Electrification Best Practices Review

Examples and Cost-Effectiveness for Commercial Kitchens, Labs & Life Science Buildings, Public Emergency Centers, ADUs, and Affordable Housing

RICAPS
Regionally Integrated Climate Action Planning Support

OFFICE OF SUSTAINABILITY
COUNTY OF SAN MATEO

C/CAG
City/County Association of Governments of San Mateo County

PENINSULA CLEAN ENERGY

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The County of San Mateo Office of Sustainability administers the Regionally Integrated Climate Action Planning Support (RICAPS) program with funding from the City/County Association of Governments, Peninsula Clean Energy, and Pacific Gas and Electric Company. RICAPS hosts a monthly working group to support local government staff in developing and implementing climate action plans that reduce greenhouse gas emissions. This Electrification Best Practices Review was developed via the RICAPS program to provide support for emission-reduction efforts.

Why pass local all-electric building reach codes?

Natural gas use in buildings currently accounts for around 25% of total GHG emissions for jurisdictions in San Mateo County. Decarbonizing the building sector by replacing these natural-gas powered functions (heating, cooling, cooking, etc.) with all-electric technology is critical to achieving the State of California's goal of carbon neutrality by 2045.

Building all-electric now is the easiest way to decarbonize the building sector and avoid natural gas emissions before they happen in the first place. Reach codes are local policies that "reach" beyond the requirements of State building code. By establishing all-electric future buildings through local reach codes, jurisdictions avoid locking in natural gas infrastructure when there is all-electric technology available. Building owners will also avoid the future costs of all-electric retrofits which will be inevitable for meeting state climate minimums. **As the new Title 24 takes effect in January 2023, jurisdictions enter a critical window to adopt these reach codes early in the code cycle, decarbonizing as many future buildings as possible.**

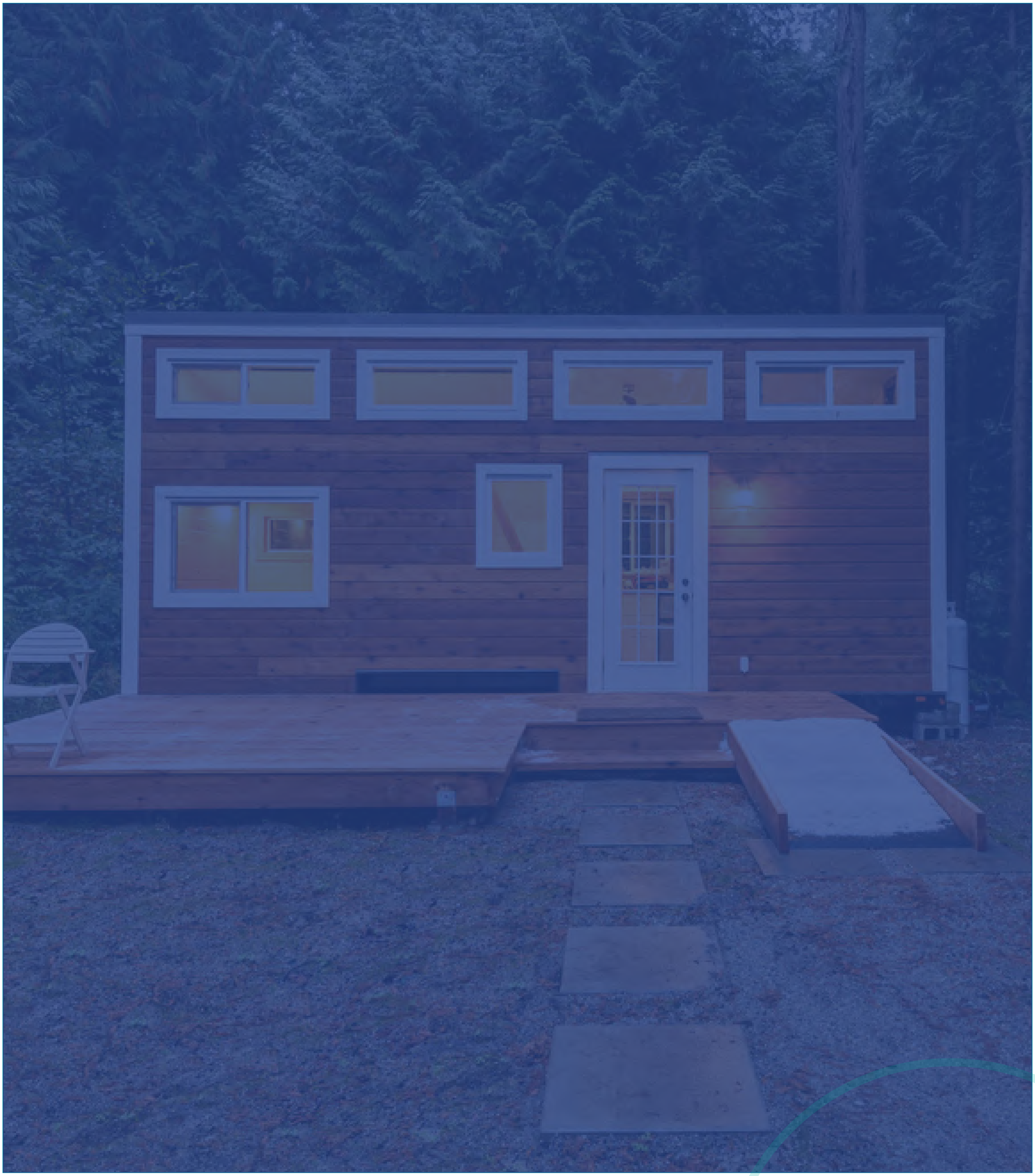
Why did we write this Best Practices Review?

As of Fall 2022, 70% of jurisdictions in San Mateo County had a reach code for new buildings in place. Unfortunately, many of those all-electric reach codes exempt entire building types, allowing developers to incorporate natural gas infrastructure without considering if an all-electric option was available, or even more cost-effective than a mixed-fuel building.

This Electrification Best Practices Review identifies the five most frequently exempted building types from all-electric reach codes in San Mateo County: commercial kitchens, ADUs, affordable housing, public emergency centers, and labs and life sciences buildings. These five building types are seen as difficult to build as all-electric, but the San Mateo County-tailored all-electric examples, best practices for electrification, and tools for implementation in this Review show that it is actually technically possible and economically feasible to build these five building types as all-electric.

