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ATTACHMENT A

CALIFORNIA ENERGY CODES & STANDARDS

A STATEWIDE UTILITY PROGRAM

Title 24, Parts 6 and 11
Local Energy Efficiency Ordinances

2019 High-Rise Residential New Construction Reach Code Cost-Effectiveness Study
For the City of San Jose (Climate Zone 4)

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LEGAL NOTICE

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Table of Contents

List of Tables

1 Introduction

The California Building Energy Efficiency Standards Title 24, Part 6 (Title 24) (California Energy Commission, 2018b) is maintained and updated every three years by two state agencies, the California Energy Commission (Energy Commission) and the Building Standards Commission (BSC). In addition to enforcing the code, local jurisdictions have the authority to adopt local energy efficiency ordinances, or reach codes, that exceed the minimum standards defined by Title 24 (as established by Public Resources Code Section 25402.1(h)2 and Section 10-106 of the Building Energy Efficiency Standards). Local jurisdictions must demonstrate that the requirements of the proposed ordinance are cost-effective and do not result in buildings consuming more energy than is permitted by Title 24. In addition, the jurisdiction must obtain approval from the Energy Commission and file the ordinance with the BSC for the ordinance to be legally enforceable.

This report documents cost-effective combinations of measures that exceed the minimum state requirements, the 2019 Building Energy Efficiency Standards, effective January 1, 2020, for new high-rise (8-stories and higher) multifamily residential construction. The analysis includes evaluation of both mixed-fuel and all-electric residential construction, documenting that the performance requirements can be met by either type of building design. Compliance package options and cost-effectiveness analysis is presented for California Climate Zones 4 only. This analysis complements that conducted for mid-rise multifamily residential construction in June 2020 (Statewide Reach Codes Team, 2020). A final report evaluating high-rise multifamily buildings for all sixteen California Climate Zones is under development and will be completed later in 2020.

2 Methodology and Assumptions

This analysis uses two different metrics to assess cost-effectiveness. Both methodologies require estimating and quantifying the incremental costs and energy savings associated with energy efficiency measures. The main difference between the methodologies is the way they value energy and thus the cost savings of reduced or avoided energy use:

- **Utility Bill Impacts (On-Bill)**: Customer-based Lifecycle Cost (LCC) approach that values energy based upon estimated site energy usage and customer on-bill savings using electricity and natural gas utility rate schedules over a 30-year duration accounting for discount rate and energy cost inflation.
- **Time Dependent Valuation (TDV)**: Energy Commission LCC methodology, which is intended to capture the “societal value or cost” of energy use including long-term projected costs, such as the cost of providing energy during peak periods of demand and other societal costs, such as projected costs for carbon emissions, as well as grid transmission and distribution impacts. This metric values energy use differently depending on the fuel source (gas, electricity, and propane), time of day, and season. Electricity used (or saved) during peak periods has a much higher value than electricity used (or saved) during off-peak periods (Horii et al., 2014). This is the methodology used by the Energy Commission in evaluating cost-effectiveness for efficiency measures in Title 24, Part 6. Both 2019 and 2022 TDV multipliers are evaluated and reported on in this analysis.

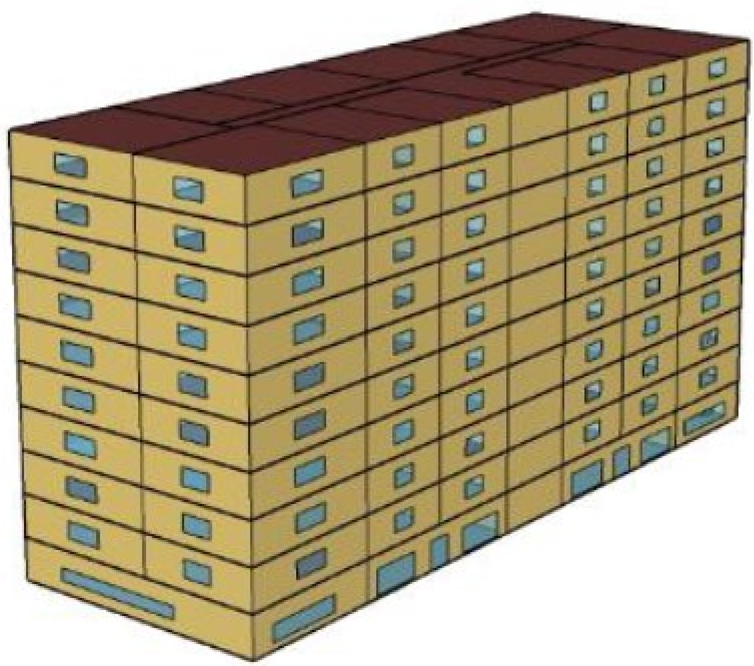
Building Prototypes

The Energy Commission defines building prototypes which it uses to evaluate the cost-effectiveness of proposed changes to Title 24 requirements. The CEC recently developed new prototype designs for multifamily buildings to more closely reflect typical designs for new multifamily buildings across the state. The new prototypes include two low-rise residential designs, a mid-rise, and a high-rise design. At the time that this report was written, there was one high-rise multifamily prototype, which was used in this analysis in development of the above-code packages (TRC, 2019). The high-rise prototype is a 10-story building with two additional below-grade parking levels, a ground floor commercial space, and nine stories of residential space. Table 1 describes the basic characteristics of the high-rise prototype and Figure 1 shows a depiction of the building.

Table 1: Prototype Characteristics

Characteristic	Multifamily 10-Story High-rise
Conditioned Floor Area	150,480 ft^2 Total: 50,040 ft^2 Nonresidential & 100,440 ft^2 Residential
Number of Stories	12 Stories Total: 2 Story Parking Garage (below grade) 1 Story of Nonresidential Space 9 Stories of Residential Space
Number of Dwelling Units / Bedrooms	(18) studios, (54) 1-bed units, & (45) 2-bed units
Foundation	Concrete podium with underground parking
Wall Assembly	Steel Frame
Roof Assembly	Flat roof
Window-to-Wall Area Ratio	40%
HVAC System	Ducted split heat pumps at each apartment. Dedicated outdoor air system for apartment ventilation.
Domestic Hot Water System	Gas central boiler with solar thermal sized to meet the prescriptive requirements by climate zone

Source: TRC 2019



Source: TRC 2019

Figure 1: 10-story high-rise multifamily prototype depiction.

The methodology used in the analyses for the prototypical building type begins with a design that meets the minimum 2019 Title 24 prescriptive requirements (zero compliance margin). Table 140.3-B and 140.3-C in the 2019 Title 24 (California Energy Commission, 2018a) lists the prescriptive measures that determine the baseline design in each climate zone for the nonresidential and high-rise residential spaces, respectively. Other features are consistent with the Standard Design in the Nonresidential ACM Reference Manual (California Energy Commission, 2019a) with two exceptions.

1. The apartments use split system heat pumps instead of a split furnace and air conditioner that is prescribed in Table 2 of the Nonresidential ACM Reference Manual. This modeling choice was made to better reflect current market data, which shows heat pumps to be the most common system type and a very low prevalence of gas furnaces for multifamily buildings four stories and greater. This is based on a report completed by TRC (TRC, 2019). In most climate zones the difference between a heat pump or gas furnace is nearly compliance neutral.
2. A dedicated outdoor air system (DOAS) is used for ventilation at the apartments. This is based on anecdotal information that this practice is more common than individual ventilation systems in high-rise buildings. It also provides variability across the mid-rise and high-rise analysis, which is important so that this analysis provides more realistic solutions for the high-rise multifamily building type. The selection of a DOAS does not match the Standard Design, which applies individual balanced fans for ventilation at all residential spaces, and results in a small compliance penalty.

The analysis also assumed electric cooking in the apartment units to reflect current market data. Laundry was not addressed in this study. The building prototype assumes central laundry facilities and no laundry in the units.

