Environmental Quality Commission

REGULAR MEETING AGENDA

Date: 8/18/2021
Time: 6:00 p.m.
Special Meeting Location: Zoom.us/join – ID# 915 4675 0502

NOVEL CORONAVIRUS, COVID-19, EMERGENCY ADVISORY NOTICE
On March 19, 2020, the Governor ordered a statewide stay-at-home order calling on all individuals living in the State of California to stay at home or at their place of residence to slow the spread of the COVID-19 virus. Additionally, the Governor has temporarily suspended certain requirements of the Brown Act. For the duration of the shelter in place order, the following public meeting protocols will apply.

Teleconference meeting: All members of the Environmental Quality Commission, city staff, applicants, and members of the public will be participating by teleconference. To promote social distancing while allowing essential governmental functions to continue, the Governor has temporarily waived portions of the open meetings act and rules pertaining to teleconference meetings. This meeting is conducted in compliance with the Governor Executive Order N-25-20 issued March 12, 2020, and supplemental Executive Order N-29-20 issued March 17, 2020.

- How to participate in the meeting
  - Access the special meeting real-time online at:
    Zoom.us/join – Special Meeting ID 915 4675 0502
  - Access the meeting real-time via telephone at:
    (669) 900-6833
    Meeting ID 915 4675 0502
    Press *9 to raise hand to speak

Subject to Change: Given the current public health emergency and the rapidly evolving federal, state, county and local orders, the format of this meeting may be altered or the meeting may be canceled. You may check on the status of the meeting by visiting the City's website www.menlopark.org. The instructions for logging on to the Zoom webinar and/or the access code is subject to change. If you have difficulty accessing the Zoom webinar, please check the latest online edition of the posted agenda for updated information (https://www.menlopark.org/AgendaCenter/Environmental-Quality-Commission-4).

Regular Session (Zoom.us/join – ID# 915 4675 0502)

A. Call To Order

B. Roll Call

C. Public Comment

The public may address the Environmental Quality Commission (EQC) on any subject not listed on the agenda. Each speaker can make public comment for a limit of three minutes once. The EQC cannot act on items not listed on the agenda other than to provide general information.

D. Regular Business

D1. Approve July 21, 2021 minutes (Attachment)

D2. Review and discuss cost effectiveness and policy options report to electrify existing buildings (climate action plan No.1 strategy) (Staff Report #21-006-EQC)

D3 Discuss annual Chair report and work plan presentation to City Council

E. Reports and Announcements

E1. Reports and Announcements from staff and commissioners

F. Adjournment

At every Regular Meeting of the Commission, in addition to the Public Comment period where the public shall have the right to address the Commission on any matters of public interest not listed on the agenda, members of the public have the right to directly address the Commission on any item listed on the agenda at a time designated by the Chair, either before or during the Commission's consideration of the item.

At every Special Meeting of the Commission, members of the public have the right to directly address the Commission on any item listed on the agenda at a time designated by the Chair, either before or during consideration of the item.

For appeal hearings, appellant and applicant shall each have 10 minutes for presentations.

If you challenge any of the items listed on this agenda in court, you may be limited to raising only those issues you or someone else raised at the public hearing described in this notice, or in written correspondence delivered to the City of Menlo Park at, or prior to, the public hearing.

Any writing that is distributed to a majority of the Commission by any person in connection with an agenda item is a public record (subject to any exemption under the Public Records Act) and is available by request by emailing the city clerk at jaherren@menlopark.org. Persons with disabilities, who require auxiliary aids or services in attending or participating in Commission meetings, may call the City Clerk's Office at 650-330-6620.

Agendas are posted in accordance with Government Code §54954.2(a) or §54956. Members of the public can view electronic agendas and staff reports by accessing the City website at menlopark.org/agenda and can receive email notification of agenda and staff report postings by subscribing to the "Notify Me" service at menlopark.org/notifyme. Agendas and staff reports may also be obtained by contacting City Clerk at 650-330-6620. (Posted:08/13/2021)

REGULAR MEETING MINUTES – DRAFT

Date: 7/21/2021
Time: 6:00 p.m.
Special Meeting Location: Zoom.us/join – ID# 915 4675 0502

A. Chair Price called the meeting to order at 6:02 p.m.

B. Roll Call

Present: Elkins, Evans, Gaillard, Kabat, London (exited at 7:30 p.m.), Price (Chair), Payne (arrived at 7:11 p.m.)
Absent: None
Staff: Rebecca Lucky- Sustainability Manager

C. Public Comment

- Steve Schmidt spoke in support of the Commission's efforts on the climate action plan.

D. Regular Business

D1. Approve May 19 2021 minutes (Attachment)

Chair Price introduced item.

ACTION: Motion and second (Gaillard/ Elkins) to approve the May 19, 2021 minutes, correcting the word "negotiation" in public comment, passed 6-1 (Payne absent).

Chair Price reordered the agenda.

D3. Review and discuss 2030 climate action plan progress report (Staff Report #21-004-EQC)

Sustainability Manager introduced MuniPC sustainability consultant to provide a presentation to the commission (Attachment).

- Peter Edmonds suggested using gross greenhouse gas (GHG) consumption per employee and/or per capita to measure progress.
- Erin Cooke spoke in support of the Commission and staff efforts on the climate action plan.

ACTION: Motion and second (Gaillard/ Kabat) to refer to the commission climate action plan subcommittee to return with brief proposal, passed 6-1 (London absent).

The Commission took a recess at 7:42 p.m.

The Commission reconvened at to 7:58 p.m.

D2. Select chair and vice chair

ACTION: Motion and second (Kabat/ Price) to select Commissioner Payne as Chair, passed 6-1 (London absent).

ACTION: Motion and second (Gaillard/ Kabat) to select Commissioner Evans as the Vice Chair, passed 6-1 (London absent).

D4. Review and discuss cost effectiveness and policy options report to electrify existing buildings (climate action plan No.1 strategy) (Staff Report #21-005-EQC)

Sustainability Manager introduced TRC and DNV consultants to provide a presentation to the commission (Attachment).

- James Tuelya spoke in support of incorporating the SB 1477 TECH program.
- Diane Bailey, representing Menlo Spark, spoke in support of the City's efforts and provided recommendations that include mandates, permit efficiency, and outreach and education.

ACTION: Motion and second (Price/ Payne) to defer to August meeting, refer to building decarbonization subcommittee for further review, and appoint Commissioner Evans to the building decarbonization subcommittee, passed 6-1 (London absent).

E. Reports and Announcements

E1. Reports and Announcements from staff and commissioners

None.

F. Adjournment

Chair Price adjourned the meeting at 9:50 p.m.

Minutes prepared by Rebecca Lucky, Sustainability Manager

D3-PRESENTATION

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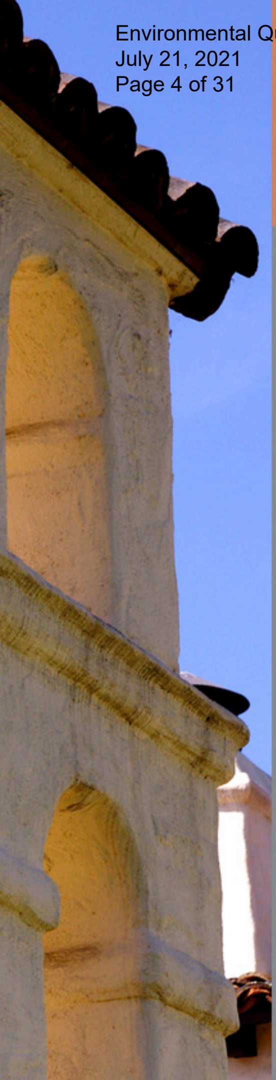
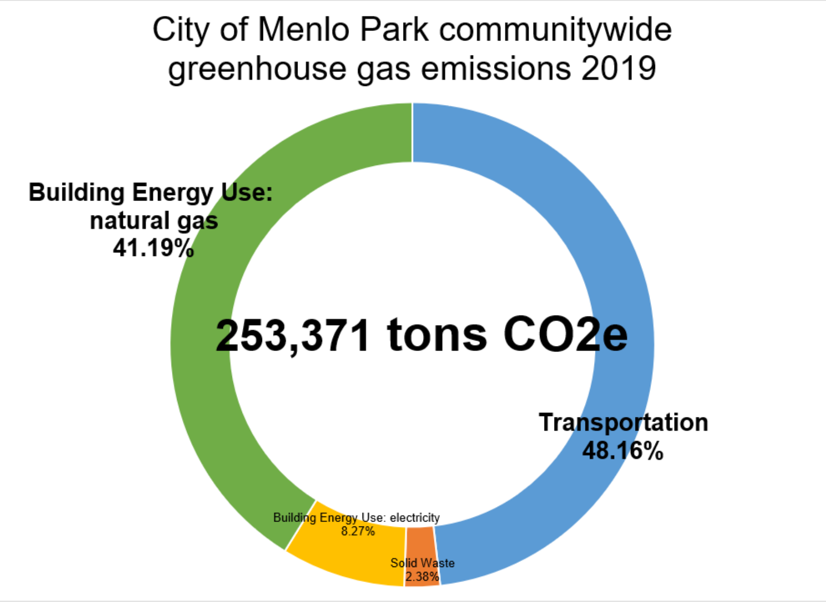
MENLO PARK 2030 CLIMATE ACTION PLAN PROGRESS

Candise Almendral, MuniPC Sustainability

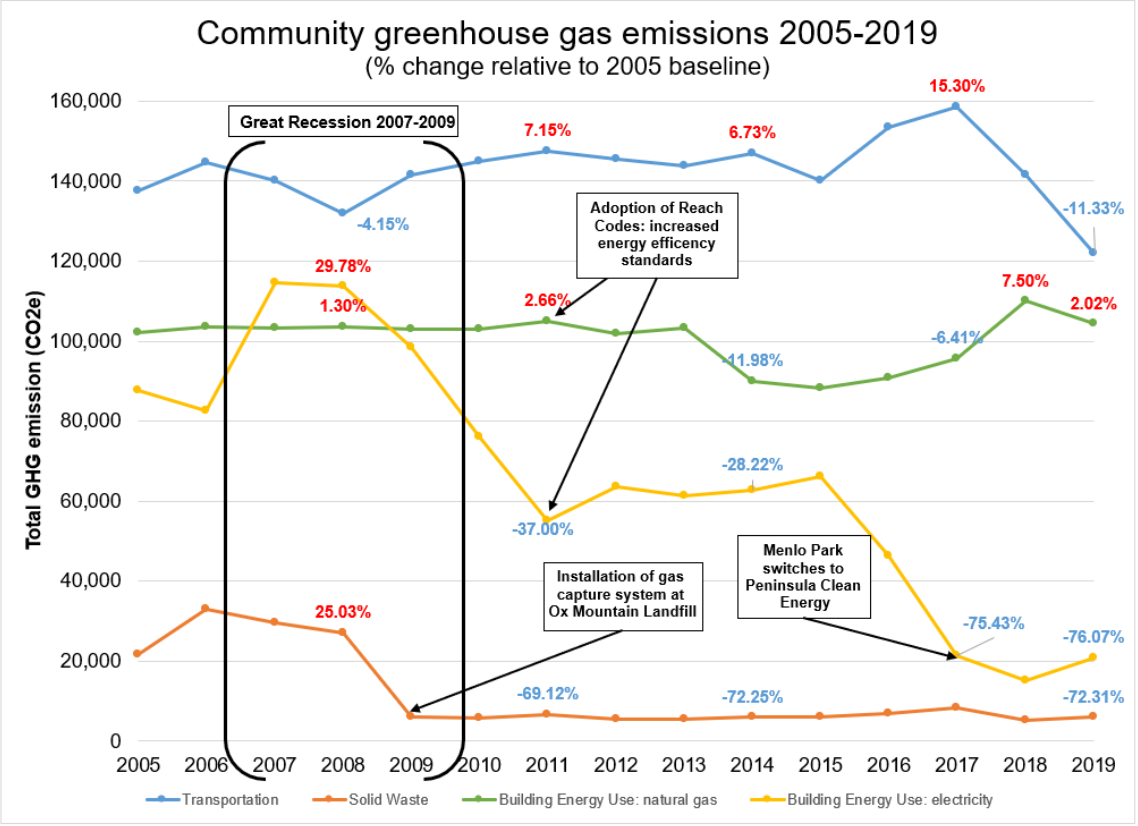


CLIMATE ACTION GOAL AND COMMUNITY GREENHOUSE GAS EMISSIONS

- July 2020: City Council adopted the goal to become carbon neutral by 2030
- Most recent 2019 data shows communitywide emissions have decreased to 253,371 tons (27.5% relative to 2005 levels)



EMISSIONS TRENDS BY CATEGORY



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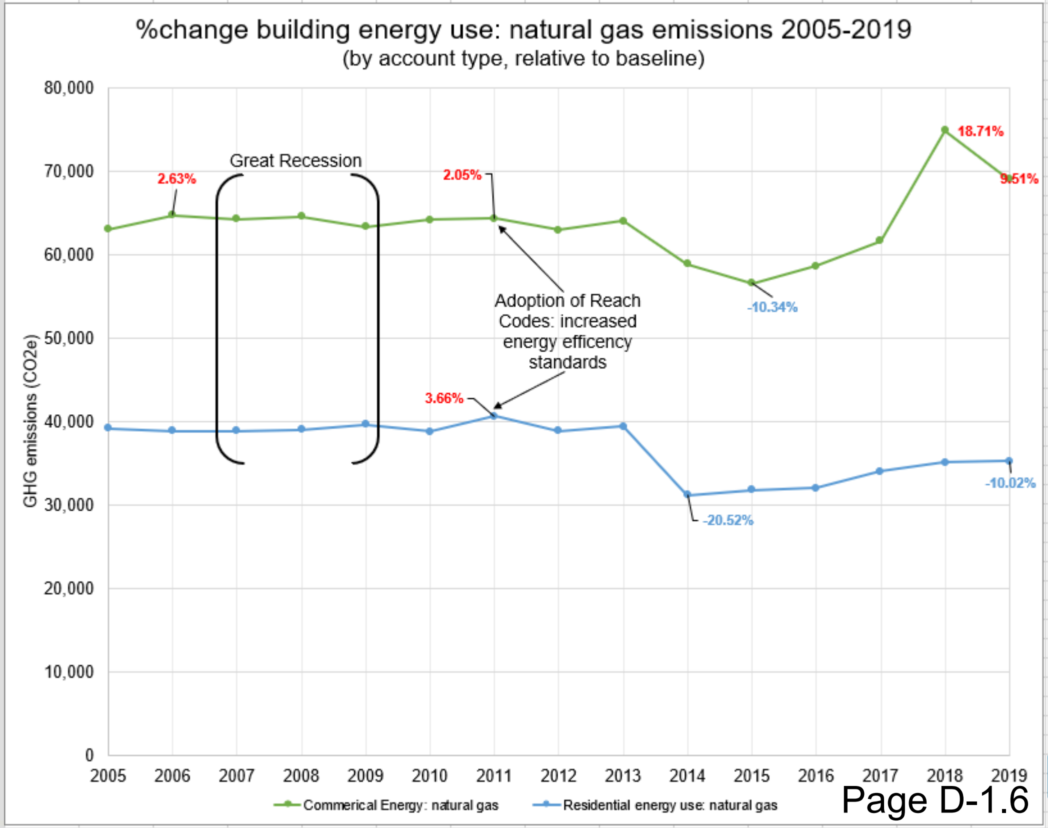
CITY OF MENLO PARK

CLIMATE ACTION PLAN 2020-21 STRATEGY NO. 1

Explore policy/program options to convert 95% of existing buildings to all-electric by 2030

- On track to achieve project milestones

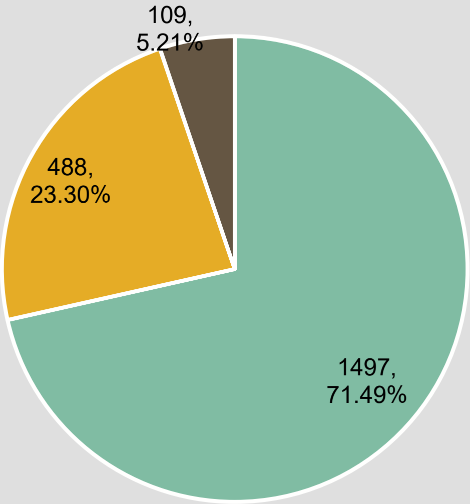


CLIMATE ACTION PLAN 2020-21 STRATEGY NO. 2

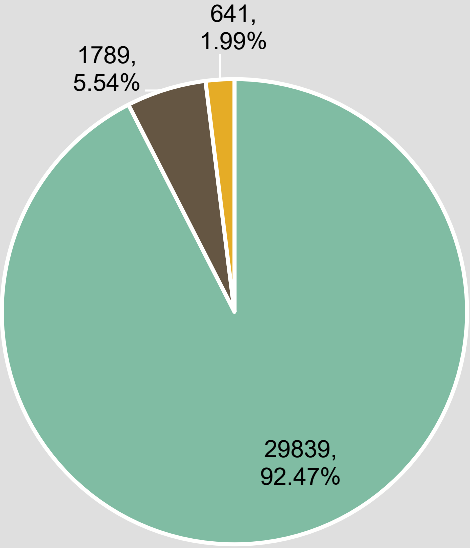
Set citywide goals for increasing electric vehicles to 100% of new vehicles by 2025 and decreasing gasoline sales 10% a year

- Implementation differed to the Beyond Gas Initiative under Joint Venture Silicon Valley

Newly registered vehicles



Registered vehicles



CLIMATE ACTION PLAN 2020-21 STRATEGY NO. 3

Expand access to electric vehicle (EV) charging for multifamily and commercial properties

- Staff is and will continue to monitor local and regional incentive programs (Peninsula Clean Energy EV Ready)
  - PCE reports five multifamily properties have applications under review
    - Properties vary in size (4-41 units). Note, two properties have yet to confirm total units
    - Scope of projects (e.g., charging type, total number of charging spaces, etc.) is also currently unknown

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CLIMATE ACTION PLAN 2020-21 STRATEGY NO. 4

Reduce vehicle miles traveled (VMT) by 25% or an amount recommended by the Complete Streets Commission

- Recently adopted Transportation Master Plan includes 14 strategies that are completed, underway, or planned.
- Transportation Management Association (TMA) feasibility study to achieve identified objectives nearing completion
  - Objective 1: Endorse and support regional/sub regional transportation demand management (TDM) efforts
  - Objective 2: Ensure TDM is available for all businesses
  - Objective 3: City to serve as an example of an employer with a robust and collaborative TDM program
- SB2 Housing grant activities considered part of the housing element update
  - Accelerate/encourage housing production in already urban/built-up areas to reduce dependance on vehicles for everyday activities and VMT

CLIMATE ACTION PLAN 2020-21 STRATEGY NO. 5

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Eliminate the use of fossil fuels from municipal operations

- Proposals for Menlo Park Community Campus microgrid currently under review
- Municipal fleet has transitioned to renewable diesel and reserved five full battery electric Ford F-150 trucks
- HVAC replacements for the Arrillaga Family Rec Center and Gym are planned to be all-electric
- Assessment of available electrical capacity City Hall completed, installation of additional spaces currently in design phase
- Currently piloting use of four full battery electric leaf blowers

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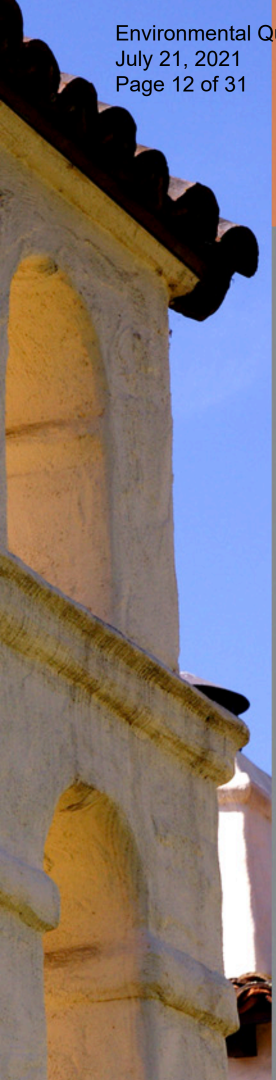
CLIMATE ACTION PLAN 2020-21 STRATEGY NO. 6

Develop a climate adaptation plan to protect the community from sea level rise and flooding

- Strategy to Advance Flood protection, Ecosystem, and Recreation along San Francisco Bay Project (SAFER Bay) grant application has been selected for further review
  - Regional project (San Francisquito Creek Joint Powers Authority) project to protect people, property, and infrastructure from Bay tides and anticipated sea level rise
- Menlo Park has partnered with OneShoreline for the construction and maintenance of the Bayfront Canal and Atherton Channel Flood project
  - High tides have kept flows in the Bayfront Canal from draining to the Bay. Even minor rainfall events have resulted in the flooding with nearby properties experiencing flooding 40 times over the past 70 years – most recently in 2017
- Local Hazard Mitigation Plan update is currently underway
  - LHMP reduces risk to life and property from a hazard events including those compounded/cause by climate change (e.g., high tides resulting increased flooding events along the Bayfront Canal)



NEXT STEPS

- Obtaining and compiling the metric data presented opportunities and challenges that will be discussed at the next EQC meeting.
- Present to City Council tentatively scheduled for August 31.
  - Would include the commission's recommendations for 2021 and beyond

THANK YOU

Existing Building Electrification Policy Options – Draft Analysis and Discussion

Prepared by Farhad Farahmand (TRC), Mayra Vega (TRC), and Blake Herrschaft (DNV-GL), in partnership with City Staff and Peninsula Clean Energy

Menlo Park Environmental Quality Commission – July 21, 2021

Introduction

- City Council scope of work for Climate Action Plan goal No.1 included analyzing the cost effectiveness to electrify existing buildings in Menlo Park and provide potential policy pathways

- Working draft is being released for the Environmental Quality Commission and staff to review and discuss before presented to the City Council on August 31

- The commission can continue discussion at its August meeting to finalize advice to the City Council

Market Readiness

End Use	Technology Available?	Contractor Familiarity?	More Challenging Building Types
Space Heating	Yes, since 1950s	All	Labs, hospitals, VAV reheat systems in commercial office (typically >50 ft2 or more)
Water Heating	Yes, since 2010	Some	Labs, hospitals, hotels, large multi-family
Cooking	Yes, since 1950s, more so since 2010	All for residential, Some for commercial	Restaurants with limited site electrical capacity
Clothes Drying	Yes, since 1940s	All for most buildings, some for laundromats, etc.	Laundromats, hotels, hospitals
Pools	Yes, since 1990s	Some	Large commercial pools

BayREN contractor list available here
Clean Energy Connection list available here

Berkeley, Half Moon Bay, Palo Alto, San Francisco, and New York City are all working towards existing building electrification mandates

Local Jurisdiction Roles in Incentives and Financing

Lead Roles

- Developing incentive programs for constituents
  - Can fund via local taxes and fees (e.g., Utility User's Tax)
  - Can partner with other agencies (e.g., Bay Area Air Quality Management District).
- Municipal financing – electrifying public buildings through green bonds or local taxes

Advocacy Roles

- On-bill financing (utility customer loan) or *tariffed* on-bill financing (utility investment tied to utility meter)
- Sharing of resources enabling electrification
  - Partner incentives (Utilities, BayREN, PCE)
  - Electrification-as-a-service partnerships
  - Tax credits, deductions and rebates
  - Loan programs (i.e., California Hub for Energy Efficiency Financing)

Statewide Utility Cost Effectiveness - Methodology

- Lifecycle periods of 15 years (nonresidential) and 30 years (residential)
- Benefit metrics
  - On-bill – Peninsula Clean Energy utility rate schedules, energy inflation, discount rates
  - Time Dependent Valuation - 'societal value or cost' such as carbon emissions
- Cost effectiveness measured in Benefit/Cost ratio and Net Present Value
- Three vintages: 80's, 90's, and 2000's

Sector	Prototypes
Residential	Single-family (2,700 ft2), Low-rise multifamily (6,960 ft2)
Nonresidential	Office (53,000 ft2), Retail (25,000 ft2), Warehouse (18,000 ft2), Quick Restaurant (2,500 ft2), Full Restaurant (5,000 ft2)

Cost Effectiveness – Residential Results

- Heat pumps are TDV cost effective using 2022 TDV
- Heat pumps are on-bill cost effective when paired with on-site solar PV

Measure	Vintage	Gross Measure Cost	PCE/ BayREN Incentive	Net Measure Cost	Year 1 Utility Cost Savings	No Incentive		With Incentive	
						On-Bill B/C Ratio	On-Bill NPV	On-Bill B/C Ratio	On-Bill NPV
SEER 21 Heat Pump at HVAC Replacement	Pre-1978	$3,749	$1,000	$2,749	-$30	0.19	-$3,290	0.26	-$2,168
	1978-1991				-$66	0	-$4,637	0	-$3,514
	1992-2010				-$67	0	-$4,820	0	-$3,697
NEEA Tier 3 HPWH at Replacement	Pre-1978	$2,775	$2,000	$775	$5	0.21	-$2,434	0.78	-$188
	1978-1991				-$6	0.13	-$2,702	0.46	-$456
	1992-2010				-$9	0.10	-$2,788	0.36	-$542

Cost Effectiveness – Nonresidential Results*

Prototype	All-Electric (Code Minimum)	All-Electric + Efficiency	All-Electric + Solar PV
Retail	Not cost effective yet	On-Bill and TDV	On-Bill and TDV
Office	Not cost effective yet	Not cost effective yet	Not cost effective (maybe TDV with efficiency measures)
Quick-Service Restaurant	Not cost effective (maybe TDV excluding cooking)	TDV (excluding cooking)	Not cost effective yet (includes battery)
Full-Service Restaurant	Not cost effective yet	Not cost effective (maybe TDV excluding cooking)	Not cost effective yet (includes battery)
Warehouse	Not cost effective yet	Not cost effective yet	On-bill

*Updated findings as of 7/20

Electrification For All

- Menlo Park contains 1,500 housing units with occupants that are below 30 percent of the area median income (AMI).
  - Mostly renters
  - 7-11% of income is spent on energy
- Equitable policy characteristics
  - Ensure access to incentives
  - Ensure bill reductions
  - Avoid increasing debt
  - Avoids "renovictions" that evict tenants when making building upgrades, or rent increases
- Partnering with local community-based organizations is critical to honest discussion and long-term commitment

Rental Housing Performance Standards (RHPS), coupled with rental housing policies, could:
- reduce the energy cost burden on tenants,
- eliminate the split incentive, and
- support cities in meeting climate goals.

26 cities in CA have rental housing inspection policies

At least **6 cities outside CA** have RHPS with energy efficiency requirements.

Sources: LEAD Tool, StopWaste, Urban Sustainability Director's Network

Policy Options Overview

#1: Public Engagment and Eductation

- Concierge assistance for residents toward financing, permit education
- Piloting projects in LMI communities
- Outreach and forums for residents and businesses

#2: Generate Funds for Financing

- Fees for building projects that generate GHGs
- Increase Utility User's Tax
- Partner with local lenders to provide streamlined financing options

#3 Time Certain Building Performance Standards

- Set a deadline for electrification (e.g., 2030)
- Require reporting and/or inspections
- Pros: Easy to understand, reduces missed opportunities, impacts all buildings
- Cons: Increased staff responsibilities, emergency replacement challenges, relies on incentive availability

Policy Options Overview

#4: Permitting

- A: Heat pumps when installing air-conditioning
- B: Electric-ready at panel upgrade or solar PV install
- C: Heat pumps installed at voluntary HVAC/DHW replacements
- D: Heat pumps installed in Additions to single family homes
- E: Heat pump pool heating for new pools
- F: Electric appliances in Alterations including HVAC/DHW
- Pros: Easy path to enforcement, opportunity to integrate incentives
- Cons: Can add significant cost w/o incentives, may decrease permit application even further, limited effectiveness

Policy Options Overview

#5: Time of Sale

- *Encourage* electrification at time of real estate sale or transfer through reduced taxes or rebates
- *Require* upgrades at time of sale, similar to Davis or San Francisco
- **Pros:** Can electrify whole buildings at a time, upgrades can be negotiated between the buyer and seller
- **Cons:** Can add significant cost w/o incentives, limited number of buildings impacted

Policy Option Evaluation: Methodology

Each policy option was scored against a set of five criteria and given a point for each definition it met for a score of 0 – 3 for each criteria. The criterial definitions are as follows:

Ease of Implementation/Process

- There is a low level of engagement necessary during the adoption process
- Does not require long term-staff resources
- Does not require coordination with other agencies.

Convenience

- Does not increase scope beyond the original plan
- Does not increase project timeline or cause a physical impact to the property
- Skilled workforce for the required upgrade is available.

Equitable

- Tenant protections exist
- There are income-qualified exemptions, incentives, and financing available
- There is community engagement on policy design and workforce development and training.

Cost Effectiveness

- Demonstrates on-bill savings
- Does not increase upfront costs
- Incentive programs are available or forth-coming.

Effectiveness

- Is an enforceable mandate,
- Transforms the market
- Is scalable

Policy Option Evaluation: Key Take-aways

Highest ranking options

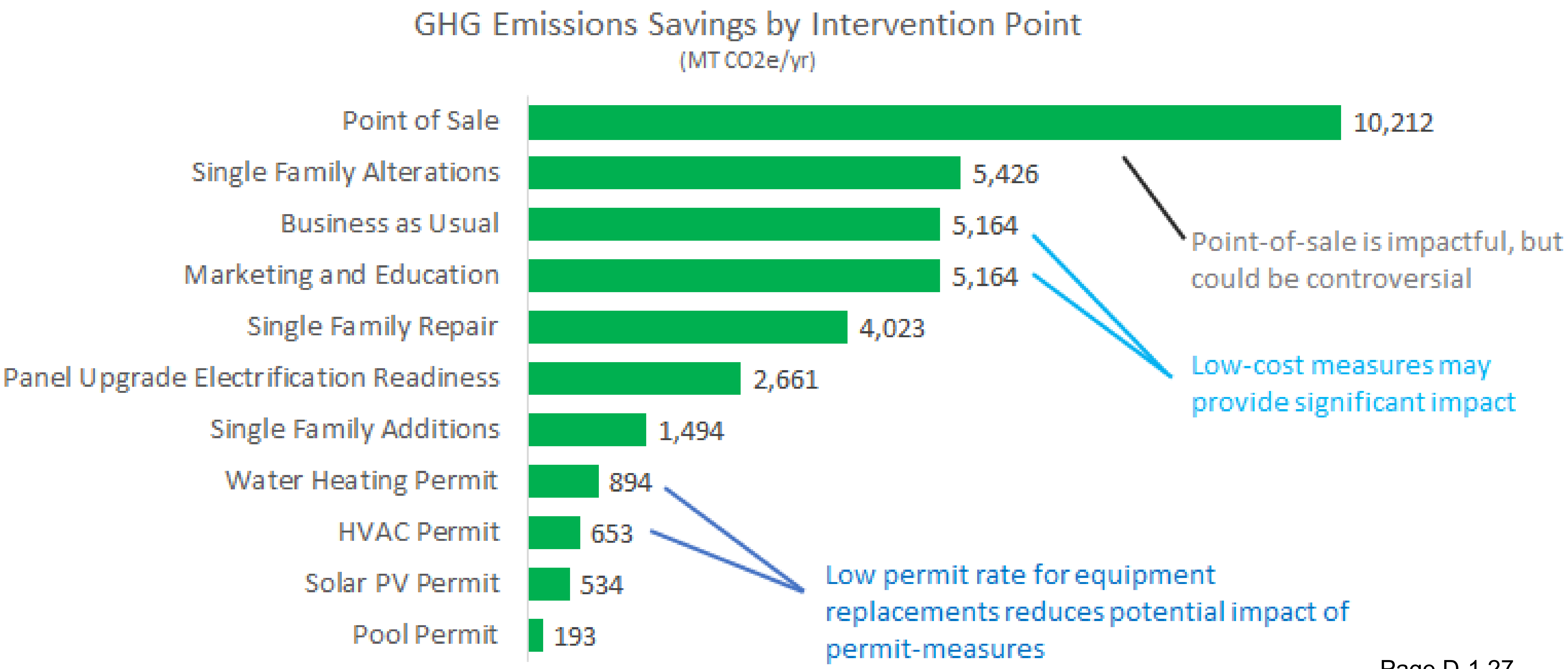
- Option 2 Generate Funds
  - Most convenient policy because it doesn't directly impact project work
  - Incentives available
  - Can be designed to generate and redistribute funds equitably
  - May be implemented by city staff relatively easily, or in partnership with utility
- Option 4A Heat Pump at A/C installation
  - Minimally intrusive
  - Does not add cost to a project where air-conditioning equipment is already being replaced

Lowest ranking options

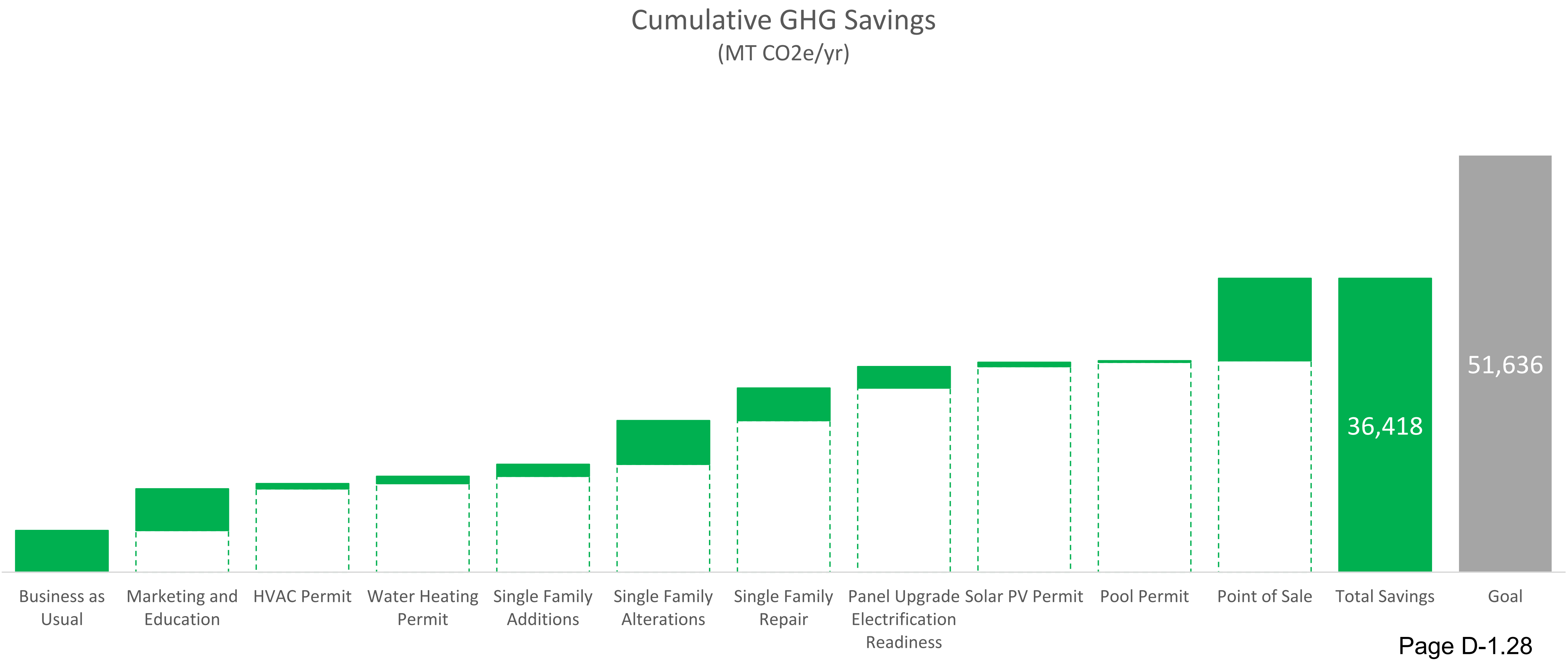
- Option 4C Heat Pump Installed Upon Voluntary Replacement
  - Susceptible to permit dodging
- Option 4D Heat Pump Installed During Additions to SF Buildings
  - Susceptible to permit dodging
- Option 3 Time Certain Building Performance Standards
  - Requires a disclosure program to become enforceable

- All of these options require
  - High level of engagement, and either new staff resources or coordination with outside agencies
  - They can all increase a project's scope of work, budget, and timeline
  - Incentives for panel upgrades, heat pump water heaters and heat pump space heaters are available but may not cover full upfront cost

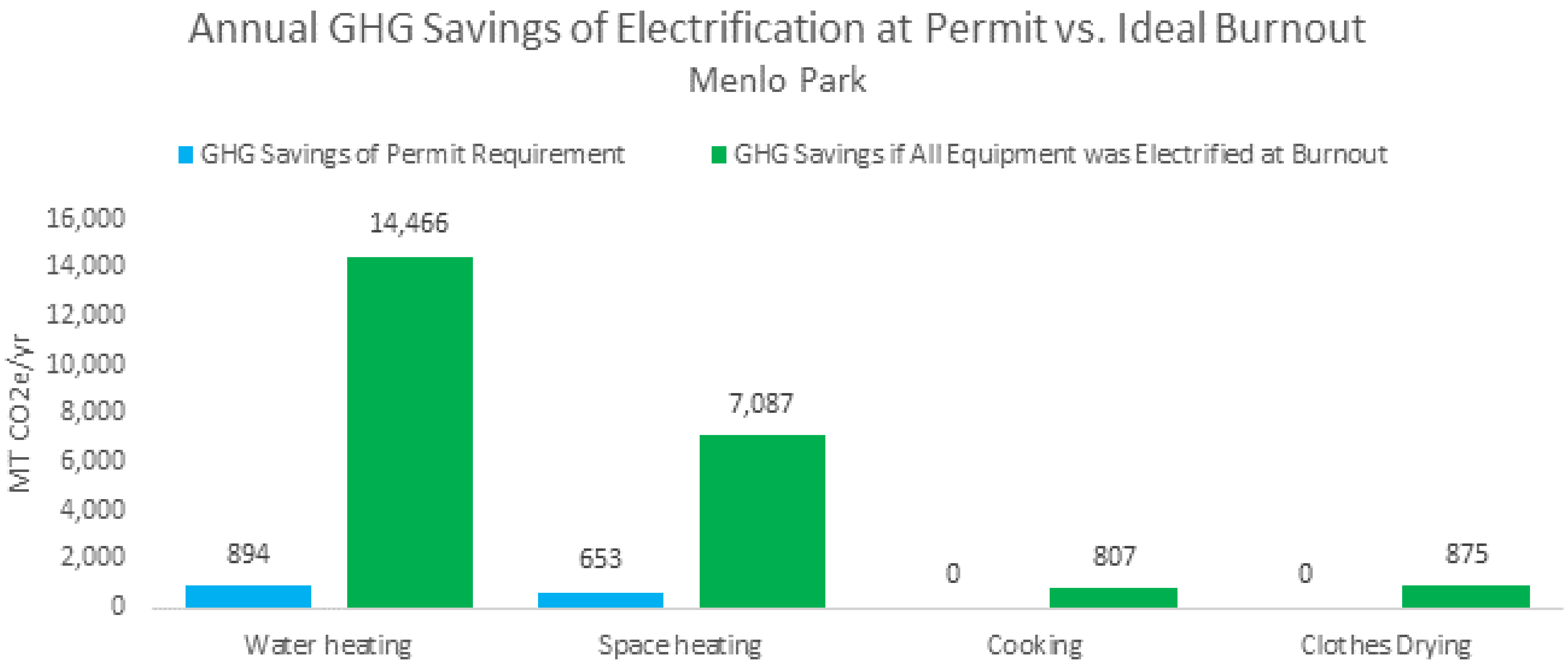
Emissions Impacts (2022 – 2030)



Emissions Impacts



Emissions Impacts – Limitations of Eqpt Permits



Next Steps

- **August 18 EQC Meeting-** finalize feedback/advice for the City Council to consider on the cost effectiveness analysis and potential policy pathways
- **August 25-** Finalize cost effectiveness analysis and policy pathways report
- **August 31 City Council Meeting-** study session to present cost effectiveness analysis
- **September 15 EQC Meeting-** finalize feedback/advice to the City Council on policy pathways if desired or needed
- **September/October City Council Meeting**- study session to dive deeper on policy pathways that includes staff and commission recommendations
- **October City Council Meeting**- City Council directs staff on next steps for CAP No. 1: electrify existing buildings

Discussion

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CITY OF MENLO PARK

STAFF REPORT

Environmental Quality Commission
Meeting Date: 8/18/2021
Staff Report Number: 21-006-EQC

Regular Business: **Review and discuss cost effectiveness and policy options report to electrify existing buildings (CAP No.1 strategy)**

Recommendation

City Council requested the commission's review and feedback on cost effectiveness and policy options to electrify existing buildings as envisioned under Climate Action Plan goal No.1: Electrify 95% of existing building by 2030.

Policy Issues

In 2019, the City Council declared a climate emergency (Resolution No. 6535) committing to catalyze accelerated climate action implementation. In July 2020, the City adopted a new CAP with the bold goal to reach carbon neutrality (zero emissions) by 2030 that included a goal to electrify 95% of existing buildings by 2030. Converting 95% of existing buildings from using natural gas to electric equipment is a top priority for the City Council as identified in their 2021 work plan.

