseline quantity methodologies do not differentiate essential and discretionary energy usage. Energy essential service that meets a household's basic needs and is reasonably necessary for that household's health, safety, and full participation in society should be more specifically defined by the IOUs as part of the essential use studies (discussed below).

The Commission establishes electric baseline quantities as part of each large electric IOU General Rate Case (GRC) Phase II proceeding. Electric Tier 1[24] baseline quantities for each IOU, expressed as usage in kilowatt-hours (kWh), are derived by analyzing historical ratepayer bills[25] for each IOU across IOU-defined baseline territories[26] and summer/winter seasons. The bill analysis selects the quantity in each baseline territory that corresponds to the IOU's baseline quantity percentage.[27] The same baseline quantity is assigned to every residential ratepayer in a given baseline territory, irrespective of a ratepayer's household size, dwelling type, appliance type, efficiency, or other factors. Gas baseline quantities, expressed as usage in therms, also differ across baseline territories and summer/winter seasons.

At this time, staff finds baseline quantities to be a reasonable estimate of essential service quantity. However, there are several essential use studies underway, discussed in the following section, the results should provide more accurate determinations of essential service quantities. When completed, these determinations should replace baseline quantities used in this affordability framework.

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[22] This type of baseline quantity is commonly called "basic" baseline quantity. A household taking electric service with basic baseline quantity may be taking gas service with gas baseline quantity as well.

[23] "All-electric residential customers" is defined by statute as "residential customers having electrical service only or whose space heating is provided by electricity, or both" (California Public Utilities Code §739). All-electric baseline quantities are generally applicable to service to customers with permanently installed electric heating as the primary heat source.

[24] PG&E and SCE Tier 1 is 100% of baseline; SDG&E Tier 1 is 130% of baseline.

[25] Certain adjustments to bill data may be made as part of each IOU's methodology, such as removing negative or zero bills.

[26] Baseline territories, defined by each IOU in its Preliminary Statements, are drawn based on climactic variation and may also be referred to as climate zones.

[27] Electric baseline quantity percentages are presently set as follows: PG&E 53.8% for basic service and 63.8% for winter all-electric service; SCE 60% for basic service and 70% for winter all-electric service; and SDG&E 50% for basic service and slightly above 60% for winter all-electric service.

b) Essential Use Studies

Pacific Gas and Electric Company (PG&E), Southern California Edison Company (SCE) and San Diego Gas and Electric Company (SDG&E) (collectively, the Joint IOUs) have each been directed to develop an electric essential use study for residential customers.[28] On November 22, 2019 PG&E filed its 2020 GRC Phase II application proposing its essential use study plan. PG&E states in its study plan that to facilitate consistency among the Joint IOU service territories and to accommodate a streamlined approach to engaging with stakeholders, the Joint IOUs propose conducting a coordinated statewide study.[29]

As part of the coordinated statewide essential use study, the Joint IOUs propose leveraging the results of the 2019 California Energy Commission (CEC) Statewide Residential Appliance Saturation Survey (2019 RASS), currently scheduled to be completed in March 2020. The 2019 RASS is a statewide study that estimates appliance saturation (percentage of households that own a given appliance) and energy use tied to a wide range of specific end uses such as space heating, air conditioning, lighting, electronics use, pools, and other uses. IOUs participating in the 2019 RASS include PG&E, SCE, SDG&E, and Southern California Gas Company (SCG).

The large gas IOUs (PG&E, SDG&E, and SCG) have not been ordered to develop gas essential use studies. Because the 2019 RASS also includes energy use estimates for gas appliances, utilizing the 2019 RASS for the purpose of studying essential use allows for the potential expansion of comparable gas utilities essential use study should the Commission seek to request development of such studies. Although staff finds baseline quantities to be a reasonable estimate of essential service quantity at this time, staff recommends that the Commission order the large gas IOUs complete essential use studies. The large gas IOUs should fully participate in the current essential use study planning process in order to leverage learnings in the event comparable gas essential use studies are required.

The electric and gas Small Multi-Jurisdictional Utilities (SMJU)[30] also have not been ordered to develop essential use studies. Staff acknowledges the SMJUs are not part of the 2019 RASS proposed as the foundation of the coordinated statewide study by the Joint IOUs. Staff recommends that additional requirements to determine essential use for SMJU residential customers not be made at this time and finds baseline quantities to be a reasonable estimate of essential service quantities. However, staff recommends that the Commission review the need for SMJU essential use studies as part of each utility's next GRC proceeding.

Whether individual studies or a coordinated study, the PG&E, SCE, and SDG&E essential use studies should provide more accurate determinations of essential energy service and eventually replace baseline quantities for that purpose. Until more robust determinations of essential service

[28] *See* D.18-08-013 (PG&E), D.18-11-027 (SCE), and November 1, 2019 Administrative Law Judge's (ALJ) Ruling Directing San Diego Gas & Electric to File/Serve Supplemental Information

[29] On November 18, 2019, SDG&E filed its essential use study plan proposal in its partial response to the November 1, 2019 ALJ Ruling to File/Serve Supplemental Information. On December 16, 2019, SCE filed its essential use study plan proposal in its 2019 Rate Design Window (RDW) application.

[30] The SJMUs are: Southwest Gas, Liberty CalPeco, Bear Valley Electric Service, and PacifiCorp. Like the large IOUs, the SMJUs file GRC applications; however, they serve fewer California customers than the large IOUs.

quantities can be made through essential use studies, staff considers baseline quantities the best estimate of essential service quantities.[31]

2) Energy Utility Essential Service Charges

For CPUC-regulated energy utilities,[32] essential service charges were determined using 2018 baseline rates[33] and quantities[34] as a proxy for essential service. Electric and gas essential service charges were calculated for summer and winter seasons and then annualized for each baseline territory or climate zone within an IOU's service territory. Essential service charges include fixed charges where applicable.[35]

Energy utility service is broadly grouped by generation/commodity service and delivery service. Electric customers may have the option of receiving electric generation services from a CPUC-regulated utility or a non CPUC-regulated supplier. There are two types of non CPUC-regulated suppliers that provide electric generation services: (1) Community Choice Aggregators (CCA)[36] and (2) Electric Service Providers (ESP).[37] Gas customers also have a similar option to receive the natural gas commodity from a CPUC-regulated utility or from non CPUC-regulated suppliers called Core Transport Agents (CTA).[38]

As CCA generation rates are not regulated by the CPUC, there is no requirement for CCAs regarding generation service baseline rates or quantities. However, CCA customers continue to receive delivery service from the incumbent IOU at baseline rates and quantities. CCA residential average monthly bills are currently the same or slightly lower than comparable IOU bills.[39] For customers served by both an IOU and CCA, staff proposes that the IOU baseline rate and baseline quantity be used to approximate both the generation and delivery portions of essential service charges.

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[31] The timeline for completion of the PG&E, SCE, and SDG&E essential use studies has not yet been determined. Even after the essential study use plans are filed by all IOUs, the completion and approval of the resulting studies will not occur until an as-yet undetermined date.
[32] Includes the large IOUs and SMJUs.
[33] Baseline rates are from 2018 residential electric standard tiered rate schedules and 2018 residential natural gas service rate schedules.
[34] Baseline quantity is for basic (e.g. dual-fuel), individually-metered service.
[35] Not all IOUs have fixed charges. For example, SCE has a monthly fixed charge of $0.94 and SCG has a monthly fixed charge of $5.00, but PG&E and SDG&E do not have fixed charges. The SMJUs have monthly fixed charges ranging from $5.00 (Southwest Gas) to $8.50 (Liberty CalPeco). Fixed charges generally reflect customer-related costs such as meter reading and billing that don't vary by energy usage.
[36] A local government or a collection of local governments may choose to form a CCA to procure electricity to meet the demand of residential, business, and municipal facilities within the CCA's jurisdiction.
[37] ESPs provide Direct Access service, typically to non-residential customers, and are not addressed in this staff proposal.
[38] CTAs are not addressed in this staff proposal.
[39]Comparisons are from the most recent Joint Rate Comparisons on each IOU website, comparing average monthly bills resulting from the IOU standard tiered rate and the lowest-priced CCA rate option.

Essential service charges for non CPUC-regulated electric utilities for 2018 were approximated using publicly available information on utility websites for two large electric utilities,[40] and using U.S. Energy Information Administration (EIA) data to estimate average rates for use in calculating essential service charges for all other non CPUC-regulated electric utilities.[41] Proxy essential service charges for non CPUC-regulated gas utilities are based on essential service charges of the most proximate CPUC-regulated gas utility.

ii. Water Service

While "water corporation" in California Public Utilities Code includes every corporation or person owning, controlling, operating, or managing any water system for compensation within this State,[42] the CPUC only regulates a portion of these utilities. Specifically, the Commission has jurisdiction over the state's investor-owned water systems and does not regulate municipal or mutual water systems.

Water service territory boundaries were obtained through the Public Health Institute's Tracking California program which collects environmental health data and information publicly available for stakeholders.[43] The Tracking California dataset was filtered to match the set of utilities whose bill data was considered in this analysis.

There are approximately 100 investor-owned utilities that the Commission regulates, which collectively provide water service to about 16 percent of California's population.[44]

Figure 4 through Figure 6 below show the service territory boundaries for CPUC-jurisdictional water utilities in central, northern, and southern California.

[40] 1) Los Angeles Department of Water and Power (LADWP) and 2) Sacramento Municipal Utility District (SMUD). As SMUD's rate structure does not include baseline quantities, PG&E's baseline territory S was used to calculate baseline quantities.
[41] U.S. EIA, 2018 Utility Bundled Residential Retail Sales, Average Price (cents/kWh). The baseline territory of the geographically closest CPUC-regulated IOU was used to calculate baseline quantities.
[42] California Public Utilities Code §241
[43] Tracking California. https://www.trackingcalifornia.org/
[44] "Water Division." California Public Utilities Commission. https://www.cpuc.ca.gov/water/

