



California
ENERGY COMMISSION



ENERGY RESEARCH AND DEVELOPMENT DIVISION

FINAL PROJECT REPORT

How to Select Strategic Pilot Sites to Decommission Portions of Gas Infrastructure in Southern California

May 2026 | CEC-500-2026-010

PREPARED BY:

Kelly Klima
Nidhi Kalra
RAND

Primary Authors

Brian Wong
Alexander Huttinger
Swaptik Chowdhury
Mark Stalczyznski
Vanessa Wolf
Aaron Kofner
RAND

Additional Team Members

Reta Ortiz
Van Do

Project Manager
California Energy Commission

Agreement Number: PIR-20-008

Reynaldo Gonzalez
Branch Manager
ENERGY SYSTEMS AND TRANSPORTATION BRANCH

Jonah Steinbuck, Ph.D.
Director
ENERGY RESEARCH AND DEVELOPMENT DIVISION

Drew Bohan
Executive Director

DISCLAIMER

This report was prepared as the result of work sponsored by the California Energy Commission (CEC). It does not necessarily represent the views of the CEC, its employees, or the State of California. The CEC, the State of California, its employees, contractors, and subcontractors make no warranty, express or implied, and assume no legal liability for the information in this report; nor does any party represent that the uses of this information will not infringe upon privately owned rights. This report has not been approved or disapproved by the CEC, nor has the CEC passed upon the accuracy or adequacy of the information in this report.

ACKNOWLEDGEMENTS

We wish to thank many people who contributed to this project. Note: Affiliations are as of time of writing the report.

Project Team, Research. We thank the staff at GTI Energy (Ernest Lever, Rupesh Muthyala) for the analysis that informed, but ultimately was not used, in the report. We also thank additional staff at Southern California Gas (N. Jonathan Peress, Kathleen Hanley) for assistance throughout the project in acquiring data.

Project Team, Communities, and Community Based Organizations. The project team worked closely with communities and community-based organizations throughout the research. We wish to deeply thank the following for assisting in working with us on this effort:

- Ariana Vito (City of Santa Monica)
- Drew Johnstone (City of Santa Monica)
- Gary Gero (County of Los Angeles)
- Heather Sharp (Century Villages at Cabrillo)
- Karen Krygier (Community Corporation of Santa Monica)
- Kristin Pawling (County of Los Angeles)
- Peter Roquemore (City of Santa Monica)
- Steve Colman (Century Villages at Cabrillo)
- Tony Foster (City of Long Beach)
- Tara Barauskas (Community Corporation of Santa Monica)

Technical Advisory Committee. A team of technical advisors provided input on the project via multiple meetings and email correspondence. The project's Technical Advisory Committee included the following contributors:

- Abhilasha Wadhwa (California Public Utilities Commission)
- Brian Hayduk (Energy by 5)
- Catherine Elder (Aspen Environmental Group)
- Daniel Hopper (Southern California Edison)
- Danilo Toskovic (PCS Energy)
- Eileen Hlavka (California Public Utilities Commission)
- Ken Rider (California Energy Commission)
- Kristina Abadjian (California Public Utilities Commission)
- Laura Humphrey (L+M Development Partners)
- Liz Gill (California Energy Commission)
- Michael Colvin (Environmental Defense Fund)
- Nick Young (Association for Energy Affordability)
- Peter Puglia (California Energy Commission)
- Robert Fortunato (ForStrategy Consulting, Inc.)
- Sean Armstrong (Redwood Energy)
- Sherri Billimoria (Rocky Mountain Institute)

- **Additional Staff.** We also received assistance from many others at RAND, including on topics related to writing (Greg Baumann), program guidance (Ben Preston), quality assurance (Kaite Elder, R.J. Briggs, Ben Miller, Ninna Gudgell), previous research (Ismael Arciniegas-Rueda, Liam Regan), workshop assistance (Hye Min Park, Zara Abdurahaman, Fernando Esteves, Avery Krovetz, Matthew Kubasak), administrative assistance (Arden Grant, Natalie Richards, Julie Ann Tajiri), and RSMeans assistance (Rahim Ali, Devin Tierney).

PREFACE

Established by the California Public Utilities Commission in 2004, pursuant to Assembly Bill 1002 (Wright, Chapter 932, Statutes of 2000), the Gas Research and Development Program is funded by California utility customers under the auspices of the California Public Utilities Commission. In 2004, the California Public Utilities Commission issued Decision 04-08-010, designating the California Energy Commission (CEC) as a research fund administrator. This program supports energy-related research, development, and demonstration not adequately provided by competitive and regulated markets. These gas research investments spur innovation in energy efficiency, renewable energy and advanced clean generation, energy-related environmental protection, energy transmission and distribution, and transportation.

The CEC's Energy Research and Development Division conducts this public-interest gas-related energy research by partnering with research development and demonstration entities, including individuals, businesses, utilities, and public and private research institutions. This program promotes greater reliability and lower costs, increases safety for Californians, and is focused on these areas:

- Building Decarbonization
- Gas System Decarbonization
- Industrial and Agricultural Innovation
- Transportation
- Resiliency, Health, and Safety
- Entrepreneurial Ecosystem

How to Select Strategic Pilot Sites to Decommission Portions of Gas Infrastructure in Southern California is the final report PIR-20-008 conducted by RAND. The information from this project contributes to the CEC Energy Research and Development Division's Gas Research and Development Program.

For more information about the Energy Research and Development Division, please visit the [CEC's research website \(www.energy.ca.gov/research/\)](http://www.energy.ca.gov/research/) or [contact](mailto:ERDD@energy.ca.gov) the Energy Research and Development Division at ERDD@energy.ca.gov.

ABSTRACT

California has some of the most aggressive policies in the United States for electrifying power in an equitable manner. Decommissioning gas infrastructure with electrification has the potential to, depending on the fuel mix, reduce greenhouse gases in line with state policies. Unfortunately, if not carefully planned, decommissioning gas infrastructure with electrification as a replacement has the potential to increase both electricity and gas rates, which in turn may have a disproportionate impact on low-income customers. In Southern California, decommissioning is particularly complex due to separate gas and electricity utilities, owned both by investors and municipalities.

Within this context, the project team asked: what is a community-level, stakeholder-informed, multi-disciplinary and objective analytical framework to identify locations in highly urban Southern California where gas decommissioning for service replacement with electrification can occur in a just, equitable, and cost-effective way? To answer, the project team used community engagement throughout the entire process. First, the team collected stakeholder decision criteria and equity concerns. Second, the team calculated costs and benefits of decommissioning with electrification as a replacement. Third, the team built a decision support tool and conducted public workshops to identify pilot sites.

The project team found that when decision-makers choose locations based solely on least cost, these locations do not necessarily reflect community priorities. When additional community priorities are considered, the resulting pilot projects for strategic decommissioning may not be the least-cost options and will likely require higher implementation costs. Furthermore, because of the price gap between gas and electricity at the time of this report, the selected pilot projects will lead higher total utility bills as a result of switching from gas to electricity, unless mitigation measures, such as solar panels, are implemented.

The research suggests that California may wish to adopt a three-step process as guidelines for decommissioning in Southern California. These proposed guidelines seek to 1) define project motivation and scope, 2) achieve buy-in from all stakeholders, and 3) conduct appropriate analyses. Following the spirit of these guidelines will help decision-makers decide how to balance what are sometimes competing priorities of greenhouse gas reduction, improved air quality index, the equity of decommissioning, and how to manage the cost. Achieving a just energy transition should be the goal of all stakeholders.

Keywords: Equity, Community Outreach, Gas Decommissioning, Building Electrification, Targeted Electrification, Guidelines for Decommissioning

Please use the following citation for this report:

Klima, Kelly, Nidhi Kalra, Geoff Danker, Brian Wong, Alexander Huttinger, Swaptik Chowdhury, Mark Stalczyński, Vanessa Wolf, Erin Coutts, Aaron Kofner. 2025. How to Select Strategic Pilot Sites to Decommission Portions of Gas Infrastructure in Southern California. California Energy Commission. Publication Number: CEC-500-2026-010.

TABLE OF CONTENTS

Acknowledgements	i
Preface.....	iii
Abstract	iv
Executive Summary.....	1
Background	1
Project Purpose and Goals.....	1
Project Approach	2
Key Results.....	2
Audiences.....	3
Knowledge Transfer and Next Steps.....	4
CHAPTER 1: Introduction	5
Background and Motivation for the Project	5
Project Purpose and Goals.....	5
Audiences for This Report.....	6
Approach, Results, and Conclusions	6
CHAPTER 2: Project Approach	7
Assumptions and Definitions	8
Steps in Research Approach	10
Step 1: Collect Stakeholder Decision Criteria and Equity Concerns.....	10
Step 2: Calculate Costs and Benefits of Decommissioning with Replacement by Electrification	11
Step 3: Build Decision Support Tool and Conduct Deliberations Workshop to Identify Pilot Sites.....	12
CHAPTER 3: Results.....	16
Information from Collecting Stakeholder Decision Criteria and Equity Concerns.....	16
Considering Alternatives to Electrification	16
Stakeholder Concerns on Costs, Equity, and Other Issues.....	16
Equity	17
Information Gleaned from Calculating Costs and Benefits of Decommissioning with Replacement by Electrification	18
Pre-Meter Costs and Benefits of Transitioning a Single Building.....	18
Post-Meter Costs and Benefits of Transitioning a Single Building	20
Capital Cost of Transitioning a Residential Building.....	20
Ratepayer and Other Impacts	28
Information Yielded by Deliberations Workshop on Identifying Pilot Sites	30

CHAPTER 4: Conclusion – Guidelines for Decommissioning	32
Three Step Guidelines for Decommissioning Gas Infrastructure	32
Define Project Motivation & Scope	32
Engage Stakeholders.....	33
Conduct a Tailored Analyses Under Conditions of Uncertainty	34
Applying the Guidelines: Selecting Sites in Southern California for Gas Decommissioning	35
Recommendations for Future Work	35
List of Terms/Glossary	37
References	38
Project Deliverables.....	44
Appendix A: Summary of Community Characteristics and Energy Infrastructure in Santa Monica, CA and Long Beach, CA	A-1
Federal.....	A-1
Local	A-2
Santa Monica, CA.....	A-3
Demographics.....	A-3
Los Angeles County Climate Vulnerability Assessment	A-3
FEMA National Risk Index	A-3
Energy Usage and Infrastructure	A-4
Building Stock.....	A-5
Neighborhoods	A-6
North of Montana.....	A-6
Wilshire Montana	A-6
Downtown.....	A-6
Mid-City.....	A-6
Ocean & Sunset Parks	A-6
Long Beach, CA	A-7
Demographics.....	A-7
Los Angeles County Climate Vulnerability Assessment	A-7
FEMA National Risk Index	A-7
Energy Usage and Infrastructure	A-8
Building Stock.....	A-9
Neighborhoods	A-10
Greater Downtown	A-10
Westside	A-10
Los Altos	A-10
Belmont & Naples	A-10

Appendix B: Energy Equity Considerations	B-1
A Framework for Equity	B-1
Energy Equity	B-2
Relationship Between Decision Criteria and Equity Metrics and Goals	B-4
Equity Vignettes.....	B-5
Energy Equity for Natural Gas Customers	B-5
Equity in Energy Efficiency Program Participation	B-5
Equity in Maintaining Post-Meter Infrastructure.....	B-5
Equity in Economic Opportunities	B-5
Trade Offs in Equity	B-6
Annotated Bibliography	B-6
Appendix C: Public Perceptions	C-1
Research Questions.....	C-1
Methods	C-1
Interviews	C-1
Scoping Workshops.....	C-3
Results	C-5
Differences and similarities among participating cities	C-8
Interview Questions	C-12
Appendix D: Hydraulic Modelling	D-1
Phase 1	D-1
Phase 2	D-2
Phase 3	D-8
Summary of Findings	D-9
Appendix E: Alternatives to Natural Gas	E-1
Definitions	E-1
Scope.....	E-2
Energy Efficiency and Demand Side Management	E-3
Criteria	E-3
Assumptions and Methodology.....	E-5
Findings	E-6
Electric Capacity in the Pilot Cities.....	E-10
Executive Summary.....	E-10
Background	E-10
Approach.....	E-10
Findings	E-11
Recommendations.....	E-12

Appendix F: Ratepayer Impacts	F-1
SoCalGas Rates.....	F-2
SoCalGas Customers in City of Santa Monica	F-2
Ratepayer Impact of Decommissioning Portions of Natural Gas System in City of Santa Monica.....	F-4
Scenario 1	F-4
Scenario 1 Revenue Requirement Results	F-7
Scenario 2	F-7
Scenario 2 Revenue Requirement Results	F-10
Scenario 3	F-10
Scenario 3 Revenue Requirement Results	F-13
Scenario 4	F-13
Scenario 4 Revenue Requirement Results	F-16
Scenario 5	F-16
Scenario 5 Revenue Requirement Results	F-19
Revenue Requirement Impacts	F-19
Natural Gas Ratepayer Impacts.....	F-21
Appendix G: Census Tracts Chosen by City Using Visualization Tool	G-1
Results: City of Santa Monica Sites (3)	G-2
Results: City of Long Beach Sites (17).....	G-5
Appendix H: Results of Deliberations Workshops.....	H-1
Recruitment and Participant Demographics.....	H-1
Deliberations Workshop format.....	H-2
Small Group Discussions of Decision Support Tool.....	H-2
Expert Panel Question and Answer Session.....	H-3
Results	H-4
New Additional Topics Raised	H-4
Pre- and post- Deliberations Workshop questionnaire.....	H-5
Methods	H-5
Findings and Discussion.....	H-6
Appendix I: Data Visualization Tool	I-1
Description of Visualization Tool.....	I-1
Visualization 1: Identifying Census Tracts of Interest	I-1
Visualization 2: Exploring Post-Meter Costs to Building Owner to Decommission	I-2
Visualization Limitations	I-4
Recommendations.....	I-4

Appendix J: Pilot Project Sites Chosen in Workshop.....	J-1
City of Santa Monica sites.....	J-1
Case Study 1: High Place (Santa Monica, CA)	J-1
Case Study 2: Cloverfield (Santa Monica, CA)	J-9
Case Study 3: Virginia (Santa Monica, CA).....	J-16
City of Long Beach sites	J-24
Case Study 4: Family Commons (Long Beach, CA)	J-25
Case Study 5: Century Villages at Cabrillo (Long Beach, CA)	J-31
Appendix K: Guidelines for Strategic Decommissioning in Southern California	K-1
Three Step Guidelines	K-1
Conclusion.....	K-4
Appendix L: Knowledge Transfer Plan	L-1
Appendix M: Project Performance Metrics.....	M-1

LIST OF FIGURES

Figure 1: Identifying Census Tracts of Interest	14
Figure 2: Exploring Post-Meter Costs to Building Owner to Decommission	15
Figure 3: Histogram of Per-Foot Costs of Decommissioning	20
Figure A.1: Data Visualizations of City of Santa Monica Infrastructure	A-5
Figure A.2: Detailed Data Visualizations of City of Santa Monica Infrastructure	A-5
Figure A.3: Data Visualizations of City of Long Beach Infrastructure	A-9
Figure A.4: Detailed Data Visualizations of City of Long Beach Infrastructure	A-9
Figure C.1: Data visualization images shared with stakeholders	C-11
Figure C.2: Zoomed in images showing all of the data in the previous Figure, as well as the location of the natural gas distribution lines and shutoff valves	C-11
Figure D.1: Flowchart for Decommissioning, shows the data workflow	D-2
Figure D.2: Disadvantaged Community is highlighted in Red and Gold shows the customers affected by the proposed decommissioning	D-3
Figure D.3: Proposed decommissioning Community highlighted in Red and Gold shows the customers affected by the proposed decommissioning.....	D-4
Figure D.4: Proposed critical infrastructure decommissioning site highlighted in Red and Gold shows the customers affected by the proposed decommissioning	D-5

Figure D.5: Proposed Mainline decommissioning pipe highlighted in Red and Gold shows the customers affected by the proposed decommissioning.....	D-6
Figure D.6: Proposed decommissioning pipe highlighted in Red	D-7
Figure D.7: Scenario 1 GIS Map with Hydraulic Modeling results overlaid with decommissioning site boundary	D-9
Figure E.1: Affected outage area A061 in 2020 Stage 3 Emergency.....	E-12
Figure F.1: Decommissioning Scenario 1 (disadvantaged communities)	F-4
Figure F.2: Decommissioning Scenario 1 – Hydraulic Modeling.....	F-5
Figure F.3: Decommissioning Scenario 2 (central neighborhood).....	F-7
Figure F.4: Decommissioning Scenario 2 – Hydraulic Modeling.....	F-8
Figure F.5: Decommissioning Scenario 3 (critical energy infrastructure).....	F-10
Figure F.6: Decommissioning Scenario 3 – Hydraulic Modeling.....	F-11
Figure F.7: Decommissioning Scenario 4 (commercial corridor).....	F-13
Figure F.8: Decommissioning Scenario 4 – Hydraulic Modeling.....	F-14
Figure F.9: Decommissioning Scenario 5 (pier)	F-16
Figure F.10: Decommissioning Scenario 5 – Hydraulic Modeling	F-17
Figure I.1: Identifying census tracts of interest.....	I-2
Figure I.2: Exploring Post-Meter Costs to Building Owner to Decommission	I-3
Figure J.1: Census Tract Maps of “High Place”	J-3
Figure J.2: Census Tract Map for “Cloverfield”	J-10
Figure J.3: Census Tract Map for “Virginia”	J-18
Figure J.4: Census Tract Maps for Case Studies 4-5	J-24

LIST OF TABLES

Table 1: Thresholds Chosen by the Cities and Community-Based Organizations.....	13
Table 2: Summary of Data or Concerns Local Stakeholders Identified.....	17
Table 3: Description of Cost Categories	21
Table 4: Range of Costs for Various Cost Items	22
Table 5: Average Annual Usage for Each Appliance by Energy Type.....	26
Table 6: Difference in Electric and Gas Appliance Maintenance Costs (in 2022 dollars)	27

Table 7: Data Requested by Stakeholders in Scoping Workshop and Availability	29
Table C.1: Summary of local affiliations for interview and workshop participants.....	C-4
Table C.2: Summary of topics addressed in interviews and workshops	C-4
Table C.3: Summary of most common stakeholder conceptions of natural gas decommissioning	C-5
Table C.4: Summary of issues commonly mentioned by stakeholders.....	C-6
Table C.5: Illustrative sample of stakeholder responses to equity vignettes	C-9
Table D.1: Data Sources and Attributes.....	D-8
Table D.2: Decommissioning Impact and Pressure Betterment Status	D-9
Table E.1: Stoplight comparison of strategies for on-site natural gas replacement.....	E-7
Table E.2: Comparison of strategies for on-site natural gas replacement	E-7
Table F.1: Natural Gas Consumption, City of Santa Monica (2021, in therms)	F-3
Table F.2: Decommissioning Scenario 1 – 10-year Revenue Requirement Proforma	F-6
Table F.3: Decommissioning Scenario 2 – 10-year Revenue Requirement Proforma	F-9
Table F.4: Decommissioning Scenario 3 – 10-year Revenue Requirement Proforma	F-12
Table F.5: Decommissioning Scenario 4 – 10-year Revenue Requirement Proforma	F-15
Table F.6: Decommissioning Scenario 5 – 10-year Revenue Requirement Proforma	F-18
Table F.7: Ratepayer Impacts.....	F-19
Table H.1: Participant Demographics.....	H-2
Table H.2: Topics Raised in Smaller Group Meetings	H-4
Table H.3: Distribution of responses pre- and post- workshop	H-8
Table H.4: Distribution of responses to questions only asked once.....	H-10
Table J.1: Post-Meter Equipment Identified to be Transitioned.....	J-3
Table J.2: Incentives Identified for this Project	J-5
Table J.3: Estimated Budget	J-8
Table J.4: Post-Meter Equipment Identified to be Transitioned.....	J-11
Table J.5: Incentives Identified for this Project	J-12
Table J.6: Estimated Budget	J-15
Table J.7: Post-Meter Equipment Identified to be Transitioned.....	J-18
Table J.8: Incentives Identified for this Project	J-19
Table J.9: Estimated Budget	J-22

Table J.10: Post-Meter Equipment Identified to be Transitioned..... J-26
Table J.11: Incentives Identified for this Project J-27
Table J.12: Estimated Budget J-30
Table L.1: Completed or Anticipated Events and Publications.....L-1
Table M.1: Project Performance Metrics.....M-1

EXECUTIVE SUMMARY

Background

California has some of the most aggressive policies in the United States for electrifying power. For example, Senate Bill 100 (SB 100, de León, 2018) and Assembly Bill 3232 (AB 3232, Friedman, 2018), taken together, aim to push the state toward zero-carbon and renewable energy resources, and reduce greenhouse gas emissions from the state's residential and commercial building stock. Decommissioning gas infrastructure with electrification has the potential to, depending on the fuel mix, reduce greenhouse gases in line with SB 100 and AB 3232. It may also be possible to avoid gas pipeline maintenance costs, by transitioning to electrification.

At the same time, California also has stated goals related to equity, such as keeping both utility bills affordable and minimizing impacts to ratepayer. Unfortunately, if not carefully planned, decommissioning gas infrastructure with electrification as a replacement has the potential to increase both electricity and gas rates, which in turn may have disproportionate impact on low-income customers. Decommissioning in locations where gas pipelines require repair and maintenance may be commonly considered the more economic option by avoiding these costs. However, in Southern California, decommissioning is particularly complex due to the existence of separate gas and electricity utilities owned both by investors and municipalities. Within this context, there is a need to first understand whether strategic decommissioning may help meet the state's goals while also helping to manage cost.

Project Purpose and Goals

The purpose of this project was to develop a community-level, stakeholder-informed, multi-disciplinary and objective analytical framework to identify locations in Southern California where gas decommissioning with service replacement via electrification can occur in a just, equitable, and cost-effective way. The project had three goals:

1. Articulating an analytical framework, or process, for selecting decommissioning sites while preserving the values of being multi-disciplinary and objective and having community involvement and informed stakeholders.
2. Creating guidelines and criteria for identifying and selecting promising future sites for gas decommissioning.
3. Identifying sites in Southern California (specifically Santa Monica and Long Beach) for gas decommissioning pilot projects.

To meet those goals, the project team engaged communities, experts, and other stakeholders; assessed costs and benefits of decommissioning (as well as non-economic factors including equity values); analyzed the resulting decision space; and developed a decision support visualization tool to help stakeholders visualize choices. The project team then selected census tracts with potential sites in Santa Monica, CA and Long Beach, CA. Stakeholder engagement ensured the participation of at least one member representing each of the following groups:

state officials and policymakers, power and gas utilities, ratepayers (households and businesses), and project developers (including restaurant owners).

Project Approach

The approach included community engagement throughout the entire process and was segmented into three main steps:

1. Collecting stakeholder decision criteria and equity concerns
2. Calculating costs and benefits of decommissioning with replacement of electrification
3. Building a decision support tool and conducting deliberation workshops to identify pilot sites

In the first step, the project team asked stakeholders about: (1) issues that are important to community stakeholders when considering whether to decommission gas; and (2) community stakeholders' perspectives on key energy equity issues. This step included conducting interviews, facilitating scoping workshops, and reviewing literature on relevant topics.

In the second step, the project team calculated the costs and benefits of decommissioning gas and replacing with electrification following the identification of major areas of impact on costs and benefits to various stakeholders. Impacts of costs and benefits across various stakeholders include: pre-meter costs to both the gas and electric utilities, post-meter costs and benefits to owners and residents, wider ratepayer community impacts for gas utility customers, ratepayer impacts for electric utility customers, and other non-cost concerns such as equity. The scope of this project was limited to focusing on electrification as the only alternative for gas.

In the third step, the project team identified sites for potential decommissioning pilots in Southern California informed by discussions and deliberations at stakeholder workshops. The project team built a data visualization decision support tool that assisted workshop participants in selecting census tracts meeting pilot criteria, then pilot sites within those tracts. The California Energy Commission requested that special focus be given to disadvantaged, vulnerable and low-income communities.

Key Results

Goal 1: Developing an Analytical Framework Process

Consistent with the previously stated project goals, the project team developed an analytical framework that laid out a process for selecting decommissioning sites. The framework includes robust stakeholder engagement to account for values such as objectivity, equity, and impacts across various stakeholders. In summary, the framework describes a process of Step 1: collecting stakeholder decision criteria and equity concerns, and Step 2: calculating costs and benefits.

These two steps developed data that was used in Step 3: conducting deliberation workshops with a range of stakeholders to identify potential pilot sites for decommissioning. A decision support tool to was developed to facilitate deliberations, which served as a visual aid to

enhance understanding of tradeoffs. A pre- and post-workshop survey of stakeholders (policymakers, power and gas utilities, ratepayers such as households and businesses, and project developers) in Santa Monica and Long Beach showed that, compared with responses collected before the deliberation workshops, post-workshop indicated:

- A significantly greater share of participants agreed that residents are aware of potential benefits of decommissioning to all stakeholders.
- Participants were more likely to agree that transitioning from gas to electricity is not a straightforward process.
- Participants were more likely to believe electrification was not as costly as they previously thought.
- Trust in a city's readiness to decommission gas in existing buildings increased.

Goal 2: Developing Guidelines for Selecting Decommissioning Sites

Development of the analytical framework and process suggested guidelines for future efforts to select decommissioning sites. The guidelines consisted of three main steps: (1) defining project scope, (2) achieving buy-in from all stakeholders, and (3) conducting appropriate analyses that account for uncertainties. The project team's research illuminated the critical need for clear communication with stakeholders to optimize site selection for gas decommissioning. Active engagement with community members, experts, and a broad array of stakeholders is necessary to identify potential pilot project sites.

Goal 3: Selecting Decommissioning Sites in Santa Monica and Long Beach

Using the developed framework and insights from community partners (including building owners, utilities, and the cities themselves) five sites in total, three sites in Santa Monica and two in Long Beach, were identified and recommended for potential decommissioning pilots. Three of the sites are multi-family housing complexes ranging from 12 to 91 units with an average of 62 units per site; one is a single-family building; and one is a 27-acre area (reflecting multiple apartment buildings owned by one Community Based Organization). The sites have a mix of electrification requirements. All of the identified sites use gas stoves, water heaters, and clothes dryers, while space heating is a mix of gas (both hydronic and wall heaters) or electricity with heat pumps. As a result, the need to replace end-use equipment and for post meter changes such as subpanel upgrades varies widely across sites. Preliminary estimates of pre-meter costs to utilities ranged from negligible (for a property at the terminus of a gas line) to \$36,000 for a nine-building, 81-unit property with office and educational space. Preliminary estimates of post-meter costs that would be borne by property owners and/or residents for each of the sites ranged from a low-end figure of \$17,000 for a single-family building to a high-end figure of \$590,000 for a multi-unit building, 91-unit apartment complex.

Audiences

The audience for this research includes stakeholders interested in strategic decommissioning of gas infrastructure in Southern California. The primary stakeholders are state officials and

policymakers, power and gas utilities, ratepayers (households and businesses), and project developers that are required by law (Senate Bill 100 and Assembly Bill 3232) to decarbonize California power generation and reduce greenhouse gas emissions from the state's residential and commercial building stock. At least one member of each audience stakeholder group was included in the research via interviews or the scoping and deliberation workshops. The results from this project will also be directly relevant to several state agencies actively exploring gas decommissioning through their various programs and policies.

Knowledge Transfer and Next Steps

This research suggests guidelines including a three-step process when considering decommissioning in Southern California. These guidelines are intended to be used by decision makers to achieve buy-in from all relevant stakeholders throughout the decommissioning process. They are designed to be considered during the initiation of any decommissioning effort and can help inform best practices. These proposed guidelines are designed to: 1) define project scope, 2) achieve buy-in from all stakeholders, and 3) conduct appropriate analyses. Following the spirit of these guidelines will help decision-makers decide how to balance across what are sometimes competing priorities of greenhouse gas reduction, improved air quality, the equity of decommissioning, and how to best manage costs. Achieving a just energy transition should be the goal of all stakeholders.

CHAPTER 1:

Introduction

Background and Motivation for the Project

California has some of the most aggressive policies in the United States for electrifying power. For example, Senate Bill 100 (SB 100) and Assembly Bill 3232 (AB 3232, Friedman, 2018), taken together, aim to push the state toward zero-carbon and renewable energy resources, gas, and reduce greenhouse gas (GHG) emissions from the state’s residential and commercial building stock. Decommissioning gas infrastructure with electrification has the potential to, depending on the fuel mix, reduce GHGs in line with SB 100 and AB 232. It may also be possible to avoid gas pipeline maintenance costs, by transitioning to electrification.

At the same time, California also has stated goals related to equity, such as keeping both utility bills and ratepayer impact low. However, if not carefully planned, decommissioning gas infrastructure with electrification as a replacement has the potential to increase both electricity and gas rates, which in turn may have a disproportionate impact on low-income customers. In Southern California, decommissioning is particularly complex due to the existence of separate gas and electricity utilities owned both by investors, such as Southern California Gas and Southern California Edison, and by municipalities such as Long Beach Utilities. Within this context, there is a need to understand whether strategic decommissioning may help meet the state’s goals while also helping to manage costs.

Empirical information on the costs and benefits of decommissioning gas infrastructure for California ratepayers can help stakeholders select the most equitable options for energy transition. The analysis of costs and benefits also may assist the California Energy Commission (CEC), the state’s energy utilities, the California Public Utilities Commission, and other regulatory agencies in determining how to proceed with future gas infrastructure decommissioning projects.

Project Purpose and Goals

The purpose of the project is to develop a community-level, stakeholder-informed, multi-disciplinary and objective analytical framework, or process, to identify strategic locations in Southern California where gas decommissioning can occur in a just, equitable, and cost-effective way. The first goal is to define the analytical framework and its associated process. That first goal supports the second goal which is to create guidelines and criteria for identifying and selecting promising sites for gas decommissioning. The third goal is to then conduct an analysis using the guidelines and criteria created to identify sites for gas decommissioning pilot projects.

In conducting research and analysis in support of this project, this report fills gaps in current understanding of the implications of gas infrastructure decommissioning, including costs and benefits to multiple stakeholders, equity considerations to low-income households that frequently bear a heavier economic burden than higher income households (discussed more

fully in Appendix B), and best practices for engaging communities on decommissioning and replacement of gas with electrification.

Audiences for This Report

The audiences for this report are stakeholders interested in the strategic decommissioning of gas infrastructure in Southern California, primarily state officials and policymakers, power and gas utilities, ratepayers (both households and businesses), and project developers that are required by law (SB 100, AB 3232) to decarbonize California power generation, and reduce GHG emissions from the state's residential and commercial building stock. At least one member of each audience stakeholder group was included in the research via interviews or the scoping and deliberations workshops. The results from this project are also relevant to several state agencies and programs.

Approach, Results, and Conclusions

The section that follows describes the project's research approach, which included collecting stakeholder decision criteria and equity concerns, calculating costs and benefits of decommissioning gas with replacement by electrification, and the conduct of scoping and deliberation workshops with stakeholders to identify pilot sites. Following that discussion, the results section lays out the insights gained from those research approaches, focusing on the project's three goals of establishing an analytical framework, or process, and setting guidelines for selecting sites for gas decommissioning, and proposing pilot sites. The report concludes with a discussion of key findings and costs and benefits, as well as suggested next steps.

CHAPTER 2:

Project Approach

The project team designed the research approach to meet the project goals of establishing an analytical framework to support selection of pilot sites for decommissioning, developing guidelines for selecting future sites, and identifying recommended pilot sites. This approach included community engagement throughout the process. The project approach consisted of three primary steps, each of which support elements of the goals:

1. Collect stakeholder decision criteria and equity concerns.
2. Calculate costs and benefits of decommissioning and replacement with electrification.
3. Build decision support tools and conduct deliberations workshops to identify pilot sites.

These steps are covered in detail after a discussion of the study's geographic areas of study, stakeholder engagement efforts, analytical/data partners, and this report's assumptions and definitions.

The study focused on the cities of Santa Monica and Long Beach (see Appendix A for more details about each), and the project team worked with both cities throughout the research process. Two community-based organizations, Century Villages at Cabrillo and Community Corporation of Santa Monica (both building owners), participated in deliberations workshops that engaged community stakeholders.

The project team engaged with relevant utilities: Southern California Gas as a project partner, the City of Long Beach municipal utility as a city partner, and Southern California Edison as a technical advisory committee (TAC) member. Both gas utilities provided infrastructure data, and Southern California Gas further assisted in analysis. Southern California Edison provided input on electricity customer ratepayer impacts and whether sufficient excess electricity capacity was available for electrification.

There were four analytic partners on this work: RAND, Gas Technology Institute (GTI), Southern California Gas, and University of California, Los Angeles's (UCLA) Los Angeles Regional Collaborative for Climate Action and Sustainability (LARC). RAND conducted equity analysis, stakeholder engagement via both a scoping workshop and deliberation workshops, decision analysis modelling, and pre- and post-meter cost calculations for decommissioning via electrification and calculation of whether there was sufficient excess electricity capacity available for electrification. RAND created the outputs of the data visualization tool, the pilot project applications, and the guidelines for strategic decommissioning. GTI used data from Southern California Gas to conduct hydraulic modelling and provide an analysis for the physical gas system (pre-meter costs). Southern California Gas also conducted calculations on ratepayer impacts. LARC supported community engagement. Multiple additional entities provided subject matter expertise via the TAC, as listed in the acknowledgements.

Assumptions and Definitions

To help scope this project, the project team compiled the following assumptions and definitions:

Decommissioning: Decommissioning is defined as either (a) turning off the flow of gas and digging up retired pipes, or (b) turning off the flow of gas and leaving the pipes in the ground.

Decommissioning costs: The decommissioning definition implies:

- The cost of the option of leaving the pipe in the ground is within the decommissioning cost, and the cost of replacing service is split out separately.
- Cost estimates allow for the engineers to leave the infrastructure in place at the building (for example, leaving gas pipes in place in the walls).

Alternatives: There are many alternatives to conventional gas, and the choice of alternative is a function of many characteristics. This project considers electrification only. Other potentially viable low-carbon replacements for gas at the meter level are out of scope for this project.¹

Time scale and technologies: The decommissioning strategies and pilot projects in scope are those that are able to initiate permitting within the next one to three years. To be considered, technologies must be feasible, cost effective, and meet local building codes.

Demographics of interest: The sponsor of this research defined two demographic characteristics to be of special interest for this project: disadvantaged community and low-income (LI) community.

- **Disadvantaged community:** Originally this research focused on a disadvantaged/vulnerable community (DVC), defined as a community in the top 25 percent scoring areas of the California Office of Environmental Health and Hazard Assessment's publicly available interactive data visualization called CalEnviroScreen. Described as "a screening methodology that can be used to help identify California communities that are disproportionately burdened by multiple sources of pollution", CalEnviroScreen provides data on socioeconomic characteristics and pollution as a function of the census tract. Over the course of this project, the California Environmental Protection Agency (CalEPA) revised its definition of the term, and the research team was tasked to focus on the new definition. As of May 2022, the definition is:
 - "Census tracts receiving the highest 25 percent of overall scores in CalEnviroScreen 4.0 (1,984 tracts)
 - Census tracts lacking overall scores in CalEnviroScreen 4.0 due to data gaps but receiving the highest 5 percent of CalEnviroScreen 4.0 cumulative pollution burden scores (19 tracts)

¹ These might include, for example, energy efficiency, hydrogen, compressed renewable gas and biopropane, or geothermal (ground source heat pump). Appendix E contains a description of these alternatives.

- Census tracts identified in the 2017 disadvantaged community designation as disadvantaged, regardless of their scores in CalEnviroScreen 4.0 (307 tracts)
- Lands under the control of federally recognized Tribes. For purposes of this designation, in consultation with CalEPA, a Tribe may establish that a particular area of land is under its control and therefore be considered a disadvantaged community even if not represented as such on CalEPA's disadvantaged community map.
- **Low-income (LI):** A low-income community, defined as a community within census tracts with median household incomes at or below 80 percent of the statewide median income or the applicable low-income threshold listed in the state income limits updated by the Department of Housing and Community Development.

Geographic scope/ Pilot project size: This research is limited to the cities of Santa Monica and Long Beach. Furthermore, as the research evolved, the sponsor and TAC directed the project to focus on large residential apartment buildings. Selecting a single building is the smallest unit practical and applicable to measuring cost. Thus, the pilot projects identified in this report are restricted to residential buildings and specifically targeting either (a) a single multi-unit building or (b) a group of a few buildings owned by the same owner.

It is worth noting that the characteristics affecting decommissioning beyond this choice of geographic scope and pilot project size has some implications for the scalability of the findings. Findings relevant to stakeholder engagement should be replicable and scalable to the rest of California. Dimensions such as types of utilities, percentage of utility customers, urban vs. rural, and climate/weather must be considered. The study focus areas considered both a large and small gas utility (Southern California Gas and City of Long Beach Municipal Utility, respectively), which should be replicable across the state. However, these focus areas did not include a municipal electric utility, so findings should be carefully scaled to those areas, as there are likely unique concerns related to these entities. Next, the pilot project sizes are all relatively small percentages of the relevant utilities' customer base. Findings could be scaled to other locations, but some costs (such as rate payer impacts) will become non-negligible when expanding to larger geographic scope. Urban vs. rural differences must also be considered. Urban areas are more conducive to decommissioning large amounts of consumption at a time, due to the higher density of customers. The findings here may not apply to rural areas, where the cost to provide infrastructure for the "last mile" is extremely higher as a function of customer served. Finally, this project focuses on areas that have historically not experienced wildfires or freezing temperatures; inclusion of both might change types of equipment, infrastructure protection, and labor and material costs.

Additional details on the geographic scope and pilot project size are reported in the Guidelines for Strategic Decommissioning (summarized in the conclusion of this report and provided in full in the Appendix K).

Amount of Excess Electricity Capacity Available: Considering the time scale (one to three years) and the size of pilot projects (a single building), it is assumed:

- Electricity is generated using the fuel mix and cost reported by California Independent System Operator (CAISO).² While it is not propagated through the study, note that this means the fuel mix for electricity generation is not GHG emission neutral.
- Local electricity infrastructure can accommodate increased demand only up to existing capacity. Thus, at the community level, electrical infrastructure may have to be upgraded resulting in ratepayer impacts on electricity customers at large. Considering the aggregate effects of large-scale decommissioning is outside the scope of this research.³
- Energy efficiency, distributed resources, and demand side management techniques will reduce upward demand pressure on the electric grid.

Who pays: This research assesses costs to the utilities (pre-meter costs) and customers being decommissioned (post meter costs), as well as ratepayer cost impacts. This research does not consider cost to the government (specifically, what the effect of different government-provided rebates might be).

Steps in Research Approach

The three research goals (articulating an analytical framework for selecting pilot sites; establishing guidelines for decommissioning; and selecting pilot sites) were all informed by three major steps of the research approach. The first two steps, (1) collecting stakeholder decision criteria and equity concerns, and (2) calculating costs and benefits of decommissioning with replacement by electrification, developed data that supported the goal of articulating an analytical framework for selecting pilot sites.

The third step, conducting deliberations workshops to identify pilot sites, informed the goal of selecting pilot sites. All three steps in the research approach informed the other goal of the project, creating guidelines for selecting sites to decommission gas infrastructure.

Step 1: Collect Stakeholder Decision Criteria and Equity Concerns

First, the project team collected stakeholder input. They began by conducting a literature review of equity considerations (Appendix B), which were used to inform two questions:

- What issues are important to community stakeholders when considering whether to decommission gas infrastructure?
- Are community stakeholders mindful of equity issues, and if so, how are they perceived?

² California Independent System Operator (CAISO). May 2022. "2021 Local Capacity Technical Study: Final Report and Study Results".

³ While outside the scope of this project, note that as large swaths of buildings are electrified, there may be a need to consider aggregate effects.

To answer these questions, the project team conducted both interviews and scoping workshops as summarized below and more fully described in Appendix C.

Interview Format and Participant Demographics

Interviews were semi-structured and included open response questions addressing perceptions of gas decommissioning and potential impacts. The questions emphasized adverse effects and who might be most impacted. The recruitment protocol, interview questions, and demographics are included in Appendix C. Thirty-minute interviews were conducted via telephone or a virtual online meeting between October 2021 and January 2022.

Scoping Workshop Format and Participant Demographics

In January 2022, RAND convened two virtual scoping workshops, in Long Beach and Santa Monica. The workshops were hosted and moderated by the study principal investigator while discussions were facilitated by trained moderators on the study staff. The same general format was used for both workshops; however, city-specific content was developed for relevant activities. Participants were compensated for the 3 ½ hours they spent in the workshops. Accommodations were made for participants who joined the scoping workshops by telephone and were not able to see visual components of the workshops. Appendix C contains additional information on the scoping workshop agenda (including equity vignettes beyond just cost to low-income customers)⁴ and demographics of attendees.

Step 2: Calculate Costs and Benefits of Decommissioning with Replacement by Electrification

The impacts of decommissioning gas and replacing its use with electricity would affect a variety of infrastructure elements and stakeholders. This step calculates the following major areas of impact on costs and benefits of a decommissioning project (specifically, decommissioning a particular building or small collection of buildings): pre-meter, post-meter, ratepayer impacts, and additional impacts not covered by the preceding three categories.

Pre-meter: This refers to pre-meter costs of ending gas service and securing the gas supply infrastructure. These costs are considered “pre-meter” as they are incurred on gas infrastructure before the pilot site’s utility meters. These costs and benefits are primarily borne by the gas utility. The best approximation that can be made to utility decommissioning costs is from abandonments. The project team analyzed cost data from 875 Southern California Gas abandonment projects in the years 2018–2021 to determine the costs and benefits of a decommissioning project. Note, while pre-meter costs might also include costs to the electric utility, this consideration was addressed separately (Chapter 3, section “Consideration of Whether Sufficient Electricity Supply Is Available to Serve Incremental Load Increase”).

⁴ Equity is a complex, multi-dimensional concern. The literature review identified several potential equity impacts associated with a transition from gas to electricity including but not limited to increasing rates and decreasing affordability for remaining gas customers, impacts on the current gas work force, distribution of economic opportunity in new electricity jobs, and concerns related to safety and environmental equity. Appendix C offers five related vignettes, on energy equity for gas customers, equity in energy efficiency program participation, equity in maintaining post-meter infrastructure, equity in economic opportunities, and tradeoffs in equity.

Post-meter: This refers to costs and benefits of transitioning a building from gas to electricity, including up-front costs (equipment, labor, permitting, regulatory compliance, remediation), ongoing costs (equipment maintenance and utility costs), change in monthly utility bills, and change in air quality. These costs and benefits are primarily experienced by the building owner and inhabitants.⁵

Ratepayer impacts: This refers to both gas and electricity ratepayers.

Additional impacts: These include non-cost (and sometimes solely qualitative) impacts not captured in the previous impact categories. Some of these are related to decision criteria, others to equity concerns. The project team solicited types of additional impact data of interest to stakeholders (see Results in Chapter 3), and then for each attempted to collect data, calculate the values, or use a proxy data set.

Ideally, one would calculate the costs and benefits of alternatives against business as usual. In this project, the gas utility provided some information about the gas infrastructure grid. However, neither utility (gas nor electricity) provided details on maintenance levels, nor on customer bills. As a result, the difference in maintenance costs before and after electrification cannot be calculated. Since the business-as-usual costs were not available, a net present value also could not be calculated. Additionally, without customer bill data, this report identifies the project costs and range of possible changes to customer bills.

Step 3: Build Decision Support Tool and Conduct Deliberations Workshop to Identify Pilot Sites

In the final step, the project team built a data visualization tool (also referred to in this report as a decision support tool), consulted with experts on suggested initial settings for the tool, and conducted deliberations workshops with stakeholders to identify pilot sites.

Work with Experts Prior to Deliberations Workshops to Focus Discussions

Some of the data requested in the scoping workshops (Table 7; Appendix A & B) were only available at the census tract level. These data were used to narrow down the sites to a few select census tracts. Specifically, there were four criteria:

- **Average Pipe Diameter:** The project team calculated average pipe diameter and used this as a proxy to identify areas where there are relatively numerous branches in the gas line.⁶ The smaller the average pipe diameter, the more likely it will be to find terminal branches (or end segments) in the census tract that would be easier and cheaper to decommission while simultaneously affecting fewer customers.

⁵ Calculations include a determination of whether sufficient electricity supply to serve incremental load exists, which has implications for costs and benefits to both the building owner and inhabitants as well as to the electric utility. The project team used a variety of data sources to inform this analysis, including publicly available reports, California ISO data, RSMMeans, and guidance from subject matter experts on the required work breakdown structures.

⁶ While the project team has data on the average gas pipe diameter, a non-disclosure agreement does not allow this report to show the pipe geometry, nor where terminal regulators (regulators with no further downstream regulators) are located for the full city regions.

- **Average Pipe Age:** The project team was not able to obtain maintenance or planned replacement data. Alternatively, the project team calculated the average age of the pipe and used this as a proxy to identify areas where pipes might be nearing the end of their life cycle.⁷ The older the average pipe age, the more likely it will be to find older pipes in the census tract that would soon need replacement.
- **DVC:** The authors used DVCs as defined at the census tract level and provided in the CalEnviroScreen (version 4.0). The required minimum threshold was the 75th percentile of the tool. At the time of this deliberations workshop, the sponsor had not yet transitioned from DVC to disadvantaged communities; the pilot project site choice (Appendix J) included consideration of disadvantaged communities.
- **Average cost to decommission a residential building:** The Results chapter describes the calculations for behind-the-meter costs to decommission various types of residential buildings. The project team used the census tract data (which may not fully represent the actual buildings) and calculated the average cost to decommission a residential building. As census tract data are uncertain, an uncertainty range is provided. While costs are higher, for large apartment buildings such as very high-density residential building complexes (which in California’s residential zoning classification are coded as R4), the cost per person to decommission is typically lower.

The project team worked with the cities and community-based organizations to define thresholds for pilot-site selection criteria of average pipe diameter, average pipe age, and DVC thresholds (see Table 1). Note that the two groups chose different criteria for selecting pilot decommissioning sites based on additional local concerns related to, among other things, forthcoming local policies.

Table 1: Thresholds Chosen by the Cities and Community-Based Organizations

City	Average Pipe Diameter	Average Pipe Age	DVC Threshold
City of Santa Monica	No limit	>50 years	>80
City of Long Beach	<3.5"	>40 years	>80

Source: RAND Research

The thresholds resulted in 3 candidate pilot site census tracts in Santa Monica and 17 candidate pilot site census tracts in Long Beach. For each census tract, the authors compiled a map with the remaining data requested by stakeholders in Step 1, such as location of R4 apartment complexes. The resulting maps (4 and 15 in Santa Monica and Long Beach, respectively) are found in Appendix G and were used in Step 3.

Develop Decision Support Tool

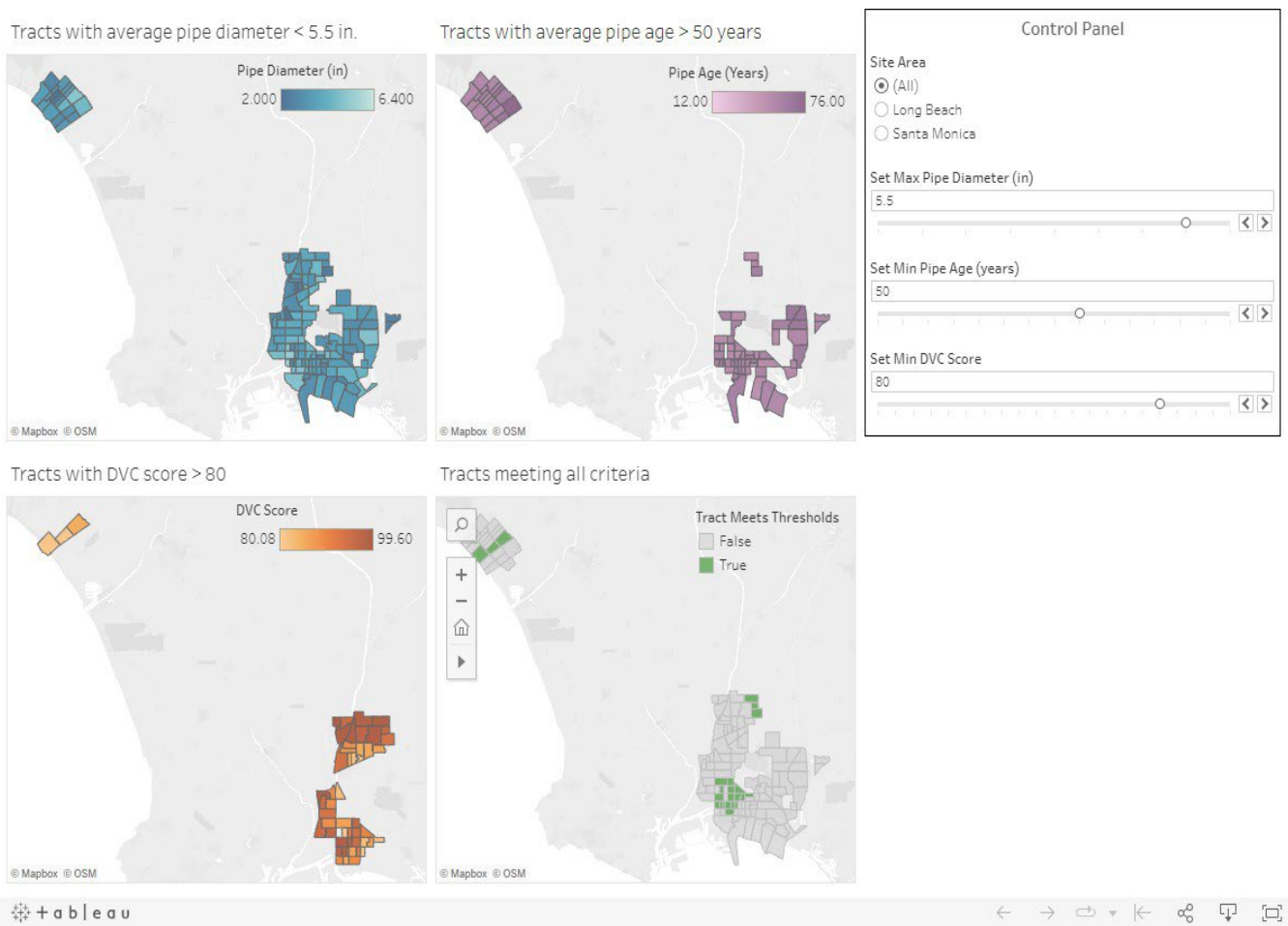
To help stakeholders explore the data as they deliberated over pilot-site selection for decommissioning, the project team created a decision support tool that was used in the deliberation workshop exercises. This tool has two visualizations: (1) Identifying Census Tracts

⁷ Note that the pipe age may not be correlated with maintenance or planned replacement data. If these data were to become available, they would be preferred over average pipe age data.

of Interest ("Tract Explorer") and (2) Exploring Post-Meter Costs to Building Owner to Decommission ("Cost Explorer"). Figure 1 and Figure 2 show a screenshot of the tool, and Appendix I describes the final decision support tool in more detail (including the reasoning behind the default views). The [decision support tool](#) is available to use at the link below:

https://public.tableau.com/views/CECPIR20-008VisualizationToolBeta/TractExplorer?:language=en-US&publish=yes&:display_count=n&:origin=viz_share_link

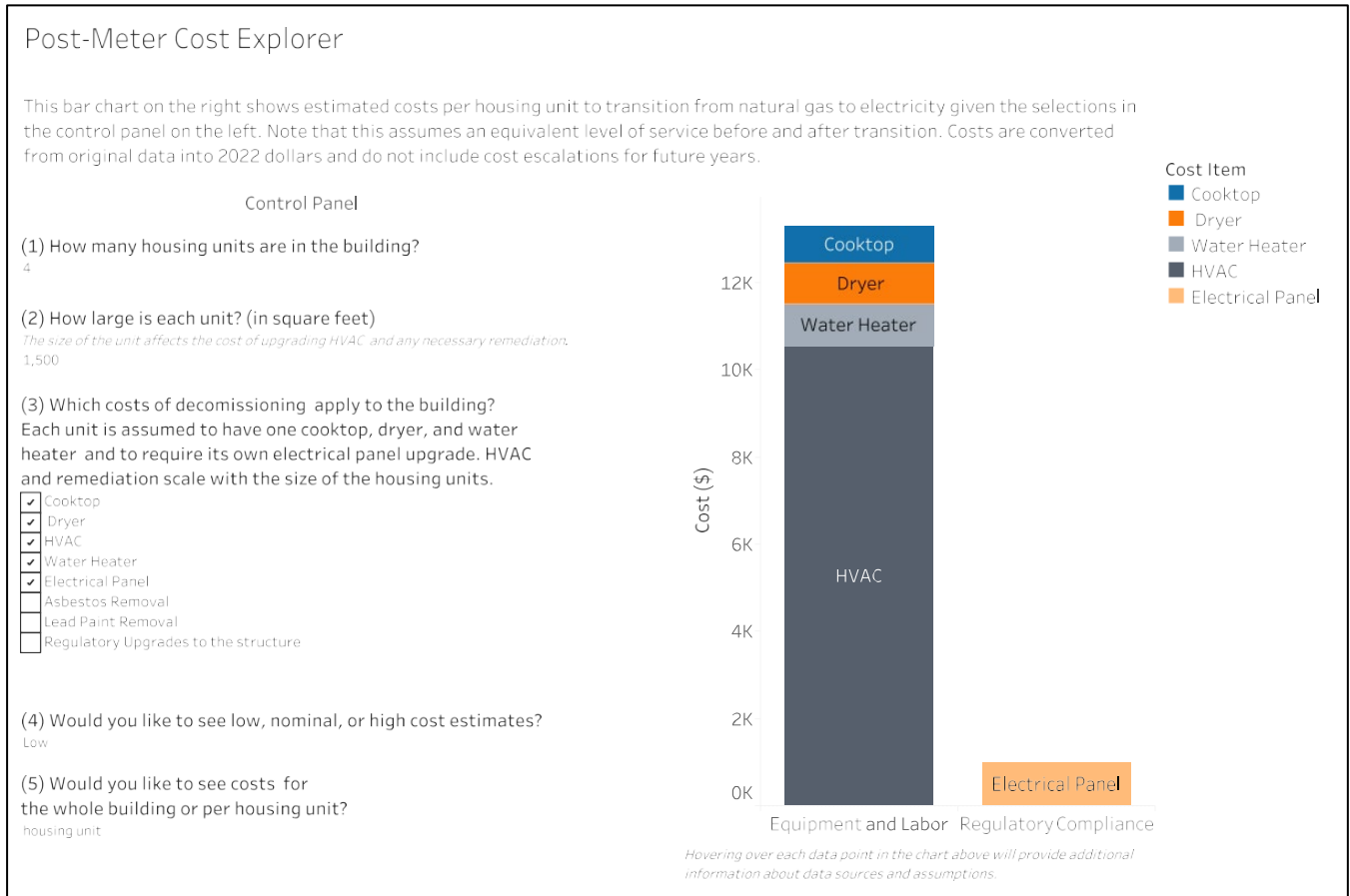
Figure 1: Identifying Census Tracts of Interest



Source: RAND Analysis of Census data and data provided by Southern California Gas

Note: The control panel in the top right allows users to zoom in to a single area if desired, and to set thresholds for each of these factors that can reflect their selection preferences. The panels will show only tracts that meet those threshold criteria, hiding those tracts that do not. This helps users see which tracts fall into the user-specified constraints for pipe age, size, and DVC score.