This Review can serve as a **resource for City Councils, advocates, developers, and the general public when a jurisdiction is considering all-electric reach codes that do not exempt entire building types automatically.** It is intended to inform the larger conversation about the policy and programmatic pathway towards building electrification and assist jurisdictions in adopting more uniform policies countywide.

Thank you to the local government staff who helped collaboratively shape this work.



1 Accessory Dwelling Units

1 – Accessory Dwelling Units

ADU Cost Effectiveness Results:
According to statewide cost analysis, all-electric ADUs are cheaper to build than mixed fuel alternatives, reducing costs of development by over $1,000 when compared to mixed fuel buildings.

Accessory Dwelling Units (ADUs) are a key strategy in addressing California's housing crisis. For the many jurisdictions focused on removing barriers for ADU development, there is a misconception that adding all-electric requirements for new construction will slow or block ADU development through increased costs (electric panel upgrades, increased permitting and regulatory burden).

All-Electric ADUs Are Cheaper to Build than Mixed Fuel: New ADU Construction Costs[1]

	Mixed Fuel Cost	All-Electric Measures	All-Electric Cost	All-Electric Incremental Cost
Appliances: space heater, water heater, clothes dryer, range				-$221 cheaper than mixed fuel
In-house gas plumbing	$540	In-house electrical upgrades for branch circuits	$600	$60
Site gas service extension	$1,998	No site gas service	$600	-$1,998 cheaper than mixed fuel
Site electric service connection upgrade 225A	$3,500	Site electrical service connection upgrade 225A	$0	$0
100A Feeder to ADU with breaker	$933	125A feeder to ADU	$3,500	$273
100A ADU subpanel	$733	125A ADU subpanel	$1,206	$213
Outdoor closet	n/A	Heat pump water heater closet**	$946	$650
Total (HPWH outside closet)	$7,704		$650	-$1,024 cheaper than mixed fuel
Total (HPWH in conditioned space)	$7,704		$6,901	-$1,674 cheaper than mixed fuel

[1] **Additional cost for outdoor close is required only for climate zones where heat pump water heater is located 'Outside'. Sources: Residential New Construction Report (2019) Table 6, RSmeans, Interviews, RS Means, CEC 2020 Reach Code Cost-effectiveness analysis

The analysis above was conducted for the 2020 code cycle. As the 2022 base code requires pre-writing for all-electric, we can assume that the all-electric incremental cost for electrical upgrades, connection upgrades, feeders, and subpanels would now be zero as they would have to be installed regardless of fuel type. This would lead to an additional $546 in cost savings over mixed fuel. Analysis was conducted by the CEC for all California climate zones.

Project Location:
Woodside, CA

Size:
2,000 sq ft

Completion Year:
2021

Collaborators:
Architect: Hilary Bates Architect AIA

Energy Consultants: Energy Design Group & Chris Hunt, Home Energy Analytics

Contractor: Mike Raynor Construction

Whiskey Hill Farm ADU Renovation

Originally a barn and previously non-permitted apartment built in 1958, this all-electric renovation project includes built in energy efficiency measures as well as all-electric water and air heat pump equipment, and an on-site microgrid (solar PV and energy storage). It also features the dual function of the agricultural uses of a barn (boarding horses), and the above-barn living unit which houses a family of five. This project is one of the few, and potentially only multi-use residential and agricultural buildings in San Mateo County.

Building Highlights:

- Microgrid: 6.4 kWh solar PV + battery storage (five Tesla Powerwalls)
- Heat pump water heater
- Air source heat pump for space heating and cooling
- Induction cooktop
- Energy efficiency measures including envelope insulation, exterior window shading, energy star appliances

Image Source: Peninsula Clean Energy

Key All-Electric ADU Considerations:

- ADUs, and Junior ADUs both must comply with the California State Energy Code (Title 24), which is progressively moving towards all-electric buildings and is updated every three years. The new code requires all-electric pre-wiring.
- Natural gas prices could more than double as residential demand declines, and more residential buildings go all-electric, according to GridWorks. Building all-electric ADUs now will insulate residents from future price increases for natural gas services.
- Equity and public health: natural gas, particularly in cooking applications, is a leading cause of indoor air pollution and can be avoided completely through an all-electric home.

Additional All-Electric ADU Examples

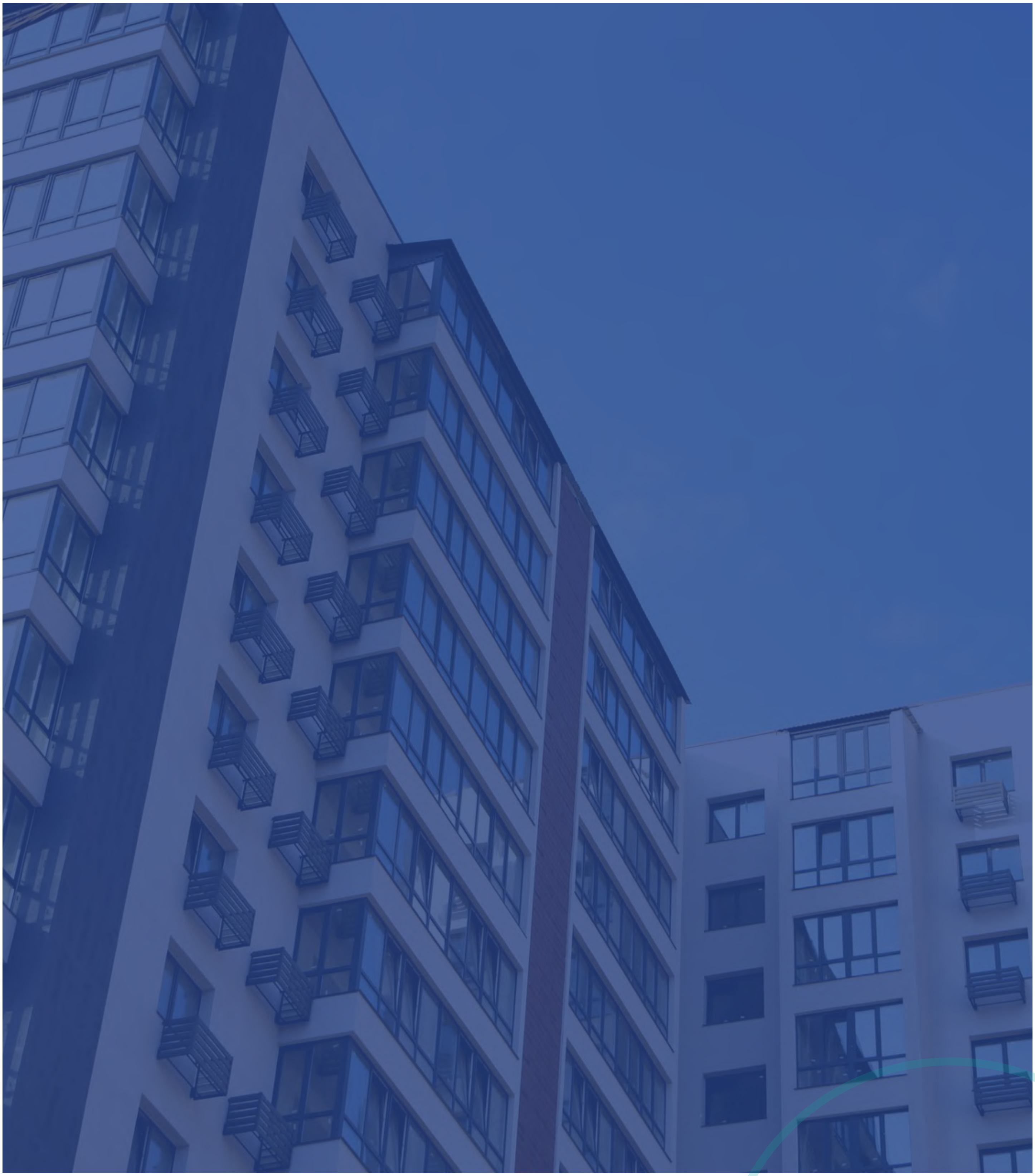
- 1,200 sq ft new ADU, Hyde Park, CA – 2020 3 bedroom two bath ADU construction project. All-electric was chosen due to cost savings ($3,500 cost savings in not running gas lines); as well as motivations to stay ahead of the State of California Building Code.
- Carbon Shack Design Barn to ADU Conversion, Los Angeles, CA—2021, This LA Times featured ADU is all-electric, featuring energy star-rated appliances including an induction cooktop, combination microwave, and convection oven.