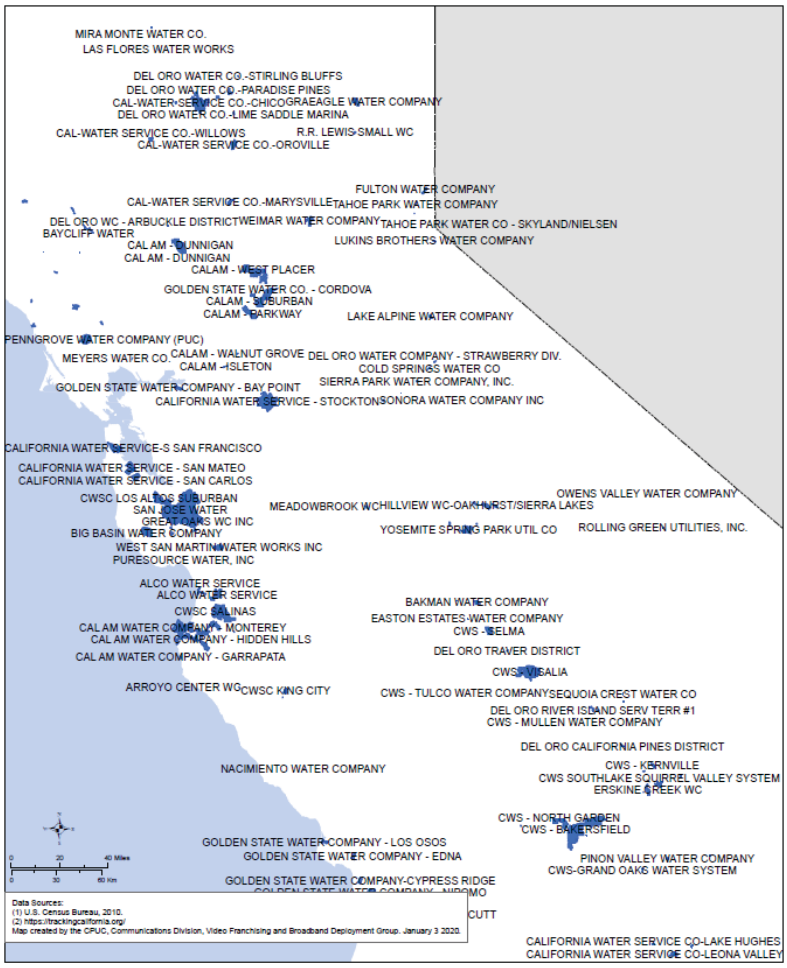

Figure 4: Central California Water District Map

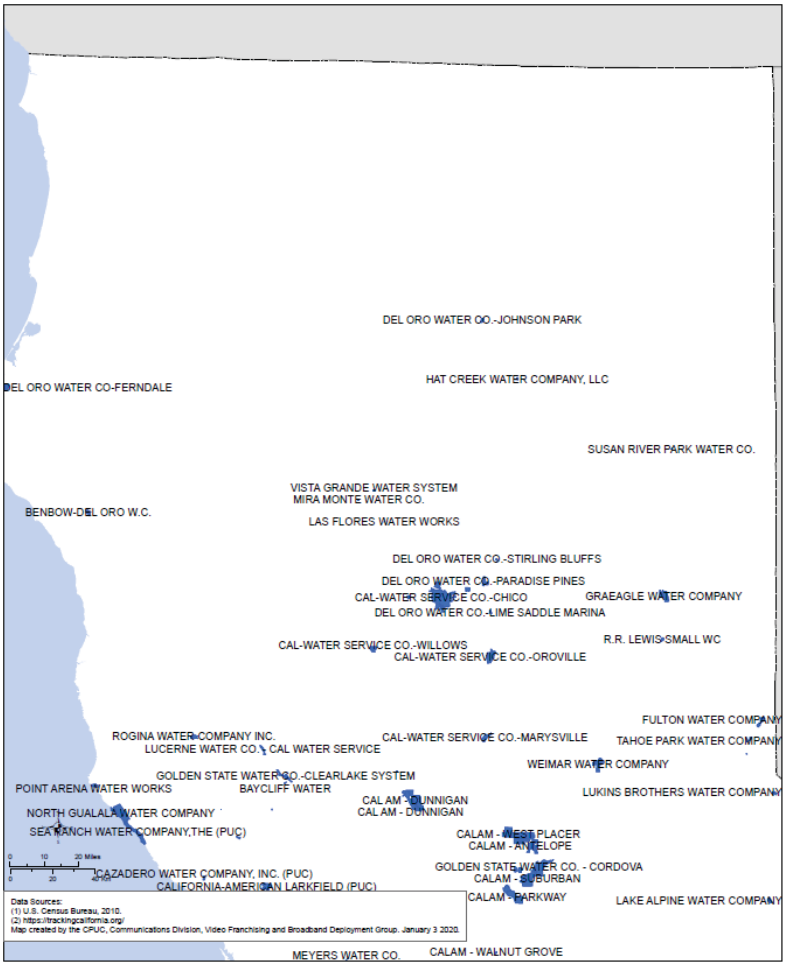

Figure 5: Northern California Water District Map

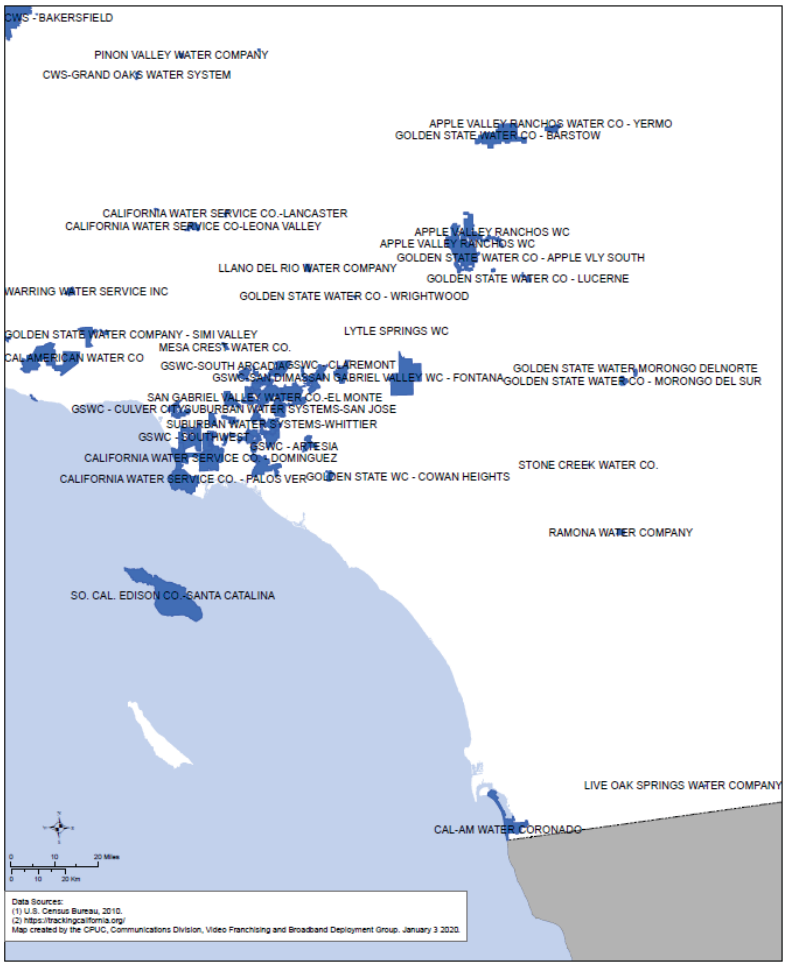

Figure 6: Southern California Water District Map

1) Water Essential Service: Six Hundred Cubic Feet

Staff proposes that essential service for water be defined as in terms of essential indoor usage; that is, the usage "adequate for human consumption; cooking; and sanitary purposes."[45] In the previous staff proposal, staff translated this set of needs into a value of 50 gallons per capita per day (gpcd). In this revision, staff recommends using a monthly value of six hundred cubic feet (ccf) per household instead.

It makes sense to use a household-level quantity for water essential service rather than a per-capita quantity. As the rest of the framework already considers affordability at the household level, eliminating assumptions about household size allows consistency with the other industries and more properly aligns with income and housing data. Additionally, water bills are delivered at the household level, regardless of the number of people within that household. Since utilities do not collect information about household size, it "would need to be derived using representative statistical data. This adds abstraction and complexity to the metrics without adding analytical value."[46]

By disregarding the average household size within a particular service area, it is possible to assign a different essential service quantity to each water system. However, more research needs to be done regarding the best way to determine each of those quantities.[47] In the interim, given the outstanding research and data challenges associated with more geographically specific essential service quantities, staff recommends a single value be used statewide. A single statewide value will also allow for apples-to-apples comparisons of affordability between water systems.

California's Environmental Protection Agency's Office of Environmental Health Hazard Assessment (OEHHA) released a draft document on *An Assessment of the State's Community Water Systems* in August 2019 indicating 6 ccf "… as representing essential water need, given currently available statewide datasets, while acknowledging the diversity of water needs of households in the state."[48] At an August 2, 2019 workshop for Commission Rulemaking 17-06-024, the State Water Resources Control Board (Water Board) noted that it was also considering adopting an essential usage quantity of 6 ccf as part of the Statewide Low-Income Water Rate Assistance Program (AB401), informed partly by the OEHHA report.[49] To maintain consistency with other state agencies, and to establish a balance between water needs and conservation, staff believes 6 ccf is the best representation of statewide essential service at this time. However, staff intends to amend the essential service quantity in the future if a value other than 6 ccf is adopted in the R.17-06-024 or

[45] California Water Code §106.3

[46] Opening Comments of the Public Advocates Office on the Administrative Law Judge's Ruling Inviting Post-Workshop Comments; September 10, 2019, p. 6.

[47] Since this analysis relies partially on information from non-CPUC water systems, there are additional challenges associated with assigning essential service quantities to those systems and calculating the resulting essential service charges.

[48] Balazs, Carolina, et al. *Achieving the Human Right to Water in California: An Assessment of the State's Community Water Systems.* California Office of Environmental Health Hazard Assessment; August 2019

[49] CPUC R.17-06-024. Administrative Law Judge's Ruling inviting Comments on Water Division Staff Report and Responses to Additional Questions; September 4, 2019, Attachment A, p.3.

AB401 proceedings, or if more geographically granular data for essential service quantities—for example, on a regional or per-system basis—become available.[50]

2) Water Utility Essential Service Charges

While our primary interest is in the affordability of water utilities under the Commission's jurisdiction, looking only at that subset of systems would understate affordability for customers who are served by a CPUC-regulated energy or communications provider, but not by a CPUC-regulated water provider. The Water Board collects water utility data through their Electronic Annual Reporting (eAR) survey, which includes service charge, quantity charge, billing cycle, and monthly bills at increments of 6, 12, and 24 ccf. Using the data provided in the eAR allows staff to easily obtain reliable data that is updated on an annual basis. This survey is performed for all water systems in California, including those not regulated by the Commission.

Since the focus of this analysis is on residential customers who pay water bills, staff excluded some non-CPUC water utilities based on the following parameters: 1) systems whose bill for six ccf was listed as zero or blank; 2) systems with less than 10 residential connections (since these systems tend not to serve residential customers); 3) outliers, defined here as systems with a monthly bill of greater than $1200 for six ccf. In total, 1700 water systems statewide were included in the analysis.

For CPUC-regulated water utilities, the essential service charge for six ccf submitted to the eAR was used when available. For CPUC-regulated utilities where this field was zero or blank, the tariff books on file at the Commission were consulted and an essential service charge for six ccf was calculated. When only a flat rate was provided, the flat rate was taken to calculate the essential service charge; if schedules were provided for both flat rates and metered service, the rate for metered service was taken to calculate the essential service charge.

[50] See "Recommendations for Implementation" section for more details.

iii. Communications Services

In California, 14 incumbent local exchange carriers (ILECs) own the legacy telephone network within a specific geographic area, providing local communications and internet access services. For the purpose of gathering service territories, subscribership, and utility rate data for this proposal, staff focused on these 14 ILECs.

For future iterations, staff will consider expanding beyond these 14 ILECs and include other carriers that provide location communications and internet access services.

For communications utilities, staff gathered service territory mapping data of the 14 ILECs from the same annual CPUC data request that was used to perform the previously mentioned California benchmark assessment. Figure 7 below shows the boundaries for ILECs in California.

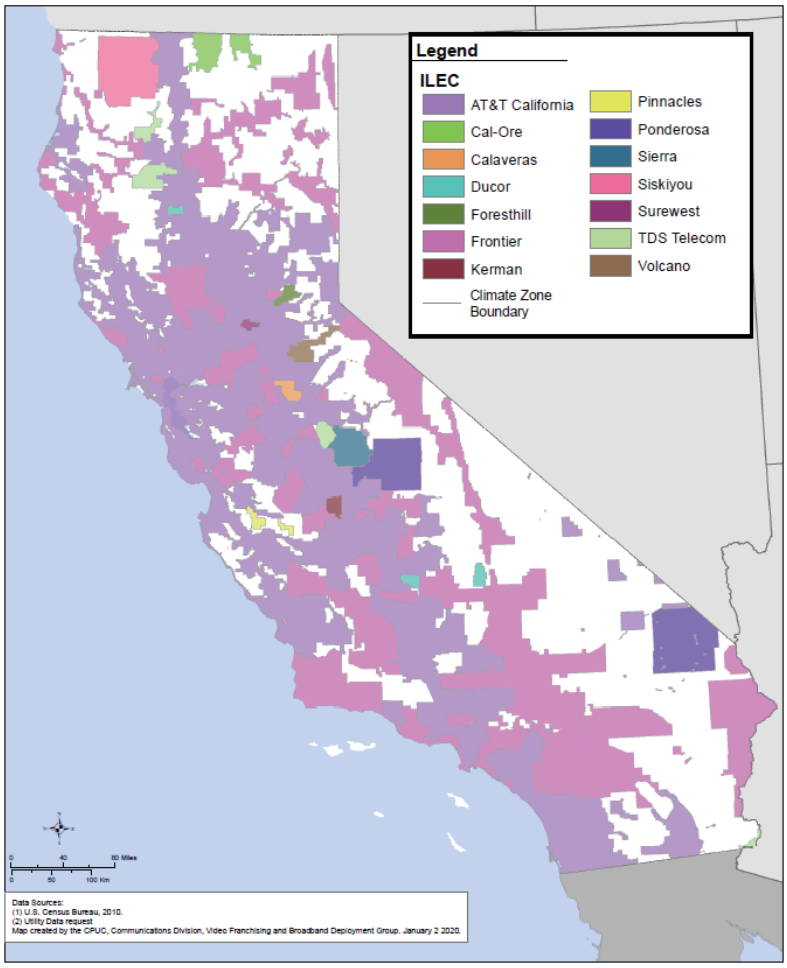

Figure 7: Communication Services Territories

1) *Communications Essential Service: Residential basic telephone service or cellular voice service, and fixed broadband*

To determine essential services and quantities for communications service, staff considered the need to enable members of a household to access telehealth records, complete activities necessary for education, telecommuting, and government assistance programs participation, and contact family and first responders in case of emergencies.

