Equitable Electrification of Existing Buildings: A Pathway to Decarbonization

Final Project Seminar

April 21, 2026 10am – 12pm

CALIFORNIA AIR RESOURCES BOARD

UCLA California Center for Sustainable Communities

Institute of the Environment & Sustainability

the Energy Coalition

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About CCSC

A team of faculty, staff, and students, working on a set of intersecting, mutually-reinforcing projects that support California communities as they transition to greater urban sustainability.

Research areas:

- How energy (electricity + gas) powers domestic life
- What the energy transition means socially, economically, ecologically, and politically
- How energy for a safe and dignified standard of living can be generated, stored, and transmitted renewably and equitably
- Conservation of water in the face of increasing, climate-driven scarcity
- How demands for energy & water change in response to development and land use
- Impacts of climate change on people and their livelihoods

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the Energy Coalition

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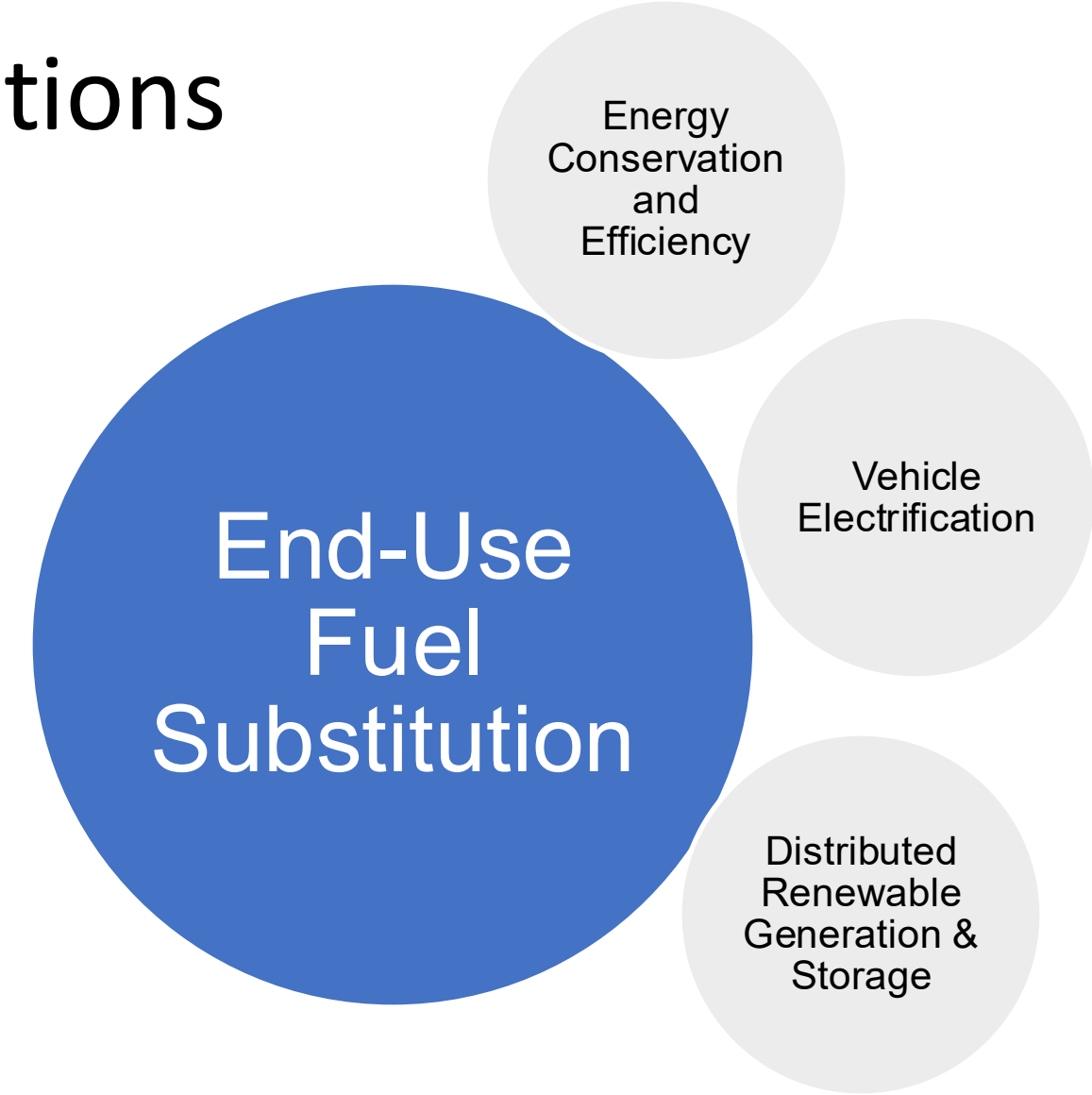
Background and Motivation

Project Scope + Definitions

Building Decarbonization

Replacing equipment for space and water heating, cooking, and clothes drying, that produce greenhouse gas emissions with clean technologies that operate without generating on-site emissions.



All types of state initiatives that interact with the project's core scope.

Why Building Decarbonization?

- Buildings are a top source of greenhouse gas & air pollutant emissions in California
- Increasing adoption of zero-emission alternatives can achieve immediate and significant emissions reductions
- Low-income communities face the greatest barriers to implementing fuel-substitution measures, but also risks from gas appliance pollution

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The Core Problem

We don't fully understand:

- Where electrification is already happening and where is it not?
- Whether disadvantaged communities are being left behind?
- What does it actually cost to electrify existing buildings?
- Why do people choose to electrify or not?
- How do impacts differ across communities and building types?
- Whether current incentive programs and policies are working?

Research Objectives

- Examine California's building electrification trends to date across several geographic and demographic dimensions
- Address building decarbonization knowledge gaps
- Develop a framework to help prioritize commercial building sub-sectors for electrification efforts according to various technical feasibility and equity dimensions

Research Tasks

Map the Electrification Landscape

- Compiled and analyzed statewide spatial data related to electrification and equity
- Conducted a literature review related to decision-making processes around electrification

Address building decarbonization knowledge gaps

- Quantified electrical service panel capacities in existing residential buildings to anticipate future retrofit needs
- Investigated consumer awareness and understanding of building decarbonization

Understand How to Prioritize Commercial Buildings

- Developed a framework for prioritizing commercial building subsectors for electrification.
- Conducted a detailed electrification feasibility assessment of a selected priority subsector.

Two main building sectors investigated:

Commercial

- Offices (Small and Large)
- Restaurants
- Retail stores
- Food stores
- Refrigerated warehouses
- Unrefrigerated warehouses
- Schools
- Colleges
- Health care
- Lodging
- Miscellaneous

+

Residential

- Single family
- Multi-family
- Mobile & Manufactured Homes

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Methodology
Existing Residential Buildings

Existing Data Analysis

Evaluate Current Progress on the Electrification of Residential Equipment

+

New Data Collection

Quantify Residential Building Electrical Capacities and Survey Renter Populations

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Evaluation of Existing Data

Existing rates of residential appliance electrification

- **State and Federal Survey Data**
  - CEC Residential Appliance Saturation Survey (RASS)
  - CEC's Energy Consumption Database
  - American House Survey (AHS)
  - EIA Residential Energy Consumption Survey (RECS)
  - Census American Community Survey (ACS)

- **Energy Program Data**
  - TECH Clean California Program Claims
  - CPUC's California Energy Data and Reporting System (CEDARS)
  - North Carolina's Database of State Incentives for Renewables & Efficiency (DSIRE)
  - Switch is On web tool
  - California Municipal Utilities Association (CMUA)

- **Electrification Costs Data**
  - TECH Clean California
  - US Energy Information Administration
  - Redwood Energy's A Pocket Guide to All Electric Retrofits

- **Published Research Reports**
  - E3, LBNL, Opinion Dynamics' Heat Pump Market Study etc.

- **Peer Reviewed Journal Articles**

- **Trade Literature**

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New Data Collection

Residential Electrical Service Panel Sizes

Collected, processed, and analyzed historical building permit data for electrical work involving panel upgrades and replacements:

- 4+ million raw panel records collected
- From 56 separate municipalities in California
- Spanning ~30 years
- 617k panel related permits identified

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New Data Collection

Residential Electrical Service Panel Sizes

Developed a novel approach to estimating the current panel sizes from:

- Anticipated panel sizes at the time of new construction based on electrical code requirements
- Anticipated rates of panel replacements/upgrades derived from historical permit data

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New Data Collection

High-Priority Community Renter Surveys

- Online and telephone surveys with 807 renters in high priority communities
- 23 multi-part questions lasting, on average, 15 minutes per survey
- Surveys conducted from February 4 – March 14, 2024
- Offered in English, Spanish, Chinese, Vietnamese
- Half of respondents lived in multi-family buildings with 11 units or more
- More than six-in-ten respondents identified as Hispanic/Latino

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New Data Collection

Multi-Family Property Owner Interviews

- In-depth interviews with owners of rental properties
- 15 property owners across regions, focusing on high priority communities
- Sample included five private small-building owners, one private low-income housing developer, eight nonprofit affordable housing providers, and one county housing authority
- Interviews conducted from September 10, 2024 to January 24, 2025
- 30-minute average interview length

Findings

Electrification in Existing Residential Buildings

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Adoption of zero-emission appliances is increasing but progress remains difficult to track

- Measuring current rates of zero-emission appliance adoption is difficult due to the nature of equipment sales and installation practices as well as a lack of inter-agency data collection and sharing.

- Most of the detailed insights we have come from program participation claims - such as from TECH Clean California. However, these data sources do not capture households that pursued electrification measures "naturally" and without incentives.

Air Source Heat Pump Installations

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Different survey data sources are available but each has important gaps

- Data collected from national level surveys are useful but lack detailed geographic insights into the experiences of California's priority communities.

- Census data collection are limited and focuses primarily on heating equipment - without differentiating between advanced heat-pump systems and legacy resistance-based heating equipment.

RECS ESS
Residential Energy Consumption Survey
Energy Supplier Survey

2019 California Residential Appliance Saturation Study (RASS)

AMERICAN COMMUNITY SURVEY
U.S. CENSUS BUREAU

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Work is underway to fill these gaps and advance zero-emission equipment adoption

- The California Energy Commission (CEC) recently established the California Heat Pump Partnership (CAHPP) to help accelerate heat-pump adoption.

- CEC is also currently working to develop new reporting standards to better track the adoption of heat pumps and other electric equipment but th ere are logistical challenges with doing so.