Background

The City Council included a top priority in their 2021 work plan to begin work in electrifying 95% of Menlo Park's existing buildings by 2030. Electricity consumed in Menlo Park is greenhouse gas free as almost all residents and businesses are subscribed to Peninsula Clean Energy. This provides an opportunity to eliminate the use of natural gas (a fossil fuel) in existing buildings by changing natural gas equipment (such as water heaters and space heating) to electric.

In 2020, new building reach codes were implemented that require all new buildings to be electric. In order to achieve carbon neutrality, eliminating natural gas in existing buildings through electrification will be crucial. However, there are many considerations in electrifying existing buildings, and include but are not limited to, equity, cost effectiveness, overall grid resiliency and capacity, and market readiness.

As a result, the City Council directed a cost effectiveness analysis and policy options report to be completed. In addition, the City Council requested the commission's review and feedback on the report.

A working draft report was provided to the commission in July that was prepared by TRC and DNV under the direction of city staff. Staff and the commission reviewed the report concurrently. The commission referred further review to the commission's building decarbonizaiton subcommittee. The subcommittee has provided a memo outlining feedback and recommendations in Attachment A. Over the last month, the consultants have received significant feedback from staff, commissioners, councilmembers and Menlo Spark, resulting in changes to the report that address some of the concerns raised in the subcommittee's memo (Attachment A). This includes updated energy escalation costs, addressing low efficiency equipment availability, and greater inclusion of climate change costs.

Analysis

The cost effectiveness analysis for Menlo Park was prepared by TRC under a contract with Peninsula Clean Energy (Attachment B). Currently the analysis includes residential buildings. Analysis for nonresidential (commercial) is still underway as data from the state was recently received. The potential policy options were developed in partnership with city staff, DNV, and PCE.

Cost effectiveness results

The cost effectiveness analysis measured costs and/or savings upon end of life of natural gas equipment and replacing it with heat pump (electric) technology. Incorporating additional savings from avoiding climate change impacts/costs is currently under development and will be included in the final report presented to the City Council later this month.

Some key highlights include:

- The upfront cost to replace natural gas equipment with electric heat pump equipment is higher. However, incentives can greatly reduce the cost making it cost effective when using high efficiency equipment. Incentives are currently offered for high efficiency heat pumps for residential space and water heating.

- The bill impact for heat pump water heating has nominal monthly bill increases in the first year ($1) or in some cases no increases depending on a building's age. On average, there will monthly savings between $6 and $8 over the life of heat pump water heaters due to changes in future energy prices.

- The bill impact for space heating is mixed depending on type of equipment used and age of the building.
    - For high efficiency space heating equipment there are nominal bill increases in the first year between $3 and $6 per month, but over the life of the equipment there will be monthly bill savings between $7 and $18.
    - There are high bill impacts in the first year for less efficient equipment potentially increasing monthly bill cost between $22 and $31, but the monthly bill impact decreases over the life of the equipment with an average monthly cost increase between $5 and $6. This can be attributed to the changes in natural gas and electricity prices in the future.

- For space and water heating, using heat pumps are cost effective when considering time of use energy pricing and the societal costs of climate change for all types of buildings and heat pump equipment regardless of energy efficiency rating.

- When heat pumps are combined with solar on buildings, it can yield even greater savings and protect against bill cost increases.

- There are also limitations to the analysis, such as type of electric equipment analyzed was focused on heat pumps. There are other consumer options for electrification, such as traditional electric resistance technology. This is generally not as efficient as heat pumps and would increase bill costs.

Market readiness

The technology is available for full electrification of all building stock today, with exception in a minority of industrial and process loads. Across all these technologies, the primary barrier is the unique site considerations and heightened electrical requirements when replacing gas appliances and the related challenges posed to contractors. A major barrier specific for HVAC and plumbing contractors has been simple preference for gas-fired equipment to maintain business-as-usual practices.

Installation in existing buildings can require a different configuration than gas equipment, and it may require both an electrician and a plumber for a task that once required only one trade. The industry will need time to become more educated and align their trade licenses in a way that provides convenient and efficient services. Mechanical contractors may be already well-suited for installation, as they are accustomed to installing air conditioner and heat pumps.

Equity

Electrification policy must make financial sense for all community members, including lower-to-moderate income (LMI) residents. Menlo Park has an estimated 1,500 LMI residents, and approximately 40% of households in Menlo Park are renter-occupied. Ensuring that benefits of electrification, such as health, safety, and affordability, are targeted toward marginalized communities reverses compounding historical injustices, many of which have been created and perpetuated by government action. The literature review included in Attachment B identified the following findings:

- Without equitable policy development, local building regulations run the risk of doing more harm than good. For example, landlords may raise rents or evict tenants when making building upgrades, a harmful practice known as “renovictions.”

- Partnering directly with local community based organizations (CBOs) can expand city efforts and deepen engagements in the creation of building decarbonization policies. CBOs and community members may initially be skeptical of governmental interventions, but early and regular engagement can lead to honest discussions around climate policy, establish a strong commitment, demonstrate accountability, repair trust, and lead to better overall policy.

- Rental property energy performance standards, coupled with rental housing policies, could reduce the energy cost burden on tenants, eliminate the split incentive, and support cities in meeting climate goals as well as general equity goals.

Policy Options

The policy options included various strategies to electrify existing buildings by 2030, such as education and outreach, developing additional incentives, adopting building code requirements that range from electric ready to equipment change out requirements, and time of sale policies. In addition, an end of life “burnout” policy requirement was added.

A key finding in the development of policy options was the groundwork that will be needed to ensure equitable and effective polices can be implemented without unintended consequences. This includes work in the following areas:

- Robust engagement and education to assist residents and business on grid resiliency through solar and battery storage and addressing climate change through all-electric buildings.
- Pilot projects that include solar, energy storage, and electrification that support LMI community members.
- Advocating at regional and state levels to advance electrification for existing buildings.
- Development of additional incentives and financing programs (such as on-bill financing) and explore possible funding mechanisms.
- Development of rental protections and/or rental license program that would not cause displacement

or rent increases because of future electrification mandates.
- Development of, or include in, housing rehab programs solar installation, energy efficiency upgrades, and building electrification.
- Modify Menlo Park's noise and building setback regulations to accommodate building electrification needs.

It is also important to note that the cost effectiveness analysis did not evaluate equipment change out prior to end of useful life- "burnout." Some of the policy options include change out before equipment end of life. This would be less cost effective, but more easily implemented and allows more flexibility and time for a community member to research, find a competent heat pump professional, access incentives, and complete a project without little disruption to space and daily water heating needs.

Next Steps
As directed by the City Council, staff will present the cost effectiveness analysis and policy options to the City Council for further direction on August 31. The feedback from the commission will be included in the staff report to the City Council.

Impact on City Resources
It is anticipated that a significant amount of resources will be needed to develop and implement the policy options.

Environmental Review
The environmental impacts of existing building electrification policies or programs and any California Environmental Quality Act (CEQA) compliance needs will be identified as they are approved for work by the City Council and analyzed further.

Public Notice
Public notification was achieved by posting the agenda, with the agenda items being listed, at least 72 hours prior to the meeting.

Attachments
A. Memorandum from the Environmental Quality Commission Building Decarbonization Subcommittee
B. Draft Cost Effectiveness Results and Potential Policy Options to Electrify Menlo Park's Existing Buildings

Report prepared by:
Rebecca Lucky, Sustainability Manager

MEMORANDUM

Date: 8/10/2021
From: EQC Building Decarbonization Subcommittee
To: EQC
Re: Building Policy Recommendations based on TRC Cost Effectiveness Report

> *Stabilizing the climate will require strong, rapid, and sustained reductions in greenhouse gas emissions, and reaching net zero CO2 emissions. Limiting other greenhouse gases and air pollutants,* ***especially methane,*** *could have benefits both for health and the climate.*
> — Panmao Zhai, IPCC Working Group I Co-Chair, August 9, 2021

Menlo Park's stated greenhouse gas reduction targets (90% reduction by 2030) require that the city begin phasing out the use of methane gas in existing buildings, where 41% of the city's emissions are generated. In December 2020, Peninsula Clean Energy (PCE) authorized $100,000 for a study assessing the cost effectiveness of building electrification policies in Menlo Park, intending to make the study conclusions and analysis broadly available to PCE's other member cities, a number of whom are also considering policies to decarbonize existing buildings.

On July 21, a consultant team led by TRC (https://www.trccompanies.com/) presented draft findings of their study to the EQC, after which the EQC asked its Building Decarbonization Subcommittee to draft a policy recommendation for City Council, pending approval by the full EQC at its August meeting. This memo captures the subcommittee's policy recommendation, recognizing that it is based on a draft of TRC's final report. We seek approval by the full EQC so that this recommendation can be sent on to Menlo Park's full City Council as the commission's official recommendation.

Summary of TRC Cost Analysis

After reviewing the TRC draft report, we conclude that even using **worst case assumptions**, for the sum of $23-$36 per household per month, city residents can convert their aging gas water heaters and furnaces to clean all-electric heat pumps and help eliminate approximately 41% of the city's greenhouse gas emissions (GHG). Below is a breakdown of these costs for single family households and multifamily households.

Worst Case* Cost Premium to Electrify Single family home		
Equipment	**$/month (no incentive)**	**$/month (w/ incentive)**
HVAC	-$22	-$10
Water Heater	-$14	-$2
HVAC + Water Heater	**-$36**	**-$12**
Solar + Prewiring	**$36**	**$36**
TOTAL	**$0**	**$24**

* Taken from TRC/Frontier draft report tables 7 and 8, using highest possible costs: 1) pre-1978 vintage building, 2) no incentives, 3) low efficiency appliances and 4) "Customer On-Bill" 30-yr NPV, which includes both upfront capital costs and operating costs

Worst Case** Cost Premium to Electrify Multifamily home		
Equipment	**$/month (no incentive)**	**$/month (w/ incentive)**
HVAC	-$11	-$8
Water Heater	-$12	-$3
HVAC + Water Heater	**-$23**	**-$11**
Solar + Prewiring	**$13**	**$13**
TOTAL	**-$10**	**$3**

** Taken from TRC/Frontier draft report tables 9 and 10, using highest possible costs: 1) pre-1978 vintage building, 2) no incentives, 3) mix of high and low efficiency equipment and 4) "Customer On-Bill" 30-yr NPV, which includes both upfront capital costs and operating costs

According to TRC these monthly cost premiums only occur under **worst case conditions assuming:** pre-1978 vintage building, no incentives and no solar. **However, if a modest amount of rooftop solar is added to these buildings, the costs premium for electrification drops to $0 for single family households and $10 per unit per month for multifamily buildings.**

Premium to electrify will be lower than study predicts. The TRC study makes some assumptions that we believe <u>overstate</u> the cost premium of electrifying existing buildings:

1. According to recent studies presented by the CPUC, natural gas prices are expected to rise further and faster than the TRC study assumes, as safety-conscious Californians defect from the gas grid, leaving a dwindling number of gas customers to pay for expensive maintenance of the frail and aging pipelines running through their neighborhoods.
2. The low efficiency equipment assumed in the study is so outdated that it is not popular in California, but the study authors included it because Federal regulations require that this low-efficiency heat pump equipment be included in California studies and arcane rules at the California Energy Commission require that cost effectiveness analyses use this outdated, low-efficiency equipment as its baseline equipment. In some cases, this inflates study costs for electrification in ways that do not reflect real life.
3. In its draft form the study does not assign any costs to continuing the status quo, which is allowing new gas equipment in the city, even though studies show that installing <u>any</u> new fossil fuel equipment will push us well past 1.5°C in temperature rise and perhaps past 2°C. This is a serious flaw in the analysis, one that economists describe as not correctly pricing externalities. While it is certainly difficult to correctly price externalities like the GHG emissions that drive climate change, their omission from this study makes it wrongly appear that not addressing climate change will be cheaper than addressing it, whereas in fact the opposite is true. Once again, this flawed assumption biases the analysis resulting in a higher apparent premium for electrification, one that will not be borne out in practice.

However, even using these flawed assumptions that make gas appliance costs look unrealistically low, the analysis still shows that the premium to electrify in a worst case scenario is modest, at $23-36 per household per month. That is equivalent to the cost of two lattes per week to save our climate and help avoid catastrophic economic consequences for future generations. Furthermore, if the building owner adds a modest amount of rooftop solar, the monthly capital and operating cost premium of electrification is reduced to $0 for single family and $10 for multifamily households.

Equity Considerations: Guardrails, Cost savings and the Creation of Good Jobs

Even though the cost premium to electrify is modest, for the city's lowest income residents who may struggle for their next meal, even this modest amount will be an impossible financial burden. Therefore, ***we recommend that the city create a special equity fund*** to <u>fully</u> electrify the ~1,400 households in the city that are currently on bill assistance through PG&E. This fund would ***fully protect the city's low income population from incurring any extra expenses related to electrification*** and, in fact, would ***result in a net gain to the wallets of low-income homeowners by reducing their energy bills,*** starting in the first month post electrification*.*

How the Low-Income Program Would be Funded. Staff estimates that approximately $3 million per year in additional revenue could be raised by simply allowing the city's utility users tax (UUT) to float to voter-approved levels, an act that would require a simple majority vote on council. Over a 10-year period, this $3 million per year in additional revenue would yield enough to fund electrification of all 1,400 low-income homes in the amount of $20,000 per household. Eligible households could be identified easily by their participation in PG&E's screened on-bill assistance programs (CARE and FERA) for low-income households.

Turnkey Solutions. Any remaining barriers to implementation for low-income households could be further reduced by providing a turnkey installation program, administered by a city partner, such as Peninsula Clean Energy or an experienced private entity such as BlocPower (https://www.blocpower.io/). BlocPower specializes in retrofitting and electrifying low income residences and has recently launched a California presence. In addition to the pocket savings from electrification for low income residents, a scaled electrification effort in our low income community could also be designed to produce good, new jobs for local residents, providing a much-needed economic boost. BlocPower, for example, includes local hiring to create jobs as part of its overall mission to increase equity in low income communities. BlocPower also creates community advisory boards that allow the company to hire locally (if working on 10 or more buildings in the area).

Reducing Household Energy Burden and Improving Health. We believe it is entirely possible that low-income households who benefit from a turnkey program such as the one outlined above will reduce their household's overall *energy burden* significantly, ***putting thousands of dollars back into the pockets of the city's lowest-income residents***. Reductions in *household energy burden* can further benefit low income households by reducing dependency on payday loans, which can carry interest rates as high as 400% over 5 months and are often used to pay utility bills ("Gassed Out", Menlo Spark p. 12). Electrification can also help lower healthcare costs to families with children, who are more likely to be diagnosed with asthma (or other respiratory or cardiac diseases) when exposed to pollutants. Children in homes with methane gas stoves are 42% more likely to develop asthma (see Weiwei Lin, Bert Brunekreef, Ulrike Gehring, Meta-analysis of the effects of indoor nitrogen dioxide and gas cooking on asthma and wheeze in children, *International Journal of Epidemiology,* p. 1724–1737, https://doi.org/10.1093/ije/dyt150). Exhaust from other household methane gas appliances pours into our city neighborhoods every day further damaging residents' lung health. A closer examination of Belle Haven, just one neighborhood that is already burdened with poor air quality, reveals that baseline asthma rates there are much higher than in other parts of the city, due in part to freeway proximity, heavily congested thoroughfares and inequitable access to indoor air filtration. Thus, children in this neighborhood are already at even *higher elevated risk of asthma* from continued exposure to methane gas stoves. As a reminder, asthma is a life-long condition, a source of stress for families, reduces quality of life and is expensive to treat. For reference, asthma medications alone cost Americans an average of $3,266 per year. ("Gassed Out", Menlo Spark, p. 13). This figure does not include high costs of urgent care or ER visits from asthma-related emergencies.

Protections for Renters. The City should also consider passing new policies to protect renters from increased rents or "renovictions" in tandem with this work. The electrification turnkey service provider mentioned above, BlocPower, specializes in retrofitting and electrifying low income residences and includes covenants in their agreements with building owners that, in partnership with local government and utilities, prohibit the electrification retrofit from being used as a legal rationale to raise rents.

Reducing Barriers to Electrification

Although the TRC report did not focus on feasibility, some Menlo Park building owners have reported challenges converting their existing buildings from gas to all-electric. The city can address these barriers in four ways:

- **Educate building owners and contractors about ways to avoid electrical panel upgrades.** Increasing a building's electric service from PG&E can result in significant delays and add cost to a project. Most residents can fully electrify their homes on their existing electrical panels, a fact that is not currently well understood by contractors. Training and education would eliminate this barrier.

- **Offer free consultation services to building owners.** Peninsula Clean Energy currently offers this service to those designing new all-electric buildings, but a similar service could be extended to existing building owners seeking to go all-electric.
- **Streamline city permitting for electrification.** Make it easy and inexpensive for building owners to get permits from the city for electrification-related work, specifically the following: 1) pre-wiring for electrification, 2) installation of a heat pump water heater, 3) installation of a heat pump HVAC, 4) installation of a heat pump pool heater and 5) installation of an electric fireplace. See the CAP Subcommittee's August 2021 (this month) memo to EQC on this topic.
- **Consider proactively providing every Menlo Park building owner with a free electrification plan.** Building owners would likely feel more comfortable with an electrification policy if they knew exactly what was involved in converting their gas appliances to all-electric. While electrifying one's home is not inherently difficult, it is possible to be steered down wrong paths by uneducated contractors. A clear, detailed plan from a third party helps avoid mishaps brought about by poorly informed choices.

Specific Policy

We recommend that the city draft and enact an ordinance that is simple, outlining one core authority, which is to prohibit the installation of new gas equipment in buildings throughout the city. Applying for a new gas appliance permit is the act that would trigger this ordinance. Since some building owners currently skirt the law and do not seek permits from the city for new gas water heaters and furnaces, the law may be difficult to enforce. However, we believe there is value in getting this law on the books and then working to beef up enforcement later, if building owners as a whole are found to be not in compliance. We would recommend that the city educate contractors and building owners about the new ordinance in an effort to increase compliance, especially among those who do not apply for permits.

Community Engagement

We recommend that Council direct staff to immediately begin public outreach on the policy and programs outlined above. Any building decarbonization policies enacted by City Council today would have a slow, gradual impact on the city's GHG emissions, since gas appliances are so long-lived and most building owners will not voluntarily replace their appliances early. That means time is critical and the Council should not delay.

Final Recommendation

Given the urgency of climate change and the relative affordability of electrification, per the TRC study, we recommend that the City Council push forward as quickly as possible on the Specific Policy outlined above plus two additional initiatives: 1) protect low income residents (see recommendation in Guardrails section above) and 2) reduce the "hassle factor" of electrification policies for building owners (see recommendations in Reducing Barriers section above). With strong, informed leadership, we believe that city residents and building owners will join in the fight against climate change.

The time to act is now. In the words of United Nations Secretary-General Antonio Guterres "there is no time for delay and no room for excuses". Our future as a species depends on it.

August 11, 2021

City of Menlo Park:

Cost Effectiveness Results and Potential Policy Options to Electrify Existing Buildings

DRAFT

Prepared for:

City of Menlo Park
701 Laurel St, Menlo Park, CA 94025

1 Acknowledgements

The development of this report was led by Farhad Farahmand (TRC), under the direction of Sustainability Manager, Rebecca Lucky (City of Menlo Park) and Peninsula Clean Energy. Collaborators and co-authors include:

- Blake Herrschaft (DNV)
- Ron J. La France (Retired Annuitant - Assistant Community Development Director)
- Mayra Vega (TRC)
- Rafael Reyes (Peninsula Clean Energy)

Thank you to the members of Menlo Park's Environmental Quality Commission subcommittee consisting of Josie Gaillard, Tom Kabat, and Angela Evans and City Council subcommittee members consisting of Vice Mayor Betsy Nash and Councilmember Jen Wolosin as well as Menlo Spark for providing feedback and support.

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2 Introduction

The City of Menlo Park (City) has set out to achieve an ambitious climate action plan (CAP) goal: to be carbon neutral or greenhouse gas (GHG) free by 2030. The 2030 CAP was adopted in 2020, and it included six strategies to begin local work in reaching this goal. One of the main strategies involves converting 95% of existing buildings to electric by 2030.

Why electric? Menlo Park procures clean and GHG free electricity for residents and business through Peninsula Clean Energy (PCE). This means that all Menlo Park residents and business have access to affordable clean and GHG-free electricity, making natural gas equipment the remaining fossil fuel in buildings that contribute to climate change (See Figure 1). Natural gas consumption emits about 12 pounds of carbon or GHG emissions per therm.

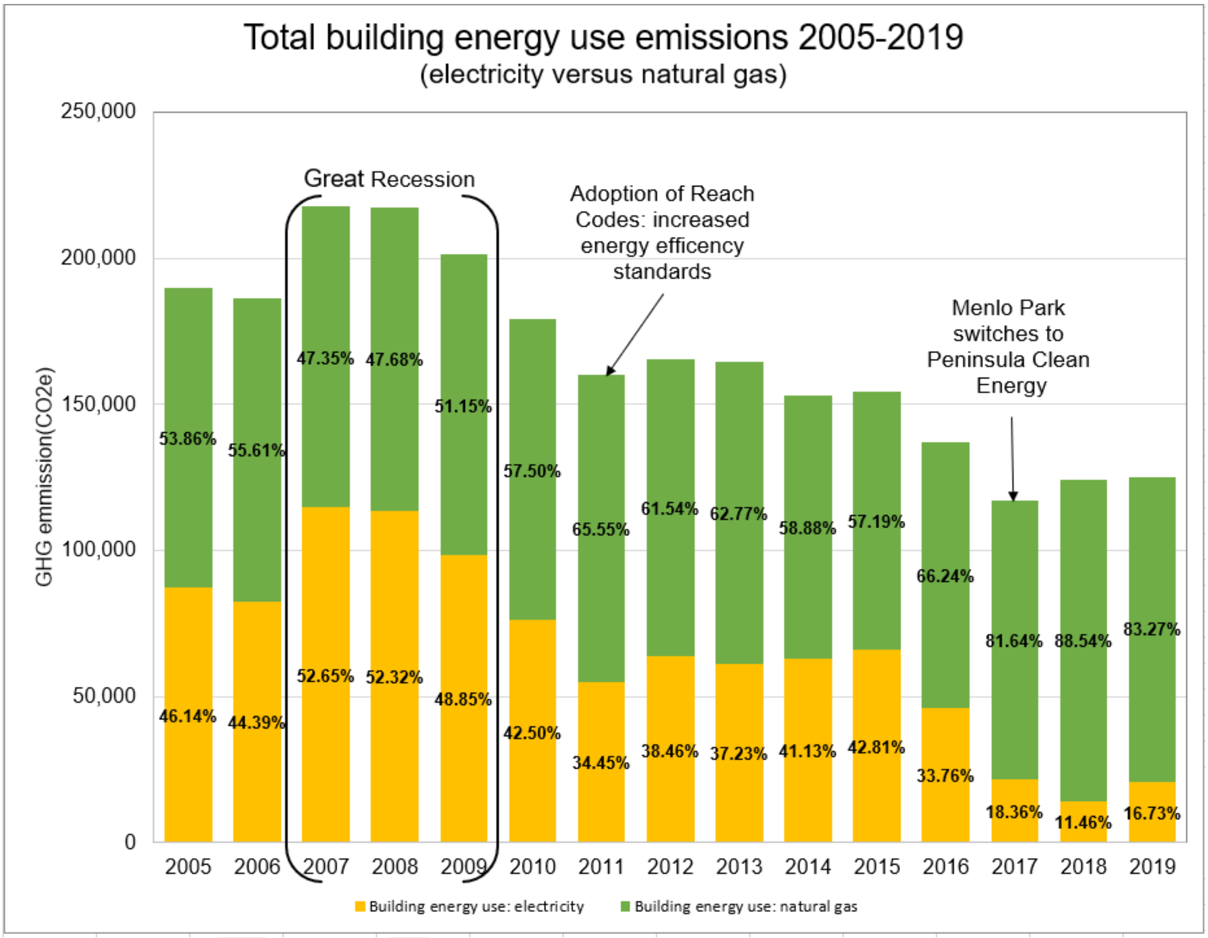


Figure 1: Menlo Park Annual Building GHG Emissions

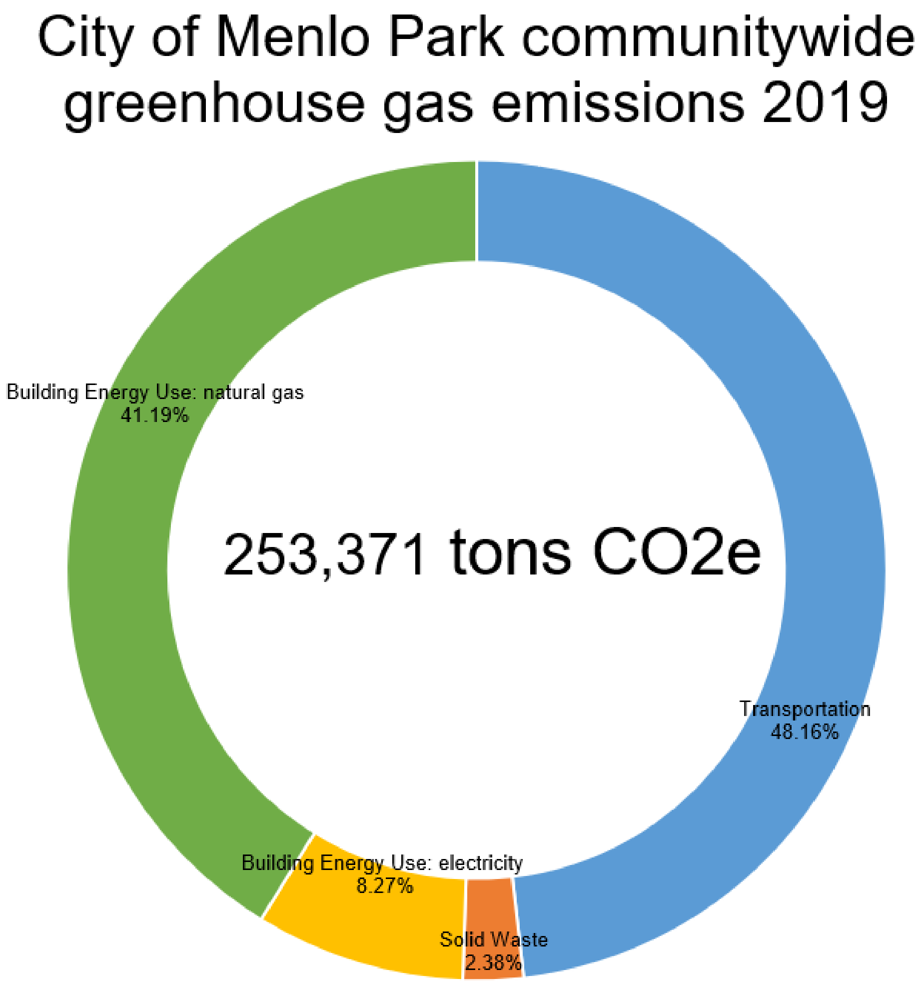


Figure 2: City of Menlo Park Communitywide GHG Emissions, 2019

Many communities with access to GHG-free electricity have an opportunity to reduce their emissions/climate change impacts by replacing all natural gas appliances and equipment with electric versions (e.g., heat pumps). Electric appliance and equipment technology has come a long way over the last few decades and is more efficient, healthier, and safer than natural gas appliances and equipment. Much of the nation's buildings (both residential and commercial) are served by all electric appliances and equipment.

Menlo Park has already positioned itself as an electric building leader through being one of the first to implement all-electric requirements for *newly constructed buildings* in 2020. Energy consumed by new buildings in Menlo Park will be GHG-free energy which will help Menlo Park reach's its climate action plan goals. The next step for Menlo Park is to strategize on how to convert its existing building stock to all-electric. However, the transition from natural gas to electric in existing buildings will take special consideration.

Electrifying *existing* buildings will present unique challenges in ensuring equity, ability to develop and access incentives/financing, addressing unique building ages and layouts, permit efficiencies barriers, and education of trade professionals.

The city council has requested that a cost effectiveness analysis be completed and potential policy options be identified as a first step to developing a plan to convert Menlo Park's existing building stock to an all-electric future. This report provides an overview of cost considerations, market readiness, ability to address equity in an all-electric future, and potential policy options, such as education and outreach, developing additional incentives, adopting building code requirements that range from electric ready to equipment change out requirements, and time of sale policies.

3 Evidence/Data And Other Considerations

3.1 Cost Effectiveness Analysis Results

The California Codes & Standards Reach Codes program is funding cost-effectiveness analysis for electrification of fossil gas appliance measures in existing buildings.[1] The Program provides technical support to local governments considering adopting a local ordinance (reach code) intended to support meeting local and/or statewide energy and greenhouse gas reduction goals.

The Program focuses on analysis that would support energy conservation standard amendments, though a jurisdiction can choose to use findings to inform any type of local ordinance. Local jurisdictions that adopt energy conservation amendments or ordinances as the term is used in Public Resources Code 25402.1(h)2 must demonstrate that the requirements of the proposed ordinance are cost-effective according to the local jurisdiction criteria, and do not result in buildings consuming more energy than is permitted by Title 24. For energy conservation amendments, the jurisdiction must obtain approval from the Energy Commission and file the ordinance with the BSC for the ordinance to be legally enforceable.

The majority of scenarios across both residential and nonresidential building types have shown a mix of cost effectiveness for electrification under the California Statewide Codes and Standards Reach Codes Team (Statewide reach code team) assumptions. Assumptions include 15- to 30-year lifecycle periods, long-term fuel escalation rates from TDV forecasts, excluding vehicle electrification from the scope, and including locally available incentives. These assumptions are assumed to be the most realistic and somewhat conservative. Other assumptions may lead to different results.

Cost effectiveness metrics that are common across the residential and nonresidential studies include:

- Use of two metrics to identify benefits:
  - **Utility Bill Impacts (On-Bill):** Values energy based upon estimated site energy usage and customer on-bill impacts using electricity and fossil gas utility rate schedules over a 30-year duration, accounting for discount rate (three percent real rate) and energy inflation (two percent real rate).
  - **Time Dependent Valuation (TDV):** California Energy Commission Life Cycle Costs methodology, which is intended to capture the "societal value or cost" of energy use including long-term projected costs such as 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.
- Cost effectiveness is presented using net present value (NPV) and benefit-to-cost (B/C) ratio metrics.
  - **NPV:** Net savings (NPV of benefits minus NPV of costs) as the cost effectiveness metric. If the net savings of a measure or package is positive, it is considered cost effective. Negative savings represent net costs.
  - **B/C Ratio:** Ratio of the present value of all benefits to the present value of all costs over 15 or 30 years (NPV benefits divided by NPV costs). The criterion for cost effectiveness is a B/C of 1.0 or greater, representing a positive return on investment.
- Three building vintages were evaluated to determine sensitivity of existing building performance on cost effectiveness of upgrades. Vintages were selected based on historical code requirements and construction practices, and represent prevailing construction practices in the 1980s, 1990s, and 2000s.

3.1.1 Residential

Methodology

The statewide reach codes team examined a single family building and a multi-family building with eight dwelling units, testing a variety of scenarios for electrification upon the end of life of existing gas appliances. The statewide reach codes team used the same methodology as in the statewide analysis (*reference*) with Menlo Park-specific exceptions:

- Local Peninsula Clean Energy (PCE) electric utility tariff (TOU-C) and Pacific Gas and Electric Company (G-1) tariffs
- Current PCE and Bay Area Regional Energy Network (BayREN) incentives

[1] https://localenergycodes.com/

- A single-family 2,700 square foot home is used in place of the 1,665 square foot home applied in the statewide study. This larger home better reflects the Menlo Park building stock, which has a median single-family square footage of 2,240 ft^2 and average of 2,426 ft^2.
- No efficiency measures, only the electrification of fossil gas appliances are evaluated, including furnace, water heater, clothes dryer, and range
- Two additional measures are evaluated showing the energy impact of converting a gas dryer and gas range/oven to electric resistance appliances

Also note that in scenarios where air conditioning (AC) is not existing on-site and is not planned to be installed, there will be additional incremental costs for installing an outdoor unit, refrigerant lines, and condensate drain pan. The incremental costs from this 'heating-only' baseline were not examined in this study.

Key Results

Key cost effectiveness results include the following. The full cost effectiveness report for nonresidential can be accessed in Attachment A. The values below are drawn from the single-family prototype findings and blended across vintages for simplicity, but results generally align between the single family and multi-family building prototypes.

- Water heating natural gas to electric measures
  - Heat pump water heaters (HPWHs) are all-electric water heaters that use refrigerant to transfer heat from air to water and are more efficient than electric-resistant and gas storage water heaters.
  - HPWHs cost approximately $2,700 more than gas water heaters over a 30-year lifecycle period, including replacements. This includes differences in equipment costs between a HPWH and a gas water heater as well as utility bill impacts over the 30 year period.
  - HPWHs were found to be cost effective when using the TDV metric.
  - On-bill impacts
    - A high-efficiency (UEF>3.0) HPWH costs approximately the same to operate as a gas equivalent in Year 1, and it saves approximately $6/month on average over 30 years. Note that while federal pre-emption disallows setting higher efficiency, it does allow parallel paths for higher efficiency as long as there is at least one feasible path for a minimum efficiency appliance to meet a state or local code. Further, high-efficiency HPWH are more commonly sold in the market and thus more likely to be purchased by consumers.
    - After BayREN and PCE incentives, a high-efficiency HPWH is narrowly cost effective when using the On-bill metric with a net present value of $1,612 over 30 years.
    - HPWHs are cost effective On-bill when combined in a measure package including on-site solar photovoltaic (PV).
- Space heating fuel-substitution measures are:
  - Baseline efficiency (14 seasonal energy efficiency ratio or SEER, an efficiency metric used specifically for air conditioners) heat pump space heaters cost approximately $500 more than baseline combined gas furnaces and air-conditioners over a 30 year lifecycle period, including replacements.
  - High efficiency (21 SEER) heat pump space heaters cost approximately $3,800 more than baseline combined gas furnaces and air conditioners over a 30 year lifecycle period, including replacements.
  - Heat pump space heaters were found to be cost effective when using the TDV metric.
  - On-bill impacts
    - A 'standard' or baseline efficiency heat pump space heater costs approximately $25/month more to operate than a gas equivalent in Year 1, and $6/month more on average over 30 years.
    - A high efficiency heat pump space heater costs approximately $5/month more to operate as a gas equivalent in Year 1 but saves approximately $17/month over 30 years. Note that while both kind

of heat pumps take advantage of fuel escalation rate assumptions, the higher efficiency version saves more energy and thus more money in the long run.

  - After BayREN and PCE incentives, a high-efficiency heat pump space heater is narrowly cost effective when using the On-bill metric by approximately $1,400 over 30 years.
  - Heat pump space heaters are cost effective On-bill when combined in a measure package including on-site solar PV.

- Clothes drying and cooking measures are not currently cost effective using either TDV or customer On-bill metrics.

Results for all appliances, both TDV and On-bill are shown in Figure 3 for a single-family building. It is important to note:

- These results assume replacement at the end of useful life, and results would become less cost effective upon early replacement.
- The results assume that the replacement will be heat pump equipment versus other electric equipment that may be more costly to operate such as the traditional electric resistance technology.
- Includes BayRen and PCE incentives: SEER 21 Heat Pump rebate is $1,000 and HPWH rebate is 2,000. These rebates reduce the upfront costs to install equipment and increase NPV savings for on-bill.
- Does not include the future costs of climate change. This analysis is under development and will be included in the updated report by the end of August 2021.

Figure 3: IOU Team Findings for Cost Effectiveness of Water Heating, Space Heating, Clothes Drying, and Cooking Measures in a 2,700 ft2 Existing Home.

Type of Equipment	Measure	Vintage	30-Year Measure Cost	Annual Electricity Savings (kWh)	Annual Gas Savings (therm)	Monthly Utility Cost Savings		30-Year Customer On-Bill		30-Year 2022 TDV	
						Year 1	Avg	B/C Ratio	NPV	B/C Ratio	NPV
Space Heating Equipment Note that the analysis focuses only on heat pump technology	Heat Pump at HVAC Replacement	Pre-1978	$501	-4,528	451	($31)	($5)	0	($2,271)	9.3	$4,160
		1978-1991		-3,173	309	($25)	($6)	0	($2,710)	5.68	$2,348
		1992-2010		-2,722	265	($22)	($6)	0	($2,683)	4.96	$1,984
	High Efficiency Equipment SEER 21 Heat Pump at HVAC Replacement	Pre-1978	$3,749	-3,261	451	($3)	$18	1.56	$2,273	3.17	$8,152
		1978-1991		-2,337	309	($6)	$9	0.77 1.07	($913) $209 with incentive*	1.96	$3,617
		1992-2010		-2,011	265	($6)	$7	0.59 0.81	($1,678) ($555) with incentive*	1.6	$2,244
	Heat Pump at HVAC Replacement + 2.82 kW$_{DC}$ PV (solar)	Pre-1978	$9,454	-27	451	$66	$70	2.42	$14,803	2	$9,478
		1978-1991		1,328	309	$72	$69	2.37	$14,339	1.81	$7,637
		1992-2010		1,779	265	$75	$69	2.38	$14,382	1.77	$7,292
Water Heating Equipment Note that the analysis focuses only on heat pump technology.	NEEA Tier 3 HPWH at Replacement	Pre-1978	$2,775	-1,146	177	$0	$8	0.87 3.20	($387) $1,859 with incentive*	1.87	$2,419
		1978-1991		-1,152	179	($1)	$7	0.77 2.83	($706) $1,540 with incentive*	1.87	$2,424
		1992-2010		-1,155	180	($1)	$6	0.74 2.71	($808) $1,438 with incentive*	1.85	$2,359
	HPWH at Water Heater Replacement + 2.82 kW$_{DC}$ PV (solar)	Pre-1978	$11,546	2,913	179	$88	$75	2.12	$14,333	1.52	$6,017
		1978-1991		2,908	181	$87	$74	2.09	$13,995	1.52	$6,003
		1992-2010		2,907	181	$87	$74	2.09	$13,893	1.52	$5,956
	2.82 kW$_{DC}$ PV (solar) + Electric Ready	Pre-1978	$13,044	4,501	0	$97	$75	1.86	$12,419	1.09	$1,156
		1978-1991		4,485		$91	$70	1.75	$10,837	1.08	$1,100
		1992-2010		4,400		$89	$69	1.71	$10,299	1.07	$848
Other Appliances	Electric Clothes Dryer	All	$313	-891	33	($15)	($10)	0	($4,058)	0	($2,242)
	Electric Range/Oven	All	$608	-295	14	($5)	($3)	0	($1,746)	0	($1,229)

Figure below summarizes the capital and energy costs for a typical 1978-1991 Menlo Park home, before including incentives, including fugitive methane emissions of the gas grid.

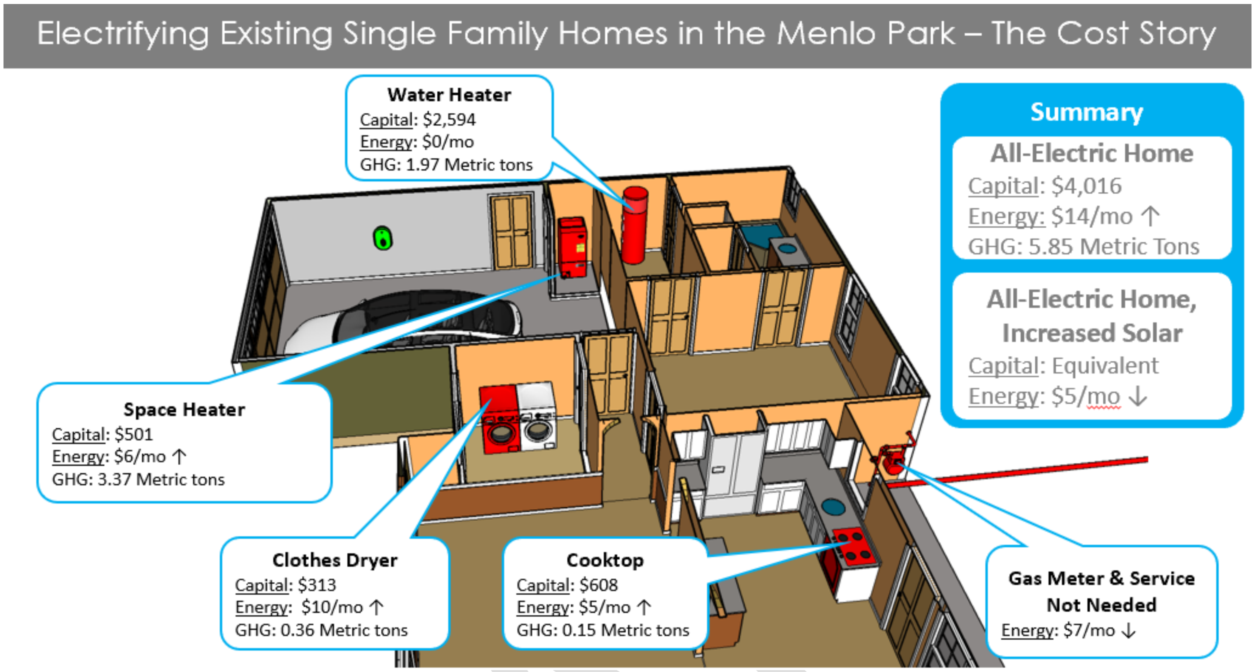


Figure 4. All-Electric Cost Savings for a Single Family Home in Menlo Park

Residential Water Heating Efficiencies Not Included in Overall Findings

A 'standard' or baseline HPWH (lowest efficiency one can legally buy with a Uniform energy factor, or UEF, an efficiency metric specifically for water heaters, of 2.0) costs approximately $10 more per month to operate than a gas equivalent in Year 1, and costs approximately the same to operate as a gas equivalent on average over 30 years. It is important to note that while 2.0 is the federal minimum efficiency, these appliances are **not available** on the market for purchase. Thus, it was excluded as part of the analysis above. However, these are included in reach code studies since federal appliance standards have a provision called pre-emption that prevents state and local jurisdiction from having higher efficiency standards for appliances that are regulated by federal appliance standards. Figure below shows the cost-effectiveness of a baseline HPWH. If a local jurisdiction seeks California Energy Commission approval, this analysis would need to be included in making a determination on the cost effectiveness of a measure. There are no rebates available for this type of technology likely because it is not sold on the market currently.

