COMMUNITY WORKSHOP:
BUILDING ELECTRIFICATION 101

CITY COUNCIL CHAMBERS
FEBRUARY 4, 2020
AGENDA

- Welcome, Introductions, Logistics and Objectives
- Basic Terminology / Local and State Codes
- Why Electrification
- What Other Jurisdictions Have Done
- Considerations for Electrification
- Timeline to Adoption
- Resources
- Q & A
- Workshop Evaluation
The City of Santa Cruz has declared a climate change emergency

City leaders say urgent action must be taken to combat catastrophic climate change

RESOLUTION NO.

RESOLUTION OF THE CITY COUNCIL OF THE CITY OF SANTA CRUZ ENDORSING THE HOUSE OF REPRESENTATIVES’ EFFORTS TO ENACT HOUSE RESOLUTION 109, THE GREEN NEW DEAL
OBJECTIVES

1. PROVIDE AN OVERVIEW OF ELECTRIFICATION AND BUILDING ELECTRIFICATION
2. PROVIDE OPPORTUNITY FOR QUESTIONS & ANSWERS
3. PROVIDE MORE RESOURCES AND FUTURE OPPORTUNITIES FOR ENGAGEMENT
DRIVERS TO EXPLORING ELECTRIFICATION

• City Council directed staff to bring back options and align timeline with Monterey Bay Community Power’s rollout of support incentives

• Monterey Bay Community Power’s Electrification Strategic Plan calls for transportation and building electrification as key emissions reduction strategies for region + incentives

• Contributes to State’s carbon neutrality by 2045 target

• Climate Emergency (2018) and Green New Deal (2019) Resolutions
CA HAS AMBITIOUS CLIMATE GOALS, BUT NO POLICY PATHWAY TO ZERO-EMISSIONS BUILDINGS YET

- **40% GHG reduction by 2030**
  - SB 32 (2016)

- **Electric sector:**
  - 60% renewable / 2030
  - 100% carbon-free / 2045
  - SB 100 (2018)

- **Carbon neutrality by 2045**

- **40% GHG reductions in buildings / 2030 (assessment)**
  - AB 3232

- **$200M incentives for low-emissions buildings and equipment**
  - SB 1477

NEW!
WHERE: 2019 TITLE 24 PART 6 California Building Code (Title 24 of the California Code of Regulations) governs residential and commercial development
• Part 6 - California Energy Code: Prescriptive or Performance Path
• Part 11 – California Green Building Code (CALGreen): Mandatory & Tier 1 & 2

Updated every 3 years
• Next update: Jan 1, 2023; city adopted 2019 Code in fall of 2019
• City adopts code with local revisions as deemed fit; Energy Code revisions must be approved by the California Energy Commission

Possible modifications to Municipal Code Health and Sanitation Title 6
<table>
<thead>
<tr>
<th><strong>Base Code Requirements</strong></th>
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<tbody>
<tr>
<td><strong>Building Electrification</strong></td>
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<tr>
<td></td>
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<tr>
<td><strong>Electric Vehicle Charging Infrastructure</strong></td>
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<td></td>
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<tr>
<td><strong>Solar PV</strong></td>
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</tbody>
</table>
What is a Reach Code?

- Overlays the base code
- Includes additional requirements, such as:
  - Energy Efficiency
  - Water Efficiency
  - Renewable Energy
  - EV Charging
  - Electrification
LEGAL REQUIREMENTS FOR LOCAL REACH CODE

- **Cost-effective**
  - Need cost-effectiveness study that demonstrates that the proposed code pays back for itself over life of building

- **Non-preempted**
  - Code offers at least one compliance pathway that is cost-effective and uses appliances that do not exceed minimum efficiency levels of federal appliance standards

- **Buildings use no more energy than state code**
  - Local buildings comply with state code
Reach Code Adoption Process

- City Explores Reach Codes
- Evaluate Reach Code Options
- Engage Stakeholders
- Develop Reach Code Ordinance
- Submit Documentation (including Cost Effectiveness studies) to California Energy Commission
- Approve Reach Code through Local Commissions/Councils
WHY ELECTRIFICATION?
WHY ELECTRIFICATION?