Staff proposes that the essential service quantity for communications be made up of multiple service elements, including residential basic telephone service[51] (basic service) or cellular voice service with 1000 minutes per month in addition to fixed broadband at a minimum connection speed[52] of 20 megabits per second (Mbps) downstream / 3 Mbps upstream and capacity of 1024 gigabytes (GB) per month. Staff recognizes that technologies are continuing to emerge and the need for electronic participation in society continues to increase, and thus proposes an annual reassessment of these standards.

a) Residential basic telephone service or cellular voice service (1000 minutes/mo)

The CPUC's Universal Service Decision has long established unlimited local calling as an essential element of basic service. [53]

Basic service provides access to services such as 911 for emergencies and 2-1-1 information services, which provide disaster preparedness, response, and recovery during declared emergencies, as well as referrals to physical and mental health resources; housing, utility, food, and employment assistance; and suicide and crisis interventions in non-emergency circumstances.[54]

Absent of basic service, cellular voice services with 1000 minutes per month, which represents the Federal Lifeline minimum service standards, serves as a viable substitute.

b) Fixed broadband service (20 Mbps/3 Mbps, 1024 GB/mo)

For the purpose of this proposal, we consider fixed broadband internet access to be a required element of essential communications service for Californians to be able to participate fully in society. According to Fair Health data, telehealth usage has grown 1,202% between 2012 and 2017.[55] In

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[51] Residential basic telephone services include local voice-grade calls, and access to 911 and directory services. https://www.cpuc.ca.gov/basicservicedefinition/

[52] The minimum connection speed is the actual connection speed to be maintained at all times and differs from advertised or maximum speed.

[53] D.96-10-066

[54] As of January 1, 2020, 39 counties in California have access to 2-1-1 information service.

[55] FH Healthcare Indicators and FH Medical Price Index 2019. Fair Health. p. 2, 25-30. 2019. https://s3.amazonaws.com/media2.fairhealth.org/whitepaper/asset/FH%20Healthcare%20Indicators%20and%20FH%20Medical%20Price%20Index%202019%20-%20A%20FAIR%20Health%20White%20Paper.pdf

terms of education needs, the Federal Communications Commission (FCC) states that "[a]ccess to broadband has become essential for students in all levels of education."[56]

In terms of broadband technologies, it is important to note that mobile broadband services are not a viable substitute for fixed broadband services due to current cost, access, and capacity limitations of wireless technology.[57] For example, schoolwork, job applications, and government services are functions that are difficult, if not impossible, to accomplish using mobile broadband services for most ratepayers.

Keeping in mind the tasks required to participate fully in society, staff considered the following benchmarks in its determination of fixed broadband essential service in terms of bandwidth and capacity:

i) Service Provider Data Request

In May 2019, staff issued a Data Request to six communications service providers.[58] The objective of the data request was to determine bandwidth and capacity requirements for specified tasks performed using a residential broadband connection.

Most respondents directed the CPUC to two FCC broadband guides as an appropriate means of calculating this need.[59,60] Frontier and Verizon were the only respondents to provide staff with the results of their own guidelines. From these responses, staff computes the average minimum bandwidth requirement for moderate use of two devices to be 20 Mbps downstream.[61] As staff explained at the second affordability workshop,[62] moderate use of two devices[63] represents how members in a household use broadband services to participate in society. 20 Mbps downstream also falls within FCC's determination of medium service, which is 12 to 25 Mbps.[64]

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[56] "2016 Broadband Progress Report." Federal Communications Commission. January 29, 2016. Accessed August 9, 2019 from https://www.fcc.gov/reports-research/reports/broadband-progress-reports/2016-broadband-progress-report/

[57] Achilles, Todd. "The Social Cost of Weak Broadband Competition in California." *Medium*. June 27, 2017. Accessed August 9, 2019 from https://medium.com/@todd.achilles/the-social-cost-of-weak-broadband-competition-in-california-e066d1383392/

[58] The six service providers are AT&T, Frontier, Comcast, Cox, Sprint, and Verizon.

[59] "Broadband Speed Guide." Federal Communications Commission. February 6, 2018. Accessed July 24, 2019 from https://www.fcc.gov/reports-research/guides/broadband-speed-guide/

[60] "Household Broadband Guide." Federal Communications Commission. February 6, 2018. Accessed July 24, 2019 from https://www.fcc.gov/research-reports/guides/household-broadband-guide/

[61] According to "Household Broadband Guide," moderate use is basic functions (email, browsing, audio, and file transfers) plus one high-demand application (multiparty video conferencing, telecommuting, and video streaming).

[62] Workshop Regarding Staff Proposal on Essential Service and Affordability Metrics, 2018 http://www.adminmonitor.com/ca/cpuc/workshop/20190826/

[63] For example, one laptop (device #1) for telecommute and one tablet or smart phone (device #2) to access telehealth records constitute moderate use of two devices.

[64] According to "Household Broadband Guide," Medium service is required for 2 moderate use devices at a time. Moderate use incorporates basic functions plus one high-demand application, including telecommuting and multiparty video conferencing. Light use incorporates only basic functions such as email, browsing, basic video, VoIP, internet radio on one or two devices.

ii) Federal Lifeline Minimum Service Standards

For purposes of the Federal Lifeline program,[65] the FCC has determined that "the minimum service standards for fixed broadband speed should be based on the service to which a "substantial majority" of consumers subscribe, and "that 70 percent of consumers constitutes a 'substantial majority' in the context of fixed broadband speeds."[66]

New standards are published in a Public Notice issued by the Wireline Competition Bureau on or before July 31 of each year, which will give the new minimum standards for the upcoming year. The Federal Lifeline minimum service standards (effective December 1, 2019), which represent what substantial majority or 70% of consumers subscribe to, are as follows:[67]

- Fixed broadband speed: 20 Mbps downstream / 3 Mbps upstream
- Fixed broadband capacity: 1024 GB per month[68]
- Mobile voice telephony: 1000 minutes per month

iii) California Benchmark

Staff performed a similar study using subscribership data at the census tract level obtained from the annual CPUC data request for broadband deployment and subscribership as of December 31, 2018 to 145 service providers.[69]

Staff examined over 11 million Californians' residential fixed broadband subscriptions and their respective downstream and upstream speeds. We found that 82% of residential connections subscribe to the proposed essential service quantities of 20 Mbps downstream and 3 Mbps upstream or better.

c) Recommendation

As a result, staff recommends a minimum connection speed of 20 Mbps downstream / 3 Mbps upstream for fixed broadband service.[70] Staff also recommends a capacity of 1024 GB per month, which is also the same as the Federal Lifeline minimum service standards, effective December 1, 2019.

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[65] 47 CFR §54.408 defines minimum service standards as "The level of service which an eligible telecommunications carrier must provide to an end user in order to receive the Lifeline support amount."
[66] Lifeline and Link Up Reform and Modernization et al., WC Docket No. 11-42 et al., Third Report and Order, Further Report and Order, and Order on Reconsideration, 31 FCC Rcd 3962, 3989-3997. (2016), paras. 78-90. https://docs.fcc.gov/public/attachments/FCC-16-38A1_Rcd.pdf/
[67] *Wireline Competition Bureau Announces Updated Lifeline Minimum Service Standards and Indexed Budget Amount*, Public Notice, WC Docket No. 11-42. Washington, DC: Federal Communications Commission, July 18, 2018. https://docs.fcc.gov/public/attachments/DA-18-739A1.pdf/.
[68] Calculated from 2019 FCC Urban Rate Survey data
[69] The Communications Division's Broadband, Video, and Market Branch issues this data request annually.
[70] Per results from the Service Provider Data Request

2) Communications Utility Rates

Staff obtained residential broadband service plan pricing information for services at or near the recommended 20 Mbps downstream / 3 Mbps upstream from the public-facing webpages of the 14 incumbent local exchange carriers (ILECs). Basic service pricing information was gathered from the tariff of these ILECs filed as of January 2019.

d. Income and Nondiscretionary Expenses

The following terms comprise the various measures of economic wellbeing that are pertinent to this study, and the scale at which those measures are being applied. Background on these concepts is provided here because they are relevant to multiple affordability metrics discussed in this proposal.

i. Income, Housing Costs, and Household Data

For this study, income and housing costs are defined at the household level. Rather than considering individual wage earners, we are considering the total income brought in by all members of a physical address. Income, in this sense, can also include money obtained by the household through passive means such as investments and rental income.

Housing costs can include either rental payments or, in the case of homeowners, mortgage payments plus property taxes. Again, these costs are defined at the household level rather than being apportioned to individuals who live within a household.

For income and housing data, we use the Public Use Microdata Samples (PUMS) dataset from the Census Bureau.[71] California PUMS data include approximately 776,000 households statewide, sampled from the U.S. census responses.[72] Unlike most other data sources on income and housing costs, PUMS provides household-level data which allows us to determine housing costs as a function of income. Furthermore, this data is available at a very geographically granular scale, allowing for differentiation between different parts of the state and variation within utility service territories.

The PUMS data associated with a single Public Use Microdata Area (PUMA) are statistically representative of the population in the geographic PUMA region. There are 265 PUMAs in California, each containing an average of about 3000 PUMS households. Depending on population density, a single PUMA may contain several less populous counties or cover just a portion of a more populous county. PUMAs are delineated by metropolitan areas and other "meaningful geographies," yielding areas with similar socioeconomic profiles.

[71] "American Community Survey: About PUMS." United States Census Bureau. June 17, 2018. Accessed August 12, 2019 from https://www.census.gov/programs-surveys/acs/technical-documentation/pums/about.html/

[72] The PUMS dataset used draws from American Community Survey 2013-2017 5-year estimates, which are the most recent 5-year estimates available.

The PUMAs in California are shown in Figure 8 below.

Figure 8: Public Use Microdata Area Boundaries

Each PUMA is comprised of a collection of census tracts, which are in turn comprised of a collection of census blocks. Census blocks are the most granular geographic unit defined by the Census Bureau and are the building blocks of the Census geography.[73] There are 710,145 census blocks in California. Census block data allow us to more accurately identify and assign utility essential service charge combinations to households.

[73] US Census Bureau: Geographic Areas Reference Manual. https://www.census.gov/programs-surveys/geography/guidance/geographic-areas-reference-manual.html

ii. Minimum Wage

Minimum wage is defined by the legally mandated hourly earnings that employers must provide to employees for a given geographic area. In many municipalities, local minimum wage requirements supersede the state minimum wage, resulting in heterogeneity in minimum wage across the state. This value is defined based on a per person basis rather than a per household basis. Households may have multiple minimum wage earners.

See Figure 9 below for a map of minimum wages for small businesses across California.

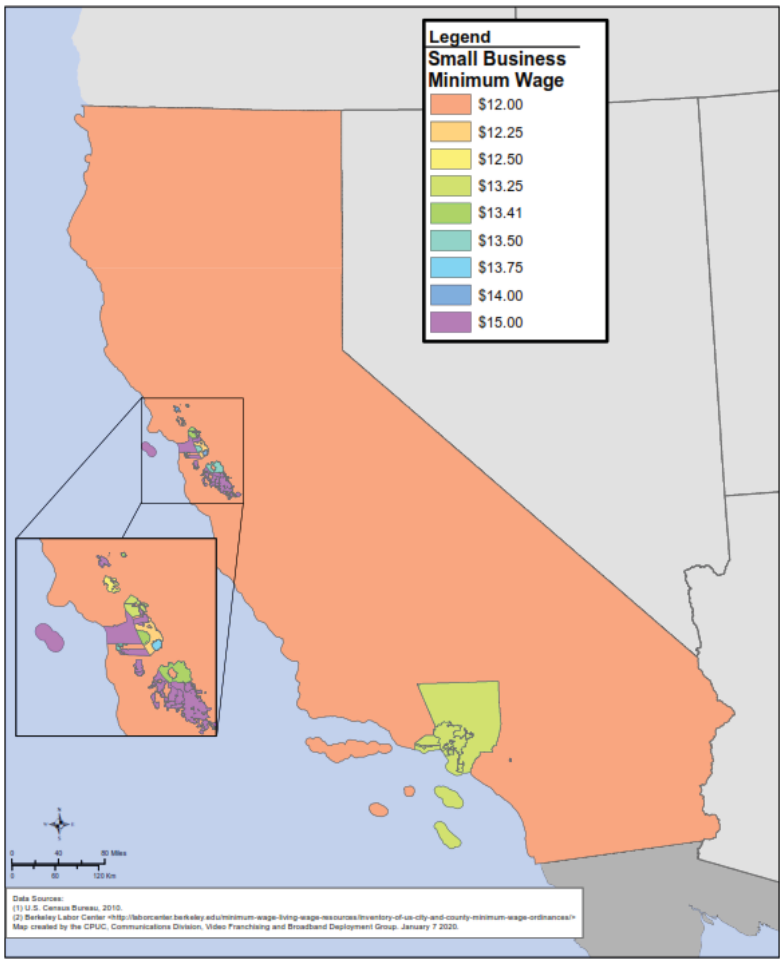

Figure 9: California Minimum Wage Map for Small Businesses

iii. Other Nondiscretionary Household Expenses

There are many important nondiscretionary household expenses aside from housing costs (food, clothing, childcare, medical expenses, etc.); however, these are largely non-uniform and difficult to characterize for an extremely diverse set of households. While there are studies that attempt to quantify these expenses,[74,75] there is very limited data to help us understand these expenses at the level of geographic granularity that we aim to achieve. Furthermore, because of the large variation in these costs between households and their relatively small magnitude compared to housing costs, we recommend excluding these costs from our analysis in order to eliminate one source of uncertainty.

iv. Community-Scale Measures of Economic Vulnerability

Unlike the previously mentioned measures of economic conditions which are defined at the household or individual scale, it is also possible to measure the conditions of a community as a whole. These metrics require a definition of the community of interest as well as the economic indicator. Such a metric will be defined in a subsequent section, but we are introducing the concept of community-scale measures of economic conditions here to distinguish from the household and individual-scale indicators that have been discussed.