All-Electric Kitchen for Carbon Shack Design Barn to ADU Conversion

Image Source: LA Times

Toolkits & Additional Resources

- PCE & BayREN incentives for heat pump water heater rebates (replacement, retrofits only); Jurisdiction specific incentives for installation (replacing gas with electric); Free energy advisor consultation, and rebates for solar + storage.
- The Switch Is On for comprehensive information on all-electric appliances
- All Electric Home- Save Money By Building your ADU with No Gas Line Tutorial with Green Living Builders LLC Rolf Bell (2021)
- California Housing Finance Agency ADU Grant Program provides up to $40,000 for costs associated with ADU construction (predevelopment) including designs and energy reports.
- All-electric directory for residential (single family, multifamily, mixed) vetted by Peninsula Clean Energy
- Jurisdictions may also consider an all-electric adaptation of pre-approved ADU programs :
    - City of San Jose, Chico, Encinitas, Danville, San Diego County are first movers in pre-approved ADU programs, though pre-approved ADU plans do not explicitly state that the building plans are all-electric or mixed-fuel.
    - Program summary: standardized ADU plans do not require city or planning approval, which leads to increases in speed and decreases in cost because of reduced regulatory burden.
    - Program offers pre-approved construction and architecture designs for ADUs
    - Policy Highlight: Encinitas: requires an efficiency kitchen for JADU developments, with no appliances that require an electrical service greater than 120 volts, or natural or propane gas.



2 Affordable Housing

Perceived Hurdles & Solutions

Percieved Hurdle:

All-electric buildings cost more.

Solution:

With the 2022 Building Code, all-electric ready (prewiring and panel capacity) buildings are required for all building types. Heat pump water heaters or HVAC appliances are also required depending on climate zone. Under the 2022 code, installing natural gas increases time and material costs.

Percieved Hurdle:

Uncertainty around electrical rates for operation of all-electric buildings could lead to higher operating costs, reducing operating income and leveraged debt, reducing competitiveness for tax-exempt bond finance and low-income housing tax credits.

Solution:

All-electric buildings, particularly when paired with solar generation and battery storage outperform mixed-fuel buildings in operating cost and costs to construct across California climate zones.

Additionally, locking in natural gas infrastructure into building operations will lead to increases in operating costs, as natural gas prices could more than double as residential demand declines and more residential buildings go all-electric, according to GridWorks. Building all-electric affordable housing now will insulate residents and developers from future price increases for natural gas services.

2 – Affordable Housing

All-electric multifamily residences in San Mateo County (Climate Zone 3) are cheaper to build and operate than mixed-fuel developments, particularly when combined with on-site solar generation and heat pumps for water and space heating. However, affordable housing is sometimes exempted from all-electric reach codes because of fears that additional requirements will slow or block much needed affordable housing development. This is of particular concern for projects that leverage multiple sources of funding (ex. Low Income Weatherization Program) which can have difficult application processes and long turnaround times.

Perceived Hurdles & Solutions *(cont.)*

Percieved Hurdle:
Gas-powered cooking equipment should be installed because of residential preferences/ familiarity of cooking with gas.

Solution:
The perceived benefits or gas-powered cooking does not consider the disproportionate health impacts of gas-powered appliances, in particular, gas stoves, on tenant health.

Low-income housing residents disproportionately suffer from long-term health conditions like asthma and heart disease because housing stock is closely linked to socioeconomic status. Gas is a major source of indoor air pollution, emitting pollutants including nitrogen dioxide and carbon monoxide. Nitrogen dioxide can lead to decreased health effects in children, including an increased risk of childhood asthma.

All-electric housing offers a significant chance to reduce environmental inequities in indoor air quality. A study of two public housing apartment buildings found significant improved health outcomes among participants who moved from conventional apartments to "green" housing, likely due to a 65% reduction in nitrogen dioxide and 57% reduction in PM 2.5.

The benefits of all electric construction include cheaper up-front costs for construction, and more equitable cost and public health outcomes. Under the 2022 building code, all-electric ready is mandatory for all building types. This means that building all-electric means one less subsystem (natural gas) to install, saving time and material cost. All-electric affordable housing is also critical for environmental justice and equity, as mixed-fuel buildings burden low-income residents with worse indoor air quality, and increasing cost burden from gas utility bills as the price of gas is expected to rise.