Eliminate natural gas (methane) related emissions by switching appliances and systems to electric powered by carbon-free sourced electricity.
IPCC Update of Methane’s Global Warming Potential and New Leakage Data Illustrates Causes of Near Term Climate Change
MBCP SERVICE AREA
TOTAL ANNUAL GHG
BY SOURCE

- Built Environment: 18%
- Vehicles: 82%

- Residential Primary Space Heating: 23%
- Residential Hot Water Heating: 30%
- Residential Cooking: 6%
- Commercial Primary Space Heating: 16%
- Commercial Hot Water Heating: 22%
- Restaurant Cooking: 3%
Transportation Electrification
- Electrification of all Relevant Vehicles
- Level II & DCFC Charging Infrastructure

Building Electrification
- Residential (New and Existing Stock) Electrification of Appliances and Infrastructure
- Commercial (New and Existing Stock) Electrification of Appliances and Infrastructure

Distributed Energy Resources
- Local Generation & Microgrids
- Energy Storage & Energy Efficiency
- Aggregation of DERs; EVSE, Appliances & Demand Response

Under Represented Community
- Targeted future programs
- A focus on inclusivity and ease of access
TRANSPORTATION ELECTRIFICATION

• 20 miles bike lanes, >90% Rail Trail funded
• ~500 JUMP bikes
• Go Santa Cruz transportation demand mgmt platform
• Electrify America electric vehicle charging investment
• 14 public and 20+ fleet electric vehicle charging
• Electric passenger vehicle and bike fleet
• MBCP and Air District: EV and EV charging incentives
• State and Federal EV rebates
On-site fossil fuel use to create heat and hot water is the largest source of energy use and GHG emissions in buildings across the U.S.

**WHY BUILDING ELECTRIFICATION?**

Over 70 million homes and businesses in the U.S. burn fossil fuel on-site for space heating and hot water production.

In a typical U.S. city, on-site fossil fuel use in buildings accounts for between 15%-40% of total citywide GHG emissions.
### Electrification benefits: not just emissions!

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior comfort (air source heat pumps)</td>
<td></td>
</tr>
<tr>
<td>Air quality and health</td>
<td></td>
</tr>
<tr>
<td>Safety and resiliency</td>
<td></td>
</tr>
<tr>
<td>Save energy and lower bills*</td>
<td>* Depends on electricity tariffs, rooftop solar, and local conditions</td>
</tr>
<tr>
<td>Renewable energy integration</td>
<td></td>
</tr>
<tr>
<td>New jobs to retrofit buildings, install heat pumps</td>
<td></td>
</tr>
<tr>
<td>Slashes GHGs, path to Zero Emissions Buildings</td>
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</tbody>
</table>
PARTNER ACTIVITY

>>Think about your home or work building...take 1 minute to introduce yourself to the person sitting beside you and together try to identify at least 3 appliances or building systems that use a combustion flame that could be converted to electric....
CA Gas Use in Homes – 2018*

- Space heating: 44%
- Water heating: 41%
- Cooking: 7%
- Clothes drying: 3%
- Misc: 4%

*CEC, 6/14/2018 IEPR workshop
BENEFITS OF BUILDING ELECTRIFICATION
Policy Triggers for California Decarbonization: Explosions


“Supper Smog” From Gas Stoves

Sean Armstrong: A New Yorker article in April of 2019 about the hidden air pollution in our homes said kitchen air during cooking was so dirty that there is actual smog formation after twenty to thirty minutes of cooking on a gas stove. Was that an exaggeration?

Dr. Brett Singer: If you add pollutants like NO2 from gas stoves to the cooking emissions, it is a mixture of pollutants deserving of a name like “smog,” although that name is already taken by outdoor air pollution.

Figure 9: Comparison of 2017 outdoor NO2 air quality data and cooking NO2 emissions for various tests: full meal on gas and single dishes (stir fry, tortillas, French fries).
INDOOR AIR POLLUTION

Carbon monoxide, Nitrogen dioxide, Nitric oxide, Formaldehyde, Acetaldehyde, Ultrafine particles...

Air pollution levels in 55–70% of homes with gas stoves would be illegal if found outdoors. (LBNL)
Cooking with Gas Can Harm Children:
Cooking with gas stoves is associated with increased risk of childhood respiratory illnesses, including asthma

Andee Krasner, MPH* and T Stephen Jones, MD, MPH

Early Life
Meta-analysis of the effects of indoor nitrogen dioxide and gas cooking on asthma and wheeze in children

Weiwei Lin,1 Bert Brunekreef1,2 and Ulrike Gehring3*

1Institute for Risk Assessment Sciences, Utrecht University, Utrecht, The Netherlands and 2Julius Center for Health Sciences and Primary Care, University Medical Center Utrecht, Utrecht, The Netherlands

Pollutant concentrations and emission rates from natural gas cooking burners without and with range hood exhaust in nine California homes


Indoor Environment Group, Energy Technologies Area, Lawrence Berkeley National Laboratory, Berkeley, CA, United States

California Environmental Protection Agency
Air Resources Board

Residential Cooking Exposure Study Finds Unheathful Levels
According to several analyses, widespread building electrification in the U.S. will likely increase electricity consumption, but will decrease total economy-wide energy consumption when including the net decrease of fossil fuels.