Measure	Vintage	30-Year Measure Cost	Annual Electricity Savings (kWh)	Annual Gas Savings (therms)	Monthly Utility Cost Savings		30-Year Customer On-Bill		3-Year 2022 TDV	
					Year 1	Avg.	B/C Ratio	NPV	B/C Ratio	NPV
HPWH at Water Heater Replacement	Pre-1978	$2,594	-1,588	179	($10)	$0	0	($2,901)	1.2	$522
	1978-1991		-1,593	181	($10)	($1)	0	($3,231)	1.2	$517
	1992-2010		-1,594	181	($11)	($1)	0	($3,334)	1.18	$466

Figure 5. Cost-effectiveness of UEF 2.0 HPWH

3.1.2 Nonresidential

The Statewide Utility Codes and Standards program has not completed the review of the Nonresidential Electrification Alteration results, but it is allowing TRC to share preliminary results to support Menlo Park's policymaking schedule. As such, these results are TRC's representation rather than the Statewide Utility Program's. TRC examined seven nonresidential building prototypes, testing a variety of scenarios for electrification at the end of useful life of an existing gas appliance. The report is still in progress, and final results are expected to be published in the third quarter of 2021.

Methodology

TRC used modified versions of the following seven U.S. Department of Energy building prototypes to evaluate cost effectiveness of measure packages: Medium Office, Stand-alone Retail, Warehouse, Quick-service restaurant, Full-service restaurant, High-rise Multifamily, and Small Hotel. The analysis assumes some equipment replacement over time across three vintages, based primarily on the Senate Bill 350 analysis.[2] The rate of replacement varies by building system and by envelope component. General prototype characteristics are outlined in Figure 3.

Nonresidential Prototypes Analyzed for Cost-Effectiveness				
Building Type (All Vintages)	**Conditioned Floor Area (ft2)**	**# of floors**	**Baseline HVAC Distribution System**	**Baseline Hot Water System**
Medium Office	53,628	3	Packaged multizone variable air volume reheat + boilers	Central Gas Storage
Stand-alone Retail	24,563	1	Packaged single zone (SZ) constant air volume (CAV) + gas furnace	Central Gas Storage
Warehouse	17,548	1	Warehouse: Gas furnace serving 10% of floor area, exhaust-only ventilation Office: Packaged SZ CAV + gas furnace	Central Gas Storage
Quick-service Restaurant	2,500	1	Packaged SZ CAV + gas furnace	Central Gas storage
Full-service Restaurant	5,000			
HRMF: 1980s	125,400 117 dwelling units	10	Packaged terminal air conditioning (PTAC) + boilers serving heating-only baseboard	Central Gas storage
HRMF: 1990s			PTAC + boilers serving heating-only fan coils	
HRMF: 2000s			Split air conditioner + gas furnace	
Small Hotel: 1980s	42,552	4	PTAC + gas wall furnace	Central Gas storage
Small Hotel: 1990s				
Small Hotel: 2000s			SZAC + furnace	

Figure 6: Nonresidential Prototypes Analyzed for Cost Effectiveness.

Note that the High-rise Multifamily prototype assumes that cooling is installed, similar to the low-rise residential analysis. In scenarios without air-conditioning, the incremental costs for electrification retrofits, or electrofits are likely to be higher than those estimated in this study.

TRC electrified appliances with heat pumps for all appliances, except for restaurant cooking appliances, which are either induction or resistance technologies. TRC examined the following packages for each prototype:

- **Mixed Fuel Code Minimum Package**: Appliance upgrades on the existing building using code-minimum fossil gas equipment.
- **All-electric Code Min**: Replace any gas equipment with electric, code-minimum equipment, including heating, ventilation and air-conditioning (HVAC), service hot water (SHW), and cooking appliances (for restaurants only). Upgrade electrical infrastructure as-required. The baseline for this package is a gas code-minimum equipment replacement, including HVAC, SHW, and appliances.
- **All-electric Code Min (2022 TDV):** All-electric Code Min, with cost-effectiveness calculations done using 2022 TDV multipliers. The baseline for this package is the same as the all-electric Code Min Baseline, except with 2022 TDV multipliers.
- **Electric HVAC + SHW:** This package is specifically for the restaurant prototypes, and it replaces gas space and water heating equipment with electric code-minimum equipment.

[2] https://www.cpuc.ca.gov/sb350/

- **All-Electric + Efficiency:** Adds efficiency measures to the All-Electric Code Min package, except in restaurants where it adds efficiency measures to the Electric HVAC + SHW package.
- **All-electric + PV:** All-electric Code Min, including a solar PV array, plus battery storage for the Restaurant prototypes only. The solar PV size is customized for each prototype based on either offsetting annual kWh consumption, or the size accommodated by 50% of the roof, whichever is smaller. Batteries were sized to offset the majority of peak load hours. The baseline for this package is the same as the All-electric Code Min Baseline.
- **All-electric + PV (2022 TDV):** All-electric + PV, with cost-effectiveness calculations done using 2022 TDV multipliers. The baseline for this package is the same as the All-electric Code Min Baseline, except with 2022 TDV multipliers.

Results

TRC identified the results summarized below. For complete findings, please reference the attached Nonresidential memo.

- **Restaurants**: no cost-effective electrofit packages identified yet.
- **Stand-alone Retail**: electrofits are cost effective using both On-Bill and TDV metrics when combining efficiency measures or solar PV. The efficiency measure packages represent a much lower upfront cost than PV, and more widespread cost effectiveness. Efficiency measures include window film and a lighting retrofit to 2019 code-minimum requirements (0.95 W/ft^2).
- **Warehouse**: electrofits are cost effective using the On-Bill metric when combining with solar PV.
- **Medium Office**: little-to-no cost-effective electrofit packages identified yet. Adding solar PV narrowly achieves a cost-effective outcome in the 1980's vintage.
- **High-rise Multifamily:** The 90's vintage, which has a negative incremental cost for electrofit, is cost effective using TDV and when including solar PV.
- **Small Hotel:** Electrofits are very cost effective, both on-bill and TDV, due to the installation of package terminal heat pumps (PTHPs) instead of separate furnace and air-conditioning systems that are assumed in the mixed-fuel baseline.

3.2 Incentives and On-bill Financing

The Team performed an extensive literature review (attached) to identifying financing options for existing building electrification. The literature review lists the currently available incentive programs and financing options for Menlo Park residents and businesses. The review also identified that local jurisdictions could serve in the lead role in providing the following financing pathways:

- **Municipal Financing** (e.g., green bonds and local taxes and fees): Voter-approved fund generation mechanisms can affirm a community's willingness to invest in decarbonization measures. Bonds can be used for public infrastructure projects, and increased revenues from utility taxes can serve to potentially provide consumer financing.
- **Incentive Programs:** A jurisdiction may lead the development of incentive programs, likely with funding from a partner organization, such as San Jose and Marin County partnering with the Bay Area Air Quality Management District. Redwood City has recently started a modest program offering electrification incentives.

Local jurisdictions may also serve educational and advocacy roles for the following mechanisms:

- **Electrification as a Service**: A local jurisdiction can play a key role in reducing market entry barriers for providers such as BlocPower, or advocate for establishing local programs that create a market for contractors and installers by paying them for projects that deliver metered bill savings.
- **Tax Credits, Deductions, and Rebates**: Federal tax incentives can be attained for eligible electrofits and stacked with incentive programs, though they are fairly low amounts.
- **On-bill Financing**: The Investor-owned utilities (IOUs) and local community choice aggregation programs can offer on-bill financing to their customers for energy efficiency and electrification upgrades. These loans are associated with the utility customer and not the meter, which usually disqualifies renters from being eligible. On-bill financing loans offer low interest rates and can serve customers with low credit history. PCE is exploring implementing an on-bill financing program in 2022 for its customers.

- The IOUs can also offer *tariffed* on-bill (TOB) financing to its customers. TOB loans are associated with the utility meter and not the customer, which allow them to serve a wide market including hard-to-reach segments such as renters.

- **Loan Programs:** A suite of loans are available for credit-worthy residential and nonresidential building owners through the California Hub for Energy Efficiency Financing, including programs for residential, affordable multi-family, and small businesses. These programs may fill in gaps where building owners may have insufficient access to incentive programs or tax deductions. Loans are expected to be one of the last options to financing a project, as they carry more risk for the applicant than many of the preceding options listed. They also can increase debt and have equity impacts, as it can further exacerbate financial vulnerability for low-income communities.

The review also noted the following financing mechanism gaps:

- High investment costs and limited incentives for heat pump space heating as a replacement for a methane gas furnace in a building that does not already have air-conditioning.
- Limited precedence for existing building electric vehicle (EV) financing. A jurisdiction may supplement PCE's EV incentive program with additional incentives or additional loan programs targeted toward EV investment in a similar manner that Boulder partnered with a local credit union (See Section 3.4 for more details).
- Nonresidential buildings are eligible for fewer incentive programs than residential. This may be due to the higher financing needs and access of the nonresidential market.

3.3 Market Readiness

3.3.1 Technology

The technology is available for full electrification of all building stock today, with exception in a minority of industrial and process loads. As outlined in the New Building Institute's Building Electrification Technology Roadmap, there are limited technology barriers to building electrification. Key takeaways from the study include:

- Space Heating
  - Various forms of heat pump systems are technically ready and available to address most retrofits, including commercial space heating needs. More difficult buildings include those with large heating loads, such as labs and hospitals, and those with physical constraints that would prevent the footprint and hot water storage necessary for a load-flexible heat pump.
  - Electric resistance boilers and electric reheat coils are technically ready and available to address niche space heating needs, but they do not offer the high efficiency and GHG reduction benefits that heat pumps do.
- Water heating
  - HPWHs are technically ready and available to address some retrofits and multi-family hot water needs with demand control capability.
  - Solar thermal and electric resistance water heaters are technically ready but have drawbacks.
- Cooking
  - Induction cooktops and electric resistance ovens are technically ready and available to address some retrofits and commercial cooking needs.
  - Barriers include:
    - Consumer desires for charbroiling.
    - Low consumer education.
    - Ferrous cookware requirements that are a separate investment from the range. This can have equity impacts in requiring further investment in new cooking equipment to use induction cooktops. Conversely, there are utility bill impacts in using electric resistance ovens, which have equity impacts on low-income communities.

- There are some range sizes that non-standard in the induction market (e.g., 24" and under, 36" and over).
- Limited stock in stores. Many models are available online, though this may lead to long shipping times.
- Induction cooktops rated for outdoor kitchens are not currently available.

- Clothes dryers
  - Heat pump dryers and combo washer/dryers (condensing dryers) are the recommended technologies to focus electrification efforts for residential buildings right now.
  - Electric resistance dryers are technically ready and available to address residential new construction and commercial laundry needs.
  - The primary roadblock is the lack of commercial-grade heat pump clothes dryers in the U.S. market, which are more common in Europe and Asia.
- Pool heating
  - Pool heat pumps are widely available in the US.
  - Contractor education will be required in order to make pool heater heat pump installations more common.

Across all these technologies, the primary barrier is the unique site considerations and heightened electrical requirements when replacing gas appliances and the related challenges posed to contractors. A major barrier specific for HVAC and plumbing contractors has been simple preference for gas-fired equipment to maintain business-as-usual practices.

3.3.2 Contractors

Although used widely throughout the United States and other countries, HPHW represent the newest technology for contractors in California. This will be a major overhaul in how contractors provide space and water heating services to customers. As mentioned in the previous section, the preferences of contractors to continue to use gas-fired equipment will continue over the next few years, resulting in a limited supply of contractors capable and willing to do this type of work. This is a natural and normal process for any industry or professional grappling with deep trade related changes. It requires a significant time investment for the contractor to learn about the technology, how to expertly install and inform customers about its use and performance, and become efficient at installing and problem solving gas to electric conversions to lower overall labor costs.

Installation in existing buildings can require a different configuration than gas equipment, and it may require both an electrician and a plumber for a task that once required only one trade. The industry will need time to become more educated and align their trade licenses in a way that provides convenient and efficient services.

Mechanical contractors may be already well-suited for installation, as they are accustomed to installing air conditioner and heat pumps. Electric ranges and dryers do not require special installation, except for an adequately-sized electrical circuit, which can be performed by a licensed electrician.

Property owners can utilize two resources to find contractors that are well versed in electrification technologies:

- Bay Area Regional Energy Network has a database of nearly 100 certified contractors throughout the Bay Area that specialize in residential energy assessments, heat pump HVAC, HPWHs, solar PV, and other building components.
- The Clean Energy Connection has a database of contractors serving single family, multi-family, and commercial properties across California. It also includes information on whether the contractor provides financing, participates in rebate programs, and speaks multiple languages.

3.4 Other Bay Area Cities' Progress Toward Existing Building Electrification

Representatives of many other cities have indicated interest in electrifying existing building stocks in order to meet GHG reduction goals. Cities at the forefront of early analysis and public engagement include the City of Berkeley and Half Moon Bay. Half Moon Bay is considering a requirement to replace natural gas equipment at the end of its useful life known as a "burnout" type regulation/ordinance.

In April 2021, the City of Berkeley developed an Existing Buildings Electrification Strategy (draft). [3] A major conclusion included that before any mandatory measures can be implemented or considered, there are equity issues that need to be addressed to make the mandatory policies effective and doable for all members of the community. This has ultimately led to a delayed ability to mandate electrification of existing buildings. Berkeley projects that they will be able to electrify all existing buildings by 2045.

Many foundational policies/activities need to be developed or enhanced to prepare for mandatory requirements such as tenant protections, advocacy at the state level, building set back requirements, and energy efficiency upgrades in the existing housing stock to ensure affordability. A road map was prepared that identifies short, medium, and long-term strategies. Below is a table that summarizes their roadmap.

Berkeley's Existing Building Electrification Strategy	
Phase 1: 2021-2025 **Short Term**	Demonstrate the benefits and feasibility of electrification through: • Community engagement • Pilot projects • Education campaigns • Well trained job force • Additional incentive programs • Larger scale financing programs, such as tariffed on-bill financing. • Collaborate with regional and state partners to ensure the ability to execute Phase 2
Phase 2: 2022-2030 **Medium Term**	The following would be only implemented after Phase 1 actions have demonstrated feasibility, cost effectiveness and best practices: • Mandating electrification at points of sale, lease, renovation, and part of a building performance standards program. • Neighborhood scale electrification Some Phase 2 actions will need to be implemented only after accessible funding and financing programs is in place or the upfront costs of electrification reach parity with gas infrastructure.
Phase 3: 2027-2045 **Long Term**	Bans the use of gas

Figure 7: Berkeley's Existing Building Electrification Strategy

In April 2021, Half Moon Bay proposed a draft building electrification ordinance that includes new construction electrification requirements, and it prohibits replacing fossil gas appliances with another gas appliance in alteration scenarios.[4] The City is conducting public engagement through September of 2021 before making a final decision.

3.5 Equity

Electrification policy must make financial sense for all community members, including lower-to-moderate income (LMI) residents. Ensuring that benefits of electrification, such as health, safety, and affordability, are targeted toward marginalized communities reverses compounding historical injustices, many of which have been created and perpetuated by government action. PCE's literature review identified the following findings:

[3] https://www.cityofberkeley.info/uploadedFiles/Planning_and_Development/Level_3_-_Energy_and_Sustainable_Development/Draft_Berkeley_Existing_Bldg_Electrification_Strategy_20210415.pdf

[4] https://www.half-moon-bay.ca.us/761/Building-Electrification

- Without equitable policy development, local building regulations run the risk of doing more harm than good. For example, landlords may raise rents or evict tenants when making building upgrades, a harmful practice known as "renovictions."
- Partnering directly with local community based organizations (CBOs) can expand city efforts and deepen engagements in the creation of building decarbonization policies. CBOs and community members may initially be skeptical of governmental interventions, but early and regular engagement can lead to honest discussions around climate policy, establish a strong commitment, demonstrate accountability, repair trust, and lead to better overall policy.
- Rental property energy performance standards, coupled with rental housing policies, could reduce the energy cost burden on tenants, eliminate the split incentive, and support cities in meeting climate goals.
- CBOs and community members should be compensated for attending workshops or meetings to cover childcare, food, travel, or other expenses.

The City of Berkeley Existing Buildings Electrification Strategy defines the multiple forms of equity, establishes the intention to design policy around the goal of Targeted Universalism, and will leverage the Greenling Institute's Equitable Building Electrification Framework.[5,6] Berkeley's strategy aims to address LMI populations' ability to invest and access available incentives, avoid increasing debt in financing programs, and invest in energy efficiency and solar and battery storage to ensure bill impacts are reduced or negligible.

Using the LEAD tool, Figure 7 shows American Community Survey data indicating that there are approximately 1,500 housing units in Menlo Park that are below the 30% area median income (AMI).[7] The occupants of these housing units are mostly renters and pay seven to eleven percent of their income on energy (also known as *energy burden*). As one example, an equitable policy would strive to ensure that the energy burden of LMI communities matches that of more affluent populations (see Section 3.1.4).

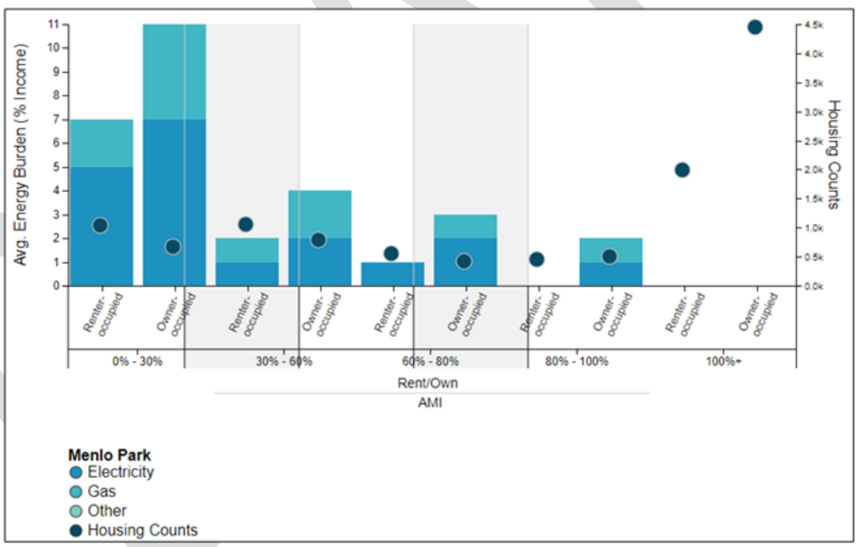


Figure 8: Average Energy Burden (Percent of Income) for Menlo Park

[5] https://www.cityofberkeley.info/uploadedFiles/Planning_and_Development/Level_3_-_Energy_and_Sustainable_Development/Draft_Berkeley_Existing_Bldg_Electrification_Strategy_20210415.pdf
[6] https://greenlining.org/wp-content/uploads/2019/10/Greenlining_EquitableElectrification_Report_2019_WEB.pdf
[7] https://www.energy.gov/eere/slsc/maps/lead-tool

4 Policy Options

This section provides an overview of possible policy and program options that Menlo Park can consider in advancing building electrification of existing buildings. The policy options currently focus on existing single family and some multi-family electrification opportunities. Nonresidential (commercial) will be added once further the cost-effectiveness data is completed. The next section of this report analyzes the GHG reductions for each option. The last section uses criteria to rank policy options for consideration.

There are three important notes to make:

1. Implementing all of the policy options will only achieve half of the needed GHG reductions by 2030; efforts at the regional, state, and federal government levels will be needed to support Menlo Park in meeting its GHG reduction goal.
2. It will be important to consider the GHG emissions differences between commercial and residential consumption when finalizing an existing building electrification strategy for Menlo Park. See graph below.
3. Similar to Berkeley's findings, significant foundational work may be needed before considering any regulations and/or mandates. Further discussion is provided below.

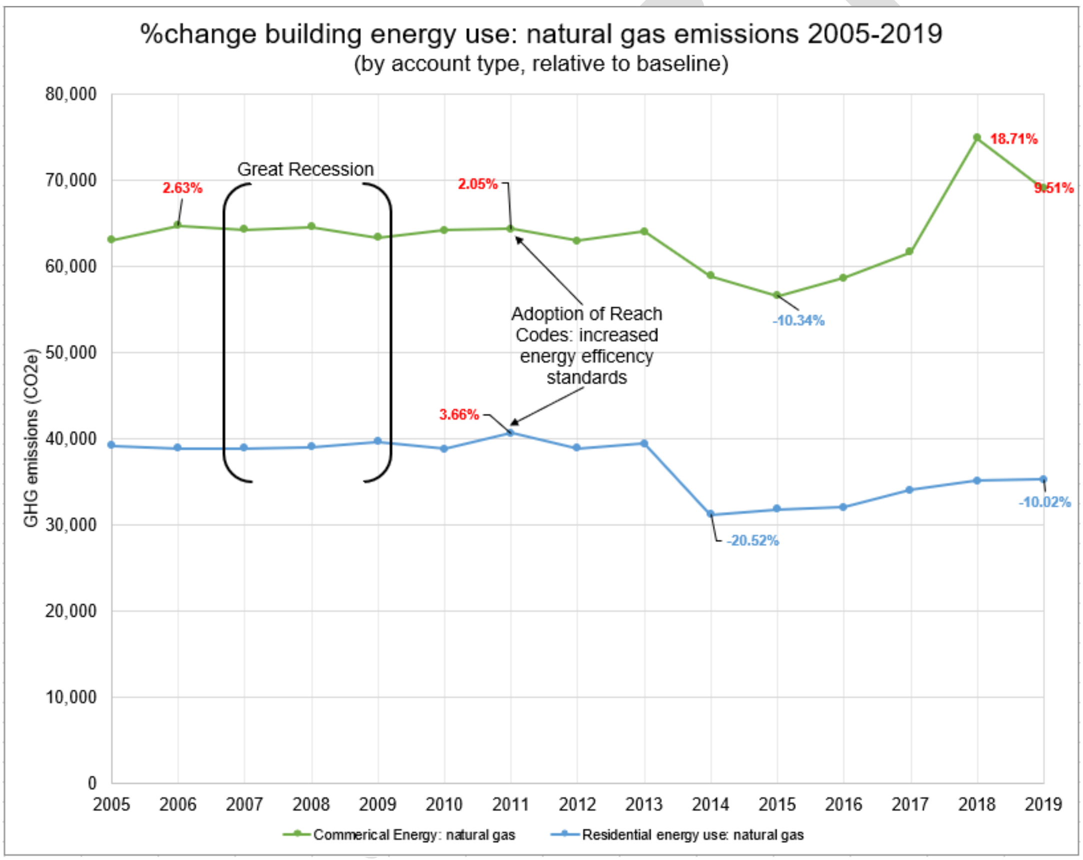


Figure 9: Natural Gas Emissions by year in Menlo Park

4.1 Groundwork to Pave the Pathway Towards Electrification Mandates

Similar to Berkeley's findings, significant foundational work may be needed before considering mandates, and includes:

- Robust engagement and education to assist residents and business on grid resiliency through solar and battery storage and addressing climate change through all-electric buildings.
- Pilot projects that include solar, energy storage, and electrification that support LMI community members.
- Advocate at regional and state levels to advance electrification for existing buildings.

- Development of additional incentives and financing programs and explore possible funding mechanisms
- Development of rental protections and/or rental license program that would not cause displacement or rent increases because of future electrification mandates.
- Development of, or include in, housing rehab programs such as solar installation, energy efficiency upgrades, and building electrification.
- Modify Menlo Park's noise and building setback regulations to accommodate building electrification needs.

Addressing these areas before mandates are adopted will be key in gaining community buy-in, trust, and support. It will help to identify and problem solve for unusual or unique building layouts or energy needs (e.g., must relocate equipment in setback areas). It will place equity at the forefront by creating policies or programs in advance of regulations to ensure that a financial safety net is provided to LMI community members.

4.2 Option 1: Public Engagement and Education

4.2.1 Develop a Robust Public Engagement and Education Program

This option involves developing a comprehensive concierge type of service to assist residents and businesses through the electrification process. This can include partnering with PCE on projects/programs, piloting projects for electrification in LMI neighborhoods, providing energy analysis and design services for all members of the community, permit counter education opportunities, large-scale community education forums and outreach for residents and businesses, and assistance with rebate and financing eligibility.

City Resources Required

Additional staff would be necessary to perform this work. The staff required could be minimized (but not eliminated) if the City is able to contract/partner with a local nonprofit, utility, or company to support the work.

4.3 Option 2: Generate Funds to Develop Additional Incentive and Financing Program Offerings

In order to provide additional incentives and financing programs for Menlo Park residents and business, Menlo Park may want to consider generating revenues from various sources to support electrification particularly for LMI residents.

4.3.1 Potential Revenue Sources

A local jurisdiction can use one time reserves as an option to fund additional incentives or programs to support electrification efforts for LMI residents. Funds from American Rescue Plan Act may also have flexibility in being used for electrification efforts.

There are a variety of ways a local government generates revenue to fund incentives and use fees as a disincentive to continue to generate GHG emissions. Local governments may incorporate a fee for building projects that generate GHG emissions and use the funding to incentivize future decarbonization offsets throughout the jurisdiction. This also has the added effect of dis-incentivizing generating GHG emissions on site. An example of this includes:

- **The City of Watsonville** adopted a carbon fund ordinance in 2015 that charges a fee to all development projects including new construction, additions, and alterations, with the exception of single family alterations. The additional carbon impact fee is between 30% and 50% of the building permit fee. Projects may be refunded the fee if they install on-site renewable generation to offset the average annual electricity load.[102]
- In late 2019, the **City of San Luis Obispo** tentatively proposed a GHG *in-lieu fee* for new construction projects that installed fossil fuel consuming appliances, ranging from $6,013 for a typical single family residence up to $89,000 for a 54,000 ft^2 office.[103] This measure has been delayed for adoption due to community concerns.

Utility Users Tax to Fund Low-Income Electrification

A utility users' tax (UUT) may be levied by municipalities to provide general fund revenue. The tax may be increased to generate funds for projects and programs that reduce GHG emissions and provide catered offerings for income-qualified projects.

- **The City of Berkeley** proposed Measure HH in 2020 to increase the UUT from 7.5 to 10% for electricity and 12.5% for methane gas.[100] The UUT proposal included special rates for income-qualified residents. Despite strong community support during survey, the ballot measure was ultimately defeated.
- **The City of Albany** proposed Measure DD to increase the UUT from 7 to 9.5% for electricity and gas and apply a tax to water service at 7.5%. The measure passed. The measure is estimated to generate an additional $675,600 in new revenues annually for the City.[101]

As part of the 2006 general election, Menlo Park voters passed a ballot measure imposing a maximum 3.5% tax on gas, electrical, and water usage, and a maximum 2.5% tax on cable, telephone, and wireless services. These maximum tax rates became effective on April 1, 2007.[8] Menlo Park City Council has maintained the tax across all utilities at 1%, and can increase this tax on natural gas to 2.5% and 3.5% without requiring a new ballot initiative. The tax would not be imposed on those on subsidized energy (electric and gas) rates such as participants in the CARE or FERA programs. Increasing the taxes up to its voter approved limits would result in an additional $3 million per year in revenues.

4.3.2 Financing

A municipality can also use borrowing capacity or loan loss reserve to develop a partnership with a local lender and create a loan program to finance electrification enhancements. A dedicated loan program brings a streamlined funding opportunity and rate certainty to property owners who are considering the prospect of electrification and would benefit from the extra financial line of sight. California has several dedicated loan programs for energy related upgrades through the California Hub for Energy Efficiency Financing, and there are a few examples outside of California of cities partnering with lenders to create customized programs, such as Fort Collins Home Efficiency Loan Program and Boulder's partnership with Elevations Credit Union.

4.4 Option 3: Time Certain Building Performance Standards

Building performance standards can alert building owners of citywide, deadline-driven requirements, allowing them to plan long-term upgrades. They also capture buildings that are not retrofitted, sold, or submitted for permit during an alteration. In some cases, cities require that upgrades be performed within certain time windows or face a penalty. Examples of these policies, and the issues contained, are listed below. Similarly, a jurisdiction may adopt an ordinance requiring that all buildings replace their existing appliances to be all-electric by 2030. To enhance compliance, cities may need add field inspection programs and penalties for noncompliance.

- **The City of Brisbane** requires most owners of buildings larger than 10,000 ft^2 to report energy benchmarking results using ENERGY STAR Portfolio Manager® to the city annually on May 15th starting in 2021. Starting in the 2023 reporting cycle, buildings will be required to demonstrate building efficiency performance metrics or conduct an audit to identify and implement savings opportunities.
- Some cities may leverage existing structure from rental policies and business license programs to enforce disclosure programs and require additional upgrades. The **City of El Cerrito** is a California example of a residential rental inspection program, operating since 1997. El Cerrito requires all residential rental units to be registered, obtain a business license, pay an annual license tax, and be inspected every two years. The inspection costs approximately $129 per multi-family unit. The inspector checks for a variety of measures including appliance installation and operation as well as electrical wiring. The cities of Richmond, San Pablo, and San Rafael also include rental inspection programs, though triggers can vary by regular time periods, time of sale, and/or complaints. These programs achieve an average of 80% compliance rates.
  - StopWaste has developed key considerations and estimates of carbon impacts to support jurisdictions exploring the idea of a *rental housing inspection program* with energy efficiency requirements.
- **The City of Berkeley** may expand their Building Emissions Savings Ordinance (BESO) program to include GHG emissions per square foot estimates and require building owners to limit emissions according to gradually decreasing threshold through 2045. This may be administratively challenging—even under the current BESO program design, a recent evaluation found that the "BESO administrative process [and ensuring compliance] is staff-intensive and time consuming."
- Outside of California, the **City of Boulder** adopted the SmartRegs program in 2010, which required that rental properties meet energy efficiency requirements by 2018 or before a rental license application approval. In 2017, 100

[8] https://www.menlopark.org/377/Utility-user-tax

percent of the rentals were inspected, and 86% were compliant. Similarly, Boulder also requires that commercial and industrial building owners complete one-time lighting upgrades and implement cost-effective retro-commissioning measures by set dates, depending on the size of the building. Failure to perform upgrades can result in fines of $0.0025 per square foot up to $1,000 per day of non-compliance. To support property owners, the City provides a set of resources including a cost estimation tool and a list of service providers.

- Since 2013, the **City of Chicago** has required multi-family and commercial buildings of at least 50,000 ft^2 to report whole-building energy use annually, according to a custom energy rating system that went into effect in 2019. The rating is required to be posted in a prominent location on the property, and either the energy rating or ENERGY STAR® score must be listed in any advertisements for sale or lease at the time of listing.
- In May 2021, the **City of Burlington** adopted an ordinance requiring rental units that consume over 90 $kBtu/ft^2$ for space heating purposes to implement energy efficiency measures up to a cost cap of $2,500/unit to complete the initial work, not including incentives. After the initial work is completed, property owners are given a three-year extension to finish the required efficiency improvements with no cost cap.
- **Gainesville, Florida** has a rental unit permit and inspection program that requires rental units apply for permits annually and demonstrate that they meet a set of energy efficiency requirements.

Time certain building performance standards raise community awareness and allow the opportunity for property owners to comply through our policy pathways, such as permitting (Option 4) or time of property transfer (Option 5). Inspection requirements for rental licensing programs can also be used to achieve equitable outcomes such as adequate living standards and fair leasing practices.

Pros	Cons
• Easy for residents to understand • Reduces missed opportunities with gas replacements during burnout • Can directly tie to time-specific goals • Ability to impact all buildings • Can be integrated well with incentives • Rental license program could be leveraged for many other uses and help create equity.	• Time certain years require enforcement in those years, such as rental license or business license programs, increasing staff responsibilities • Right timing replacements may be difficult, such as emergency replacements • May require a new tracking platform for buildings and residences • Without incentives, can add significant cost to annual operating budgets of constituents • Expected backlash from realtors

Figure 10: Pros and Cons of Time Certain Ordinance

Creating Rental License Program to Enforce End-of-life and Time-certain Electrification in Rental Housing

Rental units are notoriously difficult for energy efficiency programs, because there is a split-incentive issue. In most cases, the landlord would need to invest in energy efficiency upgrades, while the tenant reaps the benefits of energy savings. Since approximately 40% of households in Menlo Park are renter-occupied, a program targeting rental units is critical to meeting the City's residential decarbonization targets.

The City of Boulder's SmartRegs program has seen significant success. Since the programs implementation in 2013, 23,000 rental units have been licensed. In order to utilize this policy option, Menlo Park will first need to create a rental license program. Boulder first instituted rental licensing in the 2000s in order to create a pathway to track rentals in the jurisdiction, and an inspection program to ensure safety of rental units. In a conversation with Boulder staff, the investment to create the program included:

1. 1 full time employee (FTE) for a full year to create a tracking system for all rental licenses in Boulder
2. One quarter FTE continuing to implement the program
3. Creation of GIS dashboard to track rental licenses

Creation of a rental license program, with a goal of creating a rental-focused electrification policy and enforcement mechanism could be an approach to achieve the city's goals. The program would require end-of-life electrification and time certain total building electrification of all rental units by 2030, and the license would be utilized as the enforcement mechanism.

Additional benefits of a rental license program above and beyond the scope of building decarbonization initiatives include:

1. Ability to track safety of rental properties within Menlo Park
2. Ability to track rental price increases and implement programs to manage increases in rental costs
3. Ability to utilize rental licensing to track and regulate Short Term Rentals (STRs.) – Note: Boulder uses the rental license program to track STRs in addition to safety and energy efficiency
4. Venue to encourage decarbonization efforts through direct correspondence with landlords.

4.5 Option 4: Permitting

California's Title 24, Part 6 Building Energy Efficiency Standards contain various efficiency upgrade requirements that additions and alterations must comply with if the trigger conditions are met. For example, the standards dictate that space-conditioning system replacements (the trigger event) are limited to methane gas, liquefied petroleum gas, or the existing fuel type, except in the case of going from gas or liquefied petroleum gas to heat pumps (the requirement).

Local governments may use the same triggering events, such as the replacement of a mechanical and/or domestic water heating system, and further require electrification measures. In this case, a local code amendment could further require that replacement equipment be heat pump systems, as opposed to the like-for-like replacement currently allowed in Title 24, Part 6.

Encouraging or requiring electrification conversions make most economic sense when coupled with major renovations, because it can be more cost effective and less disruptive to the building owner. Solar PV installations have an added benefit of improved operational cost effectiveness.

Pros	Cons
• Easy path to enforcement • Clearly within City of Menlo Park purview • Good opportunity to integrate with incentives	• Without incentives, can add significant cost to some improvement projects • May decrease permit adoption • Permit adoption rates are low, reducing effectiveness of this approach

Figure 11: Pros and Cons of Permitting as Intervention Point

4.5.1 Option 4A-4B: Electrification Ready Upgrades in Minor Alterations and Additions:

The electrification readiness option is intended to start the conversion process for existing residential multi-fuel buildings to all-electric buildings by requiring the installation of the electrical infrastructure needed to allow for the future conversion. This approach requires additional scope of work to a building permit; however, it does not add significant cost to the project due to the contractor being hired specifically to work on the building's electrical systems.

The electrification readiness requirements are triggered by building permits with a scope of work that includes:

- The installation of a photovoltaic system or the replacement/upgrade to a main electric panel.
- The installation of a reverse cycle air conditioning condensing (heat pump) unit instead of a traditional air conditioning condensing unit.

4A: The Installation of a Reverse Cycle Air Conditioning Condensing (Heat Pump) Unit

This option would require a reverse cycle air conditioning condensing (heat pump) unit to be installed instead of a traditional air conditioning condensing unit when a building permit application is made that includes replacing an existing air conditioning condensing unit is or the installation of an entirely new system.

The reverse cycle condensing unit is the critical piece of the infrastructure needed for the conversion to HPSH (heat pump space heating equipment) system. This option also builds on the electrification provisions of electrification readiness by making the conversion to a HPWH and/or HPSH equipment no more difficult than the replacement of a gas-fired water heater (GFWH) and gas-fired space heater (GFSH) equipment like in kind.

The number of structures that are made electrification-ready could be increased by including building permit applications for additions to existing buildings that also include:

- An increase the overall condition space,
- Modifications to the electrical, plumbing, or HVAC systems.

These additional scope of work requirements to trigger of the electrification readiness option are intended to avoid capturing projects, such as a roof being added over an existing porch/patio or an increase in the square footage of a garage or carport, which do not affect the overall consumption of energy for a structure.

4B: Installation Electric-Ready Infrastructure During Photovoltaic System Installation or Panel Upgrade Replacement

When a permit application is made that includes the installation of a solar PV system or the replacement/upgrade to a main electric panel for one- and two-family homes and townhomes, the applicant would also be required to provide:

- The reservation of breaker space in the existing or new electric panel to accommodate anticipated future electrification of single and multi-family buildings' electrical load.
- Wiring to a current water heater location to allow for the installation of a HPWH in an emergency repair situation for single-family buildings.

When a permit application is made that includes the installation of a solar PV system or the replacement/upgrade to a main electric panel for all other multi-family buildings, the applicant would also be required to provide:

- Wiring to current water heater location in multi-family buildings that have all of the water heaters serving individual units installed in the same location or in buildings with a centralized building water heater.
- The reservation of breaker space and electrical capacity to accommodate the additional electrical loads associated with heat pump water and space heating, a 120-volt, 30-amp circuit per unit to allow for electric vehicle charging, electric stove, ovens, and clothes dryers can potentially necessitate the upsizing of the panel size. However, this is solely an equipment and wiring cost, and it should not adversely affect the overall labor cost.

The requirement to add wiring to the current gas fired hot water heater does add both labor and material cost. However, by having the wiring installed allows for a property owner to replace the existing gas fired water heater at the end of its life cycle with a HPWH without experiencing any additional time without hot water than would normally be experienced. The requirements do not include wiring for the HPSH due to not knowing the desired location of the heat pump space heating equipment being based on the City's zoning ordinance requirements for required side and rear yards and the City's noise ordinance, which cannot be determined until the equipment has been selected.

There is the possibility that the installed wiring to the existing water heater location may never be used due to an increase in the HPWH physical size that prohibits the HPWH from being installed in the same location. The rate of recovery for a HPWH being considerable slower than a gas fired water heater, and most manufacturers recommend that the storage size be increased for a HPWH to offset the slower rate of recovery. A typical recommendation for a replacement of a 40-gallon gas fired water heater is 60 to 80 gallons for a HPWH. The increase in physical size can potentially cause a conflict with:

- The City's zoning ordinance requirements if the water heater is located in a garage and the new HPWH encroaches into the required interior clear space for parking cars.
- Adequate space in an existing water heater closet located in single-family buildings or individual dwelling units in multi-family buildings.

However, most HPHW of larger capacities only increase height, resulting in marginal increase to footprint. The height, still being below seven feet.

4.5.2 Option 4C: Heat Pump Based Equipment Installed Upon Voluntary Replacement

The voluntary replacement option is intended to begin the electrification process by leveraging the educational and electrification readiness ground work for single- and multi-family home property owners who are voluntarily replacing existing gas fired water heating and/or space heating equipment prior to the equipment's end of life.

The conversion from an existing GFWH to a HPWH poses some challenges. HPWH require the discharge of condensate water, typically requires the installation of a larger sized water tank and involves a licensed electrical contractor to install the electrical wiring and a licensed plumber to install the HPWH. The conversion from a GFSH to a HPSH equipment only requires a licensed HVAC contractor.

Heat pump based equipment generates condensate water. Condensate is caused by moisture accumulating on the heat pump evaporator coils where the refrigerant absorbs heat. The discharge of condensate water requires both the discharge line and an overflow line in the event that the discharge line becomes plugged. The discharge of the water can be particularly challenging for equipment not located on an exterior wall, above the first floor of a structure or for structures where the first floor is a concrete slab.