[74] Teodoro, Manuel P. (2018). Measuring Household Affordability for Water and Sewage Utilities. *Journal American Water Works Association*, 110:1. https://doi.org/10.5942/jawwa.2018.110.0002/

[75] California Budget and Policy Center. (December 2017). Making Ends Meet: How Much Does it Cost to Support a Family in California?

3. Metrics and Methods

a. Hours at Minimum Wage

Hours at Minimum Wage (HM) measures the hours of work necessary for a household earning minimum wage to pay essential utility service charges.[76]

i. Goal of Metric

HM reflects the lived experience of ratepayers earning minimum wage, who are likely to be more economically vulnerable than higher income earners. It is important to understand that if essential service charges increase and minimum wages do not, a minimum wage-earning ratepayer must work additional hours to afford the same quantity of essential service.

HM provides a sense of the gross impact of utility expenses but does not indicate the economic tradeoffs an economically vulnerable household may make.

ii. Metric Components, Methodology, and Data Sources

The components to determine HM are the essential service charges and the minimum wage for a specific area.

Water: $HM_W = \frac{W}{M}$ **Electric**: $HM_E = \frac{E}{M}$ **Gas**: $HM_G = \frac{G}{M}$ **Communications**: $HM_C = \frac{C}{M}$

Combined Bundle: $HM_{total} = \frac{W+E+G+C}{M}$

In the formulas above, W represents a household's monthly essential water service charge, E represents a household's monthly essential electricity service charge, G represents a household's monthly essential gas service charge, C represents a household's monthly essential communications service charge, and M is the minimum wage for the municipality in which that household resides.

$HM_W, HM_E, HM_G, and\ HM_C$ depict the number of hours of work at minimum wage required to pay essential service charges for water, electricity, gas, and communications for a specific geography. HM_{total} depicts the number of hours work at minimum wage required to pay for all four essential service charges combined for a specific area.

[76] Teodoro, Manuel. "Measuring Household Affordability for Water and Sewer Utilities." *Journal AWWA* 110:1. January 2018. https://doi.org/10.5942/jawwa.2018.110.0002/

1) Minimum Wage – Hourly Rate

Almost all employees in California must be paid the minimum wage as required by state law.[77] California has two minimum wage standards: minimum wage for employers with 25 employees or less, and minimum wage for employers with 26 employees or more. By January 1, 2023, both of these standards will be at $15.00 per hour. At the time of writing this staff proposal, the minimum wage in 2019 was $12.00 per hour for both business sizes.

In addition to statewide standards, local municipalities and counties are allowed to enact minimum wage rates. Some of the municipalities also have different standards for employers with 25 employees or less and employers with 26 employees or more, with the former being the lower of the two by $0.50 to $1.00 per hour.

To compute HM, staff located the different minimum wages across California from the Labor Center at the University of California, Berkeley.[78] In areas with two sets of minimum wage standards, staff selected the standard for employers with 25 employees or less, which is the lower of the two. Staff then layered the different minimum wage standards onto the shapefiles for municipalities and counties were obtained from the California Open Data Portal[79] and the shapefiles for service territory and climate zone boundaries obtained from the service providers. HM was calculated independently for each combination of an essential service charge and minimum wage.

[77] Exceptions from minimum wage law may include outside salespersons; individuals who are the parent, spouse, or child of the employer; apprentices under the State Division of Apprenticeship Standards; learners with no prior applicable experiences during their first 160 hours of employment; employees and organizations with a special license by the Division of Labor Standards Enforcement authorizing employment at a wage less than the legal minimum wage.
[78] UC Berkeley Labor Center, http://laborcenter.berkeley.edu/minimum-wage-living-wage-resources/inventory-of-us-city-and-county-minimum-wage-ordinances/
[79] "CA Geographic Boundaries." *California Open Data Portal.* https://data.ca.gov/dataset/ca-geographic-boundaries/

iii. Example Calculation

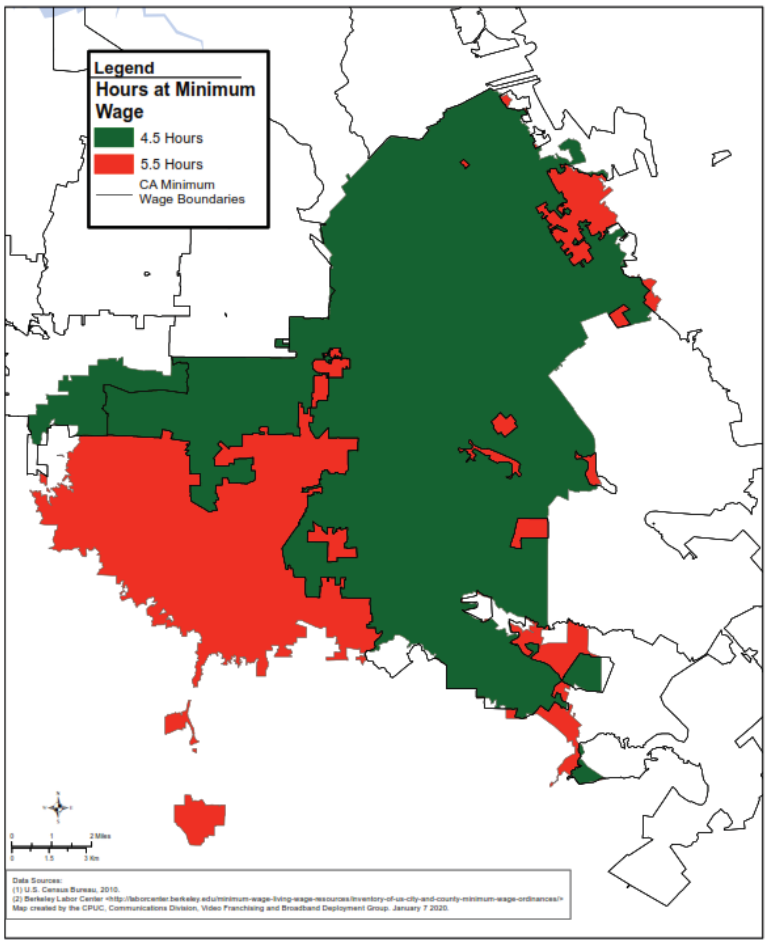

Figure 10: San Jose Water Company HM Map

The map of minimum wage areas, as shown in Figure 9, was intersected with San Jose Water Company's service territory. In Figure 10 above, the areas in green contain a minimum wage of $15 and the areas in red contain a minimum wage of $12. The total essential quantity bill of $69.37 for San Jose Water Company was divided by the minimum wage for the different areas. Below are the equations to calculate the hours needed to work for at the respective minimum wages.

$$HM_{15} = \frac{\$69.37}{\$15\ per\ hour} \approx 5.5\ hours$$

$$HM_{12} = \frac{\$69.37}{\$12\ per\ hour} \approx 4.5\ hours$$

b. Socioeconomic Vulnerability Index

While affordability is a function of a household's ability to pay for essential utility service charges, it is equally important to consider the factors that make a population more vulnerable to a given affordability impact. The Socioeconomic Vulnerability Index (SEVI) is a composite of five socioeconomic indicators: educational attainment, housing burden, linguistic isolation, poverty, and unemployment.[80]

i. Goal of Metric

SEVI provides an index that is independent of essential service charges. It answers the question: "What is the underlying socioeconomic vulnerability of a given geography?" It could serve as a useful baseline for highlighting communities that may be disproportionately impacted by a uniform rate change. The SEVI is strongly correlated with the Ability-to-Pay Index, which also aims to describe economic vulnerability at the census tract scale.[81,82] SEVI is computed from publicly available data that will be updated periodically, which will allow for continuing use in measuring affordability.

ii. Metric Components, Methodology, and Data Sources

The five factors that compose the SEVI correspond to the Socioeconomic Factors indicators used by the California Office of Environmental Health Hazard Assessment (OEHHA) in developing its CalEnviroScreen score.

OEHHA collects data for each indicator and computes a raw score at the census tract scale.[83] Since each indicator is measured on a different scale, the raw scores are put in order from highest to lowest and then ranked by percentile where, for each indicator, 0 is "good" and 100 is "bad."[84] OEHHA collects data and computes these percentiles for a variety of indicators in developing its CalEnviroScreen score, but it specifically considers the five indicators chosen here as its socioeconomic components.

The SEVI is calculated by averaging the percentiles[85] of the five socioeconomic indicators (educational attainment, housing burden, linguistic isolation, poverty, and unemployment). It is presented on a scale of 0 to 100 at the census tract scale, where 0 is considered the least socioeconomically vulnerable and 100 the most.

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[80] "CalEnviroScreen 3.0." California Office of Environmental Health Hazard Assessment. https://oehha.ca.gov/calenviroscreen/report/calenviroscreen-30).

[81] Staff previously proposed the Ability-to-Pay Index as an indicator of socioeconomic vulnerability. See: Lin, Jessica. "Affordability and access in focus: Metrics and tools of relative energy vulnerability." Elsevier Inc.: *The Electricity Journal* 31:6. September 2018. https://doi.org/10.1016/j.tej.2018.06.005/

[82] The correlation coefficient (R^2) of SEVI and API is 0.745, which indicates a strong positive correlation.

[83] Some census tracts will not have raw scores for every one of the indicators.

[84] For example, a high score in educational attainment is "good," so it is represented by a lower percentile. Conversely, a high score in poverty is "bad", so its associated percentile is also high.

[85] as calculated by OEHHA.

See Figure 11 below for a map of SEVI scores by census tract across California.