- A recent scenario analysis by NREL suggests that widespread deployment of electrification technologies (including EVs, heat pumps, etc.) could increase 2050 U.S. electricity consumption by 20-38%.

- Since electrification technologies are highly efficient, the quantity of electricity required to produce a specified output (e.g. heat an average home) is less energy intensive than the quantity of energy required to produce the same output through direct combustion of fossil fuels.

- Despite the increase in electricity consumption from electrification, NREL's analysis suggests that the efficiency of electrification technologies (along with overall improvements in appliance and building efficiency) could result in 13-21% lower final energy consumption.
Electrification Offers Pathway To Zero Emissions Buildings Sector

Annual Greenhouse Gas Emissions from Energy Use of Title 24 2019-Compliant Building

Metric tons CO2e/year

<table>
<thead>
<tr>
<th>Year</th>
<th>Gas-heated building</th>
<th>Electric-heated building</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020</td>
<td>Gas</td>
<td>Electricity</td>
</tr>
<tr>
<td>2030</td>
<td>Gas</td>
<td>Electricity</td>
</tr>
<tr>
<td>2045</td>
<td>Gas</td>
<td>Electricity</td>
</tr>
<tr>
<td>2020</td>
<td>Electricity</td>
<td>Another Electricity</td>
</tr>
<tr>
<td>2030</td>
<td>Electricity</td>
<td>Another Electricity</td>
</tr>
<tr>
<td>2045</td>
<td>Electricity</td>
<td>Another Electricity</td>
</tr>
</tbody>
</table>

NRDC analysis, climate zone 13 (Fresno) with rooftop solar. Including methane leakage
Electrification improves affordability

- Building all-electric saves +1,500 to $6,000 in construction costs.
- Residents save $4,000-$10,000 on utility bills over 20 years.
- Adding solar lowers utility bills by an additional $500 per year.
- Gas rates rising. Utilities expect 24-46% rate hike between 2019-2022

Source: E3 Study 2019 and Synapse 2018
WHAT DOES BUILDING ELECTRIFICATION LOOK LIKE?
Modern electric equipment

- Space Heating
- Water Heating
- Cooking
- Clothes Drying
The New Valley View Homes of Selma, CA

PSH18G IQ Drive® | Maytag® M1200 up to 19 SEER, 10 HSPF Heat Pump

Electricity Consumption in a Three Bedroom ZNE Home in Selma, CA: 6650 kWh/yr, ~4kW/roof
JP SERIES 115 VOLT SYSTEMS

PRODUCT LAUNCH GUIDE

Product Overview

The new JP Series offers a 115 volt product perfect for replacement of window air conditioning units or existing 115 volt systems. This product comes standard with a remote controller and remote control holder.
# Residential Heat Pump Water Heaters

<table>
<thead>
<tr>
<th>Brand</th>
<th>Model</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sanden CO2</td>
<td>Prestige Hybrid</td>
<td>Split heat pump water heater</td>
</tr>
<tr>
<td>Rheem</td>
<td>Voltex Hybrid</td>
<td>Hybrid (WIFI option adds $150/tank)</td>
</tr>
<tr>
<td>AO Smith</td>
<td>AeroTherm</td>
<td>Hybrid</td>
</tr>
<tr>
<td>Bradford White</td>
<td>Accelera</td>
<td>Hybrid</td>
</tr>
<tr>
<td>Steilbel Eltron</td>
<td></td>
<td>Hybrid</td>
</tr>
</tbody>
</table>
ENERGYGUIDE

Water Heater – ELECTRIC
Rheem Sales Company, Inc.
Model XE95T1CHD6U1
B00150

Estimated Yearly Energy Cost

$161 ELECTRIC

$225 $732

Cost Range of Similar Models

The estimated yearly energy cost of this model was not available at the time the range was published.