The condensate water needs to be captured and discharged outside in most cases because West Bay Sanitary District (District) does not allow the discharge of condensate water into the sanitary sewer system. The California plumbing Code states, “No plumbing fixtures served by indirect waste pipes or receiving discharge therefrom shall be installed until first approved by the Authority Having Jurisdiction.” and defines air conditioning condensate discharge as indirect waste. The District is the Authority Having Jurisdiction (AHJ) as it applies to the discharge of condensate water and requires all condensate water to be discharged to landscape for buildings with 1 to 50 units. A permit from the District is required thereafter with a connection fee and an annual Sewer Service Charge.

The recovery rate for a HPWH is considerable slower than a gas fired water heater. A water heater's recovery rate is the amount of hot water the amount of hot water a tank water heater can provide in just one hour after being completely drained. Most manufacturers recommend that the storage size be increased for a HPWH to offset the slower rate of recovery. While the recommended increase in size varies based on demand and rate of recovery, a typical recommendation for a replacement of a 40-gallon gas fired water heater is 60 to 80 gallons for a HPWH.

The increase in physical size can potentially cause a conflict with the City’s Zoning ordinance requirements if the water heater is located in a garage and the new HPWH encroaches into the required interior clear space for parking cars. A potential resolution to this encroachment issue is to install the HPWH in a new location however they cannot be located where they are exposed to the elements and there is a potential for considerable additional cost associated with the reconfiguration of the existing plumbing to accommodate the new hot water heater location. Additionally, heat pump equipment typically generates noise levels above 70 dBa which can potentially cause a conflict with the City’s Noise Ordinance for all heat pump equipment located outside.

The Voluntary replacement option also captures hot water replacements in multi-family buildings that have existing electric resistance water heaters located in each unit. While this does potentially add cost to the project, some of those costs can be offset with available incentives. It is difficult to ascertain if additional electrical work will be required to address the electricity requirements for a HPWH and how condensate water will be discharged due to the differing ages and construction of the existing multi-family building stock. However, the requirements would result in an approximate 66% reduction in electricity consumption per water heater.

Permits for the replacement of GFWH and GFSH are applied for and issued on-line, which poses a challenge in determining how to implement this requirement since the permit information does not note whether the replacements are voluntary or due to the end of equipment life. Additionally, the 2019 California Building Standards Code allows for emergency replacement or repair to a structure prior to obtaining a building permit. This allows property owners to make repairs in an emergency situation to prevent further damage to a structure and protect life and safety. The more likely scenario is that this option will only capture GFWH and GFSH being replaced or relocated as part of an addition and alteration projects.

The voluntary replacement option requirements only address voluntary replacement, upgrade, or relocation of the existing GFWH and GFSH. The voluntary-only provision of the requirements allows single-family property owners whose structures are electrification-ready the flexibility to research and maximize monetary incentives prior to replacing GFWH and/or GFSH equipment. Property owners making incremental improvements to their structures have time to research contactors, products, and incentives prior to the commencement of the work.

4.5.3 Option 4D: Heat Pump Based Equipment Installed During Additions to Single-Family Residential Buildings

This option would require additions to single-family homes that increase the existing conditioned space to convert the existing gas fired water heating or space heating equipment or both to heat pump based equipment, depending on the scope of work.

Conditioned space is defined in the 2019 California Energy Code as, "*An enclosed space within a building that is directly conditioned or indirectly conditioned*" and is included to avoid capturing projects whose scope of work is unrelated to water or space heating. Additionally, the option requires the structure to be made electrification ready as prescribed in the electrification readiness option. This option will add cost to the project and the cost effectiveness will be less than if replacing the equipment at the end of its life.

The electrification requirements of this option would have two exceptions.

1. Additions that do not alter the existing space heating system. This exemption is included to avoid adding the cost associated with the installation of new space heating equipment to a project where the existing system has capacity to heat the new conditioned space. Dedicated wiring for the future electrification of the existing space heating equipment is not required since the location of the HPSH equipment is based on the City's zoning ordinance requirements for required side and rear yards and the City's noise ordinance, which cannot be determined until the equipment has been selected.
2. Additions that do not alter the water supply system, which is included to avoid adding the cost associated with new water heating equipment to a project. However, it does require the installation of a dedicated 240-volt, 30-amp branch circuit to be installed within three feet from the existing water heater location to prepare the house for future electrification.

As stated in previous option analysis, the requirement to add wiring to the current gas fired hot water heater does add both labor and material cost. However, by having the wiring installed allows for a property owner to replace the existing gas fired water heater at the end of its life cycle with a HPWH without experiencing any additional time without hot water than would normally be experienced. The requirements do not include wiring for the HPSH due to not knowing the desired location for the location of the HPSH being based on the City's zoning ordinance requirements for required side and rear yards and the City's noise ordinance, which cannot be determined until the equipment has been selected.

There is the possibility that the installed wiring to the existing water heater location may never be used, due to rate of recovery for a HPWH, which is considerably slower than a gas fired water heater. A water heater's recovery rate is the amount of hot water the water heater is capable of providing in a given period of time. Most manufacturers recommend that the storage size be increased for a HPWH to offset the slower rate of recovery. While the recommended increase in size varies based on demand and rate of recovery, a typical recommendation for a replacement of a 40-gallon gas fired water heater is 60 to 80 gallons for a HPWH. The increase in physical size can potentially cause a conflict with:

- The City's zoning ordinance requirements if the water heater is located in a garage, and the new HPWH encroaches into the required interior clear space for parking cars.
- Adequate space in an existing water heater closet located in a single-family building or individual dwelling units in multi-family buildings.

A potential resolution to these conflicts is to install the HPWH in a new location; however, the equipment cannot be located where it is exposed to the elements. Where the HPWH cannot be relocated within the existing single-family buildings footprint, the existing structure would need to have a shelter constructed to accommodate the HPWH. The shelter could not be placed in the required side or rear yards and could potentially add lot coverage and/or floor area. Additionally, heat pump equipment typically generates noise levels above 70 dBa, which can potentially cause a conflict with the City's noise ordinance for all heat pump equipment located outside. The challenges associated with the relocation to accommodate a HPWH within a dwelling unit in a multi-family building are even more complex.

4.5.4 Option 4E: Heat Pump Pool Heating Equipment for New Pools

This option would require the installation of heat pump pool water heating equipment for all new pool construction. Currently all new single-family home development that includes the construction of a new pool are required to use heat pump pool water heating equipment. However, a new pool being constructed on a property with an existing single- or multi-family or non-residential building is not required to install heat pump pool water heating equipment.

The requirement for the use of heat pump pool water heating equipment for all newly constructed pools does increase the cost of the direct pool construction cost due to the additional cost associated with using heat pumps rather than gas fired equipment. Additionally, the use of a heat pump could result in the requirement to upgrade the existing electrical panel. A typical heat pump pool water heating equipment requires a 40 to 60 Amp, 240 Volt circuit and greatly depends on the size of the pool. The electrical panel upgrade could potentially trigger the electrification ready requirement for existing Single- or multi-family buildings should those policies be adopted. The additional capital cost associated with the heat pump equipment, upgrade to the panel and electrification ready provisions could add significant cost to the overall project. The noise level would be comparable to a similar sized air conditioning unit, and the noise from multiple heat pump sound sources is cumulative.

4.5.5 Option 4F: Electric Appliances and EV Charging in Alterations to Residential Buildings

This option requires alterations to single-family homes to convert the existing gas fired water heating or space heating equipment or both to heat pump based equipment depending on the scope of work. This option will add cost to the project and the cost effectiveness will be less than if replacing the equipment at the end of its life. Additionally, the option requires the structure to be made electrification ready as prescribed in the electrification readiness option. There are two exceptions to the requirements of this option:

- The first exempts alterations that do not alter the existing space heating system. This exemption is included to avoid adding the cost associated with new space heating equipment to a project. Dedicated wiring for the future electrification of the existing space heating equipment is not required, since the location of the heat pump space heating equipment is based on the City's zoning ordinance requirements for required side and rear yards and the City's noise ordinance, which cannot be determined until the equipment has been selected.
- The second exception exempts alterations that do not alter the water supply system. It is included to avoid adding the cost associated with new water heating equipment to a project. However, it does require the installation of a dedicated 240-volt, 30-amp branch circuit to be installed within three feet from the existing water heater location to prepare the house for future electrification.

The requirements also capture alterations to multi-family buildings. Specifically, it requires:

- The main panel serving the units have enough breaker space and electrical capacity to electrify all of appliances in the unit; and a 120-volt, 20-amp circuit per unit to allow for electric vehicle charging but does not require the installation of the outlet. Currently there is a rebate available through Peninsula Clean Energy to upgrade panel space for multifamily properties.
- The existing space heating equipment be replaced with heat pump space heating equipment when the heating system is altered
- The existing water heating equipment be replaced with heat pump water heating equipment when the water supply system is altered; and
- A dedicated 240-volt, 30-amp branch circuit be installed within three feet from the existing water heater location(s) when there is an existing gas fired water heater in the unit under alteration, but the work scope does not include alterations to the existing water supply system.

There are exceptions for multi-family residential buildings where the existing GFSH and GSWH systems are centralized for the entire building(s)—the systems are required to be replaced with heat pump equipment when 50% of the units in the building(s) have been altered. While these requirements do potentially add cost to the project, some of those costs can be offset with currently-available incentives. It is difficult to ascertain if additional electrical work will be required to address the electricity requirements for a HPWH due to the differing ages and construction of the existing multi-family building stock.

Alterations are defined in the 2019 California Residential Code as, "Any construction or renovation of a structure other than repair or addition". The term is used specifically in this option as it is a codified term however, it does have the potential of capturing projects where the cost of this option requirements greatly exceeds the cost of the proposed alterations. As an example, replacing a window would require making the building electrification ready by installing a dedicated 240-volt, 30-amp branch circuit within three feet from the existing GFWH location(s), The reservation of breaker space and electrical capacity to accommodate the additional electrical loads associated with heat pump water and space heating, a 120-volt, 20-amp circuit per unit to allow for electric vehicle charging, electric stove, ovens, and clothes dryers can potentially necessitate the upsizing of the panel size and the possibility that the installed wiring to the existing water heater location may never be used due to potential conflicts associated with the increase in physical size, as discussed in the electrification readiness analysis. There are three possible outcomes in this type of scenario:

1. The property owner moves forward with a permit and complies with the option requirements.
2. The property owner moves forward without the benefit of permit which prevents the inspection of the installation to ensure the proper installation of the equipment for the safety of the occupants.
3. The property owner elects to not replace the window and the potential energy efficiency gains associated with a new window are lost.

Further consideration of more exceptions need to be explored to avoid the unintended consequence of adding significant costs to small projects.

4.5.6 Option 4G: Replacement at End of Life

The requirement for the replacement of the existing gas fired water and space heating equipment at the end of life (burnout) has some significant associated challenges. However, it is the most cost effective option. The replacement of gas fired water and space heating equipment at burnout can potentially increase the amount of time between the time of burnout and the time of completed installation due to additional tasks such as adding infrastructure for the discharge of condensate water. This can ultimately result in permit avoidance and other enforcement challenges. More importantly, it could result in life and safety impacts if community members install gas equipment without the benefit of a permit and inspection to ensure proper installations.

Currently, when existing gas fired water and space heating equipment burns out it can be readily replaced by contractors who specialize in replacement and typically carry inventory so that equipment can be replaced within 24 hours of notification which is especially true with water heaters. If an ordinance is adopted that requires the replacement of existing gas fired water and space heating equipment at burnout and structures are not prepared for the installation of heat pump equipment, the time between burnout and the completed installation is greatly increased.

There are some challenges associated with heat pump water heating (HPWH) in a structure that does not have the required infrastructure to support the new type of equipment. The property owners will have to:

- Hire an electrician to install the required wiring to support the heat pump equipment;
- Schedule the installation which most likely won't be next day;
- Hire a contactor to install the heat pump equipment; and
- Schedule the installation.

This process can take several days or weeks depending on contractor and equipment availability leaving the occupants without hot water during that duration of time.

The recovery rate for a HPWH is considerably slower than a gas fired water heater. A water heater's recovery rate is the amount of hot water a tank water heater can provide in just one hour after being completely drained. Most manufacturers recommend that the storage size be increased for a HPWH to offset the slower rate of recovery. While the recommended increase in size varies based on demand and rate of recovery, a typical recommendation for a replacement of a 40-gallon gas fired water heater is 60 to 80 gallons for a HPWH.

The increase in physical size can potentially cause a conflict with the City's Zoning ordinance requirements if the water heater is located in a garage and the new HPWH encroaches into the required interior clear space for parking cars. A potential resolution to this encroachment issue is to install the HPWH in a new location however they cannot be located where they are exposed to the elements and there is a potential for considerable additional cost associated with the reconfiguration of the existing plumbing to accommodate the new hot water heater location. Additionally, heat pump equipment typically generates noise levels above 70 dBa which can potentially cause a conflict with the City's Noise Ordinance for all heat pump equipment located outside.

The challenges for replacement of space heating equipment are similar to those associated HPWH equipment with the significant exception that an HVAC contractor can install both the electrical wiring and the equipment. However, the location of the condensing unit is outside and needs to be located in compliance with the City's Zoning and Noise Ordinances.

Heat pump based equipment generates condensate water. Condensate is caused by moisture accumulating on the heat pump evaporator coils where the refrigerant absorbs heat. The discharge of condensate water requires both the discharge line and an overflow line in the event that the discharge line becomes plugged. The discharge of the water can be particularly challenging for equipment not located on an exterior wall, above the first floor of a structure or for structures where the first floor is a concrete slab.

The condensate water needs to be captured and discharged outside in most cases because West Bay Sanitary District (District) does not allow the discharge of condensate water into the sanitary sewer system. The California plumbing Code states, “No plumbing fixtures served by indirect waste pipes or receiving discharge therefrom shall be installed until first approved by the Authority Having Jurisdiction.” and defines air conditioning condensate discharge as indirect waste. The District is the Authority Having Jurisdiction (AHJ) as it applies to the discharge of condensate water and requires all condensate water to be discharged to landscape for buildings with 1 to 50 units. A permit from the District is required thereafter with a connection fee and an annual Sewer Service Charge.

Permits for the replacement of water and space heating equipment are applied for and issued on-line which poses a challenge since the permit information does not note whether the replacements are voluntary or due to the end of equipment life. Additionally, the 2019 California Building Standards Code allows for emergency replacement or repair to a structure prior to obtaining a building permit. This allows property owners to make repairs in an emergency situation to prevent further damage to a structure and protect life safety. In the event that a property owner has gas fired equipment replaced like in kind in an emergency situation and then applies for a permit, the expanded requirements would obligate them to remove and replace the newly installed equipment with a HPWH and/or HPSH equipment. An equally likely scenario is the potential of the replacement of gas fired equipment like in kind without the benefit of a building permit (permit avoidance) to avoid significant time without hot water or heat and any additional costs. The permit avoidance prevents the inspection of the newly installed equipment for compliance with the fire life safety aspects of the California Building Standards Code to ensure the proper installation for the safety of the occupants.

The Burnout option requirements could be applied to hot water replacements in multi-family buildings that have existing electric resistance water heaters located in each unit. While this does potentially add cost to the project, some of those cost can be offset with currently available incentives. It is difficult to ascertain if additional electrical work will be required to address the electricity requirements for a HPWH and how condensate water will be discharged due to the differing ages and construction of the existing multi-family building stock. However, the requirements would result in an approximate 66 percent reduction in electricity consumption per water heater.

Most water heating for non-residential applications excluding restaurants/food service and laundry services is currently achieved through electric resistance water heating due to relatively low hot water loads which is primarily associated with handwashing and some showers. The use of a HPWH could be mandated at the end of life and could result in up to a 66 percent reduction in electricity consumption per water heater. However, the noise associated with the HP equipment may not be suitable for office environments and the discharge of the condensate could pose a significant challenge.

Heat pump based heating for non-residential applications is possible however far more complicated due to the variety of building uses and systems currently installed in the existing building stock. These systems range from package Variable Air Volume (VAV) systems using a water based chiller/boiler, centralized gas fired heating packages with separate cooling to individual heating and cooling per unit in a building. It is difficult to ascertain the different types and ages of systems currently in use and the potential additional infrastructure work in a building that would be required to convert an existing non-residential building to a heat pump based space heating system.

4.6 Number of Buildings Impacted by the Permitting Options

There are 7,333 single-family homes and 5,669 multi-family units (two or more units per building) per the 2019 ACS census data. Below are the number of permits issued for additions, alterations and the installation of new electric panels, photovoltaic systems, water heaters, and HVAC equipment in single- and multi-family residential buildings between 2017 and 2020.

Single-Family Average Number of Permits by Use and Work Type							
Year	Electric Panels	PV	Water Heaters	HVAC	Additions	Alterations	Pools
2017	51	76	59	53	59	172	27
2018	34	66	38	86	61	204	16
2019	37	75	49	53	45	195	12
2020	6	125	3	39	37	249	TBD
Average	32	86	37	58	51	205	18

Figure 12: Single-Family Average Number of Permits by Use and Work Type

Multi-Family Average Number of Permits By Use and Work Type						
Year	Electric Panels	PV	Water Heaters	HVAC	Additions	Alterations
2017	3	0	14	18	0	88
2018	6	1	12	23	0	87
2019	2	2	26	10	1	73
2020	0	3	0	12	1	36
Average	3	2	13	16	1	71

Figure 13: Multi Family Average Number of Permits by Use and Work Type

Using the average number of issued permits per year and the 2019 census data the permitting options, the anticipated average number of buildings based on each permitting option are as follows.

4.6.1 Electrification Readiness

An average of 32 permits were issued specifically for new electric panels and 86 for PV systems between 2017 and 2020. This data does not include electric panel upgrade/replacement or PV system installations associated with additions and alterations, as accurate data is difficult to ascertain without review of each individual plan set. If the requirements for electrification readiness are implemented, it is anticipated that an average of 118 buildings per year will be electrification ready by 2030. This equates to 1.6% of the existing single-family and multi-family structures building stock, but it does not account for the new all-electric buildings that are currently being built in compliance with the City's adopted 2020 electric building codes.

Between 2017 and 2020 an average of 51 permits were issued for additions to single-family structures, and 1 permit was issued for a multi-family residential structure addition, per year. If the requirements for electrification readiness are expanded to include additions to single-family and multi-family buildings are implemented, it is anticipated that an additional average of 2.3% of the existing single-family and multi-family structures building stock will be made electrification ready for a total of 6% annually. This does not account for the new all electric buildings that are currently being built in compliance with the City's adopted 2019 building codes.

4.6.2 Voluntary Replacement:

The number of voluntary replacements/relocations associated with additions and alterations in single-family buildings is difficult to ascertain without review of each individual plan set. An average of 37 permits were issued specifically for the replacement of water heaters in single-family buildings and 58 for the replacement of HVAC equipment between 2017 and 2020. If the requirements for the voluntary replacement are expanded to include the mandatory replacement of existing gas fired equipment at the end of equipment life with heat pump equipment, it is anticipated that an average of 95 single-family buildings (37 water heater permits and 58 HVAC permits) and 29 multi-family buildings (13 water heater permits and 16 HVAC permits) per year will be electrification ready by 2030, which is approximately 1.7% of the existing building stock per year.

4.6.3 Additions to Single-Family Residential Buildings:

An average of 51 permits were issued specifically for additions to single-family homes between 2017 and 2020. It is difficult to ascertain the number of these permits that would have triggered the Option's requirements without review of each individual plan set. Assuming that an annual average of 51 permits for additions to single-family homes trigger at least one of the requirements, this would equate to .7% of the existing single-family home building stock having some form of heat pump equipment installed and made electrification ready annually if implemented. This is in addition to the new all-electric buildings that are currently being built in compliance with the City's adopted 2019 building codes.

4.6.4 Alterations to Single-Family Residential Buildings:

An average of 205 permits were issued specifically for alterations to single-family homes and 71 for multi-family homes between 2017 and 2020 that would have triggered the requirements. It is difficult to ascertain how many individual dwelling units are associated with of the multi-family permits without review of each individual plan set. If the requirements are implemented, it is anticipated that an average of 2.7% of the existing single-family home building stock would have some form of heat pump equipment installed and made electrification ready annually. Assuming each permit issued for a multi-family building was for a single dwelling unit, an average of 1% of the existing multi-family building stock would have some form of heat pump equipment installed and made electrification ready annually. This is in addition to the new all electric buildings that are currently being built in compliance with the City's adopted 2019 building codes.

4.6.5 Impacts to State Building Codes or City Ordinances

The permitting options will require local amendments be made to the California Building Standards Code (CBSC) and possibly the California Energy Commission Efficiency Code, the City's zoning, noise, and heritage tree ordinances. The CBSC allows for local jurisdictions to establish more restrictive and reasonably necessary to the CBSC. The local amendments are required to be based on climatic, topographic, or geographical conditions and approved by City Council. All the proposed permitting policy options will require going through the local amendment process.

Legal review is necessary to determine if building codes would require California Energy Commission approval. If so, it does require the local agency demonstrate that the measure or regulations will be cost effective. However, there may be flexibility for the agency to determine the methodology or analysis to determine cost effectiveness, such as the increasing costs of climate change.

Several aspects of the permitting options could require amendment to the City's zoning and noise ordinance. As mentioned earlier, a new HPWH may not fit into the existing GFWH location, or it could encroach into the required clear space for covered parking. Where the HPWH cannot be relocated within the existing buildings footprint, the existing structure would need to have a shelter constructed to accommodate the HPWH. The shelter could not be placed in the required side or rear yards and could potentially add lot coverage and/or floor area. Additionally, heat pump equipment typically generates noise levels above 70 dBa, which can potentially cause a conflict with the City's noise ordinance for all heat pump equipment located outside. Similarly, the location of the heat pump space heating equipment being based on the City's zoning ordinance requirements for required side and rear yards and the City's noise ordinance. The challenges associated with the relocation of existing water and space heating equipment to accommodate a heat pump equipment in multi-family buildings are even more complex.

The heritage tree ordinance prohibits installation or storage of equipment under a heritage tree. Specifically, any person who owns, controls, or has custody or possession of any real property within the city shall use reasonable efforts to maintain and preserve all heritage trees located thereon in a state of good health. This requirement can pose limits on possible heat pump equipment location.

Amending the City's zoning, noise, and heritage tree ordinances could be undertaken to exempt heat pump equipment in some capacity to encourage its installation. The process would require a comprehensive study of allowing possible equipment location to be closer to property lines and/or heritage trees then currently allowed but still maintains a distance that does not cause a nuisance for the adjoining properties. At a minimum, the process would require:

- Studying typical equipment size, weight, noise levels and installation requirements.
- Analyzing each zoning district's typical lot dimensions and size for determination of allowable distance to property line for the equipment.
- Analyzing the attenuation of sound over distance to ensure noise levels are not increased to a nuisance level by reducing the allowable proximity to property lines.
- Analyzing potential harm to heritage trees if equipment is allowed to be located under them.
- Drafting of revised Ordinance language.
- Performing potential public outreach for feedback.
- Presenting to and receiving recommendations from the Planning Commission.
- Presenting to and approval by the City Council.

4.6.6 City Resources Necessary for Permit Requirements

The permitting options potentially impact the Sustainability Manager, Building Official and City Attorney during the code adoption process for the selected options as well as the time associated with permit processing, plan review and inspection for the Building and Planning Divisions. The time impacts are cumulative with respect to each option that is adopted and to the potential number of permits each option captures. Additionally, there is the time impact associated with staff providing written and verbal educational information to the public, which is very difficult to quantify.

The permitting options that are chosen to be implemented are adopted as amendments to the California Building Standards Code. The California Building Standards Code is adopted in three year cycles, with local amendments to the code typically adopted at the same time. This does not preclude the adoption of an amendment in a non-code adoption year. For an amendment to brought forward for adoption, The Building Official will have to determine which sections of the code that is required to be amended, determine that the new code language does create conflict with any other code sections, and write the code language for the amendment. The amendments are reviewed by the City Attorney and ultimately brought to the City Council for approval. A considerable amount of time is required to write an amendment to ensure that the amendment captures the intended structures and uses and does not create any unintended consequences.

The impact associated with the electrification readiness option beyond the educational component will be the additional Building Division plan check and inspection time associated with the electrification readiness requirements. Specifically, the permit application will have to be accompanied by electrical load calculations for the structure to demonstrate compliance to both the California electric code requirements and the requirements of this option. The plan checker will have to then review the load calculations prior to issuance of the permit. Likewise, the Building Inspectors will have to confirm that the requirements of the option are incorporated into the new electric panel and the wiring installed to the existing water heater location.

The anticipated impact to staff associated with voluntary replacement option will be the additional plan check and inspection time associated with the plan checker determining whether or not the existing GFWH is being replaced, upgraded, or relocated in order to apply the requirements. Additionally, if the equipment is being relocated or placed outside of the building, a Planning Division staff member will have to review the plans for compliance with the City's zoning and noise ordinances. Likewise, the Building Inspectors will have to confirm that the existing GFHW has not been replaced, upgraded, or relocated during the construction of the project. If the scope of work has been increased during construction, the plans will be required to be updated to show the increased scope of work and compliance with the option requirements, the revisions submitted for plan review, and the revised pans issued and re-inspected for compliance.

The anticipated impact to staff associated with the additions and alterations to existing buildings options will be the additional plan check and inspection time associated with this option's requirements. Specifically, the Building Division plan checker will have to determine whether or not the existing water supply and/or space heating systems are being altered in order to apply the requirements. Likewise, the Building Inspectors will have to confirm that the existing water supply and/or space heating systems are being altered during the construction of the project. If there are alterations made during construction that are not shown on the plans, the plans will be required to be updated to show the increased scope of work and compliance with the option requirements, the revisions submitted for plan review, and the revised pans issued and re-inspected for compliance.

4.7 Option 5: Electrification Ready at Time of Sale

A jurisdiction may encourage or require electrification upgrades at time of real estate sales. The City could consider electrification ready at the time of sale. Existing examples require some energy assessment and/or label and disclosure policies, with no explicit link to electrification. Notable instances include:

- Since 2015, **City of Berkeley's** BESO has required an energy efficiency assessment for all single-family, commercial, and multi-family buildings at time of listing, and/or annual benchmarking, using either the Department of Energy Home Energy Score or ENERGY STAR Portfolio Manager. Exemptions are allowed for new construction, extensive renovations, or financial hardship (such as participation in income-qualified or tax-postponement programs). A 2020 evaluation of the program states that while the program helped the City attain energy consumption information that is useful for shaping policy, it has also been challenging for the city to track conversion rates from assessment to energy upgrade, due to privacy protections of utility program data and a lack of granular building permit data.
- The **City of Berkeley** also has a Real Property Transfer Tax that is imposed on all property transfers, and ranges from 1.5 to 2.5% of the property value. Up to 1/3 of the base 1.5% transfer tax rate is eligible for a Seismic Transfer Tax Refund, if the property owner performs voluntary seismic upgrades within one year of the transfer. [74] Historically, an average of 13% of eligible homeowners have received the refund between 2014 and 2019.[75] The City is considering updates to expand the Seismic Tax Refund Program include resilience, energy efficiency, and electrification measures for commercial and mixed-used buildings.[76]
- **The City of Davis'** Resale Program, implemented in 1976, requires a building inspection to certify that the building meets local ordinance requirements as part of a residential property transaction. The inspected items include various health and safety measures including air conditioner disconnect, furnace combustion air, laundry outlet voltage, energy standards compliance with retrofit, and pipe insulation. As of 2018, the cost for the inspection was $426. Davis inspects approximately three to four percent of its housing stock annually, and since 2014, only five percent of resale inspections have found unpermitted heating, ventilation, and air conditioning (HVAC) installations.
- **City of Piedmont** requires that at point of listing for sale of a property, a report from a Home Energy Audit or Home Energy Score (homeowner's choice) must be provided to potential buyers and submitted to the City—unless the residential building was constructed in the past 10 years. This requirement was implemented in early 2021, and there is limited compliance and implementation data at this time.
- Since 1982, the **City of San Francisco** has required energy and water conservation measures for all residential dwellings that undergo a property transfer or major improvements (e.g., $20,000 of estimated improvements for a

single-family home). Measures include a minimum of R-11 attic insulation, water heater insulation, weatherization, and duct insulation, and dwellings must be inspected for compliance. Costs are capped at $1,300 per single-family dwelling, and for multi-family buildings:

- 1% of the assessed value of the building if improvements are performed prior to property transfer
- 1% of the purchase price as stated in the real estate sales contract

Pros	Cons
• Ability to create total electrification of homes and buildings • May provide incentive for property owners to consider electrification ahead of property sales • Relatively high GHG impact	• Without incentives, can add significant cost to property transfer • Limited total number of buildings that can be impacted • Expected backlash from realtors

Figure 14: Pros and Cons of Time of Sale Ordinance

5 Projected GHG Reduction Outcomes

5.1 GHG Savings Opportunity of Proposed Policy Options

To determine the effectiveness of each proposed policy pathway, DNV-GL quantified GHG savings potential in terms of annual reduction of Metric Tons Carbon Dioxide equivalent (MT CO_2e) on an annual basis. This specifically answers the question "how much will annual emissions be reduced if we enact this policy on January 1st 2023 and it impacts buildings through December 31st 2030." The total emissions savings of all policies listed below is not expected to meet the target outlined in the CAP.

Intervention Point	Methodology	GHG Savings w/o leakage (MT CO2e yr)
Reductions needed to meet 2030 goal (95% of buildings)	95% x comm & res natural gas use from CAP	51,636[9]
Business and Usual	Assumes 10% of Menlo Park residents will electrify their home by 2030 without incentive or mandate.	5,164
Marketing and Education	Assumes 10% of Menlo Park residents will be inspired to perform total electrification by 2030 by marketing and education efforts.	5,164
HVAC Permit	Assumes every HVAC permit with existing gas equipment results in electrification.	653
Water Heating Permit	Assumes every water heating permit with existing gas equipment results in electrification.	894
Single-Family Additions	Assumes every addition results in total electrification.	1,006
Single-Family Alterations	Assumes every alteration results in total electrification.	3,652
Single-Family Repair	Assumes every repair results in total electrification.	2,708
Panel Upgrade Electrification Readiness	Assumes that 10% of panel upgrade permits results in electrification of two end uses.	2,661
Solar PV Permit	Assumes every PV installation permit receives total electrification.	359
Pool Permit	Assumes every new pool is heated with heat pumps instead of natural gas.	193
Point of Sale	Assumes every home sale results in total electrification.	6,874

Figure 15: GHG Savings of Policy Options

The waterfall chart below[10] outlines the GHG savings opportunity (excluding the gas grids fugitive methane emissions,) if each policy is selected. DNV has created a corresponding dashboard is available in Microsoft Excel®, to allow users to select or de-select each measure.

[9] The table above has yet to compare the GHG savings methodology against the methodology used by the CAP. In order to provide and apples-to-apples GHG reduction comparison, it is critical to square up against the numbers used in the CAP.

[10] Waterfall chart does not include the impact of fugitive methane emissions

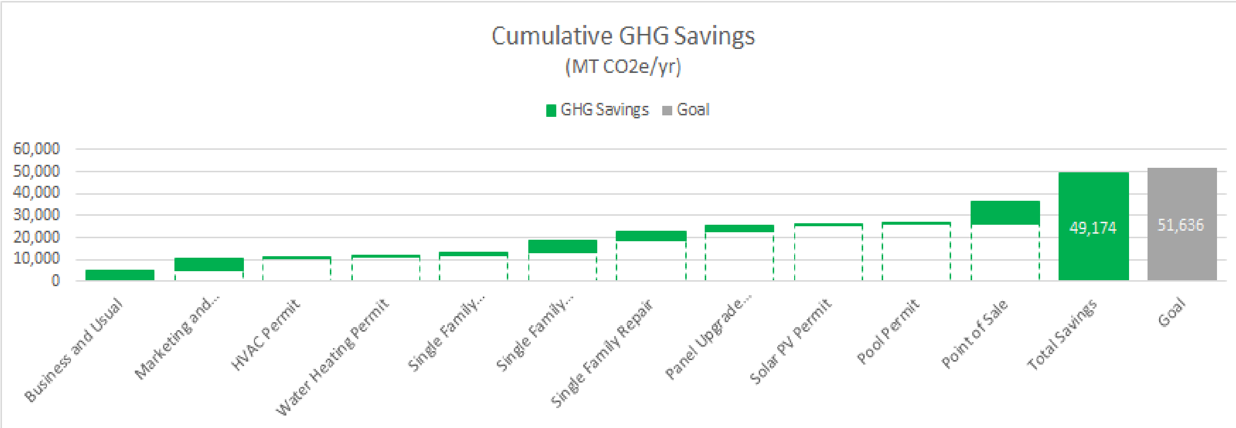


Figure 16: Cumulative GHG Savings of Proposed Options

5.2 Permits as Intervention Points Cannot Alone Meet the 2030 Goal

There appears to be a low permit capture rate within Menlo Park, which aligns with DNV's findings in a 2017 study for the California Public Utilities Commission. The chart below outlines the differences between the GHG savings of capturing every equipment replacement, as compared to the GHG savings of capturing equipment only when HVAC or water heating permits are pulled. Based on these findings, it may benefit Menlo Park to consider alternative policy pathways to meet the 2030 GHG savings goal outlined in the CAP.

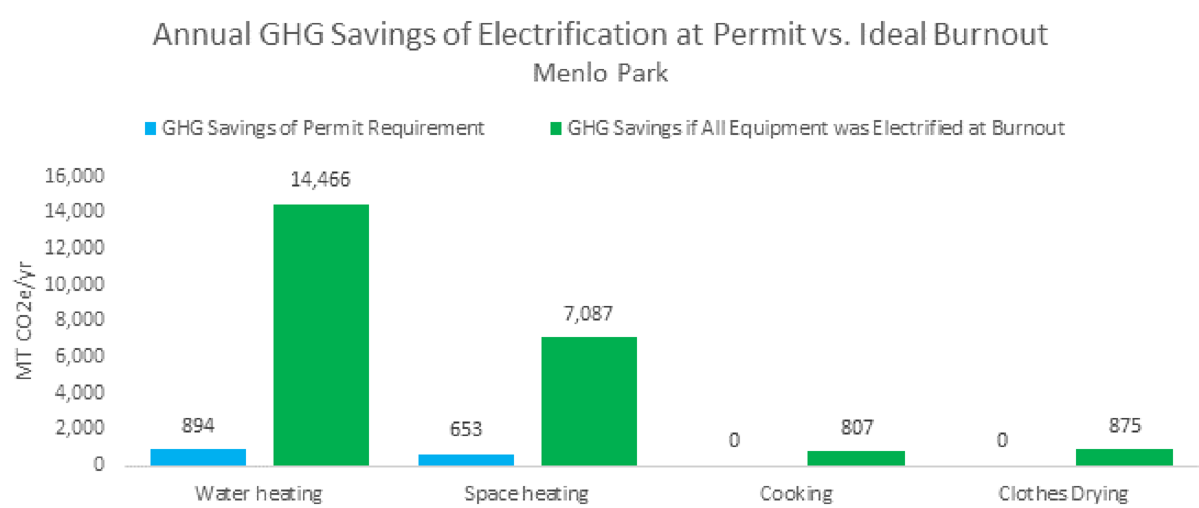


Figure 17: Annual FHG Savings of Electrification - Permit vs. Ideal Burnout

5.3 State and Federal Action is Needed to Meet Carbon Neutral Goal

Since not all projects go through the permit process, and some buildings may find a way to keep old, gas-fired equipment running long-past its life expectancy, state or federal action will needed to help reach local climate goals. Environmental health risks have long been the bedrock or local, state, and federal mandates on the reduction or end of use of certain equipment. Asbestos has been heavily regulated under many uses since 1970s Clean Air Act, lead paint has been banned for residential use since 1978, and the Montreal Protocol represented a global effort to save the planet's ozone layer by ending the use of Chlorofluorocarbons (CFCs)[11].

If the state or federal government bans the sale of gas-fired equipment, it could significantly help Menlo Park meet its ambitious climate goals. This may be the only path, which enables the world to meet its global climate goals and avoid catastrophic global warming.

[11] The Montreal protocol may be the closest example to efforts to stave off global warming today. Ozone depletion due to CFCs was a known issue since the 1970s, but slowly phased out through the 1990s with some older HVAC equipment still using CFCs today. While the ozone layer has been largely preserved, a thinning of the ozone layer over the Southern Hemisphere occurred. As a result, skin cancer rates are the highest in countries in the region – Australia and New Zealand.

6 Next Steps and Potential Criteria

Each of the options could be evaluated using the following criteria to build an electrification roadmap to help guide implementation timelines and public engagement conversations:

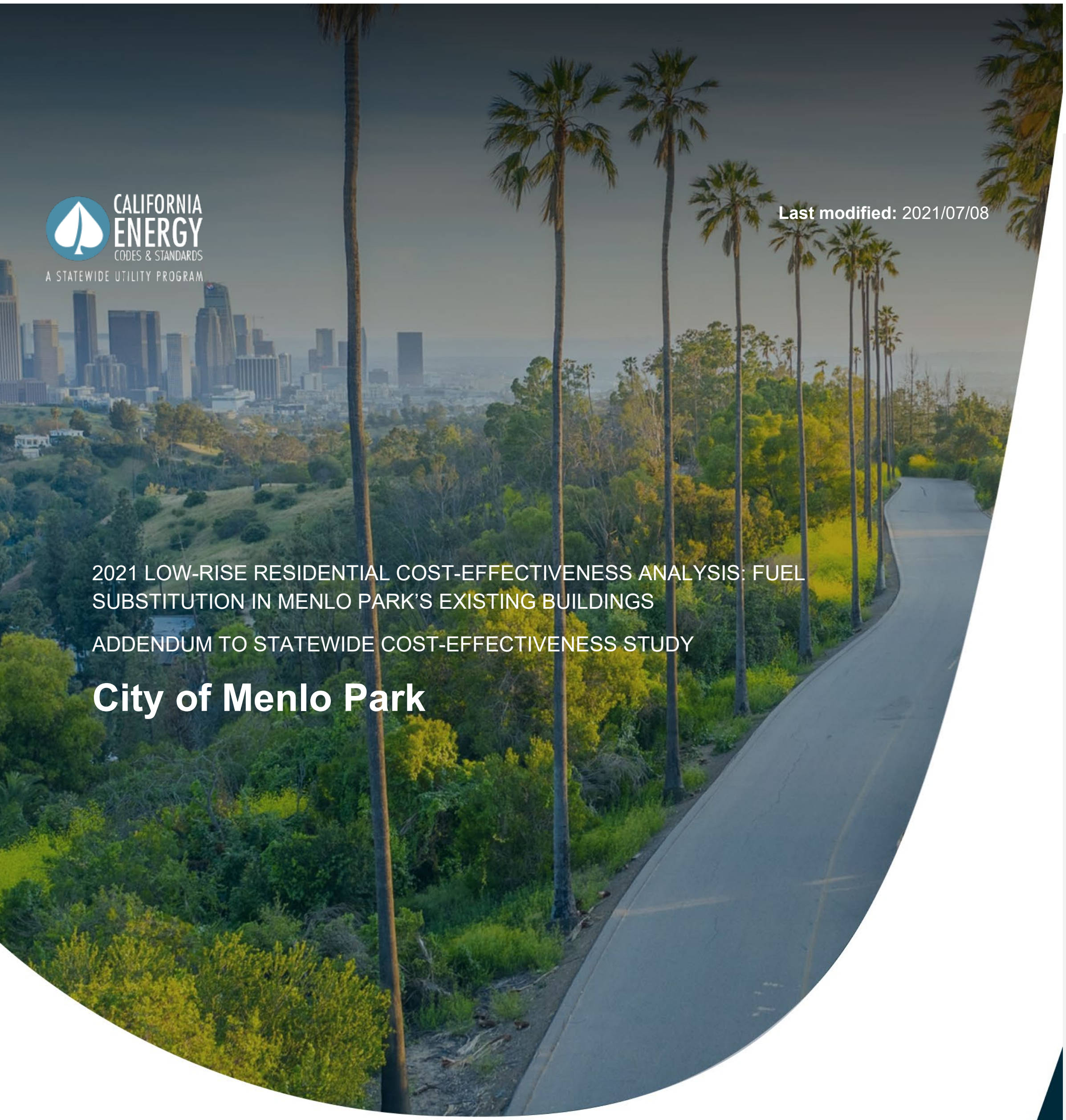
- **Ease of Implementation/Process:** 1) There is a low level of engagement necessary during the adoption process, 2) does not require long term-staff resources, 3) does not require coordination with other agencies.
- **Convenience:** 1) Does not increase scope beyond the original plan, 2) does not increase project timeline or cause a physical impact to the property, 3) skilled workforce for the required upgrade is available
- **Equitable:** 1) Tenant protections exist, 2) there are income-qualified exemptions, incentives, and financing available, 3) there is community engagement on policy design and workforce development and training
- **Cost effectiveness**: 1) Demonstrates on-bill savings, 2) does not increase upfront costs, 3) incentive programs are available or forth-coming
- **Effectiveness**: 1) Is an enforceable mandate, 2) transforms the market, 3) is scalable

7 Attachments

Attachment A: 2019 Residential Cost Effectiveness Analysis

Attachment B: Memorandum on preliminary cost effectiveness analysis for non-residential.