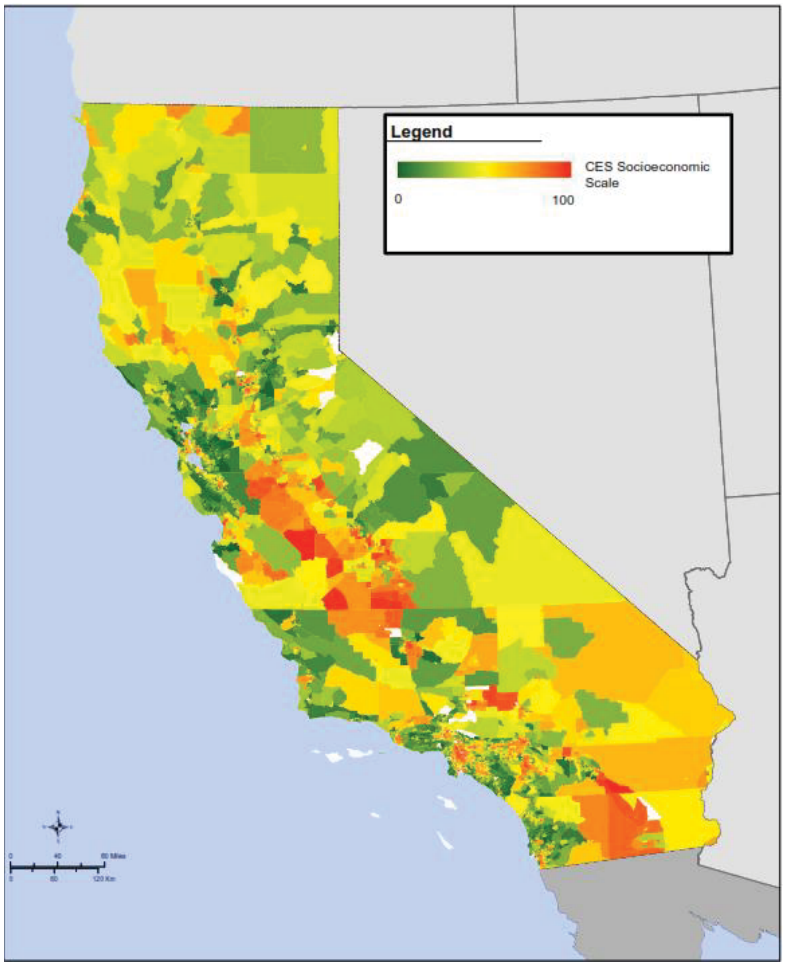

Figure 11: SEVI Scores across California

iii. Example Calculation

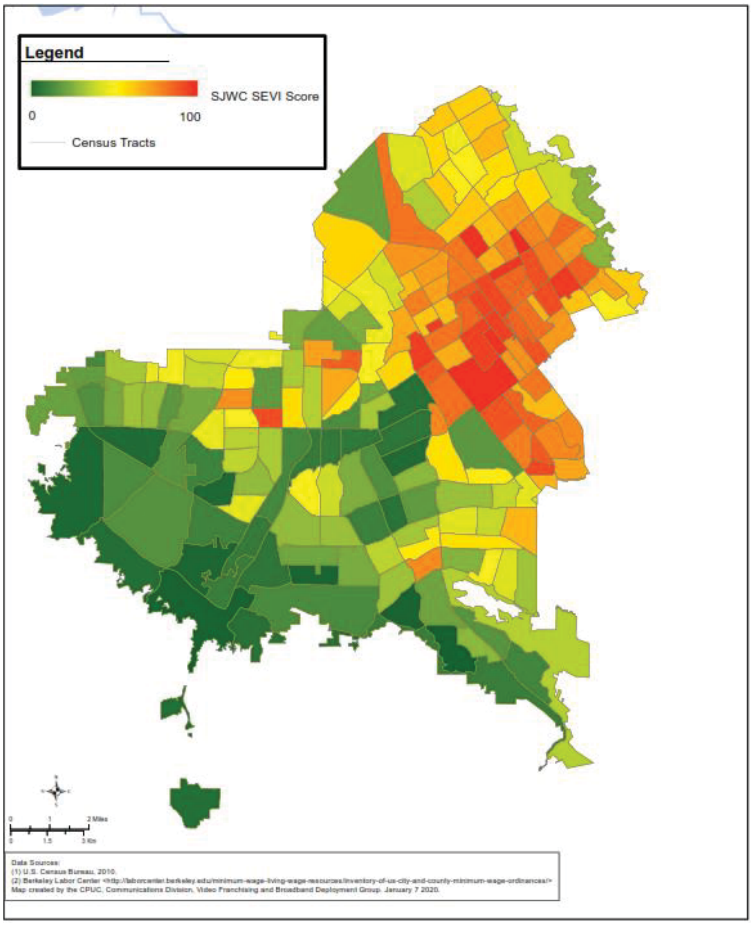

Figure 12: San Jose Water Company SEVI Map

Figure 12 above depicts the San Jose Water Company service territory, which encompasses tracts with SEVI indexes between the 3rd and the 91st percentiles statewide. That is, some of San Jose's ratepayers are located in tracts that are *less* socioeconomically vulnerable than 97% of the state, as well as tracts that are *more* socioeconomically vulnerable than 91% of the state. This implies high socioeconomic inequality within San Jose Water's service area, which is crucial given a single ratemaking area–the same change in rates will affect these communities differently.

c. Affordability Ratio

The affordability ratio (AR) is the essential service charge for a given utility expressed as a percent of a household's income after subtracting other nondiscretionary household expenses. It indicates the degree to which a household can afford service considering its budget for utilities.

i. Goal of Metric

This metric attempts to answer the question: "After a household covers other nondiscretionary expenses, what share of income goes to essential service charges?"

The goal of this metric is to describe the impact that each industry's essential service charge has on a household budget; that is, the percent of income that is spent on a specific type of essential service (water, gas, electricity, or communications), after housing costs and essential service charges for the other utility services are accounted for.

Rather than measure affordability for a community in its entirety, this metric allows for the evaluation of specific areas of the income distribution. For instance, this proposal will walk through the AR calculation for households in an example territory that fall in the 20th percentile of the income distribution. By structuring the metric in this way, it is possible to characterize the affordability of utility rates for relatively low-wage earning households that don't necessarily qualify for low-income assistance programs. The metric is also sensitive to geographic variations in the cost of living, which can significantly impact the amount of income available to cover utility expenses.

ii. Metric Components

The main components of the AR metric are the essential service charge associated with the utility service in question, household income, and other nondiscretionary household expenses. In this analysis, "other nondiscretionary household expenses" are defined as housing costs plus the essential service charges for the utilities not under consideration. By structuring the metric in this way, essential service charges for the utilities not under consideration are accounted for when calculating the available budget. However, the charges for those other utility services are not being directly evaluated for affordability within the context of that utility-specific AR.

We can also calculate a combined bundle AR, which measures the portion of a household budget, minus housing costs, that are spent on essential service charges for all four utility services at once.

Specifically, the affordability ratios for each utility at a given income band (i) are calculated as follows:

Water: $AR_{i,W} = \frac{W}{i-(H+E+G+C)}$

Electric: $AR_{i,E} = \frac{E}{i-(H+W+G+C)}$

Gas: $AR_{i,G} = \frac{G}{i-(H+E+W+C)}$

Communications: $AR_{i,C} = \frac{C}{i-(H+E+G+W)}$

Combined Bundle: $AR_{i,total} = \frac{W+E+G+C}{i-H}$

Where H represents housing costs and W, E, G, and C are the essential service charges for water, electricity, gas, and communications services, respectively.

iii. Methodology

The sections below discuss in detail how AR is calculated. This approach employs spatial and population-weighted AR averages within utility service territories and climate zones, such that AR can be flexibly reported by Census geography or utility service territory.

1) Calculation of Cost at Essential Usage Level

The first step is to calculate the essential service charge associated with each of the four utilities. This is a simple process of identifying the relevant rate associated with each utility service for households located in a given geographic area, multiplying the rate by the usage level that has been identified as the essential usage quantity, and adding in any relevant fixed costs (if applicable).

2) Calculation of Household Income and Housing Costs

Rather than compute a separate income after housing costs for every PUMS household as described in the first staff proposal, we take estimates of the 20th and 50th percentile income for an entire PUMA, and then estimate housing costs using a regression model for all households in each PUMA. The regression model predicts housing costs based on household size and household income, though household size was kept constant at the average size for each PUMA rather than predicting different housing costs for households of different sizes.[86] The model is trained on the entirety of households for each PUMA.

[86] While the determinations of essential service are independent of household size, the addition of household size strictly as a predictor of housing costs improves the accuracy of the regression model, without inappropriate assumptions regarding household composition.

For household income, we identify 20th and 50th percentile income levels based on the distribution observed within each PUMA. It is important to note that the PUMS dataset, like most large surveys with complex sample designs, purposefully oversamples certain household types to ensure reliable statistics for low frequency groups present in the population. In order to make statistically valid inferences about the income distribution of a given PUMA, sample weights need to be considered. These are provided in the PUMS dataset, and they can easily be incorporated into percentile calculations by any statistical analysis package such as Stata, R, or Python.

Sampling error associated with the estimation of 20th and 50th percentile income levels arises from the fact that any measurement based on a random sample is expected to differ from the true value for the entire population. If you were to take several different samples, each one would give you a slightly different answer, but the estimates would tend to be centered around the true value. Fortunately, because this uncertainty declines with larger sample sizes and the PUMS dataset contains between 1,100 and 5,700 households in each PUMA, the uncertainty associated with the income estimates is small enough that it is trivial compared to other sources of uncertainty.

Estimating average housing cost for a given income level is not as straightforward as determining the income levels themselves. Although income is a strong predictor of monthly housing cost (i.e., households with higher income levels tend to pay more for housing), there are many other factors that determine housing cost. These include the precise location of the residence, size of the house, the year in which the residence was purchased (which would affect real estate value) or the lease agreement was initially signed (which would affect the current rent in areas with rent control), interest rate levels at the time of purchase, whether the mortgage has been paid off, and many other variables. There is a great deal of variance in the observed housing costs for any given income level, as can be seen in Figure 13.

While our model is able to accurately predict the mean housing cost that households of a certain income level pay based on the PUMS data, this is a point estimate of housing cost and does not capture the variability in housing costs. There is simply no way to get around the variability in housing costs because this is simply reality, particularly in California which has some of the highest housing costs in the country. It is important for users of this affordability metric to keep this fact in mind when they are incorporating it in their decision-making: while we are able to give an indication of affordability for the average household at a given income level, affordability for individual households can be significantly different.

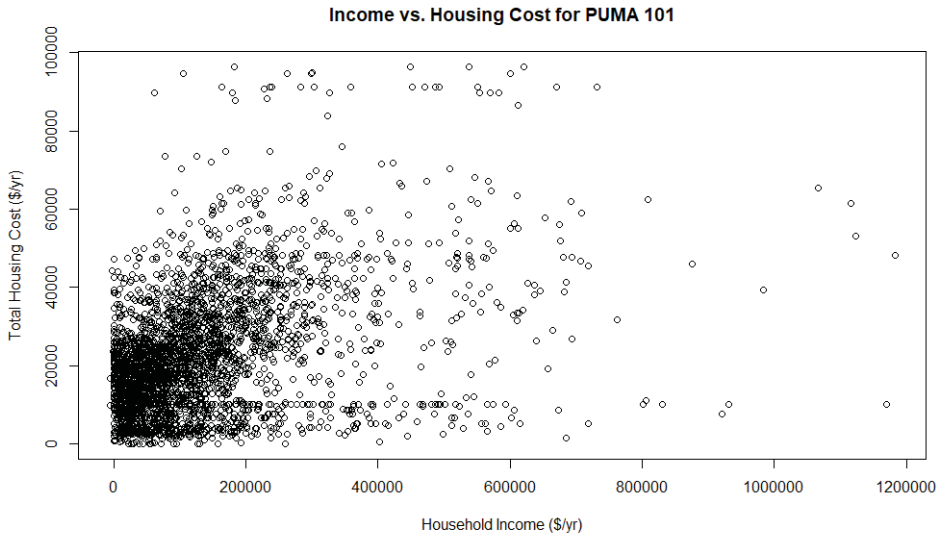

Figure 13: Income and Housing Regression Output

Although there is a great deal of variability in housing costs, it is still possible to predict the mean housing cost for a given income level and household size through regression analysis. In this process, housing cost is expressed mathematically as a function of income and household size. The coefficients of the formula (the factors that the income and household size variables are multiplied by) were assigned values such that the resulting expression fits the observed data as best as possible.[87] The coefficients were determined for each PUMA individually, thus ensuring that the predicted housing costs for each PUMA are only based on data from that PUMA. For our purposes, a monthly housing cost variable was generated by summing rent, mortgage, and property taxes for each household, thus creating a single variable that works for both renters and owners.

For this exercise, several functional forms[88] were tested by determining how much of the housing cost variability was explained by each model and whether the average differences between observed and predicted housing costs were unbiased (in other words, the model does not tend to over- or underpredict housing cost, and the degree of error does not systematically change at different income levels). We tested several different forms of relationship between housing cost and

[87] Mathematically, the sum of the square of the differences between actual housing cost from the PUMS data and the predicted housing cost from the regression formula was minimized.