All-electric examples

Project Location:
San Pedro, CA

Size:
91 units (mix of one, two, and three-bedroom apartments)

Completion Year:
2023

Collaborators:
Linc Housing Corporation, National CORE (nonprofit development); general contractor: National CORE, RRM Design Group, energy modeling: National Core

Land donated by City of Los Angeles

456 West, San Pedro, Affordable Housing Community

This project is a 91-unit apartment community in San Pedro designated for individuals and families who earn between 30-80% of the area median income. The all-electric development, which is led by two nonprofit developers of affordable housing, also offers primary care, a pharmacy, and a behavioral health center. It replaces a city-owned parking lot with land donated by the City of Los Angeles.

Funding Structure:

Funding: Housing + Community Investment Department of the City of Los Angeles, tax credits through Raymond James, construction loan by Bank of America, permanent loan by California Community Reinvestment Corporation

Building Highlights:

- Nonprofit-City financing partnership & loan structure
- All-electric with central heat pump hot water heater, energy modeling conducted by National CORE.
- Solar thermal hot water heating system

Image Source: Linc Housing, LA Urbanize

> **This project… will serve as a model for countless developments to come in this neighborhood and others throughout this region.**
>
> ***- Los Angeles Mayor Eric Garcetti***

Project Location:
Sunnyvale, CA

Size:
109,000 sq ft; 66 units; 4-story

Completion Year:
2018

Collaborators:
Civil Engineer: Sandis; Sustainability: Association for Energy Affordabiltiy; Interior Architect: David Bker Architects; MEP: Emerald City Engineers; Landscape: Fletcher Studio; General Contractor; James E. Robert-Obayashi Corp; Structural Engineer: Murphy Burr Curry

Edwina Benner Plaza Low Income Property

This 66-unit low-income property is owned by MidPen Housing, a leading low-income nonprofit affordable housing developer, and property owner. Initially conceptualized as a mixed-fuel building, a contracting change to Association for Energy Affordability led to the building being built as all-electric. This development is significant for multiple reasons, including its location in Silicon Valley, which is one of the nation's most expensive housing markets.

Building Highlights:

- Central heat pump water heating system
    - Custom high-efficiency design with CO2 refrigerant, design assisted with CEC EPIC Grant and Energy Consultant
- Compact recirculation loop for central heat pump hot water plant
- On-site rooftop solar power enough to cover common building process loads, with the rest of purchased electricity from renewable power sources
- Home energy monitor

Image Source: DB Architects

“

There were no significant differences in the construction cost in building an all-electric property versus a traditional property. Plus, there are grants available from the California Energy Commission for select all-electric construction projects.

- April Mo, Associate Project Manager, MidPen Housing

Toolkit & Additional Resources

- Prioritizing California's Affordable Housing in the Transition Towards Equitable Building Decarbonization. **California Housing Partnership, 2021.**
- Equitable Building Electrification: A Framework for Powering Resilient Communities. **Greenling Institute, 2022**

All-Electric infrastructure at Edwina Benner Plaza

Source:Silicon Valley Clean Energy

Cost Savings for Building All-Electric Affordable Housing

- **Leveraging funding incentives for energy efficiency and low-carbon building for affordable housing:** The State of California, Community Choice Aggregators (CCA), provides incentives for energy efficiency measures (Low Income Weatherization Program, LWIP) and GHG emission reduction for low-income housing developments (BUILD, California Energy Commission).
    - However, the California Housing Partnership notes that these funds can be difficult to access, and sometimes are out-of-sync with developer timelines, or other core sources of development funding.
- **All-electric developments avoid the additional cost of adding gas lines and infrastructure.** Plumbing gas for new developments, in combination with infrastructure and appliance costs can add thousands of dollars per residence. Rocky Mountain Institute found that in single family housing, adding gas infrastructure (piping, purchasing appliances, venting), added $8,800 per single family residence.

Other Affordable Housing Examples

- **Arrowhead Grove, San Bernardino, CA** – Each unit in this 184 unit project of affordable multifamily housing features individual heat pump water heaters. The project was completed in 2021, and led by National Core, RRM Design Group, and Metrics Mechanical.
- **Vista Verde, Ontario, CA** -- This 101 unit affordable housing development was completed by National Core, Southwest Engineering Group, and Onyx Architects. The building was finished in 2020 and includes individual heat pumps per unit.
- **Legacy Square, Santa Ana, CA** – Set for completion in 2022, this 93-unit affordable housing development was developed by National Core, who also did the energy modeling. The building features individual heat pumps per unit.

All-Electric Affordable Housing, San Bernadino

Image Source:Arrowhead Grove

3 Commercial Kitchens

Perceived Hurdles & Solutions

Percieved Hurdle:

All-electric commercial kitchen equipment is not available on the market; and/or is too expensive;

Solution:

Commercial electric ranges, ovens, fryers, and catering/ buffet equipment are increasingly available. Costs of purchase/ replacement are supported by programs like the California Foodservice Instant Rebates program, which allows restauranteurs to save potentially thousands of dollars per unit of commercial food service equipment.

Percieved Hurdle:

Gas-powered equipment is critical for culturally appropriate ways of cooking food, particularly among AAPI restauranters. Induction cooking technology does not accommodate wok cooking, and can't achieve wok hei (the complex charred aroma that is a hallmark of Cantonese cooking via wok).

Solution:

Induction woks are increasingly popular in Mainland China, Taiwan, Hong Kong, and Macau. Many commercial grade induction cookers are currently available that can accommodate concave pans (such as woks). In 2020, 15 million induction cookstoves were sold in Mainland China, with a growth of nearly 4% from the previous year. Though pushback against no new gas commercial kitchens may reflect important immigrant generational attitudes, all-electric kitchens are increasingly common in East Asia.

Additionally, induction wok cooking can save the average Asian food restaurant hundreds of thousands of gallons of water per year , while still achieving wok hei through total contact of heat on the pan. Water is saved via reduced water running over the stovetop to cool the metal surface that is above the flame jets, which is a common feature of conventional woks.

3 – Commercial Kitchens

Commercial kitchens are sometimes exempted from all-electric reach codes because of concerns that electric kitchen equipment cannot replace the functionality of gas, and electric kitchen equipment is not readily available for purchase. Additionally, there are concerns that all-electric kitchens will be more expensive to operate, burdening small businesses with increased operation costs. In reality, commercial electric kitchen equipment is increasingly available on market, with programs in place for restaurateurs to trial kitchen equipment before purchasing and take advantage of rebates for purchasing all-electric equipment. Avoiding the installation of new gas lines can also avoid up-front costs, and lead to increases in workplace air quality through decreased ventilation needs. The all-electric examples outlined below show that all-electric kitchens are feasible, cost-effective, and compatible with multicultural cuisines.