Attachment C: Existing Building Electrification and Multifamily Electric Vehicle Charging Policy and Financing Literature Review and Analysis



CALIFORNIA ENERGY CODES & STANDARDS
A STATEWIDE UTILITY PROGRAM

Last modified: 2021/07/08

2021 LOW-RISE RESIDENTIAL COST-EFFECTIVENESS ANALYSIS: FUEL SUBSTITUTION IN MENLO PARK'S EXISTING BUILDINGS

ADDENDUM TO STATEWIDE COST-EFFECTIVENESS STUDY

City of Menlo Park

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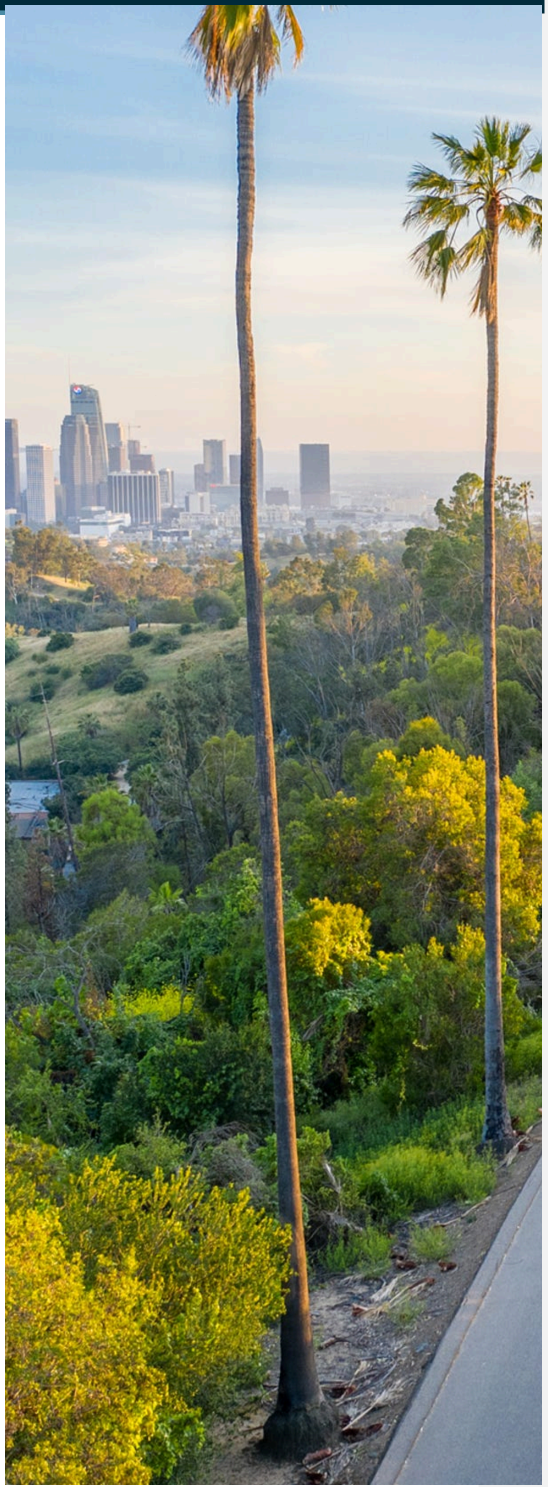
SDGE A Sempra Energy utility · SoCalGas A Sempra Energy utility · Southern California Edison An Edison International Company · PG&E Pacific Gas and Electric Company



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Acronym List

B/C – Benefit-to-Cost Ratio

BayREN – Bay Area Regional Energy Network

CBECC – California Building Energy Code Compliance

CBSC – California Building Standards Commission

CEC – California Energy Commission

CZ – Climate Zone

GHG – Greenhouse Gas

IOU – Investor-Owned Utility

PCE – Peninsula Clean Energy

POU – Publicly Owned Utility

PG&E – Pacific Gas & Electric (utility)

SCE – Southern California Edison (utility)

SCG – Southern California Gas (utility)

SDG&E – San Diego Gas & Electric (utility)

CPAU – City of Palo Alto Utilities

SMUD – Sacramento Municipal Utility District

LADWP – Los Angeles Department of Water and Power

kWh – Kilowatt Hour

NPV – Net Present Value

PV - Solar Photovoltaic

TDV - Time Dependent Valuation

Title 24 – California Code of Regulations Title 24, Part 6

TOU – Time of Use

Summary of Revisions		
Date	**Description**	**Reference (page or section)**
4/22/2021	Original Release	NA
6/23/2021	Update to include multifamily analysis; include additional detail on incremental costs.	NA
7/8/2021	Update to PCE HPWH incentive, GHG savings, and 1992-2010 HP results. Add cost details on electric ready measures.	NA

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1 Introduction

The California Codes and Standards Reach Codes program provides technical support to local governments considering adopting a local ordinance (reach code) intended to support meeting local and/or statewide energy and greenhouse gas reduction goals. The program facilitates adoption and implementation of the code when requested by local jurisdictions by providing resources such as cost-effectiveness studies, model language, sample findings, and other supporting documentation. Local jurisdictions that are considering adopting ordinances may contact the program for support through its website, LocalEnergyCodes.com.

The California Building Energy Efficiency Standards Title 24, Part 6 (Title 24) (California Energy Commission, 2018) is maintained and updated every three years by two state agencies: the California Energy Commission (the 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 analysis is an update to the statewide cost-effectiveness study for existing building upgrades completed in March 2021 (Statewide Reach Code Team, 2021) which evaluates the feasibility and cost-effectiveness of retrofit measures in existing single family homes built before 2010. This report presents results from analysis conducted in response to a request from the City of Menlo Park to evaluate the fuel substitution measures with revisions that more accurately reflect local conditions. Cost-effectiveness is reported for California Climate Zone 3 based on Peninsula Clean Energy (PCE) electric tariffs for both single family and low-rise multifamily buildings. This report was developed in coordination with the California Statewide Investor Owned Utilities (IOUs) Codes and Standards Program, key consultants, and engaged cities—collectively known as the Reach Code Team.

The Department of Energy (DOE) sets minimum efficiency standards for equipment and appliances that are federally regulated under the National Appliance Energy Conservation Act, including heating, cooling, and water heating equipment (E-CFR, 2020). Since state and local governments are prohibited from adopting 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 heating, cooling, and water heating equipment. High efficiency appliances are often the easiest and most affordable measures to increase energy performance. While federal preemption limits reach code mandatory requirements for covered appliances, in practice, builders may install any package of compliant measures to achieve the performance requirements.

2 Methodology and Assumptions

The same methodology used in the statewide analysis (Statewide Reach Code Team, 2021) is applied to this analysis with the following exceptions:

- Local PCE electric utility tariffs are used in place of PG&E tariffs.
- PCE and BayREN incentives are considered.
- A single family 2,700 square foot home is used in place of the 1,665 square foot home applied in the statewide study. This larger home better reflects the Menlo Park building stock.
- A two-story multifamily apartment building was also evaluated. The eight-unit building has four one-bedroom 780 square foot units and four two-bedroom 960 square foot units.
- Only the fuel substitution measures are evaluated.
- Two additional measures are evaluated showing the energy impact of converting a gas dryer and gas range/oven to electric resistance appliances.

Key components of the methodology are repeated below. Refer to the statewide study for further details.

2.1 Measures and Costs

In addition to the fuel substitution measures for space heating and water heating the Statewide Reach Code Team also evaluated fuel substitution for clothes drying and cooking. Standard and high efficiency heat pumps were considered in this analysis. For space conditioning, the study assumes that an existing AC and natural gas furnace is replaced with a heat pump. It is assumed there is no incremental labor except in providing new 240 V electrical service to the air handler location. In mild climates, where AC may not be installed, there will be additional costs for installing an outdoor unit, refrigerant lines, and condensate drain pan. A 21 SEER, 11 HSPF variable capacity heat pump was modeled for the high efficiency space conditioning heat pump.

The heat pump water heater (HPWH) measures are based on replacement of a natural gas storage water heater with a HPWH, assuming the existing water heater is located in the garage for single family buildings and an exterior closet for multifamily buildings. Costs include all material and installation labor including providing new 240 V electrical service to the water heater location.

Incremental costs for these fuel substitution measures are presented in Table 1, Table 2, and Table 3. All equipment is assumed to be replaced at end-of-life and incremental costs are relative to comparable gas equipment. The lifetime for the heat pump, furnace, and air conditioner are based on the Database for Energy Efficient Resources (DEER) (California Public Utilities Commission, 2021). In DEER heat pump and air conditioner measures are assigned an effective useful lifetime (EUL) of 15 years and a furnace an EUL of 20 years. The heating and cooling system components are typically replaced at the same time when one reaches the end of its life and the other is near it. Therefore, it is assumed that both the furnace and air conditioner are replaced at the same time at year 17.5, halfway between 15 and 20 years. Future replacement costs for the heat pumps are reduced by 20% to account for cost reductions as a result of a maturing market. The HVAC single family costs reflect a 3-ton heat pump or air conditioner and a 60,000 Btu/h furnace. The multifamily costs are slightly lower as they reflect a 2-ton heat pump or air conditioner and a 40,000 Btu/h furnace. Incremental costs for electric ready measures are presented in Table 4.

Table 1: HVAC Measure Cost Assumptions – Electric Replacements

	Single Family (3-ton HP/AC, 60kBtu/h furnace)			Multifamily (2-ton HP/AC, 40kBtu/h furnace)			Notes
	Gas Furnace /AC	14 SEER Heat Pump	21 SEER Heat Pump	Gas Furnace /AC	14 SEER Heat Pump	21 SEER Heat Pump	
First Cost	$8,738	$9,101	$11,247	$8,545	$8,731	$10,725	Equipment costs from on-line sources and HVAC contractors. Other supply and labor costs from 2019 report on residential building electrification in California (Energy & Environmental Economics, 2019). First cost includes disposal, electrical upgrade, and labor costs.
Replacement Cost (Future Value)	$8,738	$6,729	$8,445	$8,545	$6,433	$8,028	Future total replacement costs for the heat pumps are reduced by 20% to account for cost reductions because of a maturing market and electrical upgrade costs are removed.
Replacement Cost (Present Value)	$5,209	$4,319	$5,421	$5,094	$4,129	$5,153	Based on 17.5-year lifetime for gas furnace/AC, 15-year lifetime for heat pumps, 3% discount rate.
Remaining Value at Year 30	($1,029)	$0	$0	($1,006)	$0	$0	Residual value of the gas furnace/AC to account for the remaining life at end of 30-year analysis period.
Total Lifecycle Cost	$12,918	$13,419	$16,667	$12,633	$12,859	$15,878	
Incremental Cost	**-**	**$501**	**$3,749**	**-**	**$227**	**$3,245**	

Table 2: Water Heating Measure Cost Assumptions – Electric Replacements

	Single Family & Multifamily			Notes
	Gas Storage Water Heater	2.0 UEF HPWH	NEEA Tier 3 HPWH	
First Cost	$1,600	$4,018	$4,155	First cost based on 2018-2020 costs from SMUD incentive program for NEEA Tier 3 HPWH (Sacramento Municipal Utility District, 2020). 2.0 UEF first cost assumes 90% of equipment cost compared to NEEA Tier 3 unit based on on-line product research. Includes equipment cost, electrical upgrade, permitting, and labor.
Replacement Cost (Future Value)	$1,600	$1,874	$1,943	Future replacement cost assumes the same labor for the gas and HPWH case. HPWH replacement equipment costs are reduced by 50% to account for cost reductions because of a maturing market.
Replacement Cost (Present Value)	$1,027	$1,203	$1,247	Based on 15-year lifetime and 3% discount rate.
Remaining Value at Year 30	$0	$0	$0	
Total Lifecycle Cost	$2,627	$5,221	$5,402	
Incremental Cost	**-**	**$2,594**	**$2,775**	

Table 3: Cooking and Clothes Dryer Measure Cost Assumptions – Electric Replacements

	Single Family & Multifamily				Notes
	Gas Range	Electric Resistance Range	Gas Dryer	Electric Resistance Dryer	
First Cost	$1,510	$2,118	$1,805	$2,118	Costs from E3 study for Climate Zone 3 (Energy & Environmental Economics, 2019). No incremental replacement costs assumed.
Incremental Cost	**-**	**$608**		**$313**	

Table 4: Electric Ready Cost Assumptions

	Incremental Cost	Notes
Appliance pre-wire	$455 per appliance. $910 total for space and water heating	$125 parts, $330 labor. (Energy & Environmental Economics, 2019).
Main service panel upgrade	$3,181	Upgrade 100A to 200A (TRC, 2016)

A PV system is evaluated in combination with select fuel substitution measures. The PV system size presented in Table 5 was based on the sizing methodology of the 2019 new construction standards in Climate Zone 3. It was evaluated in CBECC-Res according to the California Flexible Installation (CFI) assumptions. Table 5 also presents incremental costs.

Table 5: PV System Capacity & Costs

	PV Size	Total Lifecycle Cost	Notes
Single Family	2.82 kW-DC	$3.18/kW-DC ($8,953 total)	First costs are from LBNL's Tracking the Sun 2019 costs (Barbose, 2019) and represent costs for the first half of 2019 of $3.70/WDC for residential systems and $3.10/WDC for small commercial systems. These costs were reduced by 26% for the solar ITC, which is the average credit over years 2021-2022. Inverter replacement cost of $0.14/WDC present value includes replacements at year 11 at $0.15/WDC (nominal) and at year 21 at $0.12/WDC (nominal) per the 2019 PV CASE Report (California Energy Commission, 2017). System maintenance costs of $0.31/WDC present value assume $0.02/WDC (nominal) annually per the 2019 PV CASE Report (California Energy Commission, 2017).
Multifamily	13.33 kW-DC total (1.67 kW-DC per dwelling unit)	$2.74/kW-DC ($4,559 per dwelling unit)	

2.2 Cost-effectiveness

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 as compared to the 2019 prescriptive Title 24 requirements. 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 impacts using electricity and natural gas utility rate schedules over a 30-year duration accounting for discount rate and energy 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 uses 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, Cutter, Kapur, Arent, & Conotyannis, 2014). This is the methodology used by the Energy Commission in evaluating cost-effectiveness for efficiency measures in Title 24, Part 6. Analysis based on both 2019 and 2022 TDV is presented in this report.

On-Bill analysis was completed using the utility rates described in Table 6. PCE's TOU-C rate is similar to PG&E's TOU-C rate except with a lower generation rate and additional credit for solar PV generation. Rates reflect PCE's most recent updates on April 1, 2021 and PG&E's March 1, 2021 updates. Monthly net energy production is credited at $0.01/kWh in addition to the retail rate. See 5.1 Utility Tariff Details in the Appendix for details.

Table 6: Utility Tariffs Applied in Analysis

Electricity	Natural Gas
PCE TOU-C	PG&E G-1

Source: Utility websites, see 5.1 Utility Tariff Details in the Appendix for details on the tariffs applied.

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 electric utility rates for PCE was not available and the assumptions used in this analysis are based on those from the statewide studies (Statewide Reach Code Team, 2019).

Results are presented as a lifecycle benefit-to-cost (B/C) ratio, a net present value (NPV) metric which represents the cost-effectiveness of a measure over a 30-year lifetime considering discounting of future savings and costs and financing of incremental first costs. 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.

3 Results and Discussion

Table 7 through Table 10 summarize cost-effectiveness of the fuel substitution measures evaluated. Cost-effectiveness analysis was evaluated using both On-Bill and TDV cost-effectiveness criteria. Site energy savings, cost savings, measure cost, and cost effectiveness including lifecycle B/C ratio and NPV of savings are provided. Where measures are dependent on building vintage (envelope efficiency measures), cost effectiveness is reported for each vintage. The electric clothes dryer and electric cooking measure results do not differ by vintage.

3.1 On-Bill Cost Effectiveness

The fuel substitution measures are not cost-effective on their own based on the On-Bill approach. When coupled with PV both the heat pump at HVAC replacement and HPWH at water heater replacement are cost-effective across all vintages. PCE[1] and BayREN[2] each offer a $1,000 incentive for a combined $2,000 incentive for installing a HPWH with a Uniform Energy Factor (UEF) of 3.1 or greater that replaces a gas water heater. These incentives reduce the first incremental cost substantially but not enough to make this measure cost-effective across the three vintages for either single family or multifamily. Because the incentives only apply to HPWHs with UEFs higher than the federal minimum standard, the cost-effectiveness results for single family cannot be used as the basis of an ordinance. Higher efficiency HPWHs can be installed as an option to an ordinance that is based on minimum efficiency equipment.

BayREN also offers a $1,000 incentive for a space conditioning heat pump with a minimum SEER of 17 and HSPF of 9.4. While this incentive improves cost effectiveness for the high efficiency heat pump measure, it is not enough to result in a positive On-Bill NPV over the lifetime.

The electric dryer and range measures are not cost-effective on their own. They may be cost effective if evaluated as a package with PV measures or if incentives were available.

For multifamily buildings, this study assumed the water heater is located in an outdoor closet. Performance of a HPWH will be slightly better if the existing water heater is located inside the unit (in conditioned space) but would create potential sound and comfort issues. Cost to install a HPWH inside the apartment would also be higher and most likely require ducting to properly vent the unit.

3.2 TDV Cost Effectiveness

Cost effectiveness improves for the fuel substitution measures based on the 2019 and 2022 TDV metric and all the measures except for the high efficiency heat pump for multifamily and the electric clothes dryer and range/oven are cost effective based on 2022 TDV. The measures are cost-effective under 2019 TDV when combined with a PV system. PV systems are more cost-effective On-Bill than with the TDV metrics, but the PV packages are all cost-effective based on all metrics.

[1] PCE incentive is currently $1,500 but will be reduced later in 2021 to $1,000. https://www.peninsulacleanenergy.com/heat-pump-water-heater/
[2] https://bayrenresidential.org/sites/default/files/2021-01/BayREN_Home+_Measures_10292020.pdf

Table 7: Single Family Equipment Fuel Substitution Cost-Effectiveness Results – No Incentives

Measure	Vintage	Measure Cost	Electricity Savings (kWh)	Gas Savings (therm)	GHG Savings (lb CO2e)	Utility Cost Savings Year 1	Utility Cost Savings Avg Annual	Customer On-Bill B/C Ratio	Customer On-Bill NPV	2019 TDV B/C Ratio	2019 TDV NPV	2022 TDV B/C Ratio	2022 TDV NPV
Heat Pump at HVAC Replacement	Pre-1978	$501	-4,528	451	2,409	-$377	-$249	0	-$8,006	0	-$5,462	9.30	$4,160
	1978-1991		-3,173	309	1,606	-$295	-$200	0	-$6,547	0	-$2,318	5.68	$2,348
	1992-2010		-2,722	265	1,398	-$262	-$179	0	-$5,922	0	-$1,109	4.96	$1,984
SEER 21 Heat Pump at HVAC Replacement	Pre-1978	$3,749	-3,261	451	2,977	-$30	$26	0.19	-$3,290	0.92	-$312	3.17	$8,152
	1978-1991		-2,337	309	1,984	-$66	-$19	0	-$4,637	0.52	-$1,788	1.96	$3,617
	1992-2010		-2,011	265	1,713	-$67	-$25	0	-$4,820	0.78	-$825	1.60	$2,244
Heat Pump at HVAC Replacement + 2.82 kWDC PV	Pre-1978	$9,454	-27	451	2,702	$786	$670	1.92	$9,644	1.33	$3,111	2.00	$9,478
	1978-1991		1,328	309	1,899	$868	$717	2.06	$11,078	1.66	$6,222	1.81	$7,637
	1992-2010		1,779	265	1,691	$901	$739	2.12	$11,720	1.79	$7,455	1.77	$7,292
HPWH at Water Heater Replacement	Pre-1978	$2,594	-1,588	179	1,358	-$114	-$71	0	-$5,032	0	-$4,546	1.20	$522
	1978-1991		-1,593	181	1,369	-125	-80	0	-$5,305	0	-$4,486	1.20	$517
	1992-2010		-1,594	181	1,372	-128	-83	0	-$5,391	0	-$4,458	1.18	$466
NEEA Tier 3 HPWH at Replacement	Pre-1978	$2,775	-1,146	177	1,491	$5	$22	0.21	-$2,434	0.22	-$2,168	1.87	$2,419
	1978-1991		-1,152	179	1,505	-$6	$13	0.13	-$2,702	0.23	-$2,140	1.87	$2,424
	1992-2010		-1,155	180	1,510	-$9	$10	0.10	-$2,788	0.24	-$2,116	1.85	$2,359
HPWH at Water Heater Replacement + 2.82 kWDC PV	Pre-1978	$11,546	2,913	179	1,651	$1,057	$852	2.00	$12,781	1.36	$4,167	1.52	$6,017
	1978-1991		2,908	181	1,662	$1,046	$843	1.98	$12,500	1.37	$4,218	1.52	$6,003
	1992-2010		2,907	181	1,666	$1,042	$840	1.97	$12,416	1.37	$4,246	1.52	$5,956
2.82 kWDC PV + Electric Ready	Pre-1978	$13,044	4,501	0	293	$1,161	$916	1.90	$12,994	1.34	$4,375	1.09	$1,156
	1978-1991		4,485		292	$1,093	$862	1.79	$11,378	1.33	$4,365	1.08	$1,100
	1992-2010		4,400		287	$1,069	$844	1.75	$10,829	1.33	$4,365	1.07	$848
Electric Clothes Dryer	All	$313	-891	33	118	-$182	-$140	0	-$4,555	0	-$3,770	0	-$2,242
Electric Range/Oven	All	$608	-295	14	59	-$55	-$42	0	-$1,949	0	-$1,692	0	-$1,229

Note: Values shaded in **red** indicate option is not cost-effective with B/C ratio less than 1. Values shaded in **green** indicate option is cost-effective with B/C ratio greater than or equal to 1. Cells with "n/a" reflect cases where cost effectiveness was not evaluated.

Commented [FF1]: Revise to assume 0 emission electricity, note that this doesn't reflect 24/7 emissions.

Add separate table depicting the value of GHG savings per Menlo Park's CAP and add to on-bill. In the Policy Options document.

Blake to sketch avoided GHG $cost/ton similar to Tom's request.

Table 8: Single Family On-Bill Cost-Effectiveness Comparison with Incentives

Measure	Vintage	Gross Measure Cost	PCE/ BayREN Incentive	Net Measure Cost	Year 1 Utility Cost Savings	No Incentive		With Incentive	
						On-Bill B/C Ratio	On-Bill NPV	On-Bill B/C Ratio	On-Bill NPV
SEER 21 Heat Pump at HVAC Replacement	Pre-1978	$3,749	$1,000	$2,749	-$30	0.19	-$3,290	0.26	-$2,168
	1978-1991				-$66	0	-$4,637	0	-$3,514
	1992-2010				-$67	0	-$4,820	0	-$3,697
NEEA Tier 3 HPWH at Replacement	Pre-1978	$2,775	$2,000	$775	$5	0.21	-$2,434	0.78	-$188
	1978-1991				-$6	0.13	-$2,702	0.46	-$456
	1992-2010				-$9	0.10	-$2,788	0.36	-$542

Note: Values shaded in **red** indicate option is not cost-effective with B/C ratio less than 1. Values shaded in **green** indicate option is cost-effective with B/C ratio greater than or equal to 1. Cells with “n/a” reflect cases where cost effectiveness was not evaluated.

Table 9: Multifamily Equipment Fuel Substitution Cost-Effectiveness Results Per Dwelling Unit – No Incentives

Measure	Vintage	Measure Cost	Electricity Savings (kWh)	Gas Savings (therm)	GHG Savings (lb CO_2e)	Utility Cost Savings		Customer On-Bill		2019 TDV		2022 TDV	
						Year 1	Avg Annual	B/C Ratio	NPV	B/C Ratio	NPV	B/C Ratio	NPV
Heat Pump at HVAC Replacement	Pre-1978	$227	-615	61	2,508	-$71	-$50	0	-$1,755	0	-$851	2.60	$363
	1978-1991		-402	40	1,585	-$47	-$34	0	-$1,261	0	-$678	1.53	$119
	1992-2010		-337	34	1,378	-$39	-$28	0	-$1,087	0	-$590	1.40	$91
SEER 21 Heat Pump at HVAC Replacement	Pre-1978	$3,245	-453	61	3,084	-$26	-$15	0	-$3,959	0.20	-$2,585	0.60	-$1,311
	1978-1991		-294	40	1,972	-$17	-$10	0	-$3,813	0.14	-$2,782	0.41	-$1,900
	1992-2010		-254	34	1,683	-$16	-$10	0	-$3,809	0.02	-$3,191	0.33	-$2,184
Heat Pump at HVAC Replacement + 1.67 kW_{DC} PV	Pre-1978	$4,785	2,044	61	3,894	$616	$492	2.80	$9,484	2.03	$4,909	1.88	$4,224
	1978-1991		2,257	40	2,971	$640	$508	2.89	$9,973	2.06	$5,075	1.83	$3,974
	1992-2010		2,322	34	2,764	$598	$475	2.70	$8,980	2.08	$5,163	1.82	$3,941
HPWH at Water Heater Replacement	Pre-1978	$2,594	-1,037	141	8,868	-$74	-$46	0	-$4,277	0	-$3,042	1.29	$753
	1978-1991		-1,037	141	8,868	-$74	-$46	0	-$4,284	0	-$3,042	1.29	$753
	1992-2010		-1,037	141	8,868	-$74	-$46	0	-$4,284	0	-$3,042	1.29	$753
NEEA Tier 3 HPWH at Replacement	Pre-1978	$2,775	-842	141	9,561	-$20	-$3	0	-$3,194	0.29	-$1,961	1.57	$1,591
	1978-1991		-842	141	9,561	-$20	-$4	0	-$3,201	0.29	-$1,961	1.57	$1,591
	1992-2010		-842	141	9,561	-$20	-$4	0	-$3,201	0.29	-$1,961	1.57	$1,591
HPWH at Water Heater Replacement + 1.67 kW_{DC} PV	Pre-1978	$7,152	1,623	141	10,254	$621	$502	1.90	$7,137	1.41	$2,905	1.67	$4,806
	1978-1991		1,623	141	10,254	$620	$502	1.90	$7,127	1.41	$2,902	1.67	$4,803
	1992-2010		1,623	141	10,254	$620	$501	1.90	$7,122	1.41	$2,899	1.67	$4,797
1.67 kW_{DC} PV + Electric Ready	Pre-1978	$8,650	2,660	0	1,386	$608	$480	1.50	$4,771	1.19	$1,650	0.97	-$239
	1978-1991		2,655		1,384	$600	$473	1.48	$4,573	1.18	$1,573	0.97	-$257
	1992-2010		2,578		1,343	$578	$456	1.42	$4,064	1.16	$1,392	0.94	-$493
Electric Clothes Dryer	All	$313	-671	25	898	-$148	-$114	0	-$3,782	0	-$2,888	0	-$1,764
Electric Range/Oven	All	$608	-232	11	395	-$48	-$37	0	-$1,786	0	-$1,737	0	-$1,073

Note: Values shaded in **red** indicate option is not cost-effective with B/C ratio less than 1. Values shaded in **green** indicate option is cost-effective with B/C ratio greater than or equal to 1. Cells with "n/a" reflect cases where cost effectiveness was not evaluated.

Table 10: Multifamily On-Bill Cost-Effectiveness Comparison with Incentives

Measure	Vintage	Gross Measure Cost	PCE/ BayREN Incentive	Net Measure Cost	Year 1 Utility Cost Savings	No Incentive		With Incentive	
						On-Bill B/C Ratio	On-Bill NPV	On-Bill B/C Ratio	On-Bill NPV
SEER 21 Heat Pump at HVAC Replacement	Pre-1978	$3,245	$1,000	$2,245	-$26	0	-$3,959	0	-$2,836
	1978-1991				-$17	0	-$3,813	0	-$2,691
	1992-2010				-$16	0	-$3,809	0	-$2,686
NEEA Tier 3 HPWH at Replacement	Pre-1978	$2,775	$2,000	$775	-$20	0	-$3,194	0	-$948
	1978-1991				-$20	0	-$3,201	0	-$955
	1992-2010				-$20	0	-$3,201	0	-$955

Note: Values shaded in **red** indicate option is not cost-effective with B/C ratio less than 1. Values shaded in **green** indicate option is cost-effective with B/C ratio greater than or equal to 1. Cells with “n/a” reflect cases where cost effectiveness was not evaluated.

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5 Appendices

5.1 Utility Tariff Details

5.1.1 PCE

Following are the PCE electricity tariffs applied in this study. The "Rate with PG&E Surchages" was used in place of PG&E's generation rate. PG&E's net energy metering (NEM) rules are applied. Additionally, monthly net energy production is credited at $0.01/kWh in addition to the retail rate at the hour of generation.

RESIDENTIAL CUSTOMER RATES

Rates Effective April 1, 2021

PENINSULA CLEAN ENERGY

RATE SCHEDULE	SCHEDULE TIMES	ENERGY CHARGE $/kWh		
		GENERATION RATE	RATE WITH PG&E SURCHARGES[1]	3.1.21 PG&E GENERATION RATE
E-TOU-C (PG&E equivalent: E-TOU-C)				
SUMMER - June 1 through September 30				
PEAK	4 pm to 9 pm every day	$ 0.10773	$ 0.15577	$ 0.16397
OFF-PEAK	All other hours	$ 0.05696	$ 0.10500	$ 0.11053
WINTER - October 1 through May 31				
PEAK	4 pm to 9 pm every day	$ 0.06141	$ 0.10945	$ 0.11521
OFF-PEAK	All other hours	$ 0.04713	$ 0.09517	$ 0.10018

5.1.2 PG&E

Following are the PG&E electricity tariffs applied in this study for non-generation rates. The electricity baseline territory used for Climate Zone 3 is T.

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)	$0.16397	(I)	$0.11053	(I)
Winter (all usage)	$0.11521	(I)	$0.10018	(I)
Distribution:**				
Summer (all usage)	$0.14292	(I)	$0.13292	(I)
Winter (all usage)	$0.09459	(I)	$0.09229	(I)

Conservation Incentive Adjustment (Baseline Usage)	($0.02659)	(R)
Conservation Incentive Adjustment (Over Baseline Usage)	$0.04925	(I)
Transmission* (all usage)	$0.03704	
Transmission Rate Adjustments* (all usage)	($0.00248)	(R)
Reliability Services* (all usage)	$0.00017	
Public Purpose Programs (all usage)	$0.01575	(I)
Nuclear Decommissioning (all usage)	$0.00093	
Competition Transition Charges (all usage)	$0.00004	
Energy Cost Recovery Amount (all usage)	$0.00032	
Wildfire Fund Charge (all usage)	$0.00580	
New System Generation Charge (all usage)**	$0.00442	

* 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	6090-E-A	*Issued by*	*Submitted*	February 26, 2021
Decision		***Robert S. Kenney***	*Effective*	March 1, 2021
		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)

	Code B - Basic Quantities		Code H - All-Electric Quantities	
	Summer	Winter	Summer	Winter
Baseline Territory*	Tier I	Tier I	Tier I	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)

Advice	5759-E	*Issued by*	*Submitted*	February 14, 2020
Decision	D.19-07-004	***Robert S. Kenney***	*Effective*	March 1, 2020
		Vice President, Regulatory Affairs	*Resolution*	

The following provide details on the PG&E natural gas tariffs applied in this study. The PG&E monthly gas rate in $/therm was applied on a monthly basis for the 12-month period ending March 2021 according to the rates shown in Table 11. The natural gas baseline territory used for Climate Zone 3 is T.

Table 11: PG&E Monthly Gas Rate ($/therm)

Month	Procurement Charge	Transportation Charge		Total Charge	
		Baseline	Excess	Baseline	Excess
Jan 2021	$0.49332	$1.09586	$1.53752	$1.58918	$2.03084
Feb 2021	$0.49073	$1.09586	$1.53752	$1.58659	$2.02825
Mar 2021	$0.42316	$1.19868	$1.68034	$1.62184	$2.1035
Apr 2020	$0.23856	$1.13126	$1.64861	$1.36982	$1.88717
May 2020	$0.23187	$1.13126	$1.64861	$1.36313	$1.88048
June 2020	$0.24614	$1.13126	$1.64861	$1.3774	$1.89475
July 2020	$0.23892	$1.13126	$1.64861	$1.37018	$1.88753
Aug 2020	$0.28328	$1.13126	$1.64861	$1.41454	$1.93189
Sept 2020	$0.41891	$1.13126	$1.64861	$1.55017	$2.06752
Oct 2020	$0.38068	$1.13416	$1.65280	$1.51484	$2.03348
Nov 2020	$0.46046	$1.13416	$1.65280	$1.59462	$2.11326
Dec 2020	$0.48474	$1.13416	$1.65280	$1.6189	$2.13754

GAS SCHEDULE G-1 Sheet 2
RESIDENTIAL SERVICE

BASELINE QUANTITIES: The delivered quantities of gas shown below are billed at the rates for baseline use.

BASELINE QUANTITIES (Therms Per Day Per Dwelling Unit) (T)

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	
P	0.39	(R)	1.88	(R)	2.16	(I)
Q	0.59	(R)	1.55	(R)	2.16	(I)
R	0.36	(R)	1.28	(R)	1.97	(I)
S	0.39	(R)	1.38	(R)	2.06	(I)
T	0.59	(R)	1.38	(R)	1.81	(I)
V	0.62	(R)	1.51	(R)	1.84	(I)
W	0.39	(R)	1.18	(R)	1.84	(I)
X	0.49	(R)	1.55	(R)	2.16	(I)
Y	0.69	(R)	2.15	(R)	2.65	(I)

(T)

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.

Get In Touch

The adoption of reach codes can differentiate jurisdictions as efficiency leaders and help accelerate the adoption of new equipment, technologies, code compliance, and energy savings strategies.

As part of the Statewide Codes & Standards Program, the Reach Codes Subprogram is a resource available to any local jurisdiction located throughout the state of California.

Our experts develop robust toolkits as well as provide specific technical assistance to local jurisdictions (cities and counties) considering adopting energy reach codes. These include cost-effectiveness research and analysis, model ordinance language and other code development and implementation tools, and specific technical assistance throughout the code adoption process.

If you are interested in finding out more about local energy reach codes, the Reach Codes Team stands ready to assist jurisdictions at any stage of a reach code project.

Visit LocalEnergyCodes.com to access our resources and sign up for newsletters

Contact info@localenergycodes.com for no-charge assistance from expert Reach Code advisors

Follow us on Twitter

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Farhad Farahmand
510.473.8421

MEMORANDUM

August 13, 2021

To: Rebecca Lucky (Menlo Park)

CC: Rafael Reyes (Peninsula Clean Energy), Kelly Cunningham (Pacific Gas & Electric Company), Christopher Kuch (Southern California Edison)

From: Farhad Farahmand (TRC)

Re: Preliminary Cost Effectiveness Results for Nonresidential Electrofits in Climate Zone 3

OVERVIEW

TRC is providing preliminary cost-effectiveness results for nonresidential alterations in Menlo Park (California Climate Zone 3), based on work we are performing on behalf of the Statewide Utility Reach Codes Program. These preliminary results are to inform near-term decision-making toward achieving Menlo Park's existing building electrification goals, and to allow Menlo Park to provide feedback on methodology and assumptions. These results have not been approved by the Statewide Utility Team, and represent solely represent TRC's work to date. We anticipate that the statewide report will be published by the third quarter of 2021.

INTRODUCTION

This memo documents preliminary cost-effectiveness analysis of measures that exceed the minimum state requirements, the 2019 Building Energy Efficiency Standards, effective January 1, 2020, for nonresidential alterations. Measures include energy efficiency, electrification, solar photovoltaics (PV), and battery storage.

The Department of Energy (DOE) sets minimum efficiency standards for equipment and appliances that are federally regulated under the National Appliance Energy Conservation Act, including heating, cooling, and water heating equipment (E-CFR, 2020). Since state and local governments are prohibited from adopting 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 heating, cooling, and water heating equipment.

METHODOLOGY

The Reach Codes Team used the following cost effectiveness methodology to analyze prototype alteration measures.

Cost-Effectiveness

This section describes the approach to calculating cost effectiveness including benefits, costs, metrics, and utility rate selection.

Benefits

This analysis used both *on-bill* and *time dependent valuation* (*TDV*) *energy* based approaches to evaluate cost-effectiveness. Both on-bill and TDV require estimating and quantifying the energy savings and costs associated with energy measures. The primary difference of on-bill and TDV is how energy is valuated:

- **On-Bill**: Customer-based lifecycle cost 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 15-year duration for nonresidential buildings, accounting for a 3 percent discount rate and energy cost inflation.
- **TDV**: TDV is developed by the Energy Commission to reflect the time dependent value of energy including long-term projected costs of energy such as the cost of providing energy during peak periods of demand and other societal costs including projected costs for carbon emissions and grid transmission impacts. With the TDV approach, electricity used (or saved) during peak periods has a much higher value than electricity used (or saved) during off-peak periods. 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.

TRC performed energy simulations using the most recent software available for 2019 Title 24 code compliance analysis, CBECC-Com 2019.1.3. TRC also simulated packages in 2022 research version software to test the impact of 2022 TDV multipliers and weather files on cost-effectiveness.

Costs

TRC assessed the incremental costs and savings of the energy packages over the 15 years for nonresidential prototypes. Incremental costs represent the equipment, installation, replacements, and maintenance costs of the proposed measure relative to the 2019 Title 24 Standards minimum requirements. Where applicable we accounted for demolition costs. TRC obtained measure costs from engineering cost estimators, manufacturer distributors, contractors, literature review, and online sources such as Home Depot and RS Means. Taxes and contractor markups were added as appropriate.

Metrics

Cost effectiveness is presented using net present value (NPV) and benefit-to-cost (B/C) ratio metrics.

- **NPV**: TRC uses net savings (NPV benefits *minus* NPV costs) as the 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 even more negative (i.e., construction and maintenance cost *savings*).
- **B/C Ratio**: Ratio of the present value of all benefits to the present value of all costs over 15 or 30 years (NPV benefits *divided by* NPV costs). The criterion for cost effectiveness is a B/C greater than 1.0, representing a positive return on investment. A value of one indicates the savings over the life of the measure are equivalent to the incremental cost of that measure.

Improving the energy performance of a building often requires an initial 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*.

Utility Rates

TRC determined appropriate utility rates for each prototype and package based on the annual load profile of each prototype and the corresponding package, the most prevalent rate in each territory. For some prototypes there are multiple options for rates because of the varying load profiles of mixed-fuel buildings versus all-electric buildings. If more than one rate schedule is applicable for a particular load profile, TRC did not attempt to compare or test a variety of tariffs to determine their impact on cost effectiveness. TRC used PG&E electric utility rates B-1 and B-10 depending on the prototype, and G-NR1 for Climate Zone 3.

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) and escalation rates used in the development of the 2022 TDV multipliers.[1,2]

Figure 1. Real Utility Rate Escalation Rate Assumptions Above Inflation

Year	Source	Statewide Electric Nonresidential Average Rate (%/year, real)	Natural Gas Nonresidential Core Rate (%/year, real)
2020	E3 2019	2.0%	4.3%
2021	E3 2019	2.0%	4.3%
2022	E3 2019	2.0%	2.7%
2023	E3 2019	2.0%	4.0%
2024	2022 TDV	0.7%	7.7%
2025	2022 TDV	0.5%	5.5%
2026	2022 TDV	0.7%	5.6%
2027	2022 TDV	0.2%	5.6%
2028	2022 TDV	0.6%	5.7%
2029	2022 TDV	0.7%	5.7%
2030	2022 TDV	0.6%	5.8%
2031	2022 TDV	0.6%	3.3%
2032	2022 TDV	0.6%	3.6%
2033	2022 TDV	0.6%	3.4%
2034	2022 TDV	0.6%	3.4%
2035	2022 TDV	0.6%	3.2%
2036	2022 TDV	0.6%	3.2%
2037	2022 TDV	0.6%	3.1%

[1] https://www.ethree.com/e3-quantifies-the-consumer-and-emissions-impacts-of-electrifying-california-homes/
[2] https://www.energy.ca.gov/event/workshop/2020-03/staff-workshop-2022-energy-code-compliance-metrics

Year	Source	Statewide Electric Nonresidential Average Rate (%/year, real)	Natural Gas Nonresidential Core Rate (%/year, real)
2038	2022 TDV	0.6%	2.9%
2039	2022 TDV	0.6%	3.2%
2040	2022 TDV	0.6%	2.9%
2041	2022 TDV	0.6%	3.5%
2042	2022 TDV	0.6%	3.4%
2043	2022 TDV	0.6%	3.4%
2044	2022 TDV	0.6%	3.4%
2045	2022 TDV	0.6%	3.5%
2046	2022 TDV	0.6%	2.0%
2047	2022 TDV	0.6%	1.8%
2048	2022 TDV	0.6%	2.1%
2049	2022 TDV	0.6%	1.7%
2050	2022 TDV	0.6%	2.1%
2035	2022 TDV	0.6%	3.2%
2036	2022 TDV	0.6%	3.2%
2037	2022 TDV	0.6%	3.1%
2038	2022 TDV	0.6%	2.9%
2039	2022 TDV	0.6%	3.2%
2040	2022 TDV	0.6%	2.9%
2041	2022 TDV	0.6%	3.5%
2042	2022 TDV	0.6%	3.4%
2043	2022 TDV	0.6%	3.4%
2044	2022 TDV	0.6%	3.4%
2045	2022 TDV	0.6%	3.5%
2046	2022 TDV	0.6%	2.0%
2047	2022 TDV	0.6%	1.8%
2048	2022 TDV	0.6%	2.1%
2049	2022 TDV	0.6%	1.7%
2050	2022 TDV	0.6%	2.1%

Prototype Characteristics

TRC used modified versions of the following five DOE building prototypes to evaluate cost effectiveness of measure packages:

- Medium Office
- Stand-alone Retail
- Warehouse
- Quick-service restaurant (QSR) and Full-service restaurant (FSR)
- High-rise multifamily (HRMF)
- Small Hotel

TRC created three vintages of prototypes by leveraging data and methodologies from IOU studies, Senate Bill 350 (SB350) analysis, and Commercial Building Energy Consumption Survey (CBECS) to identify appropriate characteristics.[3,4,5] These datasets include estimates of retrofits/upgrades to older buildings as well as field data on existing conditions. The three vintages that TRC analyzed include:

- 1980's – represents buildings built prior to 1990 (reference year 1982).
- 1990's – represents buildings built during the 1990 era (reference year 1992).
- 2000's – represents buildings built during the 2000 era (reference year 2006).