Measure Analysis

EnergyPro, using the California Building Energy Code Compliance simulation tool, CBECC-Com 2019.1.3 Beta, as the simulation engine, evaluated energy impacts using the 2019 Title 24 prescriptive standards as the benchmark, and the 2019 TDV values. CBECC-Com was used for this analysis to evaluate the high-rise building for code compliance under the 2019 non-residential standards. TDV is the energy metric used by the Energy Commission since the 2005 Title 24 energy code to evaluate compliance with the Title 24 Standards.

Using the 2019 baseline as the starting point, prospective energy efficiency measures were identified and modeled to determine the projected site energy (Therm and kWh) and compliance impacts. Annual utility costs were calculated using hourly data output from CBECC-Com, and electricity and natural gas tariffs for each of the investor owned utilities (IOUs).

This analysis focused on the residential apartments only. A prior study and report demonstrated the cost-effectiveness of above code packages for nonresidential buildings (Statewide Reach Codes Team, 2019a). The Statewide Reach Codes Team selected measures for evaluation based on the residential and nonresidential 2019 reach code analysis ((Statewide Reach Codes Team, 2019a), (Statewide Reach Codes Team, 2019b)) as well as experience with and outreach to architects, builders, and engineers along with general knowledge of the relative acceptance of many measures. Efficiency measure packages found to be cost-effective in the nonresidential building reach code analysis were applied to the nonresidential spaces for evaluating performance relative to compliance, but the incremental costs and energy impacts of these measures on the nonresidential spaces were not included in this analysis. Refer to the nonresidential reach code study for more details (Statewide Reach Codes Team, 2019a).

Federal Preemption

The Department of Energy (DOE) sets minimum efficiency standards for equipment and appliances that are federally regulated under the National Appliance Energy Conservation Act (NAECA), including heating, cooling, and water heating equipment. Since state and local governments are prohibited from adopting policies that mandate higher minimum efficiencies than the federal standards require, the focus of this study is to identify and evaluate cost-effective packages that do not include high efficiency equipment. While this study is limited by federal preemption, in practice builders may use any package of compliant measures to achieve the performance goals, including high efficiency appliances. Often, these measures are the simplest and most affordable measures to increase energy performance.

Energy Efficiency Measures

Following are descriptions of each of the efficiency measures evaluated for the residential spaces under this analysis. Because not all of the measures described below were found to be cost-effective, and cost-effectiveness varied by climate zone, not all measures are included in all packages and some of the measures listed are not included in any final package.

Improved Fenestration – Lower U-factor: Reduce window U-factor to 0.25 Btu/hr-ft^2-°F. The prescriptive maximum U-factor is 0.36 in all climates. This measure is applied to all windows on floors two through ten.

Improved Fenestration – Lower SHGC: Reduce window solar heat gain coefficient (SHGC) to 0.22. The prescriptive maximum SHGC is 0.25 for fixed windows in all climates. This measure is applied to all windows on floors two through ten.

Exterior Wall Insulation: Add one inch of R-4 exterior continuous insulation. To meet the prescriptive wall requirements, it is assumed that exterior wall insulation is used in the base case, therefore this measure adds additional R-value to existing exterior insulation. This measure is applied to all walls on floors two through ten.

HERS Verification of Hot Water Pipe Insulation: The California Plumbing Code (CPC) requires pipe insulation on all hot water lines. This measure provides credit for HERS Rater verification of pipe insulation requirements according to the procedures outlined in the 2019 Reference Appendices RA3.6.3. (California Energy Commission, 2018b).

Low Pressure Drop Ducts: Upgrade the duct distribution system to reduce external static pressure and meet a maximum fan efficacy of 0.25 watts per cfm operating at full speed. This may involve upsizing ductwork, reducing the total effective length of ducts, and/or selecting low pressure drop components, such as filters. This measure is applied to the ducted split heat pumps serving the apartments.

Solar Thermal: Prescriptively, central water heating systems require a solar thermal system with a 20% solar fraction in Climates Zones 1 through 9 and 35% solar fraction in Climate Zones 10 through 16. This measure upgrades the prescriptive solar thermal system to meet a 50% solar fraction in all climates, assuming there is available roof space for the additional collectors.

Energy Recovery Ventilation: An energy recovery ventilation system installed on the central DOAS with 67 percent sensible recovery effectiveness and 1.0 W/cfm fan efficacy (including both supply and return fans). The DOAS in the basecase model also has a 1.0 W/cfm fan efficacy, so there is no fan credit or penalty evaluated for this measure.

Efficiency measures were applied to the nonresidential spaces based on the 2019 Nonresidential Reach Code Cost-Effectiveness Study (Statewide Reach Codes Team, 2019a).

All Electric Measures

Since the base case prototype model assumes individual heat pumps for space heating and all electric appliances in the apartments, the domestic hot water system is the only equipment serving the apartment spaces to electrify in the all-electric design. The Statewide Reach Codes Team evaluated two configurations for electric heat pump water heaters (HPWHs) described below.

Clustered Heat Pump Water Heater: This clustered design uses residential integrated storage HPWHs to serve more than one apartment; 4 to 5 bedrooms on average for a total of 38 HPWHs in the 117-unit, 162-bed building. The water heaters are located in interior closets throughout the building and designed for short plumbing runs without using a hot water recirculation loop. A minimum efficiency 2.0 UEF HPWH was used for this analysis (to avoid federal preemption). This approach has been selectively used in multifamily projects because of its reliance on lower cost small capacity HPWH products. Since it uses residential equipment with each HPWH serving fewer than 8 apartments the CBECC-Com compliance software had the capability to evaluate this design strategy, even before central HPWH recirculation options were incorporated into the software. The clustered strategy is not a prescriptive option but is allowed in the performance path if the water heater serves no more than 8 units and has no recirculation control. The standard design assumes solar thermal, so the proposed design is penalized in compliance for no solar thermal and made up with other efficiency measures.

Prescriptive Central Heat Pump Water Heater: Per Section 150.1(c)8C of the 2019 Standards, the Energy Commission made an executive determination outlining requirements of a prescriptive approach for central heat pump water heating systems in December 2019 (California Energy Commission, 2019b). Key aspects of the prescriptive approach are described below:

- The system must be configured with a design similar to what is presented in the schematic in Figure 2 of the executive determination document.
- HPWH must be single-pass split system with the compressor located outdoors and be able to operate down to -20°F. In CBECC-Com 2019.1.2, the current version at the time of writing this report, the software only has the capability of modeling Sanden HPWHs.
- The system must include either a solar thermal water heating system that meets the current prescriptive requirements or 0.1 kW_{DC} of photovoltaic system capacity per apartment/dwelling unit.

For this configuration, the Statewide Reach Codes Team evaluated costs for a central HPWH system using Sanden compressors that met these prescriptive requirements. Based on the system sizing requirements, 19 Sanden units and 1,520 gallons of primary storage capacity are required for the 117-unit building.