[88] The "functional form" of a regression model is the general mathematical relationship between the predictor variables and the outcome variable, with unspecified values for the coefficients of the formula. Among the functional forms tested in this analysis was a simple linear relationship between housing cost and household income ($Housing\ Cost = a + b \cdot Household\ Income$), a similar linear relationship that also included household size ($Housing\ Cost = a + b \cdot Household\ Income + c \cdot Household\ Size$), and a logarithmic relationship between housing cost and household income ($Housing\ Cost = a + b \cdot ln(Household\ Income)$)

household income, and also tested whether the inclusion of household size as a predictor would yield better estimates.[89]

In the end, we determined that the best functional form is given by a square root relationship with household income, along with household size as an additional predictor. This equation indicates that housing costs increase proportionally with household income, but the rate of increase in housing cost tapers off at higher income levels. It also indicates that housing costs tend to increase as the size of the household increases.

$$Housing\ Cost = a + b \cdot \sqrt{Household\ Income} + c\ \cdot Household\ Size$$

Values for the coefficients of this formula (a, b, and c) were derived for each PUMA in California. These regression coefficients were then used to solve for the mean housing cost for households at the 20th and 50th percentiles in each PUMA. The mean household size for each PUMA was used when calculating these housing costs. This yields the average housing cost for all households of that income level regardless of household size, rather than deriving average housing costs for households of various sizes.

[89] It is worth noting that, although household size data was available for implementation of the housing cost model, this data was not used in our calculation of essential service quantities. Essential service quantities are defined at the household level using the data sources we have identified as the best available at this time. If, at a later date, essential usage quantities are defined on a per capita basis, household size data would be needed to calculate essential usage quantities.

3) Calculation of AR at Service Territory/Block Intersect Scale

There is a mismatch between geographic areas at which we can estimate income and housing costs (at the scale of PUMA) and the areas at which essential service charges are determined (the service territory/climate zone level). PUMA boundaries do not line up with service territory boundaries, resulting in PUMAs that straddle different utility service territories and utility service territories containing portions of multiple PUMAs, as shown in Figure 14.

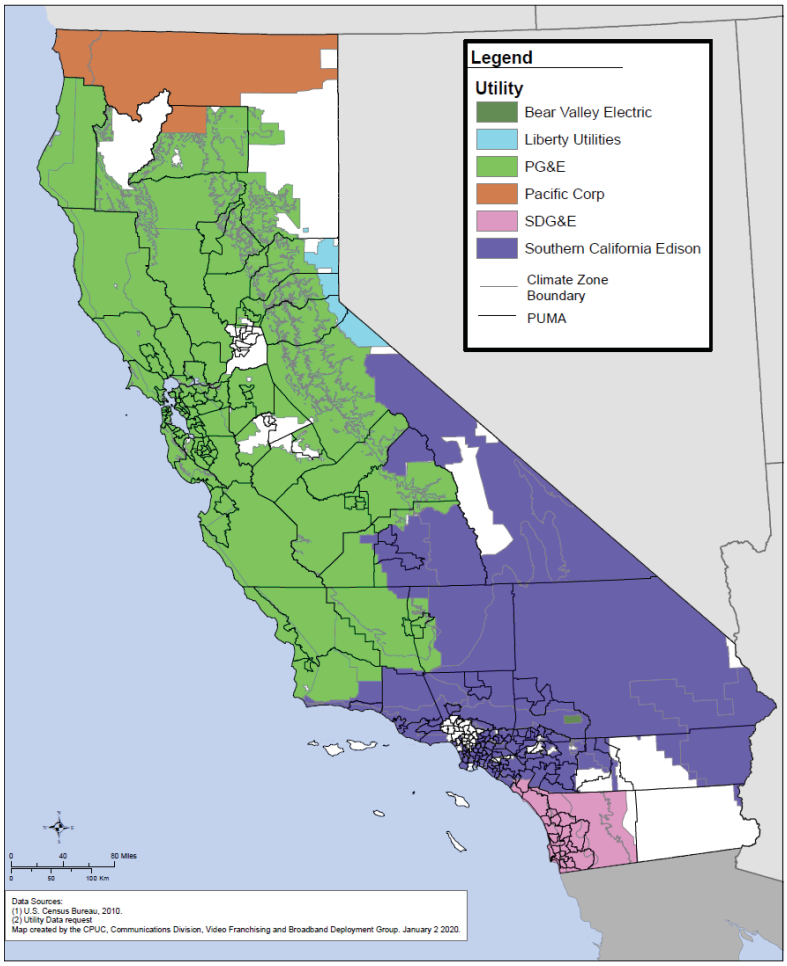

Figure 14: Electric Utility Service Territories and Climate Zone Boundaries with PUMA Boundaries Overlaid

To complicate things further, service territory boundaries for the various types of utilities overlap with one another as well. Utility essential service charges are determined by which utility provider serves a given area, as well as the climate zone in which a household is located for electricity and gas service. Therefore, the relevant boundaries for electricity and gas service are utility climate zone boundaries, and the relevant boundaries for water and communications services are service territory boundaries. Specifically for communications service territory boundaries, the 14 ILECs being

examined in the proposal have unique service areas free of other ILECs. The result is an extremely large number of unique combinations of census geographies and gas, electric, water, and communications essential service charges.

However, the goal of this study is to provide useful affordability metrics at a much higher geographic scale. In order to do that, it is necessary to aggregate estimates of AR over multiple areas where unique AR values can be calculated, some of which are only partially included in the territory of interest. To resolve this misalignment, we decided to calculate AR values for each unique combination of utility service providers that was possible within each PUMA and then aggregate those values to averages for larger geographic areas. This was done using a weighting methodology based on overlapping area and population, which is described in more detail in the Aggregation section.

In calculating AR, a single income value and a corresponding housing cost are calculated for a given PUMA and are assumed to be representative for all households in that PUMA at that income level (in other words, the values are assumed to be valid for all subsections of the PUMA). We found it preferable to accept the uncertainty arising from applying the income/housing cost regression model, rather than use a more spatially granular value for housing costs that includes utility service expenses and would be insensitive to income levels.[90]

Using a Geographic Information System (GIS) program, utility service territory boundaries were spatially intersected with 2010 census blocks. After processing the data, as discussed in Appendix I, there were 526,639 unique combinations of gas, electric, communications, and water essential service charges and census blocks considered in this analysis.

Before aggregating, abnormal AR values were adjusted to ensure that average values produced by aggregation did not present a skewed view of affordability for the larger geographic area. In some cases, AR values yielded by this analysis fell outside the bounds of the metric's meaning. A household's income after housing costs might be negative; that is, the cost of housing plus other essential utility expenses exceeds annual household income. A negative AR thus reports on the ratio of essential service charge relative to *annual debts or losses* and is not comparable to a positive AR, which reflects the ratio of essential service charge relative to annual *income* (after essential expenses). In other instances, the essential service charge in the numerator will be greater than income after housing costs and other nondiscretionary household expenses, yielding an AR greater than 1. In both cases, the meaning of this result is the same: the household in question does not have enough income to pay for essential quantities of each service.

Staff's approach to handing outlying AR values is top-coding, meaning replacing outliers with some upper or lower value that retains the contextual meaning of the metric. With this approach, both negative AR and AR greater than 1 are top-coded with an AR of 1. That is, the essential service charge comprises 100 percent of income after other nondiscretionary household expenses, whether due to negative income after nondiscretionary expenses, or due to the household's essential service charges being greater than available income.

[90] If more granular income and housing data that more closely aligns with utility service boundaries were to become available, this simplifying assumption could be mitigated or avoided altogether. See "Recommendations for Implementation" for more details.

4) Aggregation

The methodology presented thus far has demonstrated how to calculate AR for geographic areas that have unique values for the components of the metric, based on the data sources used. The final step is to calculate a weighted average AR value for a geographic area of interest, based on the AR values present within that area, weighted by area and household count. To calculate this average, a weighting factor is assigned for each area defined by the intersection of service territory and census block, as demonstrated in the conceptual example below.

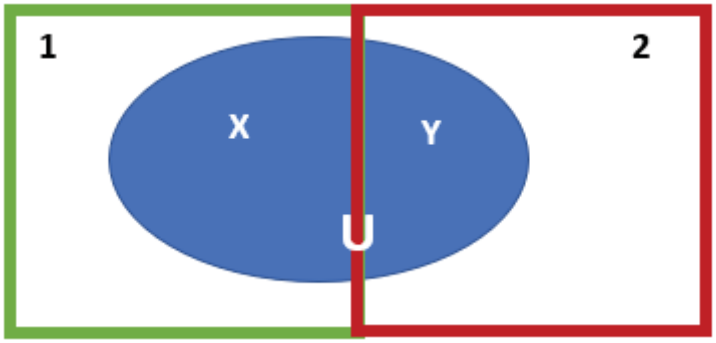

Figure 15: Intersection of Service Territory and Census Blocks

In Figure 15, Boxes 1 and 2 are census blocks. The blue circle is the service territory of Utility U. X is the part of U in block 1, and Y is the part of U in block 2—X and Y are examples of the areas defined by the intersection of census block boundaries and service territory boundaries. The areas and household counts of 1 and 2 are known from census data, and the areas of U, X, and Y are known from GIS analysis.

Where A is area and P is household count, the weighting factors W_x and W_y are:

$$W_x = \frac{A_x P_1}{A_x P_1 + A_y P_2}$$

$$W_y = \frac{A_y P_2}{A_x P_1 + A_y P_2}$$

Area is considered in this way so that if a service territory only occupies part of a census block, a proportionally sized number of housing units will be considered in the weighting. If a single service territory occupies the entire census block, as is common for energy and communications, then the entire population of housing units of that block will be considered. The weighting factors are designed to weight by the proportion of a utility's ratepayers that are represented within each intersect.

Just as we calculate a separate AR for each industry, we use a separate weighting factor for each industry. While the weighting factors are calculated in fundamentally the same way, the different

compositions of each utility's service territory relative to census blocks naturally lead to different weights.

Once the weighting factors are calculated, we multiply the AR of each service territory/census block intersect area by its respective weight and sum those values over the area of interest, thus giving a weighted average AR for the geographic area of interest. For example, to calculate a weighted average AR for a service territory, we first calculate the AR for that specific industry for all areas defined by the intersection of service territory and census block boundaries within that service territory. We then divide the number of housing units in those intersected areas by the total number of housing units within the service territory to create the weighting factor for each calculated AR value. We then multiply these two sets of numbers together and then sum the values across all of the intersected areas within the service territory to yield the final weighted average AR. A specific example of this process is provided in the next section.

iv. Example Calculation

This section presents an example calculation of water industry AR for households at the 20th percentile of the income distribution in San Jose Water's service territory. Because the service territory is comprised of many different census blocks and PUMAs, and because there are multiple providers of electricity, gas, and communications service within the water provider's territory, there are actually many more calculations that occur than are explicitly presented here to determine the weighted average AR value. Instead, this section will present illustrative examples of each step of the process, along with data tables summarizing the intermediate calculations performed over the course of the process.

First, the essential service charges are calculated for each utility for each combination of utility providers present in the service territory. As an example, part of this service territory has AT&T California as its communications provider and PG&E as its electricity and gas provider, with customers' electricity and gas essential service charges determined by the essential service quantity of climate zone X.[91] The essential usage charges for households in this portion of the service territory are shown in the calculations below:

Electricity: $0.2111/kWh x 319.3 kWh of essential usage = $67.40/month

Gas: $1.32814/therm x 36.4 therm= $48.32/month

Water: $25.28 service charge + ($4.25475/ccf x 3 ccf) + ($4.72750/ccf x 3 ccf) + $10.00 taxes and surcharges = $69.37[92]

Communications: $27.00 basic service + $60.00 Internet 18 for speeds up to 18 Mbps = $87.00

[91] The essential service quantity is annualized based on summer and winter essential service quantities.
[92] This total bill amount is obtained directly from the Water Board's 2018 eAR. The constituent components of the bill were backed out using tariff sheets on file at the Commission.

Industry	# of Utilities/Climate Zones	Min. Charge	Max. Charge
Electricity	2	$61.81	$67.40
Gas	2	$48.32	$50.60
Water	1	$69.37	$69.37
Communications	2	$56.99	$87
Total	8 possible combinations	$238.77	$272.09

Table 1: Utility Service Providers and Service Charge Ranges in San Jose Water Service Territory

The next step is to establish the income level for each PUMA of the income percentile of interest, as well as the corresponding housing costs. For this example, we will examine PUMA 8511, one of the 12 PUMAs present in the San Jose Water service territory. Based on the PUMS data, the 20th percentile income in this PUMA is $47,091/year. Based on the regression model that was established for each PUMA, in which the mean housing cost was predicted as a function of the square root of household income, the predicted housing cost in this PUMA for a household making this income level, the mean housing cost is estimated to be $19,631/year. The figure below presents the household income and housing cost data from the PUMS dataset for this PUMA, with the specified income and housing cost levels marked by red lines.