Figure 2: Exploring Post-Meter Costs to Building Owner to Decommission



Source: RAND Analysis of Census data and data provided by Southern California Gas

Note: The decision support tool allowed participants to explore post-meter costs to building owners affected by decommissioning and transitioning to electrification. By filling in values on the control panel, estimates of total costs could be investigated at both an individual unit and whole building level.

Deliberations Workshop Format and Participant Demographics

Two deliberations workshops were conducted in November 2022, one each for Long Beach and Santa Monica. The census tract maps and data visualization tool were provided to workshop participants to help them decide on candidate pilot sites. Appendix H contains a full description of these workshop agendas, as well as information on attendee demographics.

CHAPTER 3:

Results

This section conveys key information revealed by the three main research approach steps described in the previous chapter: 1) collecting stakeholder decision criteria and equity concerns, 2) calculating costs and benefits of decommissioning with replacement as electrification, and 3) conducting deliberations workshops to identify pilot sites. The conclusion section that follows this discussion of results synthesizes how the key information developed in these steps informed the project's three main goals of establishing an analytical framework for selecting decommissioning pilot sites, developing guidelines for selecting decommissioning sites, and selecting particular sites in the study's geographic areas of interest.

Information from Collecting Stakeholder Decision Criteria and Equity Concerns

Considering Alternatives to Electrification

Data gathered from stakeholders in the Southern California region strongly suggest that if stakeholders are asked to decommission gas infrastructure, some will wish to use alternatives other than electrification. When asked what alternatives to gas they were aware of, stakeholders mentioned different options,⁸ with electrification mentioned most frequently. At the same time, the stakeholders did not agree that electrification is the most viable option. In fact, many stakeholders thought it was extremely expensive compared to alternatives. This finding implies that stakeholders will question an analysis that solely considers electrification.

To facilitate acceptance of electrification, stakeholders will need to see that other options are considered in the analysis, with electrification demonstrated to be the more effective option. Moreover, stakeholders may have their own definitions of what constitutes effectiveness — cost, equity, feasibility, time horizon for implementation, and so on. Further research is needed to include high-level costing of these alternatives to aid stakeholders in assessing which pilot sites are most suited for electrification. See Appendix E for a high-level description of alternatives to electrification.

Stakeholder Concerns on Costs, Equity, and Other Issues

Focusing on decommissioning gas and replacing it with electrification, stakeholders indicated cost (including who pays that cost) was an important consideration. In addition, community stakeholders identified issues that might be important when considering whether to decommission gas, including having and understanding the correct engineering data, considering a variety of effects on customers, and considering environmental impact (Table 2). Effects on vulnerable and disadvantaged communities were another key concern.⁹

⁸ Appendix E discusses other options than electrification, including hydrogen, compressed renewable gas, biopropane, geothermal, energy efficiency, and demand side management

⁹ It is possible that there are other concerns that may be important. For example, one quality assurance reviewer suggested that there might be multiple reasons that a resident might want to retain gas (maybe for cooking, or

Table 2: Summary of Data or Concerns Local Stakeholders Identified

Type	Data or Concern
Engineering Data	<ul style="list-style-type: none"> • Map of gas infrastructure at distribution level • Age of pipes • Maintenance schedules of pipes • Time frame of project
Customers	<ul style="list-style-type: none"> • How many customers are served? • Are affected customers residential, commercial, or industrial? • Will restaurants be affected (is gas required for certain types of cooking)? • Are customers renters or homeowners? • What is the location of critical infrastructure? • Is it a historic district or not? • Is there some consideration of equity (=costs relative to median income in a given tract)? • Are there exemptions if residents want to retain gas? • Are there rebates, incentives, or other ways to entice stakeholders to participate in decommissioning? • Will appropriate public perception, communication, education, and outreach occur before, during, and after the decommissioning?
Environmental	<ul style="list-style-type: none"> • How much is gas reduced? • How does this affect traffic? • What are estimated GHG reductions? • What will the change be in indoor and outdoor air quality?

Equity

One key concern among stakeholders was how decommissioning gas will affect vulnerable and disadvantaged communities and whether the burdens will fall upon those communities disproportionately. This project conducted a literature review on energy equity and decommissioning equity and assessed the relationship between decision criteria for decommissioning and equity considerations (see Appendix B). The research suggested four key themes regarding equity in decommissioning:

- Robust community engagement is critical to identifying location specific equity concerns, and thus critical to equitable decommissioning.

for a tankless water heater), so the exemptions might encompass several categories. Another suggestion was to obtain data on location of regulators, including regulators with no downstream regulators (which would be less likely to impact gas flow).

- Support to transitioning communities must be multi-dimensional, including economic, environmental, and infrastructural support.
- Policies should consider historical inequities.
- Policies should consider leveraging existing low-income assistance programs (where they do not conflict with historical inequities).

This work informed development of multiple energy equity vignettes that support consideration of non-monetary costs and benefits (see Appendix B).

In this work, the project team was asked to engage community-based organizations to ensure that the needs and concerns of underrepresented and vulnerable communities were well represented. However, the project team did not have occasion to apply the equity metrics or vignettes during the project: the selected sites were directly recommended by the community-based organizations, and those sites were not in competition with each other for resources. Future work on decommissioning, where tradeoffs between sites and options are considered and choices made amongst them, will surely need to use equity metrics and apply tools like the vignettes developed to yield a broader understanding of how decommissioning affects different groups and how those differential effects can be addressed.

In sum, the observations made while collecting stakeholder decision criteria and equity concerns informed all the goals of the research project: the development of the analytical framework for selecting decommissioning sites, creation of guidelines for site selection, as well as the selection of sites in the project's geographic areas of interest.

Information Gleaned from Calculating Costs and Benefits of Decommissioning with Replacement by Electrification

As the scope of the assessment focused primarily on nearer-term considerations, such as the current costs of transitioning a building from gas to electricity, the factors driving the assessment could be directly informed by the existing cost evidence.

The discussion began with an analysis of pre-meter costs and benefits of transitioning a single building (primarily borne by a gas utility), then covered post-meter costs of transitioning a single building (borne by owners and occupants). That was followed by analyzing whether sufficient electricity supply exists to serve incremental loads.

Estimated changes in utility bills, as well as estimated changes in air quality were examined, followed by a discussion as to whether the pilot projects would result in impacts to the larger population of ratepayers. Finally, this section covered defining and calculating non-cost stakeholder criteria and equity metrics including data on engineering of gas infrastructure, utility customer characteristics, and environmental impacts.

Pre-Meter Costs and Benefits of Transitioning a Single Building

Transitioning a building away from gas requires deactivation of pipelines, and it is important to note that decommissioning and leaving pipes in place is an order of magnitude less expensive than digging them up and replacing them. With that context, the project team distilled 49 CFR

192.727¹⁰ and Southern California Gas's standard operating procedure for abandonment or inactivation of a gas distribution pipeline facility as follows:

- Shut off the gas supply source
- Disconnect from all gas supply sources
- Purge, clean, and fill with inert material all abandoned distribution lines
- Seal all open ends of the abandoned line

To evaluate the decommissioning costs associated with that process, the project team analyzed data from 875 Southern California Gas abandonment projects spanning the years 2018–2021. These projects all followed the procedure according to 49 CFR 192.727. Figure 3 shows the per-foot costs of decommissioning and leaving the pipelines in place (horizontal axis) and the number of projects for which costs fall in the given range (vertical axis). The cost to the utility to decommission was a median of \$42.10 and mean of \$48.10 per foot of pipe (and ranged from \$0.70 to \$130.60 per foot of pipe).^{11,12} For a single R4 apartment building complex at a terminal branch of the distribution infrastructure (which might, for example, have on average 50–100 feet of pipe to be decommissioned) that implied an average cost of approximately \$2,500 to \$5,000.

As noted at the outset of this discussion, abandonment in place is an order of magnitude cheaper than digging up pipes to replace them. For comparison, a CPUC's long-term gas planning rulemaking¹³ noted that the mean expenditure per foot for the substitution of the distribution main pipeline stands at \$649/foot, whereas the cost for the replacement of the distribution service pipeline averages at \$574/foot. Even after subtracting the cost of the replacement pipe (thus in essence leaving only the price to dig up the pipe), these costs were more than 10 times the cost to abandon in place.

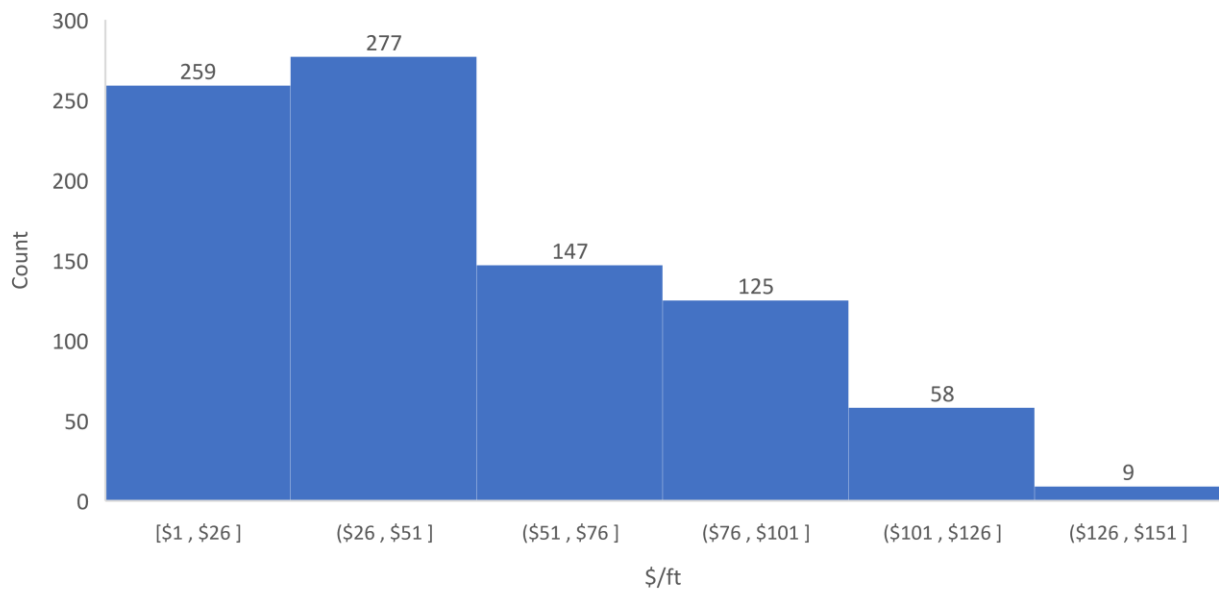
¹⁰ While the existing procedure does not require it, a second possible method for decommissioning gas infrastructure is to dig up and entirely remove the pipes and related infrastructure. This may be required in areas with extremely specialized land use regulations (perhaps due to environmental concerns). There were approximately 10 instances of this entire removal of pipes in the data set from Southern California Gas. Since each of these instances was highly specialized due to local regulations, these costs are not reported here. This scoping aligned with the same scoping for asbestos remediation, which the Technical Advisory Committee indicated was a highly specialized activity that would not apply to the majority of electrification projects.

¹¹ These costs assume abandonment and related remediation and potential for future reuse by the utility. This means that the utility retains ownership. Southern California Gas did not report any monetary costs or benefits from the option to reuse the infrastructure later (the recorded book value of the infrastructure). That is, since the utility maintains ownership, it will therefore hold both any benefits from and liability for any abandoned distribution lines, but these potential costs and benefits were not included in this analysis. Costs did not include future cost escalation. There may be price escalation due to COVID or other reasons, which would not be captured in the costs. Since 2010, the average annual cost escalation in California has been approximately 4 percent, though it has been higher in recent years [California Department of General Services, Real Estate Services Division. "DGS California Construction Cost Index CCCI"](#).

¹² For all costs presented in this section, the source data did not contain the year of the dollars (e.g., FY19 or FY20), but can later be scaled to reflect a range of years. For reference, \$1 in 2021 = \$0.96 in 2020, \$0.94 in 2019, and \$0.93 in 2018. At the time these costs were calculated and presented to stakeholders, the authors lacked pipeline material (e.g., steel vs. plastic). The pipeline material information asked about is now public at the census tract level in the "Data" section at the bottom of this page: Long-Term Gas Planning Rulemaking (ca.gov) and is included as a footnote in the report.

¹³ California Public Utilities Commission, [Long-Term Gas Planning Rulemaking](#).

Figure 3: Histogram of Per-Foot Costs of Decommissioning



Source: RAND Analyses of data provided by Southern California Gas

Note: X-axis labels are the histogram groups. For example, [\$26,\$51] is interpreted as a cost (\$/ft) of 26 to less than 51.

Post-Meter Costs and Benefits of Transitioning a Single Building

This section describes the calculation of costs and effects of replacing gas equipment and appliances in a single building with electrical counterparts. These comprise the costs of decommissioning incurred by building owners and residents “after-the-meter,” including the up-front costs of replacing the equipment (accounting for ancillary electrical work and regulatory upgrades) and the difference in the cost of electricity versus gas to operate equipment. Other effects include the impact on atmospheric gasses that absorb infrared energy, also known as GHG, and indoor air quality.

Capital Cost of Transitioning a Residential Building

The project team first estimated the capital cost of transitioning a residential building from gas to electricity. The assessment addressed the costs and benefits of replacing gas powered appliances with electric appliances for space heating, water heating, stovetop cooking (including oven), and clothes drying including capital costs, ongoing utility and maintenance costs, and impact on indoor air quality. Other uses of gas, such as fireplaces and heated pools, were out of scope.¹⁴ Costs were assessed in both single-family homes and multi-family complexes with gas submetering.

The capital cost of replacing building equipment is the sum of three component costs: equipment and labor, permitting, and regulatory compliance. Table 3 describes these costs in more detail.

¹⁴ It is likely that if fireplaces are rendered useless, or pools are no longer heated, building owners will require a special incentive to offset their loss.

Table 3: Description of Cost Categories

Cost Category	Description
Equipment and Labor	This category included the purchase cost of appliances and the labor cost of installing them.
Permitting	This category reflected the cost of obtaining regulatory permits, tests, and inspections.
Regulatory Compliance	Depending on the age and condition of a building, the transition to electricity can trigger other types of updates or remediation. This can include costs related to decommissioning, such as upgrades to electrical panels and wiring, and costs unrelated to but triggered by decommissioning, such as lead or asbestos Remediation (CA CFR, Title 8, Sections 1529 and 1532.1). ^{15,16,17}

Source: RAND Research

Note: One project Technical Advisory Board member noted that when someone electrifies apartment complexes and is aware of lead paint or asbestos, drywall is not disturbed. However, at least one project partner (Santa Monica community-based organization, Community Corporation of Santa Monica) indicated that their older buildings may include asbestos and lead, and including these regulatory costs would be required to correctly reflect costs. Thus this report split out the costs of asbestos and lead-based paint (the “regulatory costs”) so the decision maker can choose to include it or not. The tool defaults to not showing these costs

The literature on costs for the categories in Table 3 is sparse and cost values vary widely. This report therefore provides and uses the range of values found in the literature. Table 4 includes a range of values for each cost item in the second column based on this literature. Where RSMMeans is referenced, these costs use the appropriate location factors to convert to Santa Monica or Long Beach. Where the E3 report is used, it is assumed that the numbers provided were already adjusted to California.

Note that the cost for a particular building will depend upon its unique characteristics (the number and type of equipment that requires replacement and the extent of regulatory upgrades required, if any). Some costs were relatively stable across the marketplace, such as electric dryers or hot water heaters. Other costs, such as heating, ventilation and air conditioning (HVAC), were more variable. For example, HVAC cost varied by building characteristics such as number of windows, building envelope, level of insulation, and so on. The highest value found in the literature was \$53,000 for a system serving 1,500 square feet of living space; while this is reported in an attempt to be thorough, note that this is an extremely rare cost.

¹⁵ California Code of Regulations, [CA CFR, Title 8, Sections 1529](#), Retrieved Oct. 19, 2022.

¹⁶ California Code of Regulations, [CA, CFR, Title 8, Section 1532.1](#). Retrieved Oct. 19, 2022.

¹⁷ One project Technical Advisory Board member noted that when someone electrifies apartment complexes and is aware of lead paint or asbestos, drywall is not disturbed. However, at least one project partner (Santa Monica community-based organization, Community Corporation of Santa Monica) indicated that their older buildings may include asbestos and lead, and including these regulatory costs would be required to correctly reflect costs. Thus this report split out the costs of asbestos and lead-based paint (the “regulatory costs”) so the decision maker can choose to include it or not. The tool defaults to not showing these costs.

Table 4: Range of Costs for Various Cost Items

Cost Item	Approximate Unit Cost [min, nominal, max]	Assumptions for Single Family Home	Assumptions for Multi-Family Complex	Data Sources	Notes for Calculated Cost Ranges
Equipment and Labor					
Cooktop	[\$840, \$2400, \$4000] per cooktop replaced	One cooktop per building	One cooktop per unit in building	Facilities Construction Costs with RSMeans Data: 2019 (Means Facilities Construction Cost Data), 2019 (p. 462)	RSMeans lists the cost of counter cooktops (4 burners) in the range of \$480-\$2300 (p. 462). The authors multiplied the cost by 1.27 (<i>DCD 2022 Regional Modifier</i>) and 1.36 (<i>DCD Cost Escalation Index</i>) to localize the cost data for Los Angeles Region and adjust the cost from 2019 to 2022 respectively. Note, the costs for the full range may be necessary depending on what is being replaced.
Dryer	[\$950, \$2700, \$4500] per dryer replaced	One dryer per building	Ranges from one dryer per unit to one dryer per four units	Facilities Construction Costs with RSMeans Data: 2019 (Means Facilities Construction Cost Data), 2019 (p. 463)	RSMeans lists the cost of an electric dryer in the range of \$900-\$2225 (p. 463). The authors multiplied the cost by 1.27 (<i>DCD 2022 Regional Modifier</i>) and 1.36 (<i>DCD Cost Escalation Index</i>) to localize the cost data for Los Angeles Region and adjust the cost from 2019 to 2022 respectively.
HVAC	[\$4,000, 28,500, \$53,000] per HVAC System serving 1500 square feet of living space.	One HVAC system per building	One HVAC system per unit	Design Cost Data (Dcd), 2022	The cost range was estimated from several renovation and retrofit projects in California between 2018 & 2022
Water Heater	[\$950, \$2700, \$4500] per water heater	One water heater per building	One water heater per unit	Facilities Construction Costs with RSMeans Data: 2019 (Means Facilities Construction Cost Data), 2019 (p. 463).	RSMeans lists the cost of an electric 30-gallon water heater in the range of \$1275-\$1875 (p. 463). The authors multiplied the cost by 1.27 (<i>DCD 2022 Regional Modifier</i>) and 1.36 (<i>DCD Cost Escalation Index</i>) to localize the cost data for Los Angeles Region and adjust the cost from 2019 to 2022 respectively.
Permitting	Assumed to be [0.050%, 1%, 2%] of equipment and labor costs			Facilities Construction Costs with RSMeans Data: 2019 (Means Facilities Construction Cost Data), 2019 (p. 15).	RSMeans lists the cost of permitting in the range of 0.50% to 2% of the total project cost (p. 15). The authors multiplied the cost by 1.27 (<i>DCD 2022 Regional Modifier</i>) and 1.36 (<i>DCD Cost Escalation Index</i>) to localize the cost data for Los Angeles Region and adjust the cost from 2019 to 2022 respectively.

Cost Item	Approximate Unit Cost [min, nominal, max]	Assumptions for Single Family Home	Assumptions for Multi-Family Complex	Data Sources	Notes for Calculated Cost Ranges
Regulatory Upgrades					
Electrical Panel	[\$1000, \$2800, \$4600] per panel upgrade	One panel per building	One panel per unit in the building	Facilities Construction Costs with RSMeans Data: 2019 (Means Facilities Construction Cost Data), 2019 (p. 999).	RSMeans lists the cost of an Indoor 200-amp panel-board (20-40 circuits) in the range of \$1100-\$2125 (p. 999). The authors multiplied the cost by 1.27 (<i>DCD 2022 Regional Modifier</i>) and 1.36 (<i>DCD Cost Escalation Index</i>) to localize the cost data for Los Angeles Region and adjust the cost from 2019 to 2022 respectively.
Asbestos Removal	[\$15,000, 30,000, \$45,000] per 1500 sq. ft. of housing	Applied to buildings built before 1990	Applied to buildings built before 1990	Facilities Construction Costs with RSMeans Data: 2019 (Means Facilities Construction Cost Data), 2019 (p. 61- 65).	RSMeans lists the average cost of Asbestos removal as \$12/SF (p. 61-65). The authors multiplied the cost by 1.27 (<i>DCD 2022 Regional Modifier</i>) and 1.36 (<i>DCD Cost Escalation Index</i>) to localize the cost data for Los Angeles Region and adjust the cost from 2019 to 2022 respectively. The range for asbestos removal was then estimated for a 1500-square- foot home and was adapted on a square-foot basis to other buildings.
Lead Paint Removal	[\$14,200, 28,500, \$43,000] per 1500 sq. ft. of housing	Applied to homes built before 1978	Applied to buildings built before 1978	Facilities Construction Costs with RSMeans Data: 2019 (Means Facilities Construction Cost Data), 2019 (p. 61- 65).	RSMeans lists the average cost of lead paint remedial cost as \$11/SF (p. 61-65). The authors multiplied the cost by 1.27 (<i>DCD 2022 Regional Modifier</i>) and 1.36 (<i>DCD Cost Escalation Index</i>) to localize the cost data for Los Angeles Region and adjust the cost from 2019 to 2022 respectively. The range for lead removal was estimated for a 1500-square-foot home and was adapted on a square-foot basis to other buildings.
Regulatory Upgrades to the structure	[\$12,000, 45,000, \$78,000] per housing unit	Cost applied once per single-family home	Cost applied per unit in multi-family complex	Design Cost Data (Dcd), 2022	The cost range was being estimated from several renovation and retrofit projects in California between 2018 & 2022.

SOURCES: Mahone, A., et al., 2019.; RSMeans, 2019.; RSMeans, Design Cost Data, 2022.

Consideration of Whether Sufficient Electricity Supply Is Available to Serve Incremental Load Increase

The project team was asked by the CEC to consider whether sufficient electricity supply is available to serve the incremental load increase associated with transitioning away from gas. Pertinent to this report, creation of an analytical framework for selection of pilot decommissioning sites, creation of guidelines based on that framework, and selection of pilot sites requires determinations as to local sufficiency of electrical supply in relevant areas to meeting the increased load on the electrical system created by additional electrification. As to the areas of interest in this project, in Santa Monica and Long Beach, the project team's analysis identified one area at risk of not having adequate electric supply (due to extreme weather conditions, resource adequacy and planning processes, and market practices) and areas that met requirements.

Through a systems-level analysis, several sources were used in identifying constraints in the electric system. This included evaluating generation, transmission, and distribution resources.¹⁸ CAISO's historical Energy Emergency Alert 3 (EEA3), previously known as Stage 3 events, provided an indicator on resource limitations when demand peaks. EEA3s are the result of the Rotating Outage Program, which was established by the CPUC to "systematically and fairly address the need for forced reductions in electric use by cutting power to customers when the electrical system is close to collapse." (CPUC).¹⁹ Historical EEA3 results provided an indication as to where the grid may have resource limitations due to distribution, transmission, or generation factors. Since there is not a public map of EEA3 outage areas, Southern California Edison's (SCE) outage tracker was used to identify areas that were included in recent EEA3 events (SCE, "Rotating Outages").

In addition to EEA3 results, the authors also reviewed CAISO's 2019, 2020, and 2021 Local Capacity Technical Analyses. These provided context and potential root causes for EEA3 events as they identified insufficient transmission and generation resources in local planning areas. The team also considered Public Safety Power Shutoff (PSPS) areas (SCE "2020 PSPS Frequent Circuit List"), SCE's Distribution Resources Plan (DRP), CPUC's Federal Energy Regulatory Commission's Form 1, and E3's 2019 Residential Building Electrification²⁸ reports (Mahone et al., 2019). PSPS areas did not apply to Santa Monica and Long Beach as they are not in high fire-risk areas. The DRP and FERC Form 1 did not apply as the DRP was focused on implementing distributed energy resources rather than mapping capacity utilization and the FERC Form 1 is at the broader SCE system. E3's 2019 Residential Building Electrification report found summer peaks were moderated with building electrification due to efficiency gains from air-sourced heat pumps, while winter peaks grew due to fuel switching. Summer peaks were still higher than winter peaks. These other reports were considered, but EEA3 alerts and California ISO's Local Capacity Technical Analyses were most informative for the pilot cities.

¹⁸ Due to privacy concerns, the authors did not have access to customer data on monthly energy usage or current capacity of the electric grid. These data would have allowed analysts to determine in what cases there is sufficient excess electricity capacity to handle the change in load.

¹⁹ California Public Utility Commission, "[Frequently Asked Questions: The CPUC Rotating Outage Program.](#)"

EEA3 or Stage 3 results peaked in 2000 and 2001 during the California energy crisis. There were no events for nearly 20 years until 2020 and 2022, when there were two and one events, respectively. In 2020, Southern California had events on August 14 and 15, 2020, while 2022 was outside the SCE service territory.

During the 2020 events, there were rolling blackouts (CEC, 2021), but according to the data provided, those mostly did not affect the authors' study region. The sole exception was that one 2020 event was localized to the eastern region of Santa Monica along the I-10 freeway. Santa Monica is also not in a PSPS area. Long Beach was not affected by 2020 and 2022 EEA3 events nor was the city in a frequent PSPS area. While outside of

the study region, further review of CAISO's Local Capacity studies suggested the nearby El Nido area including El Segundo and Manhattan Beach as having deficient supply to meet summer peaks without local supply such as gas resources or energy storage. This issue may impact the A061 area (SCE rotating outage group designation) given their proximity; however, this discussion was limited in its analysis as non-CAISO member Los Angeles Department of Water and Power (LADWP) is between El Nido planning area and Santa Monica.

Overall, the analysis indicated that the eastern portion of Santa Monica along the I-10 is at risk due to extreme weather conditions, resource adequacy and planning processes, and market practices (CEC, "CAISO, CPUC, CEC Issue Final Report on Causes of August 2020 Rotating Outages"). Long Beach and other parts of Santa Monica do not appear to have been impacted by EEA3 outages in the past 20 years. Selection of pilot sites for decommissioning that have known issues of either supply (as suggested by CAISO in these areas) or system capacity (not demonstrated in the cities of interest) is inadvisable for further electrification given reliability concerns for customers. To this point, further work with the CAISO in providing an outage area map of Santa Monica and Long Beach would provide a more accurate representation of potentially affected areas. Beyond the scope of this project, the project team recommends a more holistic approach to the CPUC's DRP maps to include demand-side mapping for future energy needs and CAISO and LADWP coordination on Local Capacity reports to identify reliability issues at borders between load-serving entities.

Estimated Changes in Utility Bills

The analysis included estimation of impacts to homeowners' variable costs of transitioning to electricity from gas, a key factor for consumers that also bears important equity implications. These fall primarily into two categories: impacts on utility bills and the impact on ongoing maintenance of the affected systems. The project team estimate these as average annual costs.

Transitioning from gas to electricity requires increased electricity usage offset by reduced gas usage. Estimating utility bill impacts, requires usage estimates and utility rates (CEC, 2021).²⁰ By assuming customers do not change their behavior particularly when using their appliance under either scenario, one can estimate utility bill impacts. Table 5 shows appliance energy usage results for electricity and gas.

²⁰ Estimates could be made more precise using customer data on monthly energy. As noted earlier, these data were unavailable for this project due to privacy concerns.

Table 5: Average Annual Usage for Each Appliance by Energy Type

Appliance	Average Electricity Usage (kilowatt-hour/yr)	Average Gas Usage (therm/yr)
Ranges	510	29
Clothes Dryer	687	23
Water Heater	1,058	202

SOURCES: EIA, "Updated Building Sector Appliance and Equipment Costs and Efficiencies."; EPA, "ENERGY STAR Certified Residential Clothes Dryer"; EPA "ENERGY STAR Certified Water Heaters".

Note: Space heating (e.g., HVAC) is not included in this analysis since consumption data could not be identified. It is likely this is highly variable depending on usage.

Because electricity is priced using time-of-use rates, the authors shaped annual consumption numbers based on daily usage patterns. This information allows calculation of the price of electricity and gas using the latest customer rates from SCE and Southern California Gas.

In this equation,

$$Net\ Utility\ Bill = Electric\ Bill - Gas\ Bill$$

$$Electric\ Bill = Usage \cdot Load\ Profile \cdot TOU\ Rate$$

$$Gas\ Bill = Usage \cdot Rate$$

Given these inputs, electricity was found to be more expensive across the applications by \$500 annually (for a non-California Alternate Rates for Energy [CARE], non-Family Electric Rate Assistance [FEMA] customer). Despite the increased efficiency of electricity versus gas in terms of energy expenditure, the increased cost of electricity more than offsets this benefit.

Note, space heating is not included in this analysis since consumption data could not be identified (RAND is not aware of a study that directly compares new gas furnaces and new electric HVAC). However, it is worth noting that other analysis has shown space heating savings of upgrading from pre-1978 gas furnace equipment to high efficiency electric HVAC of \$2,400 annually in the SCE territory (Mahone et al., 2019). This savings from updating old to new high efficiency equipment could more than offset the rest of the increased costs from electrification, netting a \$1,900 savings per household on average.

In this analysis, electricity prices were assumed to use above-baseline allocations since deployment is small-scale. However, one would expect baselines to be updated and prices to decline to reflect the increased electric baseload for homes. The project team also assumed consumers maintain their existing load profile; however, given the higher prices during the 4:00 p.m. to 9:00 p.m. window, consumers may shift consumption outside of these periods.

The U.S. Energy Information Administration's 2023 dataset of appliance equipment costs and efficiencies (USEIA, 2023) suggests that the maintenance cost differences between gas and electric cooktops, dryers, and water heaters are negligible; in contrast electric HVAC systems are generally less costly to maintain than gas systems. Table 6 elaborates on these costs.

**Table 6: Difference in Electric and Gas Appliance Maintenance Costs
(in 2022 dollars)**

Cost Item	Approximate Annual Maintenance Cost Compared to Gas	Data Sources	Notes for Calculated Cost Ranges
Cooktop	No difference	EIA (2023)	According to the EIA, "Maintenance costs are negligible." (2023, pp. 87–94)
Dryer	No difference	EIA (2023)	According to the EIA, "Maintenance costs are negligible. DOE estimated that on average 2.7 percent of electric and 3.3 percent of gas residential clothes dryers are repaired each year." (2023, pp. 97-98)
HVAC	Ranges from -\$140 (cost savings) to \$20 (cost)	EIA (2023)	The EIA estimates the annual maintenance costs of several HVAC systems. The authors' range is based on the difference between the highest and lowest cost gas versus electric systems <ul style="list-style-type: none"> • Gas furnace: \$130/year • Gas boiler: \$160/year • Electric resistance furnace: \$50/year • Electric heat pump: \$20–150/year, depending on source and type
Water Heater	No difference	EIA (2023)	According to the EIA, electric and gas storage heaters and heat pump water heaters have the same maintenance cost at \$20/year, and electric and gas instantaneous heaters have the same maintenance cost at \$90/year (2023 pp. 56-74).

Source: EIA, "Updated Buildings Sector Appliance And Equipment Costs and Efficiencies."

NOTE: Values are based on the EIA's report of typical maintenance costs in 2022.

Estimated Change in Air Quality

Air quality comparisons from electrification were at different scales from point use to non-point use (State of New Jersey, "What are Point, Nonpoint, and Mobile Sources?"). Gas creates pollutants when combusted at its end-use as a non-point source, while electricity produces air pollutants at production known as a point source pollutant. As a result, the project team compared the total pollutants of the two fuels and reviewed the impact of combusting gas inside a home.

The carbon dioxide (CO₂) content of electricity in the California region was 0.532 pounds per kilowatt hour (lb/kWh) in 2021 (EPA, "Data Explorer: eGrid"). Comparatively, combustion of

gas yields 11.7lb/therm (EPA, “Greenhouse Gas Equivalence Calculator”). On a per unit of energy basis (kWh), the CO₂ content of gas is calculated as:

$$\frac{11.7 \text{ lb}}{\text{therm}} \times \frac{1 \text{ therm}}{29,300 \text{ Wh}} \times \frac{1,000 \text{ Wh}}{1 \text{ kWh}} = 0.40 \frac{\text{lb}}{\text{kWh}}$$

Therefore, gas emits fewer emissions than electricity in California. However, electric appliances are often more energy efficient than their gas counterparts, making electricity less carbon intensive. Furthermore, it is notable that California’s SB 100 targets 100 percent carbon-free resources for its electricity by 2045. Assuming a linear improvement in carbon intensity of electricity (that is, equal reductions each year), electricity and gas would be at parity within six years. As electricity reduces reliance on fossil fuels, emissions from electricity would become less than gas.

This analysis examined the totality of emissions. However, the source of emissions was quite different between the two types of energy. Gas is combusted inside or near homes, whereas emissions from electricity are produced upstream where the electricity is generated.

Within a few minutes of stove usage in smaller kitchens with poor ventilation, gas combustion inside homes has been shown to exceed national standards of nitrogen oxides (NO_x), a byproduct of gas combustion. Furthermore, methane emissions from stoves being off are twice as high when they are on from leaks within the appliance (Lebel et al., 2022). These risks would be eliminated by transitioning to electricity.

Ratepayer and Other Impacts

As might be expected, for transitioning a single building (even a very high density residential R4 building), the local utilities (Southern California Gas and SCE) have indicated that there would not be ratepayer impacts (see Appendix F), and therefore the project team did not develop futures for this part of the analysis. Note that ratepayer impacts will very likely arise if many buildings are transitioned. In addition, initial hydraulic modelling of gas lines suggests that when many buildings are transitioned, there will be additional impacts on neighboring stakeholders as described in Appendix D (specifically, there are effects on the physical gas system beyond those impacts included in the ratepayer analysis in Appendix F). As a result, the conclusion and guidelines to this report include a reminder that if decision makers would like to expand strategic decommissioning to broader swaths, they must calculate both ratepayer impacts and hydraulic impacts for all projects.

Define and Calculate Non-Cost Stakeholder Criteria and Equity Metrics

Stakeholders noted that several factors beyond cost could influence their willingness to accept decommissioning. Table 7 summarizes data requested by stakeholders during the scoping workshop and the proxies collected to inform these concerns. This table is not comprehensive as other types of data, such as location of terminal regulators (regulators with no further downstream regulators) may also be of interest.

Table 7: Data Requested by Stakeholders in Scoping Workshop and Availability

Data Type	Data	Availability and Description (Source: RAND Research)
Engineering	Map of gas infrastructure at distribution level	Available, subject to a data use agreement. A full map that per data use agreements is shareable can show average diameter of pipes. This is a proxy; areas with smaller average diameter tend toward terminal branches and/or fewer customers
	Age of pipes	Available as census tract average
	Maintenance schedules of pipes	Not available
Customers	How many customers are served?	Available
	Are affected customers residential, commercial, or industrial?	Available (census tract + tax record data + cities' GIS portals)
	Will restaurants be affected (is gas required for certain types of cooking)?	Location of restaurants available (census tract + tax record data + cities' GIS portals). Specifics on cooking needs unknown
	Are customers renters or homeowners?	Partially available. Census data show some information on this. To determine actual number of renters, it is necessary to work with building owners.
	What is the location of critical infrastructure?	Available (census tract + tax record data + cities' GIS portals)
	What are the locations of large multi-family housing (R4)?	Available (census tract + tax record data + cities' GIS portals)
	Is it a historic district or not?	Available (census tract + tax record data + cities' GIS portals)
	Is there a community-based organization that wants to decommission?	Available via networking through city contacts
	Is this in a DVC?	Available via CalEnviroScreen Tool
	Is there some consideration of equity (=costs relative to median income in a given tract)?	The team had shown this in a previous tool, which the CPUC members of the technical advisory committee disliked, so we did not include this here.
Environmental	How much gas reduced?	Available and calculated after a site is chosen and customer data are obtained
	Traffic maps	Available by using road width as a proxy
	Estimated GHG reduction	Available. Calculated after a site is chosen and customer data are obtained
	Estimated change in air quality index	Available. Calculated after a site is chosen and customer data are obtained

Information Yielded by Deliberations Workshop on Identifying Pilot Sites

Deliberations workshops held with community members helped identify proposed pilot project sites. Those workshops are described in full in Appendices H and the resulting sites in Appendix J. Importantly, local stakeholders, many of whom were non-experts, were able to use a decision analysis/data visualization tool the authors created to select a census tract of interest and then nominate a few buildings within those tracts as potential sites. A pre- and post-workshop survey indicated that after the deliberations workshop:

- A significantly greater share of participants agreed that residents are aware of potential benefits (reasons cited spanning cost, health, and jobs) to all stakeholders, with 32 percent agreeing or taking a neutral stance.
- Participants were more likely to agree that transitioning from gas to electricity is not a straightforward process.
- Participants were more likely to believe electrification was not as costly as they previously thought.
- Participant trust in the city's readiness to decommission gas in existing buildings increased.

This does not suggest that these changes in opinion are either preferred or not preferred. However, it is helpful to know the types of changes in opinion that might occur due to a deliberations workshop or similar community engagement efforts, thus helping decision makers to determine if this tool may or may not help achieve their messaging goals.

The deliberations activities yielded two main results. First, additional concerns connected to decommissioning of gas and switching to electrification were identified; Appendix H offers more detail describing each concern. Second, community partners recommended three sites in Santa Monica and two in Long Beach. Four of these are multi-family housing complexes ranging from 12 to 91 units with an average of 62 units per site, and one is a 27-acre area containing a mix of building types. The buildings have a mix of electrification requirements. All of them use gas for stoves, water heating, and clothes drying. Space heating is a mix of gas, both hydronic and wall heaters, or electric with heat pumps. As a result, there is a significant variety of end-use equipment replacement and potential scope for behind-the-meter upgrades such as subpanel upgrades. Appendix J describes each of the sites in more detail; a summary of these includes:

- The first Santa Monica location is High Place, a multi-building apartment complex that encompasses 91 residential units across 12 buildings served with gas by Southern California Gas, with SCE providing electricity. High Place is located in a census tract designated as a DVC. The project team estimated pre-meter decommissioning costs of approximately \$12,000, pending additional information from the gas utility. Preliminary data indicated post-meter costs between \$410,000 and \$590,000 to decommission the buildings and replace with electrification.

- The second Santa Monica location is Cloverfield, a single-building apartment complex located at 1959 Cloverfield Boulevard, encompassing 62 residential units. Southern California Gas supplies gas, and SCE supplies electricity. Cloverfield is located in a census tract designated as a DVC. Southern California Gas indicates the location is at a terminal branch of the gas network, implying no pre-meter costs. The current preliminary estimate of post-meter costs to decommission the buildings and replace with electrification was \$89,000 to \$122,000.
- The third Santa Monica location is Virginia, a 123-unit single building apartment served with gas by Southern California Gas; electricity is provided by SCE. Virginia is located in a census tract designated as a DVC. Pre-meter costs for decommissioning were estimated at \$8,700. Post-meter costs were preliminarily estimated at \$17,000 to \$24,000.
- In Long Beach, the first site selected, Family Commons, is a multi-building apartment complex owned by the community-based organization Century Villages at Cabrillo. The site has nine buildings with 81 residential units and 8,000 square feet of office and educational space served with gas by the Long Beach Utilities (the municipal utility) and with electricity by SCE. Pre-meter decommissioning costs were preliminarily estimated at \$36,000. Post-meter preliminary cost estimates were \$325,000 to \$470,000.
- The second site in Long Beach is Century Villages at Cabrillo, a 27-acre, 41-building site with 815 residential units plus office, healthcare, and educational space, as well as a commercial kitchen. The gas utility is the Long Beach Utilities (the municipal utility), and the electricity utility is SCE. As of the writing of this report, the large geographic scope necessitated different types of analyses (for example, analysis of community geothermal or similar) outside the scope of this work. This may be a good pilot project for future research looking at community decommissioning.

The preliminary costs estimated in this report may provide stakeholders and policy makers an initial basis for contemplating tradeoffs that will arise due to decommissioning requirements.

CHAPTER 4:

Conclusion – Guidelines for Decommissioning

This research suggests that California may wish to adopt a three-step process as guidelines for decommissioning in Southern California. These proposed guidelines cover issues that have been identified as important through this project, including: 1) defining project motivation and scope, 2) achieving buy-in from all stakeholders, and 3) conducting appropriate analyses. The specific items flagged within each of the steps were all identified directly by stakeholders ranging from technical experts to local community experts. Following these guidelines will increase likelihood of successful project completion and may also decrease project costs and timelines.

Three Step Guidelines for Decommissioning Gas Infrastructure

Define Project Motivation & Scope

Decommissioning gas infrastructure represents a transformation of California's energy infrastructure that has costs and benefits spread across multiple stakeholders.

In any such effort, there is first a need to understand the motivations behind it, as various stakeholders may have different motivations for decommissioning. For example, one entity may be motivated by the opportunity to break down certain political barriers, another may prioritize achieving maximum GHG emission reductions; while others may be focused on developing state-wide decommissioning strategies. It is important to ensure all stakeholders interests and motivations are appropriately reflected in the project scope.

Based on the workshops conducted as part of this project and conversations with the project TAC and the sponsor, the project team identified the following set of considerations that may help define the project scope:

- Geographic extent (for example, a few buildings, a few city blocks, an entire census tract, and so on)
- Unique weather considerations such as freezing or thawing concerns
- Project duration and proposed start date (which limits what alternatives can be considered, for example, in locations where the length of time to obtain the necessary permits is longer than the project duration)
- Number of customers in the project area
- Sector or building type decommissioned (for example, residential, commercial, industrial, hospitals, schools, and so on)
- Building or infrastructure ownership (for example, are building(s) owned by multiple entities)
- Attributes of gas pipe in scope for decommissioning (for example, terminal lines, terminal regulators, mains, age of pipe, material of pipe, and so on)

- What alternatives would be in scope (for example, electrification only or would others be considered)
- Whether regulatory compliance costs and effects (for example, asbestos or lead remediation) are to be included
- Whether it is possible to offer incentives to building owners or renters, such as appliance replacements, adding solar, and so on.

Engage Stakeholders

Successful decommissioning requires input or data from many different groups prior to conducting the engineering and economic analyses associated with the site. Depending on the type of data available, the research and analysis approach may vary. For example, if it is known ahead of time that the gas utility will provide detailed maps of distribution architecture limited to viewing in one census tract at a time (as in this study), that means the analysis must aggregate these data to census tract level or higher when using these data for decision-making. Similarly, both gas and electric utilities are unable to provide detailed customer data (often a common practice to protect customer information), and customers are also unwilling to share this data (as experienced in this study), then such data cannot be used to identify households that would most benefit from decommissioning, therefore would not be identified as a decision criterion.

Stakeholders to be considered include, but are not limited to:

The Funder. The question “Who Pays” is going to be as important as “How much does it cost?” For example, electrification may be prohibitively expensive for lower income/vulnerable populations or might inequitably distribute costs across property owners and renters. It is important to consider all the costs that might occur, and who will pay them. Funders may include, but are not limited to, governmental entities, charitable foundations, independent system operators, local utilities, building owners, and developers.

Government Leadership. Buy-in from government leadership will help identify local community groups who will be affected by the project. It will also help provide assurance that the local government will work with stakeholders to ensure the appropriate permits are obtained and building codes met.

Local Utilities. Most project scopes will require information on gas infrastructure to be decommissioned, as well as the hydraulic impact of this decommissioning. In cases where the alternative is electrification, there is a need to understand whether there is sufficient excess capacity on the line and also any potential changes in customer utility bills. Depending on the number of customers decommissioned, there may also be a need to understand ratepayer impacts.

Building Owners & Renters. Depending on the type of decommissioning, there may be a need to work with building owners and renters to determine willingness to experience a) interruption of service, b) changes in types of service or utilities as a function of the project scope, c) indirect changes to meet building code regulations, and d) noise and traffic changes from the decommissioning. It is also very likely that these stakeholders will want some sort of

incentive to offset the inconveniences borne during decommissioning (for example, adding solar, adding air conditioning, changing to an induction stove, and providing new pots & pans, and so on).

Neighboring Entities. The decommissioning of even a single building can potentially affect neighbors. This may include changes in traffic or noise during construction, or for large projects, there is the potential to affect services via either a decrease in gas or increase in demand above electricity capacity. It is important to conduct early modelling to determine spillover effects and to be transparent with neighboring entities to help build community support.

Equity should remain a central focus throughout the process. In addition to the equity vignettes described in this report, potential considerations include:

- Differences between customers with various rate structures such as CARE, FERA, standard, or other (specifically, those who limit or forgo gas use due to prohibitively high prices even when service is in place).
- Service areas best suited for decommissioning may cut across several income levels which may result in unintended equity consequences that should be accounted for. For example, evaluate strategies to prevent cost-shift burdens on vulnerable populations in scenarios where higher income households electrify more rapidly.
- Health outcomes as an equity metric. For example, it might be that electrification will improve health outcomes for low-income households due to change in indoor air quality.
- Electricity prices play a key role in shaping the demand for electrification. If electricity is more expensive than gas, higher operating costs will discourage adoption and add to the total cost of electrification beyond initial up-front costs.

Conduct a Tailored Analyses Under Conditions of Uncertainty

Conduct the appropriate analyses to determine the costs, benefits, and impacts of the project. The research suggests that limitations in data availability and uncertainty in cost estimates can limit the ability to conduct this analysis. Stakeholders and experts also disagree about what costs, benefits, and impacts of the project are important, and how tradeoffs among those values should be designed. Therefore, it is important to conduct analyses under a range of future conditions (such as changes in utility pricing) and to iterate between analysis and stakeholder engagement.

Costs and benefits include, but are not limited to, pre-meter costs, post-meter costs and benefits, ratepayer impacts for gas utility customers, ratepayer impacts for electric utility customers, and other non-cost concerns such as equity. While the relative importance of each of these differs depending on project scale, it is likely that each of these will need to be evaluated. Regardless of project objective and scope, there will be some uncertainty with these calculations (for example, due to lack of data availability). When costs or benefits are uncertain, one can turn to parameterizations, or information on ranges of costs. This includes characterizing how risks change under decommissioning gas, whether that be avoided risk of

safety incidents or reduced health impacts from gas, or increased risk of electricity outages due to demand overload during heat waves.

Consider for example, a single-building project. In this case, it is likely that ratepayer impacts will be negligible, and it is likely that highly precise data can be obtained from the building owner about infrastructure needs (such as whether this building will need building permits, asbestos remediation, and so on). Furthermore, if the project covers only one building, it may be easier to identify projects that could begin the permitting process within one to three years since there are fewer uncertainties. Additional ease in cost calculations may be obtained if the project motivation/ scope focus on certain types of strategic decommissioning priorities; for example, larger single owner buildings (for example, R4 apartment buildings) that are located on terminal branches may be suitable candidates for early decommissioning, and also easier to cost out as there are fewer hydraulic modelling considerations upstream.