All-electric examples

Project Location:
Redmond, WA

Size:
13,200 sq ft. of cooking space; 360 separate pieces of electric equipment

Capacity:
1,050 meals/ day

Completion Year:
2022

Collaborators:
Project lead: Microsoft real estate team.

Compass Group (Microsoft's food service provider); Custom electric wok created for Microsoft's Pacific Rim Eatery with commercial manufacturer Jade Range; Clevinger Associates; Contractor Lease Crucher Lewis

Microsoft Redmond Campus: All-Electric One Esterra Food Hall

Microsoft's all-electric kitchens are critical in achieving Microsoft's carbon negative by 2030 target. One Esterra, Microsoft's first 100% electric dining facility is a proof of concept for the even-larger all-electric kitchen planned for East Campus (77,000 sq ft), which will be completed by 2023. One Esterra combines nine culinary concepts, including Latin and Asian cuisine into one all-electric food hall.

Building Highlights:

- LEED Platinum
- Custom induction wok development (induction wok vs gas wok efficiency is 4:1)
- 100% renewable energy powered kitchen & building
- Commercial equipment was tested on a multi-part criteria including: Aesthetics, speed, capacity, taste, temperature. Electric equipment was found to match or outperform gas equipment.
- A typical Microsoft kitchen uses up to 80% gas powered equipment (One Esterra)

Image Source: Microsoft

> "At the end of the day, I thought the product was great and I actually enjoyed cooking in the [electric] wok. For one thing, with a traditional wok, I'd be sweating because it would be super-hot but with the electric one, I'm not even breaking a sweat.
>
> *- Compass Regional Executive Chef Jevic Acain*

Induction Wok at One Esterra *(Source: Microsoft)*

Source: Building Decarbonization Practice Guide Volume 7

Energy and Cost Savings:

- 115,800 kWh annual energy saved by switching from radiant to induction griddles & ranges (savings come from 7 ranges; 5 griddles)
- 3% reduction in electrical consumption across the building

Toolkit & Additional Resources

- **The California Foodservice Instant Rebate Program can be used by non-residential sites that receives natural gas and/ or electricity service from PG&E. Rebates cover all-electric commercial kitchen equipment, saving of hundreds of thousands of dollars per piece of equipment.**
    - **Explore the statewide map for participating dealers for California Foodservice Instant Rebates**
- **"Try before you buy" resources for restauranteurs via California Energy Wise's Food Service Technology Center allows restaurateurs to try all-electric and high-efficiency equipment.**
- **Resources also include design guides, seminars and webinars,**
- **Technical expertise and comparisons of induction technology by Frontier Energy**
- **Industry resources, chef testimonials, and culturally appropriate outreach products from the Building Decarbonization Coalition "Now We're Cooking" initiative.**

Other Commercial Kitchen Examples:

- Stanford University, Murray House, Palo Alto, CA – 2021 retrofit of a dormitory commercial kitchen to replace gas-burning commercial kitchen equipment with electric equivalents: commercial electric fryer, two electric griddles with convection ovens, and an induction range.
- Oysterman Seafood Bar & Kitchen, London, England – The restaurant switched from gas to induction units, which allowed the restaurant to serve guests at a significantly faster rate. Gas ranges and fryers are half as efficient at transferring heat as electric ranges and fryers (35% vs. 75%), and electric ranges boil water twice as fast as gas ranges. Electric kitchens therefore, use half or less as much heat to cook food and require half as much air conditioning.
- Benihana Japanese Steak House, various locations, U.S. – The first Benihana steakhouse was started in New York City in 1964 and has since grown to 116 restaurants. Benihana performs teppanyaki cooking on steel grills. Recently the restaurant chain converted its gas teppan grills to electric resistance and induction grills, which can cook meats faster, hotter, and more efficiently than gas while reducing the risk of uncontrolled fires.
- Hotel Marcel, New Haven, CT – The hotel has an all-electric commercial kitchen, which uses induction, including an induction wok setup.

Co-Benefits of All-Electric Commercial Kitchens

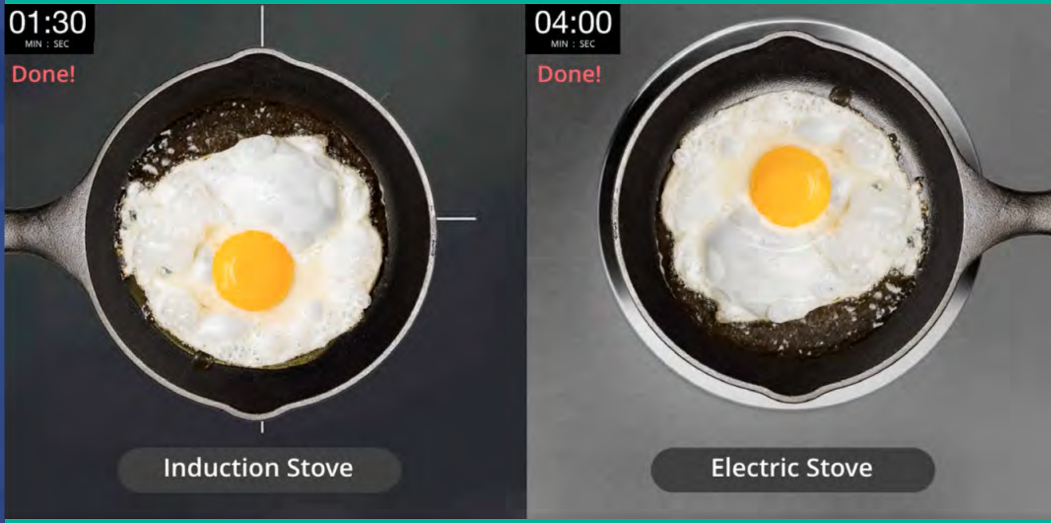
Increased worker welfare & health outcomes:

All-electric commercial kitchens can operate with reduced kitchen venting requirements (ex. Hot air fryer vs. oil fryer), and improve worker safety through no oil burns, and reduced chance of slipping on floors. Gas stoves, particularly if kitchen space is poorly ventilated, are a major source of indoor air pollution, emitting pollutants including nitrogen dioxide and carbon monoxide. An all-electric kitchen also provides more thermal comfort to kitchen staff as there is nearly
no waste heat transferred into the kitchen from open flame or gas equipment.