The analysis presented in this report assumes a certain set of existing conditions within each prototype, and that buildings operate as intended. Real building existing conditions are often a variety of old and new components, and equipment performance degrades over time. The analysis assumes some equipment replacement over time, based primarily on the SB350 analysis. The rate of replacement varies by building system and by envelope component.

TRC's prototypes and cost effectiveness results represent a range of vintages in an attempt to account for the variety of existing conditions in real buildings in a simplified way. Jurisdictions should consider how TRC's measure-specific findings would apply to the existing conditions in the jurisdictions' building stock, and in what instances they would be applicable.

Figure 2 summarizes the baseline prototype characteristics.

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[3] http://capabilities.itron.com/WO024/Docs/California%20Commercial%20Saturation%20Study_Report_Final.pdf
[4] https://efiling.energy.ca.gov/getdocument.aspx?tn=221631
[5] https://www.eia.gov/consumption/commercial/

Figure 2. Prototype Summaries

Building Type (All Vintages)	Conditioned Floor Area (ft^2)	# of floors	Baseline HVAC Distribution System	Baseline Hot Water System
Medium Office	53,628	3	Packaged multizone Variable Air Volume (VAV) reheat + boilers	Central Gas Storage
Stand-alone Retail	24,563	1	Packaged single zone (SZ) Constant Air Volume (CAV) + gas furnace	Central Gas Storage
Warehouse	17,548	1	Warehouse: Gas furnace serving 10% of floor area, exhaust-only ventilation Office: Packaged SZ CAV + gas furnace	Central Gas Storage
QSR	2,500	1	Packaged SZ CAV + gas furnace	Central Gas storage
FSR	5,000			
HRMF: 1980s vintage	125,400	10	Packaged terminal air conditioning (PTAC) + boilers serving heating-only baseboard	Central gas storage
HRMF: 1990s vintage			PTAC + boilers serving heating-only fan coils	
HRMF: 2000s vintage			Split air conditioner + gas furnace	
Small Hotel: 1980s vintage	42,552	4	PTAC + gas wall furnace	Central gas storage
Small Hotel: 1990s vintage				
Small Hotel: 2000s vintage			SZAC + furnace	

Greenhouse Gas Emissions

The analysis uses the greenhouse gas (GHG) emission multipliers developed by E3.[6] The multipliers have been developed to support development of compliance metrics for use in the 2022 California Energy Code. There are 8760 hourly multipliers accounting for time dependent energy use and carbon emissions based on source emissions, including renewable portfolio standard projections. For the 2022 code cycle, the multipliers also incorporate greenhouse gas emissions from methane and refrigerant leakage, which are two significant sources of greenhouse gas emissions.[7] There are 32 strings of multipliers – strings differ by the California climate zone and fuel type (electricity or natural gas).

Greenhouse gas (GHG) savings in lb CO_2e do not represent Peninsula Clean Energy values, but rather those for Pacific Gas & Electric Company based on the automatically generated outputs of CBECC-Res. It is likely that higher GHG savings are achievable from an increased penetration of renewable energy supply, such as that provided by Peninsula Clean Energy.

[6] https://efiling.energy.ca.gov/GetDocument.aspx?tn=233260&DocumentContentId=65748

[7] Energy and Environmental Economics, Inc. 2020. "Time Dependent Valuation of Energy for Developing Building Efficiency Standards." https://efiling.energy.ca.gov/GetDocument.aspx?tn=233257&DocumentContentId=65743

Measure Packages and Costs

TRC analyzed the electrification retrofit (*electrofits*), efficiency, solar photovoltaics (PV), and battery measures described in this section.

Electrofit

TRC examined the potential for electrofits of HVAC, hot water, cooking, and clothes drying end-uses where applicable. In some scenarios, partial electrofits were considered.

TRC received cost estimates from Western Allied Mechanical, a San Francisco Bay Area mechanical contractor for the HVAC and water heating systems, for all packages. The mechanical contractor gave labor costs for typical new installations and noted that retrofit labor costs are highly variable. Building-specific considerations such as tight conditions, prepping surfaces, elevated work, material handling, specialty rigging, and protecting existing finishes can vary building to building. These details can have a large labor cost impact, and it is difficult to define a typical condition. Because of this variation, TRC used multipliers typically ranging from 25 to 50 percent on the new construction labor cost.

For each electrofit, TRC considered the mechanical equipment impact at the central system, distribution, and zone levels. TRC assigned a retrofit labor multiplier separately to the central system equipment, distribution equipment, and zonal equipment based on challenges the installers are likely to encounter. TRC estimated a different multiplier for the mixed fuel retrofit as well as the electrofit for each prototype. The final multipliers range widely, with lower multipliers typical of like-for-like replacements such as replacing a packaged SZ unit, and higher multipliers where additional demolition, physical space, and coordination may be needed.

TRC determined electrical upgrades required for each electrofit and the cost of the upgrade through design engineering coordination with P2S Engineers and costs from RSMeans. TRC intended to capture all components of electrical upgrades, from receptacles to transformers. Costs for utility service upgrades were out of the scope of this study.

TRC assumed that all HVAC and SHW equipment has a 15-year useful life and therefore did not consider replacements in either the mixed-fuel or the all-electric scenario for all nonresidential building types. TRC assumed that the maintenance requirements would be the same in the mixed-fuel and all-electric scenarios, and therefore did not consider any incremental maintenance costs, except as noted.

Medium Office

The existing HVAC system is a VAV reheat system which includes one gas hot water boiler, one packaged rooftop unit per floor, and VAV hot water reheat boxes. The existing SHW design includes one gas storage water heater.

To replace the incumbent gas-fired boiler for the Medium Office electrofit, TRC selected a central heat pump water heater with a storage tank and electric resistance booster only to be used during peak heating demand periods. This approach utilizes the existing hydronic plumbing infrastructure and VAV terminals, and supply lower water temperature except during peak heating demand periods. To replace the existing gas storage SHW heater for the electrofit, TRC selected a central heat pump with storage tank. The HVAC and SHW electrofit systems present higher costs compared to the mixed-fuel replacements due to the increased equipment costs and electrical infrastructure needs.

For a mixed-fuel retrofit baseline, TRC assumed the gas boiler and gas water heater replacements are a one-to-one replacement of equipment at the system level, with no demolition required, and a labor retrofit multiplier of 25 percent. For the electrofit, TRC assumed a labor retrofit multiplier of 35 percent for both HVAC and SHW to account for installation of additional components and floor area required for the heat pump and storage tank. No distribution or zonal equipment changes are required as part of the electrofit.

Figure 3 shows the costs for Medium Office averaged across all climate zones for the 1980's vintage.

Figure 3. Medium Office Electrofit Costs

Mixed-fuel measure	Mixed-fuel cost	Electrofit measure	All-Electric cost	All-electric incremental cost	Source
Boilers	$45,508	Central heat pump water heater with electric resistance booster	$157,070	$111,562	Cost estimator
Service water heater	$73,479	Central heat pump water heater	$88,762	$15,283	Cost estimator
Electrical upgrades	$0	Wiring, distribution boards, and transformers to serve central HVAC and SHW systems	$31,233	$31,233	Design engineer, RSMeans
Total	$118,987		$277,065	$158,078	

Stand-Alone Retail

The existing HVAC system includes four packaged single zone rooftop ACs with gas furnaces. The existing SHW design includes one gas storage water heater.

To replace the existing packaged rooftop units for the Stand-alone Retail electrofit, the Reach Codes Team selected packaged heat pumps to replace the packaged ACs with gas furnaces. To replace the existing gas storage water heater for the electrofit, TRC selected one electric resistance point of use water heater for each of the three sinks.

TRC assumed a labor retrofit multiplier of 25 percent for both the mixed fuel and the all-electric HVAC retrofits. This is the low end of retrofit labor multipliers because in both the mixed fuel case and the all-electric case, the packaged units are drop-in replacements at the system level, with no demolition required. No HVAC distribution or zonal equipment changes are required as part of the electrofit. For a mixed-fuel SHW retrofit baseline, TRC assumed a labor retrofit multiplier of 25 percent because the water heater is a drop-in replacement of the existing water heater. For the SHW electrofit, TRC assumed a labor retrofit multiplier of 35 percent to account for installing equipment in three different locations.

Figure 4 shows the cost data for Stand-alone Retail averaged across all climate zones for the 1980's vintage.

Figure 4. Standalone Retail Electrofit Costs

Mixed-fuel measure	Mixed-fuel cost	Electrofit measure	All-Electric cost	All-electric incremental cost	Source
HVAC: Packaged SZ AC + gas furnace	$176,229	Packaged SZ Heat Pump	$173,617	($2,612)	Cost estimator
SWH: Gas storage	$1,255	Point of use electric resistance	$1,723	$468	Cost estimator
Electrical upgrades	$0	Wiring for SHW	$2,007	$2,007	Design engineer, RSMeans
Total	$177,484		$177,347	($137)	

Warehouse

The baseline HVAC system includes one packaged single zone rooftop AC with gas furnace which serves the office. The warehouse space does not have cooling, but approximately 10% of the floor area is heated by a ceiling suspended gas unit heater. Exhaust fans provide stand-alone ventilation and are not considered as part of any measure packages. The existing SHW design includes one gas storage water heater.

To replace the existing packaged rooftop unit for the office space, the Reach Codes Team selected a packaged heat pump. For the warehouse space, where 10% of the floor area is heated, TRC selected an electric radiant heater to replace the gas unit heater. To replace the existing gas storage water heater for the electrofit, TRC selected one electric resistance point of use water heater for the sink.

TRC assumed a labor retrofit multiplier of 25 percent for both the mixed fuel and the all-electric office HVAC retrofits, as well as the warehouse space mixed fuel retrofit. Similar to the Retail prototype, the equipment represents drop-in replacements without significant demolition. For the all-electric warehouse space HVAC retrofit TRC also assumed 25 percent because the electrofit requires little space and only requires hanging equipment in an open area. For a mixed-fuel SHW retrofit baseline, TRC assumed a labor retrofit multiplier of 25 percent because the water heater is a drop-in replacement of the existing water heater. For the SHW electrofit, TRC assumed a labor retrofit multiplier of 35 percent to account for installing equipment in a different location than the existing water heater.

Figure 5 shows the cost data for Warehouse averaged across all Climate Zones for vintage 1.

Figure 5. Warehouse Electrofit Costs

Mixed-fuel measure	Mixed-fuel cost	Electrofit measure	All-Electric cost	All-electric incremental cost	Source
Office HVAC: Packaged SZ AC + gas furnace	$56,013	Packaged SZ Heat Pump	$60,462	$4,449	Cost estimator
Warehouse HVAC: Gas heaters. Exhaust only ventilation	$6,529	Electric radiant heaters. Exhaust only ventilation	$10,958	$4,429	Cost estimator
SWH: Gas storage	$1,255	Point of use electric resistance	$1,149	-$106	Cost estimator
Electrical upgrades	$0	Wiring for warehouse HVAC and SHW	$6,231	$6,231	Design engineer, RSMeans
Total	$63,797		$78,800	$15,003	

Quick-Service and Full-Service Restaurants

TRC analyzed two prototypes, QSR and FSR, to discern the variance in analysis results depending on the type of restaurant. TRC developed a basis-of-design (BOD) for kitchen cooking equipment, HVAC, and service water heating (SWH) for mixed-fuel kitchens and all-electric kitchens. The BOD served as the foundation for modeling inputs and cost assumptions for the cost effectiveness analysis. None of the cooking appliances examined in this study are subject to federal energy efficiency requirements.

TRC determined cost estimates for kitchen appliances from online retailers. Whenever possible, TRC gathered costs from three different appliance retailers and used the average for the analysis. TRC adjusted material and labor costs for each climate zone based on weighting factors from RS Means.

The Reach Codes Team compared the incremental differences in equipment selection and associated costs from a mixed-fuel baseline to all-electric restaurants for HVAC, SWH, kitchen process equipment, and gas/electrical infrastructure.

For replacement and maintenance costs, TRC assumed all cooking appliance replacement at year 10. Based on interviews of subject matter experts, kitchens with all-electric cooking appliances would call for maintenance five times a year, while a typical mixed-fuel kitchen would need regular maintenance 10 times a year, with each visit costing $150.

Figure 6 and Figure 7 show the costs for QSR and FSR, respectively, averaged across all climate zones for the 1980's vintage.

Figure 6. QSR All-Electric Construction Costs

Mixed-fuel measure	Mixed-fuel cost	All-electric measure	All-electric cost	All-electric incremental cost
Mechanical Equipment				
HVAC: Packaged furnace, DX A/C	$120,811	HVAC: Packaged heat pump	$128,154	$7,343
SWH: Gas storage water heater - One 150 kBtu/hr heater - One 100-gallon tank	$21,860	SWH: Heat pump water heaters with storage tank - A.O. Smith CHP-120 - One 120-gallon tank	$27,963	$6,103
Kitchen Appliances				
Gas appliances: - French Fryer (4) - Griddle, single sided (2) Electric appliances: - Half-size electric convection oven (1)	$21,291	French Fryer (4) Griddle, single sided (2) Half-size electric convection oven (1)	$42,815	$21,524
Infrastructure Upgrades				
n/a	$0	Electrical	$25,832	$25,832
Total	**$163,962**		**$224,763**	**$60,801**

Figure 7. FSR All-Electric Construction Costs

Mixed-Fuel Measure	Mixed-Fuel Cost	All-Electric Measure	All-Electric Cost	All-Electric Incremental Cost
Mechanical Equipment				
HVAC: Packaged furnace, DX A/C	$160,889	HVAC: Packaged heat pump	$161,013	$123
SWH: Gas storage water heater - One 150 kBtu/hr heater - One 100-gallon tank	$61,194	SWH: Heat pump water heaters with storage tank - Four Colmac CxV-5 - Total 750-gallons of primary storage - One 5 kW electric resistance loop heater - One 120-gallon loop tank	$161,943	$100,749
Kitchen Appliances				
Gas appliances: - Underfired Broiler (1) - French Fryer (2) - Griddle, single sided (1) - Broiler, Salamander (1) - Oven, convection double deck (1) - Oven, Range (2) - Range, Six open Burners (2) - Range, Stock pot (2)	$52,383	Electric appliances: - Chain Broiler (1) - French Fryer (1) - Griddle, single sided (1) - Broiler, Salamander (1) - Oven, convection double - deck (1) - Oven, induction range (2) - Range, Six burner induction cooktop (2) - Range, Induction Stock pot (2)	$99,959	$47,576
Maintenance costs: - $750/yr - Assuming 15 years lifetime	$11,250	Maintenance costs: - $1,500/yr - Assuming 15 years lifetime	$22,500	$11,250
Infrastructure Upgrades				
n/a	$0	Electrical	$37,213	$37,213
Total	**$285,716**		**$482,628**	**$196,911**

High-Rise Multifamily

The existing HRMF HVAC system varies by vintage, and the electrofit system varies depending upon the existing HVAC system. A description of the mixed fuel retrofit system and the all-electric retrofit systems for each vintage are shown in Figure 8 through Figure 10.

The existing DHW design for all vintages is a gas storage water heater. For the all-electric design, TRC selected heat pump water heaters with storage to replace the gas water heaters.

In the 1980s vintage, the existing HVAC system consists of hydronic baseboard heaters in each dwelling unit, which are served by a gas boiler. The dwelling units each have packaged terminal air conditioners (PTACs) for cooling. For the all-electric HVAC design, TRC selected packaged terminal heat pumps (PTHPs) to provide both heating and cooling to the dwelling units. The PTHP fits directly into the PTAC housing. TRC assumed a weighted labor retrofit multiplier of 28% in the all-electric design and a 25% for the mixed fuel design.

For cooking, TRC assumed existing gas cooking in scenarios where there is no existing cooling and existing electric cooking in scenarios where there is existing cooling. These assumptions intend to represent the wide range of potential electrical infrastructure upgrades required (high to low, respectively). For clothes drying, TRC selected a 120-volt combination washer and dryer that replaces the existing washer and dryer without any electrical upgrade.[8]

Figure 8 shows the cost data for the 1980s vintage averaged across all Climate Zones.

Figure 8. HRMF Electrofit Costs, 1980s Vintage

	Mixed-Fuel Measure	Mixed-Fuel Cost	Electrofit Measure	All-Electric Cost	All-Electric Incremental Cost	Source
HVAC	Replace PTACs and boilers. Baseboards remain in place.	$616,741	Replace PTACs with PTHPs. Decommission boilers and baseboards.	$610,651	-$6,090	Cost estimator
DHW	Gas water heater with storage	$55,037	Heat pump water heater with storage	$275,352	$220,315	Cost estimator
Appliances	Electric stove, gas dryer	$1,151,791	Electric stove, electric dryer	$526,500	$46,800	Online retailers, E3 2019 report
Infrastructure	Wiring and distribution replacements, like for like replacement	$312	Wiring and distribution for central DHW heat pump water heater.	$8,552	$8,240	Design engineer, RSMeans
Total		**$1,151,791**		**$1,421,056**	**$269,265**	

In the 1990s vintage, the existing HVAC system consists of heating-only fan coils in each dwelling unit, which are served by a gas boiler. The dwelling units each have PTACs for cooling. TRC assumed the same all-electric HVAC design as the 1980s vintage.

Figure 9 shows the cost data for the 1990s vintage averaged across all Climate Zones.

[8] Examples available in: https://www.redwoodenergy.tech/wp-content/uploads/2019/11/Multifamily-ZNC-Guide-7-10-19-sa-clean.pdf

Figure 9. HRMF Electrofit Costs, 1990s Vintage

	Mixed-Fuel Measure	Mixed-Fuel Cost	Electrofit Measure	All-Electric Cost	All-Electric Incremental Cost	Source
HVAC	Replace PTACs, fan coils, and boilers	$1,075,630	Replace PTACs with PTHPs. Decommission boilers and fan coils.	$605,149	-$470,481	Cost estimator
DHW	Gas water heater with storage	$55,037	Heat pump water heater with storage	$275,352	$220,315	Cost estimator
Appliances	Electric stove, gas dryer	$479,700	Electric stove, electric dryer	$526,500	$46,800	
Infrastructure	Wiring and distribution replacements, like for like replacement	$312	Wiring and distribution for central DHW heat pump water heater	$8,552	$8,240	Design engineer, RSMeans
Total		**$1,610,679**		**$1,415,554**	**-$195,126**	

In the 2000s vintage, the existing HVAC system consists of central furnaces and split air conditioners. For the all-electric HVAC design, TRC selected split heat pumps to provide both heating and cooling to the dwelling units. TRC assumed a weighted labor retrofit multiplier of 25% in the all-electric and mixed fuel designs

Figure 10 shows the cost data for the 2000s vintage averaged across all Climate Zones.

Figure 10. HRMF Electrofit Costs, 2000s Vintage

	Mixed-Fuel Measure	Mixed-Fuel Cost	Electrofit Measure	All-Electric Cost	All-Electric Incremental Cost	Source
HVAC	Central furnace + Split AC	$1,183,585	Split heat pump	$1,023,382	-$160,203	Cost estimator
DHW	Gas water heater with storage	$55,037	Heat pump water heater with storage	$275,352	$220,315	Cost estimator
Appliances	Electric stove, gas dryer	$479,700	Electric stove, electric dryer	$526,500	$46,800	
Infrastructure	None	$0	Wiring and distribution for central DHW heat pump water heater	$8,552	$8,552	Design Engineer, RSMeans
Total		**$1,718,322**		**$1,833,786**	**$115,464**	

Small Hotel

The existing HVAC system varies by vintage, and the electrofit system varies depending upon the existing HVAC systems. A description of the existing system, the mixed fuel retrofit system, and the all-electric retrofit systems for each vintage are shown in Figure 11 through Figure 12.

The existing DHW design for all vintages is a gas storage water heater. For the all-electric design, TRC selected heat pump water heaters with storage to replace the gas water heaters.

In the 1980s and 1990s vintage, the existing HVAC system in the guest rooms is gas wall furnace for space heating and PTACs for cooling. For the all-electric HVAC design, TRC selected PTHPs to provide both heating and cooling to the dwelling units. The PTHP fits directly into the PTAC housing. TRC assumed a weighted labor retrofit multiplier of 25% in both all-electric and the mixed fuel design.

Figure 11 shows the cost data for the 1980s and 1990s vintage averaged across all Climate Zones.

Figure 11. Small Hotel Electrofit Costs, 1980s and 1990s Vintage

	Mixed-Fuel Measure	Mixed-Fuel Cost	Electrofit Measure	All-Electric Cost	All-Electric Incremental Cost	Source
HVAC	Replace PTACs and wall furnaces	$408,151	Replace PTACs with PTHPs. Decommission wall furnaces.	$227,317	-$180,834	Cost estimator, Online retailers
DHW	Gas water heater with storage	$36,303	Heat pump water heater with storage	$101,446	$64,842	Cost estimator, HRMF New Construction Reach Codes Cost Effectiveness Study
Infrastructure	None	$0	Wiring and distribution for central DHW heat pump water heater.	$8,240	$8,240	RSMeans
Total		**$444,754**		**$337,003**	**-$107,751**	

In the 2000s vintage, the existing HVAC system in guest rooms consists of central furnaces and split air conditioners. For the all-electric HVAC design, TRC selected split heat pumps to provide both heating and cooling to the guest rooms. TRC assumed a weighted labor retrofit multiplier of 25% in the all-electric and mixed fuel designs.

Figure 12 shows the cost data for the 2000s vintage averaged across all Climate Zones.

Figure 12. Small Hotel Electrofit Costs, 2000s Vintage

	Mixed-Fuel Measure	Mixed-Fuel Cost	Electrofit Measure	All-Electric Cost	All-Electric Incremental Cost	Source
HVAC	Central furnace + Split AC	$699,398	Split heat pump	$611,888	-$87,510	Cost estimator
DHW	Gas water heater with storage	$36,603	Heat pump water heater with storage	$101,446	$64,842	Cost estimator, HRMF New Construction Reach Codes Cost Effectiveness Study
Infrastructure	None	$0	Wiring and distribution for central DHW heat pump water heater	$8,240	$8,240	RSMeans
Total		**$736,002**		**$721,573**	**-$14,428**	

Solar PV

TRC estimated 50 percent of the roof area is available to install PV and has solar access, with a capacity of 15 W/ft^2. This approach assumes that the other 50 percent of the roof is for skylights, mechanical equipment, and walking paths. PV energy output is built into CBECC-Com and is based on the National Renewable Energy Lab's PVWatts calculator, which includes long-term performance degradation estimates.[9]

The costs for PV include first cost to purchase and install the system, inverter replacement costs, and annual maintenance costs, summarized in Figure 13. Upfront solar PV system costs are reduced by the federal income tax credit (ITC), approximately 26 percent due to a phased reduction in the credit through the year 2022.[10]

[9] More information available at: https://pvwatts.nrel.gov/downloads/pvwattsv5.pdf

[10] The federal credit drops to 26% in 2020, and 26% in 2021 before dropping permanently to 10% for commercial projects. More information on federal Investment Tax Credits available at: https://www.seia.org/initiatives/solar-investment-tax-credit-itc; https://www.seia.org/sites/default/files/2021-01/SEIA-ITC-Factsheet-2021-Jan.pdf

Figure 13. PV Construction Costs

		Unit Cost	Useful Life (yrs.)	Source
Solar PV System	Small NR <100kW (QSR, FSR, Warehouse)	$3.20 / Wdc	30	LBNL – Tracking the Sun
	Large NR >100kW (Medium Office, Retail)	$2.50 / Wdc		
Inverter Replacement (at year 11)		$0.15 / Wdc	10	E3 Rooftop Solar PV System Report
Annual Maintenance Costs		$0.02 / Wdc	1	

Battery

This measure includes installation of batteries to allow energy generated through PV to be stored and used later, providing utility cost benefits. TRC applied battery measures to only the QSR and FSR prototypes because these prototypes have significant electrical loads during peak periods (i.e., 4p-9p).

TRC ran test simulations to assess the impact of battery sizes and control algorithms on TDV savings. The battery size is optimized for each prototype to offset the majority of the peak period load. TRC used the 'Ranked Day Demand Response' control method, which assumes batteries are charged anytime PV generation is greater than the building load but discharges to the electric grid beginning on the highest priced hour of the day. This control algorithm uses the relative ranking of the highest TDV for a day to determine its rank instead of a specific TDV value as threshold. This control option is not reflective of the current products on the market and represents an ideally controlled condition where there is real-time pricing of electricity. While this control strategy is being used in the analysis, there would be no mandate on the control strategy used in practice. The current simulation software has approximations of performance characteristics changes due to environmental conditions, charge/discharge rates, and degradation with age and use.

TRC used costs of $1,000 kWh based on preliminary findings from concurrent research by the IOU Codes and Standards Program, using data from the Self Generation Incentive Program (Itron, 2019). Batteries are also eligible for the ITC if they are installed at the same time as the renewable generation source and at least 75 percent of the energy used to charge the battery comes from a renewable source. Thus, TRC applied a 26 percent cost reduction to battery costs.

Efficiency Measures

For each prototype, the Reach Code Team assessed the viability of achieving a cost effective outcome when combining efficiency measures with all-electric packages based on the NPVs achieved from each individually. The Team determined that testing All-Electric + Efficiency may be most successful for the Standalone Retail, QSR, and FSR prototypes. The efficiency measures and their applications are listed in the Figure 14.

Figure 14. Efficiency Measures Analyzed

Efficiency Measure Description	Retail	Full Service Restaurant	Quick Service Restaurant
Window film: This measure reduces window SHGC of existing windows to 0.39 by adding window film.	•	•	•
Lighting retrofit: This measure replaces the existing light fixtures to reduce the existing LPD in select areas to the following, representing 2019 code-minimum upgrades: • Standalone Retail: Reduces LPD to 0.95 W/ft^2 • Restaurants: Reduces LPD for dining spaces to 0.45 W/ ft^2; Reduces LPD for kitchen space to 0.95 W/ ft^2	•	•	•
Transfer air for commercial kitchens: This measure expands the Title 24 Part 6 Section 140.9 (b)2 requirements kitchen ventilation per the following: • Reduces the transfer air requirement for kitchens with exhaust hoods to air flows greater than 2,000 ft^3/min from 5,000 ft^3/min. For exhaust hood with air flow rate greater than 2000 ft^3/min but lower than 5000 ft^3/min, this measure would require at least 15 percent of all replacement air come from transfer air in the dining space, which would otherwise be exhausted. This measure only applies to the Quick Service Restaurant. • For exhaust hoods with an air flow rate greater than 5,000 ft3/min for Full Service Restaurant: 1. Use transfer air for at least 25 percent of all replacement air that would otherwise be exhausted; and 2. Install demand ventilation systems meeting Title 24 Section 140.9 (b)2.B.ii.		•	•

Measure Packaging

TRC examined the following packages for each prototype

- Mixed Fuel Code Minimum package: Appliance upgrades on the existing building using code-minimum fossil gas equipment.
- All-electric Code Min: Replace any gas equipment with electric, code-minimum equipment, including HVAC, SHW, and appliances. Upgrade electrical infrastructure as-required. The Baseline for this package is a gas code-minimum equipment replacement, including HVAC, SHW, and appliances.

- All-electric Code Min (2022 TDV): All-electric Code Min, with cost-effectiveness calculations done using 2022 TDV multipliers. The Baseline for this package is the same as the all-electric Code Min Baseline, except with 2022 TDV multipliers.
- Electric HVAC and SHW: This package is specifically for the restaurant prototypes, and replaces gas space and water heating equipment with electric code-minimum equipment.
- All-Electric + Efficiency: Adds efficiency measures to the All-Electric Code Min package, except in restaurants where it adds efficiency measures to the Electric HVAC and SHW package.
- All-electric + PV: All-electric Code Min, including a solar PV array, plus battery storage for FSR and QSR only. The Baseline for this package is the same as the All-electric Code Min Baseline.
- All-electric + PV (2022 TDV): All-electric + PV, with cost-effectiveness calculations done using 2022 TDV multipliers. The Baseline for this package is the same as the All-electric Code Min Baseline, except with 2022 TDV multipliers.

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COST EFFECTIVENESS RESULTS

Figure 15 through Figure 21 present the preliminary cost effectiveness results for Climate Zone 3 using PG&E electric and gas rates. TRC did not compare a variety of tariffs to determine their impact on cost effectiveness, and utility rate updates can affect cost effectiveness results.

For the Mixed Fuel Code Minimum package, the baseline is the existing building. For all other packages, the baseline is the Mixed Fuel Code Minimum package.

Figure 15. FSR Cost Effectiveness Results

Full Service Restaurant (FSR)	Vintage	Annual Elec Savings (kWh)	Annual Gas Savings (therms)	Annual GHG savings (tons)	Upfront Incremental Package Cost	15-year Lifecycle Energy Cost Savings	15-year $TDV Savings	15-year B/C Ratio (On-bill)	15-year B/C Ratio (TDV)	15-year NPV (On-bill)	15-year NPV (TDV)
Mixed Fuel Code Minimum	80's	100,806	(2,809)	2	$352,211	$276,888	$209,903	0.8	0.6	($75,323)	($142,308)
	90's	79,955	(2,380)	1	$352,211	$216,787	$161,006	0.6	0.5	($135,424)	($191,205)
	00's	60,077	(1,963)	0	$352,211	$160,076	$113,857	0.5	0.3	($192,136)	($238,354)
All-electric code minimum	80's	(311,520)	24,813	78	$233,981	($453,326)	($505,496)	-1.9	-2.2	($687,307)	($739,477)
	90's	(310,227)	24,636	77	$233,981	($453,243)	($505,670)	-1.9	-2.2	($687,225)	($739,651)
	00's	(312,028)	24,885	78	$233,981	($454,924)	($506,162)	-1.9	-2.2	($688,905)	($740,143)
All-electric code minimum + PV + Battery	80's	(248,537)	24,813	85	$544,423	($317,088)	($197,436)	-0.6	-0.4	($861,511)	($741,859)
	90's	(247,243)	24,636	84	$544,423	($317,004)	($197,608)	-0.6	-0.4	($861,427)	($742,031)
	00's	(249,052)	24,885	85	$544,423	($318,395)	($198,118)	-0.6	-0.4	($862,818)	($742,541)
Electric HVAC and SHW + Efficiency	80's	(55,145)	10,886	48	$143,990	$26,760	$62,953	0.2	0.4	($117,229)	($81,037)
	90's	(53,658)	10,709	47	$143,021	$28,306	$62,698	0.2	0.4	($114,715)	($80,323)
	00's	(58,995)	10,958	48	$142,097	$15,808	$52,444	0.1	0.4	($126,289)	($89,653)
All-electric code minimum (2022 TDV)	80's	(301,073)	23,131	70	$233,981	($448,342)	($98,842)	-1.9	-0.4	($682,323)	($332,823)
	90's	(299,969)	22,972	70	$233,981	($447,884)	($99,966)	-1.9	-0.4	($681,865)	($333,947)
	00's	(301,427)	23,184	71	$233,981	($450,175)	($98,422)	-1.9	-0.4	($684,157)	($332,403)
All-electric code minimum + PV + Battery (2022TDV)	80's	(241,504)	23,131	87	$544,423	($331,602)	($2,266)	-0.6	0.0	($876,025)	($546,689)
	90's	(240,399)	22,972	87	$544,423	($331,181)	($3,389)	-0.6	0.0	($875,604)	($547,812)
	00's	(241,858)	23,184	88	$544,423	($333,420)	($1,845)	-0.6	0.0	($877,843)	($546,268)

Figure 16. QSR Cost Effectiveness Results

Quick Service Restaurant (QSR)	Vintage	Annual Elec Savings (kWh)	Annual Gas Savings (therms)	Annual GHG savings (tons)	Upfront Incremental Package Cost	15-year Lifecycle Energy Cost Savings	15-year $TDV Savings	15-year B/C Ratio (On-bill)	15-year B/C Ratio (TDV)	15-year NPV (On-bill)	15-year NPV (TDV)
Mixed Fuel Code Minimum	80's	42,633	(306)	5	$215,324	$135,341	$106,511	0.6	0.5	($79,982)	($108,813)
	90's	32,497	(560)	3	$215,324	$96,299	$74,531	0.4	0.3	($119,025)	($140,793)
	00's	27,574	(284)	3	$215,324	$85,761	$65,358	0.4	0.3	($129,563)	($149,966)
All-electric code minimum	80's	(142,624)	12,065	39	$70,184	($242,256)	($211,832)	-3.5	-3.0	($312,440)	($282,016)
	90's	(141,190)	11,921	38	$70,184	($240,375)	($210,671)	-3.4	-3.0	($310,559)	($280,854)
	00's	(142,618)	12,011	38	$70,184	($243,185)	($212,228)	-3.5	-3.0	($313,369)	($282,411)
All-electric code minimum + PV + Battery	80's	(113,575)	12,065	41	$234,260	($150,327)	($84,836)	-0.6	-0.4	($384,587)	($319,097)
	90's	(112,141)	11,921	41	$234,260	($148,445)	($83,675)	-0.6	-0.4	($382,706)	($317,935)
	00's	(113,571)	12,011	41	$234,260	($151,265)	($85,236)	-0.6	-0.4	($385,526)	($319,496)
Electric HVAC and SHW	80's	(41,151)	4,610	17	$26,282	($39,280)	($19,603)	-1.5	-0.7	($65,562)	($45,885)
	90's	(39,679)	4,466	16	$26,282	($37,119)	($18,388)	-1.4	-0.7	($63,401)	($44,671)
	00's	(40,768)	4,556	17	$26,282	($39,483)	($19,416)	-1.5	-0.7	($65,765)	($45,698)
Electric HVAC and SHW + Efficiency	80's	(24,501)	4,610	20	$32,917	$14,086	$24,478	0.4	0.7	($18,831)	($8,439)
	90's	(22,913)	4,466	19	$31,948	$16,614	$25,819	0.5	0.8	($15,335)	($6,129)
	00's	(26,071)	4,556	19	$31,439	$7,776	$18,494	0.2	0.6	($23,663)	($12,944)
All-electric code minimum (2022 TDV)	80's	(138,948)	12,051	39	$70,184	($227,566)	($116,366)	-3.2	-1.7	($297,750)	($186,549)
	90's	(137,848)	11,870	38	$70,184	($227,750)	($118,794)	-3.2	-1.7	($297,934)	($188,978)
	00's	(138,946)	12,006	39	$70,184	($228,745)	($116,892)	-3.3	-1.7	($298,929)	($187,076)
All-electric code minimum + PV +Battery (2022TDV)	80's	(109,879)	12,051	43	$234,260	($158,529)	($7,988)	-0.7	0.0	($392,789)	($242,249)
	90's	(108,780)	11,870	42	$234,260	($158,950)	($10,418)	-0.7	0.0	($393,211)	($244,678)
	00's	(109,880)	12,006	42	$234,260	($159,935)	($8,522)	-0.7	0.0	($394,196)	($242,783)

Figure 17. Medium Office Cost Effectiveness Results

Medium Office (MO)	Vintage	Annual Elec Savings (kWh)	Annual Gas Savings (therms)	Annual GHG savings (tons)	Upfront Incremental Package Cost	15-year Lifecycle Energy Cost Savings	15-year $TDV Savings	15-year B/C Ratio (On-bill)	15-year B/C Ratio (TDV)	15-year NPV (On-bill)	15-year NPV (TDV)
Mixed Fuel Code Minimum	80's	0	3,092	17	$147,638	$62,267	$50,700	0.4	0.3	($85,371)	($96,938)
	90's	0	162	1	$147,638	$3,033	$2,677	0.0	0.0	($144,605)	($144,961)
	00's	0	100	1	$147,638	$1,894	$1,686	0.0	0.0	($145,744)	($145,953)
All-electric code minimum	80's	(87,716)	14,697	3	$184,316	$71,483	$29,069	0.4	0.2	($112,833)	($155,247)
	90's	(57,558)	9,573	1	$184,316	$44,609	$18,378	0.2	0.1	($139,707)	($165,937)
	00's	(63,627)	6,120	2	$184,316	($40,081)	($50,394)	-0.2	-0.3	($224,396)	($234,710)
All-electric code minimum + PV	80's	122,607	14,697	13	$561,038	$574,511	$479,348	1.0	0.9	$13,473	($81,690)
	90's	152,765	9,573	11	$561,038	$551,596	$468,658	1.0	0.8	($9,442)	($92,380)
	00's	146,697	6,120	11	$561,038	$462,222	$399,885	0.8	0.7	($98,815)	($161,153)
All-electric code minimum (2022 TDV)	80's	(89,850)	15,572	3	$184,316	$11,634	$107,868	0.1	0.6	($172,682)	($76,448)
	90's	(58,665)	9,480	1	$184,316	($24,155)	$56,742	-0.1	0.3	($208,471)	($127,573)
	00's	(64,256)	6,195	2	$184,316	($118,057)	($28,522)	-0.6	-0.2	($302,373)	($212,838)
All-electric code minimum + PV (2022TDV)	80's	124,181	15,572	13	$561,038	$581,508	$593,215	1.0	1.1	$20,470	$32,177
	90's	155,366	9,480	10	$561,038	$556,157	$542,089	1.0	1.0	($4,881)	($18,948)
	00's	149,775	6,195	11	$561,038	$457,031	$456,825	0.8	0.8	($104,007)	($104,213)

Figure 18. Warehouse Cost Effectiveness Results

Warehouse	Vintage	Annual Elec Savings (kWh)	Annual Gas Savings (therms)	Annual GHG savings (tons)	Upfront Incremental Package Cost	15-year Lifecycle Energy Cost Savings	15-year $TDV Savings	15-year B/C Ratio (On-bill)	15-year B/C Ratio (TDV)	15-year NPV (On-bill)	15-year NPV (TDV)
Mixed fuel code minimum	80's	3,638	120	1	$67,787	$13,879	$10,054	0.2	0.1	($53,908)	($57,733)
	90's	1,127	54	0	$67,787	$4,618	$3,402	0.1	0.1	($63,169)	($64,385)
	00's	1,085	33	0	$67,787	$4,145	$2,919	0.1	0.0	($63,642)	($64,868)
All-electric code minimum	80's	(24,313)	1,283	2	$83,396	($48,273)	($32,214)	-0.6	-0.4	($131,669)	($115,610)
	90's	(15,201)	832	2	$83,396	($28,957)	($18,925)	-0.3	-0.2	($112,353)	($102,321)
	00's	(19,212)	1,042	2	$83,396	($37,236)	($24,153)	-0.4	-0.3	($120,632)	($107,549)
All-electric code minimum + PV	80's	85,475	1,283	7	$294,192	$276,259	$202,831	0.9	0.7	($17,933)	($91,361)
	90's	94,587	832	7	$257,532	$273,461	$216,120	1.1	0.8	$15,929	($41,412)
	00's	90,576	1,042	7	$259,823	$263,805	$210,892	1.0	0.8	$3,981	($48,931)
All-electric code minimum (2022 TDV)	80's	(21,432)	1,283	3	$83,396	($39,409)	($4,999)	-0.5	-0.1	($122,805)	($88,395)
	90's	(13,605)	832	2	$83,396	($23,999)	$3,448	-0.3	0.0	($107,395)	($79,948)
	00's	(16,977)	1,042	2	$83,396	($30,331)	($848)	-0.4	0.0	($113,727)	($84,244)
All-electric code minimum + PV (2022TDV)	80's	90,263	1,283	7	$294,192	$293,568	$182,015	1.0	0.6	($624)	($112,177)
	90's	98,091	832	7	$257,532	$287,485	$190,462	1.1	0.7	$29,953	($67,070)
	00's	94,719	1,042	7	$259,823	$279,361	$186,167	1.1	0.7	$19,538	($73,657)