On the other hand, for large-scale projects the cost and benefit calculations become correspondingly more complex. There are more data to be gathered, and more uncertainties associated with these data. It is very likely that ratepayer impacts will be non-negligible, and hydraulic modelling may demonstrate that decommissioning gas within the target area may affect customers outside the project scope. Furthermore, larger projects are likely to take longer to both initiate and finish.

Applying the Guidelines: Selecting Sites in Southern California for Gas Decommissioning

Following these Guidelines, which included executing the analytical framework described in this report and engaging with stakeholders, yielded five pilot site selections for gas decommissioning, three in the City of Santa Monica and two in the City of Long Beach. Four of these sites are multi-family housing complexes ranging from 12 to 91 units with an average of 62 units per site, and one is a 27-acre area containing a mix of building types. The buildings have a mix of electrification requirements. All of them use gas for stoves, water heating, and clothes drying. Space heating is a mix of gas, both hydronic and wall heaters, or electric with heat pumps. As a result, there is significant variety of end-use equipment replacement and potential scope for behind-the-meter upgrades such as subpanel upgrades. Initial project costs to decommission vary from \$17,000 to \$590,000 depending on building characteristics. The preliminary costs estimated in this report may provide stakeholders and policy makers an initial basis for contemplating tradeoffs that will arise due to decommissioning requirements.

Recommendations for Future Work

This project sparked many discussions and topics for future research work. For example, the TAC or CEC requested data on infrastructure maintenance levels, the value of the existing infrastructure, existing electricity system capacity constraints, and customer bills (to better calculate indoor and outdoor air quality). Furthermore, there were requests to expand this to include alternatives to electrification, to include other building types (residential, commercial, hospitals, schools, mixed use), to consider larger project sizes where hydraulic impacts or ratepayer impacts might be non-negligible and/or geothermal and microgrids may be answers,

and to determine how to conduct this analysis when considering transformational changes in the electricity grid. Whether for this or future research, it will continue to be important for policy makers to consider equity of decommissioning, including how to manage the transition from gas to electricity by using rebates, incentives, or changes in building codes to spread the cost burden equitably.

List of Terms/Glossary

Term	Definition
AB	Assembly Bill
ADA	American Disability Act
CalEPA	California Environmental Protection Agency
CAM	Commission Agreement Manager
CARE	California Alternate Rates for Energy
CEC	California Energy Commission
CFR	Code of Federal Regulations
CO ₂	carbon dioxide
CPUC	California Public Utilities Commission
DCD	design cost data
DR	distributed resources
DRP	Distribution Resources Plan
DSM	demand side management
DVC	disadvantaged/vulnerable community
EE	energy efficiency
EEA3	Energy Emergency Alert 3
EPA	Environmental Protection Agency
FERA	Family Electric Rate Assistance
GHG	greenhouse gas
GTI	Gas Technology Institute
HVAC	heating, ventilation and air conditioning
kWh	kilowatt hour
LADWP	Los Angeles Department of Water and Power
LARC	Los Angeles Regional Collaborative for Climate Action and Sustainability
lb/kWh	pounds per kilowatt hour
LI	low-income
MUD	municipal utility district
NO _x	nitrogen oxides
PSPS	public safety power shutoff
SB	Senate Bill
SCE	Southern California Edison
SoCalGas	Southern California Gas
TAC	Technical Advisory Committee
TOU	time-of-use
UCLA	University of California, Los Angeles

References

- Aas D., A. Mahone, Z. Subin, M. MacKinnon, B. Lane, and S. Price. 2020. "The Challenge of Retail Gas in California's Low-Carbon Future." California Energy Commission. CEC-500-2019-055-F.
- Aditya, G.R., O. Mikhaylova, G. A. Narsilio, and I. W. Johnston. 2020. "Comparative costs of ground source heat pump systems against other forms of heating and cooling for different climatic conditions." *Sustainable Energy Technologies and Assessments* 42: 100824.
- Aditya, G.R. and G.A. Narsilio. 2020. "Environmental assessment of hybrid ground source heat pump systems." *Geothermics*. 87: 101868.
- Bertoldi, Daniel S. 2014. "[Deep energy retrofits using the integrative design process: Are they worth the cost.](#)" Master's Projects and Capstones, University of San Francisco. <https://repository.usfca.edu/cgi/viewcontent.cgi?article=1022&context=capstone>.
- Blank, T.K. and Molly, P. 2020. "Hydrogen's decarbonization impact for industry: Near-term challenges and long-term potential." Rocky Mountain Institute.
- Borgeson, M. June 2020. "A pipe dream or climate solution? The opportunities and limits of biogas and synthetic gas to replace fossil gas." *Natural Resources Defense Council*.
- Brockway, A.M., J. Conde, and D. Callaway. 2021. "Inequitable access to distributed energy resources due to grid infrastructure limits in California." *Nature Energy* 6, 9 (892-903).
- California Code of Regulations. Title 8, Section 1532.1. (n.d.). [Lead](#). https://www.dir.ca.gov/title8/1532_1.html. Accessed October 19, 2022.
- California Department of Housing and Community Development. "[Search for Mobile Home/RV Parks.](#)" <https://cahcd.my.site.com/s/mobilehomeparksearch>. Accessed November 22, 2021.
- California Department of General Services, Real Estate Services Division. "DGS California Construction Cost Index CCCI."
- California Energy Commission (CEC). "[CAISO, CPUC, CEC Issue Final Report on Causes of August 2020 Rotating Outages.](#)" <https://www.cpuc.ca.gov/news-and-updates/all-news/caiso-cpuc-cec-issue-final-report-on-causes-of-august-2020-rotating-outages>. Accessed October 19, 2022.
- California ISO (CAISO). 2018. "[2019 Local Capacity Technical Analysis: Final Report and Study Results.](#)" <http://www.caiso.com/Documents/Final2019LocalCapacityTechnicalReport.pdf>. Accessed October 19, 2022.
- CAISO. 2019. "[2020 Local Capacity Technical Study: Final Report and Study Results.](#)" <http://www.caiso.com/Documents/Final2020LocalCapacityTechnicalReport.pdf>. Accessed October 19, 2022.

- CAISO. 2020. "[2021 Local Capacity Technical Study: Final Report and Study Results.](http://www.caiso.com/Documents/Final2021LocalCapacityTechnicalReport.pdf)" <http://www.caiso.com/Documents/Final2021LocalCapacityTechnicalReport.pdf>. Accessed October 19, 2022.
- California Office Of Environmental Health Hazard Assessment. "[CalEnviroScreen 4.0.](https://oehha.ca.gov/calenviroscreen)" <https://oehha.ca.gov/calenviroscreen>. Accessed October 19, 2022.
- California Office of Environmental Health Hazard Assessment. 2021. "[Disadvantaged Communities Map.](https://oehha.ca.gov/calenviroscreen/sb535)" oehha.ca.gov/calenviroscreen/sb535. Accessed October 19, 2022.
- California Public Utilities Commission (CPUC). "[Environmental and Social Justice Action Plan.](https://www.cpuc.ca.gov/news-and-updates/newsroom/environmental-and-social-justice-action-plan)" <https://www.cpuc.ca.gov/news-and-updates/newsroom/environmental-and-social-justice-action-plan>. Accessed November 22, 2021.
- CPUC. 2021. "[FERC Financial Report: FERC Form No. 1: Annual Report of Major Electric Utilities, Licensees, and Others and Supplemental Form 3-Q: Quarterly Financial Report.](https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/electric-costs/ferc-form-1s/sce-2020q4_ferc-form1-20210419.pdf)" https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/electric-costs/ferc-form-1s/sce-2020q4_ferc-form1-20210419.pdf. Accessed June 19, 2023.
- CPUC. 2001. "[Frequently Asked Questions: The CPUC Rotating Outage Program.](https://docs.cpuc.ca.gov/published/News_release/7066.html)" https://docs.cpuc.ca.gov/published/News_release/7066.html. Accessed November 22, 2021.
- CPUC. "[Long-Term Gas Planning Rulemaking \(ca.gov\)](https://www.cpuc.ca.gov/industries-and-topics/natural-gas/long-term-gas-planning-rulemaking)". <https://www.cpuc.ca.gov/industries-and-topics/natural-gas/long-term-gas-planning-rulemaking>. Accessed October 19, 2022.
- CPUC. "[Gas and California.](https://www.cpuc.ca.gov/industries-and-topics/natural-gas/natural-gas-and-california)" <https://www.cpuc.ca.gov/industries-and-topics/natural-gas/natural-gas-and-california>. Accessed October 19, 2022.
- CPUC. "[What is a General Rate Case \(GRC\)?](https://www.cpuc.ca.gov/generalratecase)" <https://www.cpuc.ca.gov/generalratecase>. Accessed October 19, 2022.
- Christodoulides, P., L. Aresti, and G. Florides. 2019. "Air-conditioning of a typical house in moderate climates with Ground Source Heat Pumps and cost comparison with Air Source Heat Pumps." *Applied Thermal Engineering*. 158 (113772).
- City and County of San Francisco, Budget and Legislative Analyst's Office. 2021. "Decarbonizing residential buildings by eliminating gas usage."
- City of Long Beach. "[Cambodia Town.](https://www.visitlongbeach.com/neighborhoods/eastside/cambodia-town/)" <https://www.visitlongbeach.com/neighborhoods/eastside/cambodia-town/>. Accessed November 22, 2021.
- City of Santa Monica. "[Sea Level Rise in Santa Monica: Planning for a Watery Future.](https://www.smgov.net/Departments/OSE/Contact_-_Find_Us/Climate_Action_Adaptation_Plan.aspx)" https://www.smgov.net/Departments/OSE/Contact_-_Find_Us/Climate_Action_Adaptation_Plan.aspx. Accessed November 22, 2021.
- County of Los Angeles. "[Assessor Parcel Data 2020.](https://data.lacounty.gov/datasets/assessor-parcel-data-rolls-2016-2020/about)" <https://data.lacounty.gov/datasets/assessor-parcel-data-rolls-2016-2020/about>. Accessed November 22, 2021.
- County of Los Angeles, Chief Sustainability Office. "[LA County Climate Vulnerability Assessment,](https://www.cakex.org/documents/la-county-climate-vulnerability-assessment-2021)" 2021, <https://www.cakex.org/documents/la-county-climate-vulnerability-assessment-2021>. Accessed October 19, 2022.

- De León. 2018 (Sep 10). "[SB 100 - California Renewables Portfolio Standard Program: emissions of greenhouse gases.](#)" California State Legislature, Senate Bill 100, Chapter 312, Statutes of 2018. https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180AB3232.
- Eggleston, H.S., L. Buendia, K. Miwa, T. Ngara, and K. Tanabe. 2006. "2006 IPCC guidelines for national greenhouse gas inventories." Institute for Global Environmental Strategies (IGES) for the IPCC.
- Federal Emergency Management Agency (FEMA). "[National Risk Index.](#)" <https://hazards.fema.gov/nri/map>. Accessed November 22, 2021.
- Friedman et al. 2018. "AB-3232 – Zero-Emissions Buildings and Sources of Heat Energy". California State Legislature, Senate Bill 3232, Statutes of 2018.
- Fumey, B., T. Buetler, and U.F. Vogt. 2018. "Ultra-low NO_x emissions from catalytic hydrogen combustion." *Applied Energy*. 213 (334-342).
- Glanville, P., I. Mahderekal, M. Mensinger Jr., L. Bingham, and C. Keinath. 2021. "Demonstrating an Integrated Thermal Heat Pump System for Hot Water and Air-Conditioning at Full Service Restaurants." *ASHRAE Transactions*. 127, no.1 (363–370).
- Guo, M., and W. Song. 2019. "The growing US bioeconomy: Drivers, development and constraints." *New Biotechnology*. 49 (48-57).
- Hopwood, L., E. Mitchell, and S. Sourmelis. 2019. "[Biopropane: Feedstocks, feasibility and our future pathway.](#)" Prepared for Liquid Gas UK. <https://www.liquidgasuk.org/uploads/DOC5DA5B52BBA49F.pdf>. Accessed November 22, 2021.
- Hughes, P. 2008. "Geothermal (ground-source) heat pumps: Market status, barriers to adoption, and actions to overcome barriers" Oak Ridge National Laboratory, for US Department of Energy Office of Energy Efficiency and Renewable Energy, Renewable Power Office. No. ORNL/TM-2008/232.
- Jadun, P., C. McMillan, D. Steinberg, M. Muratori, L. Vimmerstedt, and T. Mai. 2017. "Electrification futures study: End-use electric technology cost and performance projections through 2050 (No. NREL/TP-6A20-70485)." National Renewable Energy Lab (NREL), Golden, CO (United States).
- Johnson, E. 2019. "Process technologies and projects for BioLPG." *Energies*. 12, no. 2 (250).
- Kalra, N., K. Klima, L. Regan, and S. Chowdury. 2022. "Equity Metrics for Climate Adaptation in the Electricity Sector." RAND Corporation.
- Lebel, E.D., C.J. Finnegan, Z. Ouyang, and R.B. Jackson. 2022. "Methane and NO_x Emissions from Gas Stoves, Cooktops, and Ovens in Residential Homes." *Environmental Science & Technology*. 56 no. 4 (2529-2539).
- Lewis, A. C. 2021. "Optimizing air quality co-benefits in a hydrogen economy: a case for hydrogen- specific standards for NO_x emissions." *Environmental Science: Atmospheres*. 1 no. 5 (201-207).

- Mahone, A., C. Li, Z. Subin, M. Sontag, G. Mantegna, A. Karolides, A. German, and P. Morris. Energy and Environmental Economics (E3). 2019. "Residential Building Electrification in California, Consumer economics, greenhouse gases and grid impacts." *Tech. Rep. E3* .
- McDermott, M., S. Mahanty, and K. Schreckenber. 2013. "Examining Equity: A Multidimensional Framework for Assessing Equity in Payments for Ecosystem Services." *Environmental Science & Policy*. 33 (416-427).
- Murphy, C., T. Mai, Y. Sun, P. Jadun, M. Muratori, B. Nelson, and R. Jones. 2021. "Electrification Futures Study: Scenarios of Power System Evolution and Infrastructure Development for the United States." No. NREL/TP-6A20-72330. National Renewable Energy Lab.(NREL), Golden, CO (United States); Northern Arizona Univ., Flagstaff, AZ (United States); Evolved Energy Research, San Francisco, CA (United States).
- National Grid. 2020. "[Future Energy Scenarios](https://www.nationalgrid.com/document/138976/download)." <https://www.nationalgrid.com/document/138976/download>. Accessed July 14, 2022.
- National Grid. "[The Hydrogen Colour Spectrum](https://www.nationalgrid.com/stories/energy-explained/hydrogen-colour-spectrum)." <https://www.nationalgrid.com/stories/energy-explained/hydrogen-colour-spectrum>. Accessed July 14, 2022.
- Natural Resources Canada, Office of Energy Efficiency. 2004. "Heating and cooling with a heat pump."
- New Jersey Environmental Protection Agency. "[What Are Point, Nonpoint, and Mobile Sources?](https://dep.nj.gov/airplanning/airtoxics/sources-of-air-toxics-2020-airtox-screen/)" <https://dep.nj.gov/airplanning/airtoxics/sources-of-air-toxics-2020-airtox-screen/>. Accessed August 12, 2023.
- Ochu, E., S. Braverman, G. Smith, and J. Friedmann. June 17, 2021. "Hydrogen Fact Sheet: Production of Low-Carbon Hydrogen." Columbia Center on Global Energy Policy.
- Rocky Mountain Institute (RMI). n.d. "Building Inventory Maps: Santa Monica."
- RSMeans. 2019. Facilities Construction Costs with RSMeans Data: 2019 (Means Facilities Construction Cost Data) (32nd ed.). 2022. Gordian. Design Cost Data (dcd). Retrieved December 21, 2022.
- Russell, A. T. 2013. "Combustion emissions." In Straif, K., A. Cohen, and J. Samet. (Eds.) "Air pollution and cancer". *IAC Scientific*. 161 (37-47).
- Southern California Edison. "[2020 PSPS Frequent Circuit List](https://www.sce.com/sites/default/files/SCE-2020-PSPS-Frequent-Circuit-List-wcag.pdf)." <https://www.sce.com/sites/default/files/SCE-2020-PSPS-Frequent-Circuit-List-wcag.pdf>. Accessed October 19, 2022.
- Southern California Edison (SCE). "[ArcGIS Web Application](http://drpep.sce.com/drpep/)." <http://drpep.sce.com/drpep/>. Accessed October 19, 2022.
- SCE. "[Rotating Outages](https://www.sce.com/outage-center/outage-information/rotating-outages)." <https://www.sce.com/outage-center/outage-information/rotating-outages>. Accessed October 19, 2022.
- SCE. "[Time-Of-Use \(TOU\) Rate Plans](https://www.sce.com/residential/rates/Time-Of-Use-Residential-Rate-Plans)" <https://www.sce.com/residential/rates/Time-Of-Use-Residential-Rate-Plans>. Accessed October 19, 2022.
- Southern California Gas Company (SoCalGas). "Residential Service." Accessed June 19, 2023.

- SoCalGas. 2023. "[SCG-04-R-E Revised Prepared Direct Testimony of Mario A. Aguirre \(Gas Distribution\)](https://www.socalgas.com/sites/default/files/SCG-04-R-E_Errata_Revised_Direct_Testimony_of_Mario_Aguirre_Gas_Distribution.pdf)." Southern California Gas Company. pp. 78-82. https://www.socalgas.com/sites/default/files/SCG-04-R-E_Errata_Revised_Direct_Testimony_of_Mario_Aguirre_Gas_Distribution.pdf. Accessed August 12, 2023.
- SoCalGas. "[Gas Pipeline](https://socalgas.maps.arcgis.com/apps/webappviewer/index.html?id=c85ced1227af4c8_aae9b19d677969335)." Southern California Gas Company. https://socalgas.maps.arcgis.com/apps/webappviewer/index.html?id=c85ced1227af4c8_aae9b19d677969335. Accessed November 22, 2021.
- Subramanyam, V., M. Ahiduzzaman, and A. Kumar. 2017. "Greenhouse gas emissions mitigation potential in the commercial and institutional sector." *Energy and Buildings*. 140 (295-304).
- Twinn, C. 2021. "Hydrogen: A decarbonisation route for heat in buildings?" London Energy Transformation Initiative.
- University of California Los Angeles. "[Energy Atlas 2.0](https://energyatlas.ucla.edu/map/usage_bld)." https://energyatlas.ucla.edu/map/usage_bld. Accessed November 22, 2021.
- United States Bureau of Labor Statistics. "[Unemployment: Long Beach city, CA Local Area Unemployment Statistics](https://bls.gov/lau/)." <https://bls.gov/lau/>. Accessed November 22, 2021.
- United States Census Bureau. 2018. "[QuickFacts: Long Beach City, California](http://www.census.gov/quickfacts/longbeachcitycalifornia)." Census Bureau QuickFacts. <http://www.census.gov/quickfacts/longbeachcitycalifornia>. Accessed November 22, 2021.
- United States Department of Homeland Security, Geospatial Management Office. "[Homeland Infrastructure Foundation-Level Data \(HIFLD\)](https://www.dhs.gov/gmo/hifld)." <https://www.dhs.gov/gmo/hifld>. Accessed November 22, 2021.
- United States Energy Information Administration (U.S. EIA). 2023. "[Updated Buildings Sector Appliance And Equipment Costs and Efficiencies](https://www.eia.gov/analysis/studies/buildings/equipcosts/)." <https://www.eia.gov/analysis/studies/buildings/equipcosts/>. Accessed June 19, 2023.
- United States Environmental Protection Agency (U.S. EPA). 2023. "[Data Explorer: eGrid](https://www.epa.gov/egrid/data-explorer)." <https://www.epa.gov/egrid/data-explorer>. Accessed June 19, 2023.
- U.S. EPA. "[ENERGY STAR Certified Residential Clothes Dryer](https://www.energystar.gov/)." Energy Star. <https://www.energystar.gov/>. Accessed June 19, 2023.
- U.S. EPA. "[ENERGY STAR Certified Water Heaters](https://www.energystar.gov/)." Energy Star. <https://www.energystar.gov/>. Accessed June 19, 2023.
- U.S. EPA. "Energy Star for small business: restaurants." Energy Star. Accessed July 20, 2022.
- U.S. EPA. "[Geothermal heating and cooling technologies](https://19january2021snapshot.epa.gov/rhc/geothermal-heating-and-cooling-technologies.html)." Renewable Heating And Cooling. <https://19january2021snapshot.epa.gov/rhc/geothermal-heating-and-cooling-technologies.html> . Accessed July 25, 2022.
- U.S. EPA. 2023. "[Greenhouse Gas Equivalence Calculator](https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator#results)." <https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator#results>. Accessed June 19, 2023.

- U.S. EPA. "[Low-Income Energy Affordability Data \(LEAD\) Tool](https://www.energy.gov/eere/slsc/maps/lead-tool)." <https://www.energy.gov/eere/slsc/maps/lead-tool>. Accessed March 8, 2022.
- Zhu, Y., R. Connolly, Y. Lin, T. Mathews, Z. and Wang. 2020. "Effects of residential gas appliances on indoor and outdoor air quality and public health in California." *UCLA Fielding School of Public Health*.
- Zirnhelt, H., B. Bridgeland, and P. Keuhn. 2015. "[Energy Savings from Window Shades](https://rmi.org/wp-content/uploads/2017/05/EnergySavingsFromWindowShades_FinalWebReport.pdf)." *Prepared for Hunter Douglas by Rocky Mountain Institute*. https://rmi.org/wp-content/uploads/2017/05/EnergySavingsFromWindowShades_FinalWebReport.pdf . Accessed April 1, 2026.
- Zumper. "[Los Angeles Metro Report](https://www.zumper.com/blog/los-angeles-metro-report)." <https://www.zumper.com/blog/los-angeles-metro-report>. Accessed December 6, 2021.

Project Deliverables

This Project Deliverables section includes a bulleted list of the products produced as identified in the Agreement and Scope of Work, and where they can be accessed. See also Appendix L and M for additional detail. For this project, the deliverables are:

- Reports
 - Research Report Outline
 - Research Report (this report), including Technology/Knowledge Transfer Plan and preliminary Project Performance Metrics
 - Pilot Project Applications
 - Decommissioning Guidelines
 - Final Technology Transfer Summary Report, including Summary of TAC Comments
- Workshops
 - Scoping workshops to elicit metrics and uncertainties
 - Deliberations workshops to identify pilot project sites
- Interim memos detailing progress
 - Community Characteristics & Energy Infrastructure Memorandum
 - Public Perception Memorandum
 - Cost Evaluation of Decommissioning Strategies Memorandum
 - Rater Payer Impacts Memorandum
 - Alternatives to Conventional Gas, Cost Evaluation Memorandum
 - Equity Framework and Energy Equity Indicators Memorandum
 - Gas Decommissioning Futures Report
 - Potential Decommissioning Pilot Sites Memorandum
 - Evaluation of Alternative Gas Decommissioning Sites Memorandum
 - Interactive Visualizations Memorandum
 - Includes [website](https://public.tableau.com/app/profile/nidhi1351/viz/CECPIR20-008VisualizationToolBeta/TractExplorer): <https://public.tableau.com/app/profile/nidhi1351/viz/CECPIR20-008VisualizationToolBeta/TractExplorer>
- Administration/Other
 - All administrative paperwork required by CEC, including Kick-off Meeting Materials, Critical Progress Review (CPR) 1 & 2 Materials, TAC 1 & 2 Materials, Final Meeting Materials, Progress Reports
 - All Budgetary paperwork, including monthly reports, Match Funds Materials, Subcontracting paperwork
 - Final Project Performance Metrics
 - High Quality Digital Photographs

Project deliverables, including interim project reports, are available upon request by submitting an email to pubs@energy.ca.gov.



California
ENERGY COMMISSION



ENERGY RESEARCH AND DEVELOPMENT DIVISION

APPENDIX A: Summary of Community Characteristics and Energy Infrastructure in Santa Monica, CA and Long Beach, CA

May 2026 | CEC-500-2026-010

Appendix A: Summary of Community Characteristics and Energy Infrastructure in Santa Monica, CA and Long Beach, CA

This appendix summarizes the community characteristics and energy infrastructure within Santa Monica, CA; Long Beach, CA; and Bassett and Avocado Heights, CA. It explores the demographics, climate and natural vulnerabilities of the city, its energy infrastructure, and provides context for understanding its neighborhoods. Data sources include the following:

Federal

- Census.gov or American Community Survey (ACS). The census is a decennial survey conducted by the US Census Bureau. It includes demographics questions and is used to reapportion seats in the House of Representatives, realign congressional districts, and used as a factor in apportioning federal funds. The same bureau also conducts the American Community Survey (ACS), which is a demographics survey used to apportion federal and state funds. It includes information about jobs and occupations, educational attainment, veterans, whether people own or rent their homes, and other related topics.
- Bureau of Labor Statistics Local Area Unemployment Statistics (BLS LAU). This is a federal-state cooperative effort to determine monthly estimates of total employment and unemployment. The data comes from the Current Population Survey (CPS), the same household survey that is used for the national unemployment rate.
- The FEMA National Risk Index. This supports prioritization of resiliency efforts by communities by synthesizing multiple risk factors. It tracks 18 natural hazards such as wildfires, earthquakes, and landslides, but also avalanches, coastal flooding, and hurricanes. The FEMA National Risk Index is calculated by taking the product of the expected annual loss and social vulnerability and divided by the community resilience. As a result, a high expected annual loss and social vulnerability coupled with a low community resilience score will result in a high-risk index score. The expected annual loss is a likelihood and consequence component of risk that measures the expected loss of building value, population, and agricultural value each year due to natural hazards. The social vulnerability is a consequence enhancing component of risk that measures the susceptibility of social groups to the adverse impacts of natural hazards. The community resilience component is a consequence reduction component of risk that measures the ability of a community to prepare and plan for, absorb, recover from, and more successfully adapt to the impacts of natural hazards.
- Homeland Infrastructure Foundation-Level Data (HIFLD). This federal database provides foundational geospatial data in the public domain to support community preparedness, resiliency, research, and more.

- Low-Income Energy Affordability Data (LEAD) Tool. This federal data dashboard provides energy affordability information to help states, communities, and other stakeholders create better energy strategies and programs by improving their understanding of low-income housing and energy characteristics.

Local

- Los Angeles County Climate Vulnerability Assessment. This report assesses how people and infrastructure in LA County may be vulnerable to climate change. It considers climate hazard, social vulnerability, and physical vulnerability in its assessment. Furthermore, it also considers the cascading impacts of how infrastructure systems rely on each other.
- Building Inventory Maps for Santa Monica by the Rocky Mountain Institute. The report provides a local analysis on the building stock, demographics, and energy mix and usage within Santa Monica. [Not public]
- SoCalGas Natural Gas Pipeline. SoCalGas provides a map of their transmission pipelines and high-pressure (greater than 60 pounds per square inch) gas distribution mains. Lower pressure distribution mains and service lines connected to gas meters are not included in the map.
- UCLA Energy Atlas. UCLA California Center for Sustainable Communities (CCSC) in the Institute of the Environment and Sustainability (IOES) developed the map to inventory residential income, building stock, and energy usage.
- Mobile Home/ RV Parks Inventory. California Department of Housing and Community Development maintains an inventory of all mobile homes and RV parks within California including their location, sites, and services offered.
- Count of Los Angeles Assessor Parcel Data 2020. This data set includes properties across Los Angeles County from the property tax assessor's office. It includes the age of the building, lot, and valuation.
- Zumper Los Angeles Metro Report. Zumper, a home rental platform, consolidates its market data in assessing the Los Angeles rental property market.

The majority of the work in this DRR was authored by Brian Wong and Alexandra Huttinger. Open items after the Technical Advisory Committee review will be addressed in the Cost Evaluation of Decommissioning Strategies Memorandum. These include utility shut off; average energy usage; distribution system overlaid on population centers; critical infrastructure; usage on each segment of the distribution system, maintenance schedules, book value of pipes, and planned upgrades; and vintage of residential cooking and HVAC systems.

Santa Monica, CA

Demographics

Santa Monica is a city in western Los Angeles County consisting of zip codes 90401, 90402, 90403, 90404, and 90405. It has a population of 93,076,¹ population density of 10,664² per square mile and median age of 40. The city has a diverse racial and ethnic mix with 64.6% white (non-Hispanic), 15.4% white (Hispanic), 10.2% Asian, 4.5% Black, and 5.3% other.³ Although it is a diverse city, each of its neighborhoods is quite different compared to the next.

The median household income is \$96,570⁴ with a median per capita income of \$56,863. The poverty rate of 9.9% of persons is lower than the national average. The unemployment rate is 7.9%⁵ and the owner-occupied housing rate is 29.0%.⁶ Santa Monica is also home to the highest one-bedroom rent in the Los Angeles metro at \$2,630 per month.⁷

Los Angeles County Climate Vulnerability Assessment

Santa Monica is at low risk to most climate vulnerabilities.⁸ Due to its position along the coast, coastal flooding is a moderate risk given the range of sea-level rise scenarios from 2030 through 2100. Through planning and community engagement, the city has chosen a natural or soft adaptation strategy and managed retreat to adapt to sea-level rise.⁹ Measures include dune restoration, beach nourishment, limiting new shoreline development, regulating vulnerable infrastructure, and relocating critical infrastructure. Furthermore, there are limited risks of extreme heat and wildfires. However, there are pockets of medium social sensitivity within Santa Monica due to preexisting health conditions, age, and income.

FEMA National Risk Index

Santa Monica has a FEMA National Risk Index of 33.0 (relatively high) compared to a California average of 22.6 due to its relatively high expected annual loss, relatively moderate social

¹ "[Census QuickFacts: Santa Monica city, California](https://www.census.gov/quickfacts/santamoniacitycalifornia)." As of November 22, 2021: <https://www.census.gov/quickfacts/santamoniacitycalifornia>

² "[Census QuickFacts: Santa Monica city, California](https://www.census.gov/quickfacts/santamoniacitycalifornia)." As of November 22, 2021: <https://www.census.gov/quickfacts/santamoniacitycalifornia>

³ "[Census QuickFacts: Santa Monica city, California](https://www.census.gov/quickfacts/santamoniacitycalifornia)." As of November 22, 2021: <https://www.census.gov/quickfacts/santamoniacitycalifornia>

⁴ "[Census QuickFacts: Santa Monica city, California](https://www.census.gov/quickfacts/santamoniacitycalifornia)." As of November 22, 2021: <https://www.census.gov/quickfacts/santamoniacitycalifornia>

⁵ United States Bureau of Labor Statistics. "[Unemployment: Long Beach city, CA Local Area Unemployment Statistics](https://bls.gov/lau/)." As of April 10, 2026: <https://bls.gov/lau/>

⁶ "[Census QuickFacts: Santa Monica city, California](https://www.census.gov/quickfacts/santamoniacitycalifornia)." As of November 22, 2021: <https://www.census.gov/quickfacts/santamoniacitycalifornia>

⁷ Zumper, "[Los Angeles Metro Report](https://www.zumper.com/blog/los-angeles-metro-report)." As of December 6, 2021: <https://www.zumper.com/blog/los-angeles-metro-report>

⁸ County of Los Angeles, Chief Sustainability Office. "[LA County Climate Vulnerability Assessment](https://www.cakex.org/documents/la-county-climate-vulnerability-assessment-2021)." 2021. As of April 10, 2026: <https://www.cakex.org/documents/la-county-climate-vulnerability-assessment-2021>

⁹ City of Santa Monica. "[Climate Action & Adaptation Plan: A 2030 Community Plan to Reduce Carbon Emissions & Become Climate Resilient](https://www.smgov.net/uploadedFiles/Departments/OSE/Climate/CAAP_SantaMonica.PDF)." As of April 10, 2026: https://www.smgov.net/uploadedFiles/Departments/OSE/Climate/CAAP_SantaMonica.PDF

vulnerability, and relatively low community resilience.¹⁰ The predominant hazard for Santa Monica is earthquake risk. In the case of Santa Monica, across the 19 census tracts, most areas had relatively moderate to high expected annual losses coupled with relatively low to moderate social vulnerability scores. Community resilience scores were also consistently relatively low. These factors led to the relatively high score risk index score.

Energy Usage and Infrastructure

Santa Monica is served by SoCalGas and Southern California Edison. The city's overall energy burden was 1% of its average median income in 2018,¹¹ the lowest tier of energy burden within California. In 2016, Santa Monica residents' annual median natural gas consumption was 645 therms (2nd highest quintile) and 9,217 kWh (4th quintile). Commercial entities have an annual median natural gas consumption of 715 therms (5th quintile) and 52,929 kWh (4th quintile).¹² Industrial usage was not available.

Santa Monica does not have any oil & natural gas wells, storage facilities, or processing plants.¹³ However, it does have natural gas transmission lines running along the eastern edge of the city near Centinela Ave and high-pressure distribution lines on the northern edge along San Vicente Blvd.¹⁴ Neighboring Playa del Rey has a natural gas storage facility.

Santa Monica does not have local bulk electricity generation or transmission resources. However, it does have 7 substations within the city. Figure A.1 shows the overall infrastructure of Santa Monica and transmission-level assets. Figures A.2 shows the detailed gas distribution system in various areas within Santa Monica.

¹⁰ FEMA, "[National Risk Index](https://hazards.fema.gov/nri/map)." As of November 22, 2021: <https://hazards.fema.gov/nri/map>

¹¹ "[Low-Income Energy Affordability Data \(LEAD\) Tool](https://www.energy.gov/eere/slsc/maps/lead-tool)." As of March 8, 2022: <https://www.energy.gov/eere/slsc/maps/lead-tool>

¹² University of California Los Angeles. "[Energy Atlas 2.0](https://energyatlas.ucla.edu/map/usage_bld)." As of November 22, 2021: https://energyatlas.ucla.edu/map/usage_bld

¹³ United States Department of Homeland Security, Geospatial Management Office. "[Homeland Infrastructure Foundation-Level Data \(HIFLD\)](https://www.dhs.gov/gmo/hifld)." <https://www.dhs.gov/gmo/hifld>. Accessed November 22, 2021

¹⁴ SoCalGas. "[Gas Pipeline](https://socialgas.maps.arcgis.com/apps/webappviewer/index.html)." Southern California Gas Company. <https://socialgas.maps.arcgis.com/apps/webappviewer/index.html>. Accessed November 22, 2021

Figure A.1: Data Visualizations of City of Santa Monica Infrastructure

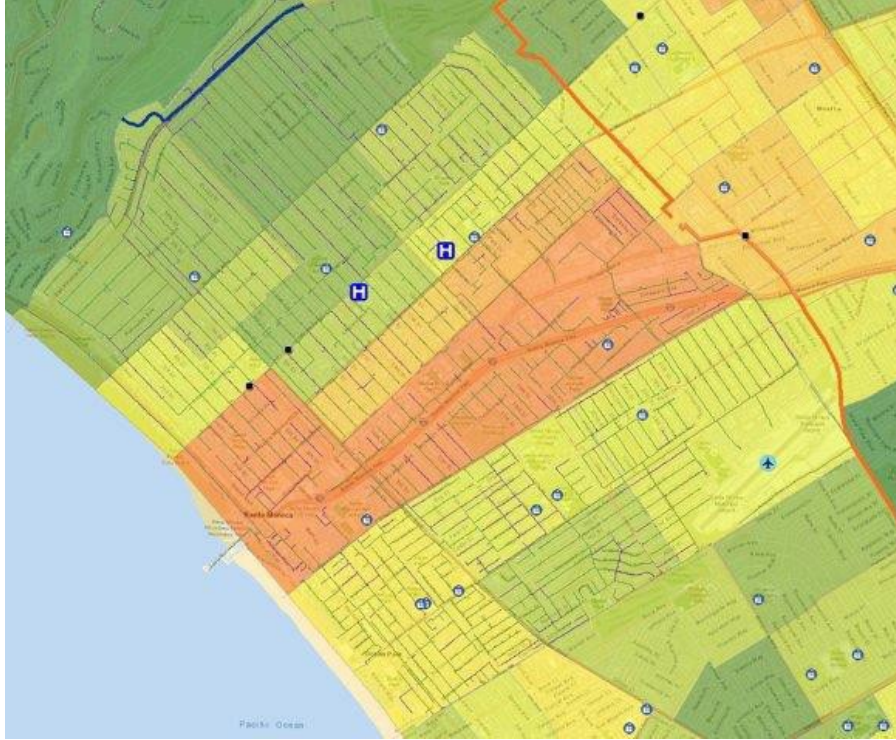
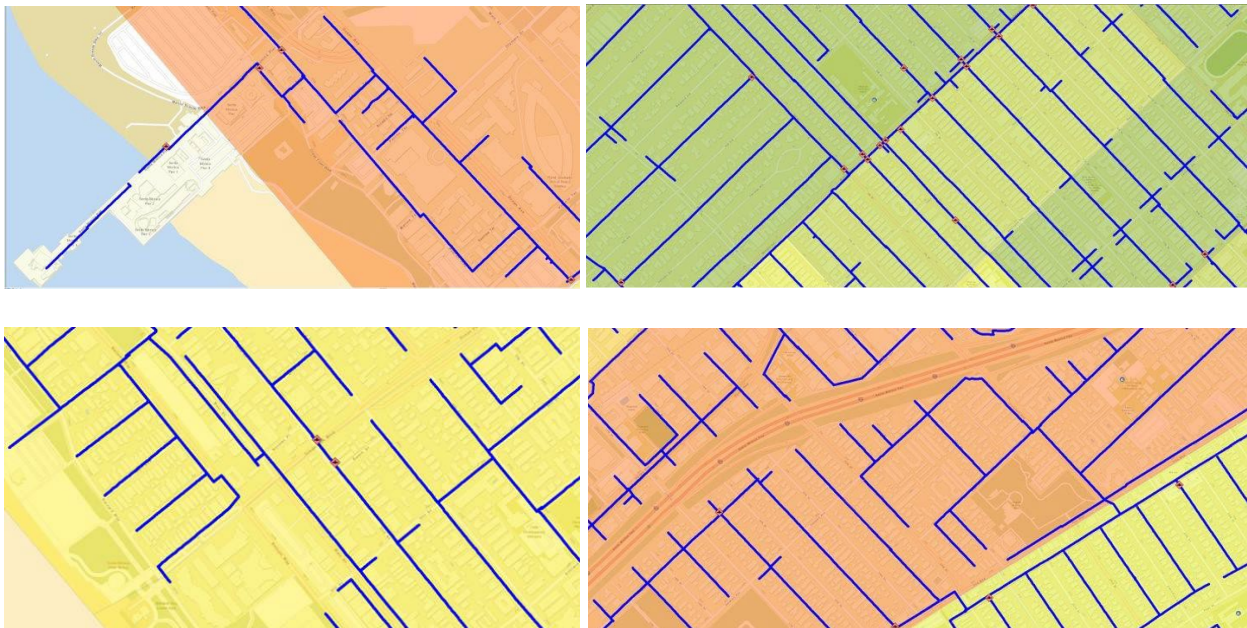


Figure A.2: Detailed Data Visualizations of City of Santa Monica Infrastructure



Note: Upper left: Santa Monica Pier. Upper right: 7th and Montana. Lower left: Ocean Park and Neilson Way
Lower right: Virginia & 20th

Building Stock

Of the residential property in Santa Monica, there are 11,592 (69%) single family buildings and 4,053 (31%) multi-family buildings. In terms of households, this is 11,592 (26%) single family and 32,068 (73%) multi-family. Most of these homes are built before 1978 with 72% of

single family and 93% of multi-family buildings.¹⁵ Santa Monica has one active mobile home park the Mountain View Mobile Inn, although it is not listed in the California registry of mobile homes as of 2021.¹⁶

Natural gas is the predominant fuel type for residential applications. It is the leading share in space heating (54%), water heating (45%), cooking (59%), and clothes drying (44%). Electricity is secondary to natural gas across most of these applications, except for water heating where other fuel types are second to natural gas.¹⁷

Neighborhoods

Santa Monica consists of different communities and neighborhoods with different barriers to adapt to natural gas decommissioning. The following is a list of neighborhoods and their characteristics.

North of Montana

North of Montana is an eponymous neighborhood that is north of Montana Avenue. Large single-family homes and the Montana Avenue commercial area highlight this neighborhood.

Wilshire Montana

Wilshire Montana is also an eponymous neighborhood that is south of Montana Avenue and north of Wilshire Avenue. It is similar to North of Montana but includes both Montana and Wilshire commercial areas.

Downtown

Downtown Santa Monica includes the Santa Monica Pier and Third Street Promenade. It is a dense area with multi-family housing and significant commercial developments.

Mid-City

Mid-City Santa Monica is a mix of single and multi-family homes. It is more diverse than the preceding area codes and has the largest Latino population in Santa Monica at nearly 30%.¹⁸ It is also home to the highest scoring CalEnviroScreen 4.0 communities due to its proximity to the I-10 Freeway.

Ocean & Sunset Parks

Ocean & Sunset Parks neighborhoods are on the southern edge of Santa Monica. It includes Silicon Beach and home to technology companies such as Snap. The neighborhood demographics is like Mid-City, roughly 15% of the local population is Latino.

¹⁵ Rocky Mountain Institute (RMI). "Building Inventory Maps: Santa Monica."

¹⁶ California Department of Housing and Community Development. "Search for Mobile Home/RV Parks." As of November 22, 2021

¹⁷ Rocky Mountain Institute (RMI). "Building Inventory Maps: Santa Monica."

¹⁸ Civic Wellbeing Partners. "[Home](https://www.civicwellbeing.org/)." <https://www.civicwellbeing.org/>. Accessed April 10, 2026

Long Beach, CA

Demographics

Long Beach is a city in southern Los Angeles County. It has a population of 462,628,¹⁹ population density of 9,206²⁰ per square mile and median age of 36. The city has a diverse racial and ethnic mix with 28.4% white (non-Hispanic), 23.9% white (Hispanic), 11.8% Asian, 10.9% Black, 17.3% other (Hispanic), and 7.7% other.²¹ Although it is a diverse city, each of its neighborhoods is quite different compared to the next.

The median household income is \$67,804²² with a median per capita income of \$32,323. The poverty rate of 16.8% of persons is lower than the national average. The unemployment rate is 10.7%²³ and the owner-occupied housing rate is 39.2%.²⁴ Long Beach's one bedroom rent is below the state median at \$1,610 per month and is one of the lowest in the Los Angeles metro area.²⁵

Los Angeles County Climate Vulnerability Assessment

Long Beach has a range of climate vulnerabilities from low to high.²⁶ With its port and offshore oil and gas infrastructure, coastal flooding from sea-level rise and extreme precipitation puts the city at unique risk from climate change. Furthermore, these pressures intersect with social vulnerabilities within Long Beach from preexisting health conditions, higher-than-average rates of poverty, low median income, and lack of educational attainment.

FEMA National Risk Index

Long Beach has a FEMA National Risk Index of 24.8 (relatively moderate) compared to a California average of 22.6 due to its relatively high expected annual loss, very low social vulnerability, and relatively low community resilience.²⁷ The predominant hazard for Long Beach is earthquake risk. In the case of Long Beach, across most areas had relatively moderate to high expected annual losses coupled with relatively low to moderate social

¹⁹ "[Census QuickFacts: Long Beach city, California](https://www.census.gov/quickfacts/longbeachcitycalifornia)." As of November 22, 2021: <https://www.census.gov/quickfacts/longbeachcitycalifornia>

²⁰ "[Census QuickFacts: Long Beach city, California](https://www.census.gov/quickfacts/longbeachcitycalifornia)." As of November 22, 2021: <https://www.census.gov/quickfacts/longbeachcitycalifornia>

²¹ "[Census QuickFacts: Long Beach city, California](https://www.census.gov/quickfacts/longbeachcitycalifornia)." As of November 22, 2021: <https://www.census.gov/quickfacts/longbeachcitycalifornia>

²² "[Census QuickFacts: Long Beach city, California](https://www.census.gov/quickfacts/longbeachcitycalifornia)." As of November 22, 2021: <https://www.census.gov/quickfacts/longbeachcitycalifornia>

²³ United States Bureau of Labor Statistics. "[Unemployment: Long Beach city, CA Local Area Unemployment Statistics](https://bls.gov/lau/)." <https://bls.gov/lau/>. Accessed November 22, 2021.

²⁴ "[Census QuickFacts: Long Beach city, California](https://www.census.gov/quickfacts/longbeachcitycalifornia)." As of November 22, 2021: <https://www.census.gov/quickfacts/longbeachcitycalifornia>

²⁵ Zumper, "[Los Angeles Metro Report](https://www.zumper.com/blog/los-angeles-metro-report)." As of December 6, 2021: <https://www.zumper.com/blog/los-angeles-metro-report>

²⁶ County of Los Angeles, Chief Sustainability Office. 2021. "[LA County Climate Vulnerability Assessment](https://www.cakex.org/documents/la-county-climate-vulnerability-assessment-2021)." <https://www.cakex.org/documents/la-county-climate-vulnerability-assessment-2021>. Accessed October 19, 2022

²⁷ FEMA, "[National Risk Index](https://hazards.fema.gov/nri/map)." As of November 22, 2021: <https://hazards.fema.gov/nri/map>

vulnerability scores. Community resilience scores were also consistently relatively low. These factors led to the relatively moderate score risk index score.

Energy Usage and Infrastructure

Long Beach is served by City of Long Beach Utility Services and Southern California Edison. The city's overall energy burden was 2% of its average median income in 2018,²⁸ the second lowest tier of energy burden within California. In 2016, Long Beach residents' annual median natural gas consumption was 6,625 kWh (5th quintile). Commercial entities have an annual median natural gas consumption of 35,169 kWh (5th quintile). Industrial usage was not available. Industrial entities have an annual median natural gas consumption of 27,870 kWh (5th quintile).²⁹

Long Beach has many oil & natural gas wells across two main regions in the city: Long Beach Oil Field (onshore) and Wilmington Oil Field (offshore). Long Beach does not have any natural gas storage facilities or processing plants.³⁰ There is a processing plant in adjacent Signal Hill. It has three natural gas transmission lines running along the eastern, northern, and western edges of the city. Furthermore, it has high-pressure distribution lines feeding the Port of Long Beach from the western transmission line, the city from the northern transmission line, and the eastern side of the City from the eastern transmission line.³¹

Long Beach has bulk electricity generation on the eastern and western edges of the city: a natural gas plant dubbed Alamitos operated by AES, a natural gas plant dubbed Haynes operated by the Los Angeles Department of Water and Power, and the Southeast Resource Recovery Facility ("SERRF") municipal solid waste plant operated by the city. There are two electric transmission lines that run along the eastern and western edges of the city adjacent to the 605 and 710 highways. It also has over 20 substations throughout the city servicing the Port and the larger City. Figure A.3 shows the overall infrastructure of the city and transmission-level assets. Figure A.4 shows the detailed gas distribution system from SoCalGas in various areas within the city.

²⁸ "[Low-Income Energy Affordability Data \(LEAD\) Tool](https://www.energy.gov/eere/slsc/maps/lead-tool)." As of March 8, 2022: <https://www.energy.gov/eere/slsc/maps/lead-tool>

²⁹ University of California Los Angeles, "[Energy Atlas 2.0](https://energyatlas.ucla.edu/map/usage_bld)." As of November 22, 2021: https://energyatlas.ucla.edu/map/usage_bld

³⁰ United States Department of Homeland Security, Geospatial Management Office. "[Homeland Infrastructure Foundation-Level Data \(HIFLD\)](https://www.dhs.gov/gmo/hifld)." <https://www.dhs.gov/gmo/hifld>. Accessed November 22, 2021.

³¹ SoCalGas. "[Gas Pipeline](https://socialgas.maps.arcgis.com/apps/webappviewer/index.html)." Southern California Gas Company. <https://socialgas.maps.arcgis.com/apps/webappviewer/index.html>. Accessed November 22, 2021

Figure A.3: Data Visualizations of City of Long Beach Infrastructure

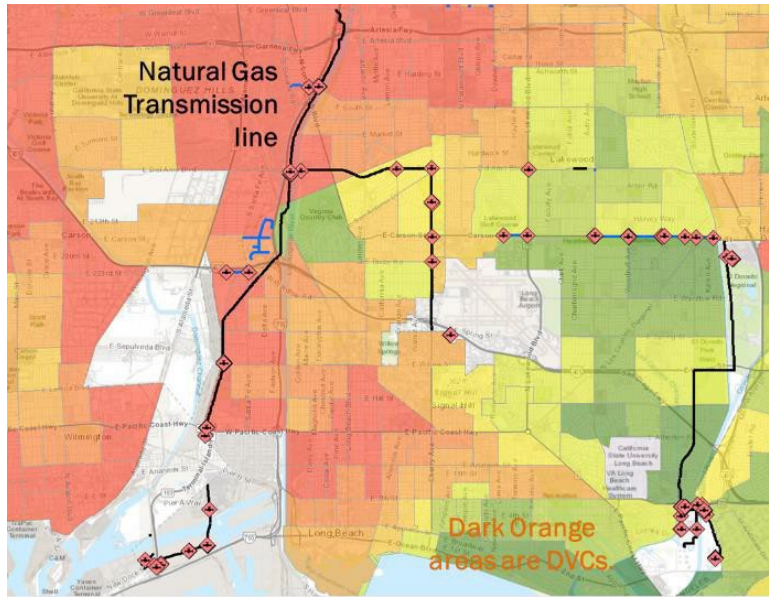
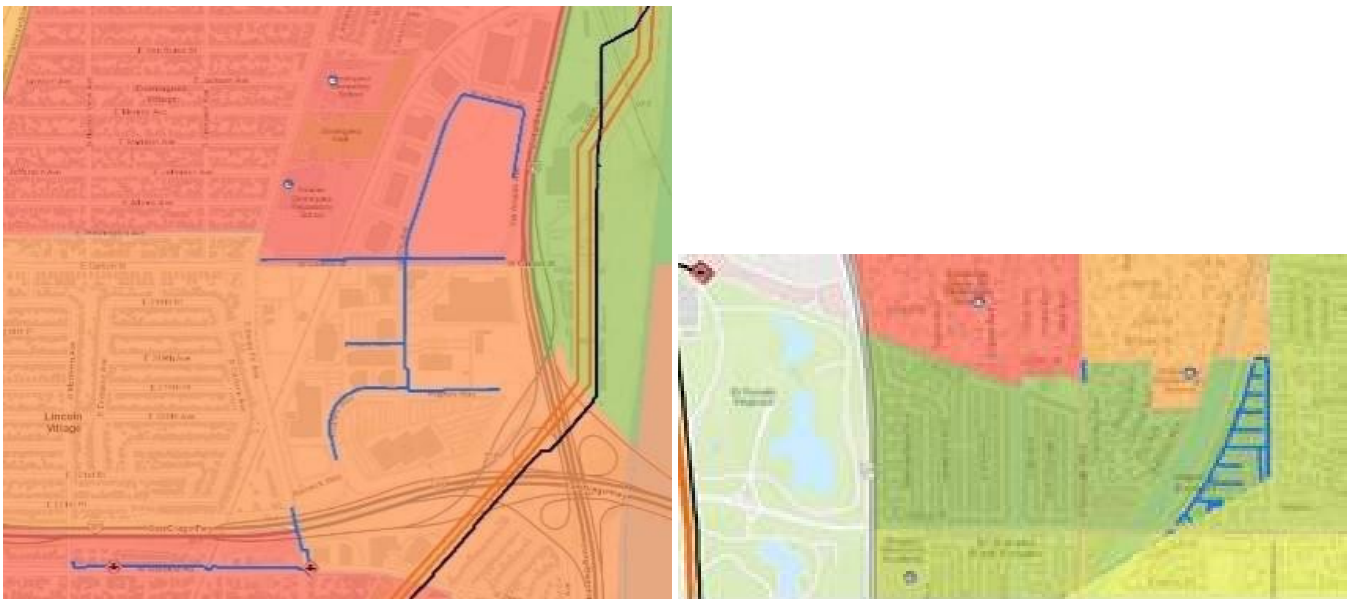


Figure A.4: Detailed Data Visualizations of City of Long Beach Infrastructure



Note: Left: Intersection of I-710 and I-405. Right: El Dorado Regional Park

Building Stock

Of the residential property in Long Beach, there are 80,104 (82%) single family buildings and 17,486 (18%) multi-family buildings. The average home was built in 1958 and median year it was built is 1955.³² Long Beach has 13 active mobile home parks with over 2,000 units servicing a combination of manufactured homes and recreational vehicles.³³

³² County of Los Angeles. "[Assessor Parcel Data \(Rolls 2016 - 2020\)](https://data.lacounty.gov/datasets/assessor-parcel-data-rolls-2016-2020/about)." Accessed November 22, 2021: <https://data.lacounty.gov/datasets/assessor-parcel-data-rolls-2016-2020/about>

³³ California Department of Housing and Community Development. "Search for Mobile Home/RV Parks." November 22, 2021.