Cost Savings due to no Gas Installation Costs:

All-electric kitchens eliminate the need for gas utility connections and indoor gas plumbing systems, saving restauranteurs installation money. Additionally, all-electric kitchen equipment (particularly induction technology) is more precise and efficient than gas: induction hobs are up to 94% efficient in heat transfer, while gas burners are 44% efficient.

Induction stove technology is as efficient as gas:



Source: Building Decarbonization Practice Guide Volume 7

4 Public Emergency Centers

Perceived Hurdles & Solutions

Percieved Hurdle:

All-electric buildings are less resilient than mixed fuel buildings.

Solution:

Natural gas provides no additional resiliency during times of power outage. All-electric buildings, particularly those that are enabled with solar and battery storage, and a backup diesel generator provide maximum resilience for potential days of power outage. The combination of a battery and on-site solar can allow the building to be grid-connected while operating independently during times of power shutoff.

Battery storage is effective to provide uninterrupted power for a number of hours, which then extends the life of a diesel generator with a finite fuel supply that can typically last for a couple of days. Batteries are also part of the prescriptive code requirements in the 2022 building code. As they would be installed anyway, new construction would have backup battery power by default, incurring no additional costs for battery installation beyond code requirements.

Percieved Hurdle:

All-electric buildings are too expensive for cities to finance.

Solution:

Avoiding the installation of new natural gas lines and hookups save upfront construction costs, while ensuring long-term cost savings against rising natural gas prices.

4 — Public Emergency Centers

Public emergency centers are sometimes exempted from all-electric reach codes because of concerns that resilient backup power can't be achieved without building natural gas. Natural gas lines offer more risk than safety during times of emergency, as they can rupture and explode during seismic events. Established technologies like microgrids, that combine solar and battery storage can be paired with a diesel backup generator for emergency power. These solutions allow public emergency centers to maintain critical functions during power outages while not locking in fossil fuel infrastructure and saddling building operators, likely the jurisdiction, with increasing utility bills as gas rates increase over time.

Project Location:
Issaquah, WA

Size:
11,400 SF

Completion Year:
2011

Collaborators:
City of Issaquah, Eastside Fire and Rescue, TCA Architecture

City of Issaquah and Eastside Fire & Rescue Fire Station 72

This Fire Station is one of the most energy-efficient fire stations in the world, winning the first place in the ASHRAE Technology Award in 2012. Eastside Fire and Rescue occupies and operates this two-story facility, which uses ground-source heat pumps and a blend of on-site generation of renewable energy and energy efficiency measures. Though not explicitly described as all-electric, this publicly funded and operated facility uses mostly all-electric technology for heating and cooling to meet the around-the-clock power needs of the firefighters that live in and operate this building. The building also supports the City Climate commitments by contributing to carbon reduction goals and is set to achieve Net Zero energy use by 2030.

Image Source: Ecotope.com

Building Highlights:

- 30kW photovoltaic array on-site
- Targets for energy efficiency achieved through a blend of heat recovery ventilation, a ground source heat pump system, solar water heating, high efficiency appliances, advanced lighting design and controls, and super-insulation.
- LEED Platinum certification, on track to meet Net Zero energy use by 2030
- The building was funded by voter-approved bonds, city capital funding, and fire mitigation funds.

City of Issaquah and Eastside Fire & Rescue Fire Station 72 *cont.*

City Policy Highlight:

- The City of Issaquah had an expedited building performance review for green building to incentivize buildings to meet its green buildings goal. The City's green buildings goal ties into the climate goal of reducing carbon emissions 50% by 2030 compared to a 2007 baseline.

Energy, Emissions, and Cost Savings:

- Uses ¼ the energy of a typical regional fire station;
- Achieved Energy Use Index (EUI) of 25 kBtu/sf per year
- 68 MT CO_2-e saved per year
- Final cost ($6.6. million) is $1.4 million under the original estimate.

Image Source: Ecotope.com

All-electric examples

Image Source: Danville San Ramon.com

Project Location:
Dublin, California

Size:
24,800 sq ft

Cost:
$15 million

Completion Year:
2020

Collaborators:
Indigo Hammond + Palyle Architects, Miyamoto, Peter Seng

City of Dublin Public Safety Complex

While not explicitly described as all-electric, the City of Dublin Public Safety Complex is an example of a municipal-owned zero energy (ZE) public safety building that leveraged energy efficiency, backup electrical power, and renewable power to build a sustainable and resilient public safety complex. The public safety complex houses essential City functions including the Dublin Police Services administration, Alameda County Fire Department, as well an expanded Emergency Operations Center. The project is a remodel of an existing building that needed to be brought up to code and could provide inspiration to other jurisdictions to leverage the public procurement process to fund the building of structures that are zero energy and all-electric.

Image Source: Peter Seng

Building Highlights:

- On-site solar panels provide 70% of building energy needs; over 500 photovoltaic panels on carports
- Backup generators provide sources of emergency power (enhanced emergency power services)
- Eligible for LEED-Platinum standard for civic buildings
    - LEED-Gold energy efficiency

Public Emergency Center Key Considerations:

- Backup battery power to maintain building functions during power outages, and natural disasters
    - Examples from data centers (Google's battery-based system to back up data centers); and healthcare (see the Labs & Life Sciences Section) demonstrate that all-electric buildings can effectively function during power outages using a combination of renewable power and battery storage.
- Leveraging municipal procurement standards for all-electric buildings (similar to the University of California internal policies detailed in the Labs & Life Sciences section), as these buildings likely go through the public procurement/ bidding process in order to be developed using public funds.
    - Recommendation: Municipal procurement and bidding processes could make it difficult to construct all-electric buildings if capital costs are higher (even if life cycle costs are favorable). Reference Issaquah's streamlined review process for green buildings for inspiration on potential ways to push forward new construction of green buildings.

Other Public Emergency Center Examples

Municipalities are increasingly leveraging public buildings like schools and libraries as resilience centers, resilience hubs (ex. cooling centers, air purification during high-smoke events, disaster preparedness, etc.) Examples of all-electric libraries, schools, and public buildings in California are profiled below, as these building types may have increasing crossover into the functionalities of a public emergency center building.

- **Public Middle School (San Francisco Unified School District), San Francisco, CA —** This project is a new (2022) all-electric facility with Zero Net Energy (ZNE) performance. The Building is 12,000 sq ft of classrooms and gymnasium space. It uses a High-efficiency ground mounted heat pump for each classroom, and a high-efficiency roof-mounted heat pump for the gymnasium. Water is heated using standard electric resistance hot water. Solar PV is also installed to offset energy cost.
- **West Berkeley Public Library, Berkeley, CA —** This project is the first "net zero" library in the state and the third municipal building of its kind in the United States (in 2015). The library is outfitted with solar panels that produced 7,027 kWh of electricity than it consumes annually. It is also a LEED Platinum facility.