CALIFORNIA HEAT PUMP PARTNERSHIP

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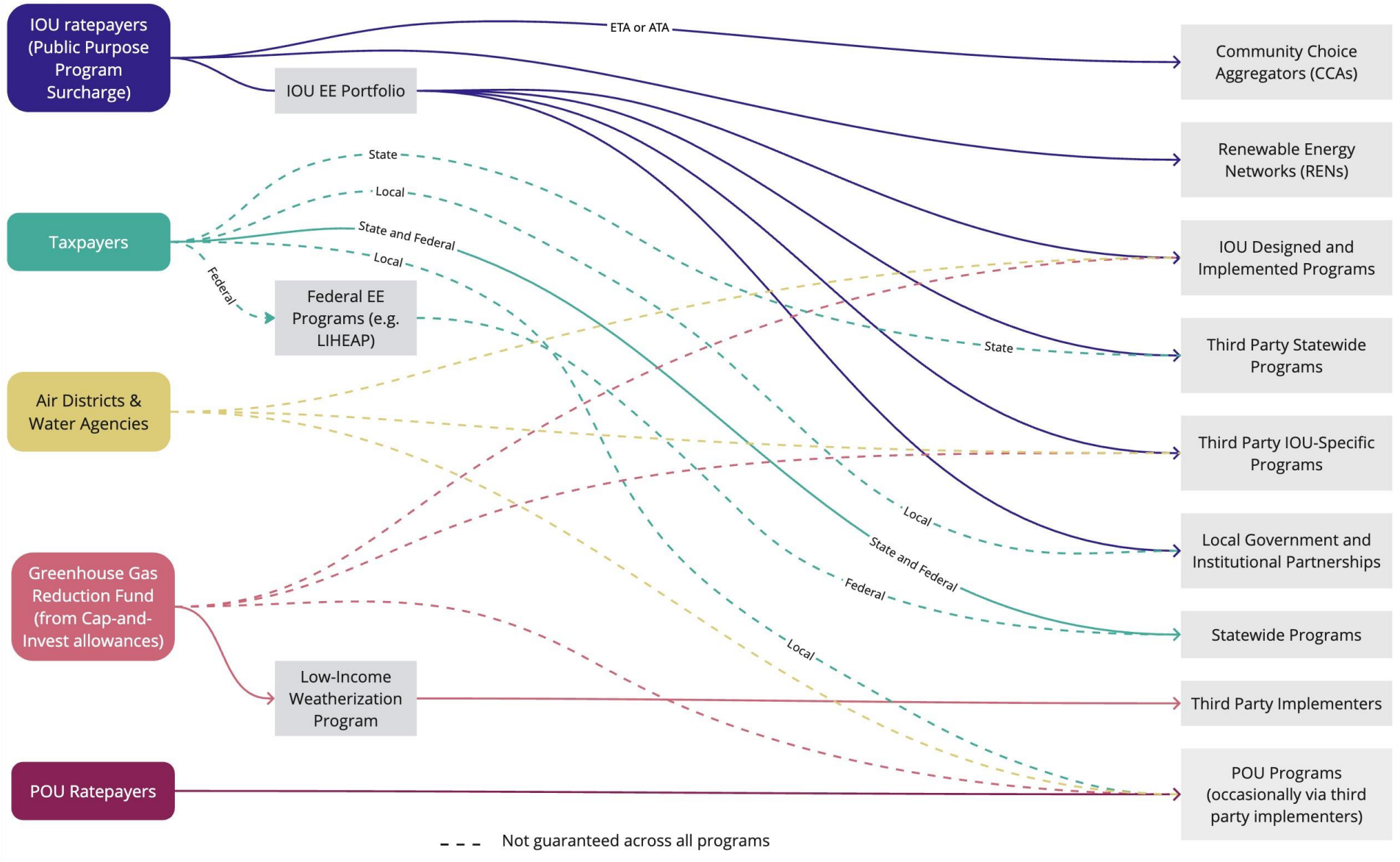
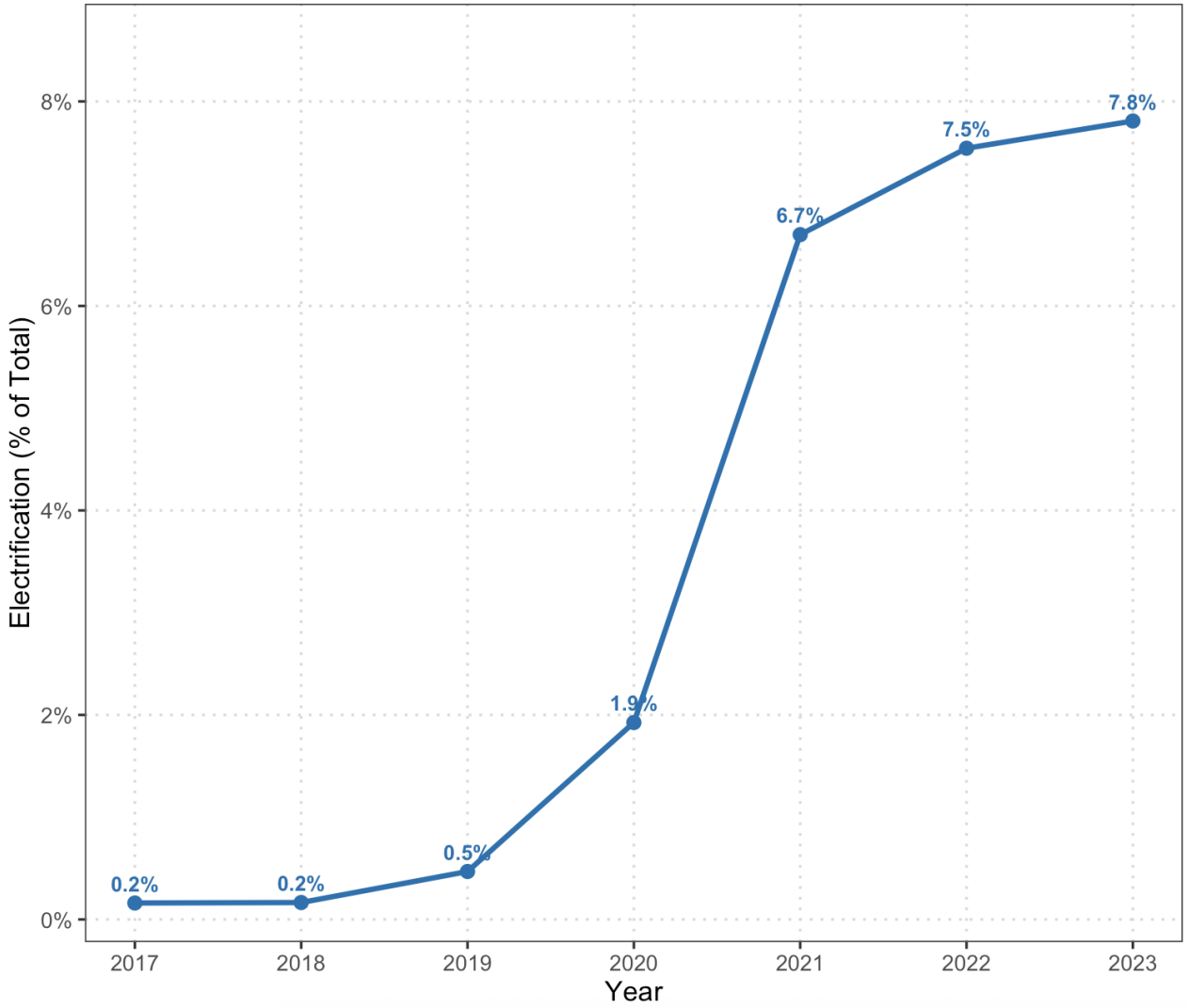
Energy program funding is complex and spans multiple sources, program administrators, and oversight bodies



Electrification program budgets, while growing, still lag far behind EE program spending



Year	EE Budget	Electrification Budget
2017	$331,047,058	$532,940
2018	$302,666,746	$501,391
2019	$326,460,519	$1,537,807
2020	$217,495,680	$4,270,230
2021	$203,802,036	$14,628,882
2022	$251,328,186	$20,501,674
2023	$283,717,337	$24,031,020

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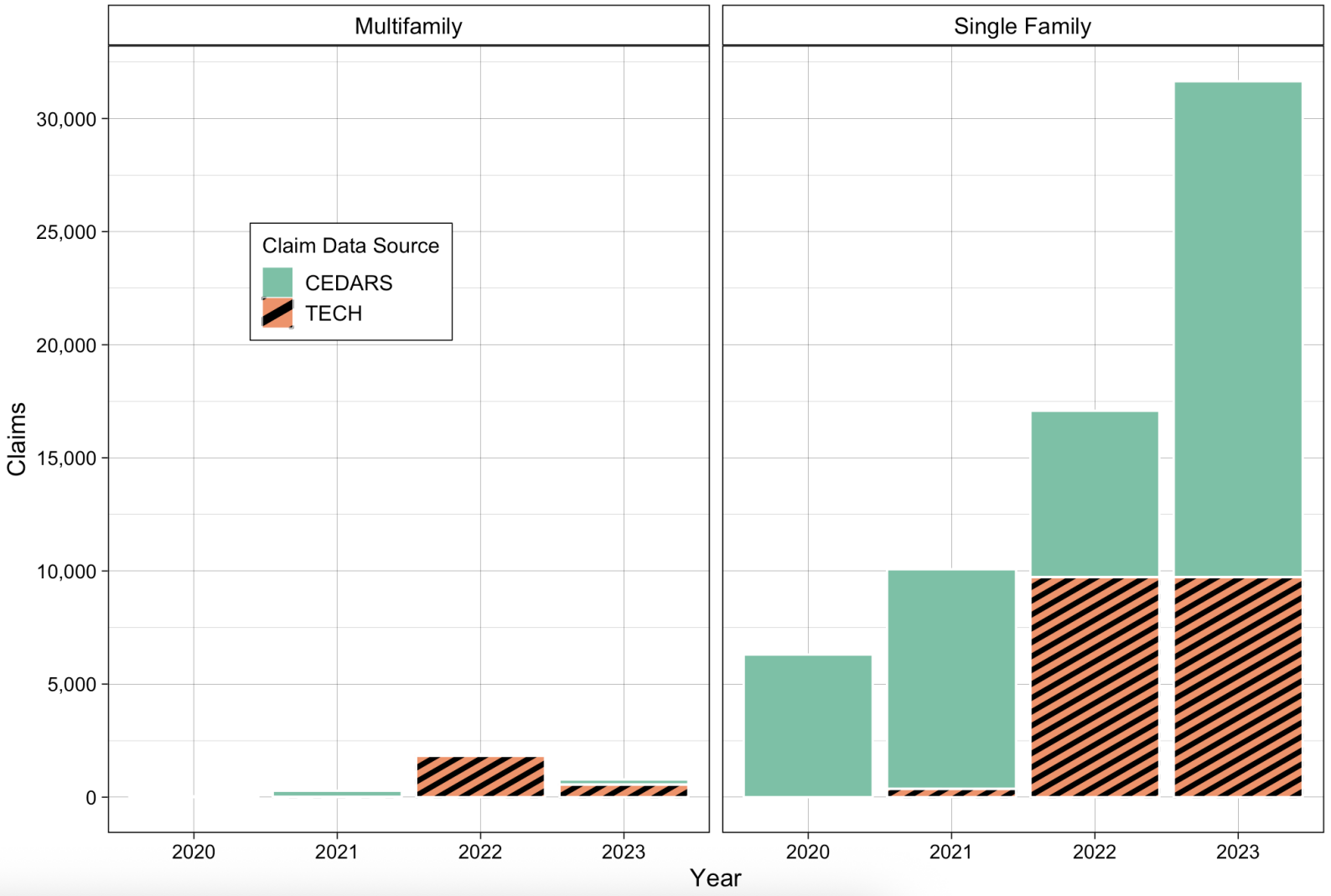
Available incentives are still likely not sufficient to achieve widespread adoption



Less than 1% of adoption can be attributed to incentives

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California is not currently on track to meet its residential fuel-substitution goals

- For example, recent published estimates suggest that California has installed 2 million heat-pumps.
- This compares to the state's goal of 6 million installed units by 2030 (just 4 years away).
- Similar goals have not yet been set for heat-pump water heaters, induction ranges, and electric ovens, clothes dryers, etc.
- Full electrification of all end-uses within a home can often require more intensive retrofit work.