Neighborhoods

Long Beach consists of different communities and neighborhoods with different barriers to adapt to natural gas decommissioning. The following is a list of neighborhoods and their characteristics.

North Long Beach, Bixby Knolls, California Heights, Los Cerritos North Long Beach is an area that surrounds the City of Signal Hill. This area also includes the Virginia Country Club.

Greater Downtown

Downtown Long Beach is a diverse neighborhood. It includes tourist attractions such as the Aquarium of the Pacific, Catalina Express, Queen Mary, Long Beach Convention & Entertainment Center, and significant commercial areas off Pine Avenue. Downtown Long Beach hosts the annual Acura Grand Prix and will also host parts of the 2028 Summer Olympics. Downtown residential areas are mostly high-rise units and lofts, but surrounding areas include craftsman cottages. North of Downtown Long Beach includes Cambodia Town and the city is home to the largest concentration of Cambodians outside of Cambodia.³⁴

Westside

The Westside is largely industrial and has a large Latino and Philippine population. It is immediately north of the Port of Long Beach.

Los Altos

Los Altos is a residential neighborhood located in eastern Long Beach and includes California State University, Long Beach and Long Beach Airport.

Belmont & Naples

Belmont and Naples neighborhoods are in the southeast area of Long Beach. These neighborhoods are largely residential but have active business districts on Broadway east of Redondo Avenue and along 2nd street through the Naples neighborhood.

³⁴ City of Long Beach. "[Cambodia Town.](https://www.visitlongbeach.com/neighborhoods/cambodia-town/)" As of November 22, 2021: <https://www.visitlongbeach.com/neighborhoods/cambodia-town/>



California
ENERGY COMMISSION



ENERGY RESEARCH AND DEVELOPMENT DIVISION

APPENDIX B: Energy Equity Considerations

May 2026 | CEC-500-2026-010

Appendix B:

Energy Equity Considerations

This appendix describes the RAND team’s work to adapt the CEC/CPUC Disadvantaged Communities Advisory Group's Equity Framework and Energy Equity Indicators for natural gas decommissioning. It includes:

- Results of our literature review
- A discussion of the relationship between decision criteria and equity considerations
- Vignettes that illustrate the complexities of assessing equity
- A placeholder for policy implications for adaptations to the Equity Framework and Energy Equity Indicators that will be proposed for natural gas decommissioning.

A first step was to review the literature on equity for natural gas decommissioning. Our review consists of three parts. First, the authors reviewed literature to provide a holistic framework for equity considerations, independently of the specific application. Second, the authors reviewed energy equity considerations broadly, using frameworks such as the CEC/CPUC Disadvantaged Communities Advisory Group's Equity Framework and Energy Equity Indicators. Third, the authors focused on literature specific to equity considerations for natural gas decommissioning. Prior to this project, the project team published “Equity Metrics for Climate Adaptation in the Electricity Sector”.¹ The results from this project built on that study.

A Framework for Equity

Equity is discussed in “Equity Metrics for Climate Adaptation in the Electricity Sector”² as:

“Equity is a sense of fairness, and fairness is a complex construct. Fair in what way? For whom? By what means? For what purpose? According to whom? In the context of what prior experiences? Furthermore, implicit to the idea of fairness is that equity is a comparative construct. Equity speaks to differences in experiences and outcomes among disparate groups. By contrast, measuring changes in the experiences and conditions of a single group, though important, is not sufficient for describing equity.

McDermott, Mahanty, and Schreckenberg’s 2013 equity framework...helpfully formalizes these ideas into four interrelated parameters of how equity is defined (McDermott, Mahanty, and Schreckenberg, 2013). The first parameter asks, “What counts as equity?” This is the content of equity and often recalls a sense of fairness in outcomes. The first dimension of this parameter is distributional equity, i.e., whether the benefits and costs of an activity are distributed fairly. But distributional equity is only one of three dimensions of what counts. A second dimension is procedural equity, i.e., which stakeholders

¹ [Equity Metrics for Climate Adaptation in the Electricity Sector | RAND](https://www.rand.org/pubs/research_reports/RRA1721-1.html). https://www.rand.org/pubs/research_reports/RRA1721-1.html

² [Equity Metrics for Climate Adaptation in the Electricity Sector | RAND](https://www.rand.org/pubs/research_reports/RRA1721-1.html). https://www.rand.org/pubs/research_reports/RRA1721-1.html

are recognized and included in processes, and is such engagement fair? A third dimension is a contextual equity, which seeks to understand the preexisting conditions that influence access to procedures, resources, and outcomes.

A second parameter asks, “who counts?” That is, among which groups is an organization or policy trying to achieve equity? Frequently, equity concerns are organized around race and ethnicity or socioeconomic status, though there are other characteristics of concern as well, including disability, age, gender, sexual characteristics, and incarceration status. There is particular interest in understanding the challenges of intersectionality, i.e., people who have more than one characteristic that might place them at a disadvantage (Crenshaw, 1991). The “who” can also be defined at different scales, e.g., equity among individuals, households, or larger communities; equity across generations; and even equity among humans and the environment or other species.

A third parameter asks, “why equity?” In other words, what is the goal of considering equity? This makes explicit what a policy or activity around equity is trying to achieve. It might be attempting not to exacerbate inequity, or it might be seeking to improve equity.

A fourth parameter asks, “How are the parameters of equity set?” Specifically, how are these issues of what, who, and why decided, and by whom? The answers to the first three parameter questions will necessarily reflect the perspectives of the parties involved and the process they use to set equity parameters.”

Energy Equity

The authors conducted a scoping review of the literature on equity and natural gas decommissioning. The authors performed a keyword search in google using a combination of different keywords such as “equity, “natural gas decommissioning”, “electrification,” and “just transition”. The authors analyzed the search results for relevance and selected the literatures which were then used for conducting the review. The authors also studied the references mentioned in the selected literature. The authors concluded the literature review after we observed a sufficient convergence on a set of shared themes. Here is highlighted the key findings from the review.

Following the equity assessment framework from McDermott et al. one observes that:

- The **context** (the *what* of equity) of equity considerations in natural gas decommissioning is to ensure fair distribution of the major costs and benefits of natural gas decommissioning.
- The **target** (the *who* of equity) are disadvantaged workers, businesses, and consumers who can potentially face the disproportionate impacts of the natural gas decommissioning.

sioning. The CPUC has defined environment and social justice (ESJ) communities (ESJ)³ to describe key characteristics of disadvantaged groups.

- The **goal** (the *why* of equity) is broadly to mitigate the potential disproportionate accrual of social and economic cost of natural gas decommissioning.

The different recommendations from the literature review can be consolidated into four broader themes:⁴

1. **Robust community engagement is critical to equitable decommissioning.** Equitable natural gas decommissioning first and foremost it requires robust community engagement to assess barriers to transitioning to other fuels and to ensure accessible, transparent and community led decision making.
2. **Support to transitioning communities must be multi-dimensional.** To assist communities and business transitioning from natural gas and to mitigate the negative impacts, it is important that multidimensional support, such as economic, environmental, and infrastructural support, is provided.
3. **Policies should focus on historical inequities.** Any equity consideration should aim to address the legacy of underinvestment and environmental injustice in low-income, minority, and other disadvantaged communities by conscious and representative policy design, implementation, and formulation.
4. **Policies should leverage existing programs.** Policies for equity consideration in natural gas decommissioning should leverage low-income assistance programs for supporting transitioning workers and communities while ensuring flexibility for tailoring to local conditions.

Drawing again on the three dimensions of the equity framework in McDermott et al. (2013), it is evident that the first theme can be categorized as procedural equity, second theme as distributional equity, and the third and fourth themes as contextual equity.

Finally, there are three shortcomings in the literature. First, equity is fundamentally a comparative construct. Measures of equity assess *differences* in experiences and outcomes *among* disparate groups. Measuring changes in the experiences and conditions of a *single group* (e.g., over time or because of some intervention) are important in tracking social progress but would not describe equity. Yet some equity frameworks do not focus on or facilitate such comparisons. As one example, the CEC/CPUC Disadvantaged Communities Advisory Group's Equity Framework was developed primarily to track the progress "for advancing the recommendation in the SB 350 Low Income Barriers Study." In other words, they track progress within a group rather than comparing it across groups.

³ California Public Utilities Commission. N.d. [Environmental and Social Justice Action Plan](https://www.cpuc.ca.gov/news-and-updates/newsroom/environmental-and-social-justice-action-plan). Retrieved November 22, 2021, from <https://www.cpuc.ca.gov/news-and-updates/newsroom/environmental-and-social-justice-action-plan>

⁴ The theme "policy focus on communities with legacy of underinvestment and environment injustice" is along the same vein of the Justice 40 initiative. Justice 40 initiative is launched by President Biden's administration to focus on addressing "the disproportionate health, environmental, economic, and climate impacts on disadvantaged communities.

Although the terms “metric” and “indicator” are often used interchangeably in the literature, they have different meanings. Indicators are the attributes of an object or a system from which conclusions on the state and quality of the phenomenon of interest can be inferred. In other words, indicators can be measured in different ways. Metrics, in contrast, are the standard of measure. The next section discusses examples of different types of metrics and their uses.

Relationship Between Decision Criteria and Equity Metrics and Goals

Equity considerations can involve a variety of questions, such as:

- Are current conditions equitable? For instance, do different communities currently have comparable access to grid capacity necessary for new residential rooftop solar PV?⁵
- Does a program or intervention improve equity? For instance, does new investment to expand grid capacity reduce those differences between communities? Used in this way, metrics can signal a change towards better or worse equity.
- Is a program’s implementation equitable? Are a program’s resources to improve infrastructure equitably allocated to different communities?

Equity metrics can help answer these questions. Equity metrics are typically quantitative assessments of how costs and benefits of a system or intervention accrue to different groups. Examples of metrics include household energy burden (the fraction of a household’s income that is spent on energy) and program participation (the fraction of households in a community that participate in consumer facing programs such as home weatherization).

Equity metrics measure some aspect of a project or program’s performance that could indicate inequities, namely the differences are in the allocation of costs and benefits (or experiences more generally) between different groups. To be useful in decision making, however, equity metrics should be coupled with equity goals, which articulate what those differences *should be* or whether a particular program or project achieves “acceptable” degrees of difference. In the framework above, goals are part of the “why” of equity. Equity goals could state that a project or program may not exacerbate disparities or must reduce disparities between certain groups. Such goals are best established in close collaboration with stakeholders.

In combination, metrics and goals can yield decision criteria that can help inform decisions. For example, a program may restrict itself to projects that do not worsen disparities (the goal) in household energy burden (the metric) between different communities.

Importantly, equity metrics typically speak only to the distributional equity in the framework, such as costs disproportionately borne by a low-income person, which is most readily quantifiable. It is important to also consider procedural and contextual equity.

⁵ Brockway, Anna M., Jennifer Conde, and Duncan Callaway. 2021. "Inequitable access to distributed energy resources due to grid infrastructure limits in California." *Nature Energy* 6, no. 9 (892-903).

Equity Vignettes

As the framework above highlights, equity is a complex, multi-dimensional concern. The literature reviewed suggested several potential effects on equity from a transition from natural gas to electricity. These include but are not limited to rising rates and decreasing affordability for remaining natural gas customers, impacts on the current work force in natural gas, distribution of economic opportunity in new electricity jobs, and safety and environmental equity. Below, there are five brief, illustrative vignettes to help make the conversations around equity concrete. These vignettes have been found to be more salient to local stakeholders than the theoretic framework. Importantly, these vignettes help stakeholders understand there are many more equity concerns than costs borne by low-income customers.

Energy Equity for Natural Gas Customers

The local utility launches a program to move people from natural gas to electricity. The program reduces costs for all customers. Since it's focused on the average customer, it doesn't meet the needs of very low-income populations, who cannot afford to switch. Over time, as more customers leave natural gas, costs will increase for the remaining customers.

The utility begins to plan for low-income customers. A new program will help these customers transition from natural gas.

Equity in Energy Efficiency Program Participation

The local government launches an energy efficiency program. This will reduce natural gas usage and bills for households by blowing insulation into the walls. The program has low take-up with low-income communities. Renters pay energy bills, but landlords need to upgrade buildings. Landlords avoid the hassle.

The local government updates the program to encourage landlords to participate.

Equity in Maintaining Post-Meter Infrastructure

A family in a mobile home park recently tried to upgrade their natural gas water heater. When the technician arrived, she found a small leak in the gas line entering the home. She could not install the water heater. The mobile home park is responsible for the gas line; the natural gas utility is not. The gas pipes look old. Residents worry that there may be additional leaks throughout the park.

Community organizers work with the mobile home park to address residents' concerns. The park upgrades old natural gas lines that they own.

Equity in Economic Opportunities

As part maintaining a safe natural gas delivery system, the utility needs to hire and train new workers. The utility offers a training program for these new job openings. Although the program is meant for vulnerable communities, participation is low in these areas. People choose not to join for several reasons. Some are living paycheck to paycheck, so they cannot start training. Some need to take care of their children. Some don't have internet to apply to

the program. These equity problems are exacerbated as natural gas infrastructure is phased out and workers do not wish to train to enter a “dying” industry.

The utility includes training pay and allows paper applications.

Trade Offs in Equity

A utility decommissioning program seeks to prioritize equity and begins decommissioning a natural gas power plant situated in a disadvantaged community, which has some of the worst air quality in the region. Shutting off the natural gas power plant would significantly improve the air quality for that community and address a long-standing inequity between this community and others. However, the shut-off would have a competing effect on equity, in that the gas power plant is the primary employer in that community. To address equity more holistically, the utility offers financial and workforce development assistance to mitigate the immediate economic impacts of decommissioning program.

Annotated Bibliography

This annotated bibliography is intended to help readers explore and understand the equity literature on which this appendix is based.

Citation: Harwood, Meghan, Sean Newlin, Kiki Velez, and Michelle Vigen Ralston, *[The Flipside Report: A White Paper on Targeted Geographic Electrification in California's Gas Transition](https://buildingdecarb.org/wp-content/uploads/the_flipside_report_-_targeted_electrification_for_gas_transition.pdf)*, Berkeley, California: Building Decarbonization Coalition, Common Spark Consulting, Inc., July, 2021. As of October 12, 2021: https://buildingdecarb.org/wp-content/uploads/the_flipside_report_-_targeted_electrification_for_gas_transition.pdf

Summary: In this white paper published by Building Decarbonization Coalition and Common Spark Consulting on targeted geographic electrification in California’s gas transition, the authors noted that any electrification program should “prioritize investment in vulnerable communities”. They argued that vulnerable communities have disproportionately suffered from the negative impacts of fossil fuel usage and any unmanaged transition “will do further harm to already struggling communities”. Thus, they concluded that any electrification program must ensure that needs of vulnerable communities are prioritized.

The report also provided recommendations for achieving a 70successful transition off gas system. The recommendation included the following (directly quoted from page 17):

- Providing resources and investments in trusted community-based organizations to lead and support a community driven transition to electrification,
- Leverage successful direct install, integrated programs and approaches that provide subsidized comprehensive energy upgrades,
- Partner with affordable housing and housing rights advocates to establish standard tenant protection and anti-displacement measures that state or local agencies can adopt to limit rent increases and restrict evictions, and
- Propose rate reforms that better align baseline energy needs and affordability for low-income and multifamily renter households.

Citation: Aas, Dan, Amber Mahone, Snuller Price, Zack Subin, Mike Mac Kinnon (UCI), and Blake Lane (UCI), "[Draft Results: Future of Natural Gas Distribution in California](https://www.nrdc.org/sites/default/files/future-natural-gas-distribution-california-06062019.pdf)," in *CEC Staff Workshop for CEC PIER-16-011: Energy + Environment Economics*, June 6, 2019. As of April 10, 2026: <https://www.nrdc.org/sites/default/files/future-natural-gas-distribution-california-06062019.pdf>

Summary: In a CEC Staff Workshop presentation, researchers at Energy + Environment Economics explored the equity concerns of replacing gas equipment with electric equipment. They noted that electrification is the cost-effective way to achieve California's climate policy goals but barring policy intervention, low-income households will face the "disproportionate share" of higher average cost due to reduction in gas demand. The authors further identified components of a successful gas transition including (directly quoted from page 27):

- Reduce barriers to building electrification
- Targeted building electrification pilots
- Avoid gas system expansion, reduce costs
- Targeted retirements of gas distribution system
- Accelerated depreciation
- Changes to rate design and cost allocation
- Exit fees for departing gas customers
- Other funds to manage the equity impacts
- Shut-down gas distribution system and replace
- Any remaining gas-connected end-uses with
- Electric or other fuels

Citation: Davis, Lucas, and Catherine Hausman, [Who Will Pay for Legacy Utility Costs?](https://haas.berkeley.edu/wp-content/uploads/WP317.pdf), Energy Institute at Haas, Energy Institute WP 317R, 2021. As of October 12, 2021: <https://haas.berkeley.edu/wp-content/uploads/WP317.pdf>

Summary: Davis et al. (2021) in their paper titled "Who Will Pay for Legacy Utility Costs" discussed equity related implications of rapid electrification. Through their analysis of utility expenditures, they observed that a "considerable portion of capital and operating expenses are not eliminated by customer exit". Further, they observed patterns in customer base loss for utilities in predominantly African American cities and which can potentially lead to high energy bills for urban African American populations.

They also noted that disproportionate loss of customers from rural population may also lead to rural/suburban divide in energy bills and infrastructure quality.

The study recommended few policy interventions for addressing equity considerations such as:

- Subsidizing building electrification for low-income households or other disadvantaged groups,
- Accelerating depreciation schedules used in rate making to recover capital costs more quickly,
- By shifting costs to shareholders by disallowing or partially disallowing legacy costs for investor-owned utilities,

- By shifting the legacy costs out of natural gas sector through various potential policies including allowing the customers of electric utilities to cover the cost associated with transition.

Citation: Gridworks. September, 2019. [California's Gas System in Transition: Equitable, Affordable, Decarbonized and Smaller](https://gridworks.org/wp-content/uploads/2019/09/CA_Gas_System_in_Transition.pdf). As of October 12, 2021: https://gridworks.org/wp-content/uploads/2019/09/CA_Gas_System_in_Transition.pdf

Summary: Gridworks also explored the gas system transition in their report "California's Gas System in Transition-Equitable, Affordable, Decarbonized and Smaller" published in 2021. In the report, the author noted that a "comprehensive strategy to ensure low income and disadvantaged communities are empowered" is needed to ensure that such communities are not left behind. Such strategy can include (directly quoted from page 5):

- Producing a study on the barriers preventing low-income customers from transitioning to all-electric buildings and residences, conducted and completed by the CEC with input from the public and other relevant state agencies, with a focus on rental, multi-family, and existing homes,
- Conducting meaningful engagement with and involvement of low-income and disadvantaged communities throughout the gas transition,
- Designing bill protections for all low-income customers,
- Developing programs and resources to enable communities to electrify, and prioritizing resources to transition low-income and disadvantaged communities,
- Creating a one-stop shop for low-income customers to allow them to pair the transition to electric technologies with other programs including energy efficiency, weatherization, and solar and storage installation,
- Ensuring protections for renters to prevent displacement, including rent stabilization and just-cause eviction protections.

Citation: Cochran, Jaquelin, Paul Denholm, Meghan Mooney, Daniel Steinberg, Elaine Hale, Garvin Heath, Bryan Palmintier, Ben Sigrin, David Keyser, and Devonie McCamey, [The Los Angeles 100% Renewable Energy](https://docs.nrel.gov/docs/fy21osti/79444-ES.pdf), Golden, CO: National Renewable Energy Lab (NREL), March, 2021, Chapter 10. As of April 10, 2026: <https://docs.nrel.gov/docs/fy21osti/79444-ES.pdf>

Summary: Los Angeles 100% Renewable Energy Study (LA100) was a study conducted by National Renewable Energy Laboratory (NREL) and other partners to analyze the potential pathways which can be taken by Los Angeles to achieve 100% clean energy future. In the study, the author noted that although the benefits of clean energy transitions will be shared by all communities, disadvantaged communities (as identified by CalEnviroScen Scores) could see "reduced local and regional air pollution, improved indoor air quality from electrification, reduced vulnerability to climate change and improved health outcomes". However, they also commented that a conscious and intentionally designed policy making, and program

implementation is required to prioritize these communities for just and equitable “clean energy futures”.

Citation: Raimi, Daniel, Wesley Look, Molly Robertson, and Jake Higdon. August 11, 2020. [“Economic Development Policies to Enable Fairness for Workers and Communities in Transition.”](https://www.edf.org/sites/default/files/content/worker-fairness-economic-development-report.pdf) *Resources for the Future*. As of April 10, 2026: <https://www.edf.org/sites/default/files/content/worker-fairness-economic-development-report.pdf>

Summary: In a report by Resources for the Future (RFF) and Environmental Defense Fund (EDF) published in August 2020, the researchers explored the economic development policies for enabling a fair transition for workers and communities to a low- emission future. They identified three major mechanisms through which government can provide support to workers and communities (directly quoted from page 9):

- **Capacity building** involves programs that provide technical assistance, planning, or research to support local economic development efforts. Such programs can be effective tools to reduce knowledge gaps and increase human capital and productivity.
- **Financial support to public and community organizations** helps public or quasi-public organizations deliver local economic development programming. This support may be direct (e.g., grants or loans) or indirect (e.g., loan guarantees) and can enhance the human and physical capital stock (including infrastructure) in a community and,
- **Financial support to private, for-profit firms** may similarly be direct or indirect; the federal government may also offer tax credits, which are not applicable to public entities because they do not pay taxes. These programs are often intended to support small businesses that may struggle to access affordable borrowing, or to jump-start local businesses in sectors that policymakers believe hold promise for future prosperity.

Few other insights from the report include:

- Supporting medium- and long-term local development goals via federal intervention,
- Increased coordination between stakeholders and horizontal and vertical level of government,
- Leveraging “existing economic development programs” to support workers and communities affected by transition,
- Increasing spending to support affected workers and communities and,
- Geographically targeting the economic development policies in areas with disproportionate transition impacts.

Citation: Look, Wesley, Daniel Raimi, Molly Robertson, Jake Higdon, and Daniel Propp. March 25, 2021, [Enabling Fairness for Energy Workers and Communities in Transition](https://www.edf.org/sites/default/files/documents/RFF-EDF%20Fairness%20for%20Workers%20and%20Communities%20Synthesis%20Report.pdf), Resources for the Future. As of April 10, 2026: <https://www.edf.org/sites/default/files/documents/RFF-EDF%20Fairness%20for%20Workers%20and%20Communities%20Synthesis%20Report.pdf>

Summary: In a report published by Resources for the Future (RFF) and Environment Defense Fund (EDF) in 2021, researchers reviewed the federal policy options and principles for a “just transition” for energy workers and communities in transition in the United States. In their report, researchers analyzed a series of reports on just transition policies in United States and Europe and distilled them into four primary categories namely:

- Economic development,
- Workforce development,
- Public benefits and,
- Infrastructure and environmental remediation.

The researchers also highlighted “equitable and inclusive policymaking and implementation” as a critical pillar of “just transition” and asserted that “equity and fairness play a central role in just transition policy”. In the report they observed that for an equitable and fair transition, the policy should be guided by the procedural equity considerations, programs need to be accessible and transparent, address the legacy of underinvestment and environmental injustice in many communities and actively fund the environmental remediation efforts by leveraging polluter-pays principle.

Citation: Billimoria, Sherri, and Mike Henchen. July 2020. [Regulatory Solutions for Building Decarbonization: Tools for Commissions and Other Government Agencies](https://rmi.org/insight/regulatory-solutions-for-building-decarbonization/). Rocky Mountain Institute (RMI). As of October 12, 2021: <https://rmi.org/insight/regulatory-solutions-for-building-decarbonization/>

Summary: Rocky Mountain Institute also explored different regulatory solution for building decarbonization in a report published in 2020. In the report, they identified 3 major categories of strategies (directly quoted from page 5-6):

- Managing the transition,
- Holistic approaches to decarbonization and,
- Near-term market opportunities.

The equity considerations are embedded in the “holistic approaches to decarbonization” and include strategies such as (directly quoted from page 8):

- Inclusive public processes,
- Enabling community-led decision-making
- Dedicated funding and other supports for low- and moderate-income customers and,
- Adopting other low- and moderate-income programs for supporting transitioning customers and communities.

The authors also noted a need for “planning for workforce development”.

Citation: Atteridge, Aaron, and Claudia Strambo. 2020. [Seven Principles to Realize a Just Transition to a Low-Carbon Economy](https://www.sei.org/publications/seven-principles-to-realize-a-just-transition-to-a-low-carbon-economy/): Stockholm Environment Institute. As of April 10, 2026: <https://www.sei.org/publications/seven-principles-to-realize-a-just-transition-to-a-low-carbon-economy/>

Summary: Stockholm Environment Institute in 2020 also published a report exploring the concept of “just transition” to a low carbon economy and identified seven principles. The seven principles are (directly quoted from page 4):

- Actively encouraging decarbonization,
- Avoiding creation of carbon “lock in” and more “losers” in carbon intensive industry through sustained investment in such industry,
- Supporting affected region with lower economical capacity for diversification and places which bear lower historical responsibility for global emissions,
- Support workers, their families and the wider community affected by closures or downscaling.
- Cleaning up environmental damage and ensure that related costs are not transferred from the private to the public sector,
- Addressing existing economic and social inequalities and,
- Ensuring an inclusive and transparent planning process.

Citation: Miller, Carmelita, Stephanie Chen, Lisa Hu, and Isaac Sevier. September 30, 2019. *[Equitable Building Electrification: A Framework for Powering Resilient Communities](https://greenlining.org/publications/reports/2019/equitable-building-electrification-a-framework-for-powering-resilient-communities/)*, Oakland, CA: The Greenlining Institute. As of October 12, 2021: <https://greenlining.org/publications/reports/2019/equitable-building-electrification-a-framework-for-powering-resilient-communities/>

Summary: Greenlining Institute also researched the framework for an equitable building electrification and published a report in 2019. In the report, they presented a five-step framework for equitable building electrification, and which includes (directly quoted from page 5):

- Assessing community needs including barriers to electrifying homes,
- Establishing community-led decision making to ensure community buy-in,
- Developing metrics and tracking plan track both clean energy and community benefits,
- Ensuring funding and existing low-income energy program leveraging and,
- Focusing on improving outcomes depending upon metrics and feedbacks received.



California
ENERGY COMMISSION



ENERGY RESEARCH AND DEVELOPMENT DIVISION

APPENDIX C: Public Perceptions

May 2026 | CEC-500-2026-010

Appendix C:

Public Perceptions

This Appendix summarizes the public perceptions studies described in the main text.

Research Questions

The following research questions investigated included:

1. What does the phrase “natural gas infrastructure decommissioning” mean to community stakeholders?
2. What are issues that community stakeholders think will be important when considering whether to decommission natural gas?
3. What alternatives to natural gas are known to the community stakeholders?
4. Are known energy equity issues on community stakeholders’ minds, and what do they think about them?
5. When operating under data uncertainty, how would community stakeholders choose where to decommission?

These are important to study because the answers a) frame the initial decision analysis on what is and isn’t in scope for decommissioning, as well as b) help guide the necessary communication tools for any pilot decommissioning guidelines pertaining to tailoring content to reflect base knowledge, assumptions, and potential information gaps among local stakeholders.

Methods

RAND used a mixed methods approach to answer these questions, conducting interviews, and conducting facilitated Scoping Workshops.

Interviews

Target population

RAND sought to gather public perceptions on local considerations for natural gas decommissioning among community members engaged in, and impacted by, energy transition initiatives in the City of Santa Monica and the City of Long Beach. The target characteristics were to include viewpoints from individuals affiliated with city offices, local nonprofits, local businesses, and residents in general. RAND sought to include diverse perspectives by recruiting individuals who owned or rented their residence, across a variety of incomes, ages and other demographic characteristics. The composition was chosen to reflect both residential and commercial consumers of natural gas, and to capture city-level considerations on decommissioning. These pools of community members were not intended to be representative of the general population, rather, their experiences and viewpoints were indicative of some exposure to planning for, or participating in, energy transitions; either as early adopters or as parties who have considered social, economic and environmental impacts—both negative and positive—of energy transitions.

RAND sought a cross section of perspectives from employees of a variety of city offices including sustainability, planning, emergency services and equity. Other public sector parties that were invited to participate included individuals representing education, healthcare, parks and recreation, transportation, public utilities for water and energy and chambers of commerce in each city. In the non-profit sector, RAND sought participation from affordable housing providers and developers, members of neighborhood associations, and community-based organizations focused on local issues affecting residents. In the commercial sector, RAND invited restaurant owners, hotel and hospitality managers and owners, business owners and representatives involved in boiler and heat pump sales, and local business association members.

Recruitment

Potential participants were identified by a) the point of contact for each partner city, b) the RAND team's existing contacts, c) snowball sampling and d) web and social media searches for community fora where neighborhood representatives, community-based organizations, small businesses and residents share information about local issues. Potential participants were invited via email to attend a phone or video interview. 105 potential participants were sent an initial solicitation. 44 potential participants responded and volunteered to participate in 30-minute interviews conducted between October 2021 and January 2022 via telephone or virtual online meeting; thus the response rate was 42%. Interview participants were not compensated for their participation. The vast majority of exclusions were non-responses to emails, and in less than ten cases (spread evenly among Santa Monica and Long Beach) potential participants indicated that they were unable to participate due to schedule constraints.

Participation

There were 28 interviewees for Santa Monica and 16 interviewees for Long Beach, as summarized in Table C.1. Overall, 15 participants (34%) were employees of a city office, 14 (32%) were residents affiliated with a local non-profit organization or neighborhood association, 9 (20%) were residents affiliated with a local business or business association. The remainder (6 (14%)) were residents from a variety of professions/affiliations. Participating city offices included sustainability, public works, planning, transportation, energy, emergency services and equity. Local non-profit organizations included healthcare, education and affordable housing, as well as residents who were members of local climate change and sustainability advocacy groups, racial and ethnic minority local advocacy groups, and neighborhood associations. Local businesses and business associations included food and beverage and hospitality sectors representing restaurants and hotels, as well as vendors of boiler and heat pump systems for swimming pools. While this report does not provide specifics (due to human subject protection rules), limited demographic information was collected: 39% (17/44) were female and 61% (27/44) were male. Median age was 41 and ranged from 27-74 (32 disclosed their age). 75% were homeowners and 25% were renters (36 disclosed whether they owned or rented). 31 participants were willing to disclose their annual salary, median annual salary was \$138,000 and ranged from \$50,000 to \$275,000.

City of Long Beach interviews included more city expertise (56% of participants in City of Long Beach were city employees as compared to 21% of participants in City of Santa Monica), and the City of Santa Monica interviews included more local business expertise from restaurants, hotels and pool heater vendors (29% of participants in City of Santa Monica were affiliated with local businesses as compared to 6% of participants in City of Long Beach). These different make-ups were likely influenced by the recruitment strategy and prevailing circumstances. The prevalence of city and non-profit representation over local businesses and residents is reflective of pandemic-related pressures on availability and motivation to participate in a virtual interview for the purpose of research. Given these conditions, the 42% response rate and inclusion of local business perspective is indicative of a successful recruitment strategy that offered a forum in which individuals with disparate perceptions, interests and decision-making power, were able to share opinions via a forum where the participants felt safe and willing to provide their insights.

Topics covered

The interviews were semi-structured and included open response questions addressing perceptions of natural gas decommissioning and potential impacts with an emphasis on adverse effects and who might experience them. The topics addressed in the interview guide are summarized in Table C.2, additionally, the interview questions are included as an appendix.

Scoping Workshops

Workshop format

Building on interviews that addressed meanings, issues and equity around natural gas decommissioning, RAND sought to further elicit local perceptions and considerations through inviting all interview participants to join city-specific small group discussions in a workshop setting. In addition to collectively discussing meanings, issues, and equity the topics of energy alternatives and scoping a potential decommissioning pilot site were addressed. RAND convened two virtual workshops in January 2022, one for each city respectively. The duration of each workshop was 3 ½ hours and participants were compensated for their time.

Workshops were hosted and moderated by the study principal investigator and discussions were facilitated by study staff who were trained moderators. The same general format was used for Santa Monica and Long Beach workshops and city-specific content was developed for relevant activities. As summarized in Table C.2, five activities corresponding to the 5 research questions were conducted in each workshop. Activities were designed to elicit participants' perceptions. Virtual 'break-out rooms' with a trained facilitator encouraged small group discussion to capture as wide a variety of perspectives as possible and virtual workshop aides (collaboration boards, chats) allowed participants multiple channels for contribution. There were 7 breakout groups across the two workshops. Accommodations were made for participants who joined the workshops by telephone and were not able to see visual components of the workshops.

Workshop participation

Sixteen stakeholders attended the City of Santa Monica workshop and 12 stakeholders attended the City of Long Beach workshop. As shown in Table C.1, in the Santa Monica workshop, 6 participants were affiliated with a local non-profit organization, 4 participants were employees of a city office, 3 were affiliated with a local business, and 3 were residents not affiliated with a business, non-profit or city office. In the Long Beach workshop, 2 participants were affiliated with local non-profit organizations, 4 participants were employees of a city office, 3 were affiliated with a local business, and 3 were residents not affiliated with a business, non-profit or city office. Taken across both cities, 29% of workshop attendees were employees of city offices, 29% were residents affiliated with local non-profit organizations or neighborhood associations, 21% were residents affiliated with a local business or business association, and 21% were residents from a variety of professions/affiliations. 37% were female and 63% were male. Additional demographic information was available for a subset of workshop attendees: median age was 42 and ranged from 27-68. 87% were homeowners and 13% were renters. Median annual salary of workshop participants was \$146,500 and ranged from \$100,000 to \$275,000.

Table C.1: Summary of local affiliations for interview and workshop participants

Participant affiliation	City of Santa Monica Interviews	City of Santa Monica Workshop	City of Long Beach Interviews	City of Long Beach Workshop
City office employees	6 (21%)	4 (25%)	9 (56%)	4 (33%)
Non-profit organization / neighborhood association	10 (36%)	6 (38%)	4 (25%)	2 (17%)
Local business	8 (29%)	3 (19%)	1 (6%)	3 (25%)
Residents not affiliated with a business, non-profit or city office	4 (14%)	3 (19%)	2 (13%)	3 (25%)
Total	28 (100%)	16 (100%)	16 (100%)	12 (100%)

Table C.2: Summary of topics addressed in interviews and workshops

Topic	Interviews	Workshops
Meaning	What comes to mind when I say "decommission natural gas"?	Small group facilitated discussions on What does 'decommission natural gas' mean to you?
Issues	To your knowledge, is there anything your community is doing regarding decommissioning natural gas? In a statewide plan to decommission natural gas, what do you think should come first?	Small group facilitated discussions on Who is affected by natural gas decommissioning?

Topic	Interviews	Workshops
Alternatives	[Not addressed in interview guide]	During small group facilitated discussions, participants were asked about alternatives to natural gas as currently used.
Equity	In your community, what concerns would you have? Who do you think this will hurt the most? Why? Are there equity concerns associated with this?	During small group facilitated discussions, participants were presented with a series of 4 equity vignettes to discuss.
Discussing a decommissioning pilot site	[Not addressed in interview guide]	All participants were presented with city- specific visual information as a reference for identifying potential pilot sites, followed by a facilitated discussion of potential sites and decision criteria.

Results

In order to protect participant anonymity, we have aggregated and anonymized the responses. To help keep data from interviews and Scoping Workshops separate, all interview data are provided as *percentages of responses*, and all workshop data are provided as *counts of responses*.

Q1: What does the phrase “natural gas infrastructure decommissioning” mean to community stakeholders?

Workshop breakout room groups were asked “*What does ‘decommission natural gas’ mean to you?*” and “*Who is affected by natural gas decommissioning?*” Table C.3 lists responses that participants offered, grouped by frequency of mention.

Table C.3: Summary of most common stakeholder conceptions of natural gas decommissioning

Response summary	Frequency in workshops	Frequency in interviews
Reduce natural gas use	Mentioned in 3 of 7 groups	7%
New appliances	Mentioned in 3 of 7 groups	33%
Discontinue use of natural gas infrastructure	Mentioned in 3 of 7 groups	48%
Transition away from natural gas	Mentioned in 2 of 7 groups	19%

Summary of groups affected by natural gas decommissioning as raised in 44 interviews with stakeholders in Santa Monica and Long Beach

In response to the question “Who is affected by natural gas decommissioning?”, 4 workshop breakout room groups mentioned residents, 3 mentioned businesses, and 3 mentioned natural

gas industry workers and utility workers. In interviews, 64% of interviewees mentioned residents, 45% mentioned businesses, 25% mentioned natural gas industry workers and utility workers as groups who might be harmed by energy transitions. The types of groups mentioned and the frequency of mention is reported below.

- Low-income (mentioned by 45% of stakeholders)
- Disadvantaged areas (mentioned by 32% of stakeholders)
- Small business owners, including restaurants (mentioned by 25% of stakeholders)
- Single family homeowners (mentioned by 25% of stakeholders)
- Gas company (mentioned by 18% of stakeholders)
- Renters (mentioned by 16% of stakeholders)
- Industry (mentioned by 16% of stakeholders)
- Small landlords (mentioned by 14% of stakeholders)
- Cities (mentioned by 11% of stakeholders)
- Natural gas company workers (mentioned by 7% of stakeholders)

Q2: What are issues that community stakeholders think will be important when considering whether to decommission natural gas?

Table C.4 lists issues that participants brought up in workshop breakout rooms, grouped by frequency of mention.

Table C.4: Summary of issues commonly mentioned by stakeholders

Issue	Frequency in workshops	Frequency in interviews
<ul style="list-style-type: none"> • Impact on low-income and fixed-income households. 	Mentioned in 7 of 7 groups.	<ul style="list-style-type: none"> • 64% mentioned impact on low-income households.
<ul style="list-style-type: none"> • Public perception, communication, education, and outreach. 	Mentioned in 4 of 7 groups.	<ul style="list-style-type: none"> • 45% mentioned perceptions and need for robust education and outreach.
<ul style="list-style-type: none"> • Cost of conversion to alternatives to natural gas, ongoing cost of alternative energy provision. • Challenges of retrofitting existing buildings and energy infrastructure. 	Each concept mentioned in 4 of 7 groups.	<ul style="list-style-type: none"> • 26% mentioned costs and challenges of retrofits.
<ul style="list-style-type: none"> • Readiness of alternatives. • What will the roll-out be? Phased? Exemptions? Over what period? • Are alternatives cleaner than natural gas, all-in? 	Each concept mentioned in 3 of 7 groups.	<ul style="list-style-type: none"> • 26% mentioned readiness of alternatives • 19% mentioned questions about roll-out • 12% questioned environmental impact (are alternatives cleaner?)

Issue	Frequency in workshops	Frequency in interviews
<ul style="list-style-type: none"> • Resilience of alternatives. • Rebates and incentives need to motivate both tenants and landlords. • Impact on independent restaurants and other small profit margin businesses that rely on natural gas for their good and services. • Market acceptance of alternatives given widely held preferences for cooking with gas. 	<p>Each concept mentioned in 2 of 7 groups.</p>	<ul style="list-style-type: none"> • 21% mentioned resilience of alternatives • 12% rebates and tenants versus landlords • 17% mentioned restaurants and other businesses • 7% mentioned acceptability of alternatives

Questions included in the interview guide addressed what a process of decommissioning might entail, whom might be affected, and whether some people might be disproportionately negatively impacted. Beyond the points articulated in Table C.4, the following summary presents the most frequently mentioned issues as raised during interviews. Note, the researchers did not specifically ask about any of these topics; rather, these were volunteered by the participants.

Summary of local concerns for natural gas decommissioning as raised in 44 interviews with stakeholders in Santa Monica and Long Beach

- **Burden**
 - Low-income households (mentioned by 64% of stakeholders)
 - Disproportional burden among low income and pollution-exposed households (mentioned by 31% of stakeholders)
- **Cost**
 - Scale of retrofits for older building stock is extensive (mentioned by 62% of stakeholders)
 - Cost of conversion, ongoing cost of alternative energy provision (mentioned by 57% of stakeholders)
 - Conversion costs for single family homeowners and small business owners, including independent landlords, are very expensive (mentioned by 45% of stakeholders)
- **Decommissioning is far reaching**
 - Need to address public perception through communication, education and outreach (mentioned by 45% of stakeholders)
 - Long process, requires a phased approach (mentioned by 40% of stakeholders)
- **Demand for alternatives**
 - Incentives needs to be accessible to those who will benefit most (mentioned by 36% of stakeholders)

- **Consequences**

- Retrofits would be disruptive (mentioned by 33% of stakeholders)
- What would happen to existing natural gas infrastructure? (mentioned by 31% of stakeholders)

Additional local concerns for natural gas decommissioning as raised in 44 interviews with stakeholders in Santa Monica and Long Beach

In addition to the most frequently mentioned issued, the following is a list of issues and concepts that were mentioned less often.

- Readiness of alternatives, e.g., in commercial applications, alternatives to natural gas that can meet peak demand (mentioned by 26% of stakeholders.)
- Natural gas is perceived as a residential amenity (mentioned by 26% of stakeholders)
- Burden is disproportionately among communities of color (mentioned by 26% of stakeholders)
- Impact on jobs (mentioned by 29% of stakeholders)
- Would decommissioning push people or businesses out? (mentioned by 26% of stakeholders)
- Challenges of retrofitting existing grid infrastructure for increased electricity demand (mentioned by 26% of stakeholders)
- Impact on city resources (mentioned by 24% of stakeholders)

Positive aspects of natural gas decommissioning as raised in 44 interviews with stakeholders in Santa Monica and Long Beach

Interviews did not ask about potential benefits of decommissioning natural gas, however, the following positively regarded topics were volunteered by interview participants:

- Greenhouse gas emissions reductions (mentioned by 43% of stakeholders)
- Air quality and health improvements from reductions in methane and combustion products (mentioned by 25% of stakeholders)
- Safety, e.g., less risk of fugitive methane (mentioned by 14% of stakeholders)
- Cost savings (mentioned by 9% of stakeholders)
- New jobs creations (mentioned by 9% of stakeholders)

Differences and similarities among participating cities

Interviewees in Santa Monica and Long Beach expressed similar standpoints though there were a few notable areas where responses differed. The greatest divergence was that 50% of Long Beach interviewees mentioned that decommissioning impacts city resources, whereas only 12% of Santa Monica interviewees made similar observations. This divergence is most likely due to differing circumstances and perceptions in a) Long Beach, a city with its own natural gas utility for which the revenue funds a portion of the city budget, and b) Santa

Monica, city served by a regional utility. Interviewees in Santa Monica talked more about the need for incentives to be accessible to those who will benefit the most (mentioned by 40% in Santa Monica; 20% in Long beach). Among Long Beach interviewees, 57% described decommissioning as long process (include describing the need for a phased approach), versus 36% interviewees in Santa Monica.

Q3. What alternatives to natural gas are known to the community stakeholders?

Workshop breakout room groups were asked *"If natural gas infrastructure is decommissioned, what alternatives could there be?"* All groups (7 of 7) mentioned electrification, and in all but one group, this was the first alternative to be mentioned. Four groups mentioned synthetic or renewable natural gas, 2 groups mentioned demand side management and 1 group mentioned hydrogen. Among the groups that mentioned electrification, 4 groups also aspects of discussed solar generation and battery storage, 3 groups mentioned induction cook tops, and 1 group mentioned heat pumps.

While interviews did not directly address alternatives, 81% of interviewees mentioned electrification, 7% mentioned synthetic or renewable natural gas, 10% mentioned demand side management and 7% mentioned demand hydrogen. Among interviewees who mentioned electrification, 18% brought up solar generation and battery storage, 15% brought up induction cook tops, and 27% brought up heat pumps.

Q4. Are known energy equity issues on community stakeholders’ minds, and what do they think about them?

Workshop breakout room groups were presented with a series of 4 equity vignettes. These vignettes were short written descriptions of scenarios in which income and wealth inequalities among residents predisposed the least affluent people to experience disproportioned burdens associated with energy transitions. Each group started with a different vignette to allow for at least one group to consider a vignette without being pressed for time. If a group finished discussing a vignette, they moved onto another. Most groups discussed 2-3 vignettes. Table C.5 summarizes the equity vignettes and illustrative comments from stakeholders. Comments have been lightly edited for length and clarity.

Table C.5: Illustrative sample of stakeholder responses to equity vignettes

Vignette summary	Stakeholder responses
Vignette 1 addressed energy equity for natural gas consumers, describing a scenario in which the needs of very low-income customers were not met by a program to transition customers from natural gas to all electric	<ul style="list-style-type: none"> • People don’t get the message until it's too late in many of these situations. It would be better if there was more effort to bring in the low- income populations at the outset. • May need to take subjective factors such as willingness into consideration. • The cost of not switching needs to be clearly articulated.

Vignette summary	Stakeholder responses
Vignette 2 addressed equity in energy efficiency program participation, describing a divergence in interest between renters and landlords in a weatherization program.	<ul style="list-style-type: none"> • Often rebates don't cover all the costs to the landlord, such as labor and repainting. • Residents might need to be out of their homes for 2-3 days to have upgrades done. • A lot of landlord-owners are retired or semi-retired and they may find it personally overwhelming to figure out the logistics of how to do major construction on their building. So even if it's financially attractive, it's just not of interest to them.
Vignette 3 addressed equity in natural gas infrastructure, describing a scenario of a mobile home park managing upgrades to ageing natural gas pipe infrastructure following resident advocacy.	<ul style="list-style-type: none"> • In an emergency situation, they might replace gas for gas because it's fastest. • Without resident advocacy this would not have happened, that burdens the residents. • This is a very common situation where we continue an expensive status quo versus stepping back and considering other alternatives.
Vignette 4 addressed equity in economic opportunities, describing barriers to participation in a job training program.	<ul style="list-style-type: none"> • These are well known issues that could be avoided • Concern for moving from union to non-union or vice versa. Either direction leads to significant frictions for labor since there's a distrust of non-union work and unions don't necessarily want new members. • These are real challenges but are not insurmountable. There are really good programs that organizations in our city have collaborated to provide that offer people training and pathways into different careers.

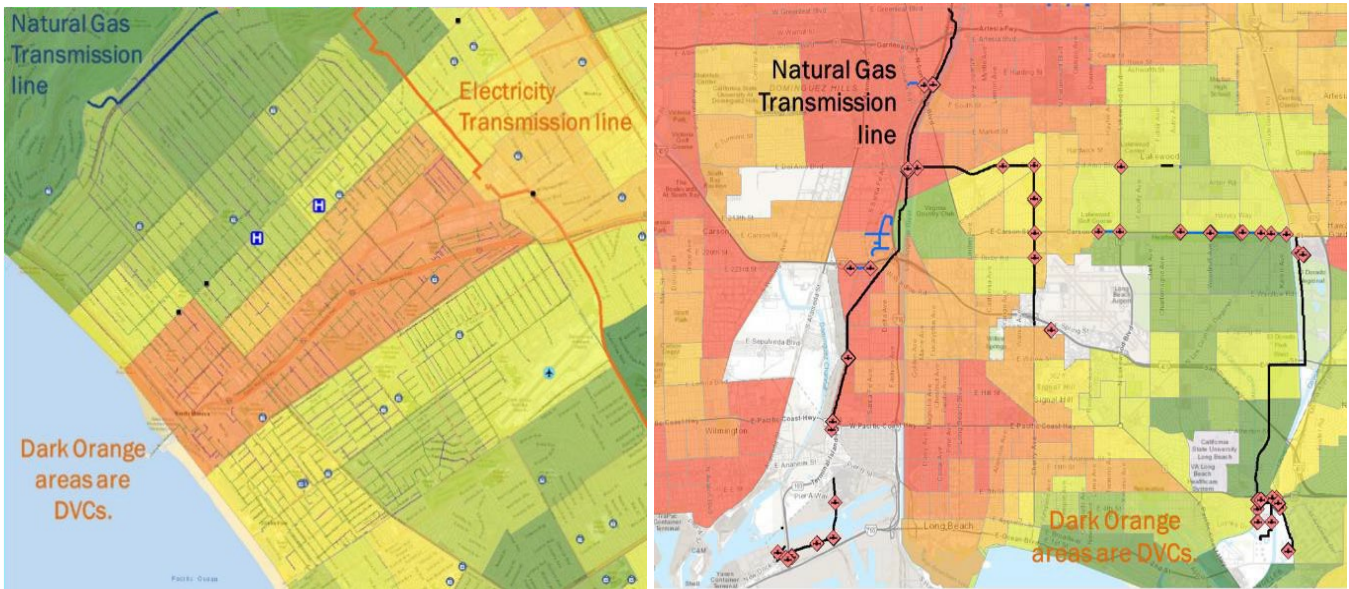
Breakout room facilitators noted that most groups did not shy away from discussing these topics and many affirmed that these are real and common issues faced in their cities. There was one breakout group that shied away from these topics; after some prompting, even this group was willing to talk about these issues. Participants brought up other government programs they felt mirrored these vignettes, including energy efficiency in rental units and green leases, and successes and challenges with earthquake retrofit programs. Facilitators also noted that participants expressed a desire for energy equity programs to be considered in context with other policies aimed at protecting low-income residents, such as housing and air quality. Similar to our other findings, these observations may be related to the composition of workshops' participants, reflective of both who was invited and who was able to participate.