Figure 19. Retail Cost Effectiveness Results

Retail (RE)	Vintage	Annual Elec Savings (kWh)	Annual Gas Savings (therms)	Annual GHG savings (tons)	Upfront Incremental Package Cost	15-year Lifecycle Energy Cost Savings	15-year $TDV Savings	15-year B/C Ratio (On-bill)	15-year B/C Ratio (TDV)	15-year NPV (On-bill)	15-year NPV (TDV)
Mixed Fuel Code Minimum	80's	157,836	(1,497)	13	$178,825	$374,441	$400,298	2.1	2.2	$195,616	$221,473
	90's	128,627	(1,132)	12	$178,825	$306,529	$330,867	1.7	1.9	$127,704	$152,043
	00's	111,283	(1,345)	8	$178,825	$252,433	$275,690	1.4	1.5	$73,609	$96,865
All-electric code minimum	80's	(39,706)	3,832	14	$3,471	($45,056)	($30,431)	-13.0	-8.8	($48,527)	($33,902)
	90's	(31,545)	2,809	10	$3,471	($31,568)	($29,294)	-9.1	-8.4	($35,040)	($32,765)
	00's	(35,483)	3,339	12	$3,471	($40,089)	($29,469)	-11.5	-8.5	($43,560)	($32,940)
All-electric code minimum + PV	80's	249,195	3,832	27	$520,937	$503,018	$588,085	1.0	1.1	($17,919)	$67,148
	90's	257,355	2,809	23	$520,938	$518,580	$589,221	1.0	1.1	($2,358)	$68,284
	00's	253,417	3,339	25	$520,938	$599,511	$589,025	1.2	1.1	$78,573	$68,087
All-electric + Efficiency Measures	80's	54,910	3,832	25	$93,821	$235,177	$220,386	2.5	2.3	$141,356	$126,565
	90's	44,824	2,809	19	$80,533	$189,969	$172,392	2.4	2.1	$109,436	$91,858
	00's	17,844	3,339	18	$79,043	$127,773	$111,385	1.6	1.4	$48,730	$32,342
All-electric code minimum (2022 TDV)	80's	(35,499)	3,348	12	$3,471	($39,061)	($11,127)	-11.3	-3.2	($42,533)	($14,599)
	90's	(28,570)	2,452	8	$3,471	($26,865)	($14,997)	-7.7	-4.3	($30,336)	($18,468)
	00's	(31,865)	2,910	10	$3,471	($34,159)	($11,871)	-9.8	-3.4	($37,630)	($15,342)
All-electric code minimum + PV (2022 TDV)	80's	258,421	3,348	24	$520,938	$503,899	$481,009	1.0	0.9	($17,039)	($39,928)
	90's	265,350	2,452	21	$520,938	$519,248	$477,118	1.0	0.9	($1,689)	($43,820)
	00's	262,055	2,910	23	$520,938	$517,196	$480,244	1.0	0.9	($3,741)	($40,694)

Figure 20. HRMF Cost Effectiveness Results

Highrise Multifamily (HRMF)	Vintage	Annual Elec Savings (kWh)	Annual Gas Savings (therms)	Annual GHG savings (tons)	Upfront Incremental Package Cost	30-year Lifecycle Energy Cost Savings	30-year $TDV Savings	30-year B/C Ratio (On-bill)	30-year B/C Ratio (TDV)	30-year NPV (On-bill)	30-year NPV (TDV)
Mixed Fuel Code Minimum	80's	81,743	279	10	$3,063,764	$631,499	$394,769	0.2	0.1	($2,432,266)	($2,668,996)
	90's	73,187	139	7	$4,352,364	$562,138	$350,597	0.1	0.1	($3,790,226)	($4,001,767)
	00's	40,614	(18)	4	$5,168,400	$307,860	$193,674	0.1	0.0	($4,860,540)	($4,974,726)
All-electric code minimum	80's	(166,209)	16,337	71	$660,313	($758,233)	($345,680)	-1.1	-0.5	($1,418,546)	($1,005,993)
	90's	(181,938)	16,342	68	($520,022)	($863,596)	($407,041)	0.6	1.3	($343,574)	$112,980
	00's	(186,902)	19,434	85	$175,631	($761,891)	($332,774)	-4.3	-1.9	($937,522)	($508,404)
All-electric code minimum + PV	80's	(24,985)	17,159	80	$914,485	$278,275	$201,298	0.3	0.2	($636,210)	($713,187)
	90's	(38,332)	16,342	81	($265,849)	$211,107	$872,714	>1	>1	$476,956	$1,138,563
	00's	(43,296)	19,434	98	$429,803	$312,415	$946,982	0.7	2.2	($117,389)	$517,179
All-electric code minimum (2022 TDV)	80's	(273,990)	17,772	72	$660,313	($1,564,454)	($515,714)	-2.4	-0.8	($2,224,766)	($1,176,027)
	90's	(309,011)	17,874	64	($520,022)	($1,784,472)	($659,757)	0.3	0.8	($1,264,450)	($139,735)
	00's	(288,709)	25,834	109	$175,631	($1,255,033)	($283,410)	-7.1	-1.6	($1,430,664)	($459,041)
All-electric code minimum + PV (2022TDV)	80's	(138,491)	17,772	103	$914,485	($498,087)	$590,638	-0.5	0.6	($1,412,572)	($323,847)
	90's	(173,512)	17,874	95	($265,849)	($718,586)	$446,596	0.4	>1	($452,737)	$712,445
	00's	(143,342)	25,834	124	$429,803	($179,383)	$764,356	-0.4	1.8	($609,187)	$334,552

Figure 21. Small Hotel Cost Effectiveness Results

Retail (RE)	Vintage	Annual Elec Savings (kWh)	Annual Gas Savings (therms)	Annual GHG savings (tons)	Upfront Incremental Package Cost	15-year Lifecycle Energy Cost Savings	15-year $TDV Savings	15-year B/C Ratio (On-bill)	15-year B/C Ratio (TDV)	15-year NPV (On-bill)	15-year NPV (TDV)
Mixed Fuel Code Minimum	80's	917	307	2	$634,374	$8,878	$9,265	0.0	0.0	($625,496)	($625,109)
	90's	755	126	1	$634,374	$4,837	$5,562	0.0	0.0	($629,537)	($628,813)
	00's	408	213	1	$1,045,348	$5,285	$4,684	0.0	0.0	($1,040,062)	($1,040,664)
All-electric code minimum	80's	(70,984)	9,462	42	($119,961)	($64,992)	($11,075)	1.8	10.8	$54,969	$108,886
	90's	(71,350)	9,512	42	($119,961)	($67,100)	($11,048)	1.8	10.9	$52,861	$108,913
	00's	(73,402)	9,780	43	($30,564)	($72,689)	($10,877)	0.4	2.8	($42,124)	$19,688
All-electric code minimum + PV	80's	54,175	9,462	48	$104,218	$255,503	$256,877	2.5	2.5	$151,285	$152,659
	90's	53,809	9,512	48	$104,218	$253,472	$256,903	2.4	2.5	$149,254	$152,685
	00's	51,757	9,780	49	$193,615	$245,221	$257,075	1.3	1.3	$51,606	$63,460

June 2021

EXISTING BUILDING ELECTRIFICATION AND MULTIFAMILY ELECTRIC VEHICLE CHARGING

POLICY AND FINANCING LITERATURE REVIEW AND ANALYSIS

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1 Executive Summary

This study is intended to aid Menlo Park, Peninsula Clean Energy, and other agencies to understand the policy and financing landscape for existing building electrification and multifamily EV charging infrastructure retrofits. TRC has compiled research on relevant state and local building codes and financing approaches that could support achieving carbon neutrality goals. TRC has preliminarily identified gaps and developed recommendations for future programs.

TRC recommends that municipalities address all areas of the market by invoking as many effective policy and financing options as resources allow. The highest ranking in this study include:

- Policy: The jurisdiction has the ability to serve as the lead agency in all of these policy options, which is beneficial to enforce customized policies but may also lead to higher administrative investment.
  - Triggered Appliance Conversion (e.g., time of transfer, burnout permit, major alteration) – Highly scalable and readily enforceable if permits are pulled regularly. An example of successful policy implementation includes City of Davis's Resale Program (triggered at point of transfer). A notable gap is the limited implementation period of local policies requiring significant energy upgrades at the time of major alterations.
  - Building Performance Standards (e.g., emissions criteria achieved by a deadline) – Highly scalable and readily enforceable. The City of Boulder's SmartRegs Program is an example that has achieved high compliance in existing building energy efficiency compliance.
  - Municipal Buildings Lead with Electrification – An important policy to raise the profile of community goals, increase government familiarity with the challenges and opportunities of electrification, and establish notable precedents. Jurisdictions should also explore electrification policies as part of Capital Improvement Projects.
  - Achieving Equitable Outcomes – Early and regular communications with marginalized community members can avoid inadvertently harmful policies, and ensure electrification works to reverse compounding historical injustices. A key policy approach includes rental property energy performance standards.
- Financing: Local jurisdictions can serve in the lead role in providing the following financing pathways:
  - Municipal Financing (e.g., Green Bonds and Local Taxes and Fees) – Voter-approved fund generation mechanisms can affirm a community's willingness to invest in decarbonization measures. Bonds can be used for public infrastructure projects, and increased revenues from utility taxes can serve potentially provide consumer financing.
  - Incentive Programs – A jurisdiction may lead the development of incentive programs, likely with funding from a partner organization, such as San Jose and Marin County partnering with BAAQMD.

    Local jurisdictions may also serve educational and advocacy roles for the following mechanisms:
  - Electrification as a Service – A local jurisdiction can play a key role in reducing market entry barriers for providers such as BlocPower, or advocate for establishing local programs like

NYSERDA's that creates a market for contractors and installers by paying them for projects that deliver metered bill savings.

- Tax Credits, Deductions, and Rebates – Federal tax incentives can be attained for eligible electrofits and stacked with incentive programs, though they are fairly low amounts.
- Ratepayer-Funded Tariffed On-Bill Investment – Tariffed on-bill programs serve a wide market, including the harder to reach markets such as renters with modest credit history.
- Loan Programs – A suite of loans are available for credit-worthy residential and nonresidential building owners through the state financing authority. These programs may fill in gaps where building owners may have insufficient access to incentive programs or tax deductions. Loans are expected to be one of the last options to financing a project, as they carry more risk for the applicant than many of the preceding options listed.

TRC noted the following financing mechanism gaps

- High investment costs and limited incentives for heat pump space heating as a replacement for a methane gas furnace in a building that doesn't already have air-conditioning.
- Limited precedence for existing building EV financing. A jurisdiction may supplement PCE's EV incentive program with additional incentives, or additional loan programs targeted toward EV investment in a similar manner that Boulder partnered with a local credit union.
- Nonresidential buildings are eligible for fewer incentive programs than residential. This may be due to the higher financing needs and access of the nonresidential market.

Alongside exploring these policy and financing options, TRC recommends local jurisdictions:

- Thoroughly assess the people and buildings that must be reached to achieve the carbon neutrality goals (e.g., square footage of buildings by type, number of multifamily buildings with parking, major property owners in the City, energy burden for low-income residents, etc …).
- Understand the scale of the challenge to estimate the corresponding scale of the solutions necessary (e.g., dollars of investment, outreach strategies, retrofit rates, consumer protections, etc…).
- Support a range of market transformation strategies (e.g., workforce development, permit streamlining, etc…).

2 Codes and Policies

This chapter provides examples of policies, implementation tools, and strategies that were deployed to support existing building electrification and existing multifamily EV readiness topic areas. Each policy example contains descriptions of mechanisms, applicability to topic areas, instances of policy implementation, and results if available. An example is presented in the following format:

{Name of Policy Mechanism}

{Role of Municipality} | {Policy Action}

TRC has listed policy examples in perceived order of maturity and prevalence.

2.1 Existing Building Electrification

All of the established precedents identified in this literature review are intended to be directly applicable to building electrification policies; however, only a limited set of planned policy approaches currently consider building electrification specifically. All policy approaches are provided for full context and consideration.

2.1.1 Municipal Buildings Lead with Electrification

Local Government Authority | Municipal Resolution

To raise the profile and encourage acceptance of new policies, government agencies often start with mandating and implementing new policies on their own assets and business practices.

- **California** established a requirement for 100 percent of new state buildings, major renovations, and build-to-suit leases beginning design after October 2017 to be verified zero net energy (ZNE), and 50 percent of existing square footage to include measures achieving ZNE by 2025.[1] The Department of General Services definition of ZNE allows offsetting natural gas with renewable electricity production on a kBtu basis.
- **San Mateo County's** climate action plan establishes a goal for carbon neutrality by 2035 across government operations, including the electrification of 100 percent of existing County-owned building stock.[2] The other areas covered in the plan include water, transportation, solid waste, materials management, and carbon sequestration.

Local government could set an example, learn from experience, and chart a pathway for existing building electrification by mandating electrification on its own existing building portfolio.

[1] https://www.dgs.ca.gov/OS/Resources/Page-Content/Office-of-Sustainability-Resources-List-Folder/Zero-Net-Energy

[2] https://www.smcsustainability.org/wp-content/uploads/Attachment-A-Government-Operations-Climate-Action-Plan-Pathway-to-Carbon-Neutrality.pdf

2.1.2 Triggered Appliance Conversion

Local Government Authority | Local Ordinance or Resolution

Local governments have some leverage in requiring electric equipment or preparation for electric equipment through amendments to the building code, ordinance(s), or time of sale requirements. Electrification could be prompted for certain types of building permits, such as installation of space- and water-heating equipment, additions, or alterations.[3] Policy levers can range from providing pre-wiring for future electrical equipment, to replacement of fossil fuel equipment when an event is triggered (e.g. building permit or sale of property).

City of Berkeley's Equitable Electrification Strategy includes many of the trigger mechanisms and strategies described in this study, including time of sale and replacement and renovation.[4] The proposed timeline goal for Berkeley is to decarbonize by 2045. Prior to implementing a electrification requirement, it will be imperative for local governments to consider related market preparedness and developments that encourage electric replacement prior to the fossil fuel equipment's end of life. The market must have a robust supply chain, a well-stocked equipment distribution network, and promote a well-trained contractor workforce for installations.

Triggered at Point of Building Sale or Transfer

A jurisdiction may encourage or require electrification upgrades at time of real estate sales. Existing examples require some energy assessment and/or label and disclosure policies, with no explicit link to electrification. Notable instances include:

Within California

- Since 2015, **City of Berkeley** Building Emissions Savings Ordinance (BESO) has required an energy efficiency assessment for all single family, commercial, and multifamily buildings at time of listing, and/or annual benchmarking, using either the Department of Energy Home Energy Score or ENERGY STAR Portfolio Manager.[5,6] Exemptions are allowed for new construction, extensive renovations, or financial hardship (such as participation in income-qualified or tax-postponement programs). A 2020 evaluation of the program states that while the program helped the City attain energy consumption information that is useful for shaping policy, it has also been challenging for the city to track conversion rates from assessment to energy upgrade, due to privacy protections of utility program data and a lack of granular building permit data.[7]
- **City of Davis'** Resale Program, implemented in 1976, requires a building inspection to certify that the building meets local ordinance requirements as part of a residential property transaction. The inspected items include various health and safety measures including air

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[3] http://www.buildingdecarb.org/uploads/3/0/7/3/30734489/building_decarbonization__legal_opportunities.pdf

4 https://www.cityofberkeley.info/uploadedFiles/Planning_and_Development/Level_3_-_Energy_and_Sustainable_Development/Draft_Berkeley_Existing_Bldg_Electrification_Strategy_20210415.pdf

[5] https://www.cityofberkeley.info/beso/

[6] https://www.cityofberkeley.info/benchmarking_buildings/

[7] https://www.cityofberkeley.info/uploadedFiles/Planning_and_Development/Level_3_-_Energy_and_Sustainable_Development/BESO%20Evaluation%20Final%20Report.pdf

conditioner disconnect, furnace combustion air, laundry outlet voltage, energy standards compliance with retrofit, and pipe insulation.[8] As of 2018, the cost for the inspection was $426. The City inspects approximately three to four percent of its housing stock annually, and since 2014, only five percent of resale inspections have found unpermitted heating, ventilation, and air conditioning (HVAC) installations.[9]

- **City of Piedmont** requires that at point of listing for sale of a property, a report from a Home Energy Audit or Home Energy Score (homeowner's choice) must be provided to potential buyers and submitted to the City—unless the residential building was constructed in the past 10 years.[10] This requirement was implemented in early 2021, and there is limited compliance and implementation data at this time.
- Since 1982, the **City of San Francisco** has required energy and water conservation measures for all residential dwellings that undergo a property transfer or major improvements (e.g., $20,000 of estimated improvements for a single-family home).[11] Measures include a minimum of R-11 attic insulation, water heater insulation, weatherization, and duct insulation, and must be inspected for compliance. Costs are capped at $1,300 per single-family dwelling, and for multifamily buildings:
  - 1% of the assessed value of the building if improvements are performed prior to property transfer
  - 1% of the purchase price as stated in the real estate sales contract

Outside of California

- **City of Minneapolis'** Truth in Sale of Housing (TISH) requires home inspections prior to sale. Inspected items include water heater and space heater venting and improper gas lines.[12] Home energy data is also collected in an energy disclosure, but no energy improvements are required. All of the data is published and available to the public.
- **City of Chicago** requires the seller of a residential property to provide a *heating cost disclosure form* to the prospective purchaser during the sale of a property, based on historical information. Landlords are required to provide the same report to prospective renters.[13] No retrofits are required.
- **City of Austin's** Energy Conservation Audit and Disclosure (ECAD) Ordinance requires energy audits and disclosures for all buildings to promote energy efficiency. Audits are required at time of sale for residential buildings (costing $200-$300), annually for commercial buildings larger than 10,000 ft2, and every ten years for multifamily buildings.[14] The ECAD Ordinance requires multifamily buildings that are high-energy users (exceeds 150 percent of average energy use for

[8] https://www.cityofdavis.org/city-hall/community-development-and-sustainability/building/resale-program
[9] https://www.bayrencodes.org/wp-content/uploads/2020/12/EE-and-Electrification-White-Paper_FINAL_12.28.2020.pdf
[10] https://piedmont.ca.gov/common/pages/DisplayFile.aspx?itemId=17376920
[11] https://sfenvironment.org/residential-energy-conservation-ordinance
[12] https://www.minneapolismn.gov/resident-services/property-housing/buying-selling/tish/
[13] https://www.chicago.gov/content/dam/city/depts/dol/rulesandregs/HeatingCostDisclosureRules.pdf
[14] https://austinenergy.com/ae/energy-efficiency/ecad-ordinance/energy-conservation-audit-and-disclosure-ordinance

multifamily properties) to make energy efficiency improvements to reduce energy use by at least 20 percent.

Each of these ordinances carry penalties ranging from a few hundred to a few thousand dollars for non-compliance.

Triggered by Major Alteration

California's Title 24, Part 6 Building Energy Efficiency Standards contain various efficiency upgrade requirements that additions and alterations must comply with if the trigger conditions are met. For example, the standards dictate that space-conditioning system replacements (the trigger event) are limited to methane gas, liquefied petroleum gas, or the existing fuel type, except in the case of going from gas or liquefied petroleum gas to heat pumps (the requirement).

Local governments may use the same triggering events, such as the replacement of a mechanical and/or domestic water heating system, and further require electrification measures. In this case, a local code amendment could further require that replacement equipment be heat pump systems, as opposed to the like-for-like replacement currently allowed in Title 24, Part 6.

Encouraging or requiring electrification conversions make most economic sense when coupled with major renovations, because it can be more cost effective and less disruptive to the building owner. Solar photovoltaic (PV) installations have an added benefit of improved operational cost effectiveness.

Notable instances include:

Within California

- **City of Piedmont** recently passed an existing building ordinance requiring:[15]
    - Projects proposing an entire new upper level on a low-rise residential building or increasing a low-rise residential building's total roof area by 30 percent or more, install solar panels on the roof.
    - A renovation project on a low-rise residential building that costs $25,000 or more will require the applicant to choose one item from a list of energy efficiency or heating system electrification improvements to include in the renovation.[16] A renovation project on a low-rise residential building that costs $100,000 or more will require the applicant to choose two items.
    - An application for an electrical panel upgrade must include capacity in the panel to accommodate future electrification of all appliances in the residence. The building official has the authority to approve of a panel physical size that can accommodate an amperage larger than the service connection, ostensibly with a main breaker that sized no larger than the building service.
    - An application for a kitchen or laundry area renovation must include electrical outlets for future appliance installation.
- **City of Portola Valley** requires that nearly all residential additions or remodels, including accessory dwelling units, achieve a certain number of GreenPoint Rating Points, depending on

[15] https://piedmont.ca.gov/cms/one.aspx?portalId=13659823&pageId=17415806
[16] https://piedmont.ca.gov/common/pages/DisplayFile.aspx?itemId=17426428

the exact scope. The project documents must include the proposed measures to achieve the required number of points, and prior to building permit issuance, documentation must be provided by a certified GreenPoint Rater.[17]

- **City of Chula Vista** Existing Home Energy Sustainability Ordinance (EHSO) requires two-to-four efficiency measures to be installed for existing homes performing major alterations that were built in Chula Vista before 2006, such as adding square footage, moving interior walls, or moving windows and doors.[18]
- **City of Berkeley** is planning for a *time of replacement and renovation plan* that requires equipment changeout at the end of life or during a renovation. Their current timeline would require electric HVAC and hot water as early as 2025 if accessible financing and funding is available.[19]
- **City of Emeryville** is considering adopting model code language developed by East Bay Community Energy that requires replacement HVAC equipment be heat pumps in low-rise and high-rise residential, office, and retail buildings, and that panel upgrades be electric-ready to the extent that the service connection capacity allows.[20]

Outside of California

- **City of Seattle** adopted an energy code that requires heat pump installation in commercial alterations (and new construction) effective on building permits applied after January 1, 2022. There are exemptions that would allow methane gas in limited instances, but exemptions are specific to occupancy types (e.g., less than five percent of the conditioned floor area) and technologies (e.g., existing district energy or emergency generators).[21]
- **City of Boulder**'s Green Building and Green Points Program required that renovations that add over 500 square feet to pre-existing housing also have to meet an energy efficiency requirement that may trigger mandatory upgrades.[22]

2.1.3 Building Performance Standards

Local Government Authority | Local Ordinance

Setting performance standards and enforcing compliance via a timeline can allow for long-term planning by building owners.

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[17] https://www.portolavalley.net/building-planning/green-building-and-your-project
[18] https://www.chulavistaca.gov/departments/clean/retrofit
[19] https://www.cityofberkeley.info/uploadedFiles/Planning_and_Development/Level_3_-_Commissions/Commission_for_Energy/2021-01-27_EC_Item%209_Late%20Communication_Item%204_Proposed%20Existing%20Building%20Electfication%20Strategies.pdf
[20] https://ebce.org/reach-codes/
[21] http://seattle.legistar.com/View.ashx?M=F&ID=9085266&GUID=545EA5F5-8C47-4A56-80FF-7846BA07EFCF
[22] https://www.aceee.org/toolkit/2020/02/residential-energy-use-disclosure-guide-policymakers

Disclosure Programs

Energy use disclosures can educate building owners and provide customized, discrete next steps toward compliance with specific thresholds.[23] In some cases, cities require that upgrades be performed within certain time windows or face a penalty.

Within California

- **City of Brisbane** requires most owners of buildings larger than 10,000 ft^2 to report energy benchmarking results using ENERGY STAR Portfolio Manager to the city annually on May 15th starting in 2021. Starting in the 2023 reporting cycle, buildings will be required to demonstrate building efficiency performance metrics or conduct an audit to identify and implement savings opportunities.[24]
- Some cities may leverage existing structure from rental policies and business license programs to enforce disclosure programs and require additional upgrades.[25] The **City of El Cerrito** is a California example of a residential rental inspection program, operating since 1997. El Cerrito requires all residential rental units to be registered, obtain a business license, pay an annual license tax, and be inspected every two years. The inspection costs approximately $129 per multifamily unit. The inspector checks for a variety of measures including appliance installation and operation as well as electrical wiring.[26,-27] The cities of Richmond, San Pablo, and San Rafael also include rental inspection programs, though triggers can vary by regular time periods, time of sale, and/or complaints. These programs achieve an average of 80 percent compliance rates.
- **City of Berkeley** may expand their BESO program to include greenhouse gas emissions per square foot estimates and require building owners to limit emissions according to gradually decreasing threshold through 2045.[28] This may be administratively challenging—even under the

Relevant Resources

1. While existing building electrification will ultimately require mandatory approaches, disclosures may provide an important foundational dataset and administrative framework. The American Council for an Energy Efficient Economy has published a Guide for Policymakers to establish energy disclosure programs, as has the Federal Office of Energy Efficiency and Renewable Energy.

2. StopWaste developed key considerations and estimates of carbon impacts to support jurisdictions exploring the idea of a Rental Housing Inspection Programs with energy efficiency requirements.

[23] https://www.aceee.org/toolkit/2020/02/residential-energy-use-disclosure-guide-policymakers
[24] https://www.brisbaneca.org/bbep#:~:text=The%20first%20step%20was%20development,May%2015th%20starting%20in%202021.
[25] https://rmi.org/rental-efficiency-standards-a-win-for-equity-and-climate/
[26] http://www.el-cerrito.org/563/Residential-Rental-Inspection-Program
[27] https://library.municode.com/ca/el_cerrito/ordinances/code_of_ordinances?nodeId=958375
[28] https://www.cityofberkeley.info/uploadedFiles/Planning_and_Development/Level_3_-_Commissions/Commission_for_Energy/2021-01-27_EC_Item%209_Late%20Communication_Item%204_Proposed%20Existing%20Building%20Electfication%20Strategies.pdf

current BESO program design, a recent evaluation found that the "BESO administrative process [and ensuring compliance] is staff-intensive and time consuming."[29]

Outside of California

- **City of Boulder** adopted the SmartRegs program in 2010, which required that rental properties meet energy efficiency requirements by 2018 or before a rental license application approval. In 2017, 100 percent of the rentals were inspected, and 86 percent were compliant.[30] Similarly, Boulder also requires that commercial and industrial building owners complete one-time lighting upgrades and implement cost-effective retro-commissioning measures by set dates, depending on the size of the building.[31] Failure to perform upgrades can result in fines of $0.0025 per square foot up to $1,000 *per day* of non-compliance. To support property owners, the City provides a set of resources including a cost estimation tool and a list of service providers.

- Since 2013, the **City of Chicago** has required multifamily and commercial buildings of at least 50,000 ft^2 to report whole-building energy use annually according to a custom energy rating system that went into effect in 2019. The rating is required to be posted in a prominent location on the property, and either the energy rating or ENERGY STAR® score must be listed in any advertisements for sale or lease at the time of listing.[32]

- In May 2021, the **City of Burlington** adopted an ordinance requiring rental units that consume over 90 $kBtu/ft^2$ for space heating purposes to implement energy efficiency measures up to a cost cap of $2,500/unit to complete the initial work, not including incentives. After the initial work is completed, property owners are given a three-year extension to finish the required efficiency improvements with no cost cap.[33]

- **Gainesville, Florida** has a rental unit permit and inspection program that requires rental units apply for permits annually, and demonstrate that they meet a set of energy efficiency requirements.[34]

- **City of Boston** has proposed updates to the Building Emissions Reduction and Disclosure Ordinance (BERDO) intended to meet carbon neutrality by 2050 (Figure 1).[35] Every building over 20,000 ft^2 will need to achieve zero emissions per square foot by the year 2050. The policy has flexible compliance options, such as alternate timing or carbon payments, as well as the purchase of off-site renewable energy combined with on-site electrification. The policy does not currently account for time-of-use of electricity but may in the near future.

[29] https://www.cityofberkeley.info/uploadedFiles/Planning_and_Development/Level_3_-_Energy_and_Sustainable_Development/BESO%20Evaluation%20Final%20Report.pdf
[30] http://rmi.org/wp-content/uploads/2018/05/Better-Rentals-Better-City_Final3.pdf
[31] https://bouldercolorado.gov/sustainability/boulder-building-performance-efficiency-requirements

[33] https://go.boarddocs.com/vt/burlingtonvt/Board.nsf/files/C2RKKP51C01A/$file/BCO%20Chapter%2018.%20Housing%20Change%20re%20Energy%20Efficiency%20and%20Weatherization%20in%20Rental%20Housing_Revised%20-%20%20City%20Council%205.10.2021.pdf
[34] https://gainesville.legistar.com/View.ashx?M=F&ID=8805396&GUID=444F88CC-EDFB-4498-AA98-04C0110A3AD0
[35] https://www.imt.org/boston-introduces-building-performance-standard/

Figure 1. Boston's Emissions Performance Standards Extending to 2050.

Building use	Emissions standard (kgCO_2e/SF/yr.)					
	2025 - 2029	2030-2034	2035-2039	2040-2044	2045-2049	2050-
Assembly	7.8	4.6	3.3	2.1	1.1	0
College/ University	10.2	5.3	3.8	2.5	1.2	0
Education	3.9	2.4	1.8	1.2	0.6	0
Food Sales & Service	17.4	10.9	8.0	5.4	2.7	0
Healthcare	15.4	10.0	7.4	4.9	2.4	0
Lodging	5.8	3.7	2.7	1.8	0.9	0
Manufacturing/ Industrial	23.9	15.3	10.9	6.7	3.2	0
Multifamily housing	4.1	2.4	1.8	1.1	0.6	0
Office	5.3	3.2	2.4	1.6	0.8	0
Retail	7.1	3.4	2.4	1.5	0.7	0
Services	7.5	4.5	3.3	2.2	1.1	0
Storage	5.4	2.8	1.8	1.0	0.4	0
Technology/Science	19.2	11.1	7.8	5.1	2.5	0

- The **State of Colorado** recently signed into law HB21-1286, which requires buildings to track progress toward meeting a 90 percent reduction in emissions by 2050 from 2005 levels. The implementation of the law will be developed through a stakeholder process starting in late 2021.[36]

Appliance NOx Emission Limit

Another approach to effectively disallow gas appliances upon burnout or by a deadline is to set the equipment outdoor emission limits low enough based on health and safety reasons. Many dwellings use gas wall furnaces for heating, which can contribute to poor indoor air quality because of over spillage of furnace combustion products.[37] Few or no gas equipment would meet the low combustion emission thresholds, and this helps pave the path for electrification.

The State's health and safety code permits local governments to exceed the State's indoor air quality (IAQ) standards. However, potential limitations to the approach include Clean Air Act (CAA) preemption and complications from interactions with building ventilation requirements.[38]

There are no known instances of this policy implementation, but TRC did find examples of air-quality related policies:

- **Portola Valley's** fireplace policy prohibits wood burning fireplaces unless they are an EPA-qualified or EPA-certified fireplace for air quality reasons. The policy is also enforced at the time-of-sale, requiring Certificate of Compliance for the wood burning heater, or removal of the appliance.[39]

[36] https://www.imt.org/colorados-new-building-performance-standards/

[37] https://www.osti.gov/servlets/purl/1375004

[38] http://www.buildingdecarb.org/uploads/3/0/7/3/30734489/matrix_of_decarbonization_options.pdf

[39] https://www.ci.portola.ca.us/uploads/4/3/3/5/43350423/ord_354-_wood_stove_ordinance_amendment_2019_and_open_burn_ban.pdf

- The Express Terms proposed 2022 Standards by the **California Energy Commission** (draft policy, not final) includes a provision in Table 150.0-G requiring a greater airflow rate over natural gas ranges than electric ranges, reflecting the increased NO2 emissions resulting from natural gas combustion.[40]

A more feasible, though indirect, approach for a local jurisdiction may be to support the regional Air Quality Management District via advocacy to establish this requirement, rather than local ordinance adoption. The Bay Area Air Quality Management District is considering such a program, though the timeline is uncertain.[41]

2.1.4 Elimination of Fossil Fuel Infrastructure

Support Utility | Resolution, Advocacy, and Support

Local governments may adopt a *no reconnection* methane gas policy to eliminate gas utility obligation to serve gas, and over time, develop strategies for gas infrastructure pruning, while prioritizing low-income neighborhoods. The main barrier and area needing clarity remains how this interferes with the utility's obligation to serve gas and coordination with utilities. Identifying suitable locations that meet technical, financial, equity, and community considerations to implement gradual reduction and elimination of gas infrastructure requires high and sustained commitment and resources from municipalities.

Initial market penetration may be targeted in sites and neighborhoods where high-cost propane is used for heating to capture improved economics while the local market develops.[42]

- **City of Berkeley** is in the process of drafting a plan containing phased actions. Pilot programs are projected to begin prior to 2025, and the strategy may begin wider implementation in 2030, pending appropriate funding and financing strategies.[43]

2.1.5 Achieving Equitable Outcomes

Local Government Authority | Resolution, Advocacy, and Support

Electrification policy must make financial sense for all populations, including lower-to-moderate income (LMI) residents. Ensuring that benefits of electrification, such as health, safety, and affordability, are targeted toward marginalized communities reverses compounding historical injustices, many of which have been created and perpetuated by government action.

- **The Zero Cities Project**, led by the Urban Sustainability Director's Network, supported the development of workplans for several cities that center equity and community decision-making in the development of local building decarbonization policy.[44] Takeaways from projects implemented at Portland, San Francisco, Washington, DC, Boston, and several others include:

[40] https://efiling.energy.ca.gov/GetDocument.aspx?tn=236876&DocumentContentId=70030
[41] See slides 23-34: https://www.baaqmd.gov/~/media/files/board-of-directors/2021/sscic_presentations_04192021_v2-pdf.pdf?la=en
[42] https://www.colorado.edu/rasei/sites/default/files/attached-files/accelerating_the_us_clean_energy_transformation_final.2.pdf
[43] https://www.cityofberkeley.info/uploadedFiles/Planning_and_Development/Level_3_-_Energy_and_Sustainable_Development/Draft_Berkeley_Existing_Bldg_Electrification_Strategy_20210415.pdf
[44] https://www.usdn.org/uploads/cms/documents/rm_zero_cities_project_report_portland.pdf

- Without equitable policy development, local building regulations run the risk of doing more harm than good. For example, landlords may evict tenants when making building upgrades, a harmful practice known as "renovictions."
- Partnering directly with Community Based Organizations (CBOs) can expand city efforts and deepen engagements in the creation of building decarbonization policies. CBOs and community members may initially be skeptical of governmental interventions, but early and regular engagement can lead to honest discussions around climate policy, establish a strong commitment, demonstrate accountability, repair trust, and lead to better overall policy.
- Rental property energy performance standards, coupled with rental housing policies, could reduce the energy cost burden on tenants, eliminate the split incentive, and support cities in meeting climate goals (See Section 2.1.3 for related policies).
- CBOs and community members should be compensated for attending workshops or meetings to cover childcare, food, travel, or other expenses.

- **City of Berkeley** Existing Buildings Electrification Strategy defines the multiple forms of equity, establishes the intention to design policy around the goal of Targeted Universalism, and will leverage the Greenling Institute's Equitable Building Electrification Framework.[45,46]
- **The Executive Branch of the U.S. Government** has established an Environmental Justice Interagency Council, as part of a broad executive order on climate action, that will ensure that achieving environmental justice is including in their mission when developing programs, policies, and activities designed to combat climate change.[47]

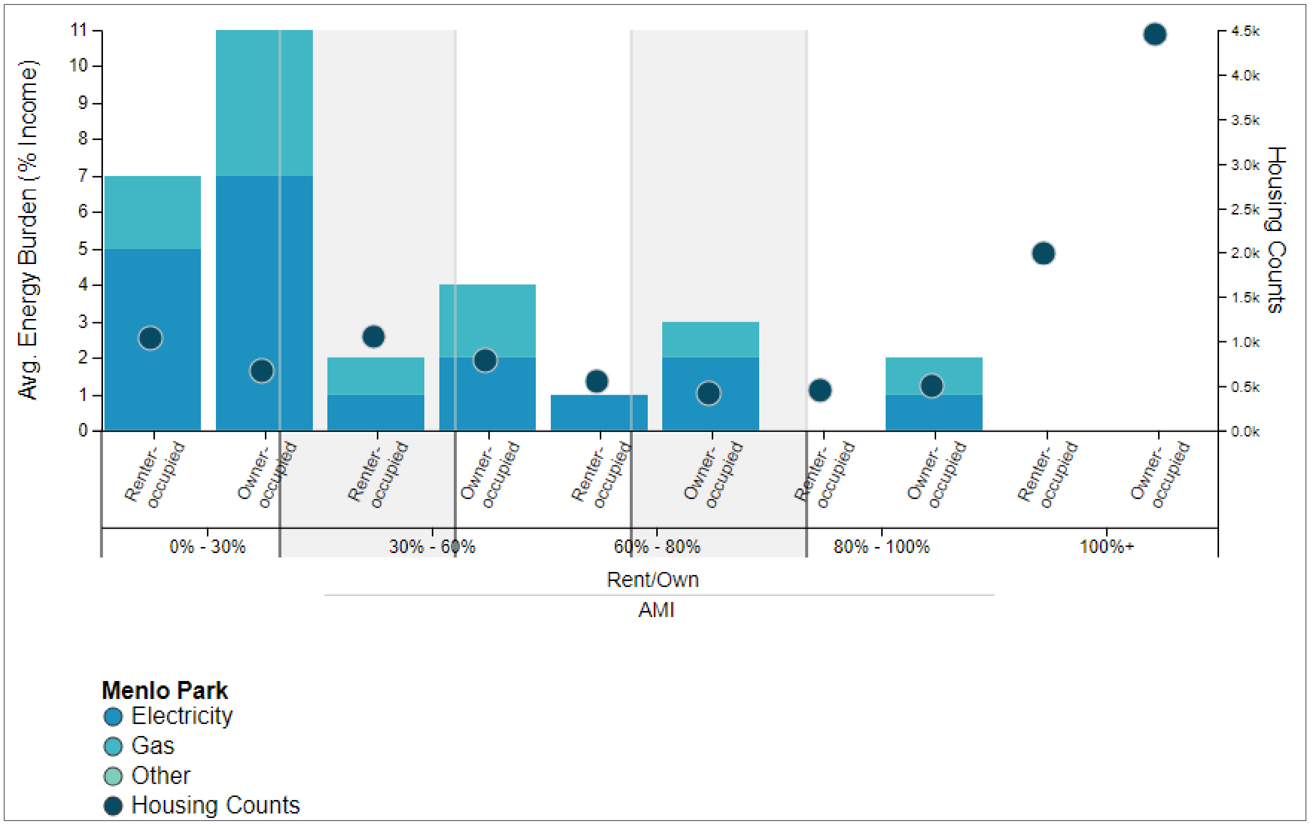
Relevant Resource

The U.S. Department of Energy's Low-Income Energy Affordability Data (LEAD) Tool extracts data from the U.S. Census Bureau's 2018 American Community Survey 2018 to help communities create better energy strategies and programs by improving their understanding of low-income housing and energy characteristics.

Using the LEAD tool (see sidebar), the American Community Survey indicates that there are approximately 1,500 housing units in Menlo Park that are below the 30 percent Area Median Income (AMI). The occupants of these housing units are mostly renters and pay seven to eleven percent of their income on energy (also known as 'Energy Burden'). As one example, an equitable policy would strive to ensure that the energy burden of LMI communities matches that of more affluent populations (see section 3.1.4)

[45] https://www.cityofberkeley.info/uploadedFiles/Planning_and_Development/Level_3_-_Energy_and_Sustainable_Development/Draft_Berkeley_Existing_Bldg_Electrification_Strategy_20210415.pdf
[46] https://greenlining.org/publications/reports/2019/equitable-building-electrification-a-framework-for-powering-resilient-communities/
[47] https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/27/executive-order-on-tackling-the-climate-crisis-at-home-and-abroad/

Figure 2. Average Energy Burden (percent of income) for Menlo Park



2.2 Existing Multifamily EV Charging

2.2.1 Establish Alteration Threshold

Local Government Authority | Local Reach Code

Examples of existing policy governing clear definitions and threshold for EV infrastructure requirements in multifamily building alterations are limited.

- **City and County of San Francisco** requires that 100 percent of the total number of parking spaces on a building site be EV charging spaces (EV spaces) capable of supporting future electric vehicle supply equipment (EVSE) for major multifamily alterations. In major alterations where existing electrical service will not be upgraded, this requirement applies to the maximum extent that does not require an upgrade to existing electrical service.[48] Major alterations appear to be defined as 25,000 ft^2 of floor area or more where interior finishes are removed and significant upgrades to structural and mechanical, electrical, and/or plumbing systems are proposed.
- **City of Carlsbad** requires multifamily projects install EV infrastructure when performing major alterations (i.e., interior finishes are removed, upgrades to structural and mechanical, electrical and/or plumbing systems, and a grading permit to rehabilitate or install 2,500 square feet or more of landscaping; or repave, replace or add 2,500 square feet or more of vehicle parking and drive area). These buildings must have 5 percent of parking by EV capable and 5 percent EVCS.[49]
- **California's** green building standards, Title 24 Part 11, requires 10 percent EV capable spaces for additions and alterations of existing residential buildings as new construction. The requirements apply where the addition or alteration increases the building's conditioned area, volume, or size, and only to and/or within the specific area of the addition or alteration.[50]

Relevant Resources

1. The Alternative Fuels Data Center maintained by the Department of Energy, contains a variety of laws and incentives related to clean transportation. TRC explored the database but it's possible more relevant findings existing than those presented.

2. The Charge4All tool, developed by Arup, will help prioritize EV charging suitability based on density, ground conditions, electrical infrastructure, road types, and equity factors to support development at multi-family dwelling sites. The tool is currently in beta testing, and timeline and cost for commercial service have yet to be determined.