Different end-use equipment consume different amounts of power

Electric Vehicle Charging

- 3.3 - 20 kW Peak Power -> 15 – 100 Amp Breaker

Cooking

- 7 – 12 kW Peak Power -> 30 – 50 Amp Breaker

HVAC

- 1 - 7 Ton Rating -> 15 – 125 Amp Breaker

Water Heating

- 10 – 100 Gallon Tank Capacity -> 10 - 30 Amp Breaker

Clothes Drying

- 1.5 - 9 Cubic ft. Drum Capacity -> 15 – 30 Amp Breaker

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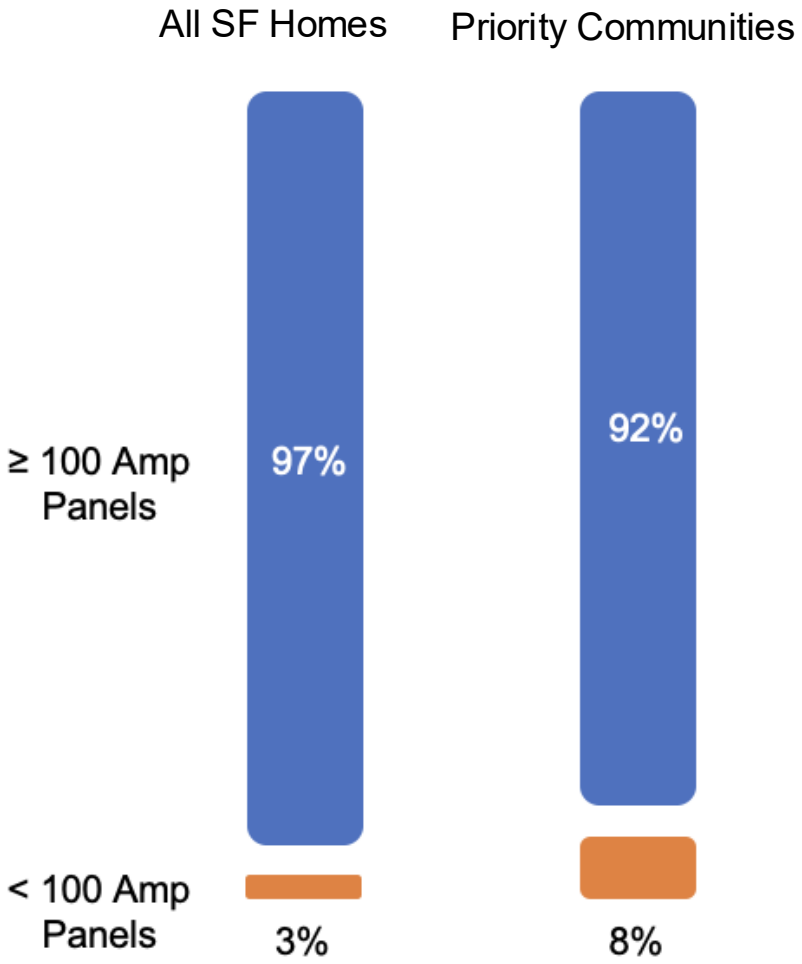
Most of CA's Single-Family homes should have sufficient capacity to fully electrify



- ≥100 Amp panels are generally considered sufficient to support the full electrification of most SF homes.
- Smaller sized panels (<100 Amp) will likely need to be upsized to support full electrification. These were found to be 4x more prevalent in priority communities.
- Part of the reason for this is that homes in these types of communities tend to be older, smaller, and have more deferred maintenance.

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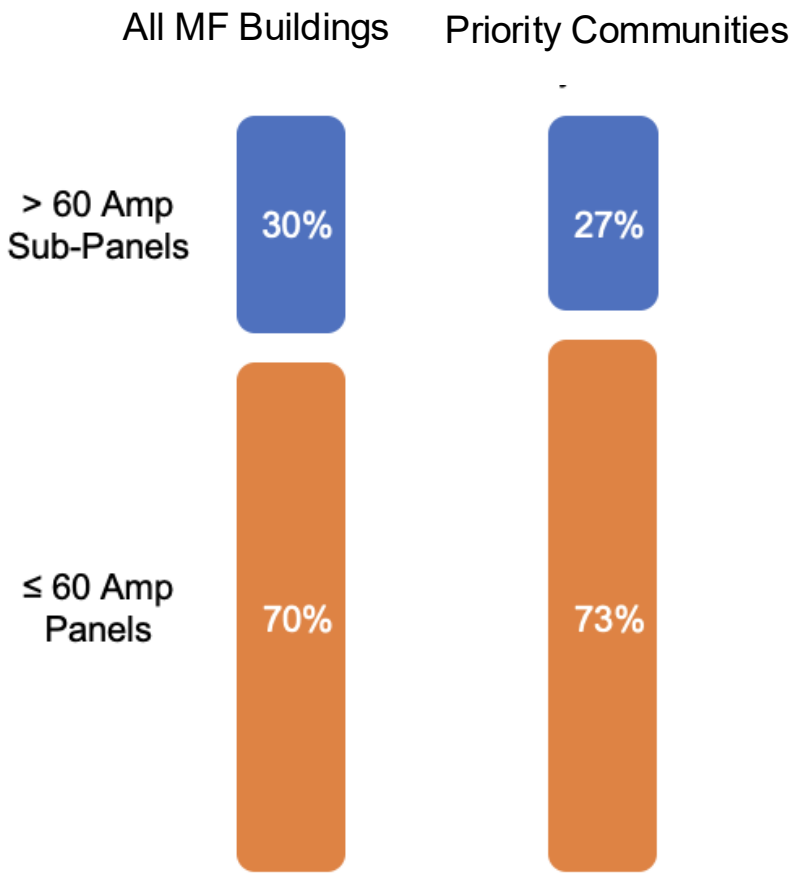
However, the state's Multi-Family buildings face significant challenges



- Only 30% of MF buildings are estimated to have electrical sub-panels (for each dwelling unit) that would be ready to support comprehensive electrification of all existing gas end-use equipment (>60 Amp).
- We also observed declining rates of electric heating equipment adoption among 2-4 unit MF buildings in the period from 2017 - 2022.

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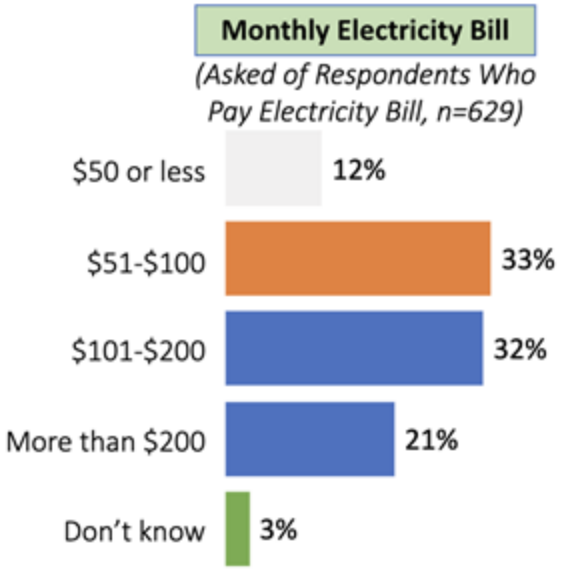
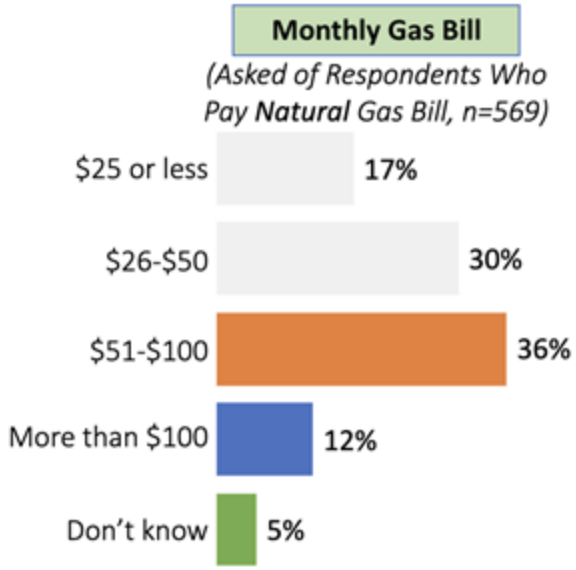
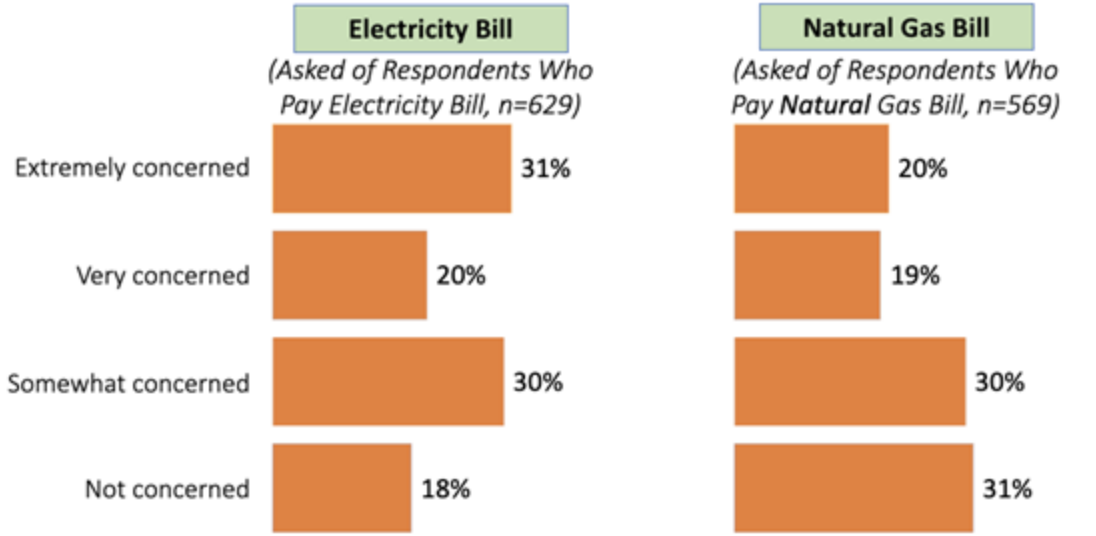
Findings from Renter Surveys

- Respondents whose households pay their utility bills report that their gas bills are far lower.
- There is somewhat more concern about the affordability of electricity bills than natural gas bills.







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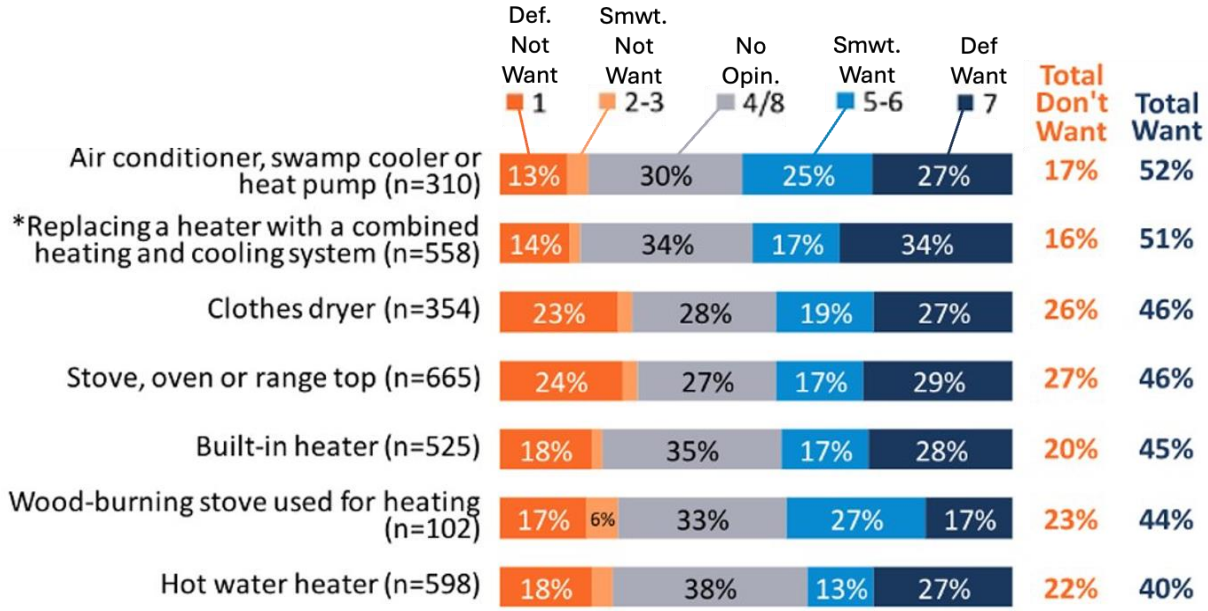
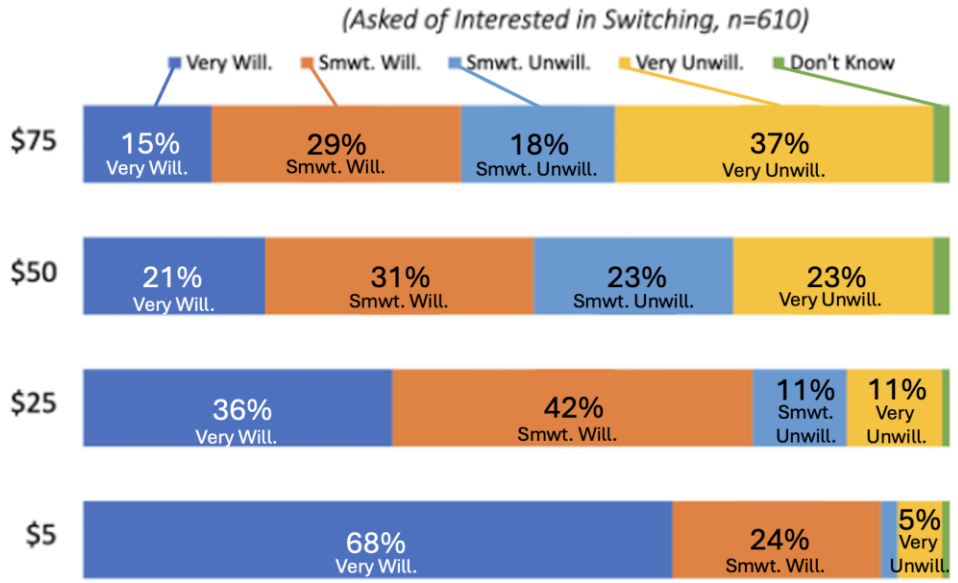
Findings from Renter Surveys