Q5. When operating under data uncertainty, how would community stakeholders choose where to decommission?

All workshop participants were presented with city-specific visual information. The workshop host and a guest speaker used screen sharing to present a preliminary data visualization tool with the following publicly available datasets: Google Street Map; location of Hospitals, schools, airport, major retail stores; legend of Disadvantaged & Vulnerable Communities

(DVCs); natural gas transmission lines; electricity transmission lines. A snapshot of the initial image shared is in Figure C.1.

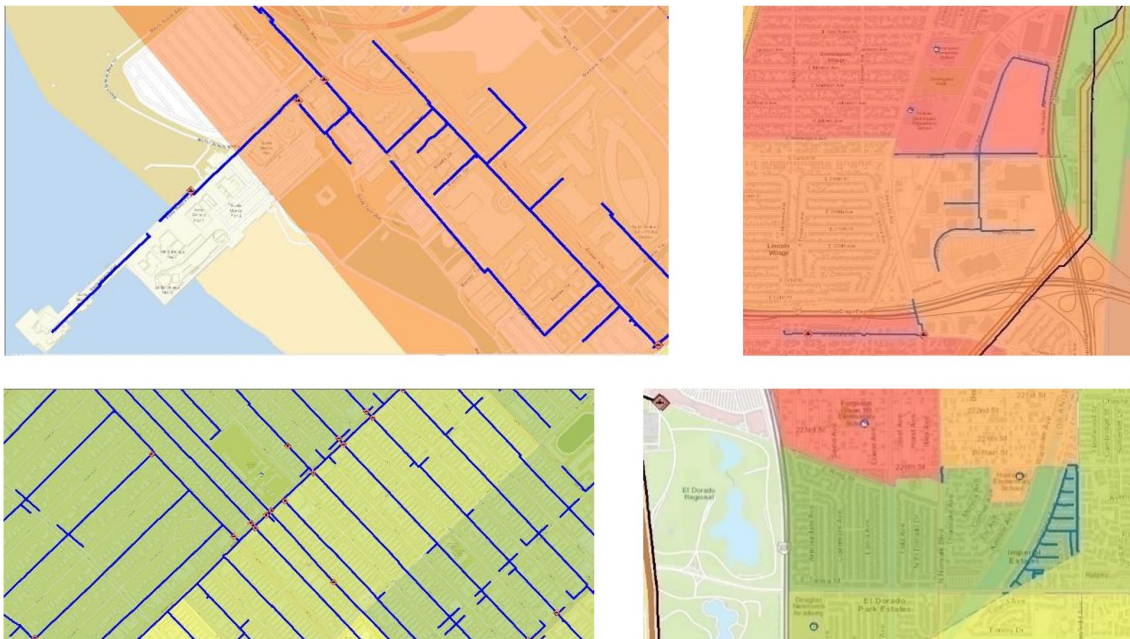
Figure C.1: Data visualization images shared with stakeholders



Left is City of Santa Monica, Right is City of Long Beach

As a follow on, a zoomed in version of each city was presented, showing the local natural gas distribution lines and the shutoff valves. Some sample zoomed in areas are shown in Figure C.2.

Figure C.2: Zoomed in images showing all of the data in the previous Figure, as well as the location of the natural gas distribution lines and shutoff valves



Left are sample images from City of Santa Monica, Right is City of Long Beach

Note that the figures are all at different geographic scales; those are removed here explicitly to protect Southern California Gas' data.

We found that the a) understanding of the data and b) types of request(s) for different data both varied between the two Scoping Workshops:

- The City of Santa Monica stakeholders wanted **customer centric data**. They tended not to be interested in the specifics of the engineering, and were picking decommissioning sites as a function of their local knowledge. For example, they would suggest to decommission a hospital, or a local high school, or an affordable housing area, or an area of town and had no real interest in the natural gas infrastructure layout or age of pipes. They also indicated that it might be good to decommission the largest customers first.
- Conversely, the City of Long Beach stakeholders wanted **engineering data**. They were not willing to make a decision when they were unable to see the distribution level data from the city's municipal utility (and were only able to see the Southern California Gas dataset). They indicated they required much more detailed engineering data, including age of pipes and existing maintenance schedules. At the time of the workshop, the Long Beach municipal utility had not entered a data sharing agreement and data visualizations only included the small footprint of Southern California Gas' natural gas provision in the city.

We believe there are two possible reasons for this difference. One is simply that the workshop participant groups were different, and these findings reflect the differences in the sample. A second possibility is that there was less information available for the City of Long Beach workshop (the municipal utility had not provided distribution level data); it may be that the City of Long Beach participants would, upon seeing the distribution level data, veer more toward the opinions of the City of Santa Monica participants (who were not using these data to make their decisions).

Interview Questions

1. What comes to mind when I say "decommission natural gas"?
2. Describe how you use natural gas in your residence/ workplace or residence/workplace of people you represent.
3. To your knowledge, is there anything your community is doing regarding decommissioning natural gas?
4. Let us assume that the state of California decides to move forward with a rule to decommission all natural gas in the state.
 - a. What do you think should come first?
 - b. In your community, what concerns would you have?
 - c. Who do you think this will hurt the most? Why?
 - i. Are there equity concerns associated with this?
5. Demographics: gender, age, occupation, annual salary, rent or own primary residence
6. Are there other individuals or organizations you recommend we speak to?
7. Any other questions for us?



California
ENERGY COMMISSION



ENERGY RESEARCH AND DEVELOPMENT DIVISION

APPENDIX D: Hydraulic Modelling

May 2026 | CEC-500-2026-010

Appendix D:

Hydraulic Modelling

The objective of this task is to evaluate the operational consequences of altering the gas flow and the feasibility of decommissioning select portions of a local distribution network. GTI Energy partnered with SoCalGas to utilize gas hydraulic modeling to evaluate the operational consequences of altering gas flow in select pipelines of the local gas distribution network. The gas hydraulic modeling task was conducted in three phases: The first phase involved analyzing the local gas distribution system and abandonment procedures of the local distribution company (LDC) to identify the potential decommissioning sites. The second phase involved assuming a baseline of natural gas usage similar to today,¹ and performing detailed hydraulic modeling of the selected sites using DNV's Synergi v4.9 gas hydraulic modeling tool to evaluate the operational consequences of altering gas flow at the selected sites. In the third phase, the results from the gas hydraulic modeling were integrated with other useful information such as pipeline data, customer gas usage data, public datasets (critical infrastructure such as hospitals), CalEnviroScreen 4.0, etc. to determine the feasibility of decommissioning the selected sites.

Phase 1

GTI Energy and SoCalGas Distribution Systems Engineering Support and Distribution Engineering team reviewed the existing SoCalGas natural gas distribution network in the Santa Monica region including the high-pressure transmission pipelines, regulator stations, and medium to low-pressure distribution pipelines to analyze the system's operational conditions, pressure constraints, and system behavior. The project team also reviewed SoCalGas's company operations standard for abandonment or inactivation of gas distribution pipelines procedure to help in the scenario selection process.

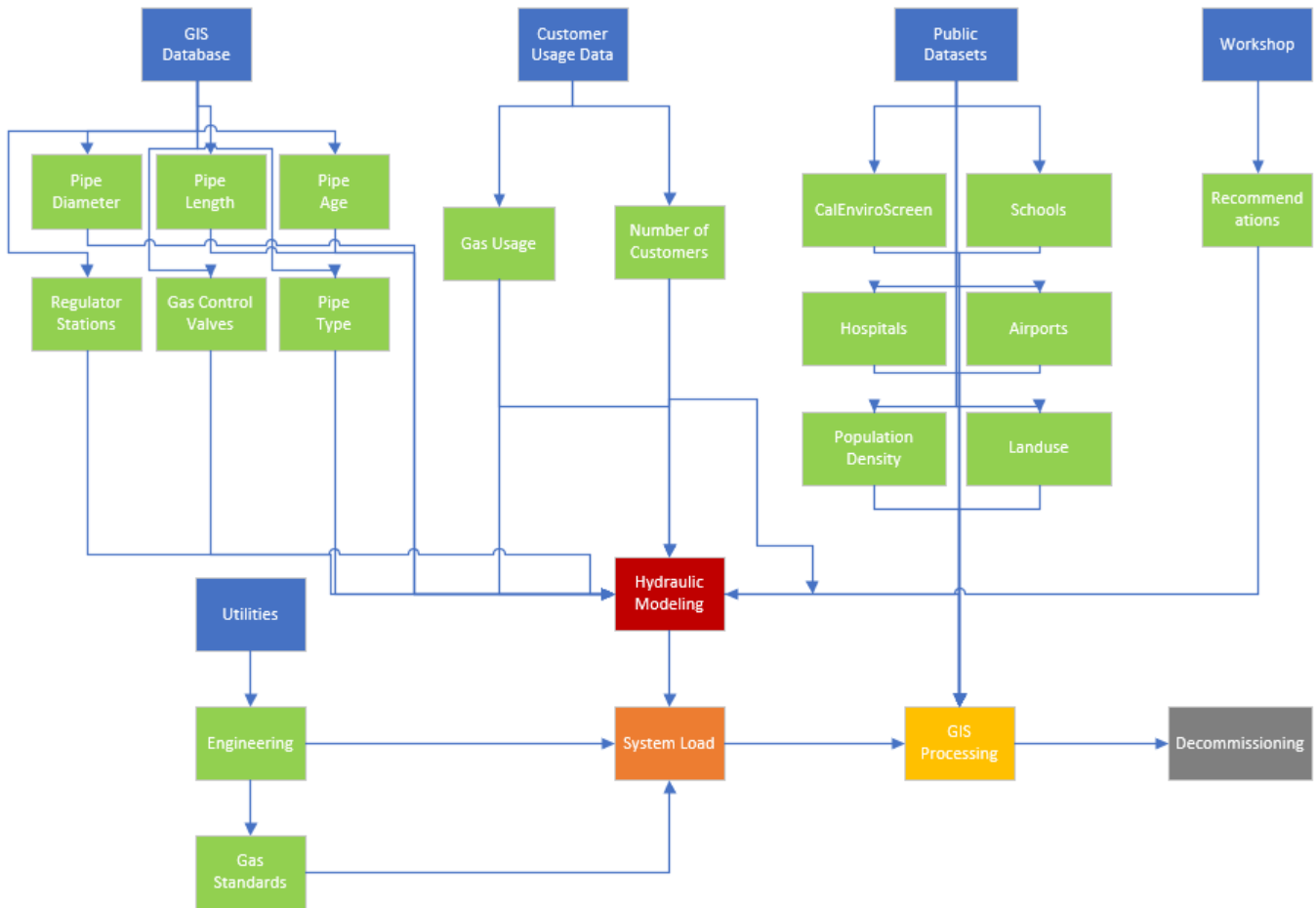
The project team reviewed data from disparate data sources with various stakeholders, including utilities, local businesses, residents, and community groups, to discuss and solicit feedback on identifying suitable sites for decommissioning. Based on the discussions and feedback, the project team identified five relevant areas for decommissioning. These scenarios include decommissioning an entire disadvantaged and vulnerable community ("DVC" as defined by The Office of Environmental Health Hazard Assessment), a couple of city blocks, a single main line, critical Infrastructures such as hospitals, and historical sites such as Santa Monica Pier. Due to the disparate databases and large volume of Synergi files and processing times, the project team decided to perform hydraulic modeling of the below-mentioned selected sites rather than the entire Santa Monica distribution system. **These are neither proposed nor "final" selection sites**, merely sites that cover a range of natural gas infrastructure types, such as customers (e.g., critical infrastructure and residential buildings), service areas (community and street), service location (upstream and downstream impacts)

¹ Note: Natural gas usage may be dropping over time with energy efficiency, rebate programs, etc. More research would be needed to determine under significantly different natural gas usage scenarios, whether upstream/downstream effects may or may not be negatively impactful leading to the potential for the distribution system integrity to not be maintained.

and DVCs (CalEnviroScreen 4.0 Percentile Score 80-100%), etc. The project team used the same sites for the gas hydraulic modeling:

1. Disadvantaged community between Wilshire Blvd, Colorado Ave & Pico Blvd, Palisades Beach Road, & Centinela Ave in Santa Monica
2. Mid Santa Monica between Colorado Ave, S Centinela Ave, Santa Monica Blvd, & the alley S/O 20th St
3. Critical Infrastructure within the vicinity of S Bundy Dr, Colorado Ave, Stanford St, Nebraska Ave, Exposition Blvd & Virginia Ave, Santa Monica
4. 8" Main located along Wilshire Blvd between Stanford and Centinela Ave
5. Santa Monica Pier along Moss Ave, Ocean front walk and Pier Colorado Ave

Figure D.1: Flowchart for Decommissioning, shows the data workflow

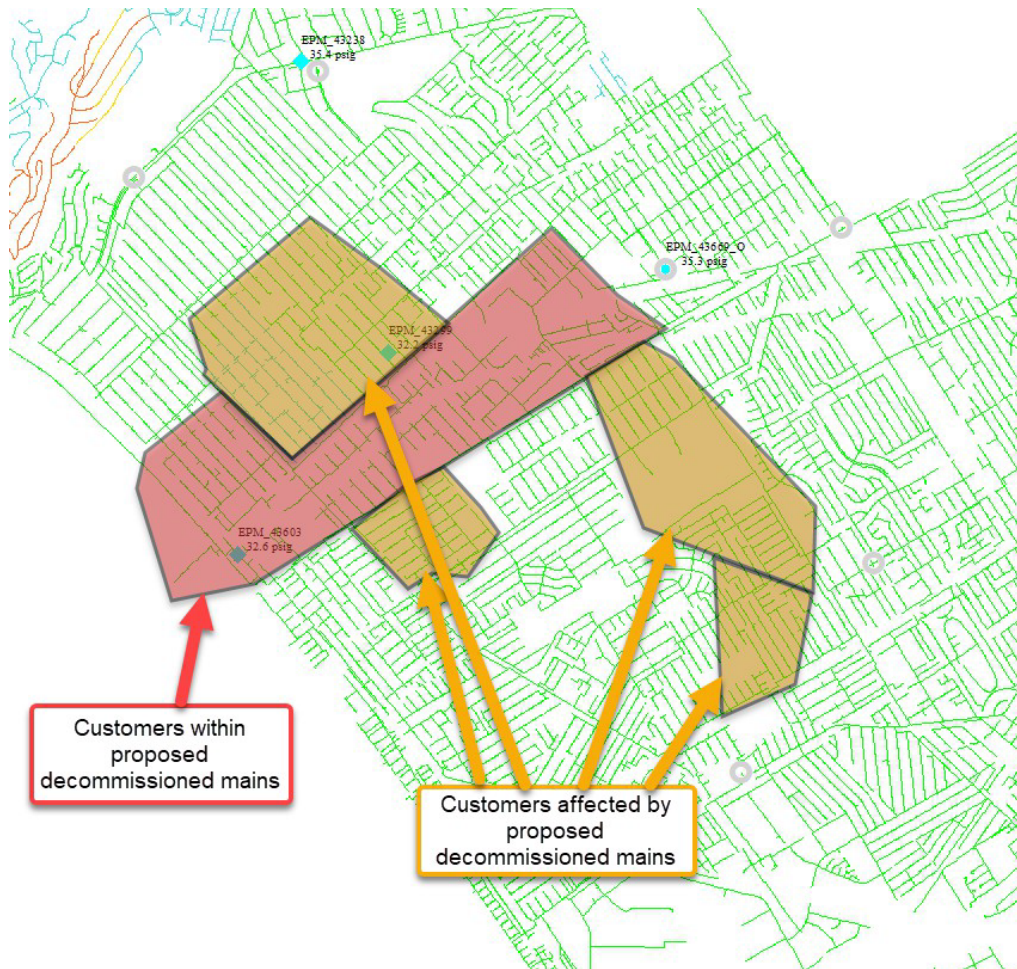


Phase 2

Performing the hydraulic modeling on above mentioned selected sites helped the project team evaluate the operational impacts of decommissioning select pipelines on the entire Santa Monica distribution system. Below is a summary of the scenarios and detailed results are available with SoCalGas.

Scenario 1: Disadvantage Community between Wilshire Blvd, Colorado Ave & Pico Blvd, Palisades Beach Rd & Centinela Ave

Figure D.2: Disadvantaged Community is highlighted in Red and Gold shows the customers affected by the proposed decommissioning



Note: The red area is the customers within the defined scenario. The gold indicates the additional customers outside the defined scenario that would be affected (there would be a reduced maximum flow rate leading to the potential for the distribution system integrity to not be maintained) if the pipe in the scenario were to be decommissioned.

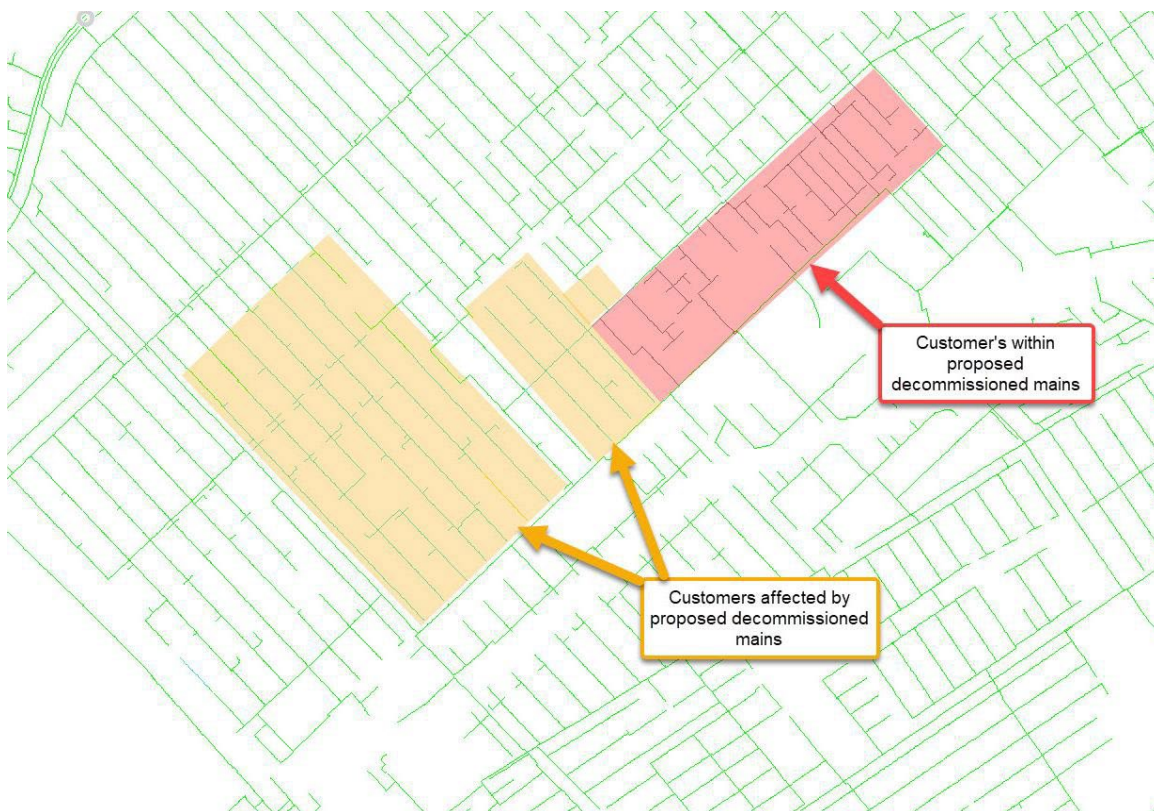
For the first scenario, the project team ran a portion of the disadvantaged and vulnerable community (DVC) as identified by CalEnviroScreen 4.0. CalEnviroScreen is a screening methodology that can be used to identify California communities that are disproportionately burdened by multiple sources of pollution. The DVC of interest, highlighted in "red" in figure 2 is located between Wilshire Blvd, Colorado Ave & Pico Blvd, Palisades Beach Rd & Centinela Ave and has a CalEnviroScreen Score Percentile range of 80-100%.

The impact zones of the decommissioning are highlighted as the "gold" zones in Figure 2. The total number of decommissioned customer meters in the red zone are 5,670 and the total customer dwelling units are 11,906 for a total winter gas usage of 189 million standard cubic feet per hour (mscfh). Additional customer meters affected by the decommissioned zone are 13,383 involving 20,151 customer dwelling units with winter gas consumption of 205 mscfh.

Critical customers (require continued service during an outage) are 171 meters and 259 customer dwellings. The hydraulic modeling highlights how decommissioning impacts are not limited to the area of interest but in fact, can impact upstream and downstream of the selected site due to gas supply dependency. The project team identified a significant impact on the surrounding distribution system and to continue service and maintain distribution system integrity to the customers in the gold zone affected by the proposed decommissioning, the utility company will have to initiate pressure betterment projects. These projects could be enhancements like new or rebuilt regulator stations, creating/splitting/merging pressure systems, and uprate or derate of maximum allowable operating pressure (MAOP) and/or set pressure of the pipeline systems.

Scenario 2: Mid Santa Monica between Colorado Ave, S Centinela Ave, Santa Monica Blvd, & the alley S/O 20th St

Figure D.3: Proposed decommissioning Community highlighted in Red and Gold shows the customers affected by the proposed decommissioning



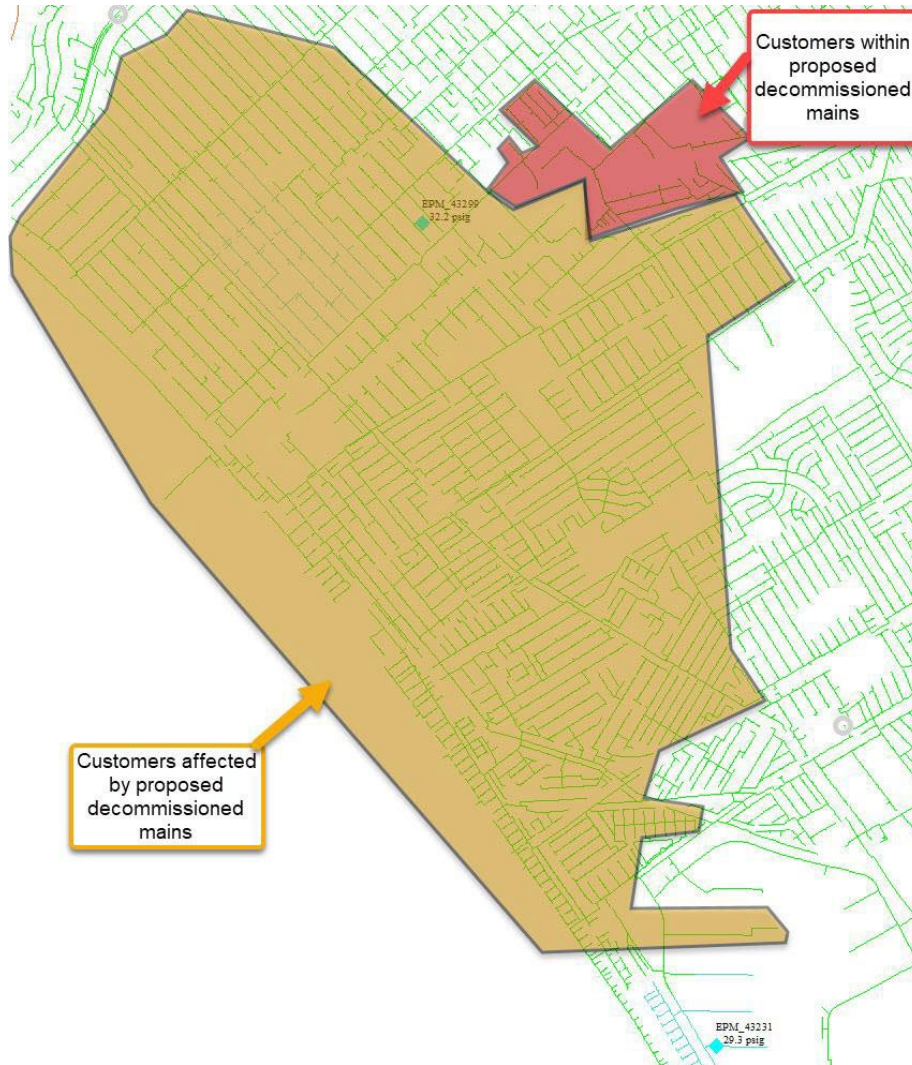
Note: The red area is the customers within the defined scenario. The gold indicates the additional customers outside the defined scenario that would be affected (there would be a reduced maximum flow rate leading to the potential for the distribution system integrity to not be maintained) if the pipe in the scenario were to be decommissioned.

For the second scenario, the project team considered decommissioning a couple of city blocks to analyze the impacts (see Figure 3). The analysis showed that total number of customer meters decommissioned were 1,474, total customer dwelling units were 2,454 and the winter gas usage in the red zone is about 26 mscfh. Due to the decommissioning additional customer

meters affected are 6,488, total customer dwelling units are 11,463 and the total winter gas usage is 85 mscfh. Critical customers impacted due to the proposed decommissioning are 22 meters. Compared to Scenario 1, Scenario 2 did not have a significant impact on the distribution system and did not trigger any pressure betterment projects.

Scenario 3: Critical Infrastructure within the vicinity of S Bundy Dr, Colorado Ave, Stanford St, Nebraska Ave, Exposition Blvd & Virginia Ave

Figure D.4: Proposed critical infrastructure decommissioning site highlighted in Red and Gold shows the customers affected by the proposed decommissioning



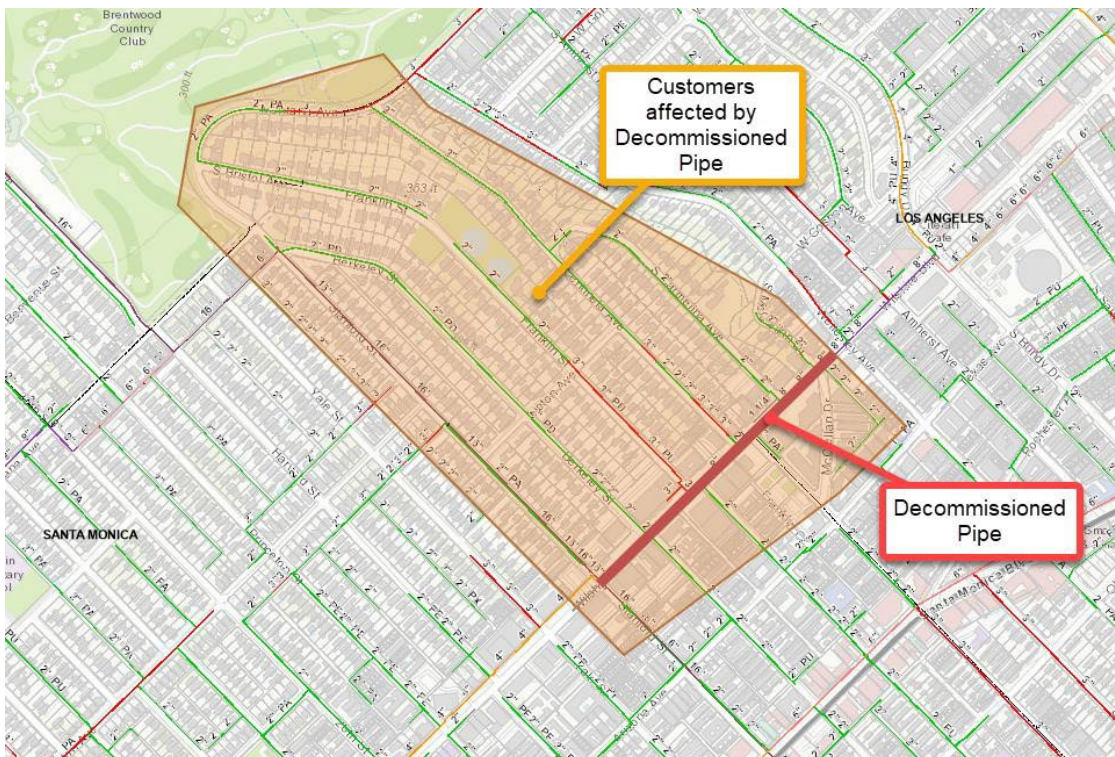
Note: The red area is the customers within the defined scenario. The gold indicates the additional customers outside the defined scenario that would be affected (there would be a reduced maximum flow rate leading to the potential for the distribution system integrity to not be maintained) if the pipe in the scenario were to be decommissioned.

Scenario 3 represents the decommissioning of critical infrastructure such as hospitals (see Figure 4). The number of decommissioned customer meters in this scenario totaled 1,176, customer dwelling units totaled 1,647 with a total winter gas usage of 43 mscfh. 43,291 additional customer meters were impacted due to the decommissioning and total customer

dwelling units were 74,410 units with a winter usage of 778 mscfh. The number of critical customers impacted in this decommissioning includes 400 meters and 721 customer dwellings. The modeling team identified that scenario 3 has a significant impact on the surrounding distribution system and triggers pressure betterment projects. These projects could be enhancements like new or rebuilt regulator stations, creating/splitting/merging pressure systems, and uprate or derate of MAOP and/or set pressure of the pipeline systems.

Scenario 4: 8" Main located along Wilshire Blvd between Stanford and Centinela Ave

Figure D.5: Proposed Mainline decommissioning pipe highlighted in Red and Gold shows the customers affected by the proposed decommissioning



Note: The red area is the customers within the defined scenario. The gold indicates the additional customers outside the defined scenario that would be affected (there would be a reduced maximum flow rate leading to the potential for the distribution system integrity to not be maintained) if the pipe in the scenario were to be decommissioned.

In this scenario, the proposed decommissioning site is a 8" mainline serving the communities along Wilshire Blvd near Los Angeles (see Figure 5). The earlier scenarios considered multiple pipelines compared to single mainline in this scenario. The results show the number of decommissioned customer meters as 21 with winter gas usage of 6 mscfh. 792 additional customer meters were affected by the decommissioned pipe with a winter usage of 14 mscfh. 5 critical customer meters were also affected due to the decommissioning. The modeling team noted a significant impact on the surrounding distribution system indicating a need for pressure betterment projects to continue service and maintain system integrity for the customers impacted by decommissioning.

Scenario 5: Santa Monica Pier along Moss Ave, Ocean front walk and Pier Colorado Ave

Figure D.6: Proposed decommissioning pipe highlighted in Red



Note: The red area is the customers within the defined scenario. The gold indicates the additional customers outside the defined scenario that would be affected (there would be a reduced maximum flow rate leading to the potential for the distribution system integrity to not be maintained) if the pipe in the scenario were to be decommissioned.

Scenario 5 considered that the line serving the Santa Monica Pier was decommissioned (see Figure 6). The total number of customer meters decommissioned were 14, total customer dwelling units were 14 with a winter gas usage of 2.2 mscfh. 8 critical customer meters were decommissioned. The analysis results showed that there was no significant impact on the surrounding distribution system and it didn't trigger any pressure betterment projects.

The scenarios that triggered pressure betterment projects recommend pipe installations as a way to maintain the supply and system integrity. On further analysis such as economic cost/benefit analysis the operations team can recommend other types of enhancements like a new or rebuilt regulator station, or creating/splitting/merging pressure systems, or uprating or derating of MAOP and/or set pressure for the pipeline systems. Anytime a decommissioning project is proposed a new analysis would be required as medium-pressure pipeline systems are constantly changing as the communities they serve.

Phase 3

The results from the hydraulic modeling are then integrated spatially with other data layers to evaluate the consequence of the proposed decommissioning sites and make an informed decision on identifying the final decommissioning sites. Due to the complex spatial data layers and disparate data sources, the project team posted the results in a spatial format in a GIS database instead of the tabular format.

Data Layers are shown in Table D.1, summary characteristics of the scenarios in Table D.2, and the resulting map in Figure D.7.

Table D.1: Data Sources and Attributes

Data Source	Attribute	Type
Pipeline Data	Length Date of Operation Material Nominal size Plastic Type Pressure Type Valve Type	Steel Plastic PA PU PE High Pressure Medium Pressure Plug Ball Gate
Gas Consumption Data	Hourly Monthly Annual Customer Type	Residential Commercial Industrial
Public Dataset	CDE California Public Schools CalTrans Public Use Airports Retail Superstores Hospitals USA Population Density 2019 Annual Landuse Dataset CalEnvironScreen 4.0	CES_P Score
Hydraulic Modeling	Pressure Contours (mscfh)	<15.2 15.2 - 20.0 20.0 - 25.0 25.0 - 30.0 30.0 - 38.0 38.0 - 43.0 43.0 >

Table D.2: Decommissioning Impact and Pressure Betterment Status

Scenario	Significant Impact to surrounding Distribution System? (Yes/No)	Pipe Installation required? (Yes/No)	Approximate Total length pipe required to be installed (in ft)
Scenario 1	Yes	Yes	570
Scenario 2	No	No	N/A
Scenario 3	Yes	Yes	9,632
Scenario 4	Yes	Yes	1,303
Scenario 5	No	No	N/A

Figure Note: The “Approximate Total length pipe required to be installed (in ft)” is if no alternative strategies were pursued for the upstream/downstream impacted areas, then this the length of pipe that would need to be installed to maintain NG service.

Figure D.7: Scenario 1 GIS Map with Hydraulic Modeling results overlaid with decommissioning site boundary

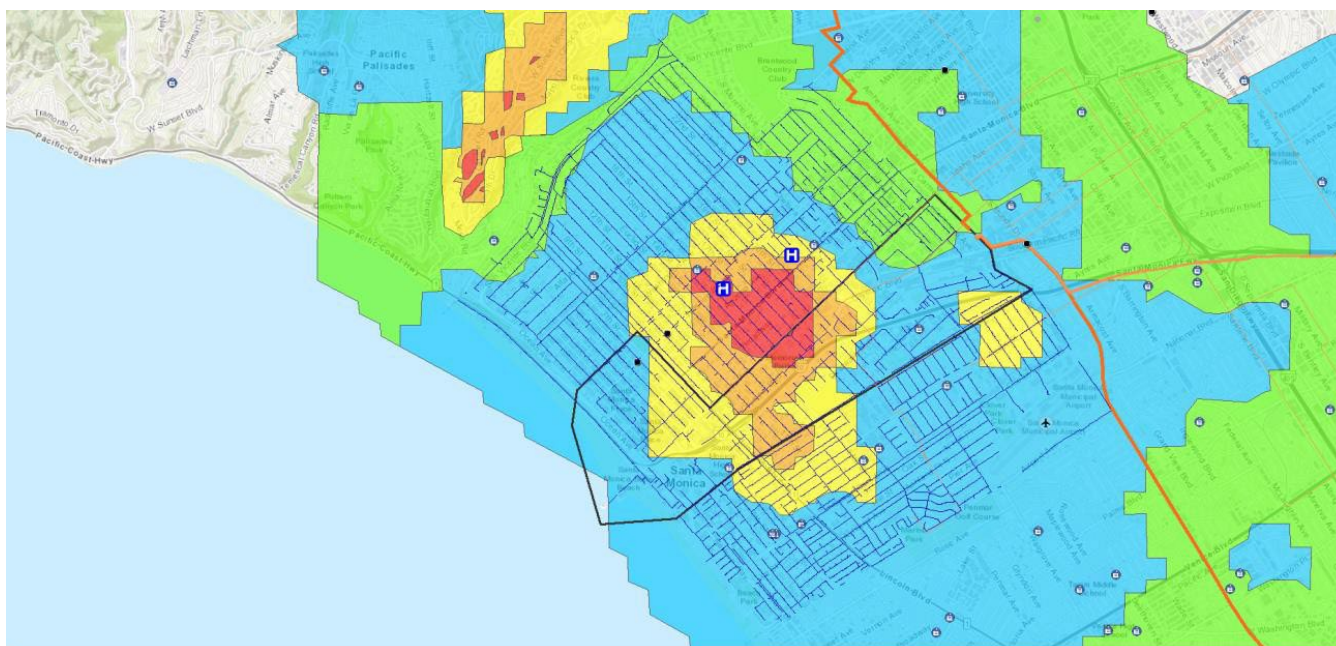


Figure Note: The decommissioning sites are displayed as black polylines and the impact of decommissioning are displayed as different polygons. The red contour indicates a pressure betterment project requirement to continue service and maintain the system integrity to the customers outside of the decommissioning site.

Legend:

Red: Pressure Contour < 15.2 mscfh Orange: Pressure Contour 15.2 – 20.0

Yellow: Pressure Contour 20 – 25

Blue: Pressure Contour 25 – 30.0

Green: Pressure Contour 30 – 38.0

Summary of Findings

We find that decommissioning the high-pressure pipelines is not feasible as that would shut the gas supply to the entire Santa Monica distribution system. Altering the “mains” would have similar operational consequences albeit in a specific area depending on the selected mains.

However, service lines seemed more viable for decommissioning as the operational consequence would be limited and curtailed to only those customers who depended on the service line. Therefore, terminal end service lines and service lines with one or two customers could easily be selected for decommissioning with minimum impact on the operations. However, decommissioning a service line with one or a handful of customers probably will not make a huge impact on the operations or reduce greenhouse gas emissions or assist in achieving the net-zero goals.

These findings can be used to help identify the type of pilot projects that will have a minimal impact on pressures; the future upgrade costs could help decide where decommissioning costs could be offset by future savings from not having to upgrade. From our sample scenarios, it seems like a single pipeline decommissioning is typically a non-issue. Especially customers on terminal end lines or customers on cul-de-sac or lines feeding single residential customers or couple customers on the street can easily be decommissioned. While the scenarios did not include the Long Beach data, we believe a robust finding is that anything like a Main or Service line with Single-feed or Terminal End lines could be decommissioned without significant impact to the distribution system.

Conversely, critical infrastructure or commercial and industrial customers or Mains versus services line have to be studied on a case-by-case basis as the consequences are not limited to the pipes we decommission but it can impact the upstream and downstream network of the selected site, making it hard to generalize. Thus, general guidance to use these findings is:

- Look for single pipeline decommissioning, especially on terminal ends
- Since hydraulic modeling is computationally very expensive, it will need to be rerun for the scenarios selected by the decision-makers.



California
ENERGY COMMISSION



ENERGY RESEARCH AND DEVELOPMENT DIVISION

APPENDIX E: Alternatives to Natural Gas

May 2026 | CEC-500-2026-010

Appendix E:

Alternatives to Natural Gas

This Appendix describes alternatives to natural gas use in pilot sites in Santa Monica and Long Beach. These alternatives were discussed with stakeholders in January 2022, were mentioned by the TAC, or were identified by our team as being potentially viable low-carbon replacements for natural gas at the meter-level.

The purpose of this analysis is to explore the viability and relative attractiveness of each strategy within the next 1-3 years and at the scale of the meter-level. Section 4.1 presents definitions of the strategies. Section 4.2 provides context for this meter-level analysis in the context of larger community-level concerns and factors, including the need to consider energy efficiency at community-level planning. Section 4.3 presents the social and economic criterion that were identified to aid in the analysis. Section 4.4 presents the assumptions and methodology applied to the comparison. The final result (Section 4.5) is a stoplight chart highlighting the performance of each strategy in relation to a baseline strategy of electrification.

The final stoplight chart (Table 4) is intended as an aid to stakeholders' decision making process. Our team designed the chart to help facilitate conversation, understanding, and assessment of alternative strategies as they are weighed in comparison to electrification. This presents positive features as well as barriers to implementation in a format that stakeholders can use to evaluate alternative strategies.

Definitions

Electrification is the replacement of fossil fuel burning end-use equipment with electric appliances. Electrification is considered as a potential replacement for cooking, clothes drying, HVAC, and water heating.

Hydrogen is an energy carrier that can be used to store, move, and deliver energy produced from other sources. At the scale of the meter-level, hydrogen is considered to be produced onsite or shipped and stored in tanks.¹ This technology is a potential replacement for cooking, clothes drying, HVAC, and water heating.

Hydrogen is typically described by the production process, as follows:²

- **Grey Hydrogen.** Hydrogen made from fossil fuels including natural gas, methane, and coal with no GHG emissions control. Currently, around 98 percent of hydrogen production is grey.³

¹ We don't consider infrastructure-level transition of natural gas pipelines to carry Hydrogen, nor do we consider installation of Hydrogen pipelines, as this is outside of both the 1-3 year timeframe and the size of projects under consideration.

² [The Hydrogen Colour Spectrum. National Grid.](https://www.nationalgrid.com/stories/energy-explained/hydrogen-colour-spectrum) Accessed on 7/14/2022: <https://www.nationalgrid.com/stories/energy-explained/hydrogen-colour-spectrum>

³ Ochu, E., Braverman, S., Smith G., and Friedmann, J. (June 17, 2021). [Hydrogen Fact Sheet: Production of Low-Carbon Hydrogen.](https://www.energypolicy.columbia.edu/publications/hydrogen-fact-sheet-production-of-low-carbon-hydrogen/) Columbia Center on Global Energy Policy. <https://www.energypolicy.columbia.edu/publications/hydrogen-fact-sheet-production-of-low-carbon-hydrogen/>

- **Blue Hydrogen.** Hydrogen made from natural gas using steam reforming processes used to make grey hydrogen; but, CO₂ emissions are controlled using carbon capture and storage.
- **Turquoise Hydrogen.** Unproven at scale, hydrogen made in a process called methane pyrolysis, producing hydrogen and solid carbon. In the future, turquoise hydrogen may be a as a low-emission fuel, if manufactured with renewable energy and the carbon is permanently stored or used.
- **Green Hydrogen.** Made by electrolyzing water using clean electricity from renewable energy sources. No direct CO₂ is emitted in the production of green hydrogen.

Compressed renewable natural gas (CRNG) and **biopropane (bioLPG)** are biofuels, or energy sources derived from organic materials. CRNG is the gaseous product of the decomposition of organic matter that has been processed to purity standards. RNG includes biomethane from anaerobic digestion of biomass and biomethane from gasification of biomass wastes and residues.⁴ CRNG and bioLPG are substitutable in natural gas and propane appliances, respectively, or may provide a functional replacement for some natural gas uses that cannot be electrified (such as some cooking equipment). At the scale of the meter-level, CRNG or bioLPG is considered to be delivered to the site in refillable tanks. This technology is a potential replacement for cooking, HVAC and water heating in commercial and restaurant units.

Geothermal (ground source heat pump, or GSHP) is a highly energy efficient technology using buried pipes as a heat transfer. GSHPs require electricity to operate and are sized for residential and commercial applications. At the meter-level, a GSHP can be installed with pipes buried in a horizontal configuration, or a vertical configuration when space is limited. This technology is a potential replacement for HVAC and water heating.

Scope

The following strategies are out-of-scope in our assessment of meter-level pilot projects, but would be appropriate and even necessary to consider for community-level (neighborhood, city, county, and state):

- Community-based electrification
- Community-based geothermal heating
- Microgrids
- Large scale transformations to the electric grid (e.g., new substations)
- Large scale transformations of the natural gas infrastructure to be reliant on RNG or SNG.
- Impacts of electric vehicle charging sites on grid capacity

Additionally, any community-level or statewide strategy must consider energy supply and energy infrastructure capabilities and restrictions. The following section briefly explores energy efficiency and demand side management as a co-strategy that should be considered for all decommissioning efforts at a large scale.

⁴ *The Challenge of Retail Gas in California's Low-Carbon Future.* California Energy Commission.

Energy Efficiency and Demand Side Management

Energy efficiency and demand side management (EE/DSM) refers to actions designed to manage and optimize a site's energy consumption and to cut costs. EE/DSM can be used concurrently with any strategy to replace natural gas consumption. Although one only consider meter-level impacts in the comparison of alternatives, it is important to note that the cumulative effects of demand for alternatives across an entire community, city, or state may put a strain on the infrastructure providing those alternatives. Therefore, this short section describes EE/DSM techniques that can be implemented, and likely will have to be implemented in any large-scale effort to decommission natural gas use in buildings.

Effective EE/DSM techniques for residential units include wall and attic insulation, double-pane windows, envelope sealing, insulated window shades,⁵ outdoor shading (trees, shade cloth, shade structures), high albedo roofs, and modified user behavior. Implementing energy efficiency in summer (reducing cooling load), though not directly impacting natural gas usage, can effectively reduce peak electrical load that would result from whole-house electrification, thereby eliminating the need for electrical panel and infrastructure upgrades in certain cases.⁶

EE/DSM techniques for commercial units include window replacement, modification, or "re-manufacture," wall, roof, and floor insulation, envelope sealing, high albedo walls and roofs, insulated window shades, smart HVAC control systems, and modified user behavior.⁷ In addition to building envelope EE/DSM techniques, restaurants can replace existing equipment with energy efficient models, install smart thermostats and other equipment controls, and modify user behavior.⁸ Case studies have shown promising energy-use reductions in emerging technologies such as integrated hot water/air conditioning heat pump units.⁹

Criteria

The following criteria were used to evaluate and compare alternative strategies:

- **Cost to resident (building owner):** Costs to building owner include all upgrades behind-the-meter within a building. As described in Table 8, the costs considered in the deep dive on electrification are the cost of equipment and labor, permitting, and regulatory upgrades. Thus the evaluation of costs of alternatives is limited to these costs (other costs sometimes mentioned in the literature, such as lifecycle costs, are not included).
- **Cost to resident (ratepayer):** It is assumed the pilot projects will have minimal impact on customers outside the decommissioned site. For residents living onsite, their "ratepayer" costs are assumed to be electrical utility bills plus the costs of whatever

⁵ Bridgeland, B. & Keuhn, P. (2015). Energy Savings from Window Shades. Rocky Mountain Institute.

⁶ City and County of San Francisco (Budget and Legislative Analyst's Office). (2021). Decarbonizing residential buildings by eliminating natural gas usage. [Policy analysis report]

⁷ Bertoldi, D. (2014). Deep energy retrofits using the integrative design process: Are they worth the cost. [Master's Projects and Capstones, University of San Francisco].

⁸ Energy Star. (n.d.) Energy Star for small business: restaurants. Accessed July 20, 2022.

⁹ Glanville, P., Mahderekal, I., Mensinger Jr., M., Bingham, L., & Keinath, C. (2021). Demonstrating an Integrated Thermal Heat Pump System for Hot Water and Air-Conditioning at Full Service Restaurants. ASHRAE Transactions, 127(1), 363–370.

alternative energy source has replaced natural gas (could be electricity, resulting in a higher electricity bill).

- **Alternative-specific cost to NG utility:** This is any of the project costs for installation of the alternative that the natural gas utility would need to bear. This does not include the project cost of decommissioning (as that is researched in a separate memo).¹⁰
- **Impact on community-level electricity demand:** This refers to the incremental amount of electricity required to enact the strategy. This may be useful as a stepping stone to future analyses that may wish to consider the community-wide impact on electrical infrastructure that could result from widespread adoption of the strategy.
- **GHG reduction:** Refers to lifecycle greenhouse gas emissions reductions, from energy production to final use. A 50% zero-carbon electricity mix is assumed for Santa Monica and Long Beach based on the timeframe of 1-3 years.
- **Indoor air quality:** Includes usage and leakage of CO₂ and NO_x from appliances.
- **Technical risk:** Includes technical risk of actualizing appliances, technologies, or techniques within a respective strategy by 2030. As electric versions of appliances currently exist and electricity is our baseline, then this will compare whether or not versions exist in other fuel types, particularly hydrogen.
- **Pioneering value:** Refers to a level of excitement, expectation, or trailblazing associated with an alternative energy source. This criterion is weighted according to credible literature that names the strategy as effective or critical for GHG emissions mitigation and underutilized in existing GHG mitigation projects (either due to technology limitations or public perception).

Criteria that were mentioned by the TAC, but are outside the scope of this effort, are:

- Many health/safety/societal costs
- Cost to repair any currently damaged infrastructure. For example, costs to repair aging electricity infrastructure are not included
- Difference between care, standard, and low-usage customers (i.e., those who don't use gas due to prohibitively high pricing even when service is in place)
- Distribution of cost among property owners and renters
- Equity considerations of lower monthly utility costs for customers with on-site solar & battery
- How to avoid a cost-shift burden on more vulnerable populations under the scenario of more rapid electrification by high income/wealth households

¹⁰ For the purposes of this analysis, we assume the pilot projects will be selected such that electricity infrastructure hosting capacity can accommodate electrification (our baseline scenario) without significant upgrades. On a large enough scale, electrification will require electricity infrastructure upgrades and may increase the appeal of alternative strategies, but is outside the scope of our analysis.

- Marginal cost of increased reliability needed to service load increases across additional use cases from building electrification
- Any sort of rebates (regardless of motivation). These might include rebates from the government, the utilities, or private companies. For example, one possible rebate might be rebates to low-income customers. Another rebate might be either for or from DSM programs. Our research here helps inform rebates, not the other way around

Assumptions and Methodology

We examined functional replacements for natural gas use common in the building sector. Within the building sector, building types identified as pilot candidates for the cities of Santa Monica and Long Beach were scoped to: single family homes, multi-unit residential, commercial, and restaurants. Based on these building types, common functions were identified that use natural gas as an energy source. These are: cooktop, oven, dryer, HVAC, and water heater. Not all of these functions are found in every building type. However, discussion of alternative strategies to provide zero-emission energy sources needs to begin at the function level, not the building level. Once it is understood which strategies apply to which functions, building-level analysis can be pursued.

The authors examined the strategies defined for implementation on a 1-3 year horizon. These strategies, once again, are electrification, hydrogen, CRNG or bioPLG, and GSHP. Each strategy offers a replacement for one or more functions that commonly use natural gas as an energy source. Electrification was chosen as a baseline because of relatively high levels of certainty around each of the criteria identified. Each strategy is compared to the baseline strategy of electrification. Furthermore, comparisons are on a use-by-use basis. For example, GSHP strategy is only compared to electrification for the functional replacement of HVACs and water heaters; the authors did not consider if GSHP is an alternative strategy for cooktops.

The details of the appliances chosen for an electrification strategy are not elaborated in this comparison. For example, electrifying a cooktop may involve a consumer choice between electric coil and induction; similarly, electrification of HVAC could involve an electric furnace or an air source or CO2 heat pump. This approach necessarily makes comparisons of cost to building owners, who ordinarily bear the cost of appliance replacement, uncertain across the strategies. Nonetheless, an order of magnitude of cost can be estimated, and this was the approach taken.

The comparisons are at the meter-level, meaning that aggregate effects of many buildings in a community adopting the strategy are not considered here. Neither did the authors consider implementations of the strategy that require infrastructure-level change. For example, this does not consider a hydrogen strategy involving the conversion of natural gas pipelines to deliver hydrogen gas. This research only considered a strategy in which hydrogen is produced or stored onsite. Note that every strategy that can be enacted at the meter-level does contribute incrementally to the demand for electricity, and this marginal contribution was compared across the strategies.

Strategies are being compared in a viable context – for example, when comparing GSHP with the electrification baseline, it is assumed that there is a building under consideration that is

seeking an alternative energy source for HVAC and/or water heating, and furthermore there is enough undeveloped land on-site available for GSHP installation. If not, the comparison becomes null.

The cost to the NG utility to decommission a site at the meter-level is negligible for strategies that occur on the 'customer side' of the meter, like electrification. However, we do indicate uncertainty about costs to the NG utility from hydrogen and GSHP installation. In the former, the cost depends on the utilities' role in providing hydrogen; in the latter, there is a potential that decommissioned natural gas pipelines may be removed to bury GSHP heat exchange lines.