First Hour Rating
(How much hot water you get in the first hour of use)

very small low medium high

Estimated Yearly Electricity Use

- Your cost will depend on your utility rates and use.
- Cost range based only on models fueled by electricity with a high first hour rating (75 gallons and over)
- Estimated energy cost is based on a national average electricity cost of 12.00 cents per kWh.

Estimated yearly electricity use: 1341 kWh

www.ftc.gov/energy.

ENERGYGUIDE

Water Heater – Natural Gas
Rheem Sales Company, Inc.
Model ECORHE50
B00007

Estimated Yearly Energy Cost

$231 GA

$225 $297

Cost Range of Similar Models

First Hour Rating
(How much hot water you get in the first hour of use)

very small low medium high

Estimated Yearly Energy Use

- Your cost will depend on your utility rates and use.
- Cost range based only on models fueled by natural gas with a high first hour rating (75 gallons and over)
- Estimated energy cost is based on a national average natural gas cost of $1.09 per therm.

Estimated yearly energy use: 212 therms

www.ftc.gov/energy.
Load Sharing Between Dryers, Water Heaters and Cars with the Dryer Buddy and NeoCharge
## CONDENSING WASHER/DRYERS

1400W AT 120V

<table>
<thead>
<tr>
<th>Make And Model</th>
<th>Magic Chef MCSCWD20W3</th>
<th>Haier HLC1700AXW</th>
<th>Summit SPWD2201SS</th>
<th>Deco DC4400CV</th>
<th>LG WM3488HW</th>
<th>Whirlpool WFC8090GX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>$720</td>
<td>$1,000</td>
<td>$1,000</td>
<td>$1,200</td>
<td>$1,300</td>
<td>$1,500</td>
</tr>
<tr>
<td>kWh/year</td>
<td>85 kWh/year</td>
<td>65kWh/year</td>
<td>65kWh/year</td>
<td>96kWh/year</td>
<td>120 kWh/year</td>
<td>180kWh/year</td>
</tr>
<tr>
<td>Drum Capacity (cu. ft.)</td>
<td>-</td>
<td>2.0</td>
<td>2.0</td>
<td>3.5</td>
<td>2.3</td>
<td>2.8</td>
</tr>
<tr>
<td>Volts/Amps</td>
<td>-</td>
<td>120V/10A</td>
<td>115V/12A</td>
<td>110V/15A</td>
<td>120V/15A</td>
<td>240V/30A</td>
</tr>
</tbody>
</table>
EXISTING GREEN BUILDING PROGRAM

- Water Use Reduction
- Building Material Supply Chain Impacts Reduction
- Improves Occupant Health Outcomes
- Improves Building Longevity
- Reduces Maintenance Costs
- Improves Disaster Resiliency
- Increases Waste Diversion Rate
- **Educates & Optimizes All-Electric Design**
- Reduces Cost of Ownership
- Leads by Example
Spa and Pool Heated with a Heat Pump

An All-Electric Resort
WHAT ARE OTHER JURISDICTIONS DOING?
OTHER JURISDICTIONS HAVE ADDRESSED

1. Electric-preferred and All-electric buildings
2. All-electric retrofit ready buildings
3. Additional solar PV requirements and/or carbon in lieu of fees
4. Natural Gas prohibitions
5. Additional electric vehicle charging requirements
BERKELEY BANS GAS PIPING FROM BUILDING PERMITS FOR PUBLIC SAFETY AND CLIMATE CHANGE: AUGUST 6, 2019
### OTHER JURISDICTIONS

#### Natural Gas Infrastructure Moratorium

- Alameda, Berkeley, Carlsbad, Morgan Hill,
- San Francisco, San Jose

#### All Electric Reach Code

- Brisbane, Carlsbad, Cupertino, Healdsburg, Los Altos Hills, Los Gatos, Menlo Park, Mountain View, Pacifica,
- Palo Alto, Santa Rosa, Saratoga, Windsor

#### Electric Preferred

- Berkeley, Davis, Marin County, Mill Valley, Milpitas, Palo Alto,
- San Francisco, San Jose, San Luis Obispo, San Mateo, Santa Monica
CHALLENGES TO ELECTRIFICATION
POTENTIAL BARRIERS

1. Availability of equipment

2. Training, experience and availability of qualified designers and installers

3. Potential high GWP factor of refrigerant in heat pumps

4. Environmental justice concerns over who pays for legacy natural gas infrastructure

5. Potential upgrades to the electricity distribution grid

6. Others?
WHAT ABOUT PUBLIC SAFETY POWER SHUTOFFS?

• New water heaters, stoves and heaters all have electric ignitions since pilot lights are no longer legal. As a result, they do not work when the electricity is off regardless of their primary fuel source.