- Pluralities of respondents are open to replacing all the appliances tested in the survey with electric versions if it was at no cost or $5/month to switch

If it would not cost you anything, how much would you want the owner or landlord of your home or apartment building to replace the following appliances in your home with versions that use only electricity? We're going to use a one to seven scale to answer this question; one will mean you would definitely NOT want that and seven would mean you would definitely want it.
(Ranked by 5-7 (Total Want))





Multifamily Property Owners In Their Own Words: Barriers and Challenges

I'll say the only reason I did it was because of the rebates. From a financial point of view to electrify a building and then have PG&E raise the rates 20%, it doesn't make sense unless the government is going to incentivize property owners to help them do that. – Private small/mid-size building owner, Bay Area, 91 units

Our utilities went up with LADWP 104%. So you are asking about converting, but yet the electrical went up and we still, even though with Section 8 buildings, you can't pass off the electrical (increase) - you cannot pass it along. So the owners is absorbing those costs. – Low-income housing developer (for profit), Southern California (including Long Beach), 1,200 units, legacy buildings

I feel like working with the utility companies is pretty much a nightmare. It takes forever. It's so hard to do anything. It takes forever to get a response. The system is so slow. Costs are just going up there for you. With the inflation, when we started this process, we had penciled out a certain amount for the equipment. Two years later, the equipment is 20% more expensive, and we're still waiting on the utility for stuff. So yeah, the process is really bad. . . – Private small building owner, San Francisco, 3 units

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Methodology

Existing Commercial Buildings

Existing Data Analysis

Evaluate Current Progress on the Electrification of Commercial Equipment
+
Develop a Framework to Prioritize Commercial Sub-Sectors for Electrification

New Data Collection

Study the Feasibility of Electrification within a Single Priority Subsector

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Commercial Scope: Subsector Definitions

The following subsector classifications are based upon those used in the CEC's Commercial End-Use Survey (CEUS):

- Offices (small and large)
- Restaurants
- Retail Stores
- Food Stores
- Refrigerated Warehouses
- Unrefrigerated Warehouses
- Schools
- Colleges
- Health Care
- Lodging
- Miscellaneous

Evaluation of Existing Data

Existing rates of commercial appliance electrification

- **State and Federal Survey Data**
  - CEC's California Commercial End Use Survey (CEUS)
- **Energy Program Data**
  - CPUC's California Energy Data and Reporting System (CEDARS)
  - North Carolina's Database of State Incentives for Renewables & Efficiency (DSIRE)
  - Switch is On web tool
  - California Municipal Utilities Association (CMUA)
- **Electrification Costs Data**
  - US Energy Information Administration
  - California Energy Codes and Standards Cost-Effectiveness Reports
  - Redwood Energy's Pocket Guide to All Electric Commercial Retrofits
- **Gas and electric usage data**
  - Account-level sourced from IOUs and provided to the UCLA research team under a data sharing agreement with the CPUC's Energy Division
  - CEC's Energy Consumption Database

Evaluation of Existing Data

Commercial Subsector Prioritization Framework

A multi-criteria framework was developed to evaluate priority subsectors for electrification.

Emissions

- CO_2 Emissions
- Ambient NOx Emissions
- Indoor NOx Emissions

Social Impact

- Emissions Exposure Risk for Residential Populations
- Exposure of Sensitive Populations
- Worker Vulnerability

Difficulty

- Electric Grid Outage Vulnerability Risk
- Technology Readiness
- End Use Diversity (Variance)
- Median Building Vintage
- Median Building Size
- Average Gas Use per Premise

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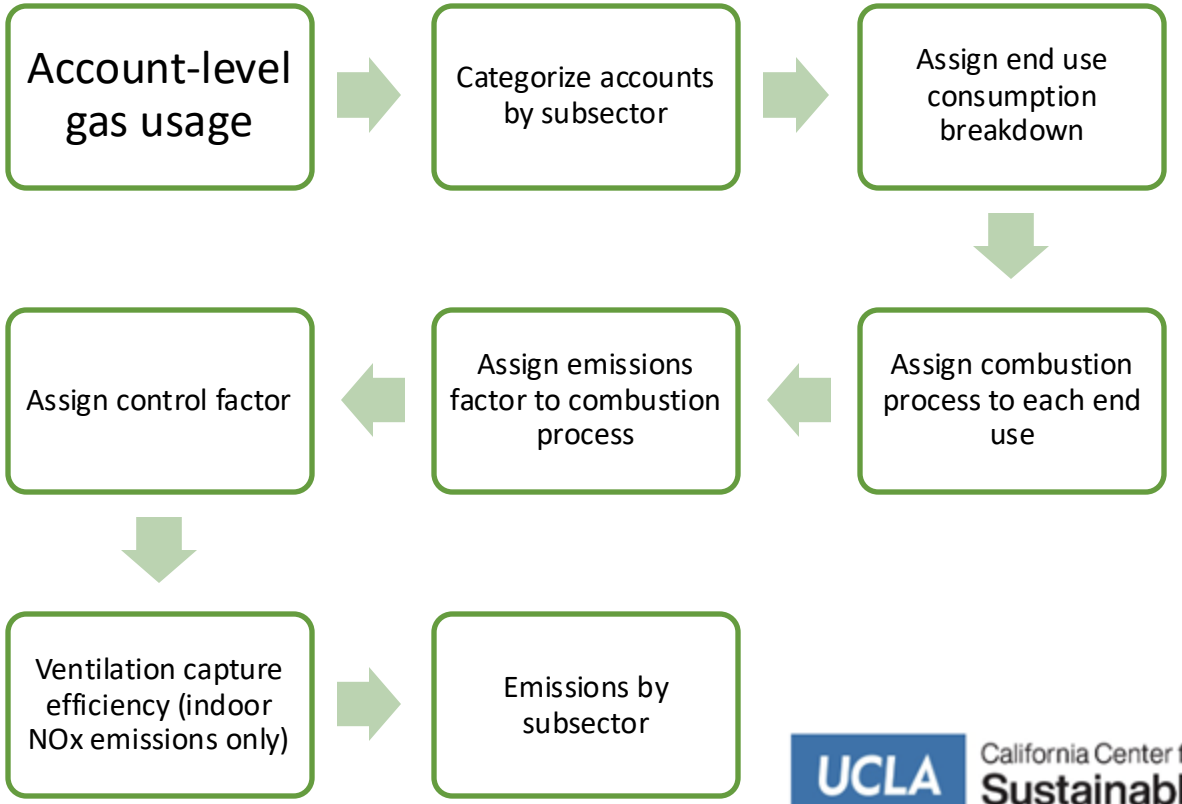
Evaluation of Existing Data

Commercial Subsector Prioritization Framework

Emission reductions benefits were quantified using historical gas usage data and accounting for end-use specific emission controls technologies.

Emissions

- CO2 Emissions
- Ambient NOx Emissions
- Indoor NOx Emissions



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Evaluation of Existing Data

Commercial Subsector Prioritization Framework

Social Impact

- Emissions Exposure Risk for Residential Populations
- Exposure of Sensitive Populations
- Worker Vulnerability

Social impacts were quantified based upon sensitive population exposures and worker vulnerabilities.

The estimated total population living within all residential parcels located in proximity to all identified facilities within each CEUS subsector

Calculation relied on the ambient NOx emission estimates in addition to the use of data from the Public Health Alliance of Southern California Healthy Places Index (HPI)

Weighted average of Occupational Employment and Wage Statistics

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Evaluation of Existing Data

Commercial Subsector Prioritization Framework

Difficulty

- Electric Grid Outage Vulnerability Risk
- Technology Readiness
- End Use Diversity (Variance)
- Median Building Vintage
- Median Building Size
- Average Therms per Premise

The difficulty of implementation reflected the technical readiness of equipment and building integration challenges.

- PSPS grid outage events
- Adapted Technology Readiness Level scoring by end use
- Computed in terms of the variance in the breakdown of gas usage by gas end-use within each commercial subsector
- Parcel level building attribute information obtained from CoreLogic
- Utility account level electricity and gas consumption data

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Methodology

Priority Sub-Sector Feasibility Assessment

Existing Data Analysis

Analysis of CoStar Commercial Property Data for Priority Sub-Sector Properties

+

Literature Review Focusing on Challenges to Electrification in Priority Sub-Sector Buildings

+

New Data Collection

Feasibility Assessment of Electrification in Priority Sub-Sector Buildings Including Phone Calls, Interviews, and Property Site Visits

Findings

Electrification in Existing Commercial Buildings

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Commercial Incentives Exist and their Budgets Are Growing - but Businesses Still Rarely Use Them

Year	Total EE Budget	Total EE Claims	Total Electrification Budget	Total Electrification Claims
2017	$498,670,284	318,752	$5,589,499	1,238
2018	$421,587,893	234,924	$5,601,738	2,628
2019	$385,031,381	180,194	$9,828,179	2,428
2020	$284,060,568	52,143	$8,024,990	376
2021	$339,747,242	65,557	$17,447,317	1
2022	$467,236,085	70,791	$22,851,100	173
2023	$511,071,108	10,665	$33,185,825	299

Upfront costs of all end-use electrification in commercial buildings are not well understood - but evidence suggests existing commercial incentives are inadequate

Available sources only provide estimates for a few commercial building types. Incremental costs to replace all gas end-uses with zero-emission alternatives include:

- Medium office buildings face estimated costs of $158,078 per facility.
- Quick-Service Restaurants face estimated costs of $60,835 per facility.
- Full-Service Restaurants face estimated costs of $123,855 per facility.