Table E.1 displays scores for each alternative strategy relative to the baseline of electrification. Scores of "parity", "better", and "worse" are given wherever literature supports the comparison, or where the conclusion is self-evident or follows from definitions. "Prohibitive" was assigned with care when criteria performance would, in the research team's judgement, pose a significant deterrent to implementation. The score "unknown or uncertain" was assigned when published documentation could not be found, or where credible reports contradicted. Table E.2 explains the reasoning and sources used to determine every score. The performance of electrification in each criteria is also defined, so as to be clear what comparison to "baseline" means for each strategy.

Findings

Table E.1 shows that costs for the implementation of hydrogen for the building types in our study are not generally known. Hydrogen performs poorly on non-financial criteria, most notably in having a very high technical risk (in part, the lack of proven technology is why cost data is simply not available). However, the pioneering value of a hydrogen- powered residence, commercial building, or restaurant is high, both for proof-of-concept as well as for the highly cited need for hydrogen in GHG reductions scenarios.

Biofuels such as CRNG or bioLPG that can be stored and transported in tanks face fewer technical hurdles to hydrogen, such as existing use of LPG in restaurants and commercial buildings which would, theoretically, enable easy retrofits. However, limitations on production and supply, including nonexistent market products, pose a profound obstacle to widespread adoption. This strategy contains the most uncertainty – half of the criteria ranked as unknown or uncertain.

Geothermal is a more attractive strategy than electrification for ratepayers, community impact on electricity demand, and GHG reductions in the near-term. This, of course, assumes that the building site has adjacent land where the heat exchange pipes can be buried. However, the upfront costs of installation, which are assumed would be borne by the building owner, are very high and pose a significant barrier to implementation.

Table E.1: Stoplight comparison of strategies for on-site natural gas replacement

		Alternative Decommissioning Strategy			
		Electrification	Hydrogen	CRNG, bioLPG	Geothermal (GSHP)
	Functions under consideration for replacement	Cooktop Oven Dryer HVAC Water Heater	Cooktop Oven Dryer HVAC Water Heater	Cooktop Oven HVAC	HVAC Water Heater
Criteria	Cost to resident (building owner)	baseline			prohibitive
	Cost to resident (ratepayer)	baseline			better
	Alternative-specific cost to NG utility	baseline		parity	
	Impact on community-level electricity demand	baseline	worse	better	better
	GHG reduction	baseline	worse		better
	Indoor air quality	baseline	worse	worse	parity
	Technical risk	baseline	prohibitive	prohibitive	parity
	Pioneering value	baseline	better		better

parity
 better
 worse
 prohibitive
 unknown or uncertain

Table E.2: Comparison of strategies for on-site natural gas replacement

Criteria	Electrification (baseline)	Sources	Hydrogen	Sources
Functions under consideration for replacement	Cooktop Oven Dryer HVAC Water heater	E3, 2019	Cooktop Oven Dryer HVAC Water heater	
Cost to resident (building owner)	Cost of equipment and labor, permitting, and regulatory upgrades	RAND internal team	Unknown	
Cost to resident (ratepayer)	Electric utility bill		Unknown	

Criteria	Electrification (baseline)	Sources	Hydrogen	Sources
Alternative-specific cost to NG utility	No significant costs anticipated		Uncertain; if NG utility provides hydrogen service, cost will be high	<i>Hydrogen: A decarbonization</i> , 2021 Blank & Molly, 2020
Impact on community-level electricity demand	Incremental increase in electricity demand	Murphy et al., 2021	Higher than baseline due to electricity required to make hydrogen	<i>Hydrogen: A decarbonization</i> , 2021
Criteria	CRNG, bioLPG (portable tanks)	Sources	Geothermal (GSHP)	Sources
GHG reduction	GHG emissions proportional to electricity demand	Murphy et al., 2021	Worse than baseline due to green hydrogen not implementable at current fuel mix	<i>Future Energy Scenarios</i> , 2020 <i>Hydrogen: A decarbonization</i> , 2021 Blank & Molly, 2020
Indoor air quality	No combustion byproducts		Air quality impacts due to combustion byproducts (NO _x)	Fumey et al., 2018 Lewis, 2021
Technical risk	Low	Jadun et al., 2017 E3, 2019	High	<i>Hydrogen: A decarbonization</i> , 2021 Blank & Molly, 2020
Pioneering value	No significant innovations required to adopt strategy; high visibility sites may have more pioneering significance		High	The significance of hydrogen implementation is described in <i>Future Energy Scenarios</i> , 2020
Function under consideration for replacement	Cooktop Oven HVAC	Hopwood et al., 2019	HVAC Water heater	EnerGuide, 2004
Cost to resident (building owner)	Uncertain; in some applications, may avoid costs of appliance or electrical upgrades		High installation costs	Aditya et al., 2020 Christodoulides et al., 2019
Cost to resident (ratepayer)	Uncertain; lower electric utility bill than baseline, but accompanied by cost of fuel, transport and refilling		Lower electricity bill compared to baseline due to high efficiency	EnerGuide, 2004
Alternative-specific cost to NG utility	No significant costs anticipated		Uncertain; digging could require decommissioned pipe removal	
Impact on community-level electricity demand	None at the user level		Lower than baseline due to high efficiency	EnerGuide, 2004

Criteria	Electrification (baseline)	Sources	Hydrogen	Sources
GHG reduction	Uncertain; accounting methods differ; also vary with biomass source and manufacture process	A pipe dream, 2020 Aas, 2020 Eggleston et al., 2006	Better than baseline due to high efficiency	Brown et al., 2017 Subramanyam et al., 2016 Aditya & Narsilio, 2020
Indoor air quality	Air quality impacts due to combustion byproducts (NOx)	Russell, 2013	Parity with baseline	
Technical risk	BioLPG “drop-in” replacement for existing LPG users; however, limitations on production and supply	Hopwood et al., 2019 Guo & Song, 2019 Johnson, 2019	Low. Proven technology; implementation limited by site configuration	EPA, 2022 EnerGuide, 2004
Pioneering value	Uncertain; potential for commercial and restaurant		Potential if high upfront cost and trust in technology can be overcome	Hughes, 2008

Sources¹¹

¹¹ A pipe dream or climate solution? The opportunities and limits of biogas and synthetic gas to replace fossil gas. (2020). Issue Brief. NRDC.

Aas, D., Energy and Environmental Economics, Inc, & University of California, Irvine. Advanced Power and Energy Program. (2020). The Challenge of Retail Gas in California's Low-carbon Future: Technology Options, Customer Costs, and Public Health Benefits of Reducing Natural Gas Use: Final Project Report. California Energy Commission.

Aditya, G.R., Mikhaylova, O., Narsilio, G.A., & Johnston, I.W. (2020). Comparative costs of ground source heat pump systems against other forms of heating and cooling for different climatic conditions. Sustainable Energy Technologies and Assessments, 42, 100824.

Aditya, G.R. & Narsilio, G.A. (2020). [Environmental assessment of hybrid ground source heat pump systems](https://doi.org/10.1016/j.geothermics.2020.101868). Geothermics, 87(101868). <https://doi.org/10.1016/j.geothermics.2020.101868>

Blank, T.K. & Molly, P. (2020). Hydrogen's decarbonization impact for industry. Rocky Mountain Institute.

Christodoulides, P., Aresti, L., & Florides, G. (2019). Air-conditioning of a typical house in moderate climates with Ground Source Heat Pumps and cost comparison with Air Source Heat Pumps. Applied Thermal Engineering, 158, 113772.

Eggleston, H.S., Buendia, L., Miwa, K., Ngara, T., & Tanabe, K. (2006). 2006 IPCC guidelines for national greenhouse gas inventories. Japan.

EnerGuide. (2004) Heating and cooling with a heat pump. Natural Resources Canada's Office of Energy Efficiency. Energy and Environmental Economics (E3). (2019). Residential Building Electrification in California.

Fumey, B., Buetler, T., & Vogt, U.F. (2018). Ultra-low NOx emissions from catalytic hydrogen combustion. Applied Energy, 213, 334-342.

Future Energy Scenarios. (2020). National Grid.

Guo, M., & Song, W. (2019). The growing US bioeconomy: Drivers, development and constraints. New biotechnology, 49, 48-57.

Hopwood, L., Mitchell, E., Sourmelis, S. (2019). Biopropane: Feedstocks, feasibility and our future pathway. NNFCC. Prepared for Liquid Gas UK.

Electric Capacity in the Pilot Cities

Executive Summary

There is a concern of sufficient electric supply to serve the incremental load from building electrification. By evaluating recent Energy Emergency Alert 3 (EEA3) outages, the eastern portion of Santa Monica along the I-10 is an area with potential inadequate infrastructure. Long Beach and other parts of Santa Monica do not appear to have been impacted by EEA3 outages in the past 20 years.

Background

As California considers strategic decommissioning of natural gas resources, a new source of energy will need to replace existing gas end uses. Electricity is a leading candidate given its pathway to 100% renewables, existing infrastructure, and market-ready substitute appliances. As such, there is concern regarding the capacity of the electric grid to handle this incremental electric load from building electrification.

Approach

Taking a systems-level analysis, several sources were used in identifying constraints in the system. This included evaluating generation, transmission, and distribution resources. California Independent System Operator's historical Energy Emergency Alert 3 (EEA3), previously known as Stage 3 events, provided an indicator on resource limitations when demand peaks. EEA3s are the result of the Rotating Outage Program, which was established by the California Public Utilities Commission (CPUC) to "systematically and fairly address the need for forced reductions in electric use by cutting power to customers when the electrical system is close to collapse."¹² Historical EEA3 results can thus provide an indication as to where the grid may have resource limitations from distribution, transmission, or generation

Hughes, P. (2008). Geothermal (ground-source) heat pumps: Market status, barriers to adoption, and actions to overcome barriers (No. ORNL/TM-2008/232). Oak Ridge National Laboratory, for US Department of Energy Office of Energy Efficiency and Renewable Energy, Renewable Power Office.

Hydrogen: A decarbonization route for heat in buildings? (2021). Leti.

Jadun, P., McMillan, C., Steinberg, D., Muratori, M., Vimmerstedt, L., & Mai, T. (2017). Electrification futures study: End-use electric technology cost and performance projections through 2050 (No. NREL/TP-6A20-70485). National Renewable Energy Lab.(NREL), Golden, CO (United States).

Johnson, E. (2019). Process technologies and projects for BioLPG. *Energies*, 12(2), 250.

Lewis, A. C. (2021). Optimising air quality co-benefits in a hydrogen economy: a case for hydrogen-specific standards for NOx emissions. *Environmental Science: Atmospheres*, 1(5), 201-207.

Murphy, C., Mai, T., Sun, Y., Jadun, P., Muratori, M., Nelson, B., & Jones, R. (2021). Electrification futures study: Scenarios of power system evolution and infrastructure development for the united states (No. NREL/TP-6A20-72330). National Renewable Energy Lab.(NREL), Golden, CO (United States); Northern Arizona Univ., Flagstaff, AZ (United States); Evolved Energy Research, San Francisco, CA (United States).

Russell, A.T. (2013). Combustion emissions. In Straif, K., Cohen, A., and Samet, J. (Eds.) *Air pollution and cancer*. IAC Scientific, 161, 37-47.

Subramanyam, V., Ahiduzzaman, M., & Kumar, A. (2017). [Greenhouse gas emissions mitigation potential in the commercial and institutional sector](#). *Energy and Buildings*, 140. pp. 295-304. <https://doi.org/10.1016/j.enbuild.2017.02.007>.

¹² CPUC. 2001. "[Frequently Asked Questions: The CPUC Rotating Outage Program](#)." https://docs.cpuc.ca.gov/published/News_release/7066.htm. Accessed November 22, 2021.

limitations. Since there is not a public map of EEA3 outage areas, Southern California Edison's (SCE) outage tracker¹³ was used to identify areas that were included in recent EEA3 events.

In addition to EEA3 results, the team also reviewed CAISO's 2019,¹⁴ 2020,¹⁵ and 2021¹⁶ Local Capacity Technical Analyses. These provided context and potential root causes for EEA3 events as they identify insufficient transmission and generation resources in local planning areas.

The team also considered Public Safety Power Shutoff (PSPS) areas,¹⁷ SCE's Distribution Resources Plan¹⁸ (DRP), Federal Energy Regulatory Commission's Form 1,¹⁹ and E3's 2019 Residential Building Electrification²⁰ reports. PSPS areas did not apply to the City of Santa Monica and the City of Long Beach as they are not in high fire-risk areas. The DRP and FERC Form 1 did not apply as the DRP was focused on implementing distributed energy resources rather than mapping capacity utilization and the FERC Form 1 is at the broader SCE system. E3's 2019 Residential Building Electrification report found summer peaks were shaved with building electrification due to efficiency gains from air-sourced heat pumps, while winter peaks grew due to fuel switching. Summer peaks were still higher than winter peaks. These other reports were considered, but EEA3 alerts and CAISO's Local Capacity Technical Analyses were most informative for the pilot cities.

Findings

EEA3 or Stage 3 results peaked in 2000 and 2001 during the California energy crisis. There were no events for nearly 20 years until 2020 and 2022, where there were 2 and 1 events, respectively. 2020 included events in Southern California on August 14 and 15, 2020, while 2022 was outside the SCE service territory.

Of the 2020 events, one was localized to the eastern region of Santa Monica along the I-10 freeway as shown in Figure E.1.

¹³ "[Rotating Outages](https://www.sce.com/outage-center/outage-information/rotating-outages)" <https://www.sce.com/outage-center/outage-information/rotating-outages>

¹⁴ CAISO. "[2019 Local Capacity Technical Analysis: Final Report and Study Results](http://www.caiso.com/Documents/Final2019LocalCapacityTechnicalReport.pdf)." May 15, 2018. <http://www.caiso.com/Documents/Final2019LocalCapacityTechnicalReport.pdf>

¹⁵ CAISO. "[2020 Local Capacity Technical Study: Final Report and Study Results](http://www.caiso.com/Documents/Final2020LocalCapacityTechnicalReport.pdf)." May 1, 2019. <http://www.caiso.com/Documents/Final2020LocalCapacityTechnicalReport.pdf>

¹⁶ CAISO. "[2021 Local Capacity Technical Study: Final Report and Study Results](http://www.caiso.com/Documents/Final2021LocalCapacityTechnicalReport.pdf)." May 1, 2020. <http://www.caiso.com/Documents/Final2021LocalCapacityTechnicalReport.pdf>

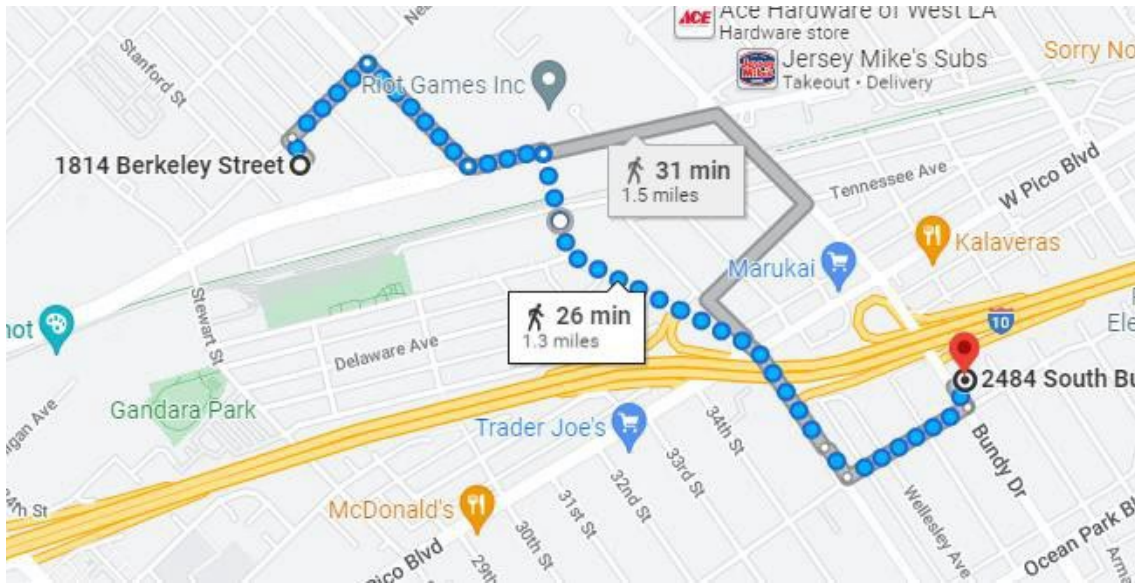
¹⁷ Southern California Edison. "[2020 PSPS Frequent Circuit List](https://www.sce.com/sites/default/files/SCE-2020-PSPS-Frequent-Circuit-List-wcag.pdf)." <https://www.sce.com/sites/default/files/SCE-2020-PSPS-Frequent-Circuit-List-wcag.pdf>. Accessed October 19, 2022.

¹⁸ [Southern California DRPEP](https://drpep.sce.com/drpep/). <https://drpep.sce.com/drpep/>

¹⁹ CPUC. 2021. "[FERC Financial Report: FERC Form No. 1: Annual Report of Major Electric Utilities, Licensees, and Others and Supplemental Form 3-Q: Quarterly Financial Report](https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/electric-costs/ferc-form-1s/sce-2020q4_ferc-form1-20210419.pdf)." https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/electric-costs/ferc-form-1s/sce-2020q4_ferc-form1-20210419.pdf. Accessed June 19, 2023.

²⁰ Mahone, A., C. Li, Z. Subin, M. Sontag, G. Mantegna, A. Karolides, A. German, and P. Morris. Energy and Environmental Economics (E3). 2019. "Residential Building Electrification in California, Consumer economics, greenhouse gases and grid impacts." Tech. Rep. E3.

Figure E.1: Affected outage area A061 in 2020 Stage 3 Emergency



Further review of CAISO’s Local Capacity studies showed nearby El Nido area including El Segundo and Manhattan Beach as having deficient supply to meet summer peaks without local supply such as gas resources or energy storage. This issue may impact the A061 area given their proximity; however, the team is limited in its analysis as non- CAISO member Los Angeles Department of Water and Power (LADWP) is between El Nido planning area and the City of Santa Monica.

The City of Long Beach was not impacted by 2020 and 2022 EEA3 events nor is the city in a frequent PSPS area. Santa Monica is also not in a PSPS area.

Recommendations

The team recommends avoiding areas with known issues of system capacity constraints for further electrification given the reliability concerns for customers. While our analysis did not identify any such areas in the City of Santa Monica or the City of Long Beach, further work with CAISO in providing an outage area map of Santa Monica and Long Beach would provide a more accurate representation of potentially affected areas.

Beyond the scope of this project, the team recommends a more holistic approach to the CPUC’s Distribution Resource Plan maps to include demand-side mapping for future energy needs and CAISO and LADWP coordination on Local Capacity reports to identify reliability issues at borders between load-serving entities.



California
ENERGY COMMISSION



ENERGY RESEARCH AND DEVELOPMENT DIVISION

APPENDIX F: Ratepayer Impacts

May 2026 | CEC-500-2026-010

Appendix F:

Ratepayer Impacts

This appendix provides an assessment of potential financial impacts to natural gas ratepayers associated with isolating and decommissioning specific parts of an integrated gas delivery network. It describes the impact of certain decommissioning actions on natural gas ratepayers, with special consideration given to the impacts on disadvantaged (CalEnviroScreen) and bill assistance (low-income) ratepayers.¹ For purposes of this ratepayer impact analysis, decommissioning is defined as decommissioning natural gas mains and meters only. These pipes and meters will no longer receive a flow of natural gas and pipes will be abandoned in place in the ground. The authors also assume infrastructure in place at the building-level will not be removed. The business-as-usual or baseline revenue requirement already accounts for any future costs of removing the natural gas assets.

This analysis examines the impact of decommissioning actions on natural gas ratepayers in the city of Santa Monica, CA.

The summary findings are:

- Decommissioning actions can result in downstream impacts to customers outside the decommissioning zone
- Pressure betterment or system improvement costs would be borne by customers still on the natural gas system
- Natural gas infrastructure investments are amortized over long time periods; customers participating in decommissioning would not be paying for the full life of the natural gas assets which they beneficially used
- The City of Santa Monica is located at the far west end of the gas system and is relatively isolated from other parts of the system, making decommissioning in Santa Monica less complex than other parts of SoCalGas' service territory. Santa Monica also enjoys year-round moderate weather and temperatures, with less heating and cooling needs compared to other customers on the system.

Caveats:

- Electric system upgrades and impacts to electric rates were not included in this analysis
- Santa Monica's gas usage and number of customers are very small compared to the whole SoCalGas service territory. The gas usage is small because of small scope of the decommissioning projects as well as they temperate climate in Santa Monica.
- The size and scale of the analyzed scenarios are small compared to SoCalGas' system as a whole. These decommissioning scenarios are site-specific, system-specific, and customer-specific. Data should not be extrapolated and scaled to determine broader system-wide or state-wide conclusions. Each potential decommissioning project much

¹ These are defined by California Senate Bill 535 as communities in 25% highest scoring census tracts in the California Office of Environmental Health Hazard Assessment CalEnviroScreen tool.

be evaluated individually, within the context of other projects (as well as electric system capacity and customer willingness to decommission). It's also important that potential decommissioning scenarios represent an opportunity to address customer safety needs, long-term rate affordability, customer energy preference, and alignment with California's climate goals.

SoCalGas Rates

The California Public Utilities Commission sets the rates SoCalGas can collect from its customers.² Typically, the CPUC conducts a general rate case proceeding to determine the amount of money, or *revenue requirement*, SoCalGas needs to provide safe and reliable energy, while providing the utility an opportunity to earn a reasonable return on its investment.

The revenue requirement includes operating and maintenance expenses that cover day-to-day costs of doing business, as well as capital investments to upgrade utility infrastructure. However, it does not include the commodity cost of gas.³ SoCalGas buys natural gas from various suppliers and passes that cost directly through to its bundled core customers, while unbundled core and non-core customers do not rely on SoCalGas for this service. While SoCalGas can receive an incentive for buying gas at

prices that are lower than benchmark prices, gas commodity procurement is generally a "pass-through" expense and does not include a profit margin for gas utilities. Natural gas utility revenue and profits were decoupled from gas sales in 1978 in California, and as a result, utility profits do not depend on how much natural gas is sold.

Once the CPUC establishes a revenue requirement in the General Rate Case, a cost allocation proceeding is conducted to establish the share of the cost for which each customer class is responsible (cost allocation) and the pricing and rates each customer class will be subject to (rate design).

SoCalGas Customers in City of Santa Monica

SoCalGas is the sole natural gas distribution utility serving the residents of Santa Monica. SoCalGas currently (December 2021) serves 41,363 customers (39,621 residential customers, 1,713 commercial customers, and 29 industrial customers) through 42,459 connected meters. The average annual natural gas consumption in the City of Santa Monica across all customer classes is 2,617.19 therms. When broken out by customer class, the residential sector averaged 349.26 therms annually, the commercial sector averaged 5,758.38 therms annually, and the industrial sector averaged 1,743.94 therms annually.

Table 1 below provides total monthly consumption for each customer class as well as average monthly consumption for calendar year 2021.

² California Public Utility Commission. "[General Rate Case](https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/electric-rates/general-rate-case)". As of April 10, 2026: <https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/electric-rates/general-rate-case>.

³ California Public Utility Commission. "[Natural Gas and California](https://www.cpuc.ca.gov/industries-and-topics/natural-gas/natural-gas-and-california)". As of April 10, 2026: <https://www.cpuc.ca.gov/industries-and-topics/natural-gas/natural-gas-and-california>.

Table F.1: Natural Gas Consumption, City of Santa Monica (2021, in therms)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Total Monthly Gas Consumption (therms)												
Residential	2,156,146	2,121,133	1,867,052	1,399,663	1,135,127	1,034,720	878,706	798,584	894,221	1,083,208	1,357,935	2,052,333
Commercial	883,971	941,558	968,513	885,784	866,897	816,099	769,024	752,642	805,370	894,698	965,040	1,178,268
Industrial	5,546	4,812	3,481	4,260	4,869	4,715	3,918	3,613	3,485	3,943	4,509	6,911
Average Monthly Gas Consumption (therms)												
Residential	54	53	47	35	28	26	22	20	22	27	33	50
Commercial	509	543	556	505	501	464	435	428	457	515	545	666
Industrial	205	166	120	147	168	163	135	129	120	136	155	238

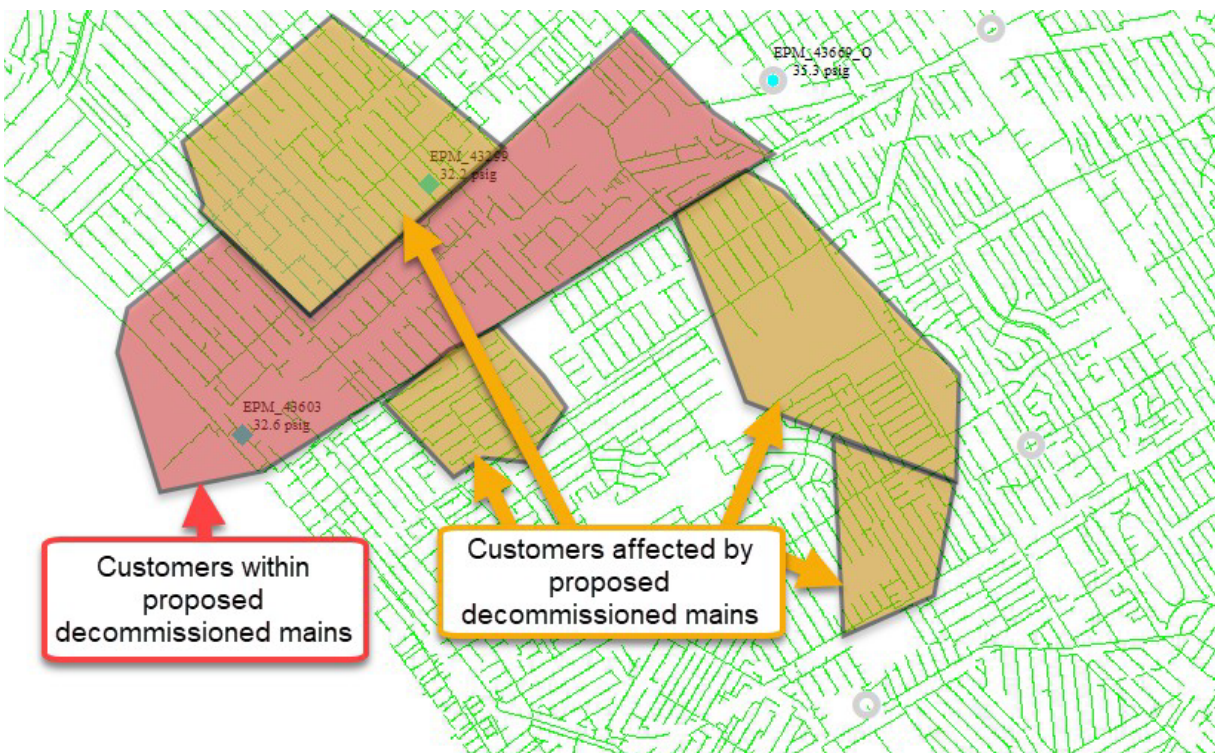
Ratepayer Impact of Decommissioning Portions of Natural Gas System in City of Santa Monica

This study examines five prospective decommissioning scenarios, as outlined below. The analyses are time sensitive; insofar as these scenarios are relevant in the future, SoCalGas must analyze the system and proposals at that time. This analysis reviewed the pipeline system as it is today (July 2022) and does not reflect a future state.

Scenario 1

This scenario examined decommissioning Santa Monica’s entire disadvantaged community bounded by Wilshire Boulevard, Colorado Avenue & Pico Boulevard, Palisades Beach Road, and Centinela Avenue.

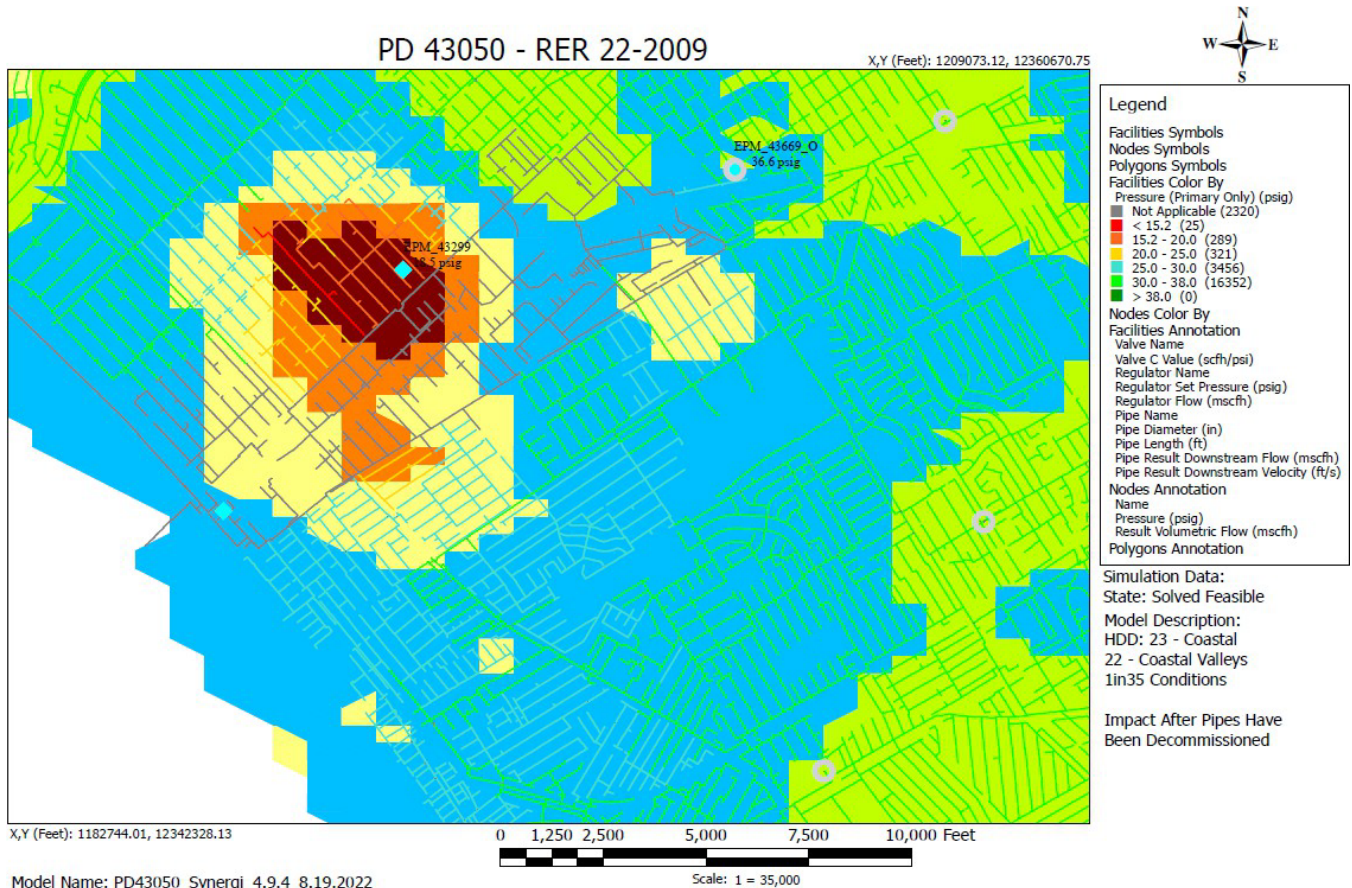
Figure F.1: Decommissioning Scenario 1 (disadvantaged communities)



Note: Red shape showing customers within proposed decommissioning zone and directly affected. Yellow shape showing customers outside proposed decommissioning zone that are indirectly affected.

Figure F.1 displays Scenario 1, which examined decommissioning a total of 154,000 feet of pipeline currently servicing 5,670 customer meters, representing 11,906 total customer dwelling units, all located in the disadvantaged communities in Santa Monica. These customers currently consume approximately 189 million standard cubic feet per hour (mscfh) in the winter (peak usage on the coldest day of the year). This scenario would include decommissioning 171 meters serving critical customers (those that would presumably require service to be maintained if there were an outage, e.g., schools, gathering facilities, etc.), representing 259 customer dwellings.

Figure F.2: Decommissioning Scenario 1 – Hydraulic Modeling



Model Name: PD43050_Synergi_4.9.4_8.19.2022
 Model Coordinate System: NAD 1983 UTM ZONE 11N
 Synergi Gas 4.9.4 (17 Jan 2022)

9/15/2022 2:38:40 PM

Figure Note: Green = Good; Blue/Yellow = Acceptable; Orange = At Risk; Red = Requires Pressure Betterment/System Improvement Project

This scenario would result in significant impacts to the surrounding gas distribution system and would necessitate pressure betterment projects. As shown above in Figure F.2, decommissioning the disadvantaged communities would result in 13,383 additional, downstream customers (and a total of 20,151 total customer dwelling units) affected by the decommissioned pipe. These impacted downstream customers currently consume up to approximately 205 mscfh under winter design conditions. Maintaining service to surrounding and downstream areas would necessitate the installation of 570 feet of total new pipelines.

Installation of this new infrastructure would likely take several weeks and would include re-routed traffic, trucks and heavy equipment, and construction disturbance while the pipelines are installed.

Table F.2: Decommissioning Scenario 1 – 10-year Revenue Requirement Proforma

Revenue Requirement	Total	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Pressure Betterment	550,616	28,412	27,966	28,952	28,142	27,361	26,599	25,856	25,130	24,413	23,696
Assets to be Decommissioned ¹	11,175,005	663,659	648,638	665,824	644,292	623,363	602,866	582,771	563,045	543,519	523,988

Note:

¹ Currently included in rates

^A Decommissioned assets include Main and Meters only. Service Lines or any other assets not included in this analysis.

^B O&M costs involving pressure betterment, or Savings from decommissioning currently not included in this analysis.

Scenario 1 Revenue Requirement Results

The scenario includes decommissioning approximately \$11,175,014 of natural gas assets that are currently included in rates. The pressure betterment needed to maintain service for downstream customers is estimated to cost \$550,616.

Scenario 2

This scenario examined decommissioning a central neighborhood in the City of Santa Monica bounded by Colorado Avenue, S Centinela Avenue, Santa Monica Boulevard, and the alley S/O 20th Street.

Figure F.3: Decommissioning Scenario 2 (central neighborhood)



Figure Note: Red shape showing customers within proposed decommissioning zone and directly affected. Yellow shape showing customers outside proposed decommissioning zone that are indirectly affected.

Figure F.3 displayed Scenario 2, which examined decommissioning a total of 23,650 feet of pipeline servicing 1,474 customer meters, representing 2,454 total customer dwelling units, located in a central neighborhood in Santa Monica. This would include decommissioning 22 meters for critical customers (those that would need service maintained if there were an outage, e.g., schools, gathering facilities, etc.). These customers currently consume approximately 26 million standard cubic feet per hour (mscfh) in the winter.

Figure F.4: Decommissioning Scenario 2 – Hydraulic Modeling

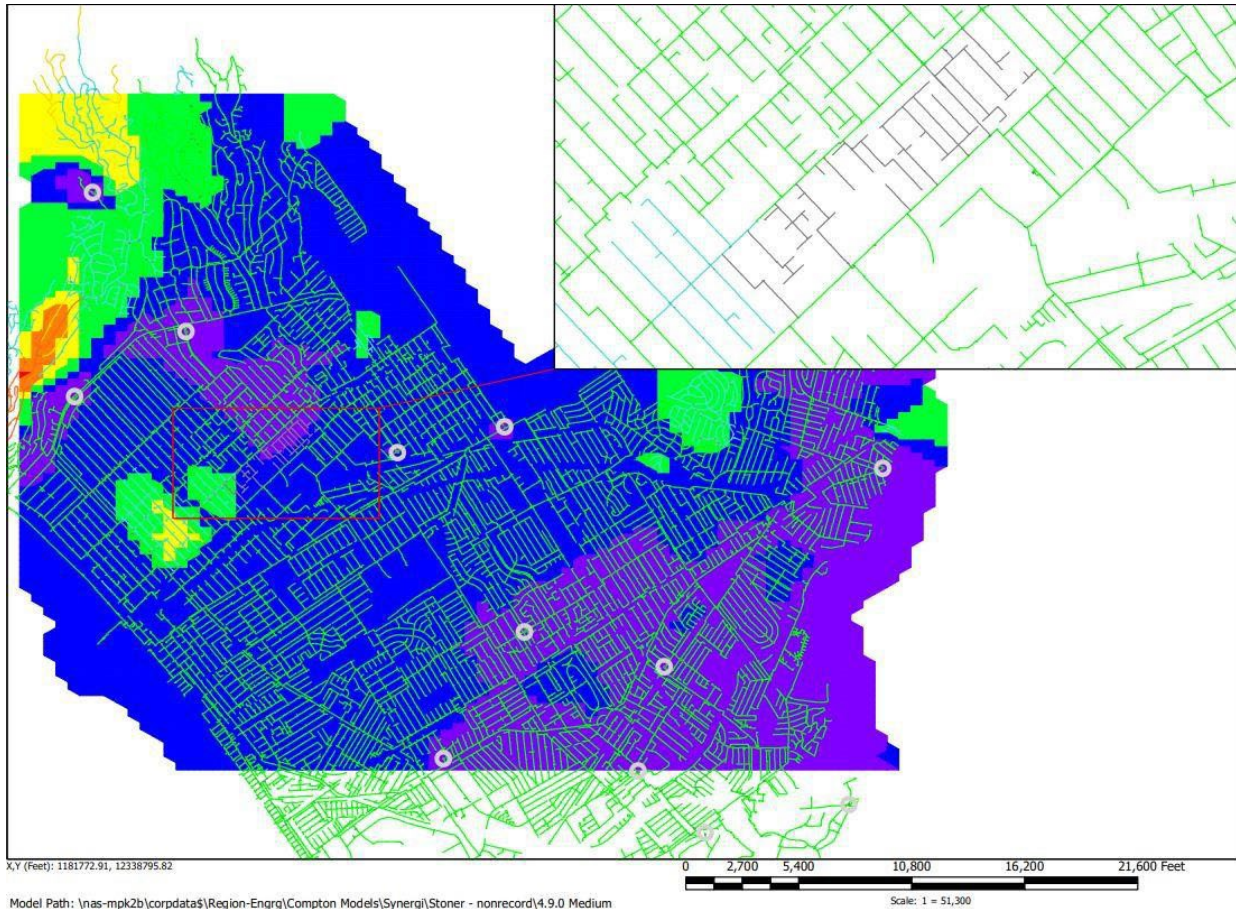


Figure Note: Purple = Good; Blue/Green = Acceptable; Yellow/Orange = At Risk; Red = Requires Pressure Betterment/System Improvement Project

Figure F.4 shows how this scenario would impact approximately 6,488 additional customers located downstream of the decommissioned scenario by reducing the capacity of their infrastructure down from a “Good” level to an “Acceptable” level. This means that any other actions in the vicinity have the potential to push these areas to “At Risk” or “Requires Pressure Betterment” which would necessitate action by SoCalGas. These customers represent 11,463 dwelling units and consumed approximately 85 mscfh in the winter.

Table F.3: Decommissioning Scenario 2 – 10-year Revenue Requirement Proforma

Revenue Requirement	Total	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Pressure Betterment	—	—	—	—	—	—	—	—	—	—	—
Assets to be Decommissioned ¹	1,797,258	108,643	106,098	108,799	105,224	101,747	98,340	94,999	91,717	88,467	85,217

Note:

¹ Currently included in rates

^A Decommissioned assets include Main and Meters only. Service Lines or any other assets not included in this analysis.

^B O&M costs involving Pressure Betterment, or Savings from decommissioning currently not included in this analysis.

Scenario 2 Revenue Requirement Results

This scenario includes decommissioning approximately \$1,797,258 of natural gas assets that are currently included in rates. Pressure betterment would not be necessitated in this scenario.

Scenario 3

This scenario examined decommissioning critical infrastructure within the vicinity of S Bundy Drive, Colorado Avenue, Stanford Street, Nebraska Avenue, Exposition Boulevard & Virginia Avenue.

Figure F.5: Decommissioning Scenario 3 (critical energy infrastructure)

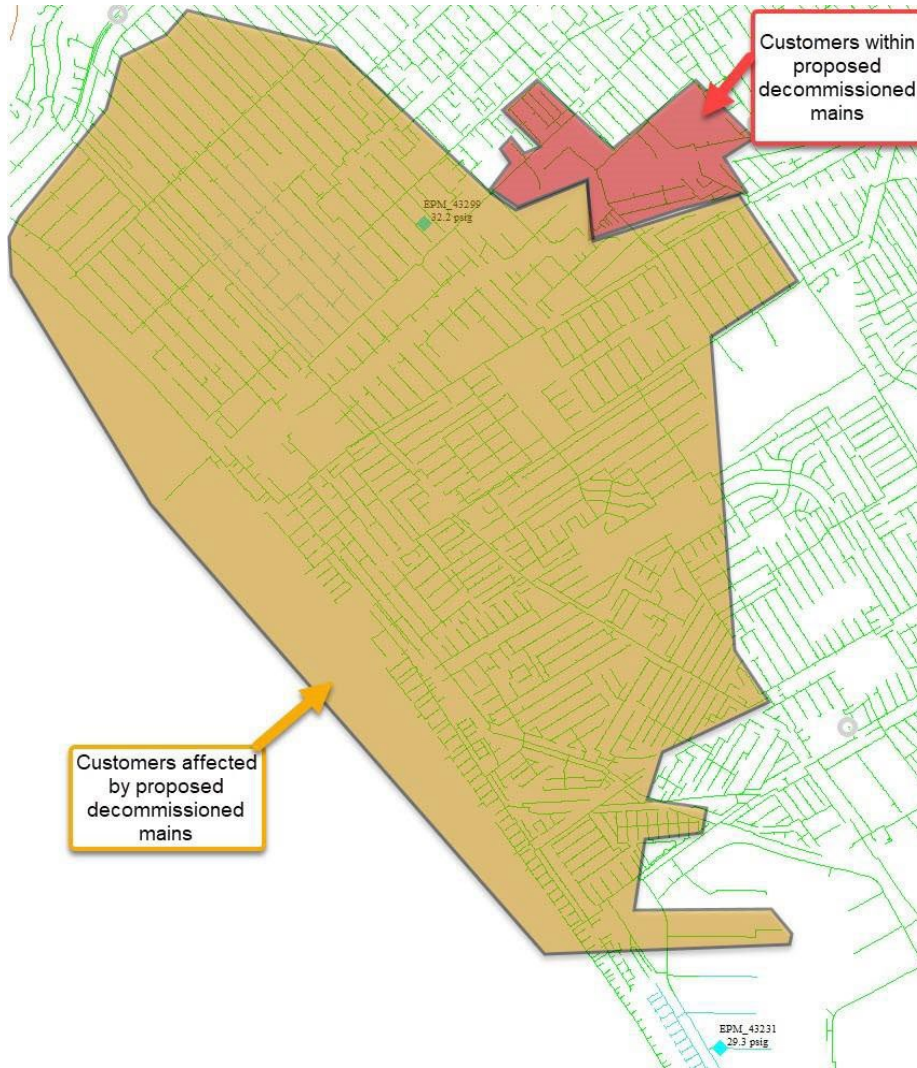


Figure Note: Red shape showing customers within proposed decommissioning zone and directly affected. Yellow shape showing customers outside proposed decommissioning zone that are indirectly affected.

Figure F.5 displays Scenario 3, which examined decommissioning a total of 35,232 feet of pipeline servicing 1,176 customer meters, representing 1,647 total customer dwelling units, located in central Santa Monica. This scenario would include decommissioning 400 meters, representing 721 customer dwelling for critical customers (those that would need service

maintained if there were an outage, e.g., schools, gathering facilities, etc.). These customers currently consume approximately 43 million standard cubic feet per hour (mscfh) in the winter.

Figure F.6: Decommissioning Scenario 3 – Hydraulic Modeling

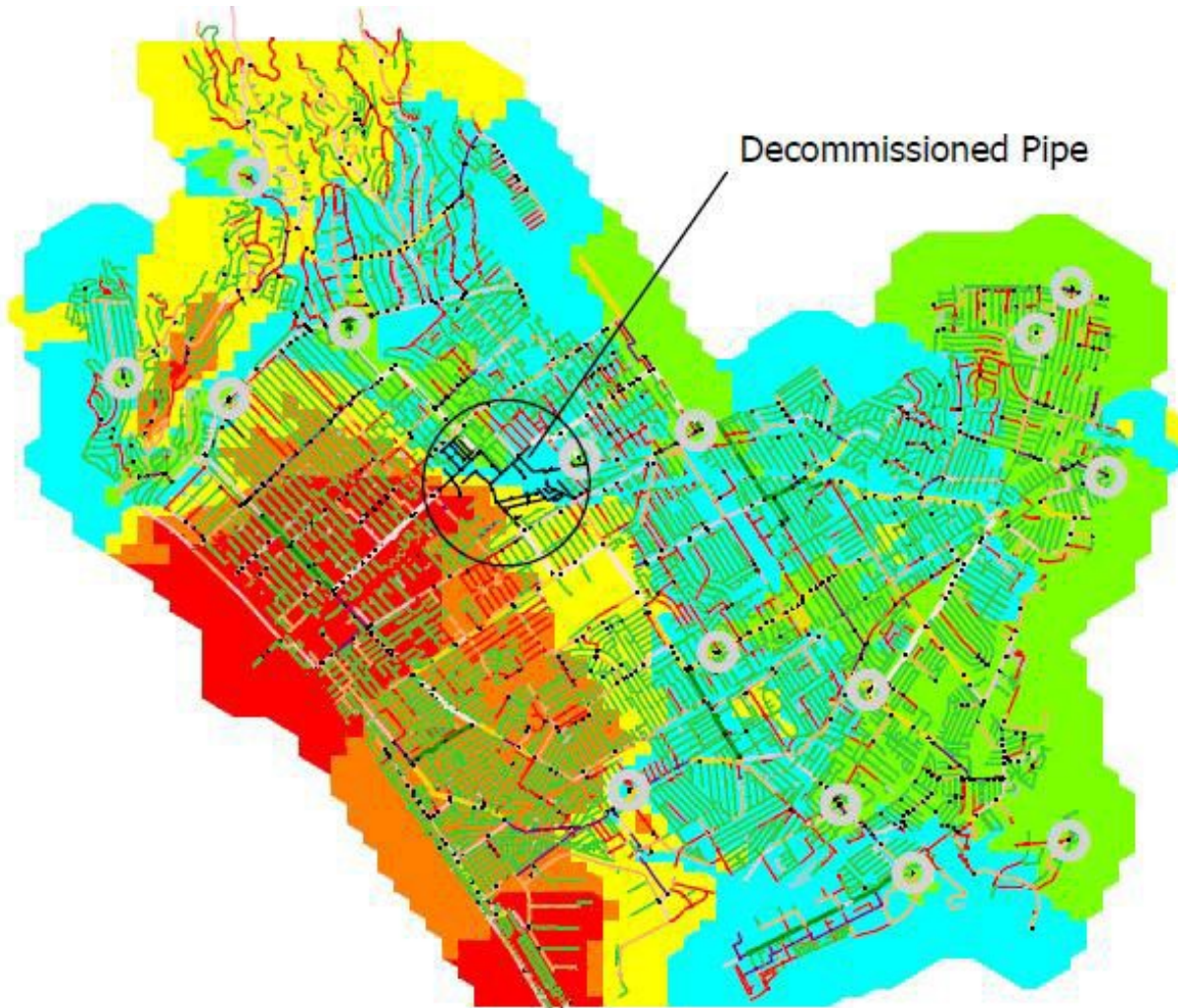


Figure Note: Green = Good; Blue/Yellow = Acceptable; Orange = At Risk; Red = Requires Pressure Betterment/System Improvement Project

This scenario would result in significant impacts to the surrounding gas distribution system and would necessitate pressure betterment projects. As Figure 6 shows, decommissioning this scenario would result in 43,291 additional, downstream customers (and a total of 74,410 total customer dwelling units) affected by the decommissioned pipe. These downstream customers impacted currently consume approximately 778 mscfh. This would necessitate the installation of 9,632 feet of total new pipelines to be installed to maintain service to surrounding and downstream areas. Installation of this new infrastructure would likely take multiple months and would include re-routed traffic, trucks and heavy equipment, and construction disturbance while the pipelines are installed.

Table F.4: Decommissioning Scenario 3 – 10-year Revenue Requirement Proforma

Revenue Requirement	Total	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Pressure Betterment	9,216,322	475,568	468,095	484,600	471,053	457,971	445,223	432,784	420,631	408,632	396,629
Assets to be Decommissioned ¹	2,540,321	150,481	147,092	151,012	146,139	141,404	136,767	132,221	127,759	123,342	118,924

Note:

¹ Currently included in rates

^A Decommissioned assets include Main and Meters only. Service Lines or any other assets not included in this analysis.

^B O&M costs involving Pressure Betterment, or Savings from decommissioning currently not included in this analysis.

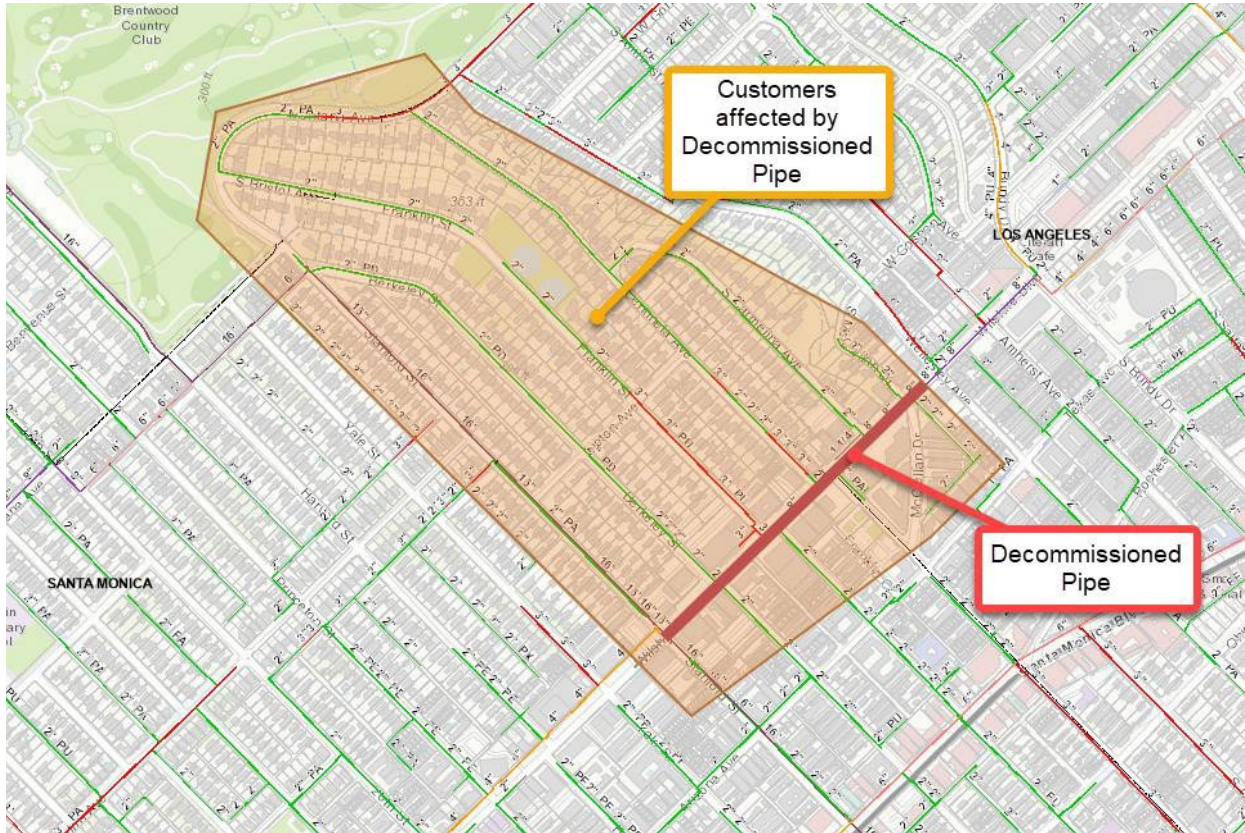
Scenario 3 Revenue Requirement Results

This scenario includes decommissioning approximately \$2,540,321 of natural gas assets that are currently included in rates. The pressure betterment needed to maintain service for downstream customers is estimated to cost \$9,216,322.