• Gas stoves can sometimes be lit with a match during a power outage; however the exhaust fan will not work making the stove unsafe to operate.

• All-electric appliances can easily be set up to use a backup power source including generators or solar-powered batteries.

• Heat pump water heaters, like other tank-style water heaters hold substantial amounts of hot water, ready to use in case of service disruption.

• Gas negatively impacts disaster recovery time. Not only are gas lines and leaks a dangerous liability during fires, gas service typically take longer to get operational again after a safety shutoff or disaster-related inspection and repair, compared to electricity.
TIMELINE TO ADOPTION
OUTREACH THRU FEBRUARY

Community Workshop 1: Building Electrification 101
  >>>Feb. 4 | City Council Chambers | 6 – 7:30 pm

City Council Study Session
  >>>Feb. 18 | City Council Chambers | 1 – 3:30 pm

Developer’s Roundtable
  >>>Feb. 26 | Civic Auditorium Tony Hill A, B C Room | 3:30 – 5 pm

Community Workshop 2: Bldg Electrification Policy Options
  >>>Feb. 27 | Downtown Main Library Community Room | 6 – 7:30 pm

Electrification Coffee Talk with Trades, Vendors, Designers and Builders
  >>>Feb. 11 – March 10 | 11th Hour Coffee | 8:30-9:30 am
ADOPTION PROCESS

PLANNING COMMISSION

>> March 5 | City Council Chambers | 7 pm

CITY COUNCIL – FIRST ORDINANCE HEARING

>> March 24 | TBD time

CITY COUNCIL – SECOND ORDINANCE HEARING

>> April 7 | City Council Chambers | TBD time

BUILDING ELECTRIFICATION EXPO AT EARTH DAY

>> April 18 | San Lorenzo Park | 11 am – 4 pm

CALIFORNIA ENERGY COMMISSION APPROVAL OF REACH CODES

>> April – June, 2020

IMPLEMENTATION = ???
OTHER RESOURCES

- FAQs
- BERKELEY’S HOME ELECTRIFICATION FACT SHEET: ELECTRIC INDUCTION COOKTOPS
- BERKELEY’S HOME ELECTRIFICATION FACT SHEET: ELECTRIC HEAT PUMP WATER HEATERS
- SANTA CRUZ ELECTRIFICATION RESOURCES (IN DEVELOPMENT)
- SANTA CRUZ BUILDING ELECTRIFICATION OPTIONS FACT SHEET (IN DEVELOPMENT)
- SANTA CRUZ BUILDING ELECTRIFICATION OPTIONS – GHG SAVINGS ESTIMATES (IN DEVELOPMENT)
FY 19-20 Building Electrification Program Options

Affordable Housing/Multi-Unit Dwelling Electrification Grants ($1.2M)
• **Goal:** Provide a grant for developers to build new, all-electric housing
  • **Progress:** Collecting stakeholder feedback to influence program design
  • **Anticipated Launch:** Early 2020

Heat Pump Hot Water Heater Rebates for residential customers ($60K)
• **Goal:** Incentivize homeowners to electrify their water heater
• **Anticipated launch:** Early Summer
Q & A
QUESTIONS

1. PLEASE PASS YOUR QUESTIONS TO THE FRONT FOR ANSWERING

2. IF WE DON’T KNOW THE ANSWER TO YOUR QUESTION, WE WILL ANSWER IT IN THE FUTURE AND UPDATE THE FREQUENTLY ASKED QUESTIONS LIST.

PLEASE DO NOT FORGET TO COMPLETE AND SUBMIT THE SHORT MEETING EVALUATION FORM
THANK YOU + QUESTIONS?

Kurt Hurley
Green Building Specialist
khurley@cityofsantacruz.com | 8.31.420.5124

Dr. Tiffany Wise-West
Sustainability and Climate Action Manager
twise-west@cityofsantacruz.com | 831.420.5433

https://www.facebook.com/SantaCruzClimateAction/
FY 19-20  Resiliency for Residential Customers

Provide back up storage to low-income homes and MUDs and pilot a virtual power plant for the homes above that are receiving storage. ($1M)

• **Goal:** support MBCP’s most vulnerable customers

• **target customers:** ~20k CARE, Medical Baseline, & solar in high fire risk areas

• **Process:**
  • Develop program criteria, structure, and turnkey process
  • Contract with VPP company

• **Anticipated launch:** Mid 2020
FY 19-20 Other Programs

SmartConnect Microgrids at Critical Facilities

- **Goal:** Provide $25M to support resiliency and back up generation at critical facilities

- **Progress:** Staff is currently working with emergency preparedness organizations, local public agencies, and other stakeholders in the above counties to identify critical facilities that are likely to be impacted by the PSPS.