5 Labs & Life Science

Perceived Hurdles & Solutions

Percieved Hurdle:

Labs and life science buildings cannot perform their core functions without natural gas.

Solution:

Innovators like the University of California and Allogene have proven that there are market-ready electric alternatives for key lab and life science functions. These functions include emergency backup power, and the sterilization of water and other materials. Examples of all-electric compatible technology includes the chemical treatment of legionella bacteria, and on-site generators as sources of emergency power.

Percieved Hurdle:

New buildings in this economically important and growing sector will not be built in a jurisdiction unless there is a reach code exemption easing the way for development.

Solution:

All-electric labs and life science buildings are cost competitive with mixed fuel buildings and add competitive edge for businesses in this sector. These qualities demonstrate that natural gas is not an economic pre-requisite for development.

All-electric lab and life science buildings were shown by a University of California study to be cost-comparable, or slightly less expensive than mixed fuel buildings over a 20-year lifecycle cost perspective.

Modern all-electric equipment can also provide competitive edge, with companies like Allogene claiming that all-electric manufacturing is key for quality control and innovative manufacturing.

5 – Labs & Life Science

Labs and life science buildings are often exempted from all-electric reach codes due to the perception that these buildings need natural gas to preserve key functions like emergency backup power and, sterilization of water and materials. Other misconceptions include the idea that if there is not a blanket exemption for labs, potential developers in this growing economic sector will choose other jurisdictions to develop their headquarters. The all-electric examples below show that not only are all-electric labs and hospitals are technologically possible, but they can also add competitive edge for businesses in the biotech sector and reduce building operating costs across the lifespan of the building.

Image Source: Allogene Therapeutics

Project Location:
Newark, California

Size:
136,000 sq ft

Cost:
$15 million

Completion Year:
2020

Collaborators:
City of Newark, Dome Construction, CRB, RIOs, Savills, McMillan Electric

All-Electric Allogene Theraputics Cell Manufacturing Facility | Cell Forge 1 “CF1”

The all-electric cell manufacturing facility, which is owned and operated by Allogene Theraputics (a biotechnology company) was constructed from the ground-up in 2020 and is notable for using all-electric modern manufacturing processes. Allogene has stated that all-electric manufacturing gives their product advantages over competitors using more conventional lab and manufacturing spaces. The fully electric facility produces allogeneic CAR T cell products at large-scale and includes testing, clinical capabilities, administrative, and warehouse space.

Building Highlights:

- On-track for LEED Gold certification
- Powered by renewable power: 2,400 rooftop solar panels and 1,000 kWh battery energy storage in combination with purchased renewable electricity to offset the remainder of electric consumption;
- Heat pump technology for heating and cooling;
- Energy metering and performance monitoring to track and improve building performance over time

Energy and Cost Savings:

- Zero upfront cost model for battery energy storage installation through power purchase agreement (PPA) financing

Image Source: CRB Group

All-electric examples

Image Source: AIA California, UC California Irvine

Project Location:
University California Irvine

Size and Scope:

- **$1.3 billion project**
- **Hospital: 357,000 BGSF (building gross square feet); 144 inpatient beds, emergency, inpatient surgery, PACU/ Prep/ Recovery**
- **Comprehensive Cancer & Ambulatory Center: 223,000 BGSF; Cancer Center Clinic, Outpatient Surgery, Radiation Oncology, Phlebotomy Lab, Research & Cell Therapy Lab, Conference capabilities**

Completion Year:
Construction began in 2021, expected date of completion: 2025

Collaborators:
Core Team: UC Irvine Health General Contractor: Hensel Phelps, Architect: CO Architects: Structural Engineer: Degenkolb; MEP Engineers: tk1sc; Civil Engineer: Stantec, Landscape Architect: Ridge Landscape Architects

Image Source: AIA California, UC California Irvine

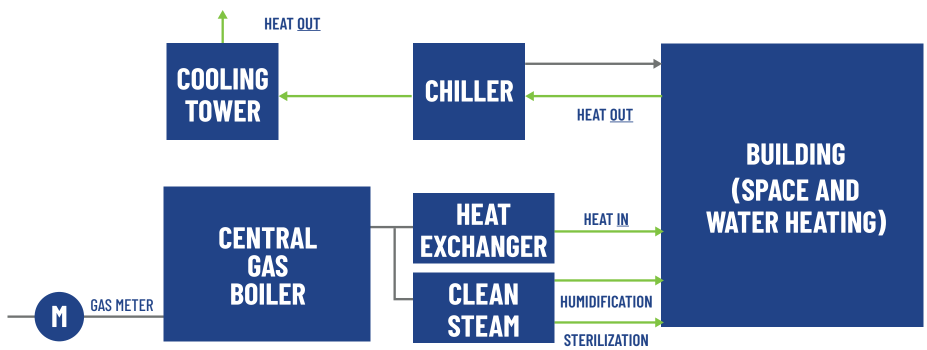
University of California Irvine, Medical Campus

This fully electric medical campus at University of California Irvine was guided by University of California policies on all-electric buildings, and problem solved for difficult technology considerations for all-electric sterilization, humidification, heat recovery and kitchen uses that are specific to laboratory and life science needs. The project includes a 144 bed hospital and ambulatory care center, as well as a shared surgery suite, and balanced challenges for building lifespan (minimum 70 years), patient, and operational demands of a hospital.