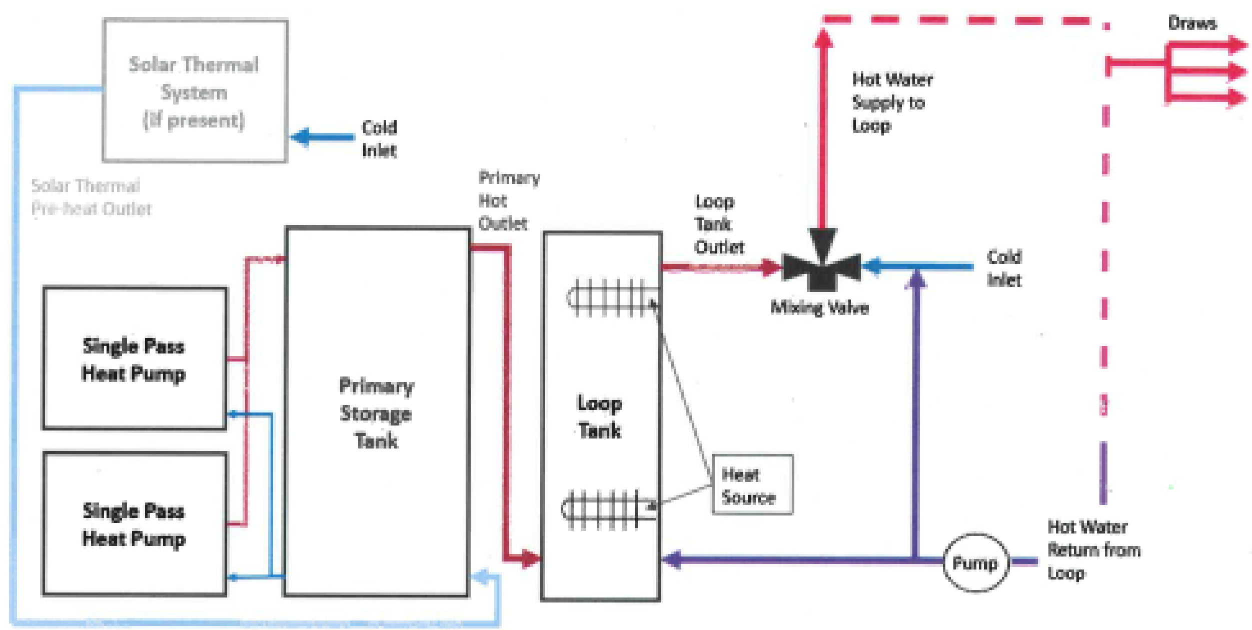


Figure 2: Prescriptive central heat pump water heater system schematic.

All-electric measures were applied to the nonresidential spaces based on the 2019 Nonresidential Reach Code Cost-Effectiveness Study (Statewide Reach Codes Team, 2019a).

Renewable Energy

Solar Photovoltaic (PV): There is no existing requirement for PV in the 2019 Title 24 nonresidential code for high-rise residential buildings (four or more stories). The PV sizing methodology was developed to offset a portion of annual residential electricity use and avoid oversizing which would violate net energy metering (NEM) rules. In all cases, PV is evaluated using the PV simulations within CBECC-Com using a Standard module type, 180-degree azimuth, and 22-degree tilt. The analysis evaluated a PV system capacity equal to 0.1 kW_{DC} per apartment. The benefit of the PV was applied to the apartment units.

Package Development

Four packages were evaluated for each climate zone, as described below.

1) **Efficiency – Mixed-Fuel**: This package applies efficiency measures that do not trigger federal preemption including envelope, water heating distribution, and duct distribution efficiency measures.
2) **Efficiency – All Electric**: This package applies efficiency measures that do not trigger federal preemption in addition to converting any natural gas appliances to electric appliances. For the residential spaces, only water heating is converted from natural gas to electric.
3) **Efficiency & PV – Mixed-Fuel**: Beginning with the Efficiency Package, PV was added to offset a portion of the apartment estimated electricity use.
4) **Efficiency & PV – All Electric**: Beginning with the Efficiency Package, PV was added to offset a portion of the apartment estimated electricity use.

Incremental Costs

Energy Efficiency Measure Costs

Table 2 summarizes the incremental cost assumptions for measures evaluated in this study relative to the residential parts of the building. Incremental costs represent the equipment, installation, replacement, and maintenance costs of the proposed measures relative to the base case. Replacement costs are applied to PV inverters over the 30-year evaluation period. There is no assumed incremental maintenance on the envelope, HVAC, or DHW measures. Costs were estimated to reflect costs to the building owner. When costs were obtained from a source that did not already include builder overhead and profit, a markup of 10% was added. All costs are provided as present value in 2020 (2020 PV$). Costs due to variations in furnace, air conditioner, and heat pump capacity by climate zone were not accounted for in the analysis. While the efficiency measures will reduce required cooling and heating capacities, in most cases they will not be reduced enough to drop to the next nominal capacity system.

Table 2: Incremental Cost Assumptions

Measure	Performance Level	Incremental Cost (2020 PV$)	Source & Notes
Window U-factor	0.25 vs 0.36	$27,342	$6.95/ft^2 window area based on analysis conducted for the 2019 and 2022 Title 24 code cycles (Statewide CASE Team, 2018).
Window SHGC	0.22 vs 0.25	$0	Data from CASE Report along with direct feedback from Statewide CASE Team that higher SHGC does not necessarily have any incremental cost impact (Statewide CASE Team, 2017b).
Exterior Wall Insulation	Add 1-inch	$8,497	$0.86/ft^2 based on adding 1" of exterior insulation on a wall with some level of existing exterior insulation. Costs are averaged from two sources ((Statewide CASE Team, 2014), (Statewide CASE Team, 2017a)) and for expanded polystyrene (EPS) and polyisocyanurate products with a 10% mark-up added to account for cost increases between the time of the reports and 2020.
HERS Verified Pipe Insulation	HERS verified pipe insulation vs no verification	$13,275	$83 per apartment for a HERS Rater to conduct verification of pipe insulation based on feedback from HERS Raters.
Low Pressure Drop Duct Design	0.25 W/cfm vs 0.35 W/cfm	$16,824	$144 per apartment. Costs assume 1.5 hours labor per multifamily apartment. Labor rate of $96 per hour is from 2019 RSMeans for sheet metal workers and includes an average City Cost Index for labor for California cities.
Central HRV/ERV (on central DOAS)	HRV/ERV with 67% sensible heat recovery and bypass	$110,331	Based on costs from the 2022 CASE Repot (Statewide CASE Team, 2020b)
Solar Thermal	50% solar fraction vs prescriptive 20%-35%	$59,452 - $84,932	Costs based on 2022 multifamily solar thermal measure CASE proposal (Statewide CASE Team, 2020a) and include first cost of $70,727 and $8,834 present value for replacement/maintenance costs.
Renewable Energy (PV)			
PV System	System size varies	$3.17/$W_{DC}$	First costs are from LBNL's Tracking the Sun 2018 costs (Barbose et al., 2018) and represent costs for the first half of 2018 of $2.90/$W_{DC}$ for nonresidential systems ≤500 kW_{DC}. These costs were reduced by 16% for the solar investment tax credit, which is the average credit over years 2020-2022. Inverter replacement cost of $0.14/$W_{DC}$ present value includes replacements at year 11 at $0.15/$W_{DC}$ (nominal) and at year 21 at $0.12/$W_{DC}$ (nominal) per the 2019 PV CASE Report (California Energy Commission, 2017). System maintenance costs of $0.31/$W_{DC}$ present value assumes additional $0.02/$W_{DC}$ (nominal) annually per the 2019 PV CASE Report (California Energy Commission, 2017). 10% overhead and profit added to all costs.

All Electric Measure Costs

The Statewide Reach Codes Team reached out to stakeholders to collect project cost information for central gas boilers and both clustered and central HPWH designs. Project data sources included Association for Energy Affordability (AEA), Redwood Energy, Mithun, Ecotope, and the All-Electric Multifamily Compliance Pathway 2022 Draft CASE Report (Statewide CASE Team, 2020a). Costs are presented in Table 3.

Table 3: Costs for Gas versus Electric Water Heating Equipment over 30-Year Period of Analysis

	Central Gas Boiler (CZs 1-9)	Central Gas Boiler (CZs 10-16)	Clustered HPWH	Central HPWH
System Quantity/Description	1 boiler recirc		38 units 50 gal each no recirc	19 units 1,547-gal total recirc
Total Equipment Cost	$131,270		$153,409	$270,261
Solar Thermal	(20% SF) 122,216	(35% SF) $147,696	-	-
Solar PV	-	-	-	$31,351 (8.8 kW_{DC})
Total First Cost	$202,920	$224,641	$153,409	$301,612
Maintenance/Replacement Cost (NPV)	$84,257	$84,257	$98,467	$147,450
Total Cost (NPV)	$343,653	$369,133	$251,876	$454,745
Incremental Cost CZ 1-9 (NPV)			($91,777)	$111,092
Incremental Cost CZ 10-16 (NPV)			($117,257)	$85,612

Typical costs for the water heating systems are based on the following assumptions:

Central Gas Boiler: Based on the average of total estimated project costs from contractors for four multi-family projects ranging from 32 to 340 apartments and cost estimates for mid-rise and high-rise buildings from the All-Electric Multifamily Compliance Pathway 2022 Draft CASE Report (Statewide CASE Team, 2020a). The cost per dwelling unit ranged from $547 to $2,089 and the average cost applied in this analysis was $1,122 per dwelling unit. Costs include installation of gas piping from the building meter to the water heater. Water heater lifetime is assumed to be 15 years and the net present value replacement cost at year 15 is $84,257.