With over **50,000 restaurant** establishments in IOU territories, based upon these cost figures the estimated minimum total cost to replace all gas equipment with zero-emission equipment in the restaurant sector alone would **exceed $3 billion.**

Estimates source: 2021 Reach Code Cost-Effectiveness Analysis Non-Residential Alterations Report

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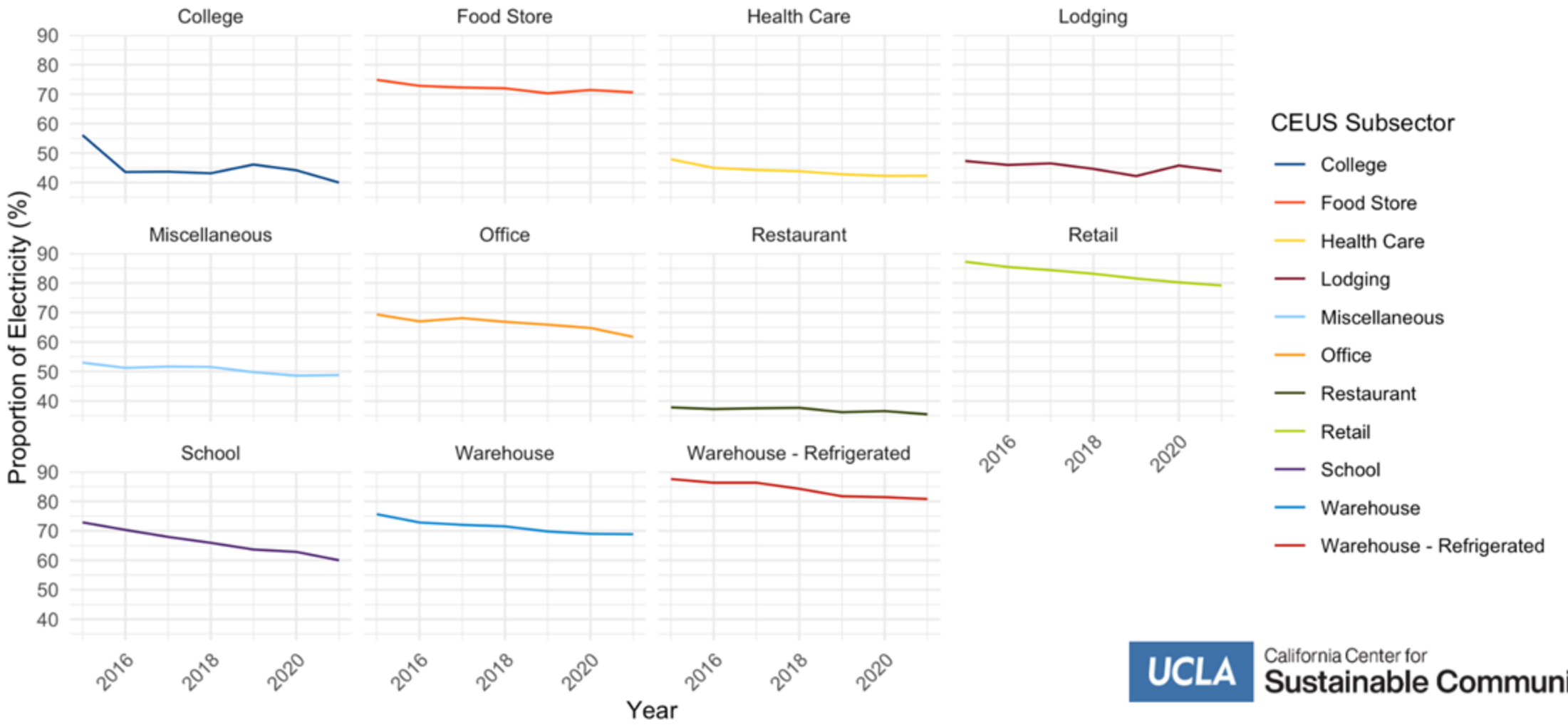
Energy usage data suggest electrification rates in many commercial subsectors may be declining



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Findings

Commercial Building Subsector Prioritization

Findings from Metrics Analysis

Emissions

- Offices emit the most CO2 and ambient NOx in tons, but colleges have the highest average CO2 and NOx emissions per facility
- Restaurants have the highest total indoor NOx emissions by far

Social Impact

- Offices and miscellaneous buildings have the most total exposed proximity to residential populations in DACs ad non-DACs
- Miscellaneous buildings expose the most sensitive populations of any subsector
- Restaurants have the most employees at the lowest average wage

Difficulty

- Miscellaneous and refrigerated warehouses are the hardest buildings to electrify with the most technical difficulty

Commercial Building Subsector Prioritization

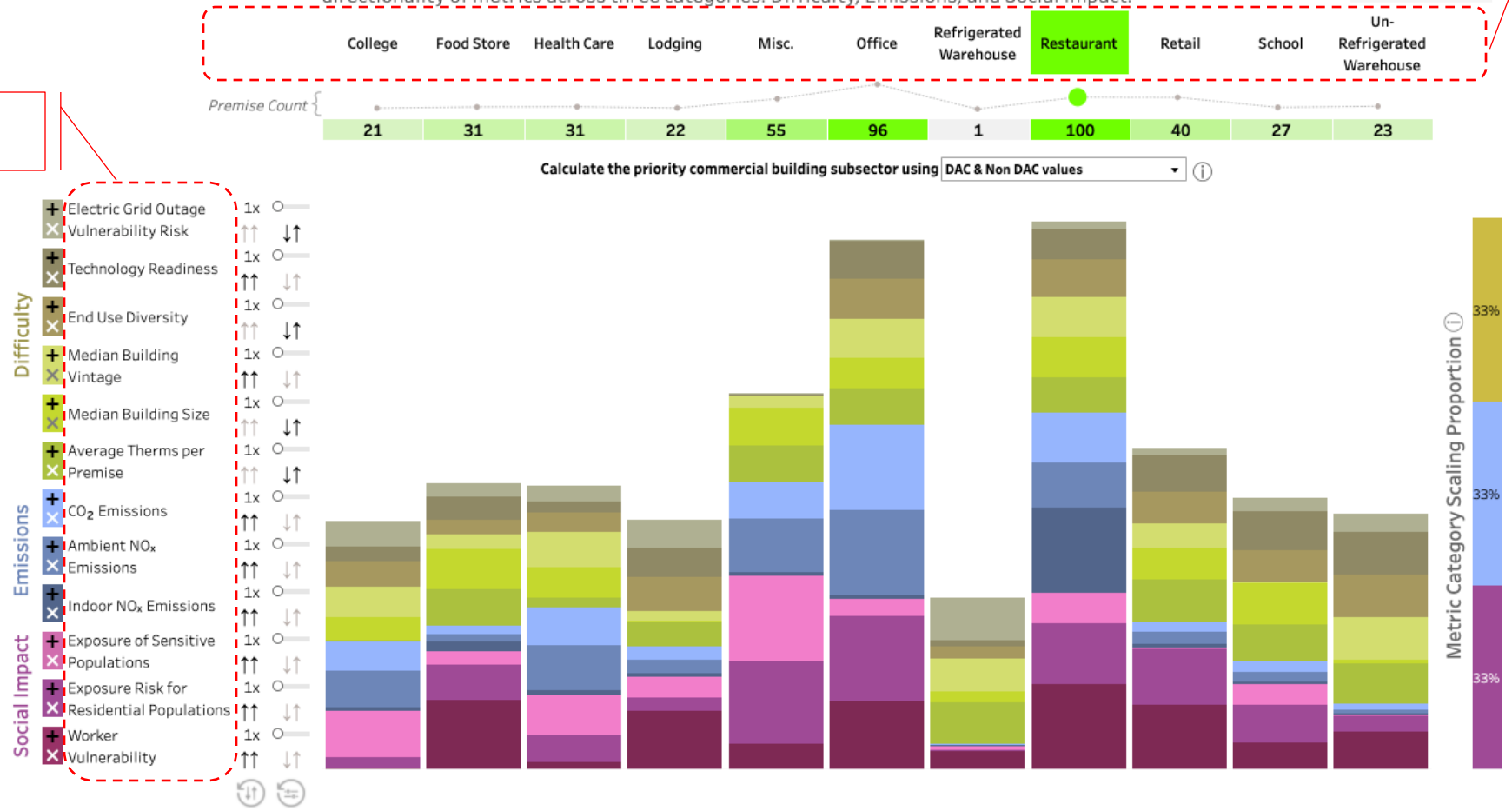
menu ×

About | Tool | Spatial Context | Tutorial

Tool | This framework was developed to identify a priority commercial building subsector (highlighted in green) for building electrification. The tool below allows users to manipulate the weights, inclusion, and directionality of metrics across three categories: Difficulty, Emissions, and Social Impact.

Commercial building subsectors

Metrics



Aggregated Statewide Scores

The tables below provide the raw and normalized scores that drive the tool. These values will update based on the DAC status filter and will remain static regardless of weight and directionality manipulations in the tool.

	College	Food Store	Health Care	Lodging	Misc.	Office	Refrigerated Warehouse	Restaurant	Retail	School	Un-Refrigerated Warehouse
Electric Grid Outage Vulnerability Risk	41.16	70.33	61.86	34.87	99.39	100.00	1.00	85.34	85.97	70.79	58.17
Technology Readiness	33.83	57.13	23.74	70.52	1.00	92.72	12.26	71.14	88.05	92.26	100.00

Commercial Building Subsector Prioritization

menu ×
About
Tool

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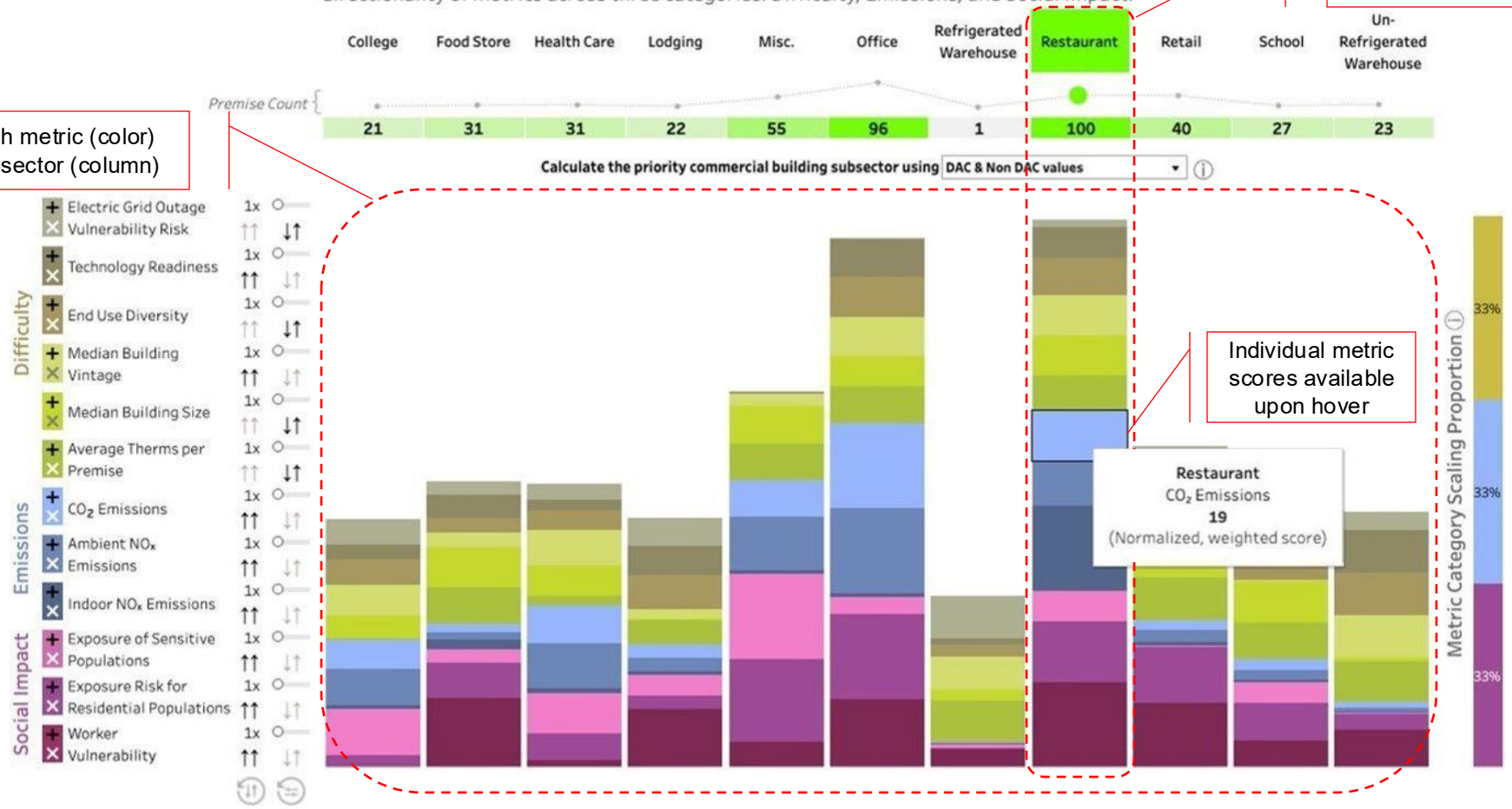
Subsector with highest priority score highlighted in green