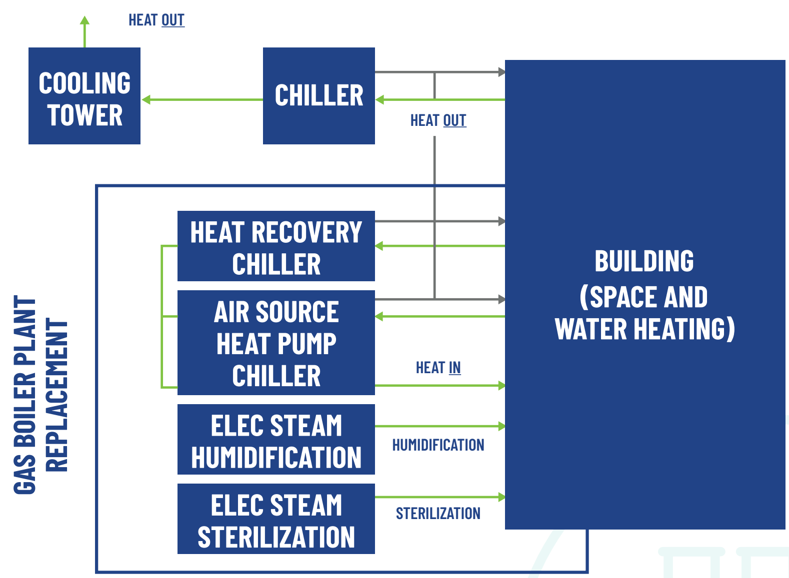
University of California Irvine, Medical Campus *cont.*

Building Highlights:

- On-track for LEED Platinum (Hospital Standard)
- Central utility plant: no boilers: air sourced heat pumps, water cooled chillers, heat recovery chillers. Air sourced heat pumps are unique in going all-electric, but also presented the following challenges by using all-electric technology: increased noise, and need for outdoor space.
- HVAC Systems: flexible changes in how controls are used to allow building to operationalize rooms.
- Chemical treatment for legionella bacteria instead of gas-powered heat treatment.



CONVENTIONAL CENTRAL PLANT



"ALL-ELECTRIC CENTRAL UTILITY PLANT – UCI HOPSITAL

Key functionalities for laboratory & life science electrification:

- **Emergency power (ex. keeping refrigerator functionality, hospital functionality): battery storage (Allogene); devices timed to turn off but maintain temperature (J Craig Venter Institute Laboratory). UCI Medical Campus installed a rooftop generator plant designed to power the entire hospital that goes above and beyond code, which includes 12 MW backup generator plant comprised of 4 individual 3 MW generators.**
- **Sterilization of materials and water, particularly targeting Legionella bacteria: see UCI Campus strategy for chemical instead of gas powered sterilization against Legionella bacteria.**
- **Design of a centralized utility plant to use heat pump technology, if applicable.**

Energy and Cost Savings Results for UC Laboratory Buildings

- The University of California conducted an extensive carbon neutral new building cost study in 2017, which compares capital costs for commonly found buildings on UC Campuses (including laboratories). Though the results are somewhat University of California specific, the results show that all-electric laboratory buildings outperform gas + electric laboratories both on energy and capital cost when considering 20-year life cycle costs.
- Laboratory buildings capital equipment costs- all-electric is only marginally more expensive than mixed fuel: average all-electric lab is $4.19/ sf (1.5%) more expensive than gas
- All-electric buildings are comparable, or slightly less expensive than gas + electric buildings from a 20-year life cycle cost perspective, once capital and energy costs are both factored in (see graph below)
- All-electric laboratory buildings leads to significant energy savings compared to the gas+ electric baseline, leading to 23% savings in EUI (energy use intensity, which expresses a building's energy use as a function of its size or other characteristics)
- Net present energy cost for all electric buildings is 8% lower for laboratory buildings when compared to mixed fuel.

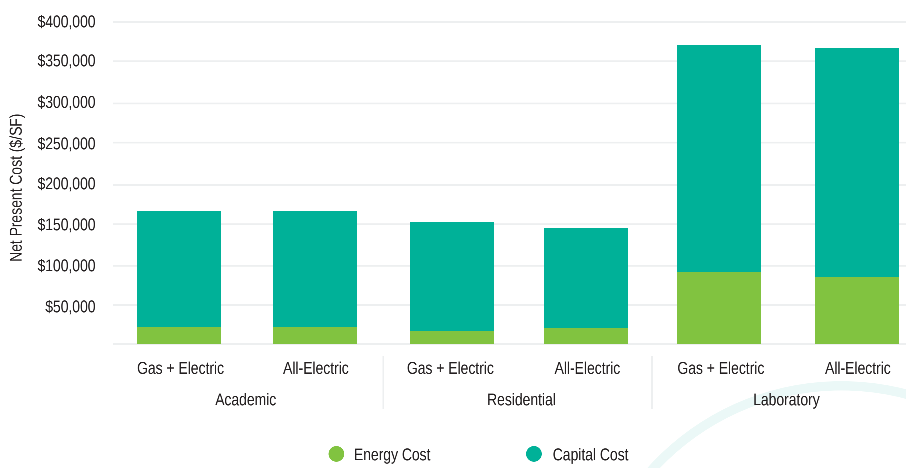


Figure 1 UC Average Total Net Present Costs across All Campuses

Image Source: Carbon Neutral New Building Cost Study

Image Source: Anza Borrego Foundation

Additional All-Electric Labs & Life Sciences Examples:

- **University of California Anza-Borrego Desert Research, Borrego Springs, CA–** This all-electric research station uses heat pumps instead of traditional propane tanks in addition to heat pump water heaters. Rooftop Solar PV offsets 100% of the energy use of the building, which is LEED Gold qualified.
- **J Craig Venter Institute Laboratory, La Jolla, CA–** This net-zero energy, LEED Platinum, carbon neutral biological building is a non-for-profit laboratory located on UC San Diego's campus. Technology highlight: freezers, which normally would have been a major source of energy spend were switched to water cooled freezers, which saves both energy and water via water recovery.
- **LBNL Integrative Genomics Building, Walnut Creek, CA –** This laboratory building uses all-electric heating systems for airside and waterside heat recovery, which effectively halves the carbon footprint of this laboratory. All-electric systems are combined with energy efficiency systems that use 1/3 of the energy of the prior facility that housed the lab, in combination with minimized cooling systems, and a solar array that offsets 14% of energy use. The building also uses metrics for energy efficiency that track building performance over time.

Key Considerations

- **Leverage solar PV + battery storage for cost effectiveness, as energy spend is significant for this building type**
- **Energy efficiency is a pre-requisite for cost-effective electrification.**
- **Payback period for electrification vs. natural gas is variable, and often lengthy.**
- **The RFQ/ RFP process for new building development is an important point of leverage for selecting all-electric building capable designers and contractors.**
- **Internal building sustainability policies like the University of California's were critical in motivating lab and life science buildings to look for creative all-electric approaches.**
- **Installing cogen capabilities for labs is a significant cost saver: labs that use cogen have almost half the energy costs of labs not that do not have cogen capabilities.**

Toolkit & Additional Resources

- Electric bunsen burner alternatives to central gas, **Stanford University**
- UC Cost Effectiveness Survey for gas vs. electric, **compares cost for mixed gas and electric to all-electric**
- AIA Climate Action Webinar Series, **provides a deep dive into the UCI Medical Campus**

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