Clustered HPWH: Based on costs from one project with RHEEM HPWHs used in a clustered design. Costs include water heater interior closet, electrical outlets, and increased breaker size and sub feed. Water heater based on 2.0 UEF 80-gallon appliance with 38 total HPWHs serving the building (1 per 4 to 5 bedrooms). Water heater lifetime is assumed to be 15 years and the net present value replacement cost at year 15 is $98,467. This design assumes 8 water heater closets per floor, at approximately 15 square feet per closet. While this has an impact on leasable floor area, the design impacts have been found to be minimal when addressed early in design and is equivalent to less than one percent of the residential floor area.

Central HPWH: Based on average total installed project costs from four multi-family projects with Sanden HPWHs ranging from 4 to 16 Sanden units per project. The cost per Sanden HPWH ranged from $13,094 to $15,766 and the average cost applied in this analysis was $14,224 per HPWH. Based on the prescriptive system sizing requirements, 19 Sanden units are required for the 117-unit building, resulting in a total first cost of $270,261. Water heater lifetime is assumed to be 15 years. Because Sanden HPWHs are an emerging technology in the United States, it is expected that over time their costs will decrease and for replacement at year 15 the costs are assumed to have decreased by 15%.

Solar Thermal: Based on system costs provided in the All-Electric Multifamily Compliance Pathway 2022 Draft CASE Report (Statewide CASE Team, 2020a). First costs reflect the material, labor, and markup costs presented in the Draft CASE Report for the high-rise prototype. Replacement and maintenance costs assume replacement of the solar thermal tank at year 15 at $6,110 and glycol replacement of $1,300 each time at years 9, 18, and 27. The cost of the remaining useful life of the glycol at year 30 is deducted from the final cost. The Draft CASE Report included costs for replacing the solar collectors at year 20. Collectors can have longer lifetimes up to 30 years if well maintained, therefore this analysis does not assume any replacement of the collectors over the 30-year analysis period.

Table 4: Solar Thermal Detailed Costs over 30-Year Period of Analysis

Solar Fraction	20%	35%
Materials	$39,854	$57,450
Labor	$56,001	$58,390
Markup	27.5%	27.5%
First Cost	$122,216	$147,696
Replacement/Maintenance (2020 $PV)	$5,910	$5,910
Total Cost (2020 $PV)	**$128,126**	**$153,605**

Natural Gas Infrastructure Costs

This analysis assumes that in an all-electric new construction project, natural gas would not be supplied to the building. Eliminating natural gas to the building would save costs associated with connecting a service line from the street main to the building, piping distribution within the building, and monthly meter connection charges from the utility. Incremental costs for natural gas infrastructure in the mixed-fuel building are presented in Table 5. Cost data for the plan review and service extension was estimated on a per building basis and then apportioned to the residential and nonresidential portions of the buildings based on annual gas consumption. For the base case prototype building 49% to 82% of estimated building annual gas use is attributed to the residential water heating system across all climate zones. A statewide average of 75% was calculated and applied to the costs in Table 5 based on housing starts provided by the California Energy Commission for the 2019 Title 24 code development process. The meter costs were based on the service provided to the residential and nonresidential portion of the building separately. Following the table are descriptions of assumptions for each of the cost components. Costs for gas piping from the meter to the gas boilers are included in the central gas boiler costs above. Gas piping distribution costs were typically included in total project costs and could not be broken out in all cases.

Table 5: Natural Gas Infrastructure Cost Savings for All-Electric Building

Item	Total	NonResidential Portion	Residential Portion
Natural Gas Plan Review	$2,316	$588	$1,728
Service Extension[1]	$4,600	$1,169	$3,431
Meter	$7,200	$3,600	$3,600
Total First Cost	***$14,116***	***$5,357***	***$8,759***

[1]Service extension costs include 50% reduction assuming portion of the costs are passed on to gas customers.

Natural Gas Plan Review: Total costs are based on TRC's 2019 reach code analysis for Palo Alto (TRC, 2019) and then split between the residential and nonresidential spaces in the building proportionately according to annual gas consumption with 75% of the annual load is attributed to residential units on a statewide basis.

Service Extension: Service extension costs to the building were taken from PG&E memo dated December 5, 2019, to Energy Commission staff, include costs for trenching, and assume non-residential new construction within a developed area. The total cost of $9,200 from the memo is reduced by 50% to account for the portion of the costs paid for by all customers due to application of Utility Gas Main Extensions rules[1]. The resultant cost is apportioned between the residential and nonresidential spaces in the building based on annual gas consumption of residential and nonresidential uses, with 75% of the annual load natural gas use attributed to residential units on a statewide basis.

Meter: Cost per meter provided by PG&E for commercial meters. Assume one meter for nonresidential boilers serving space heating and service water heating, and another for residential boilers serving domestic hot water.

Cost-effectiveness

Cost-effectiveness is presented based on both TDV energy, using the Energy Commission's LCC methodology, and an On-Bill approach using residential customer utility rates. Both methodologies require estimating and quantifying the value of the energy impact associated with energy efficiency measures over the life of the measures (30 years) as compared to the prescriptive Title 24 requirements.

Cost-effectiveness is presented using both lifecycle net present value (NPV) savings and benefit-to-cost (B/C) ratio metrics, which represent the cost-effectiveness of a measure over a 30-year lifetime taking into account discounting of future savings and costs.

- **Net Present Value (NPV) Savings:** NPV benefits minus NPV costs is reported as a cost effectiveness metric. If the net savings of a measure or package is positive, it is considered cost effective. Negative savings represent net costs. A measure that has negative energy cost benefits (energy cost increase) can still be cost effective if the costs to implement the measure are more negative (i.e., material and maintenance cost savings).
- **Benefit-to-Cost (B/C) Ratio:** Ratio of the present value of all benefits to the present value of all costs over 30 years (NPV benefits divided by NPV costs). The criteria for cost effectiveness is a B/C ratio greater than 1.0. A value of one indicates the NPV of the savings over the life of the measure is equivalent to the NPV of the lifetime incremental cost of that measure. A value greater than one represents a positive return on investment. The B/C ratio is calculated according to Equation 1.

Equation 1

$$Benefit - to - Cost\ Ratio = \frac{NPV\ of\ lifetime\ benefit}{NPV\ of\ lifetime\ cost}$$

Improving the efficiency of a project often requires an initial incremental investment. In most cases the benefit is represented by annual "On-Bill" utility or TDV savings, and the cost by incremental first cost and replacement costs. However, some packages result in initial construction cost savings (negative incremental cost), and either energy cost savings (positive benefits), or increased energy costs (negative benefits). In cases where both construction costs and energy-related savings are negative, the construction cost savings are treated as the 'benefit' while the increased energy costs are the 'cost.' In cases where a measure or package is cost-effective immediately (i.e. upfront construction cost savings and lifetime energy cost savings), B/C ratio cost-effectiveness is represented by ">1". Because of these situations, NPV savings are also reported, which, in these cases, are positive values.

The lifetime costs or benefits are calculated according to Equation 2.

[1] PG&E Rule 15: https://www.pge.com/tariffs/tm2/pdf/GAS_RULES_15.pdf

Equation 2

$$PV\ of\ lifetime\ cost/benefit = \sum_{t=1}^{n} Annual\ cost/benefit_t * (1+r)^t$$

Where:

- *n* = analysis term
- *r* = real discount rate
- *t* = year at which cost/benefit is incurred

The following summarizes the assumptions applied in this analysis to both methodologies.