Stacked bar chart for each metric (color) and each commercial subsector (column)



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Technology Readiness	33.83	57.13	23.74	70.52	1.00	92.72	12.26	71.14	88.05	92.26	100.00

Commercial Building Subsector Prioritization

menu ×

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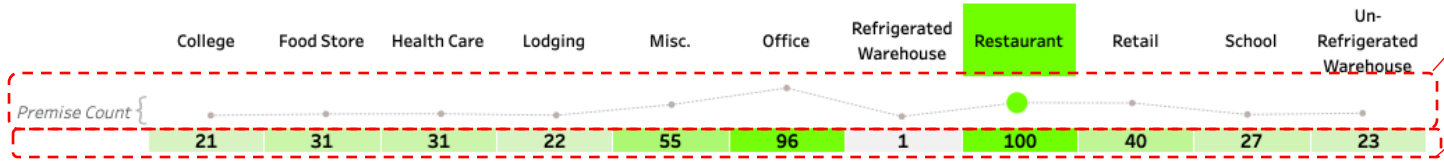


Premise count per commercial subsector

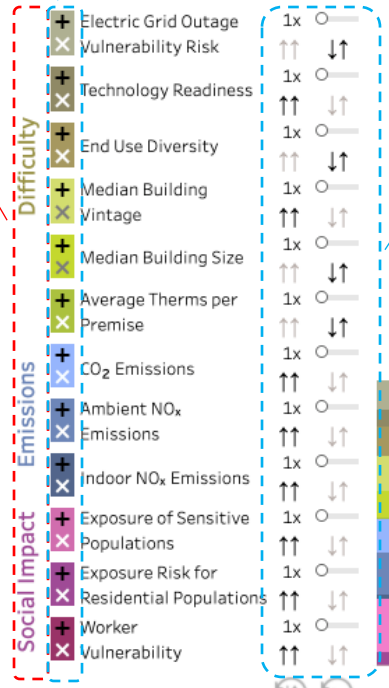
Final, re-normalized priority score per subsector

Controls to include or exclude metrics

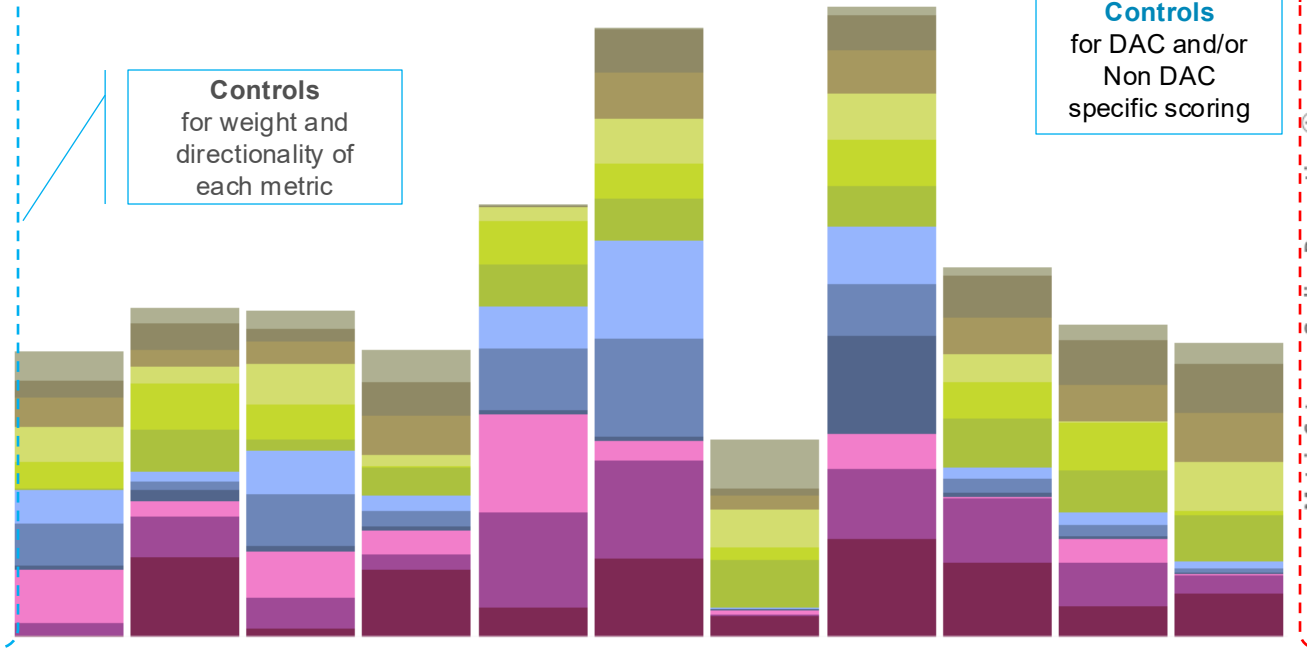
Calculate the priority commercial building subsector using DAC & Non DAC values

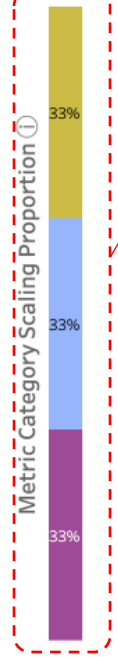
Controls for DAC and/or Non DAC specific scoring

Metric category



Controls for weight and directionality of each metric





Share of each metric category

Aggregated Statewide Scores

The tables below provide the raw and normalized scores that drive the tool. These values will update based on the DAC status filter and will remain static regardless of weight and directionality manipulations in the tool.

Scroll down to view the underlying data

	College	Food Store	Health Care	Lodging	Misc.	Office	Refrigerated Warehouse	Restaurant	Retail	School	Un-Refrigerated Warehouse
Electric Grid Outage Vulnerability Risk	41.16	70.33	61.86	34.87	99.39	100.00	1.00	85.34	85.97	70.79	58.17
Technology Readiness	33.83	57.13	23.74	70.52	1.00	92.72	12.26	71.14	88.05	92.26	100.00

Aggregated Statewide Scores

The tables below provide the raw and normalized scores that drive the tool. These values will update based on the DAC status filter and will remain static regardless of weight and directionality manipulations in the tool.

Normalized Scores

Scores in this table are normalized from the raw data, scaled to a range of 1 (minimum) to 100 (maximum).

	College	Food Store	Health Care	Lodging	Misc.	Office	Refrigerated Warehouse	Restaurant	Retail	School	Un-Refrigerated Warehouse
Electric Grid Outage Vulnerability Risk	41.16	70.33	61.86	34.87	99.39	100.00	1.00	85.34	85.97	70.79	58.17
Technology Readiness	33.83	57.13	23.74	70.52	1.00	92.72	12.26	71.14	88.05	92.26	100.00
Median Building Vintage	71.71	36.36	82.32	22.21	29.29	92.93	77.02	96.46	57.57	1.00	100.00
Median Building Size	45.99	6.83	28.07	100.00	12.65	30.35	74.03	7.91	26.		
Average Therms per Premise	100.00	16.76	77.85	41.55	14.07	12.50	4.73	16.55	1.		
CO_2 Emissions	35.43	10.84	44.71	15.59	42.96	100.00	1.00	58.49	12.		
Ambient NO_x Emissions	43.60	9.04	52.79	15.67	63.36	100.00	1.00	53.89	13.78	11.34	5.17
Indoor NO_x Emissions	3.57	10.24	5.15	4.31	4.73	4.16	1.29	100.00	4.77	2.99	1.00
Exposure Risk of Sensitive Populations	54.36	16.14	48.03	24.97	100.00	20.50	4.27	35.31	1.00	24.08	1.86
Exposure Risk for Residential Populations	13.64	42.49	31.23	16.23	97.34	100.00	1.00	72.77	65.52	45.12	18.10
Worker Vulnerability	1.00	81.16	8.80	68.48	30.61	80.89	22.24	100.00	76.59	31.60	44.90

Retail
Median Building Vintage
57.57

Raw Scores

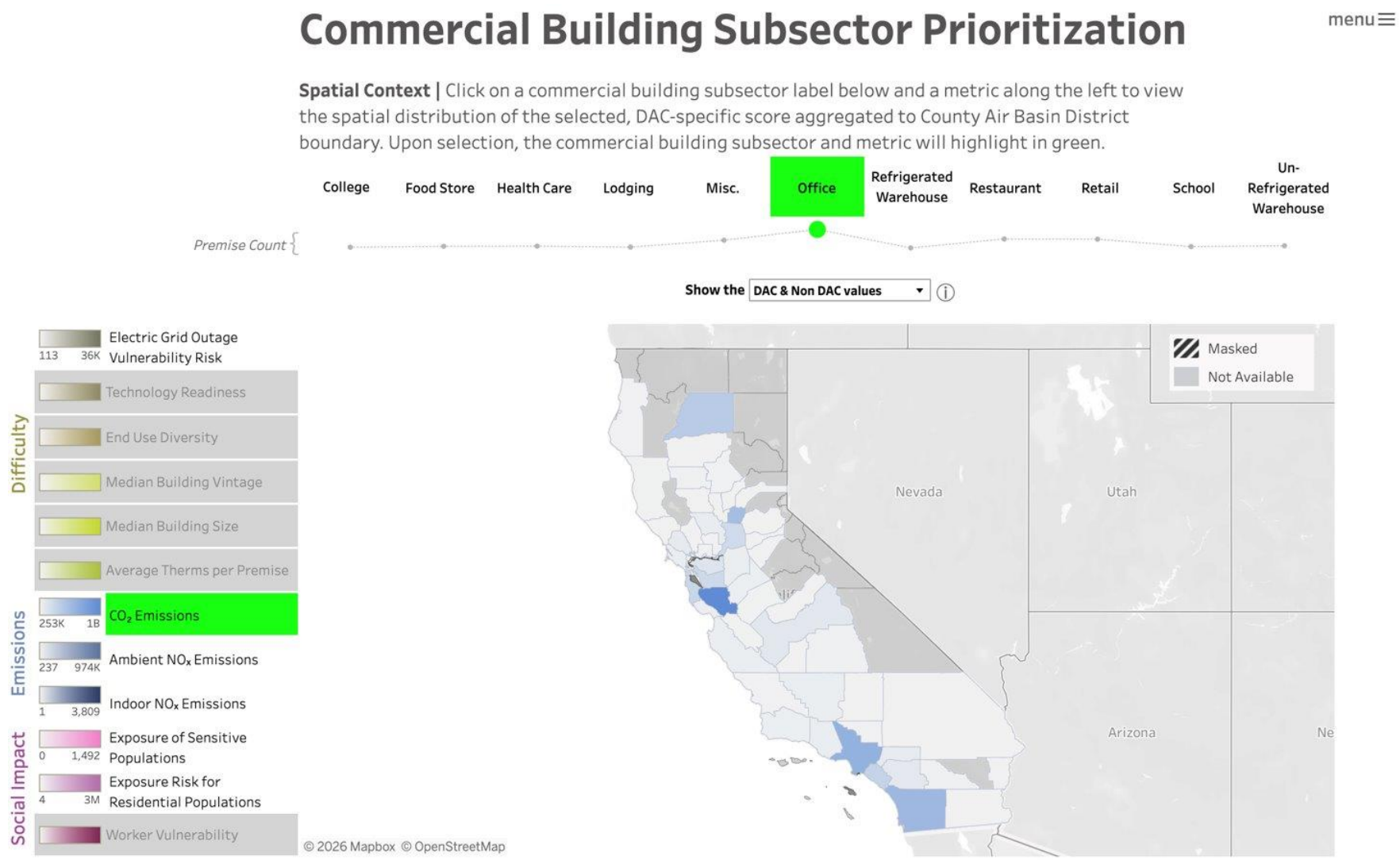
Scores in this table are the raw values representing a variety of metric-specific units.