- **Anticipated Launch:** Early 2020

Reach Code consulting

- **Goal:** Contract with a consultant team that will provide resources, education and assistance to jurisdictions interested in adopting Reach Code

- **Anticipated launch:** Early 2020
REFRIGERANT LEAKAGE

Figure 3-1: Annual GHG emissions from a 1990s vintage single family home for Sacramento

- Mixed fuel vs All-electric emissions over time:
  - 2020: 
    - Mixed fuel: [Emissions Value]
    - All-electric: [Emissions Value]
  - 2030: 
    - Mixed fuel: [Emissions Value]
    - All-electric: [Emissions Value]
  - 2050: 
    - Mixed fuel: [Emissions Value]
    - All-electric: [Emissions Value]

- Emission reductions:
  - Mixed fuel: 45% reduction
  - All-electric: 61% reduction
  - Mixed fuel: 82% reduction

Legend:
- NG leakage
- NG combustion
- Refrigerant leakage
- Electricity (indirect)
FY 19-20 | Transportation Program Updates

**Central Coast Incentive Program – CALeVIP ($7M)**
- **Goal:** accelerate EV adoption through greater EV infrastructure across the tri-county region
- Launched October 30, 200+ Applications so far
- $5M Provisionally Reserved in Day 1
- **Monterey:** $2,167,000 provisionally reserved; 72% of total funds
- **Santa Cruz:** $3,317,00 provisionally reserved; 97% of total funds
- **San Benito:** $254,000 provisionally reserved; 45% of total funds

**Fund Electric School Buses ($1.2M)**
- **Goal:** replace fossil-fuel powered school buses with electric buses
- Funding distributed via MBARD’s Zero Emissions School Bus Program
- **Progress:** Working on MOU with MBARD
- **Anticipated Launch:** Early 2020

**Rebate for Home Chargers ($160K)**
- **Goal:** Provide rebates to individuals for the purchase of a home charger as well as rebates for panel upgrades if needed
- **Anticipated launch:** Early Summer
Residential Natural Gas Infrastructure Costs and Methane Leakage: $25,000+ per home, 2.7%-5.2% leakage

The total methane leakage rate from California’s residential natural gas infrastructure is estimated to be 4.18% (2.7 – 5.2%). Owner paid cost increases due to more expensive gas appliances and infrastructure. Property owner and developer cost increases are in lighter blue.

- $1,000-$3,000 Furnace (Navigant 2018)
- $100+ Dryer (Navigant 2018)
- $141-$3,717/ft 2” Low Pressure Distribution (CPUC 2016, SoCal Gas 2015)
- $7M/Well (EIA 2016)
- $80M/Station 1 per 50-60 miles (PG&E 2018)
- $110+ Stove (Redwood Energy 2019)
- 0.3% - 0.9% Appliance and Incomplete Combustion (Fischer 2018)
- 0.31% Leak Residential Meter (CEC 2017)
- 0.68% Leak Low Pressure Distribution (CEC 2017)**
- 0.02% Leak Seasonal Storage (CEC 2017)**
- 0.07% Leak Transmission (CEC 2017)
- $200-1,000/Fixture Gas piping in the home (SEA 2017)
- $16,567 Meter + Lateral Installation (PG&E 2016)
- $136-480/ft 4”-24” High Pressure Distribution (CPUC 2016, SoCal Gas 2015)
- $5M-43M/Mile 24”-42” Very High Pressure Transmission***

Property Owner / Developer Costs in BLUE

Gas Leakage by Segment in YELLOW

Appliance costs are the marginal cost ($) of gas over all-electric
*heat pump water heater equal in cost to on demand gas water heating
**Also Canyon leaked 4.62 Billion cubic feet and alone cost $1.014 billion shared by 5.6 million meters - $181/meter cost (Reuters, Aug 6, 2018)
***Average of various sources (Cochran 2018, Lennon 2019, SoCalGas 2014, NemeC 2015, Nogueras 2011)