- Analysis term of 30 years
- Real discount rate of 3% (does not include inflation)

On-Bill Customer Lifecycle Cost

Residential utility rates were used to calculate utility costs for all cases and determine On-Bill customer cost-effectiveness for the proposed packages. Utility costs of the nonresidential spaces were not evaluated in this study, only apartment and water heating energy use. The Statewide Reach Codes Team obtained the recommended utility rates from representative utility based on the assumption that the reach codes go into effect in 2020. Annual utility costs were calculated using hourly electricity and gas output from CBECC-Com, and applying PG&E utility tariffs summarized in Table 6. Appendix A – PG&E Utility Rate Tariffs includes details on the utility rate schedules used for this study. The applicable residential time-of-use (TOU) rate was applied to all cases. For cases with PV generation, the approved NEM2 tariffs were applied along with minimum daily use billing and mandatory non-bypassable charges. For the PV cases annual electric production was always less than annual electricity consumption; and therefore, no credits for surplus generation were necessary. Future changes to the NEM tariffs are likely; however, there is a lot of uncertainty about what those changes will be and when they will become effective.

Based on guidance from the IOUs, the residential electric TOU tariffs that apply to individually metered residential apartments were also used to calculate electricity costs for the central water heating systems. Baseline allowances included in the electric tariff were applied on a per unit basis for all-electric service.

Based on guidance from PG&E, master metered multifamily service gas tariffs were used to calculate gas costs for the central water heating systems. The baseline quantities were applied on a per unit basis, as is defined in the schedules, and when available water heating only baseline values were used.

Utility rates were applied using the rates presented in Table 6. San Jose Clean Energy (SJCE) rates were not evaluated but the tariffs are very similar and the tariff structure identical to PG&E's E-TOU-C tariff. Total electricity rate differences per kWh are less than one cent between PG&E's E-TOU-C and either SJCE's GreenSource or TotalGreen.

Table 6: IOU Utility Tariffs Applied Based on Climate Zone

Climate Zones	Electric/Gas Utility	Electricity (Apartment Use)	Electricity (Central Water Heating)	Natural Gas (Central Water Heating)[1]
4	PG&E	E-TOU-C	E-TOU-C	PG&E GM

[1] This rate is allowed assuming no gas is used in the apartments.

Utility rates are assumed to escalate over time, using assumptions from research conducted by Energy and Environmental Economics (E3) in the 2019 study Residential Building Electrification in California (Energy & Environmental Economics, 2019). Escalation of natural gas rates between 2019 and 2022 is based on the currently filed General Rate Cases (GRCs) for PG&E. From 2023 through 2025, gas rates are assumed to escalate at 4% per year above inflation, which reflects historical rate increases between 2013 and 2018. Escalation of electricity rates from 2019 through 2025 is assumed to be 2% per year above inflation, based on electric utility estimates. After 2025, escalation rates for both natural gas and electric rates are assumed to drop to a more conservative 1% escalation per year above inflation for long-term rate trajectories beginning in 2026 through 2050. See the statewide mid-rise new construction cost-effectiveness report (Statewide Reach Codes Team, 2020) for additional details.

TDV Lifecycle Cost

Cost-effectiveness was also assessed using the Energy Commission's TDV LCC methodology. TDV is a normalized monetary format developed and used by the Energy Commission for comparing electricity and natural gas savings, and it considers the cost of electricity and natural gas consumed during different times of the day and year. Two versions of TDV were evaluated in this study: the 2019 TDV values used under the current 2019 Title 24 code for code compliance and the 2022 TDV values recently developed and approved by the California Energy Commission for the 2022 Title 24 cycle which will become effective January 1, 2023.

The CEC adopted the Time Dependent Valuation (TDV) methodology to more accurately reflect the variations in the value of energy used (or saved) based on the mix of generation resources and demand on the grid at any given time, as well as impacts on retail energy costs. The 2022 TDV values reflect changes in the generation mix as well as the shift in the peak demand time from mid-afternoon toward early evenings.

The TDV values are based on long term discounted costs of 30 years for all residential measures. The CBECC-Com simulation software results are expressed in terms of TDV kBtus. The present value of the energy cost savings in dollars is calculated by multiplying the TDV kBtu savings by a net present value (NPV) factor, also developed by the Energy Commission. The 30-year NPV factor is $0.154/TDV kBtu for nonresidential projects under both the 2019 and 2022 Title 24.

Like the customer B/C ratio, a TDV B/C ratio value of one indicates the savings over the life of the measure are equivalent to the incremental cost of that measure. A value greater than one represents a positive return on investment. The ratio is calculated according to Equation 3.

Equation 3

$$TDV\ Benefit - to - Cost\ Ratio = \frac{TDV\ energy\ savings\ *\ NPV\ factor}{NPV\ of\ lifetime\ incremental\ cost}$$

2019 and 2022 TDV Differences

There were key changes to the 2022 TDV methodology as compared to the 2019 TDV. Major updates include the following and are further described in the final 2022 TDV methodology report (Energy & Environmental Economics, 2020).

- Updated weather files to reflect historical data from recent years
- New load profiles representing building and transportation electrification and renewable generation
- Addition of internalized cost streams to account for carbon emissions
- Shaped retail rate adjustment partially scaled to hourly marginal cost of service
- Addition of non-combustion emissions from methane and refrigerant leakage

The impact of these key changes for electricity TDV are lower values during the mid-day that correspond with an over-supply of solar production and a shift of the peak TDV to later in the day as a result of increasing levels of rooftop PV systems. However, the overall magnitude of the 2022 TDV does not increase significantly relative to 2019 TDV. For natural gas TDV there is a large increase in magnitude with the 2022 TDV roughly 40 percent higher than in 2019. This is driven by the new retail rate forecast, increased fixed costs for maintaining the distribution system, and the new carbon cost component.

The updated weather files represent an updated dataset based on historical weather sampled from recent years (1998-2017) to reflect the impacts of climate change. Cooling loads increase significantly, particularly for the mild climates zones where cooling energy use was previously low. Heating loads decrease on average 30 percent across the 16 climate zones. The weather files used for the 2019 code cycle had not been updated since the 2013 code cycle. The California Energy Commission and the Statewide Reach Codes Team contend that the updated 2022 weather files better reflect changing climate conditions in California.

Greenhouse Gas Emissions

Equivalent CO_2 emission savings were calculated based on estimates from Zero Code reports available in CBECC-Com simulation software.[2] Electricity emissions vary by region and by hour of the year, accounting for time dependent energy use and carbon emissions based on source emissions, including renewable portfolio standard projections. Hourly profiles for Climate Zones 1 through 5 and 11 through 13 were used in this analysis for Climate Zone 4. For natural gas, a fixed factor of 0.005307 metric tons/therm is used. To compare the mixed fuel and all-electric cases side-by-side, greenhouse gas (GHG) emissions are presented as CO_2-equivalent emissions per dwelling unit.

3 Results & Discussion

The primary objective of the evaluation is to identify cost-effective, non-preempted performance targets for high-rise multifamily buildings, under both mixed-fuel and all-electric cases, to support the design of local ordinances requiring new high-rise residential buildings to exceed the minimum state requirements. The packages presented are representative examples of designs and measures that can be used to meet the requirements. In practice, a builder can use any combination of non-preempted or preempted compliant measures to meet the requirements.
This analysis evaluated a package of efficiency measures applied to a mixed-fuel design and a similar package for an all-electric design. Each design was evaluated using PG&E electric and gas utility rates for San Jose. Solar PV was also added to the all-electric packages.

Table 7 presents measures that are included in the mixed-fuel and all-electric packages for Climate Zone 4.

Table 7: Measure Package Summary

Climate Zone	MEASURE SPECIFICATION	
	Window SHGC	Fan Watt Draw
CZ04	0.22	0.25 W/cfm

Table 8 presents cost effectiveness results for all the Climate Zone 4 packages analyzed over the 30-year period of evaluation. Both mixed-fuel and all-electric results are relative to the mixed-fuel 2019 Title 24 prescriptive baseline. B/C ratios for all packages are presented using the On-Bill methodology as well as both 2019 and 2022 TDV methodologies.