	College	Food Store	Health Care	Lodging	Misc.	Office	Refrigerated Warehouse	Restaurant	Retail	School	Un-Refrigerated Warehouse
Electric Grid Outage Vulnerability Risk	130,279	192,387	174,345	116,170	254,277	255,570	44,756	224,355	225,702	193,379	166,490
Technology Readiness	1.91	2.55	1.63	292	1.00	3.54	1.31	2.94	3.41	3.53	3.74
Median Building Vintage	1973	1968	1974	1966	1967	1976	1973	1976	1971	1963	1977
Median Building Size	10,579.75	6,782.50	8,842.50	15,816	7,346.75	9,063.50	13,298.00	6,887.00	8,700.		
Average Therms per Premise	24,693	5,107	19,482	10,	4,472	4,103	2,275	5,058	1,39		
CO_2 Emissions	1,361,106	417,280	1,717,369	599,	1,649,947	3,839,109	39,690	2,245,886	471,47		
Ambient NO_x Emissions	1,517	347	1,828		2,186	3,426	75	1,865	50		
Indoor NO_x Emissions	8.10	28.24	12.86	1034	11.59	9.87	1.21	299.47	11.72	6.33	0.32
Exposure of Sensitive Populations	3,146,075	1,156,928	2,816,628	1,616,	5,520,947	1,383,732	539,074	2,154,583	369,028	1,570,120	413,648
Exposure Risk for Residential Populations	1,048,893	2,812,007	2,123,922	1,207,	6,163,421	6,326,235	276,684	4,662,359	4,219,414	2,972,410	1,321,775
Worker Vulnerability	0.12	1.00	0.21	086	0.45	1.00	0.35	1.21	0.95	0.46	0.60

Retail
Median Building Vintage
1971
(Year)

Individual, normalized and raw metric scores available upon hover

The tool can also use be applied for more targeted geographic and scenario analyses



Findings

Priority Subsector Feasibility Assessment

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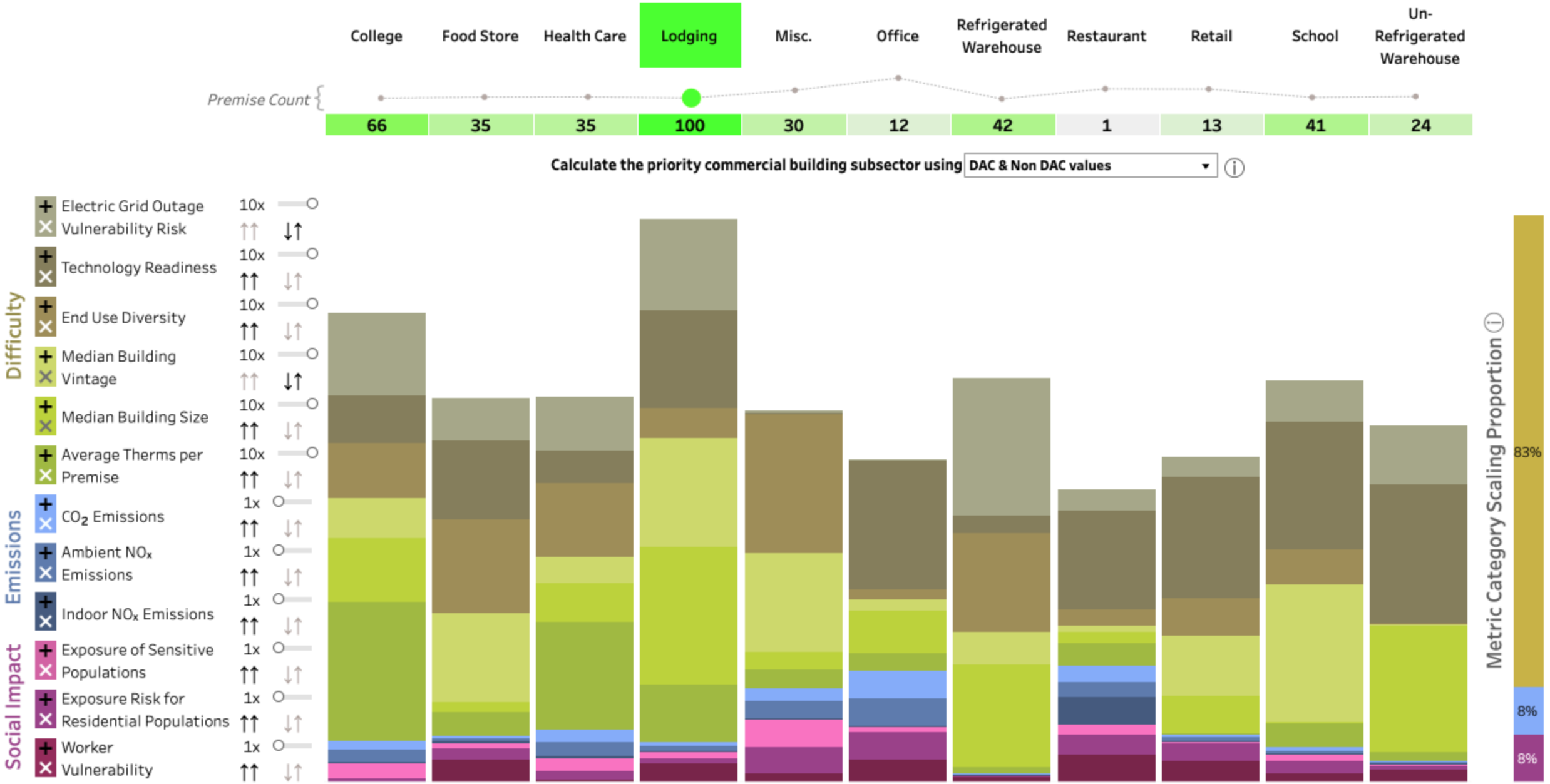
Selecting a priority subsector

- Maximize returns to learning

- Select a sub-sector which represents:

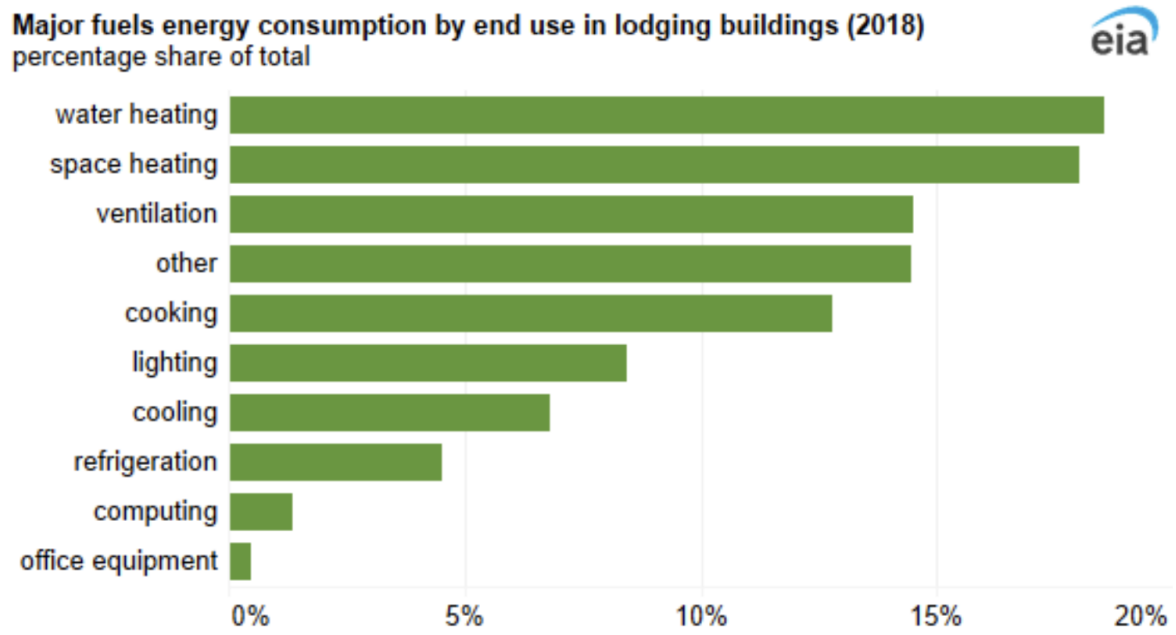
  - a diversity of end uses
  - a diversity in physical building characteristics (i.e. the total number of units, number of floors, luxury scale, amenities)
  - a diversity of ownership type (e.g. chain, independent)

Selecting a priority subsector: Lodging



Key Findings from Lodging Subsector Analysis

- More than half of hotels in California are small (under 50 rooms), built before 1990, and independently operated.
- Roughly 65% of hotels offer gas-intensive amenities - and these are disproportionately present in larger, higher-end, and more recent hotels.
- Over half of hotels are Economy to Midscale and are in suburban areas or small towns.



Data source: U.S. Energy Information Administration, *Commercial Buildings Energy Consumption Survey*

Figure 57. Major Fuels Energy Consumption by End Use in Lodging Buildings (2018), EIA