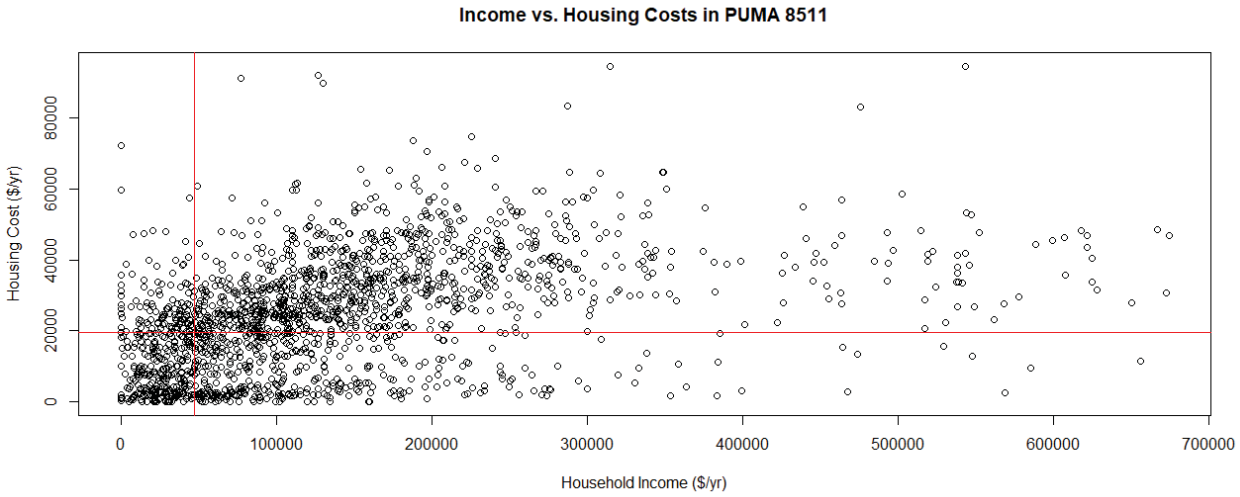

Figure 16: Income vs. Housing Costs for PUMA 8511

A summary of the 20th percentile income and housing cost estimates for the PUMAs present in the San Jose Water service territory are presented below.

# of PUMAs	12
Min. 20th Percentile Income	$24,441
Max. 20th Percentile Income	$70,252
Min. 20th Percentile Housing Cost	$14,362
Max. 20th Percentile Housing Cost	$26,682

Table 2: Summary Income and Housing Cost Data for San Jose Water's Service Territory

With the utility essential service charges, household income, and housing cost information in hand, the next step is to calculate AR values for every area within San Jose Water's service territory that is demarcated by the intersection of the utility service providers' territory boundaries and the census block boundaries. Essentially, this means calculating the AR of every unique combination of utility provider and PUMA that falls within the San Jose Water service territory. As an example, the AR for households that fall within PUMA 8511 and have the previously mentioned combination of utility providers would have the following water industry AR:

$$\text{Water AR} = (12 \times \$69.37) / (\$47{,}091 - \$19{,}631 - 12 \times (\$67.40 + \$48.32 + \$87)) = 0.0333$$

For this particular PUMA, households that earn the 20th percentile income, pay the average housing cost for households of that income level, and receive utility services from the abovementioned combination of providers pay approximately 3.33% of their disposable income (once housing costs and other utility services are accounted for) for their water essential service charges. In total there are 7,702 possible combinations of utility providers and PUMAs in this service territory. The AR values range from 2.00% to 10.89%.

The final step of the calculation is to aggregate the individual AR values to a weighted average for the service territory as a whole. This step requires the use of a GIS program to determine what portion of each area for which an AR value was calculated lies within the service territory of interest. This information, combined with the number of households that exist within those areas as well as the number of households that exist within the service territory as a whole, are used to calculate a weighting factor for each AR value. For the individual AR value presented in this example, the weighting factor is 0.0036, meaning that the households that fall within this area make up 0.36% of the households in the entire service territory.

With 7,702 areas, this means that each one contributes a very small portion to the overall weighted average. After weighting all of the AR values and summing them together, we get a final weighted average water AR of 4.96%.

4. Conclusion

Staff recommends the affordability framework as outlined in this proposal. Staff believes that the combination of definitions and metrics proposed here satisfies both the goals of the OIR and the guiding principles outlined in Section 1. Staff has established a common language with which to discuss essential service and affordability and has introduced data sources and metrics that express these concepts quantitatively.

The OIR states that while existing low-income rate programs are "vital to ensuring that low-income customers have access to utility services, they do not address the issue of whether services are affordable -for low-income customers under subsidized rates, or for middle-income earners or for customers just above the qualifying income limit -nor how the consumption of multiple services, such as electricity, gas, water, and telecommunications, may impact affordability."[93] Our proposed methods for collecting and synthesizing data across industries will allow the Commission to gain a much clearer picture of the experience of the affordability of rates for the diversity of ratepayers in California.

Staff has explored the sources of uncertainty and the limitations of our approach—we believe that the recommended data sources are the best available for calculating the proposed metrics, and that the methods described are effective, useful, and accurate at a variety of scales.

Staff has created a flexible and robust affordability framework and, in doing so, provided the first in-depth and cross-industry exploration of affordability of utility service in California. While the Commission must decide how these metrics should be incorporated in its decision-making, Staff will continue to develop plans to implement and utilize this affordability framework to best suit the Commission's needs and policy goals.

[93] OIR, p.7

5. Recommendations for Implementation

The majority of this proposal focuses on the central objective of the affordability rulemaking: establishing shared definitions, data sources, metrics, and methods for estimating utility essential service affordability while accounting for California's geographic and economic diversity.

This section addresses objectives related to implementation, in order to ensure that these metrics are "usable by and relevant to Commission decision-makers." This means that, at a minimum, they be easily maintained by staff, and that they allow affordability to be assessed among utilities, over time, and at different rates and quantities.

a. Integrating Metrics into Commission Decision-Making Activities

The Commission balances many considerations when determining whether to approve utility applications with ratepayer impact. In this section we discuss potential uses of the affordability metrics for decision-making purposes. Our goal is to provide consistent, reliable information about the impact of utility rates to be considered holistically alongside the Commission's other decision-making tools.

i. Evaluate Proposals with Rate Implications

When utilities propose a change to rates, the change in rates over time is often compared to the Consumer Price Index or inflation. While these macroeconomic indicators might serve as a reasonable proxy for anticipated changes in the price of consumer goods and the value of money, the essential quantity of utility service benefits from an evaluation that is sensitive to a household's ability to pay.

Staff proposes that the Commission adopt the affordability metrics proposed herein be calculated and presented to assist decision-makers with evaluating affordability of a residential rate change proposed in a utility's general rate case and other proceedings with a rate impact. In order to provide timely, relevant information to decision-makers, the affordability metrics should be calculated as closely to the projected implementation date as possible using best available data at that time.[94]

Several practical considerations regarding application of the affordability framework must be resolved. For example, general rate case applications request the revenue requirement that will ultimately end up in residential rates, but the requested revenue requirement is subject to substantial revision during the proceeding. A rate case proceeding may not conclude for up to eighteen months,[95] during which time the reference point for current rates, to which proposed rates are

[94] For example, rates in Proposed Decisions may be based on settlement agreements or may be otherwise altered from those originally presented in the utility application. The affordability metrics should be calculated using both the original and updated rates.

[95] CPUC proceedings are statutorily required to conclude within eighteen months, unless extended.

compared, will likely reset due to intervening rate changes.[96] In addition, the total revenue requirement requested in GRCs is a multiyear request—generally a test year and two or more post-test year revenue requirements—so to evaluate the total impact of the rate request, multi-year forecasting will likely be required. This would require the projection of income, housing costs, and other utility essential use charges for multiple years in the future.

Staff recommends that the affordability metrics be tested in an actual Commission proceeding. To obtain the most meaningful results and stakeholder involvement, staff recommends a General Rate Case of one of the large electric IOUs. Staff does not propose that the results of this test form the basis for Commission decision—the intent of the test is solely to examine how the framework be best used in a proceeding, and use the results to inform future work by Staff. Learnings from this test will inform how the affordability framework is applied to proposals with rate implications more generally. Testing the affordability metrics in a GRC should also not preclude the Commission from using them elsewhere in the interim. Indeed, staff encourages the Commission to consider the affordability of rate changes using these metrics as often as possible.

ii. Present Affordability Metrics in an Annual Affordability Report

Staff recommends that the Commission prepare an annual affordability report. This affordability report would provide a detailed summary of prescribed and observed affordability assessments, including the metrics introduced in this proposal as well as information related to utility service disconnections, arrearages and other metrics of observed hardship.

This report can be a stand-alone report or be integrated into existing reports. As a stand-alone report, the Commission should publish the report on its website, linking the report to each of the industry Divisions' websites. While electric and gas affordability metrics may eventually be presented in an existing report such as the Public Utilities Code Section 913.1 Annual Report to the Governor and Legislature *Actions to Limit Utility Cost and Rate Increases* (Senate Bill (SB) 695 Report)[97] staff recommends that a stand-alone report be issued at this time.

[96] Resetting the reference point implies using updated income and essential expense data that is contemporaneous with the reference point data, which involves forecasting assumptions.

[97] While the Assembly Bill (AB) 67 Annual Report to the Governor and Legislature *California Electric and Gas Utility Cost Report* (AB 67 Report) is another possible report into which the electric and gas annual affordability report may be inserted, the AB 67 Report generally focuses on revenue requirements and does not report utility costs down to residential rate level.

An example of the type of maps—based on the outputs of this framework's metrics— that would be included in this report is provided as Figure 17 below.

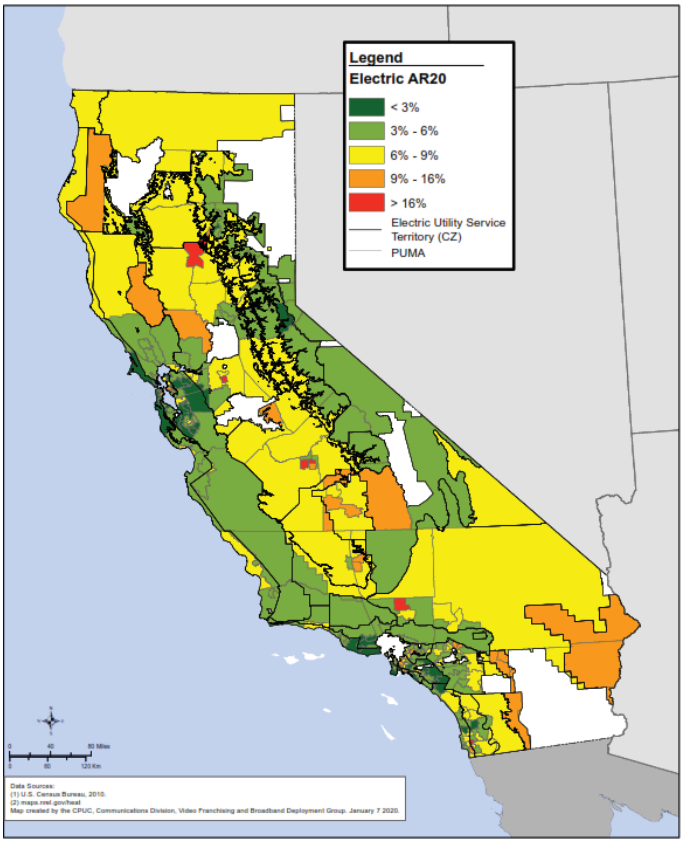

Figure 17: Electric Utility AR20 Map

b. Creating Metrics: Data Procurement, Analysis, and Presentation

i. Coordinating Ongoing Utility Data Requests

As discussed in the Definitions and Data Sources section, several data requests were submitted to utility service providers in order to collect information necessary to compute affordability metrics. Some of these sources will change infrequently; others might change as often as monthly. As such, staff recommend that a regular and timely process be developed to refresh data sources. Utilities should provide rates and service territory boundaries in a consistent format that can be read into the program used for affordability metric calculations.

For energy utilities, staff recommends that Energy Division issue an annual data request for the previous calendar year requesting monthly Tier 1 (electric) and baseline (gas) rates in effect for the year, monthly baseline quantities, and an annualized essential service charge by baseline territory

calculated from the rate and baseline quantity data.[98] Staff also recommends that Energy Division continue to issue quarterly data requests to the large electric IOUs for the rate and bill tracker tool that models forecasted revenue requirements and their projected residential rate and bill impacts, as this tool will be used for evaluating rate and quantity affordability metrics inputs.[99]

For communications, staff recommends adding the basic rack rate[100] to the existing Request for Broadband Deployment and Subscription Data[101] that Communications Division issues to California broadband service providers annually.