Compliance margin for the Mixed-Fuel case is 7.2 percent, which meets the CALGreen Tier 1 energy performance requirement for high-rise residential buildings of at least 5 percent. This package is cost-effective based on all three metrics.

[2] More information at: : https://zero-code.org/wp-content/uploads/2018/11/ZERO-Code-TSD-California.pdf

The all-electric packages, with the clustered and the Sanden heat pump water heater scenarios, have compliance margins from two and four percent, respectively without PV. All four scenarios are cost-effective based on 2022 TDV. Only the clustered heat pump water heater scenarios are cost-effective based on 2019 TDV, although the Sanden combined with PV is very close. Both scenarios with PV as well as the clustered HPWH without PV are cost effective from an on-bill perspective.

The results are based on PG&E electricity rates and not SJCE rates. However, because of the similarities between the two tariffs, the Statewide CASE Team concludes that results will be very similar, and the conclusions remain even for customers under SJCE tariffs.

Table 8: Climate Zone 4 Mixed Fuel & All-Electric Results per Apartment[1]

						On-Bill			2019 TDV		2022 TDV	
CASE	Comp. Margin	Total Gas Savings (therms)	Total Electric Savings (kWh)	GHG Reductions (lb CO2)	Incremental Cost	30-yr Utility Cost Savings (2020 PV$)	B/C Ratio	NPV	B/C Ratio	NPV	B/C Ratio	NPV
Mixed Fuel	7.2%	0	95	37	$144	$678	4.7	$534	3.2	$321	3.2	$313
All-Electric (Sanden HPWH)	4.0%	81	-499	952	$702	$154	0.2	($548)	0.5	-$328	2.5	$1,068
All-Electric (Sanden + PV[2])	5.6%	81	-332	1646	$1,018	$1,238	1.2	$219	0.98	-$21	2.35	$1,375
All-Electric (Clustered HPWH)	2.4%	81	-615	939	-$715	-$422	1.7	$293	>1	$908	>1	$1,654[3]
All-Electric (Clustered + PV[2])	3.9%	81	-449	1032	-$399	$650	>1	$1,049	>1	$1,216	>1	$1,961[3]

[1] Values in red indicate B/C ratios less than 1.

[2] 0.1 kW_{DC} PV per apartment.

[3] Clustered HPWH 2022 analysis completed with the water heaters using outside air as source air, NPV savings results will increase based with interior air as source air as was assumed for the 2019 models.

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Appendix A – PG&E Utility Rate Tariffs

The following pages provide details on the PG&E electricity and natural gas tariffs applied in this study. Table 9 describes the baseline territories that were assumed for each climate zone.

Table 9: PG&E Baseline Territory by Climate Zone

	Baseline Territory
CZ01	V
CZ02	X
CZ03	T
CZ04	X
CZ05	T
CZ11	R
CZ12	S
CZ13	R
CZ16	Y

The PG&E monthly gas rate in $/therm was applied on a monthly basis for the 12-month period ending April 2020 according to the rates shown in Table 10. Rates are based on historical data provided by PG&E.[3]

Table 10: PG&E Monthly Gas Rate ($/Therm)

Month	Procurement Charge	Transportation Charge		Total Charge	
		Baseline	Excess	Baseline	Excess
Jan 2020	$0.45813	$0.99712	$1.59540	$1.45525	$2.05353
Feb 2020	$0.44791	$0.99712	$1.59540	$1.44503	$2.04331
Mar 2020	$0.35346	$1.13126	$1.64861	$1.48472	$2.00207
Apr 2020	$0.23856	$1.13126	$1.64861	$1.36982	$1.88717
May 2019	$0.21791	$0.99933	$1.59892	$1.21724	$1.81683
June 2019	$0.20648	$0.99933	$1.59892	$1.20581	$1.80540
July 2019	$0.28462	$0.99933	$1.59892	$1.28395	$1.88354
Aug 2019	$0.30094	$0.96652	$1.54643	$1.26746	$1.84737
Sept 2019	$0.25651	$0.96652	$1.54643	$1.22303	$1.80294
Oct 2019	$0.27403	$0.98932	$1.58292	$1.26335	$1.85695
Nov 2019	$0.33311	$0.96729	$1.54767	$1.30040	$1.88078
Dec 2019	$0.40178[7/]	$0.96729	$1.54767	$1.36907	$1.94945

[3]The PG&E procurement and transportation charges were obtained from the following site: https://www.pge.com/tariffs/GRF.SHTML#RESGAS

Pacific Gas and Electric Company
U 39 San Francisco, California

	Revised	Cal. P.U.C. Sheet No.	46539-E
Cancelling	Revised	Cal. P.U.C. Sheet No.	46325-E

ELECTRIC SCHEDULE E-TOU-C Sheet 2
RESIDENTIAL TIME-OF-USE (PEAK PRICING 4 - 9 p.m. EVERY DAY)

RATES:
(Cont'd.)

E-TOU-C TOTAL RATES

Total Energy Rates ($ per kWh)	PEAK		OFF-PEAK		
Summer					
Total Usage	$0.41333	(I)	$0.34989	(I)	
Baseline Credit (Applied to Baseline Usage Only)	($0.08633)	(R)	($0.08633)	(R)	
Winter					
Total Usage	$0.31624	(I)	$0.29891	(I)	
Baseline Credit (Applied to Baseline Usage Only)	($0.08633)	(R)	($0.08633)	(R)	
Delivery Minimum Bill Amount ($ per meter per day)	$0.32854				
California Climate Credit (per household, per semi-annual payment occurring in the April and October bill cycles)[†]	($35.73)				(T)

Total bundled service charges shown on customer's bills are unbundled according to the component rates shown below. Where the delivery minimum bill amount applies, the customer's bill will equal the sum of (1) the delivery minimum bill amount plus (2) for bundled service, the generation rate times the number of kWh used. For revenue accounting purposes, the revenues from the delivery minimum bill amount will be assigned to the Transmission, Transmission Rate Adjustments, Reliability Services, Public Purpose Programs, Nuclear Decommissioning, Competition Transition Charges, Energy Cost Recovery Amount, DWR Bond, and New System Generation Charges based on kWh usage times the corresponding unbundled rate component per kWh, with any residual revenue assigned to Distribution.

[†] Pursuant to D.20-04-027, distribution of the October 2020 California Climate Credit will be advanced and split to the May 2020 and June 2020 bill cycles, $17.87 and $17.86 respectively.. (N) (N)

(Continued)

Advice	5661-E-B	*Issued by*	*Submitted*	April 28, 2020
Decision		***Robert S. Kenney***	*Effective*	May 1, 2020
		Vice President, Regulatory Affairs	*Resolution*	

Pacific Gas and Electric Company
U 39
San Francisco, California

	Revised	Cal. P.U.C. Sheet No.	46540-E
Cancelling	Revised	Cal. P.U.C. Sheet No.	46252-E

ELECTRIC SCHEDULE E-TOU-C Sheet 3
RESIDENTIAL TIME-OF-USE (PEAK PRICING 4 - 9 p.m. EVERY DAY)

RATES:
(Cont'd.)

UNBUNDLING OF E-TOU-C TOTAL RATES

Energy Rates by Component ($ per kWh)	PEAK		OFF-PEAK	
Generation:				
Summer (all usage)	$0.16735	(R)	$0.11391	(R)
Winter (all usage)	$0.11859	(R)	$0.10356	(R)
Distribution**:				
Summer (all usage)	$0.12767	(I)	$0.11767	(I)
Winter (all usage)	$0.07935	(I)	$0.07705	(I)

Conservation Incentive Adjustment (Baseline Usage)	($0.03294)	(I)
Conservation Incentive Adjustment (Over Baseline Usage)	$0.05339	(I)
Transmission* (all usage)	$0.03595	
Transmission Rate Adjustments* (all usage)	$0.00314	
Reliability Services* (all usage)	($0.00066)	
Public Purpose Programs (all usage)	$0.01296	(I)
Nuclear Decommissioning (all usage)	$0.00101	(I)
Competition Transition Charges (all usage)	$0.00096	(R)
Energy Cost Recovery Amount (all usage)	$0.00005	(I)
DWR Bond (all usage)	$0.00580	
New System Generation Charge (all usage)**	$0.00571	(I)

* Transmission, Transmission Rate Adjustments and Reliability Service charges are combined for presentation on customer bills.
** Distribution and New System Generation Charges are combined for presentation on customer bills.