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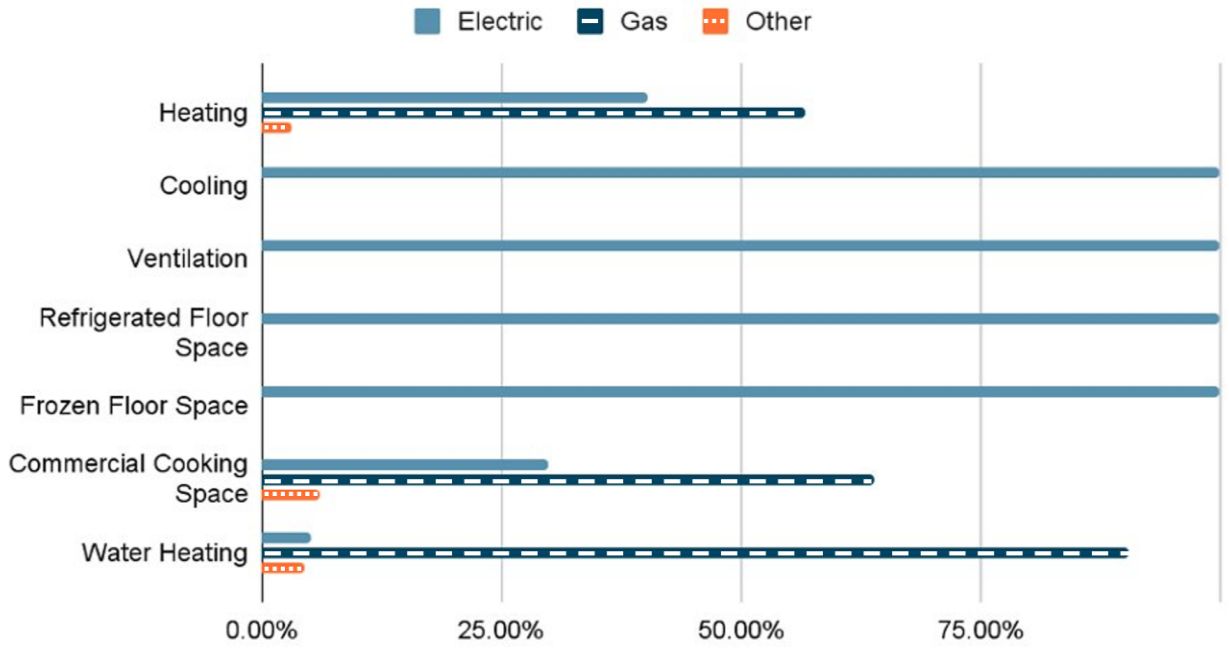
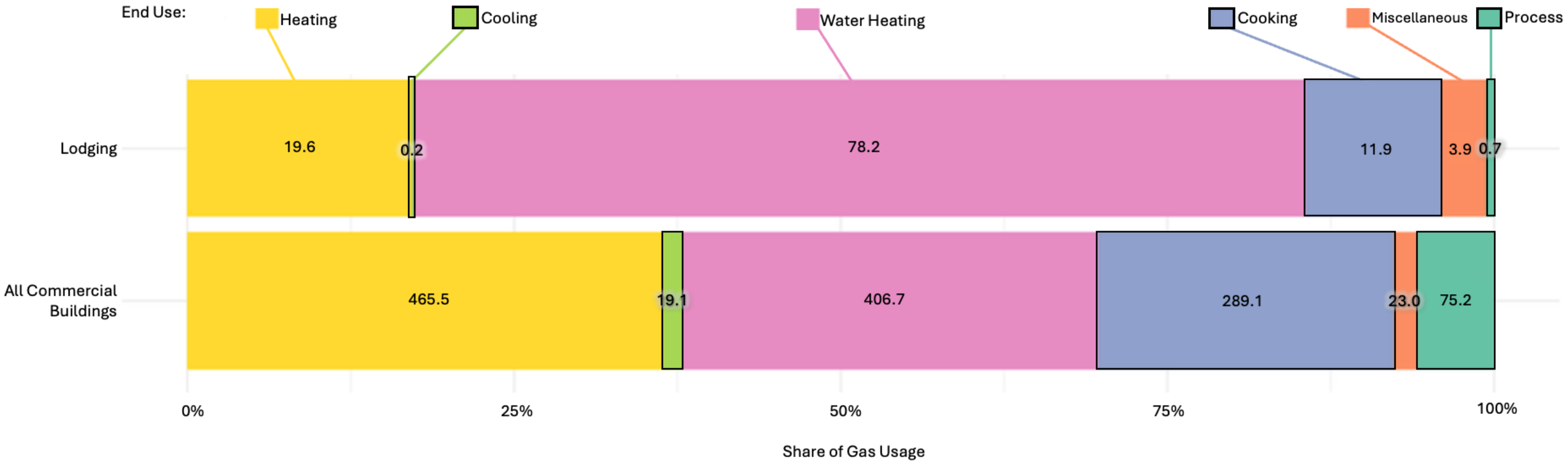
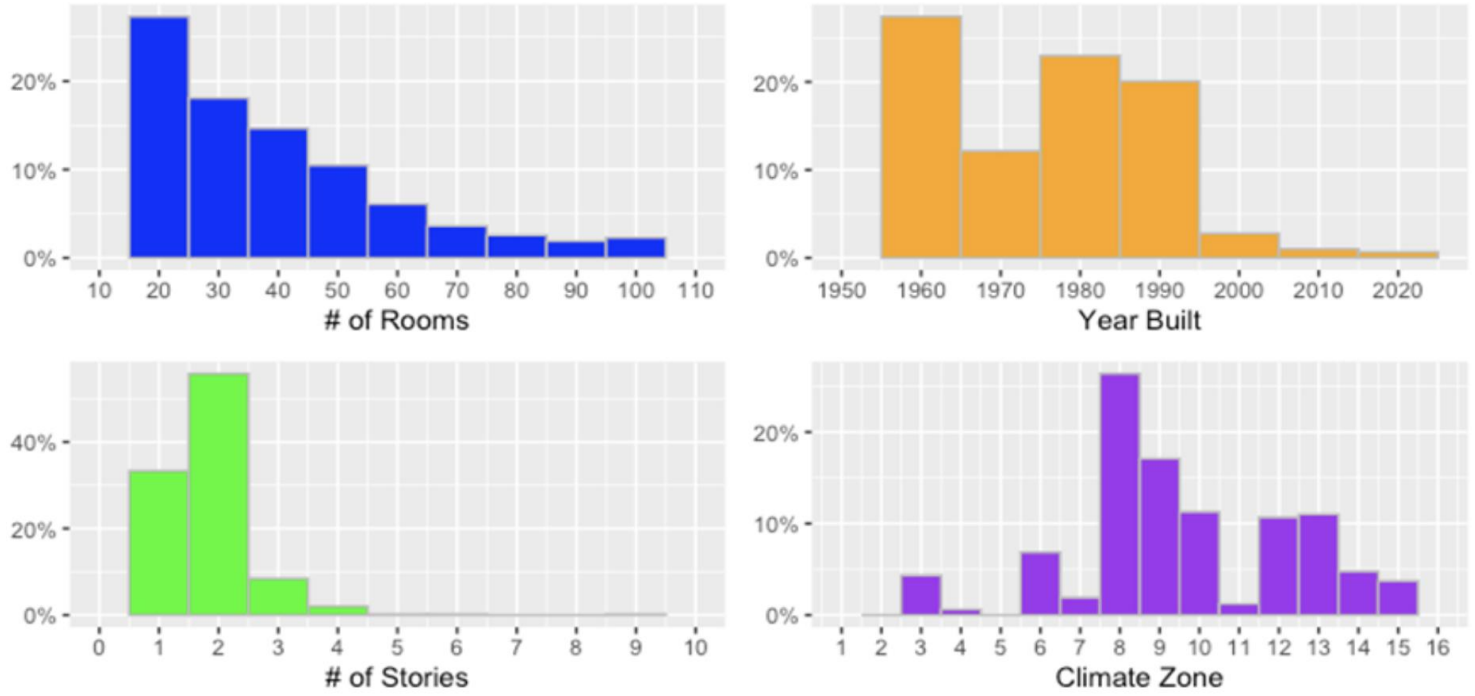
Lodging subsector uses significantly more gas hot water heating than other subsectors with minimal penetration of electric fuel





Equity Considerations in Lodging Subsector

- Hotels in DACs represent about 16% of hotels statewide (1,153 units)
- Among these, hotels with a high diversity of gas end-uses are concentrated in inland Southern California climate zones and face hotter and drier conditions with higher cooling demands.



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Operational realities make lodging hard to engage

- 181 call attempts, multiple virtual conversations. Conversations that occurred were often brief and surface-level.

- Structural challenges to deeper industry engagement:
  - Only a small number of hotels have dedicated facilities staff.
  - Most properties route calls through front desk staff who are too busy for energy program conversations.
  - General managers lack authority and owners are often absent.

- Tailored engagement approaches are needed for the industry

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Site Visits & Takeaways

- 10 properties visited across Los Angeles and Orange Counties.
- Visits focused on observing the building exterior and neighborhood context when full facilities access was not possible.
- Conversations with front desk staff, managers, and maintenance personnel highlighted the day-to-day realities of hotel operations:
    - Limited staff capacity and deferred maintenance challenges.
    - While interviews were often brief, site visit attempts confirmed many of the barriers heard through virtual outreach,

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Key Barriers in the Lodging Subsector

Financial	Time and Staffing	Decision-making Gaps	Low Prioritization	Property Transitions	Unique operational contexts
Upgrades are viewed as unaffordable for small and independent properties	Day-to-day operations leave no capacity for program discussions	General managers lack authority, while owners are often off-site or unreachable	Sustainability is seen as non-urgent relative to immediate business pressures	Closures, rebranding and ownership changes disrupt program participation	Hostels have restricted access, while larger hotels' decentralized management slows communication

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Policy and Research Recommendations

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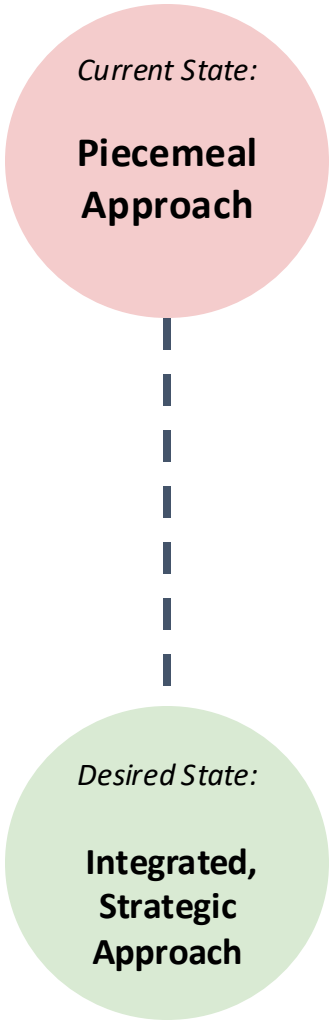
Policy Recommendations



Establish a clear, long-term goal to deploy zero-emissions equipment in all domestic end-uses.

Increase incentives and other financial support mechanisms to help people interested in ***replacing polluting cooking end-use equipment*** in residential and commercial buildings.

Eliminate all incentives for replacement of existing domestic gas appliances with more efficient, new gas-powered equipment.

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Policy Recommendations Continued

- Work to develop new utility rate tariffs that help to guarantee cost neutrality (or savings) for customers pursuing fuel-substitution projects.
- Include non-energy benefits in fuel-substitution program evaluations.
- Explore new cost-share models to avoid rent increases and potential tenant displacement from fuel-substitution retrofits.
- Couple fuel-substitution projects with distributed energy resource deployment to help address affordability and grid capacity/reliability concerns.
- Encourage the adoption of local government policies that accelerate the pace of building decarbonization.

Policy Recommendations: Infrastructure and Capacity Constraints

- Develop a roadmap for requiring the future inclusion of intelligent components within electric service panels.
- Increase transparency around utility methods for assessing the need for grid infrastructure capacity upgrades.
- Incentivize holistic planning around household power capacity constraints.
- Coordinate service panel capacity upsizing processes within utility-administered electrification incentive programs.

Policy Recommendations: Data Needs

- Improve relevant data collection and transparency across all program administrators.

- Improve data collection, access, and sharing to better coordinate the targeting of electrification incentives with the needs for long-term gas infrastructure planning.

Policy Recommendations: Commercial-Specific

- Increase overall incentives and financing for commercial business that offset upfront and soft costs.
- Commercial program design should be expanded to include both pre- and post-retrofit phases to ensure successful and sustained electrification outcomes.
- Tailor commercial program design and future appliance regulations to subsector-level and eliminate “one-size-fits-all” approach.
- Explore new engagement and outreach strategies, especially in the commercial sector.

Future Research Needs

Study residential decarbonization **non-energy benefits**.	Study **real-world power utilization** from different electrified appliance / equipment configurations.	Study opportunities to increase **electrification benefits through integrated building envelope upgrades.**
Study how **equity concerns** should be interpreted within the context of **commercial properties.**	Study electrical panel capacity of mobile/manufactured homes and non-residential buildings.	Study small commercial business owners' perspectives, beliefs, and priorities for electrification.
Conduct a comprehensive building cost study for commercial and residential buildings.	Further study of miscellaneous end use appliances, especially within the context of health care and miscellaneous subsectors.	Conduct a comprehensive study of renter and household electrification experiences and preferences.

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Thank you!
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