For water utilities, staff recommends Water Division issue an annual data request for Class A and B utilities. The data request should include, at minimum, monthly median usage for each Class A and B billing area. Staff also recommends the rate and bill tracker tool be expanded for use with water utilities, to ensure the most accurate data is obtained directly from utilities in a consistent format.

ii. Developing and Maintaining Tools for Calculating Metrics

To develop and compute the metrics used in this report, staff used several programs including R, Python, ArcGIS and Excel. We recommend that metric calculation be formalized in an open-source statistical programming language that may be published online and distributed freely along with underlying data sources. We recommend that the Commission ensure support for the affordability framework by maintaining staff in each industry trained in these types of statistical and geospatial tools. While we recommend that, at minimum, computation of affordability metrics be done by staff at the Commission, sharing sources and calculation methods in this fashion will maximize accessibility and rigor as any party, utility, or member of the public with knowledge of the relevant statistical programming language can access the underlying data and computation routines.

iii. Further Refining Metric Calculations and Summaries

As discussed extensively in the Affordability Ratio methods section, staff disaggregated utility costs from the cost of housing (using a regression model to estimate housing costs based on trends in a PUMA). This method introduces additional uncertainty in our estimates of income less housing costs, a central component of the affordability ratio. To attain more accurate estimates of income less housing costs at finer spatial scales, the Commission should purchase custom Census cross-tabulations that present housing costs (separate from utilities) grouped by income quintile, for each block or block group in California.

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[98] Staff recommends that the rates requested be the standard residential rate for electric and gas service. Baseline quantities should be provided for basic and all-electric service. Fixed charges should be provided where applicable.
[99] The rate and bill tracker tool is capable of presenting proposed Tier 1 rates and resulting essential service charges.
[100] Rate for a service without any promotional or introductory discounts.
[101] Data request due April 1st of each year. Required data fields include residential broadband technology, downstream bandwidth, and upstream bandwidth by census block code.

iv. Presenting Affordability Metrics Online

In order to enable wide public access to computed affordability metrics, staff also recommend that computed values be published via a web mapping tool on at least an annual basis.[102] In this format, affordability metrics can readily be summarized at several scales of general interest (at a minimum, for PUMA and census tract boundaries, as well as utility service territory boundaries). To do so, financial support should also be allocated for GIS resources including program licenses, publishing costs, computational resources, and staff trained in geospatial tools.

v. Explore Data Describing Ratepayer Experiences of Unaffordability

Staff has proposed two metrics (HM and AR) that describe the affordability of utility rates for a given prescribed quantity of essential service. The recommendations for implementation include incorporating data concerning energy disconnections, and staff recommend that the Commission identify other analogous data sources for water and communications to describe ratepayer hardship across all industries. Staff should compile existing data sources for "hardship indicators" such as disconnections and arrearages across all industries and develop more concrete recommendations for routine data requests or data collection. This could include data such as those from the PUC Code §745 analysis, which included a survey with questions regarding energy hardship, and a created normalized metric describing ratepayers' reported economic difficulty paying energy bills. Such data could be included in annual affordability reporting or other appropriate venues.

[102] Tableau and ArcGIS online are both now in common use at the Commission. For an example of a publicly-facing Tableau presentation, see the CPUC webpage presentation of IOU Renewable Portfolio Standard Contracts: https://www.cpuc.ca.gov/RPS/ .

6. Recommendations for Future Work

Staff recommends a second phase to this proceeding to address the following topics:

- **Study affordability and disconnections –** As part of the Energy Disconnections and Reconnections Rulemaking Proceeding (R.18-07-005), electricity disconnection data was gathered at the zip code level. Staff recommends analyzing this data alongside calculated affordability metrics. This analysis should explore whether there is a correlation between affordability and frequency of disconnections, and possibly aid in expanding the affordability reporting framework to include measures of hardship such as disconnections. An affordability and disconnections analysis could also aid the Commission in making determinations based on affordability, as those determinations will be grounded in empirical observations of unaffordability.

- **Create framework for forecasting inputs in order to calculate affordability metrics in future years** – In order to estimate the affordability implications of a rate change in a future year, some inputs for the proposed affordability metrics would need to be forecasted. For example, household incomes and housing costs would need to be estimated in order to calculate the AR associated with a future year rate change. Staff will need to develop a framework for this forecasting in order to apply the proposed affordability metrics to proceedings with rate implications for future years.

- **Resolve missing utility service provider data** – In developing these metrics, Staff identified several areas where it was unclear whether households had access to one or more utility services, particularly gas service.[103] Staff was unable to resolve whether this data was simply missing or if customers in those areas did not have access to those services. If the latter, Staff needs to decide how to adjust the affordability metrics to account for this. For instance, if households do not have natural gas service, should they be treated as all-electric customers or should some additional amount of nondiscretionary expense be assumed for alternative heating fuel?

[103] More information about this issue can be found in Appendix I.

Appendix I – GIS Procedure

The intersect tool creates a new shapefile of overlapping boundaries between shapefiles and removes the non-overlapping areas. Examining the shapefiles provided by utilities revealed that edges of service territory boundaries occasionally overlapped. When performing these intersections, smaller utilities took precedence over larger utilities.

Census blocks with no housing units were removed from analysis, leaving 400,705 census blocks. Intersecting these blocks with electric climate zone, gas climate zone, water utility, and ILEC yielded 527,273 areas, each with a unique combination of utility service territories and census block.

There were 634 intersects with no known water, electric, gas, and communications utility service providers, which were dropped from the analysis. Intersects with no data for three or fewer service providers remain.

Utility coverage	*Intersects*	*Housing Units*
4	405,196 (76.84%)	13,598,503.49 (89.95%)
3	104,518 (19.82%)	1,405,737.54 (9.30%)
2	12,909 (2.45%)	88,669.26 (0.59%)
1	4,060 (0.77%)	24,627.87 (0.16%)
0	634 (0.12%)	1,097.46 (0.01%)

Table A-1: Utility Coverage by Census Block/Service Territory Intersect in California

The following co-occurrence matrix shows the number of intersects missing each kind of utility. It can be read as "__ intersects are missing both X and Y service providers." For example, 19,230 intersects are missing a gas service provider only, and 4,128 intersects are missing an electricity and gas service provider.

	GAS	ELECTRIC	ILEC	WATER	TOTAL
GAS	19,230	4,128	2,229	11,654	**37,241**
ELECTRIC	4,128	10,012	1,617	4,451	**20,208**
ILEC	2,229	1,617	6,240	4,814	**14,900**
WATER	11,654	4,451	4,814	109,570	**130,489**

Table A-2: Utility Coverage Gaps by Utility Type Across Census Block/Service Territory Intersections

Areas with no service provider for a utility service were assigned an essential service charge value of $0 for that utility. This yielded 160,851 households (1.06%) with no assigned gas essential service charge, 62,044 households (0.41%) with no assigned electric essential service charge, 25,092

households (0.17%) with no assigned communications essential service charge, and 1,413,361 households (9.35%) with no assigned water essential service charge.

While we have assigned a $0 essential service charge for these households for the purposes of calculating a utility service AR, we acknowledge that a $0 essential service charge in this case may erroneously imply that a household incurs no cost for a particular type of service. This assumption is faulty for households without water service who must purchase bottled water or maintain a well, or for households without gas service who must purchase propane or other heating fuels. Future analysis could include estimates of non-utility essential service provision.

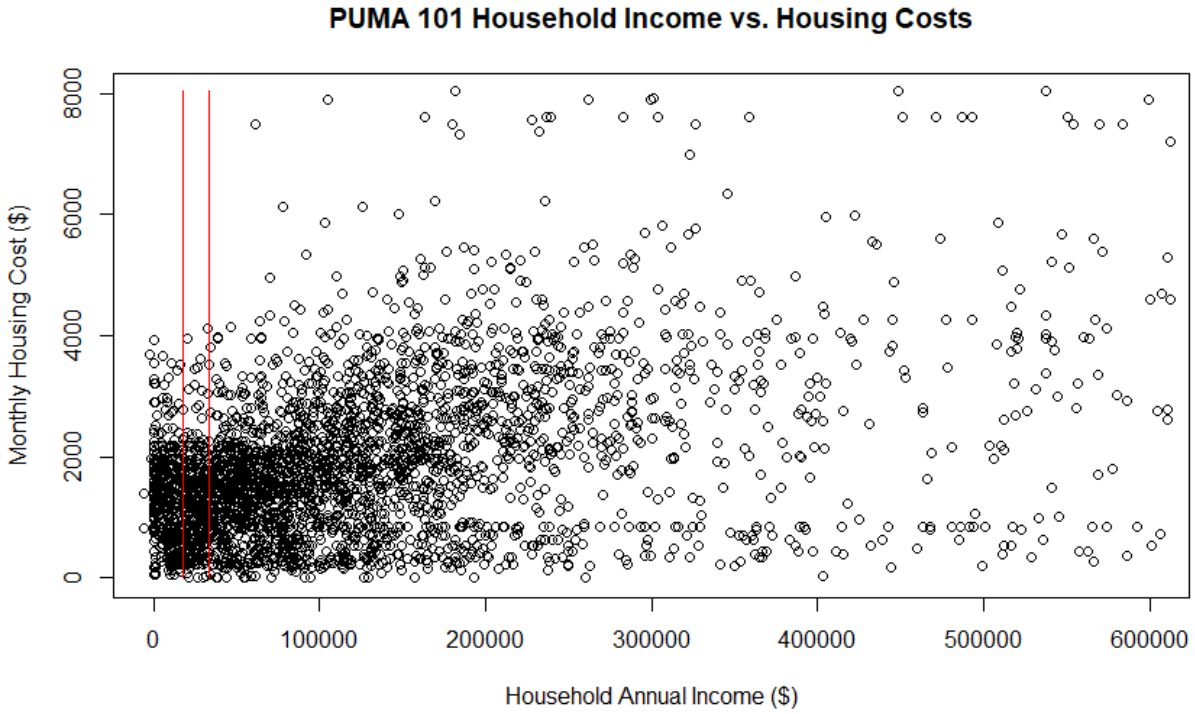
For the resulting areas defined by the intersected boundaries, unique values for essential service charges, income, and housing cost (for the specified income percentile) were used to calculate AR.

APPENDIX B

In response to those arguments in favor of reverting to the approach used by the original staff proposal, the housing cost estimation methodology put forward in the original staff proposal does not do a better job than the regression approach of controlling for the large degree of variance in housing costs within each PUMA. Even though the original staff proposal's methodology only uses data for a 10% band of the income distribution (thus discarding the data for the remainder of the distribution), there is still a large degree of housing cost variance within that subset of the data for each PUMA.

The graph below illustrates how discarding the income and housing cost data outside of a 10% band of the income distribution (as would be the case with the methodology put forth in the original staff proposal) still retains the wide range of housing cost values within the vicinity of the 20th percentile of the income distribution. The graph shows all of the income and housing cost data points for PUMA 101 from the Census PUMS dataset, with the exception of a handful of households with extremely high income levels (greater than 5 times the weighted average income for the PUMA), since these would skew the plot axes and make it difficult to see the majority of the data points. The vertical red lines on this plot indicate the 15th and 25th percentiles of the income distribution for the PUMA.

In the original staff proposal, AR_{20} was calculated by calculating AR for each individual household in the dataset and simply ignoring the values outside of this narrow band of the income distribution between the 15th and 25th percentiles. The AR values for the households that fall within this band were simply averaged to approximate the AR for households at the 20th percentile of the income distribution. Ignoring that it was later determined that calculating AR values for individual households within the PUMS data set is infeasible due to uncertainty around utility assignment, these households still display a wide degree of variation in housing costs with a range of approximately $4000/month. The methodology in the original staff proposal does not control for the large range in housing costs. It simply collapses the variation by calculating an average of the AR values for this subset of households. Fundamentally, this is no different from estimating the average housing cost for 20th percentile income households by using a regression model that is calibrated using the full set of data.



Although the full set of data has a wider range in housing costs, it is because the full dataset includes households with higher income levels. This added variability in housing costs for higher income levels does not add to the uncertainty in the estimate of housing cost for 20th percentile income households, since the housing cost variation is unchanged for that portion of the income distribution. The additional housing cost data only informs the regression model as to how correlated housing costs are with income, and what the nature of that relationship is.