(Continued)

Advice	5661-E-B	*Issued by*	*Submitted*	April 28, 2020
Decision		**Robert S. Kenney**	*Effective*	May 1, 2020
		Vice President, Regulatory Affairs	*Resolution*	

ELECTRIC SCHEDULE E-TOU-C Sheet 4 (T)
RESIDENTIAL TIME-OF-USE (PEAK PRICING 4 - 9 p.m. EVERY DAY)

SPECIAL CONDITIONS:

1. BASELINE (TIER 1) QUANTITIES: The following quantities of electricity are to be used to define usage eligible for the baseline credit (also see Rule 19 for additional allowances for medical needs):

BASELINE QUANTITIES (kWh PER DAY)

Baseline Territory*	Code B - Basic Quantities		Code H - All-Electric Quantities	
	Summer Tier I	Winter Tier I	Summer Tier I	Winter Tier I
P	14.2	12.0	16.0	27.4
Q	10.3	12.0	8.9	27.4
R	18.6	11.3	20.9	28.1
S	15.8	11.1	18.7	24.9
T	6.8	8.2	7.5	13.6
V	7.5	8.8	10.9	16.9
W	20.2	10.7	23.6	20.0
X	10.3	10.5	8.9	15.4
Y	11.0	12.1	12.6	25.3
Z	6.2	8.1	7.0	16.5

2. TIME PERIODS FOR **E-TOU-C**: Times of the year and times of the day are defined as follows: (T)

Summer (service from June 1 through September 30):

Peak:	4:00 p.m. to 9:00 p.m.	All days
Off-Peak:	All other times	

Winter (service from October 1 through May 31):

Peak:	4:00 p.m. to 9:00 p.m.	All days
Off-Peak:	All other times	

* The applicable baseline territory is described in Part A of the Preliminary Statement

(Continued)

Pacific Gas and Electric Company
U 39 *San Francisco, California*

	Revised	*Cal. P.U.C. Sheet No.*	35762-G
Cancelling	Revised	*Cal. P.U.C. Sheet No.*	35696-G

GAS SCHEDULE GM
MASTER-METERED MULTIFAMILY SERVICE

Sheet 2

RATES: Customers on this schedule pay a Procurement Charge and a Transportation Charge, per meter, as follows:

	Per Therm Baseline		Per Therm Excess	
Procurement Charge:	$0.23856	(R)	$0.23856	(R)
Transportation Charge:	$1.13126		$1.64861	
Total:	$1.36982	(R)	$1.88717	(R)
California Natural Gas Climate Credit (per Household, annual payment occurring in the April bill cycle)	($27.18)			

Public Purpose Program Surcharge:

Customers served under this schedule are subject to a gas Public Purpose Program (PPP) Surcharge under Schedule G-PPPS.

See Preliminary Statement, Part B for the Default Tariff Rate Components.

The Procurement Charge on this schedule is equivalent to the rate shown on informational Schedule G-CP—Gas Procurement Service to Core End-Use Customers.

Pacific Gas and Electric Company		Revised	*Cal. P.U.C. Sheet No.*	35447-G
U 39 San Francisco, California	*Cancelling*	Revised	*Cal. P.U.C. Sheet No.*	34307-G

GAS SCHEDULE GM Sheet 3

MASTER-METERED MULTIFAMILY SERVICE

BASELINE QUANTITIES: The above rates are applicable only to residential use. PG&E may require the Customer to submit a completed "Declaration of Eligibility for Baseline Quantities for Residential Rates." The delivered quantities of gas shown below are billed at the rates for baseline use. As an exception, service under this schedule not used to supply space heating but used to supply water heating from a central source to residential dwelling units that are individually metered by PG&E for either gas or electricity will be billed using a baseline quantity of 0.5 therms per dwelling unit per day (Code W) in all baseline territories and in both seasons.

BASELINE QUANTITIES (Therms Per Day Per Dwelling Unit)

Baseline Territories **	Summer (April-October) Effective Apr. 1, 2020		Winter Off-Peak (Nov,Feb,Mar) Effective Nov. 1, 2019		Winter On-Peak (Dec, Jan) Effective Dec. 1, 2019		(T)
P	0.29	(R)	0.87	(R)	1.00	(I)	
Q	0.49	(R)	0.64	(R)	0.77	(I)	
R	0.33	(R)	0.84	(R)	1.19	(I)	
S	0.29	(R)	0.54	(R)	0.68	(I)	
T	0.49	(R)	0.94	(R)	1.06	(R)	
V	0.56		1.18	(R)	1.29	(I)	
W	0.23	(R)	0.61	(R)	0.87	(R)	
X	0.33	(R)	0.64	(R)	0.77	(I)	
Y	0.36		0.87	(R)	1.00	(I)	

SEASONAL CHANGES: The summer season is April-October, the winter off-peak season is November, February and March, and the winter on-peak season is December and January. Baseline quantities for bills that include the April 1, November 1 and December 1 seasonal changeover dates will be calculated by multiplying the applicable daily baseline quantity for each season by the number of days in each season for the billing period.

STANDARD MEDICAL QUANTITIES: Additional medical quantities (Code M) are available as provided in Rule 19.

RESIDENTIAL DWELLING UNITS: It is the responsibility of the Customer to advise PG&E within 15 days following any change in the number of residential dwelling units, mobile home spaces, and permanent-residence RV units receiving gas service.

CENTRAL BOILERS: Service to central boilers for water and/or space heating will be billed with monthly baseline quantities related to the number of dwelling units furnished such water and/or space heating.

ATTACHMENT B

Updated Natural Gas Infrastructure Prohibition Ordinance
Questions and Answers

1. **What type of construction will the updated natural gas infrastructure prohibition ordinance cover?**
The updated ordinance prohibiting natural gas infrastructure (i.e. natural gas piping to heat water, space, food, etc.) will extend the existing ordinance from new detached accessory dwelling units, single-family, and low-rise multifamily buildings to all new construction with exemptions available for: retail food (cooking appliances only), hospitals, industrial, and manufacturing facilities.

2. **How is a Retail Food Facility identified?**
A Retail Food Facility eligible to have their cooking appliance(s) exempted under the updated ordinance are those defined and permitted by the Santa Clara County Department of Environmental Health. Retail Food Facilities are typically designated on planning documents submitted to the City as they must be designed well in advance of securing a building permit since they must include commercial grade equipment and specifications, such as at least one exhaust hood and replacement air to allow for this use. Please note that for those facilities receiving an exemption, the City's underlying reach code requirements for any mixed use spaces (see Summary), including requiring electrification-readiness, will still apply.

3. **How will the updated ordinance impact restaurant spaces located within a mixed-use building (e.g. residential multifamily dwelling units with ground floor retail, including restaurant space)?**
Restaurants meeting Santa Clara County's Retail Food Facility definition and located within a mixed-use building are eligible to apply for an exemption for its cooking appliances during the building permit approval process. Any approved exemptions would only apply to the designated restaurant space and, for this exempted space, the City's reach code requirements (see Summary) would still apply. The remainder of the building (not included within the restaurant space) would need to be all-electric and comply with the updated ordinance.

4. **What if the restaurant space was located on an upper floor (i.e. not ground floor) of a mixed-use building?**
The same exemption criteria would apply as described in #3 above.