Scenario 4

This scenario examined decommissioning the 8" main located along Wilshire Boulevard between Stanford and Centinela Avenue.

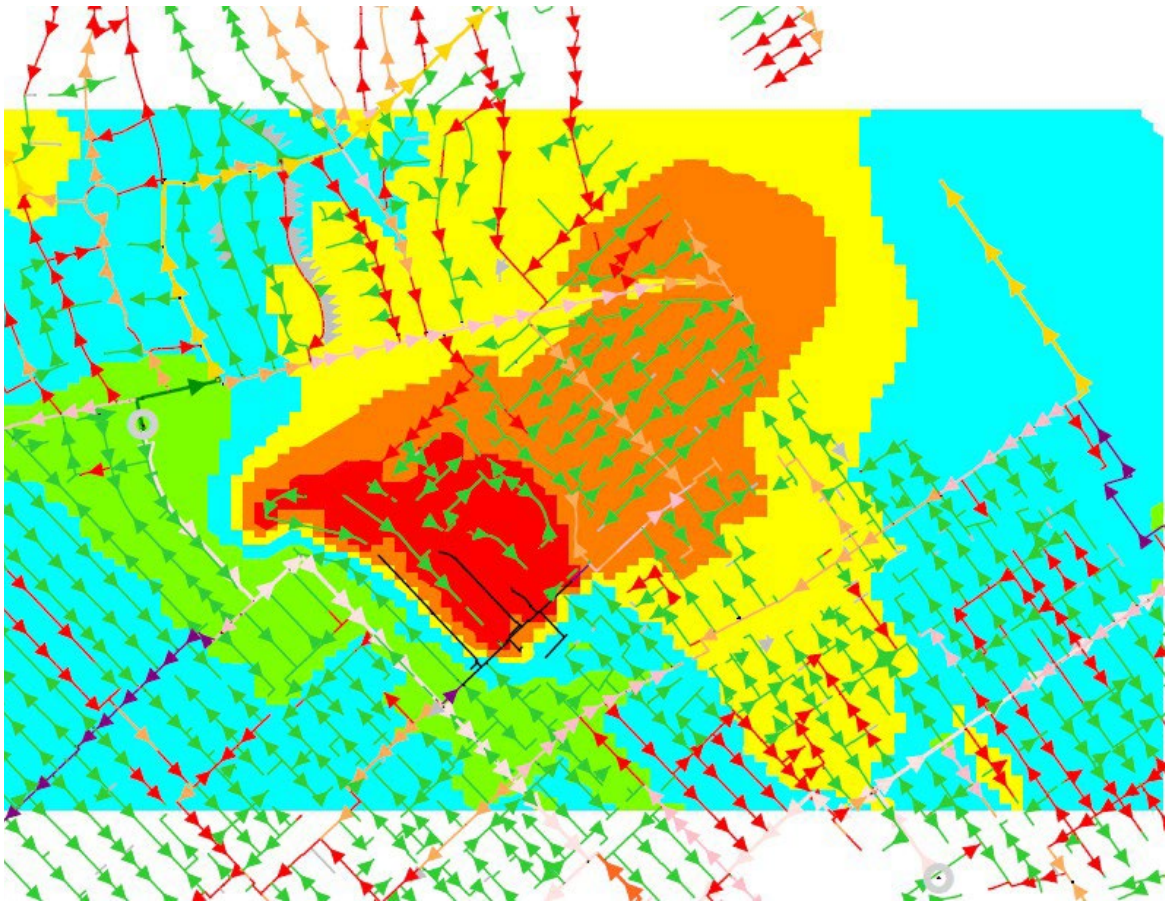
Figure F.7: Decommissioning Scenario 4 (commercial corridor)



Note: Red shape showing customers within proposed decommissioning zone and directly affected. Yellow shape showing customers outside proposed decommissioning zone that are indirectly affected.

Figure F.7 displays Scenario 4, which examined decommissioning a total of 1,200 feet of pipeline servicing 21 customer meters located on the Wilshire commercial corridor in Santa Monica. This would include decommissioning 5 meters for critical customers (those that would need service maintained if there were an outage, e.g., schools, gathering facilities, etc.). These customers currently consume approximately 6 million standard cubic feet per hour (mscfh) in the winter.

Figure F.8: Decommissioning Scenario 4 – Hydraulic Modeling



Note: Green = Good; Blue/Yellow = Acceptable; Orange = At Risk; Red = Requires Pressure Betterment/System Improvement Project

This scenario would result in significant impacts to the surrounding gas distribution system and would necessitate pressure betterment projects. As Figure F.8 shows, decommissioning this scenario would result in 792 additional, downstream customers (and a total of 1,135 total customer dwelling units) affected by the decommissioned pipe. These downstream customers impacted currently consume approximately 14 mscfh. This would necessitate the installation of 1,303 feet of total new pipelines to be installed to maintain service to surrounding and downstream areas.

Table F.5: Decommissioning Scenario 4 – 10-year Revenue Requirement Proforma

Revenue Requirement	Total	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Pressure Betterment	1,259,564	64,994	63,973	66,229	64,377	62,589	60,847	59,147	57,486	55,846	54,206
Assets to be Decommissioned ¹	83,962	4,913	4,805	4,937	4,779	4,626	4,476	4,330	4,186	4,043	3,901

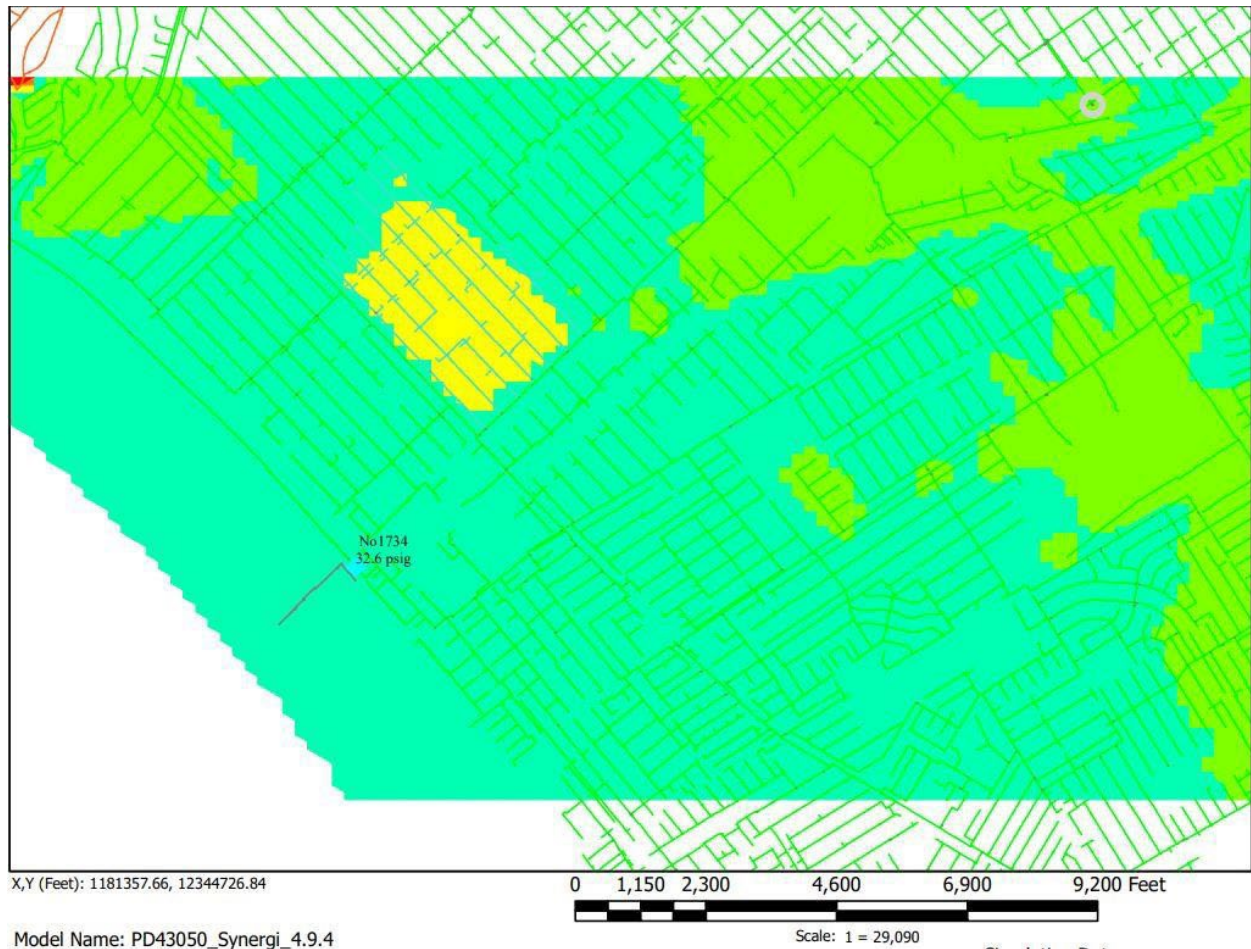
Note:

¹ Currently included in rates

^A Decommissioned assets include Main and Meters only. Service Lines or any other assets not included in this analysis.

^B O&M costs involving Pressure Betterment, or Savings from decommissioning currently not included in this analysis.

Figure F.10: Decommissioning Scenario 5 – Hydraulic Modeling



Note: Green = Good; Blue/Yellow = Acceptable; Orange = At Risk; Red = Requires Pressure Betterment/System Improvement Project

This scenario would not result in significant impacts to the surrounding gas distribution system and would not likely necessitate pressure betterment projects. Since this is a single-fed line at the edge of the system, there are no impacts on the system; only to the customers currently being served by the gas main.

Table F.6: Decommissioning Scenario 5 – 10-year Revenue Requirement Proforma

Revenue Requirement	Total	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Pressure Betterment	—	—	—	—	—	—	—	—	—	—	—
Assets to be Decommissioned ¹	132,380	7,681	7,516	7,725	7,481	7,243	7,011	6,783	6,560	6,339	6,118

Note:

¹ Currently included in rates

^A Decommissioned assets include Main and Meters only. Service Lines or any other assets not included in this analysis.

^B O&M costs involving Pressure Betterment, or Savings from decommissioning currently not included in this analysis.

Scenario 5 Revenue Requirement Results

This scenario includes decommissioning approximately \$132,380 of natural gas assets that are currently included in rates. Pressure betterment would not be necessitated by this scenario.

Revenue Requirement Impacts

For consistency and simplicity, the above results, insofar as downstream betterment is required, recommend pipe installations as a way to maintain feed and system health for all scenarios. Pipeline installations are a typical remedy for such pressure issues; however, depending on the economic cost/benefit of the prospective solution(s), other types of enhancements (e.g., new or rebuilt regulator station(s), creating/splitting/merging pressure systems, uprate or derate of maximum allowable operating pressure (MAOP) and/or set pressure or the pipeline systems, etc.) may be necessary.

It is important to note that each time a decommissioning project is proposed, a new analysis would be required. Medium pressure pipeline systems are dynamic, constantly evolving like the communities they serve. This would mean that SoCalGas’ engineering team would need to evaluate each project that affects our pipeline systems and make recommendations to maintain system resiliency on a case-by-case basis, and even potentially re-evaluate proposals if significant time has lapsed since they were last considered.

Additionally, while initial projects may not immediately impact non-participating customers and therefore not require costly enhancements, subsequent projects may further degrade the pipeline system’s redundancy and/or resiliency enough to require more costly solutions to maintain the system to design/integrity standards. SoCalGas has built in resiliency or “operational margin” into our pipeline systems to allow for changes like new customers to interconnect, or increased demand from our existing customers, without jeopardizing service to others. Decommissioning projects along with customer and load growth and maintenance activities can have an accumulative impact on eroding this operational margin necessitating future enhancements – forecasting all future operational needs and cost impacts of these projects is unrealistic.

Table F.7: Ratepayer Impacts

	Jan-22	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
		Figure 1	Figure 3	Figure 5	Figure 7	Figure 9
City of Santa Monica Additional Costs to Recover (\$000)		\$29	\$0	\$485	\$66	\$0
City of S. Monica Reduction in Throughput (Mth)						
Residential		1,868	431	310	380	
Core C&I		3,341	194	742	134	72
NGV		417		417		
Noncore C&I		146				

	Jan-22	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
		Figure 1	Figure 3	Figure 5	Figure 7	Figure 9
City of S. Monica Reduction in Number of Customers						
Residential		5,384	1,525	1,083	854	
Core C&I		899	110	127	30	14
NGV		4		4		
Noncore C&I		1				
Transportation Rates: SCG						
Residential Class Average	\$1.09046	\$1.09089	\$1.09047	\$1.09074	\$1.09047	\$1.09047
Change \$/therm compared to Current Rates		\$0.00043	\$0.00001	\$0.00028	\$0.00001	\$0.00001
Change % compared to Current Rates		0.04%	0.00%	0.03%	0.00%	0.00%
Core Commercial Class Average						
Core Commercial Class Average	\$0.63128	\$0.63238	\$0.63133	\$0.63170	\$0.63137	\$0.63130
Change \$/therm compared to Current Rates		\$0.00110	\$0.00005	\$0.00042	\$0.00010	\$0.00002
Change % compared to Current Rates		0.17%	0.01%	0.07%	0.02%	0.00%
Average Core						
Average Core	\$0.91920	\$0.92013	\$0.91924	\$0.91962	\$0.91925	\$0.91922
Change \$/therm compared to Current Rates		\$0.00093	\$0.00004	\$0.00042	\$0.00005	\$0.00002
Change % compared to Current Rates		0.10%	0.00%	0.05%	0.01%	0.00%
NonCore C&I Class Average Distribution						
NonCore C&I Class Average Distribution	\$0.18162	\$0.18175	\$0.18165	\$0.18168	\$0.18164	\$0.18162
Change \$/therm compared to Current Rates		\$0.00012	\$0.00003	\$0.00006	\$0.00002	\$0.00000
Change % compared to Current Rates		0.07%	0.01%	0.03%	0.01%	0.00%
Average Noncore						
Average Noncore	\$0.06362	\$0.06365	\$0.06362	\$0.06363	\$0.06362	\$0.06362
Change \$/therm compared to Current Rates		\$0.00003	\$0.00001	\$0.00001	\$0.00000	\$0.00000
Change % compared to Current Rates		0.05%	0.01%	0.02%	0.01%	0.00%

	Jan-22	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
		Figure 1	Figure 3	Figure 5	Figure 7	Figure 9
System Average Rate with BTS \$/therm	\$0.43217	\$0.43236	\$0.43218	\$0.43228	\$0.43219	\$0.43218
Change \$/therm compared to Current Rates		\$0.00019	\$0.00001	\$0.00011	\$0.00001	\$0.00000
Change % compared to Current Rates		0.04%	0.00%	0.03%	0.00%	0.00%
SCG Residential Bill (Zone 1)						
Residential Class Monthly Average (Jan- Dec)	\$59.84	\$59.86	\$59.84	\$59.85	\$59.84	\$59.84
Change \$/month compared to Current Rates		\$0.02	\$0.00	\$0.01	\$0.00	\$0.00
Change % compared to Current Rates		0.04%	0.00%	0.02%	0.00%	0.00%
CARE Monthly Average (Jan-Dec)	\$46.10	\$46.12	\$46.10	\$46.11	\$46.10	\$46.10
Change \$/month compared to Current Rates		\$0.02	\$0.00	\$0.01	\$0.00	\$0.00
Change % compared to Current Rates		0.04%	0.00%	0.02%	0.00%	0.00%

Natural Gas Ratepayer Impacts

Table F.7 provides estimated natural gas customer bill impacts resulting from the decommissioning actions analyzed under each of the five scenarios.

The rates model added the Santa Monica Pressure Betterment Revenue requirements for the maximum Year 2025 (which range from \$0 to \$485,000 for each Scenario) adds to Base Margin, which is \$3 billion. The Base Margin is from the General Rate Case’s Decision. The total rates revenue requirement includes Base Margin, Operating Costs (such as Greenhouse Gas) and Regulatory Account amortizations, is \$3.95 billion.

The rates model allocates costs among customer classes and divides by estimated volumes for each customer class to calculate the rates. The model subtracted the City of Santa Monica’s volumes (ranged from 72 Mth to 5,772 Mth for each Scenario) and also, subtracted the number of customers for each scenario. Santa Monica’s volumes and number of customers are very small compared to the whole SoCalGas service territory.

It is important to understand that the size and scale of these decommissioning scenarios are small when compared to the SoCalGas system as a whole. Under these scenarios, although the costs can be spread across millions of natural gas ratepayer still utilizing the system, customers remaining on the system would be bearing the costs of actions taken by customers in Santa Monica. As the revenue requirement analysis provides, infrastructure investments

were made on behalf of the customers that would be decommissioned; hence it may be relevant to show an accelerated depreciation schedule (both 5 years and 10 years) in addition to the business-as-usual case.

In addition, these decommissioning scenarios are site-specific, system-specific, and customer-specific. Data should not be extrapolated and scaled to determine broader system-wide or state-wide conclusions. Each potential decommissioning project must be evaluated individually, within the context of other projects (as well as electric system capacity and customer willingness to decommission). It's also important that potential decommissioning scenarios represent an opportunity to address customer safety needs, long-term rate affordability, and customer energy preference.



California
ENERGY COMMISSION



ENERGY RESEARCH AND DEVELOPMENT DIVISION

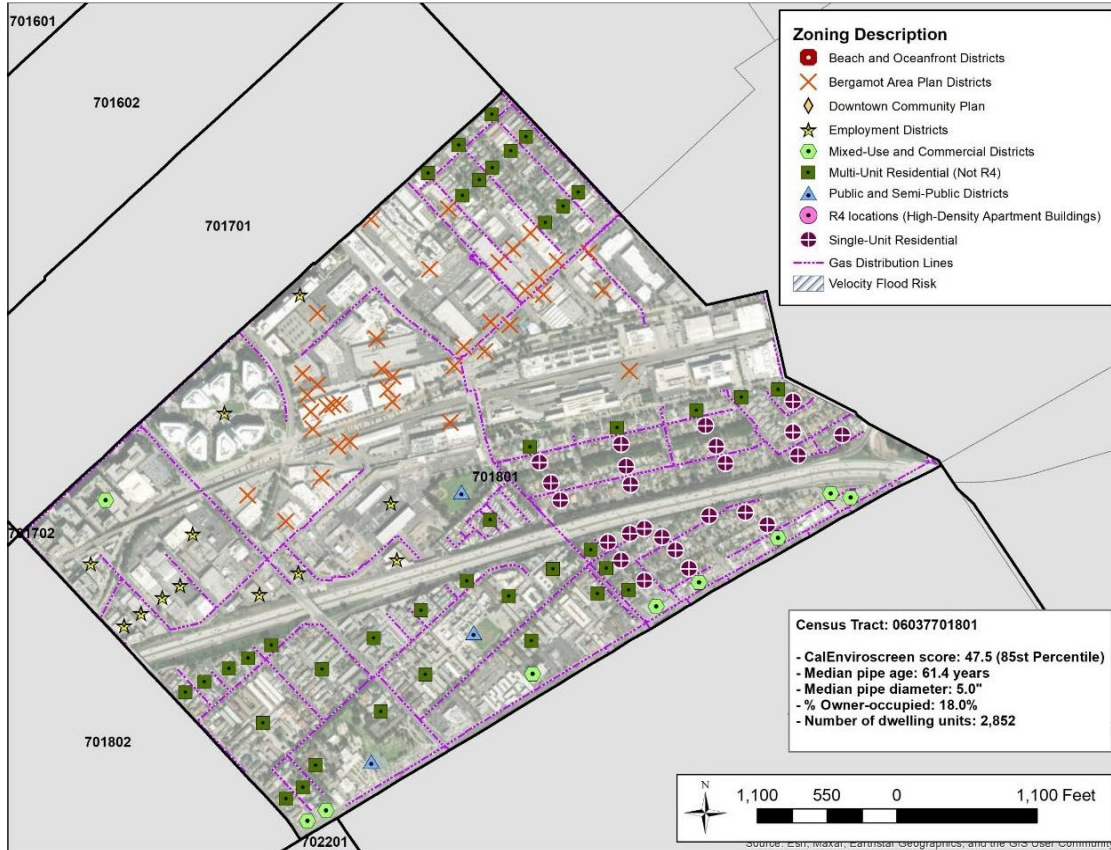
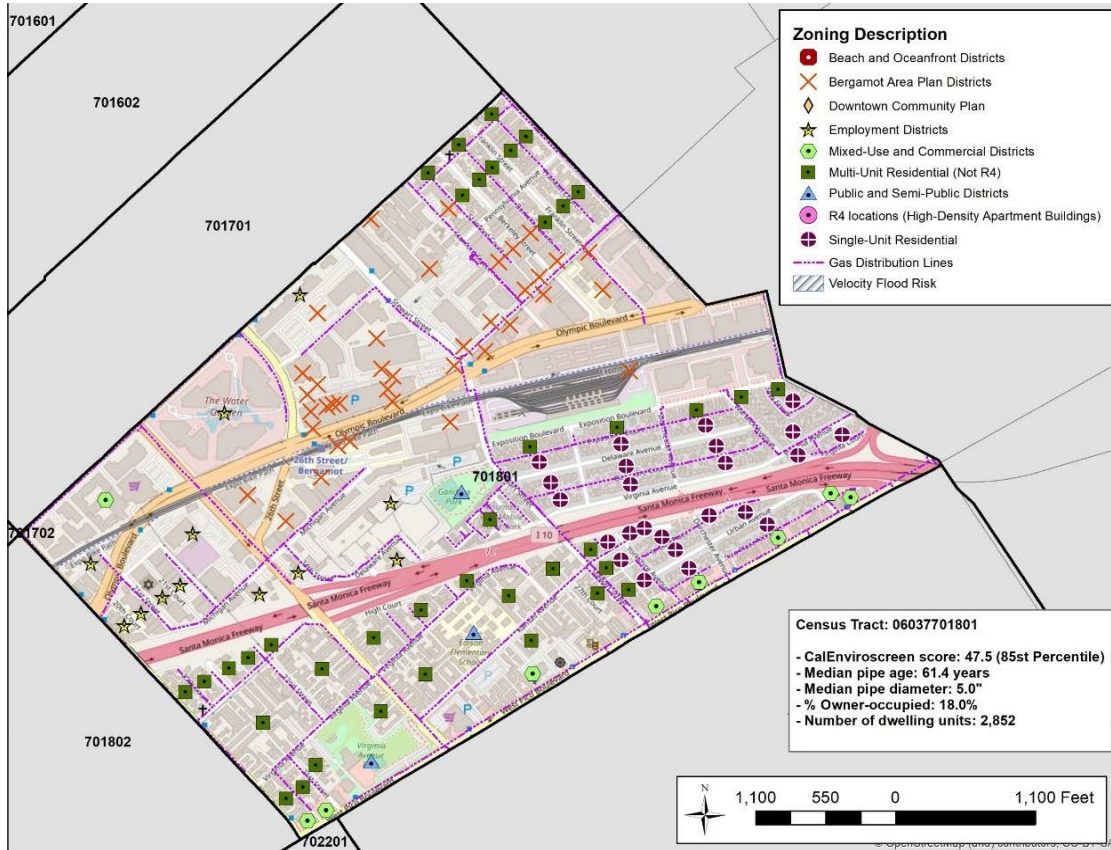
APPENDIX G: Census Tracts Chosen by City Using Visualization Tool

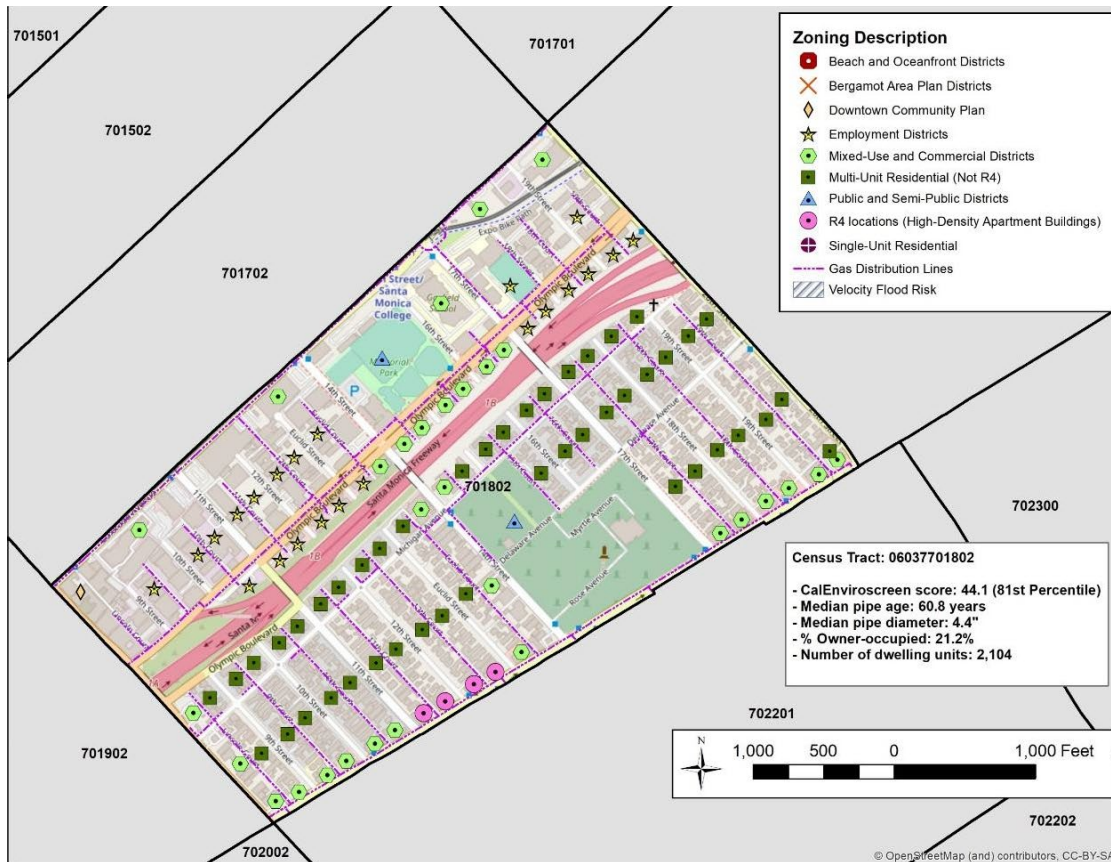
May 2026 | CEC-500-2026-010

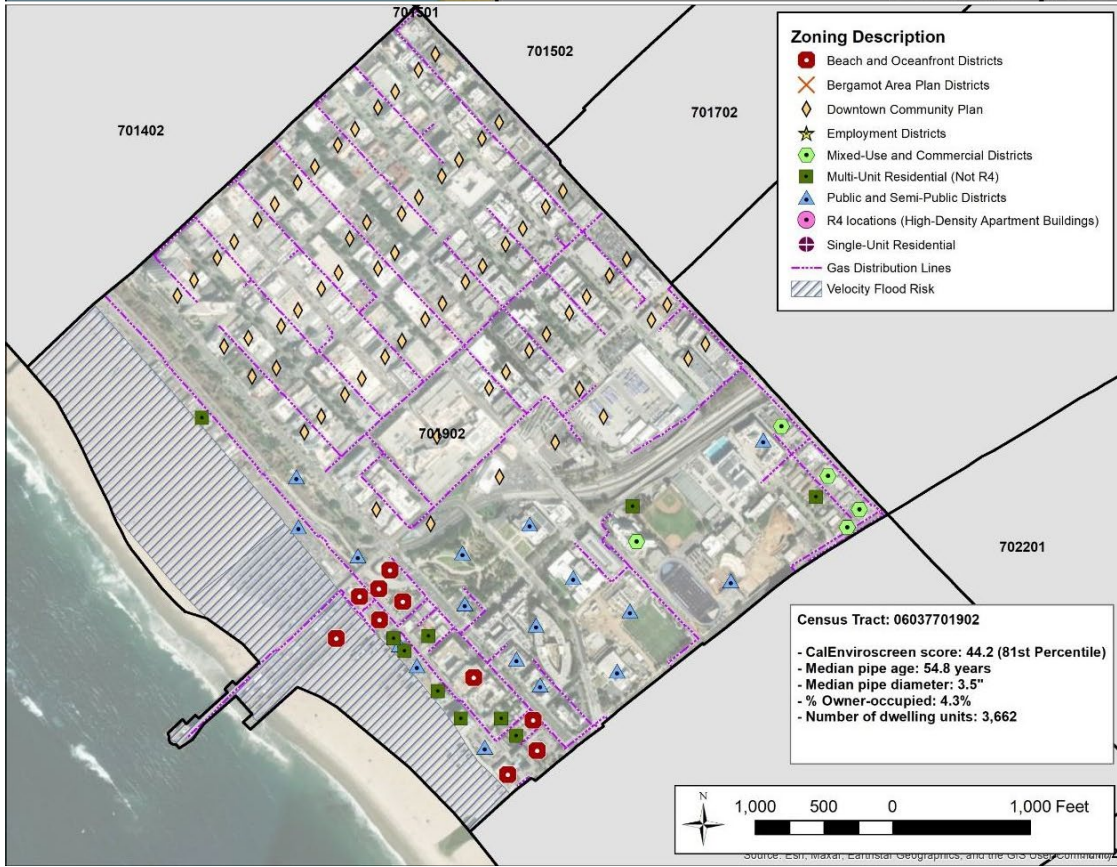
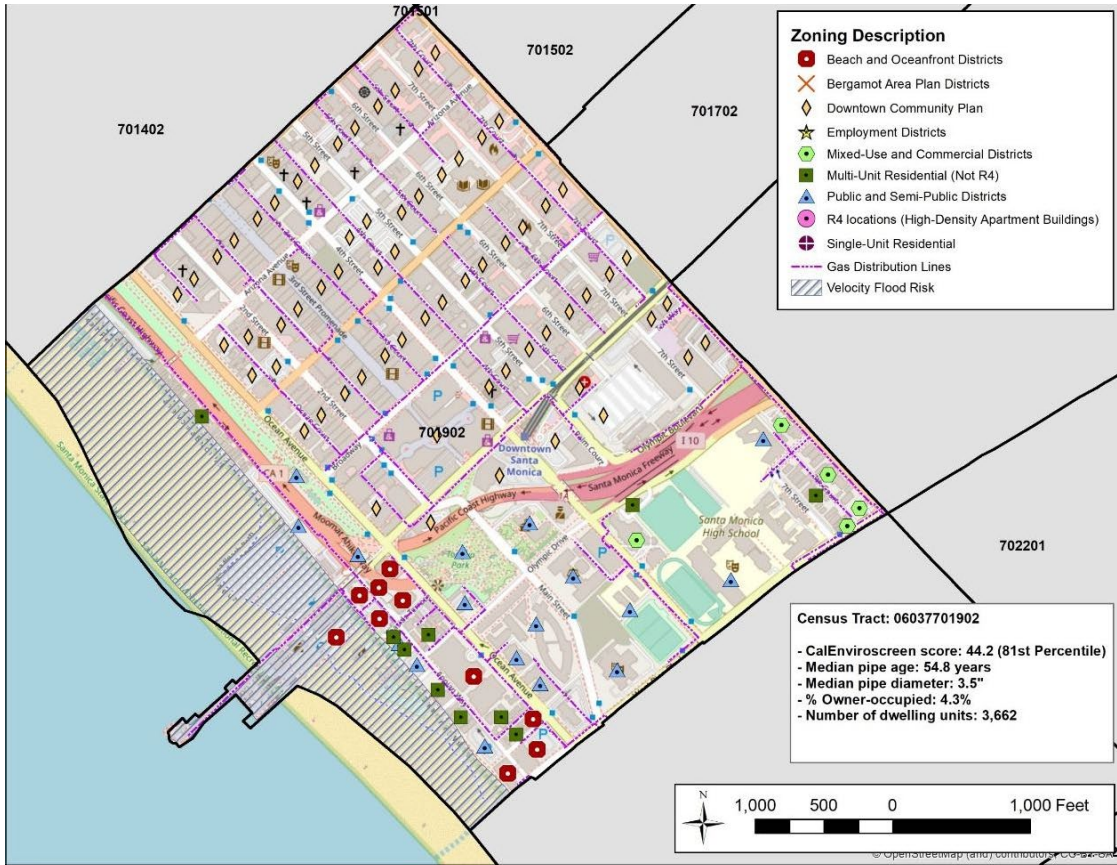
Appendix G: Census Tracts Chosen by City Using Visualization Tool

This appendix displays the census tract maps of the 3 candidate pilot site census tracts in the City of Santa Monica, and 17 candidate pilot site census tracts in the City of Long Beach used in the Deliberations Workshop (Appendix H). There were 4 and 15 R4 apartment complex pilot sites for City of Santa Monica and City of Long Beach, respectively.

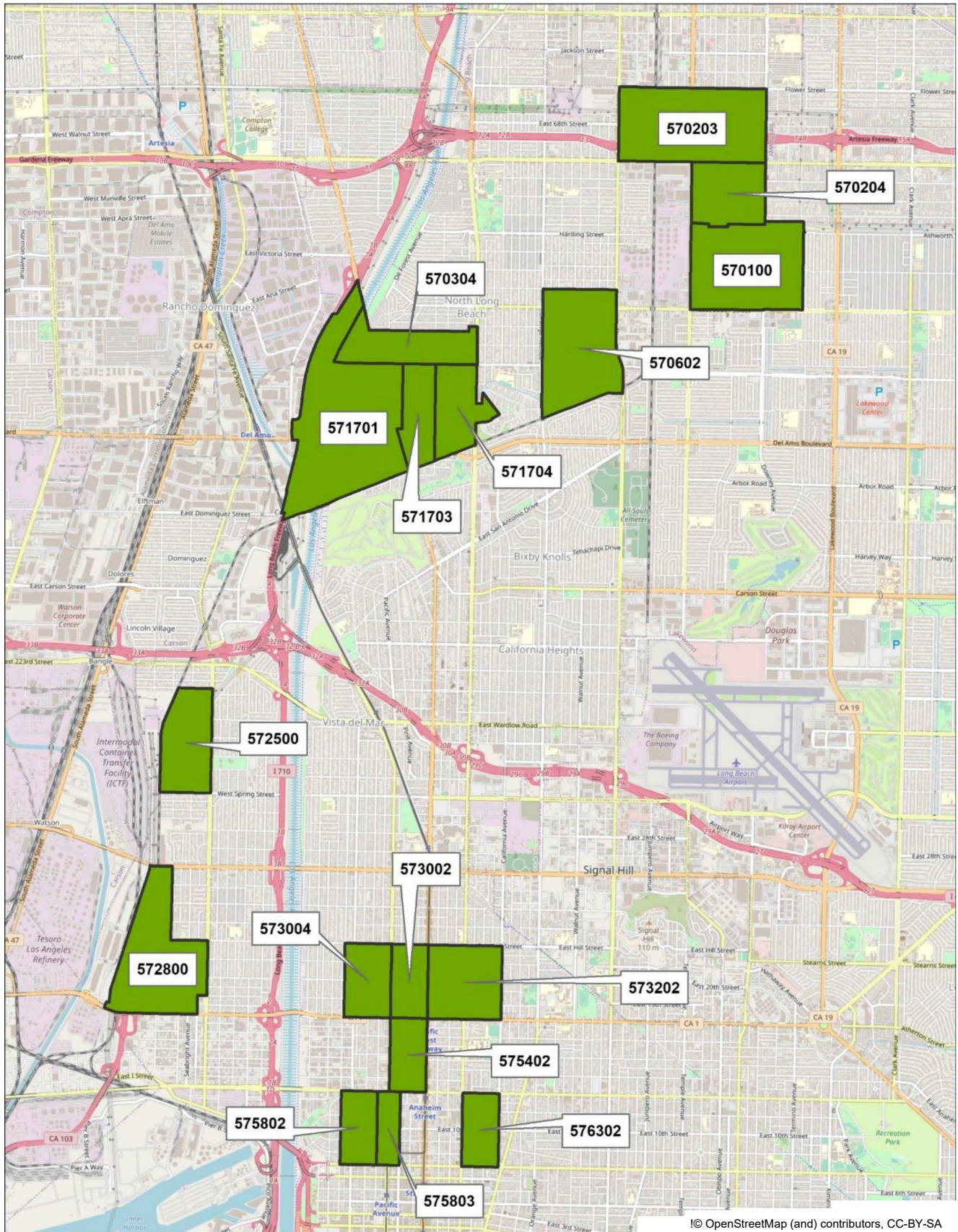
Results: City of Santa Monica Sites (3)



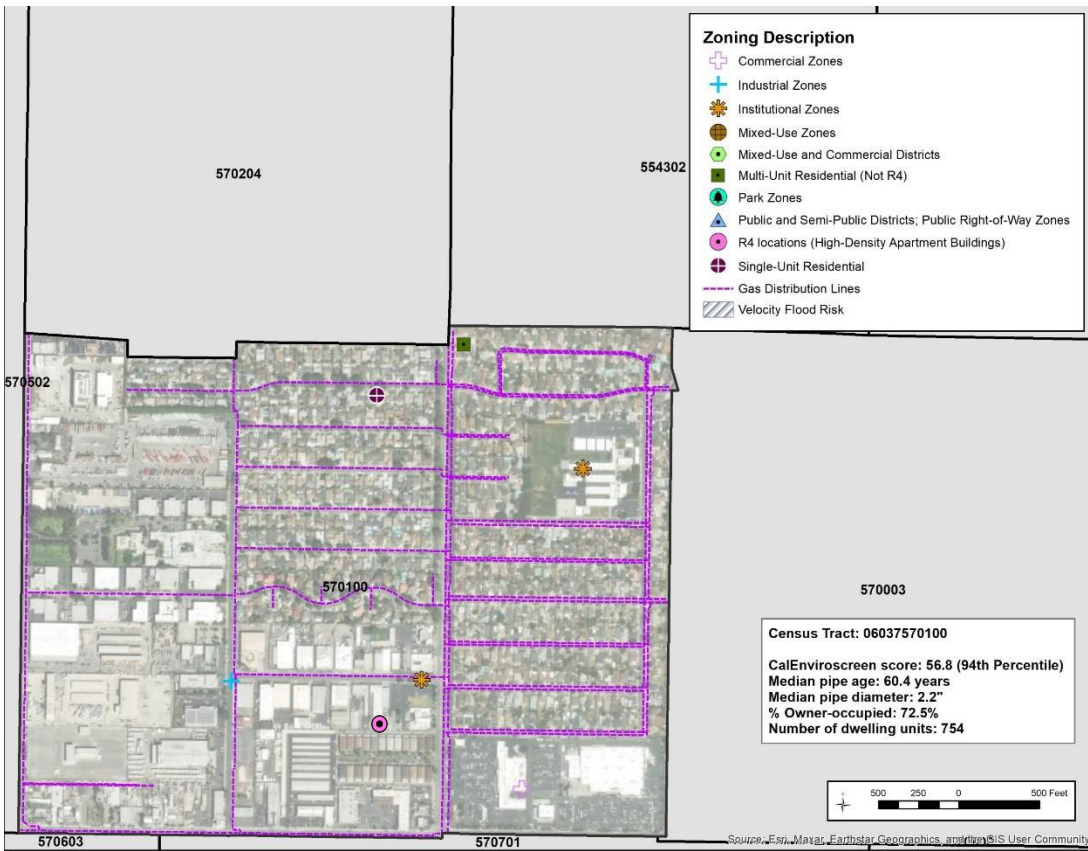
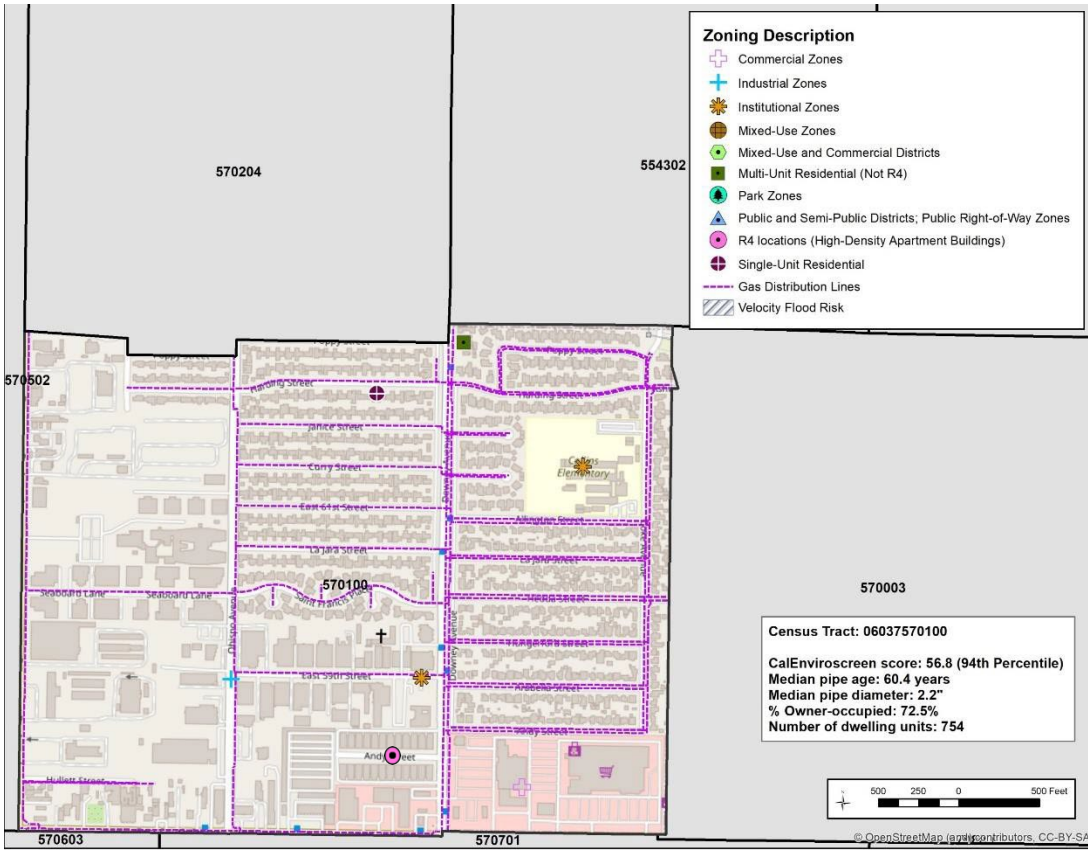


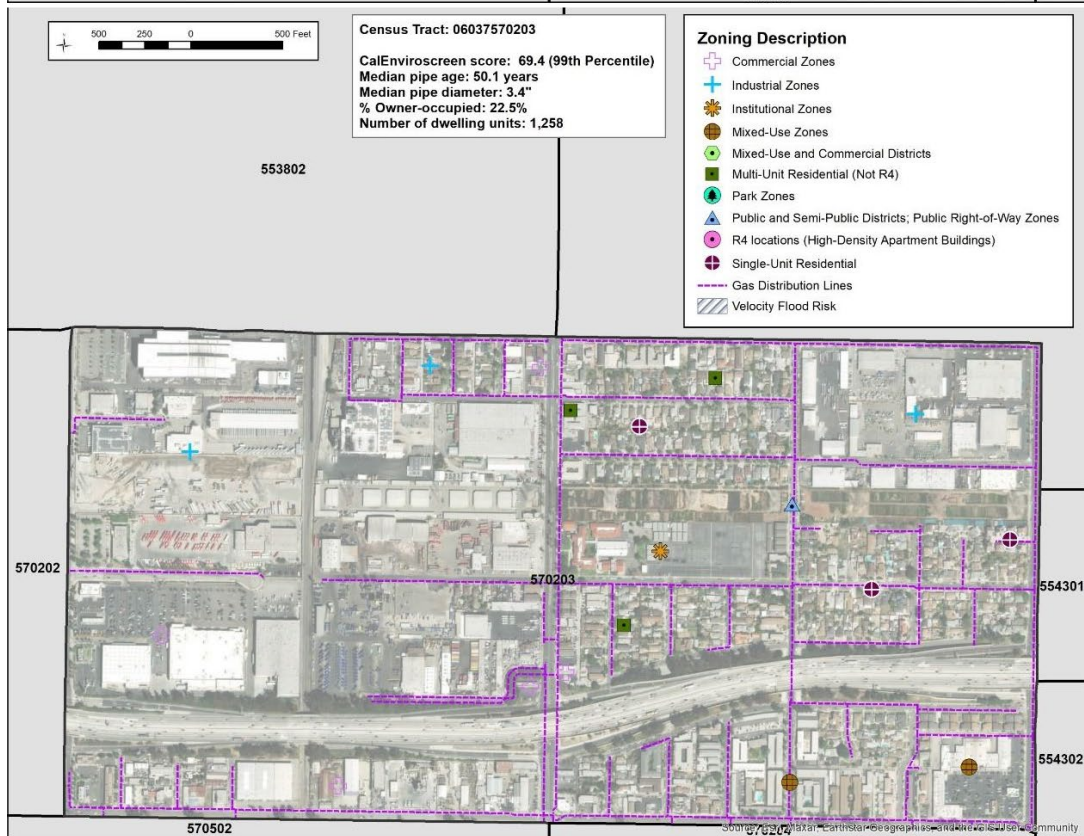
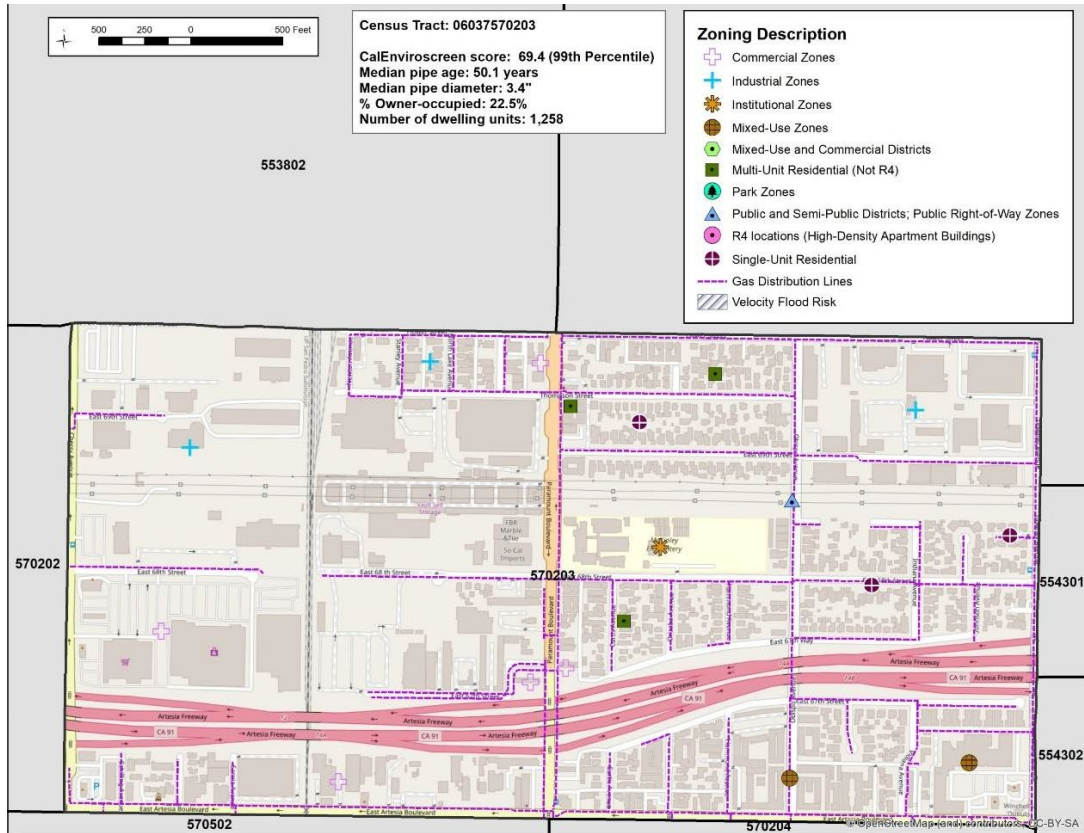