3. East Bay Community Energy commissioned a report indicating that direct install Level 1 charging programs can enable large scale deployment at multifamily unit dwellings due to low costs and strong market acceptance from both property tenants and owners.

[48] https://codelibrary.amlegal.com/codes/san_francisco/latest/sf_building/0-0-0-87834

[49] https://www.carlsbadca.gov/services/depts/pw/environment/cap/evres.asp

[50] https://codes.iccsafe.org/content/CAGBSC2019

- **City of Menlo Park** requires that nonresidential additions or alterations affecting over 10,000 ft^2 of building area provide a Level 2 raceway for 5 to 10 percent of the associated total parking spaces, and Electric Vehicle Supply Equipment for one plus 1 percent of total required parking spaces. There are currently only voluntary requirements for residential buildings.[51]
- **The City of Los Angeles** Department of Public Works initiated a pilot program to provide Level 2 EV charging stations on streetlights in the right-of-way, and has installed 431 stations over the last few years.[52] While this program is not directly related to multifamily alterations, it may support broader access to EV charging for tenants that do no reside in multifamily buildings triggered by other city policies to install EV charging stations.

[51] https://www.menlopark.org/1480/Electric-vehicle-EV-chargers
[52] https://bsl.lacity.org/smartcity-ev-charging.html

3 Incentives and Funding Mechanisms

This chapter starts by presenting existing incentives and resources for existing building electrification and for existing multifamily EV charging. The chapter then identifies various funding and dispersion mechanisms that municipal governments can either lead or play a critical role in catalyzing to leverage stable financial resources to support electrification initiatives.

The **City of Berkeley** estimated that they require $700M to $1.4B in investment to electrify 90 percent of all Berkeley buildings by 2045, including envelope efficiency and solar PV measures to ensure equitable outcomes.[53] To put these numbers into context, here are some characteristics for Berkeley:

- Population of 122,000
- 20.7M square feet of nonresidential space and 65.1M square feet of residential space
- 35,432 total buildings, 92 percent of which are residential
- Residential comprises 48 percent of greenhouse gas emissions from buildings, while nonresidential comprises 52 percent

For further context, E3 estimates that approximately $10B per year is necessary, every year from now through 2050, to electrify all of the 8.7M single-family buildings and 3.3M low-rise multifamily units in the state of California.[54] The scale and speed of the building-industry investments that are necessary to avoid the worst impacts of climate change are unprecedented.

3.1 Consumer Financing

3.1.1 Incentive Programs

Co-Lead with Other Agencies | Municipal Resources

Building Electrofit

The following entities provide program incentives or for heat pump water heaters (HPWH), heat pump space heating, induction cooking, and/or heat pump clothes drying often including income-qualified options. This is not an exhaustive list but includes some of the most relevant programs for San Mateo County and the neighboring region:

Community Choice Aggregators: Peninsula Clean Energy, Silicon Valley Clean Energy, Clean Power SF, East Bay Community Energy, Marin Clean Energy, San Jose Clean Energy, and Sonoma Clean Power. **Peninsula Clean Energy** provides up to $1,500 to replace a methane gas water heater, with bonus

[53] https://www.cityofberkeley.info/uploadedFiles/Planning_and_Development/Level_3_-_Commissions/Commission_for_Energy/2021-01-27_EC_Item%209_Late%20Communication_Item%204_Proposed%20Existing%20Building%20Electfication%20Strategies.pdf

[54] https://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=6442467615 . Does not include high-rise multifamily or nonresidential.

incentives of $1,000 for California Alternate Rates for Energy (CARE) and Family Electric Rate Assistance (FERA) customers, and up to $1,500 for panel upgrades.[55]

Regional Agencies: Bay Area Regional Energy Network (BayREN), StopWaste, California Department of Community Services and Development (CSD), Bay Area Air Quality Management District (BAAQMD), and South Coast Air Quality Management District (SCAQMD).

- **BayREN** currently administers the Home+ program, which provides $1,000 rebates each for HPWHs and heat pump space heaters, and $300 each for induction cooktops and clothes dryers in single family residences. Their Bay Area Multifamily Building Enhancements program provides significant incentives via the Clean Heating Pathway (e.g., $1,000 for each in-unit heat pump, or $15,000 for a central heat pump water heater serving at least 19 units).[56]
- The CSD's **Low-Income Weatherization Program**, funded by the State's cap-and-trade proceeds, focuses on low-income multifamily buildings located in disadvantaged communities as defined by the CalEPA, and it funds electrification upgrades within its portfolio.[57]

Local Governments:

- **County of Marin** administers the Electrify Marin program with funding from BAAQMD, providing rebates for water heaters, space heaters, and cooktops replacing of gas equipment for existing single-family properties. [58] Appliance specific rebates range from $250 for an induction cooktop to $1000 for a heat pump water heater, and a $500 rebate is available for updates to the main electric service panel. Income-qualified owners qualify for 2x-4x higher rebates.
- **City of San Jose** had an Electrify San Jose program with funding from the BAAQMD, which provided rebates for switching from methane gas water heater to an electric heat pump water heater. The maximum rebate per single- and multifamily dwelling was $4,500 with an electric service panel upgrade, or $2,000 without.[59] CARE and FERA customers qualified for additional rebate amounts.
- **City of Santa Monica** administers the Electrify Santa Monica pilot program which provides up to $1,000 in rebates for replacement of gas equipment in existing residential properties, ($1,800 for income-qualified applicants), and service panel upgrades.[60] Appliance specific rebate amounts range from $100 for a HPWH to $300 for induction cooking.
- **Redwood City** has started a rebate program for homeowners offering $500 for heat pumps, $500 for electrical panel upgrades if necessary, $500 for income-qualified residents, $500 for level 2 chargers, and $250 for electric lawn care equipment.[61]

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[55] https://www.peninsulacleanenergy.com/heat-pump-water-heater/

[56] https://www.bayrenresidential.org/get-rebates; https://bayareamultifamily.org/; https://www.bayren.org/clean-heating

[57] https://www.csd.ca.gov/Pages/Low-Income-Weatherization-Program.aspx

[58] https://www.marincounty.org/depts/cd/divisions/sustainability/energy-programs/electrify

[59] https://www.sanjoseca.gov/your-government/departments-offices/environmental-services/climate-smart-san-jos/electrify-san-jos

[60] https://www.smgov.net/uploadedFiles/Departments/OSE/Categories/Energy/Electrify%20Santa%20Monica%20Rebate%203%20pg%20PDF.pdf

[61] https://www.redwoodcity.org/home/showpublisheddocument/23493/637566742860930000,

Investor Owned Utilities (IOUs): IOUs, including Pacific Gas and Electric Company (PG&E) and Southern California Edison, provide incentives for new construction and retrofit projects that include multiple electrification technologies. Fifteen of the sixteen separate building electrification programs that the IOUs implement fund HPWHs.[62]

- **PG&E** provides equipment rebates for retrofitting with ENERGY STAR high efficiency electric heat pump storage water heaters. Qualifying products listed in their rebate catalog qualify for a $300 per unit.[63]
- **Southern California Edison** provides $1,000 in rebates for HPWHs, $300 per ton for central HVAC heat pumps, and $600 per ton for minisplit HVAC heat pumps.[64]

State Agencies: The **California Public Utilities Commission** (CPUC) is administering and/or implementing several relevant programs listed below. These programs are primarily intended to improve market conditions for heat pump water heaters statewide rather than achieve deep penetration of electrofits in any locale.

- The Technology and Equipment for Clean Heating (TECH) Initiative will provide incentives to heat pump space and water heating to encourage sales and adoption, up to $120M program budget statewide.
- The Self-Generation Incentive Program (SGIP) was updated to include incentives for HPWHs as energy storage devices (anticipated to be a $1500 rebate) up to a program budget of $45M statewide.[65] The proposed incentive would pay a bonus for models with controls that enable HPWHs to be grid responsive. This typically requires additional hot-water storage and capability to perform pre-determined load-shift modes.[66]

TECH and SGIP combined are anticipated to fund approximately 75,000 heat pump water heater installations across California, made available by the third quarter of 2021.

Municipal Utilities: City of Palo Alto, Alameda Municipal Power, and Sacramento Municipal Utility District provide rebates in the range of thousands of dollars to electrify a wide range of residential appliances.[67]

Each program has specific funding rules, and some rebates can be layered while others may not. For example, a PG&E rebate cannot be layered with a BayREN rebate as they come from the same pool of public funding, while the PCE rebate can. Figure 2 below depicts how the layered funding sources can cover conversions of existing methane gas equipment in Menlo Park residential buildings. The

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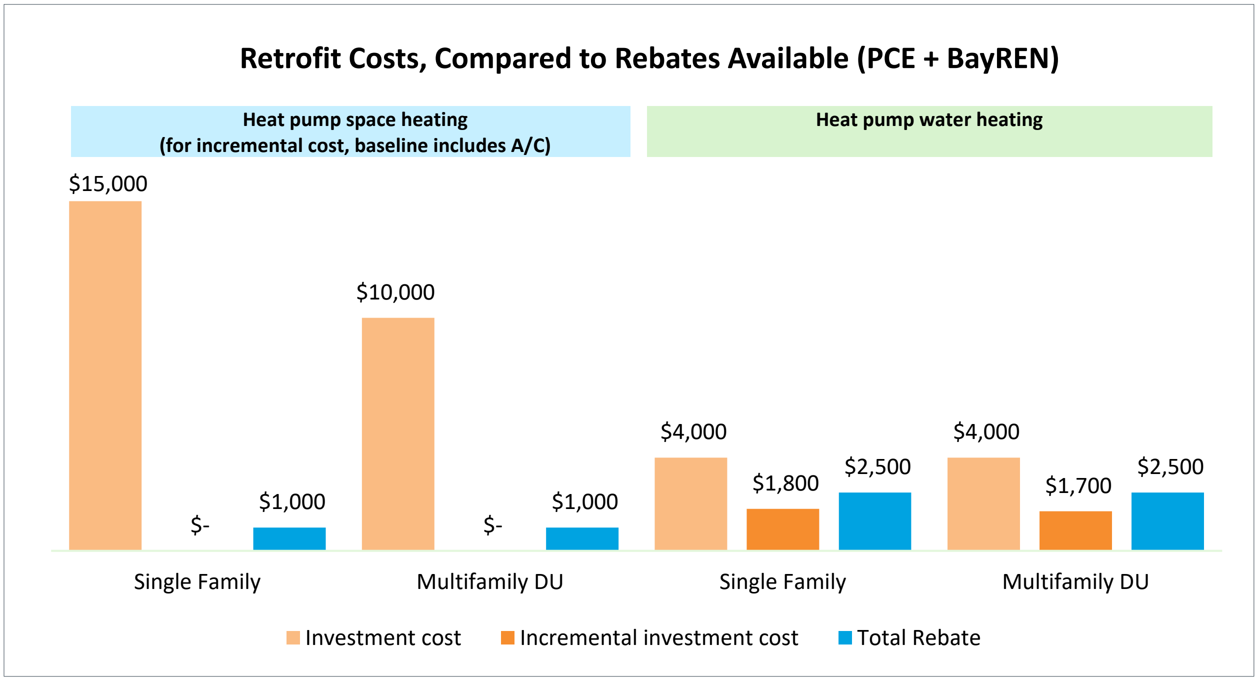
[62] https://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=6442465700
[63] https://www.pge.com/pge_global/common/pdfs/save-energy-money/savings-solutions-and-rebates/rebates-by-product/ee_residential_rebate_catalog.pdf
[64] https://www.sce.com/residential/rebates-savings/rebates
[65] *Self-Generation Incentive Program*. Retrieved from https://www.cpuc.ca.gov/sgip/
[66] Retrieved from Heat Pump Water Heater Workshop - Part 2: https://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/Utilities_and_Industries/Energy/Energy_Programs/Demand_Side_Management/Customer_Gen_and_Storage/SGIP.HPWH.Workshop.Part2.pdf
[67] https://www.cityofpaloalto.org/gov/depts/utl/residents/save_energy_n_water/rebates/heat_pump_water_heater/program_details.asp; https://www.smud.org/en/Rebates-and-Savings-Tips/Go-Electric/Residential-Go-Electric

investment costs are estimated from the Energy & Environmental Economics retrofit study, and do not include panel upgrades.[68]

As an example, a multifamily building (up to four dwelling units) in Menlo Park can receive a $1,500 incentive from Peninsula Clean Energy and a $1,000 incentive from BayREN to replace an in-unit existing methane gas water heater with a HPHW. This would cover about half of the estimated investment cost of $3,349-4,388 to install a heat pump water heater, and it would more than cover the incremental cost ($1,435-1,927) compared to replacing a like-for-like methane gas water heater.[69]

For heat pump space heating, the incremental cost is assumed to be $0 if the existing installation or planned retrofit includes air-conditioning. If air-conditioning is not included, costs associated with siting the exterior unit, electrical wiring, and refrigerant piping add up to dwarf BayREN's current incentive offering.

Figure 3. Retrofit Costs Compared to Rebates Available



Existing Multifamily EV Charging Rebate Programs

The following programs reduce cost barriers for EV charging in major alterations:

- The **Peninsula-Silicon Valley Incentive Project**, funded by the California Energy Commission as part of the California Electric Vehicle Infrastructure Project (CALeVIP), offers rebates in for installations at new, replacement, or make-ready sites.[70] The incentives for direct current fast EVSE greater than 100 kW covers 75 percent of total project costs, up to $70,000; projects located in disadvantages communities (DACs) has a higher cap at $80,000. For Level 2 EVSE for

[68] https://www.ethree.com/e3-quantifies-the-consumer-and-emissions-impacts-of-electrifying-california-homes/
[69] https://www.ethree.com/wp-content/uploads/2019/04/E3_Residential_Building_Electrification_in_California_April_2019.pdf
[70] https://calevip.org/incentive-project/peninsula-silicon-valley

multi-unit dwelling projects, the maximum incentive amount is $5,500 outside of DACs, and $6,000 for DACs.

- **Peninsula Clean Energy's** EV Ready Program is providing $28M to install 3,500 charging ports in San Mateo County over the next four years. Incentives range from $2,000 to $5,500 per port for existing multi-unit dwellings. There is no limit on the cap for installing L1 chargers, and a cap of $44,000 for L2 EVSE ports. An additional $4,000 is available for main panel upgrades.[71]
- **Santa Monica's** EV Charging Station Rebate Program for multifamily unit dwellings (MUDs) and small businesses provides up to $1,000 ($1,800 for income-qualified applicants) to offset the cost of purchasing and installing residential Level 1 or Level 2 charging infrastructure.[72] The program offering can be layered with SCAQMD EV residential EV charging pilot, which provides an additional $250.[73]

3.1.2 Tax Credits, Deductions, and Rebates

Co-Lead with Other Agencies | Municipal Resources

Beyond equipment rebates and building retrofit program incentives, there are number of federal tax deduction and tax credits, equipment tax credits, and examples of local tax refund/rebates applicable to electrification retrofits.

- The **Energy-Efficient Commercial Buildings Federal Tax Deduction** offers $1.80/ft2 tax deduction to buildings that install qualifying building systems that reduce the building's total energy and power cost by 50 percent in comparison to the most recent ASHRAE 90.1 standards, for the year when the system installation was completed.[74]
- The **Residential Energy Efficiency Federal Tax Credit** was retroactively extended from 2017 through the end 2021. Residential property owners are eligible for tax credits of $300 for qualifying HPHW and qualifying heat pump air conditioning equipment, with the maximum tax credit for all improvements of $500 in 2005-2021.[75]

On a municipal level the city can provide tax rebate to encourage electrification measures.

- **City of Berkeley**'s Real Property Transfer Tax is imposed on all property transfers, and ranges from 1.5 percent - 2.5 percent of the property value. Up to 1/3 of the base 1.5 percent transfer tax rate is eligible for a Seismic Transfer Tax Refund, if the property owner performs voluntary seismic upgrades within one year of the transfer. [76] Historically, an average of 13 percent of eligible homeowners have received the refund between 2014 and 2019.[77] The City is considering

[71] https://www.peninsulacleanenergy.com/ev-ready-incentives/
[72] https://www.smgov.net/uploadedFiles/Departments/OSE/Categories/Transportation/Phase3_EV_RebatePacket.pdf
[73] http://www.aqmd.gov/home/programs/community/community-detail?title=ev-charging-incentive
[74] https://programs.dsireusa.org/system/program/detail/1271/energy-efficient-commercial-buildings-tax-deduction
[75] https://www.energystar.gov/about/federal_tax_credits
[76] https://www.cityofberkeley.info/Finance/Home/Real_Property__Transfer_Tax_Seismic_Refunds.aspx
[77]

updates to expand the Seismic Tax Refund Program include resilience, energy efficiency, electrification measures for commercial and mixed-used buildings.[78]

3.1.3 Grant Programs

Co-Lead with Other Agencies | Municipal Resources

Federal grants are targeted to specific demographics and types of projects, creating a patchwork of funding that is generally not available to all residents. Generally, the Biden Administration has signaled an emphasis in delivering grants (and loans) to energy projects that create new, high-paying jobs.[79]

- **Community Development Block Grants** (CDBGs) is a program administered by the Department of Housing and Urban Development and provide communities with energy improvements by giving state and local governments the ability to transform a portion of their CDBG funds into federally guaranteed loans.[80] The grant is only available for projects in cities with populations of less than 50,000, except principal cities in metropolitan areas.
- The **Weatherization Assistance Program** is a grant program administered by the Department of Energy for residential energy efficiency retrofits (including electrofit measures) and solar additions. This program focuses on residences with elderly individuals, individuals with disabilities, and families with children. Recipients must be a resident of California and have an annual income that is below 60 percent of the state median Income.[81]
- The **U.S. Department of Transportation** has highlighted several EV infrastructure programs with substantial funding, though they are primarily for Highway installations and other public areas.82 Nevertheless, President Biden's American Jobs Plan includes %15 billion to fund a national network of 500,000 charging stations, including grant and incentive programs for local governments to accelerate deployment in apartment buildings.83

3.1.4 Loan Programs

Co-Lead with Other Agencies | Municipal Resources

A municipality can use borrowing capacity or loan loss reserve to develop a partnership with a local lender and create a loan program to finance electrification enhancements. A dedicated loan program

[78] https://www.cityofberkeley.info/uploadedFiles/Planning_and_Development/Level_3_-_Commissions/Commission_for_Energy/2021-01-27_EC_Item%209_Late%20Communication_Item%204_Proposed%20Existing%20Building%20Electfication%20Strategies.pdf

[79] https://www.politico.com/news/2021/03/04/granholm-clean-energy-spending-473668

[80] https://www.hudexchange.info/programs/cdbg-state/

[81] https://www.benefits.gov/benefit/1844

82 https://www.fhwa.dot.gov/environment/alternative_fuel_corridors/resources/ev_funding_report_2021.pdf

83 https://www.whitehouse.gov/briefing-room/statements-releases/2021/04/22/fact-sheet-biden-administration-advances-electric-vehicle-charging-infrastructure/

brings a streamlined funding opportunity and rate certainty to property owners who are considering the prospect of electrification and would benefit from the extra financial line of sight.

Within California

- The California Hub for Energy Efficiency Financing has several financing options available for energy related upgrades, excluding solar PV but including several electrification measures. The program is administered by CPUC and paid for with IOU program funds.[84] Eligible properties must receive either electric or gas service from an IOU, and up to 30 percent of financing can be used for non-eligible improvements.
    - **Residential Energy Efficiency Lending** (REEL) and program provides financing for energy related upgrades for owners of any residential property up to four units. Borrowers can access up to $50,000 for payback terms between 5 to 15 years. Interest rates are between 3.99 – 5.99 percent depending on credit scores, and the average interest rate is 5.02 percent across all terms. Only 28 percent of loans were made to customers with credit scores less than 700, and 18 percent of loans were made to upgrade properties in disadvantaged communities. In early 2021, approximately 1,059 loans have been administered on a total of $2.6M. For every dollar lent, $6.60 in private lending has been leveraged.[85]
    - The **Affordable Multifamily Financing** (AMF) program is available for properties of five or more units, where at least 50 percent of the units are restricted to income-eligible households. The property must be subject to deed restrictions that require the owner to keep rents affordable for a minimum of five years. Repayment can be either direct to the finance company or on-bill for master-metered multifamily properties.
    - The **Small Business Financing** (SBF) program is for business and nonprofit building owners or tenants with fewer than 100 employees and limitations on annual revenue.
- **BayREN** has recently launched the Small Business Microloan program provides no-interest financing on ENERGY STAR certified products. The program is still in a pilot phase. Pre-existing monthly debt payments must be less than half of the business's monthly income.[86]
- **Property-Assessed Clean Energy** (PACE) is a financing mechanism available to private ownership models that enables low-cost, long-term funding for energy efficiency, renewable energy, and water conservation projects. PACE allows property owners to borrow money to pay for energy improvements and repay via a special contractual assessment on the property over a length of the agreement terms (up to 20 years). California state law enabled municipalities to offer PACE financing programs since 2008. The California State Treasurer says that PACE may be used to finance electrification conversions, though specific examples have not been identified.

  PACE has had consumer protection issues such as abusive contractor practices and unsustainable loans.[87] In 2010, the Federal Housing Finance Agency (FHFA) directive prevented Fannie Mae and Freddie Mac from purchasing home mortgages with a PACE lien, and the residential PACE activity had since subsided, except for PACE programs that operate with loan

[84] https://gogreenfinancing.com/
[85] https://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=6442467615
[86] https://www.missionassetfund.org/bayren/
[87]

reserve funds or other measures that address concerns raised in FHFA's directive.[88] Nonetheless, the California Alternative Energy and Advanced Transportation Financing Authority (CAEATFA) has established a PACE Loss Reserve program to mitigate risk to mortgage lenders associated with residential PACE financing.[89]

- **Fannie Mae** provides HomeStyle Energy Mortgage works with lenders to offer loan products to their consumers specifically for energy or water improvements. Borrowers can finance energy or water efficiency improvements or resiliency upgrades when purchasing or refinancing a home. HomeStyle Energy may be a more affordable financing solution than a subordinate lien, home equity line of credit, PACE loan, or unsecured loan.[90]

Outside of California

- **City of Fort Collins** instituted a Home Efficiency Loan Program with local banks to identify inefficient homes occupied by low-to-moderate income families. The program also connected the building owners with local contractors and suppliers who do the renovations. The City's borrowing capacity helped deliver up to $3.25M over 15 years and provide on-bill financing of efficiency projects, including HVAC upgrades, envelope upgrades, and solar PV.[91]
- **City of Boulder** leveraged a local credit union, Elevations Credit Union, and created an energy loan for homeowners that Boulder County supports with a loan loss reserve. Loan rates range from an APR of 2.75 percent for a 3-year loan up to 8.125 percent for a 15-year loan.[92] Similar offerings are available to homeowners in Colorado with various local municipal program partners.
- **Connecticut Green Bank** provides a sub-ordinated debt vehicle, technical assistance, and outreach strategy for their Solar for All program. The program is available to all homeowners (not renters), not dependent on credit score, and focuses on enrolling low-to-moderate income (LMI) applicants. The program aimed to reduce the energy burden for LMI customers down to where it would be if the applicant was affluent and was able to reach 7.5 percent of LMI multifamily housing in the state since FY2014.

3.1.5 Electrification as a Service

Co-Lead, or Support IOUs and Community Choice Aggregations (CCAs) | Pilot, or Support and Advocacy

Building owners can *host* the electrification or EVSE infrastructure and receive lease payment from vendors for allowing them to develop, install, own, and operate the equipment. This is similar to a power purchase agreement for solar installations. In these arrangements, a third-party company would finance and own the asset and be responsible for system design, install, and operation and maintenance, while the host building receives reoccurring payments for providing the property for the system, or they agree to purchase the energy at an agreed upon rate.

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88 https://programs.dsireusa.org/system/program/detail/3527/local-option-municipal-energy-districts
89 https://www.treasurer.ca.gov/caeatfa/pace/index.asp
90 https://singlefamily.fanniemae.com/originating-underwriting/mortgage-products/homestyle-energy-mortgage
91 https://www.fcgov.com/utilities/epicloan
92 https://www.elevationscu.com/loans/energy-loans

- **BlocPower** provides heat pump leasing models aimed at affordable multifamily buildings and small/medium commercial buildings. Since 2012, the company has completed energy projects in 1,000 buildings, and implements leasing structures, project management, and monitoring while delivering energy bill reductions.[93]
- **SparkFund** provides a subscription-based approach to energy systems for commercial and industrial customers, with monthly payments for energy upgrades and operation that deliver outsized utility bill savings.[94]
- **NYSERDA** and **National Grid** are in the process of launching the Home Energy Savings Program pilot, which utilizes ratepayer funding for a pay-for-performance approach that funds whole-house efficiency measures. The program solicits bids from service providers and installing contractors who will develop a project pipeline to receive payments from the program. Development of financing for upfront measure costs is encouraged in a variety of ways, as preferred by the service provider, including upfront payments from customers, debt financing, and equity financing. Service providers and installing contractors are compensated by the program over a period of three years via metered reductions in energy and bill savings.[95]

A fundamental challenge to the *as-a-service* model is to identify buildings with predictable energy consumption that provide steady revenue streams and motivates vendors. This is an area where local governments can provide a critical matchmaking function between technology providers and high potential host sites, such as defining provider criterion and a portfolio of qualifying host sites, to lower development and customer acquisition costs. Local governments can further assist with the development of template agreements that lower the transactional costs of electrification-as-a-service projects.

3.1.6 Ratepayer-Funded Tariffed On-Bill Investment

Support to CPUC, IOUs, and CCAs | Support and Advocacy

There are multiple types of on-bill financing and investment. According to a recent white paper on accessible financing:[96]

> *"A tariffed on-bill program allows a utility to pay for cost-effective energy improvements at a specific residence, such as home heating and cooling units, and to recover its costs for those improvements over time through a dedicated charge on the utility bill that is immediately less than the estimated savings from the improvements. The tariffed on-bill model differs from on-bill loans and repayment models in that tariffs are not a loan, but rather a utility investment for which cost recovery is tied to the utility meter according to terms set forth in a utility tariff."*

Tariffed on-bill models, also known as *pay as you save*, are particularly well suited for LMI homeowners and renters of all incomes, because they do not provide cost or credit barriers while enabling behind-the-meter investment.

[93] https://www.blocpower.io/
[94] https://www.sparkfund.com/case-studies/
[95] https://www.nyserda.ny.gov/All-Programs/Programs/Home-Energy-Savings-Program/Portfolio-Managers

[96] https://www.buildingdecarb.org/uploads/3/0/7/3/30734489/bdc_whitepaper_final_small.pdf

Municipalities must rely on CPUC regulation to authorize, and the IOUs and perhaps CCAs to administer on-bill financing in the coming years. Local governments would ensure that renters have access to on-bill savings associated with decarbonization investments and enforce affordable housing provisions.

- The **Town of Windsor** and the **City of Hayward** received permission from their oversight bodies and implemented tariffed on-bill water efficiency programs, known as Windsor Efficiency PAYS and Green Hayward PAYS, respectively. **BayREN** now administers the Water Upgrades $ave program, which has enrolled 584 multifamily units and 247 single family units across the nine Bay Area counties. 87 percent of program participants would recommend the program.[97]
- **Sonoma Clean Power** is launching an on-bill financing program in March 2021.
- The **Southeast Energy Efficiency Alliance** has invested in a variety of loan and on-bill financing programs and found that tariff on-bill investments have outperformed loans in multiple metrics.[98]

3.2 Municipal Mechanisms

3.2.1 Green Bonds

Local Government Authority | Resolution, Ballot Measure

Green bonds issued by municipal entities help finance projects with a positive climate impact, such as renewable energy and energy efficiency. Funds can likely only be used for public buildings. Governments issue bonds, and investors receive principle and fixed interest payments in return. CAEATFA has provided Energy Conservation Bond financing to 26 projects amounting to $212M.[99]

Green bonds have higher transactional costs than conventional loans and have standards and certification for use of funds to qualify attaching the green label. Notable issuances of green bonds include:[100]

- **Hayward Unified School District** issued $20M in bonds for renewable energy and sustainability projects.
- **Imperial Irrigation District** issued $65M in bonds for renewable energy projects.
- **Sacramento Municipal Utility District** issued $75M in bonds for green building projects.

In 2019, the cumulative issuance of municipal bonds exceeded $8 billion, and the California Green Bond Market Development Committee was launched.[101]

97

98 https://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=6442467615

99 https://www.treasurer.ca.gov/caeatfa/incentives.asp

100 https://www.treasurer.ca.gov/cdiac/webinars/2019/greenbonds/green-bonds-session.pdf

101 https://gspp.berkeley.edu/centers/cepp/projects/green-bonds-market-development-committee/ca-green-bond-market-development-committee

3.2.2 Local Taxes and Fees

Local Government Authority | Ballot Measure

Local governments may tax building projects for greenhouse gas emissions and use the funding to incentivize future decarbonization offsets throughout the jurisdiction. A utility users' tax (UUT) may be levied by municipalities to provide general fund revenue. The tax may be increased to generate funds for projects and programs that reduce greenhouse gas emissions.

- **City of Berkeley** proposed Measure HH in 2020 to increase the UUT from 7.5 percent to 10 percent for electricity and 12.5 percent for methane gas.[102] Despite strong community support from a survey, the ballot measure was ultimately defeated.
- **City of Albany** proposed Measure DD to increase the UUT from 7 percent to 9.5 percent for electricity and gas and apply a tax to water service at 7.5 percent. The measure passed. The measure is estimated to generate an additional $675,600 in new revenues annually for the City.[103]
- **City of Watsonville** adopted a Carbon Fund Ordinance in 2015 that charges a fee to all development projects including new construction, additions, and alterations, with the exception of single-family alterations. The additional carbon impact fee is between 30 and 50 percent of the building permit fee. Projects may be refunded the fee if they install on-site renewable generation to offset the average annual electricity load.[104]
- In late 2019, the **City of San Luis Obispo** tentatively proposed a greenhouse gas *in-lieu fee* for new construction projects that installed fossil fuel consuming appliances, ranging from $6,013 for a typical single-family residence up to $89,000 for a 54,000 ft^2 office.[105] This measure has been delayed for adoption due to political pressure.

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[102] https://www.cityofberkeley.info/Clerk/City_Council/2020/07_Jul/Documents/2020-07-21_(4pm)_Special_Item_05_Placing_a_Tax_Measure_on_the_November_pdf.aspx
[103] https://cdn.kqed.org/wp-content/uploads/2020/10/09-Measure-DD-City-of-Albany-UUT.pdf

[105] https://www.sanluisobispo.com/news/local/environment/article234680472.html

4 Recommendations and Gaps

Given the pace and scale of efforts necessary to achieve carbon neutrality, municipalities must address all areas of the market by invoking as many effective policy and financing options as resources allow. To assess the policy and financing options that may be most effective, TRC developed a scoring system by which to rate each option described in this report. Each option was assessed on a red ("low") to green ("high") scale according to each of the following characteristics:

- Availability – How widely available is the policy or financing option currently, particularly in California? An option with several examples would indicate a high degree of readiness for replication.
- Ease of Implementation – How easily would this policy or financing option be administered from the perspective of the agency, and/or participate in from the perspective of the applicant? Reduced administrative burden suggest quicker processing, a high application rate, and stretching resources for a longer program period.
- Scalability – If given enough resources, can the policy or financing option be scaled to capture all of targeted population?

TRC also characterized each policy and financing option by target market (residential buildings, nonresidential buildings, or EV infrastructure), target population (building owners, renters), target income level (i.e., low-income), and potential role for the municipality (lead or advocate). These characterizations allowed for a standardized format to develop recommendations and point to significant gaps.

Results are sorted by those scoring highest in Figure 3, and are accompanied by a narrative providing further detail.

Figure 4. Policy and Financing Characteristics Summary

	Sub-Category	Mechanism	Bldg	EV	Availability	Ease of Implementation	Scalability	Recom-mended	Muni Role
Policy	Triggered	2.1.2 Point of Transfer	●		🟠	🟢	🟢	●	Lead
Policy	Gov't Buildings	2.1.1 CIP	●		🟢	🟢	🔴	●	Lead
Policy	Performance	2.1.3 Disclosure	●		🟠	🟠	🟢	●	Lead
Policy	Triggered	2.1.2 Major Alteration	●	●	🟠	🟠	🟢	●	Lead
Policy	Achieving Equitable Outcomes	2.1.5	●		🟠	🟠	🟢	●	Lead, Advocacy
Policy	Performance	2.1.2 Emissions Limits	●		🔴	🔴	🟢		Advocacy, Lead
Policy	Eliminate Gas Inf.	2.1.4	●		🔴	🔴	🟢		Advocacy
Consumer Financing	Incentive Programs	3.1.1 CCA (PCE) - EV		●	🟢	🟢	🟠	●	Advocacy
Consumer Financing	Incentive Programs	3.1.1 Regn'l Agency (BayREN)	●		🟢	🟠	🟢	●	Advocacy
Consumer Financing	Incentive Programs	3.1.1 Local Gov't - Bldg	●		🟠	🟢	🟢	●	Lead
Consumer Financing	Tax Credit/Deduction	3.1.2 Federal	●		🟢	🟠	🟢	●	Advocacy
Consumer Financing	Electrification as a Service	3.1.5	●	●	🟠	🟠	🟢	●	Advocacy
Consumer Financing	Incentive Program	3.1.1 CCA (PCE) - Bldg	●		🟢	🟠	🟠	●	Advocacy
Consumer Financing	Incentive Programs	3.1.1 IOUs (PG&E)	●		🟢	🟢	🔴		Advocacy
Consumer Financing	Tariffed On-Bill	3.1.6	●		🟠	🟠	🟢	●	Advocacy
Consumer Financing	Incentive Programs	3.1.1 Regn'l Agency (CSD)	●		🟢	🟠	🔴		Advocacy
Consumer Financing	Loan Programs	3.1.4 AMF	●		🟠	🟠	🟠	●	Advocacy
Consumer Financing	Loan Programs	3.1.4 Municipal Support	●		🟠	🔴	🟢		Lead
Consumer Financing	Loan Programs	3.1.4 REEL	●		🟠	🟠	🟠	●	Advocacy
Consumer Financing	Loan Programs	3.1.4 SBF	●		🟠	🟠	🟠	●	Advocacy
Consumer Financing	Grants	3.1.3 WAP	●		🟠	🔴	🟠		Lead
Consumer Financing	Incentive Programs	3.1.1 Local Gov't - EV		●	🔴	🟠	🟠		Lead
Consumer Financing	Loan Programs	3.1.4 PACE	●	●	🔴	🟠	🟠		Lead, Advocacy
Consumer Financing	Tax Credit/Deduction	3.1.2 RPTT	●		🔴	🟠	🟠		Lead
Consumer Financing	Incentive Programs	3.1.1 State Agencies	●		🔴	🔴	🟠		Advocacy
Consumer Financing	Grants	3.1.3 CDBGs	●	●	🟠	🔴	🔴		Lead
Muni	Local Taxes and Fees	3.2.2 UUT, Carbon Tax	●		🟠	🟢	🟢	●	Lead
Muni	Green Bond	3.2.1	●	●	🟠	🟠	🔴	●	Lead

4.1 Policy Findings

4.1.1 Recommendations

TRC recommends that Menlo Park and other jurisdictions with similar goals explore the following policy options in the near term for building electrification:

- 2.1.1 Municipal Buildings Lead with Electrification – An important policy to raise the profile of community goals, increase government familiarity with the challenges and opportunities of electrification, and establish notable precedents. Jurisdictions should also explore electrification policies as part of Capital Improvement Projects though this policy cannot scale beyond municipal projects.
- 2.1.2 Triggered Appliance Conversion – Highly scalable and readily enforceable if permits are pulled regularly. An example of successful policy implementation includes City of Davis's Resale Program (triggered at point of transfer).
- 2.1.3 Building Performance Standards – Highly scalable and readily enforceable. The City of Boulder's SmartRegs Program has achieved high compliance in existing building energy efficiency compliance.
- 2.1.5 Achieving Equitable Outcomes– Critical to reversing the lasting impacts of discriminatory policies and ensuring

The jurisdiction has the ability to serve as the lead agency in all of these policy options, which is beneficial to enforce customized policies but may also lead to higher administrative investment.

4.1.2 Gaps

TRC noted the following policy mechanism gaps:

1. Though there are several examples of policies triggering additional requirements at the time of major alterations (2.1.2), they have not been implemented for a significant time period and have unknown potential for success. Applicants may attempt to dodge electrification requirements through creative permit applications or avoiding the process entirely.
2. There are very limited examples of existing building policies applying to electric vehicle infrastructure.

4.2 Financing Findings

4.2.1 Recommendations

TRC recommends that jurisdictions explore the following financing pathways for building electrification, largely serving in advocacy and educational outreach roles:

Consumer Financing

- 3.1.1 Incentive Programs – A local jurisdiction may share eligible incentives with project applicants. Several entities, notably PCE and BayREN, have incentive programs in place that are broadly applicable, including carveouts for low-income populations. PCE in particular has two programs specifically for adding EV charging infrastructure in existing multifamily buildings, although is slightly limited in scalability as applicants must be PCE customers to be eligible.

A local jurisdiction may also lead the development of incentive programs, likely with funding from a partner organization. San Jose and Marin County funded electrofit incentives by partnering with BAAQMD.

- 3.1.2 Tax Credits, Deductions, and Rebates – Federal tax incentives can be attained for eligible electrofits and stacked with incentive programs, though they are fairly low amounts.
- 3.1.5 Electrification as a Service – A local jurisdiction can play a key role in fostering an Electrification as a Service market by reducing market entry barriers for providers such as BlocPower. Or, a jurisdiction can advocate for establishing a local program like NYSERDA's, which creates a market for contractors and installers by paying them for projects that deliver metered bill savings.
- 3.1.6 Ratepayer-Funded Tariffed On-Bill Investment – Tariffed on-bill programs serve a wide market, including the harder to reach markets such as renters with modest credit history. Local jurisdictions can advocate with the CPUC to ensure this policy option becomes available.
- 3.1.4 Loan Programs – A suite of loans are available for credit-worthy residential and nonresidential building owners through the state financing authority. These programs may fill in gaps where building owners may have insufficient access to incentive programs or tax deductions. Loans are expected to be one of the last options to financing a project, as they carry more risk for the applicant than many of the preceding options listed.

Municipal Financing

- 3.2.1 Green Bonds and 3.2.2 Local Taxes and Fees – Voter-approved fund generation mechanisms can affirm a community's willingness to invest in decarbonization measures. Bonds can be used for public infrastructure projects, and increased revenues from utility taxes can serve potentially provide consumer financing.

4.2.2 Gaps

TRC noted the following financing mechanism gaps:

1. The investment for heat pump space heating as a replacement for a methane gas furnace can be very high in a building that doesn't already have air-conditioning, which is prevalent in the Bay Area according to the Residential Appliance Saturation Survey. TRC did not identify incentives large enough to support this market to transition away from methane gas.
2. As with policy options, there is limited precedence for existing building EV financing. A jurisdiction may supplement PCE's EV incentive program with additional incentives, or additional loan programs targeted toward EV investment in a similar manner that Boulder partnered with a local credit union.
3. Nonresidential buildings are eligible for fewer incentive programs than residential. This may be due to the higher turnover rate of nonresidential spaces and equipment, the higher financing needs and access of the nonresidential market.

4.3 Further Considerations

TRC recommends that local jurisdictions thoroughly assess the people and buildings needing that must be reached to achieve the carbon neutrality goals. Understanding the scale of the challenge (e.g., square footage of buildings by type, number of multifamily buildings with parking, major property owners in the City, energy burden for low-income residents) will allow the jurisdiction to estimate the corresponding scale of the solutions necessary (e.g., dollars of investment, outreach strategies, retrofit rates, consumer protections).

Several related issues emerged throughout the course of TRC's research that did not explicitly fit within the scope of this report. These additional considerations, listed briefly below, suggest that the policy and financing options in this report would be implemented more effectively if the jurisdiction a range of market transformation strategies:

1. Protecting consumers must be a priority to prevent the abusive practices that emerged in the PACE program. For example, financing energy upgrades with home-secured debt is inappropriate for homeowners with lower incomes.
2. Simplifying permitting processes will reduce administrative burden. Coordinating the processes across jurisdictions will familiarize the building industry with requirements.
3. Measure packaging, such as combining electrofits, EV charging, efficiency, demand response compensation, and/or on-site solar may drive down operating costs and improve cost effectiveness. Adding vehicle-to-building charging or battery storage may improve resiliency and project appeal.
4. Inspecting, auditing, and/or evaluation provides an accurate understanding of program impacts and informed position by which to make future investments.
5. Targeting outreach and programs to portfolio property owners may generate economies of scale.
6. Achieving 'early wins' can demonstrate feasibility, drive down market barriers, and improve public perception.
7. Ensuring that the workforce is well-trained and incentivized to perform high-quality installations will require dialogue with local trade associations, unions, training programs, and certifying bodies. These efforts can achieve equitable outcomes, as demonstrated by the RichmondBUILD and Rising Sun Center for Opportunity's Climate Careers programs.[106,107]
8. Providing technical assistance with engineering and financing approaches can simplify compliance and mitigate negative experiences.

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106 http://www.ci.richmond.ca.us/1243/RichmondBUILD

107 https://risingsunopp.org/