5. **Since the California Energy Commission (CEC)'s Title 24 modeling software currently only allows Sanden single-pass systems to be modeled in order to meet compliance, will new construction projects be able to use larger more central systems as well as multi-pass systems to meet compliance in the future?**
Yes. The CEC currently has a version of compliance software for Nyle and Colmac and possibly AO Smith using a single-pass system. This updated version is undergoing testing and will be made available for the public to use by the end of 2020. Future versions of the software, expected by mid-2021, will allow for multi-pass systems to be modeled in the software. In the meantime, the City will consider alternate calculation methodologies that can be used to demonstrate compliance with the CEC's current energy modeling software.

6. **How would the updated ordinance apply to a core and shell development project that does not yet have tenants, but whose future tenants may be interested in installing a Retail Food Facility (such as a restaurant) in the future?**
   The California Retail Food Code and Santa Clara County Department of Environmental Health mandate specific construction requirements, such as grease ducts, for Retail Food Facility/restaurant spaces. Since these requirements need to be included as part of the original plan submittal, a Retail Food Facility space would need to be designated as such in a core and shell development project when submitting for a building permit and the updated ordinance would apply to it unless an exemption for the cooking appliance in the eligible facility/space is requested.

7. **What will be the effective date of the updated natural gas infrastructure prohibition? For a project that's in the pipeline, when will those projects be expected to comply with the updated ordinance?**
   City staff are planning to return to City Council in November 2020 and, if approved by Council, anticipate the updated ordinance effective date to be around August 2021. Projects would be expected to comply with the updated ordinance when applying for a building permit after the effective date.

8. **Should the City be requiring all-electric buildings given the potential for future power outages?**
   Power outages, due to wildfires, public safety, or other reasons, are a legitimate concern, but will actually impact new natural gas and electric appliances similarly. The reason for this is that nearly all new gas equipment includes an electronic component to start and operate the equipment for both safety and efficiency. This means that during a power outage, neither gas nor electric equipment (if relatively new) will operate. Additionally, research shows that when gas or electric service is disrupted due to natural disasters (such as an earthquake or fire), the average time to service restoration for electricity has been much faster than for natural gas. There is also a resiliency argument in favor of electricity. If you have onsite solar PV and battery storage, you can island your building from the grid and operate a small amount of critical load.

9. **As electrification accelerates, what is being done to make sure communities aren't being adversely impacted by the rising natural gas rates, especially those who cannot afford to retrofit their homes to electricity?**
   City staff are currently working on a building decarbonization roadmap, as part of the City's American Cities Climate Challenge grant, to identify areas and populations in San José that will be most adversely affected by the impacts of climate change, such as wildfires, increased flooding, and rising temperatures. The roadmap will allow us to prioritize our most vulnerable populations that will be most impacted by the effects of climate change. For example, we know which communities are facing a higher energy burden right now. The California Public Utilities Commission (CPUC) is also very aware of the need to transition away from natural gas in an equitable way and is actively working on this issue.

10. **Can you use heat pumps for space heating?**
    Yes. There are several options available for space heating depending on the type of building, including:
    a. Mini Split Heat Pump – Single outdoor unit serving one apartment and connected to one or more indoor fan coil units (ducted or ductless).

b. Variable Refrigerant Flow/Volume – Ductless systems that contain fewer outdoor units and can provide central heating and cooling. These are often large outdoor units usually located on the roof with manifold refrigerant piping to indoor units. These systems are extremely efficient and can achieve very high efficiencies by intelligently moving heat around a building.
c. Ducted Heat Pump – Similar to ducted air conditioning system but simpler and can provide heating and cooling.
d. Terminal Packaged Air Conditioning Systems – This system is commonly found in hotels and affordable housing. It can be loud, but it is easy to maintain and offered at a lower cost.

The above products are available from a variety of well-established American, Asian, and European manufacturers with local representation and distribution. There are many different options and a reputable mechanical engineer will know about all these heat pump space heating options.

11. How do you size a heat pump water heater (HPWH)?

A HPWH should be sized differently than a natural gas water heater. An optimal HPWH system will have storage tank(s) sized to meet the anticipated 2-3 hour peak load and heat pump recovery rate sized just large enough to recharge the storage slowly in between peaks, over many hours. This is the opposite of gas water heating, where tankless (no storage) with very high recovery rates is most efficient.

HPWHs can be individual or central systems. Individual systems can be located inside of a unit and they can discharge their cool air to the unit or be ducted to the outside. Larger central systems need access to outside air because they are generally extracting heat from the air and transferring it to the water. Project owners can consult a HPWH manufacturer to obtain sizing recommendations.

12. Are there any good examples of using the rejected cool air from the heat pumps?

Heat pumps expel cool air for air-source heat pumps and chilled water for water-source heat pumps. In an ideal scenario, this cold air or water would be captured and utilized. This works well in large commercial buildings with the engineering expertise to design these systems. There are products that generate hot water and chilled water for a whole building. These tend to more highly engineered systems and generally are not turn-key solutions.

13. Can you discuss solar thermal versus solar photovoltaic (PV) on all-electric buildings?

Solar thermal is commonly used with central natural gas heating. With central HPWHs, it is better to use all solar PV instead of solar thermal. This helps to simplify the building. If you have solar thermal and HPWH, you have to very thoughtfully connect those systems, and neither will operate at maximum efficiency. HPWH plus solar PV means a simpler building with fewer moving parts, and fewer different systems to maintain.

14. With indoor space being limited, has the City seen successful use of varied or rooftop mounted storage tanks?

Yes, HPWHs or storage tanks can be placed wherever space is available, including the roof. There are existing projects with all of their storage and HPWHs on the roof. Heat pump water heaters and storage tanks can also be located in separate locations, subject to manufacturer maximum distance requirements.

ATTACHMENT C
All-Electric Building Ordinances by Jurisdiction

Jurisdiction	Systems Covered		New Construction Building Types Covered								Exemptions to New Construction Building Types Identified as Covered
	Whole Building	Water and Space Heating Only	Low Rise Residential	High Rise Residential	Hotel	Retail	Office	Restaurant	Life Sciences (Labs)	Municipal Property	
Alameda	X									X	
Berkeley	X		X	X	X	X	X	X	X	X	
Brisbane	X		X	X	X	X	X	X		X	Low-rise residential cooking and fireplaces; for-profit cooking appliances (e.g. restaurants, commercial kitchens, etc.)
Burlingame	X		X	X	X	X	X	X	X	X	Single-family cooking and fireplaces and commercial cooking.
Cupertino	X		X	X	X	X	X	X		X	ADUs, nonresidential kitchens, factories, hospitals/ emergency centers, other research/development, and essential facilities
East Palo Alto	X		X	X	X	X	X				Emergency operations centers and 100% affordable housing
Hayward	X		X							X	ADUs up to 400 sqft
Healdsburg	X		X		X	X	X	X	X	X	Essential services (includes hospitals/ emergency center), technical processes, residential and nonresidential cooktops, fireplaces and pools/spas
Los Gatos	X		X								
Menlo Park	X	X	X	X	X	X	X	X	X	X	Hospitals/ emergency centers, residential appliances other than water heating, space conditioning, and clothes drying systems (e.g. pool, stoves and fireplaces), lab space heating, and nonresidential cooking appliances
Morgan Hill	X		X	X	X	X	X	X	X	X	
Mountain View	X		X	X	X	X	X	X		X	Hospitals/ emergency centers and for-profit cooking appliances

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Piedmont	X		X								
Palo Alto	X		X							X	
Redwood City	X		X	X	X	X	X	X			Hospitals, 100% affordable housing, ADUs, and commercial cooking appliances
Richmond	X	X	X	X	X	X	X	X		X	Hospital/ emergency centers, residential stoves, and fireplaces, and for-profit cooking appliances
San José	X		X							X	
San Mateo	X		X				X				100% affordable housing
San Mateo County	X		X	X	X	X	X	X	X	X	Hospitals/ emergency centers, lab space heating, for-profit cooking appliances may apply
Santa Cruz	X		X	X	X	X	X	X	X	X	Restaurant (only cooking exempted), Industrial Process Heat, and ADUs ≤750 square feet
Santa Rosa	X		X								
Windsor	X		X								