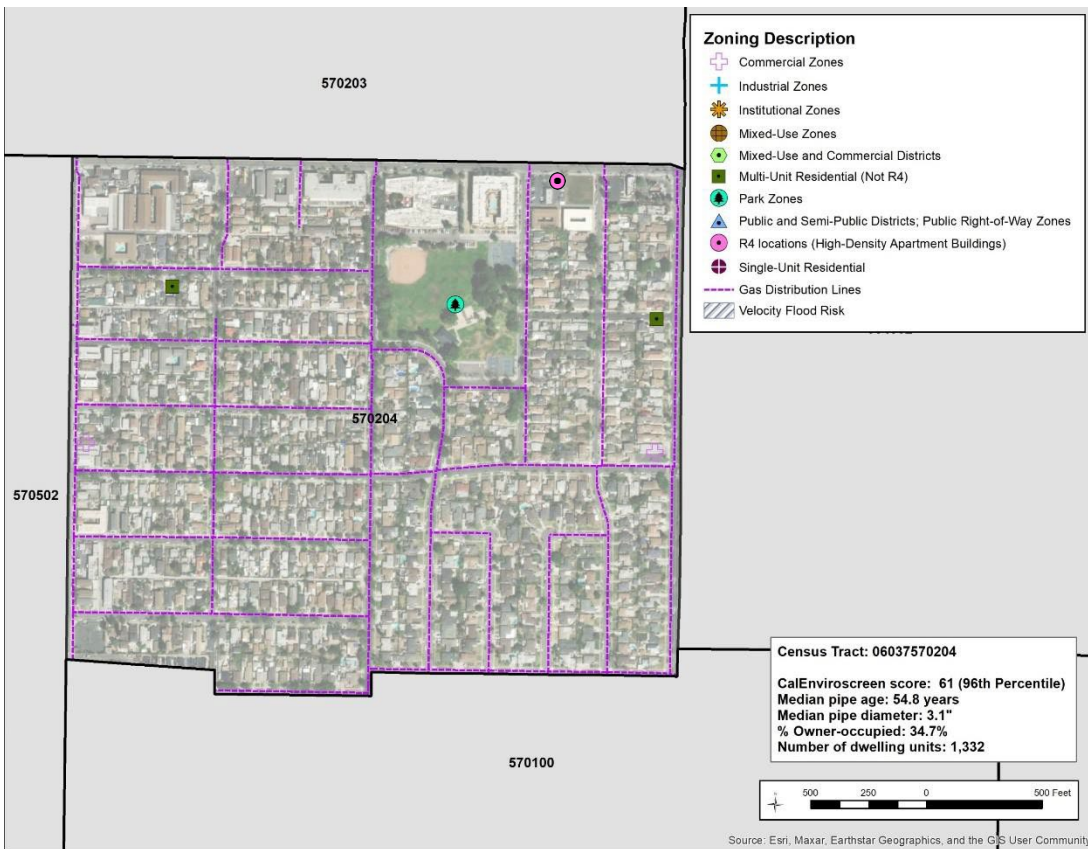
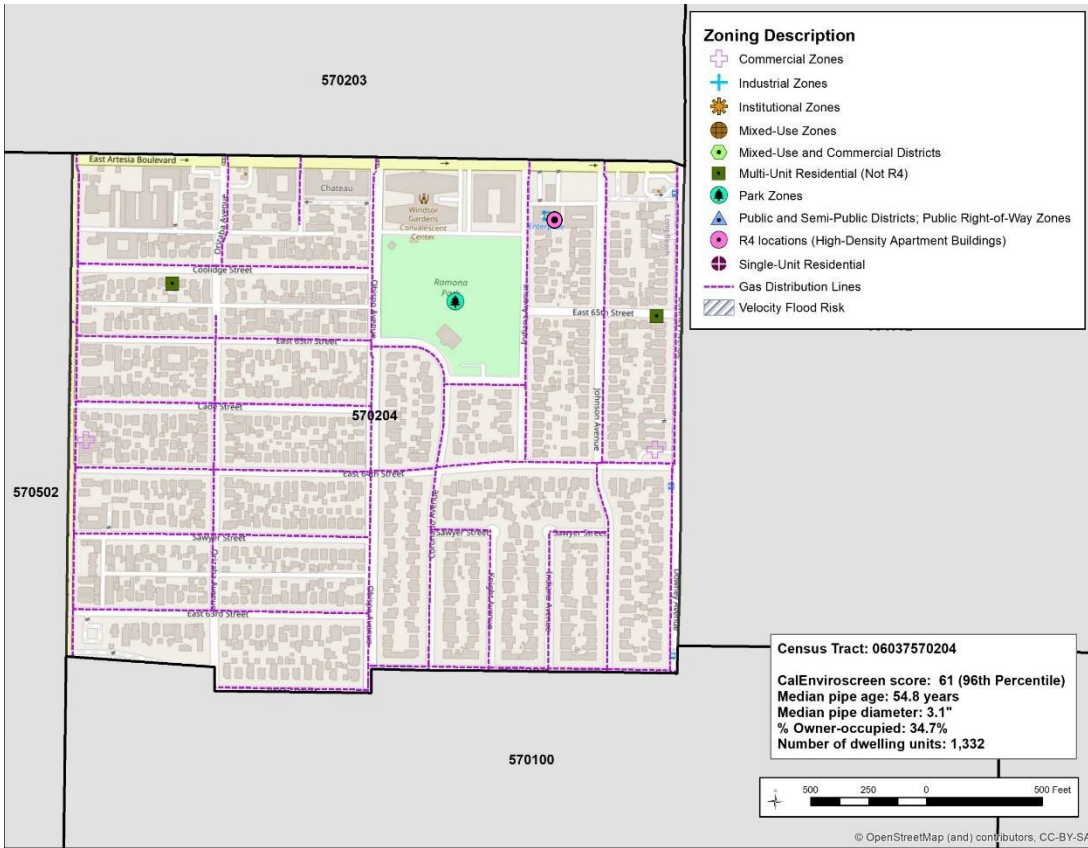
Results: City of Long Beach Sites (17)

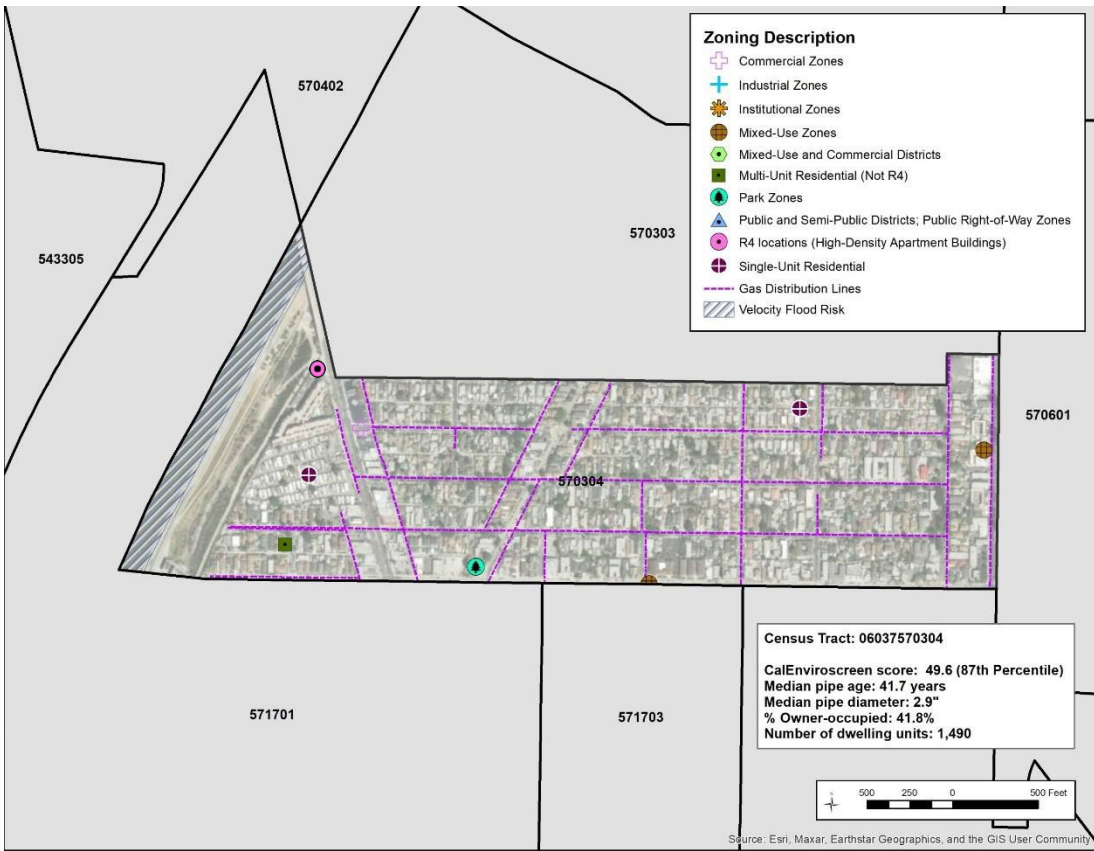
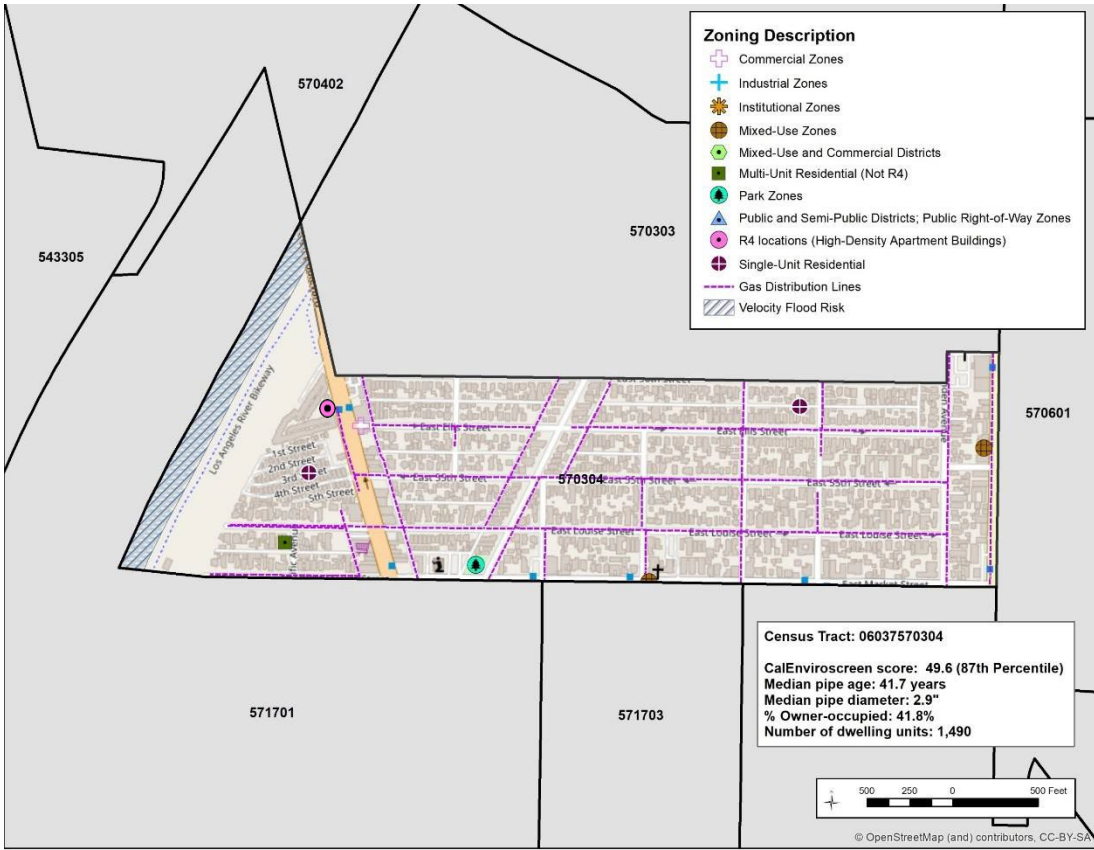


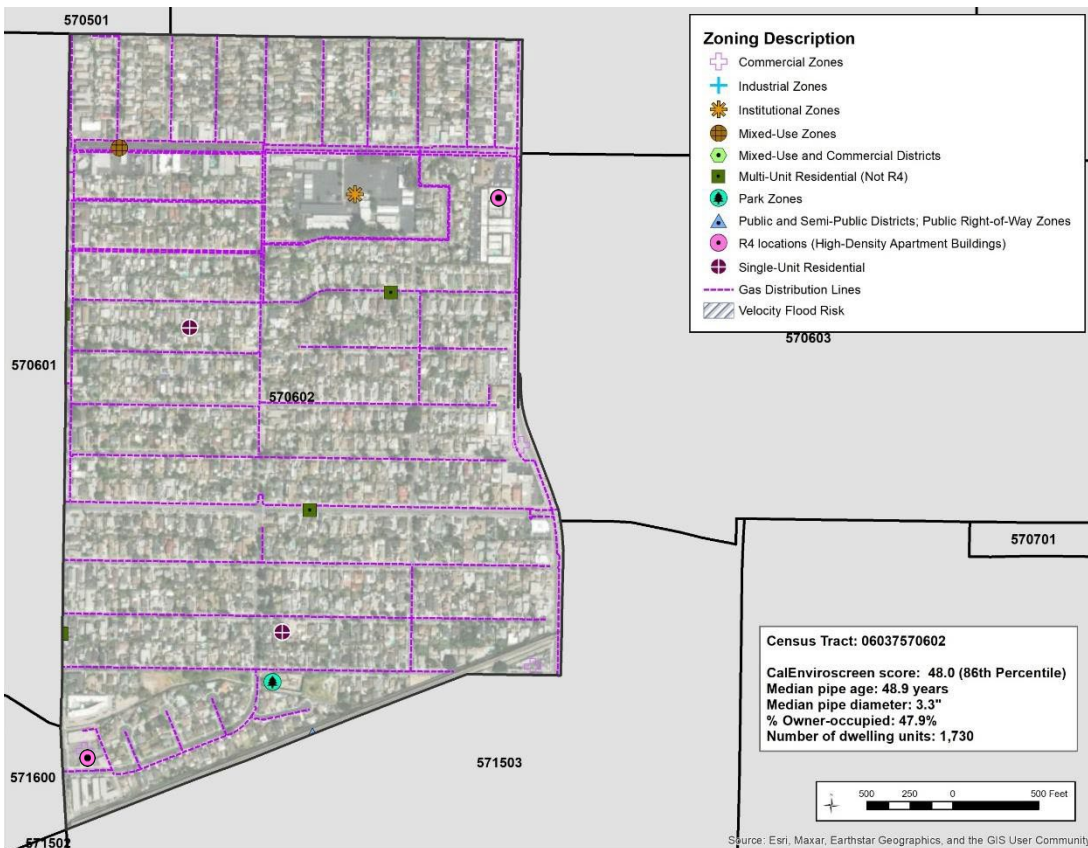
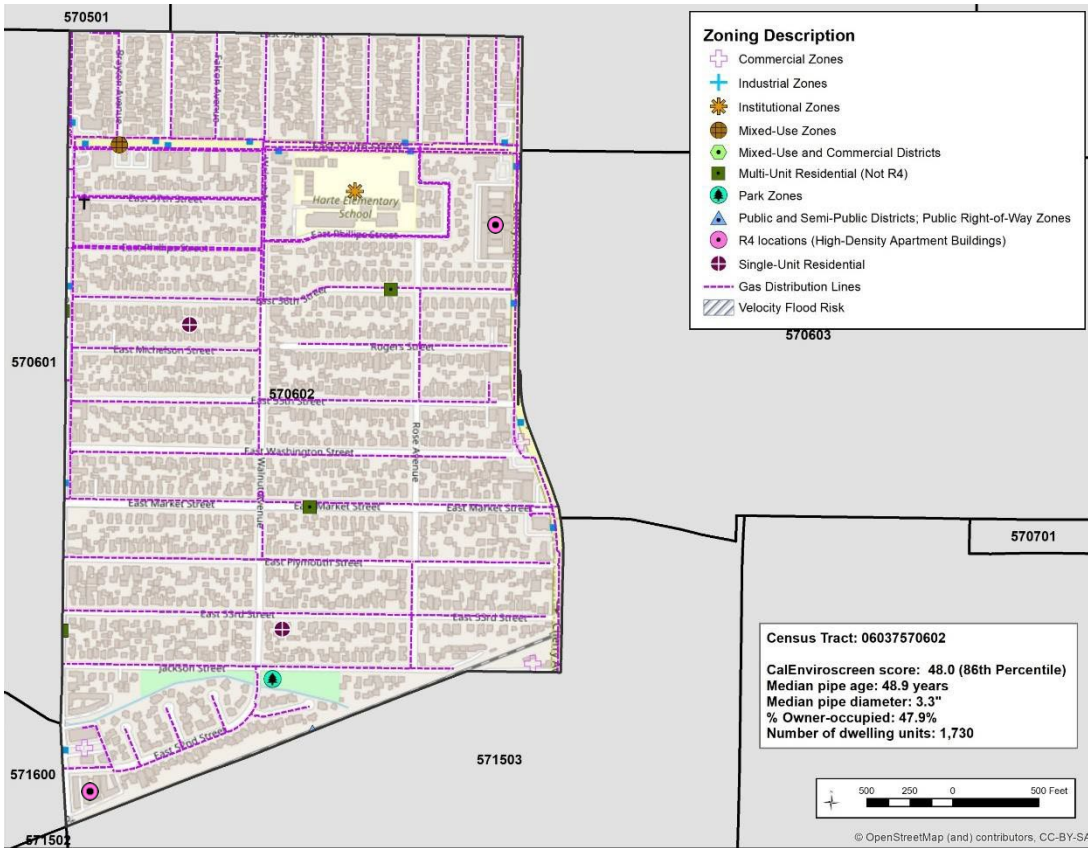
© OpenStreetMap (and) contributors, CC-BY-SA

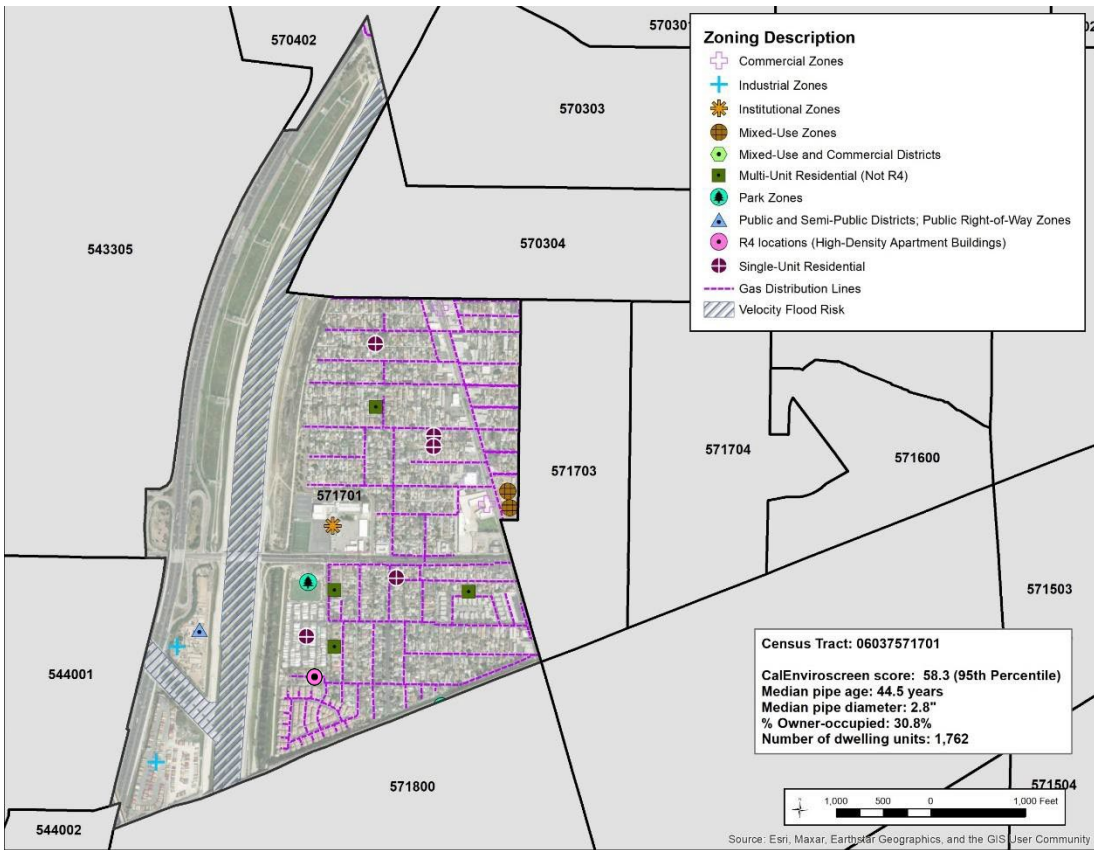
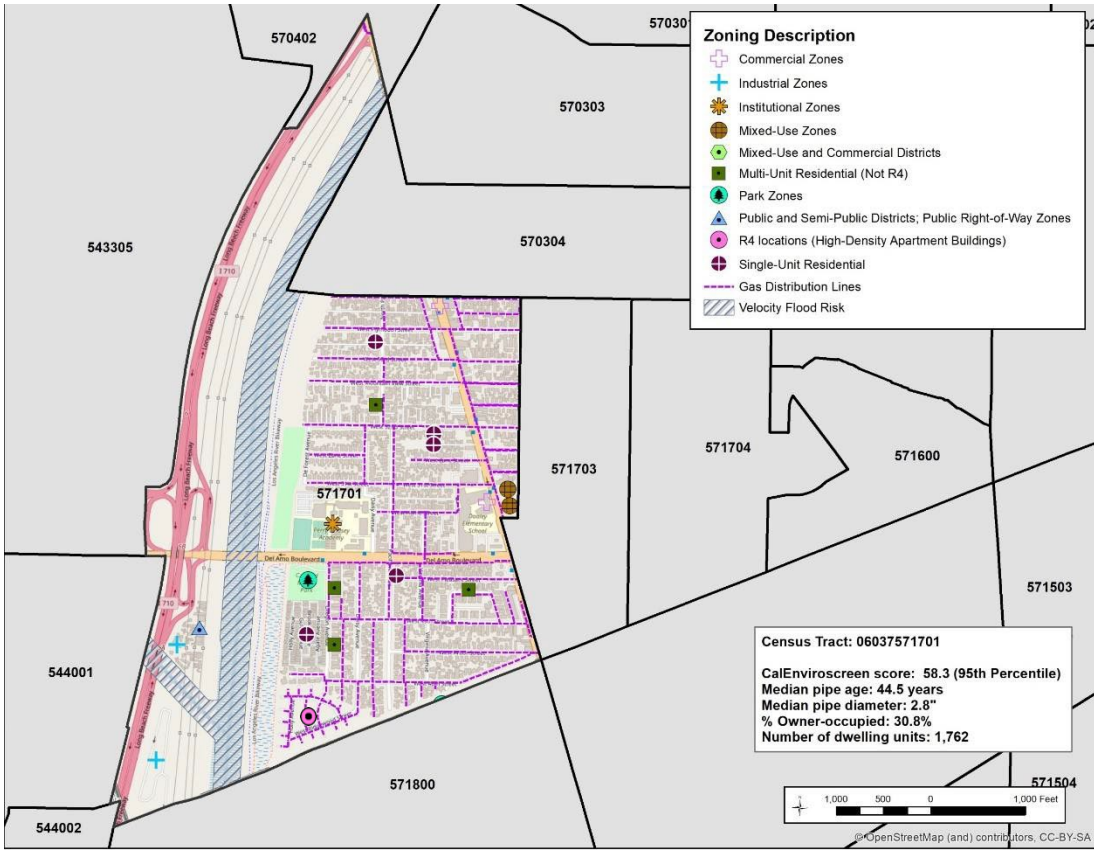


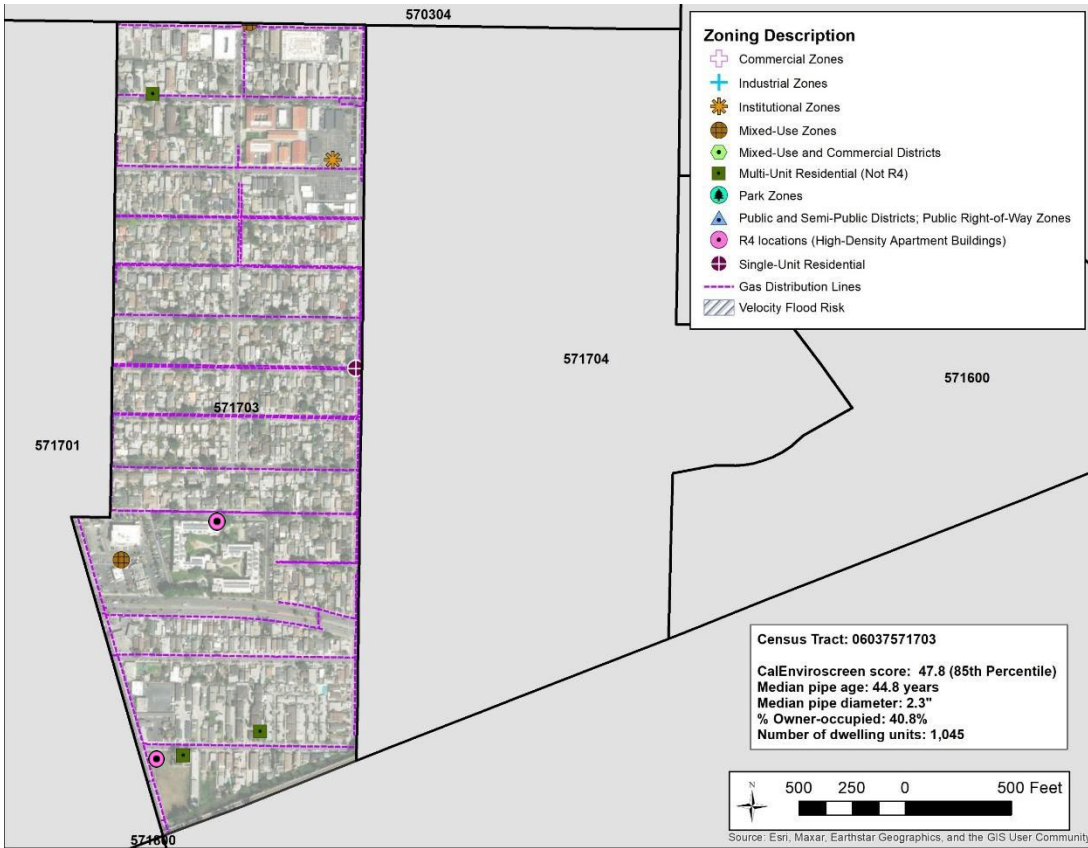
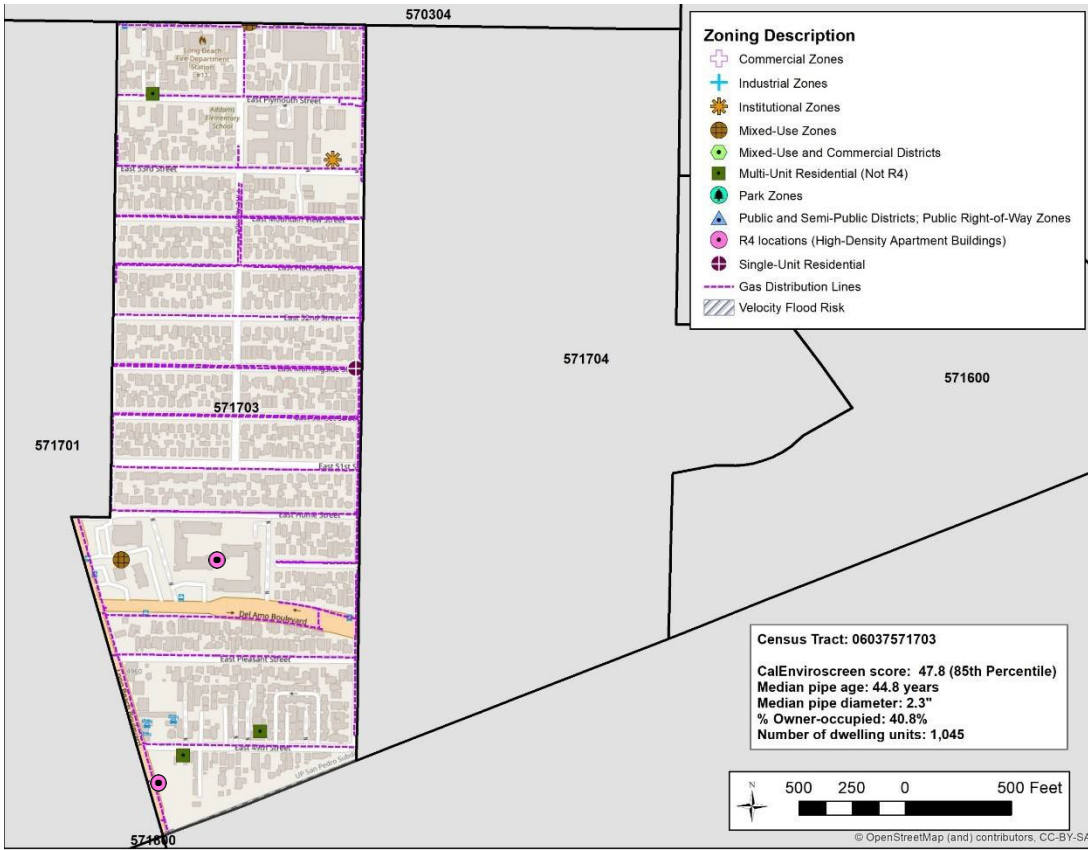


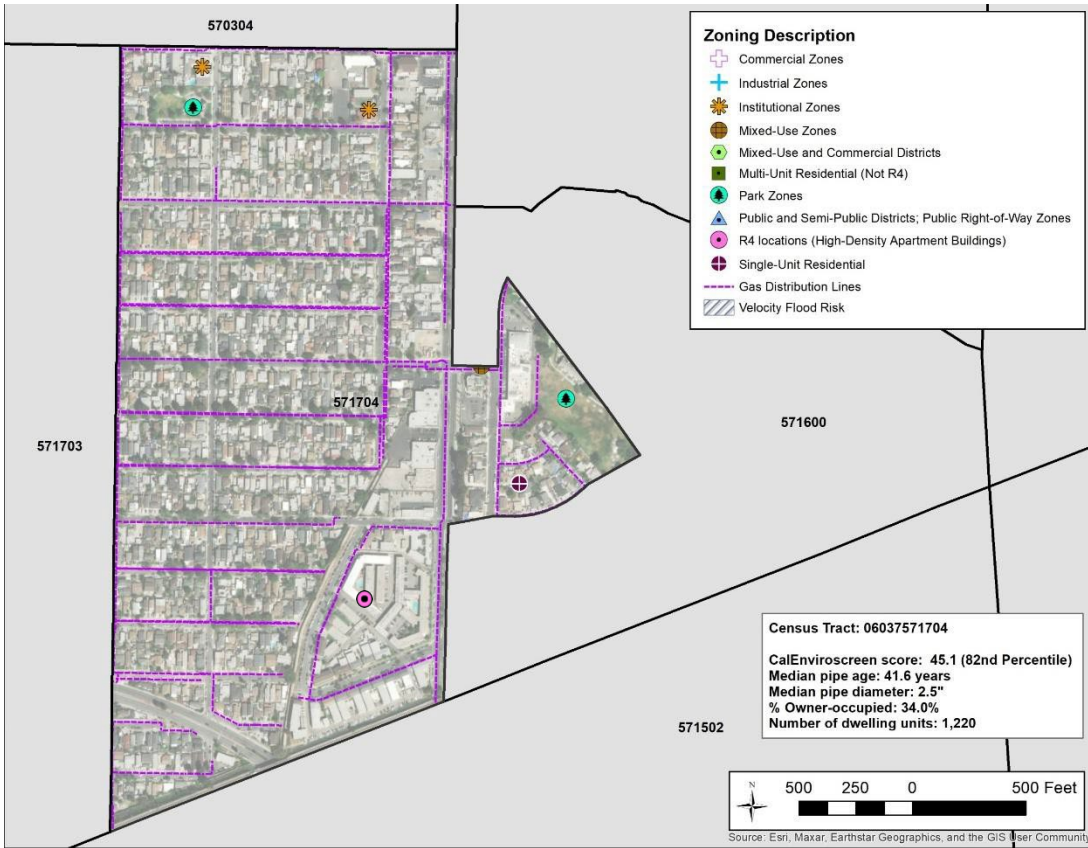
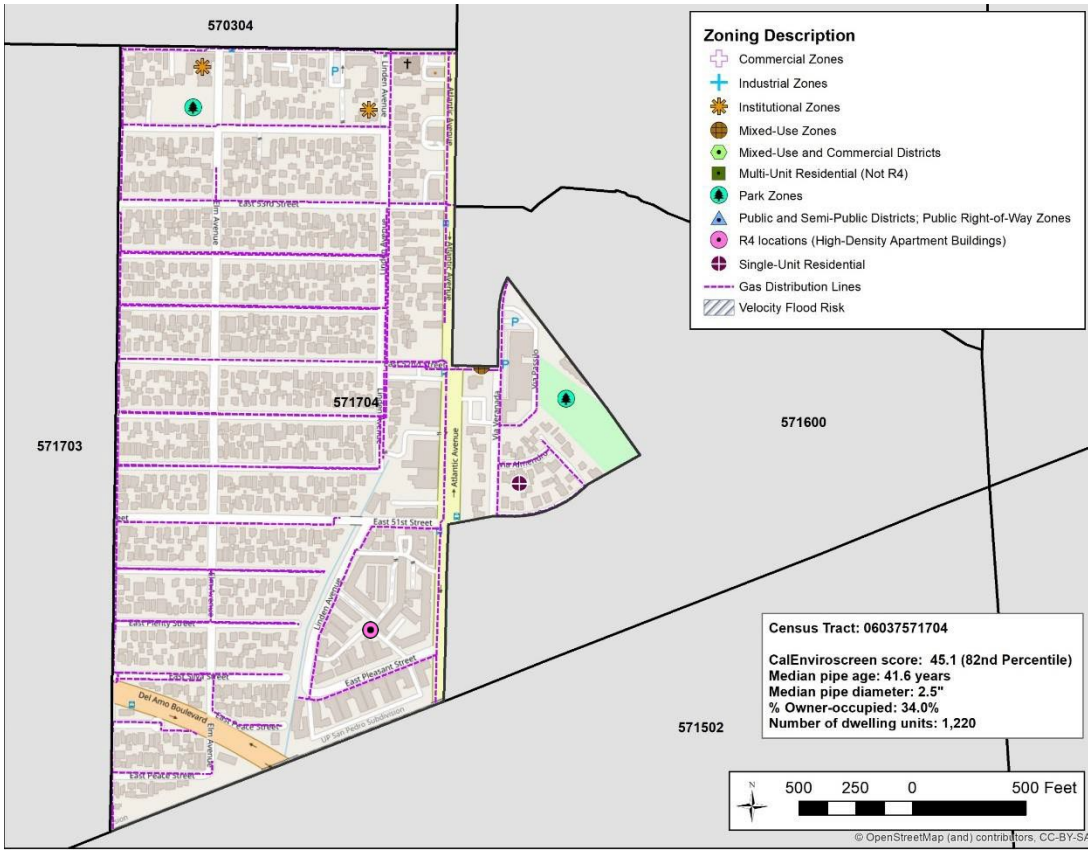


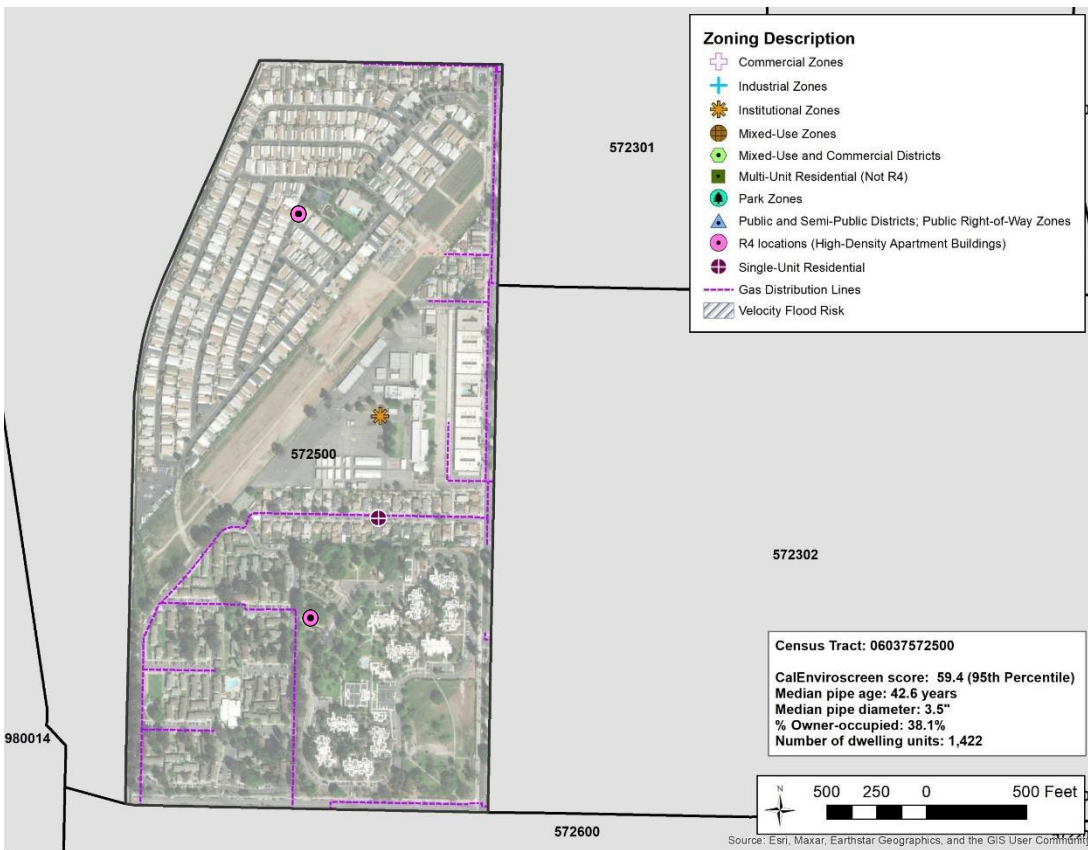
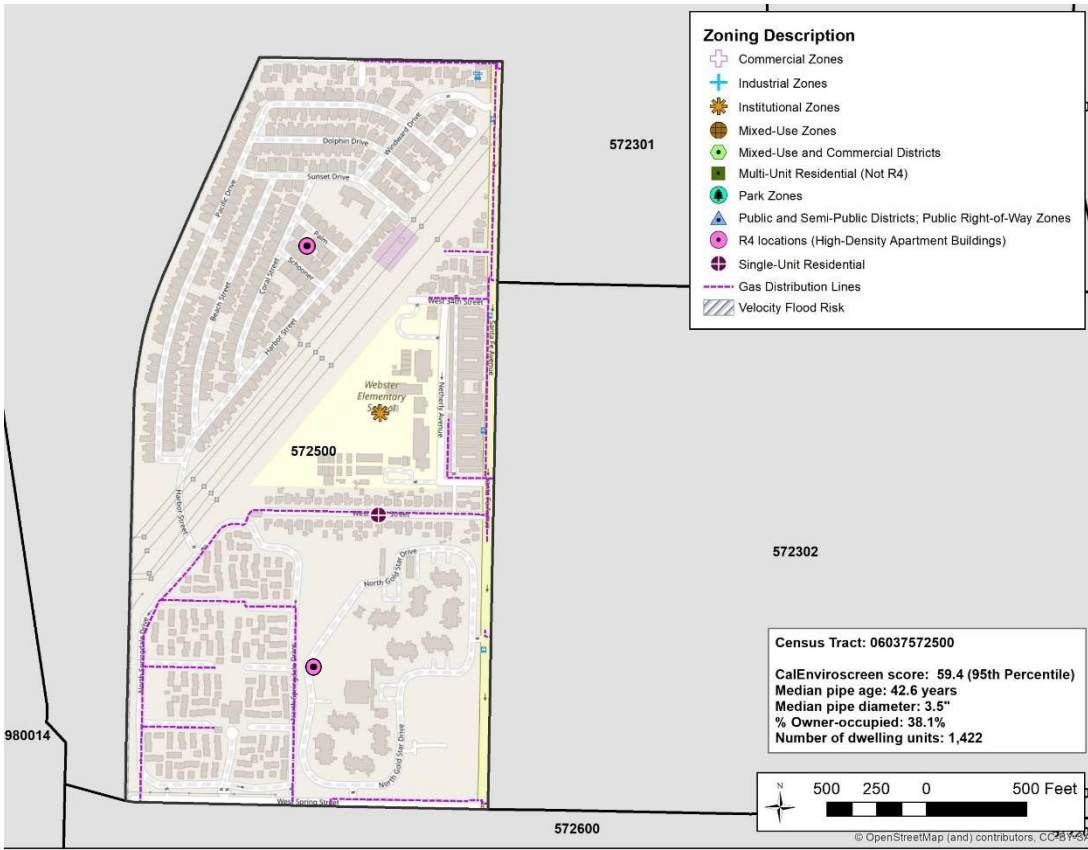


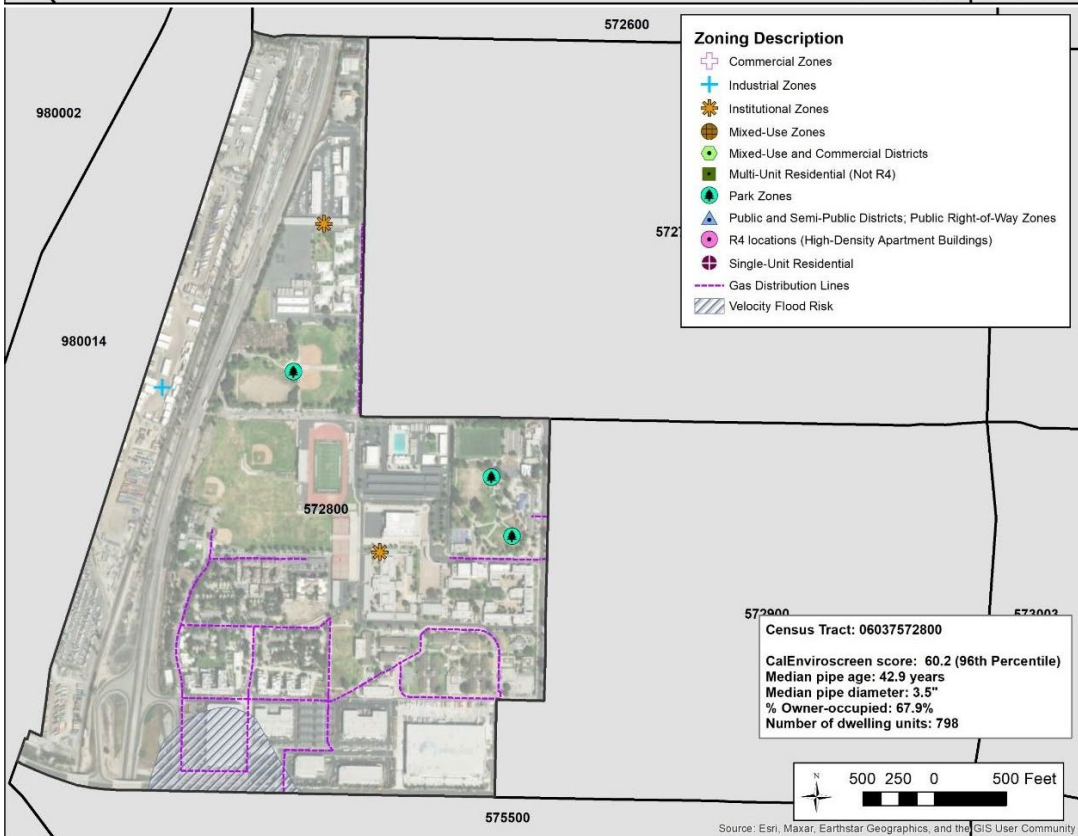
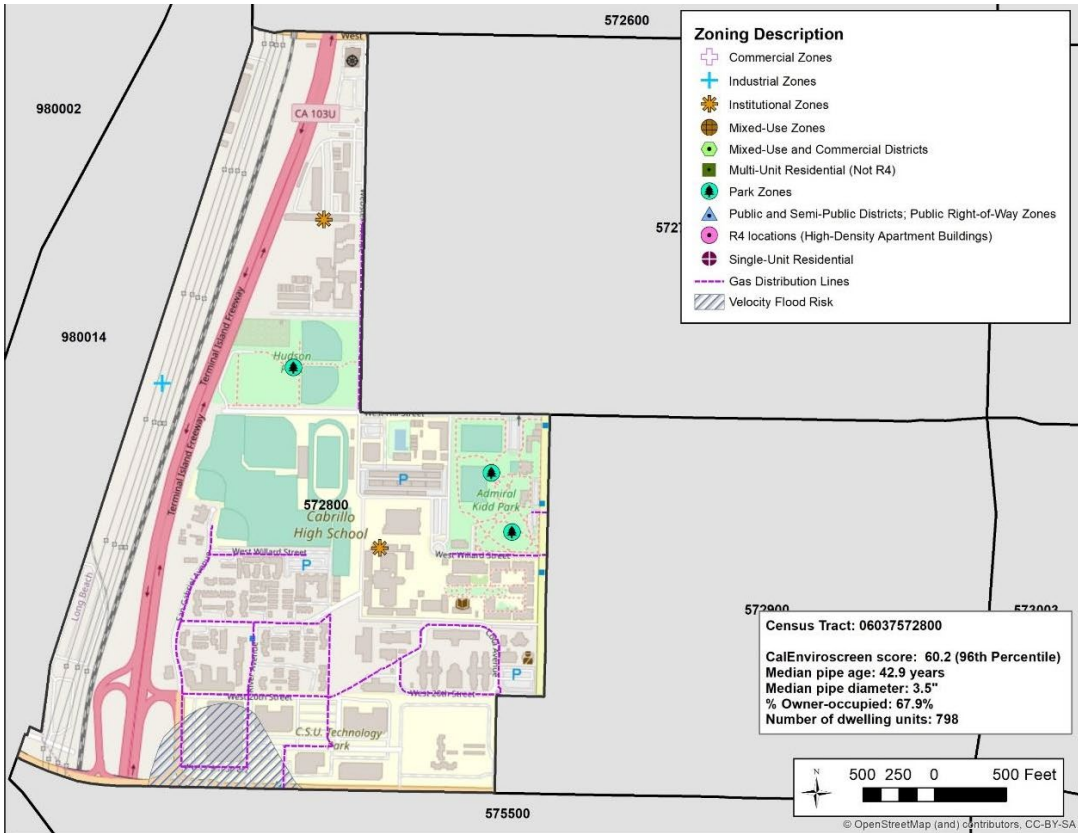


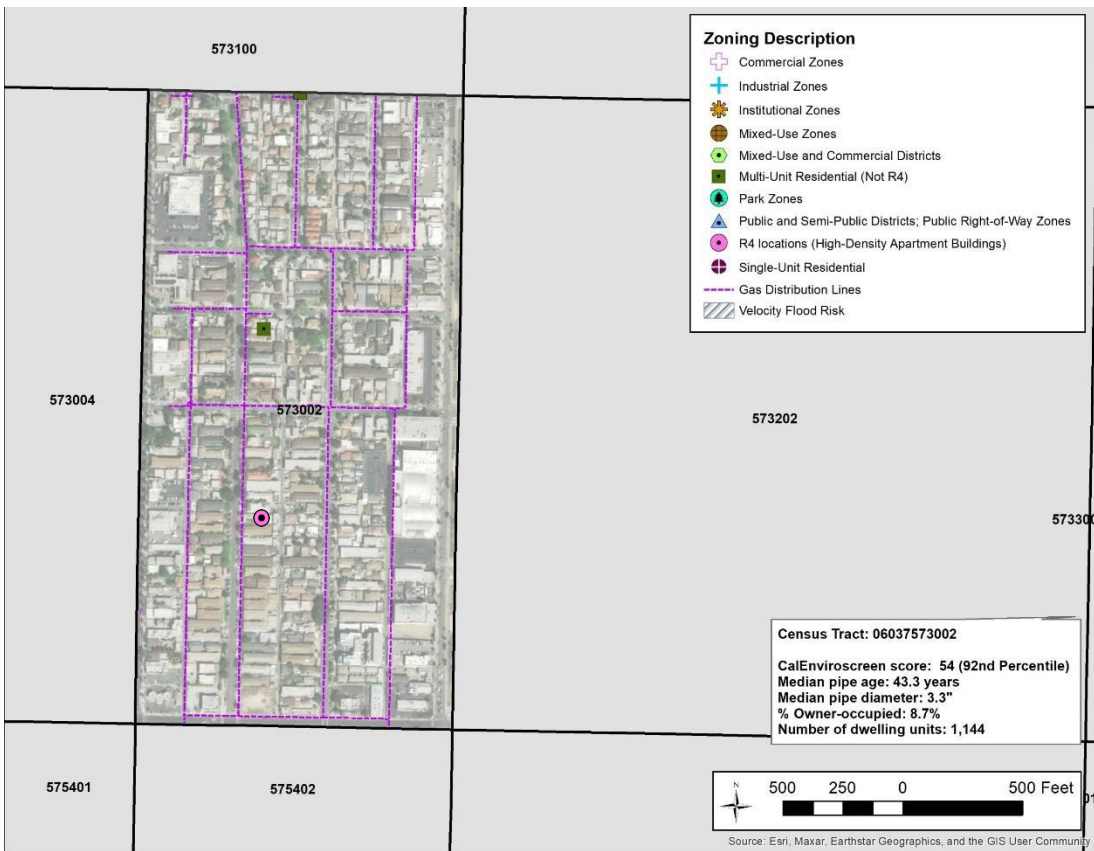
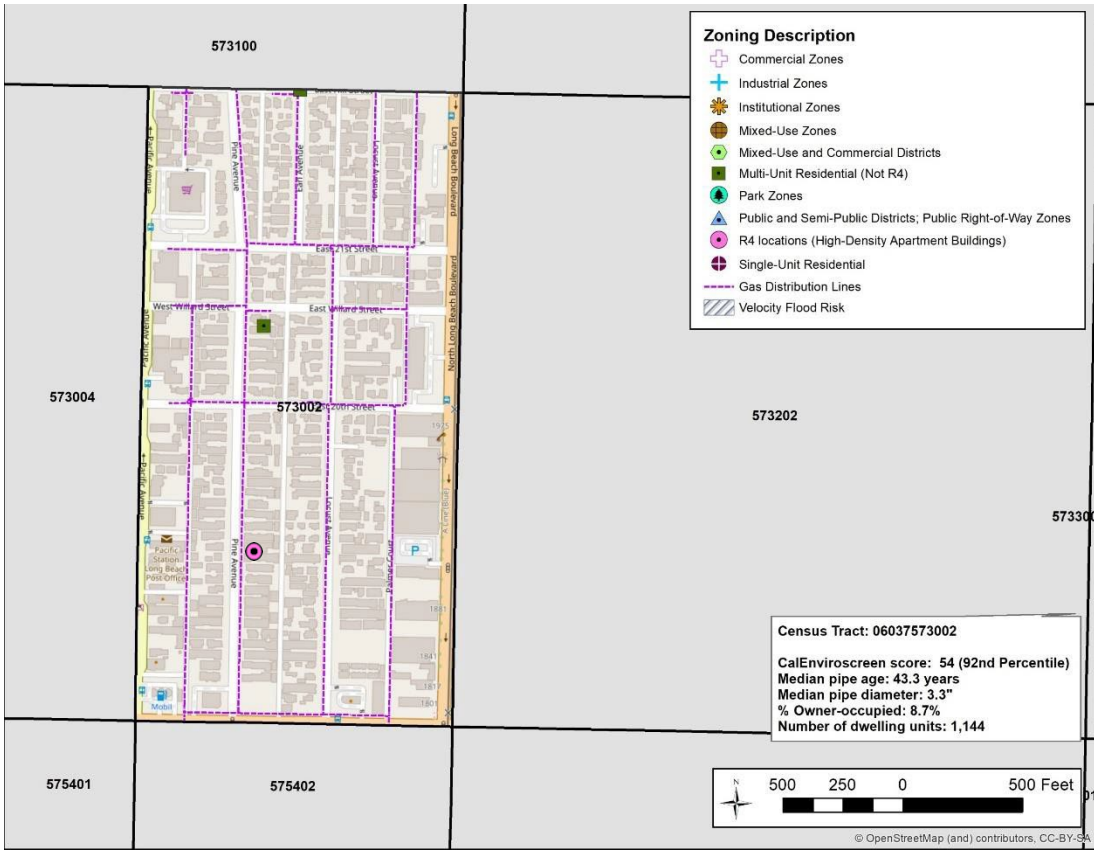


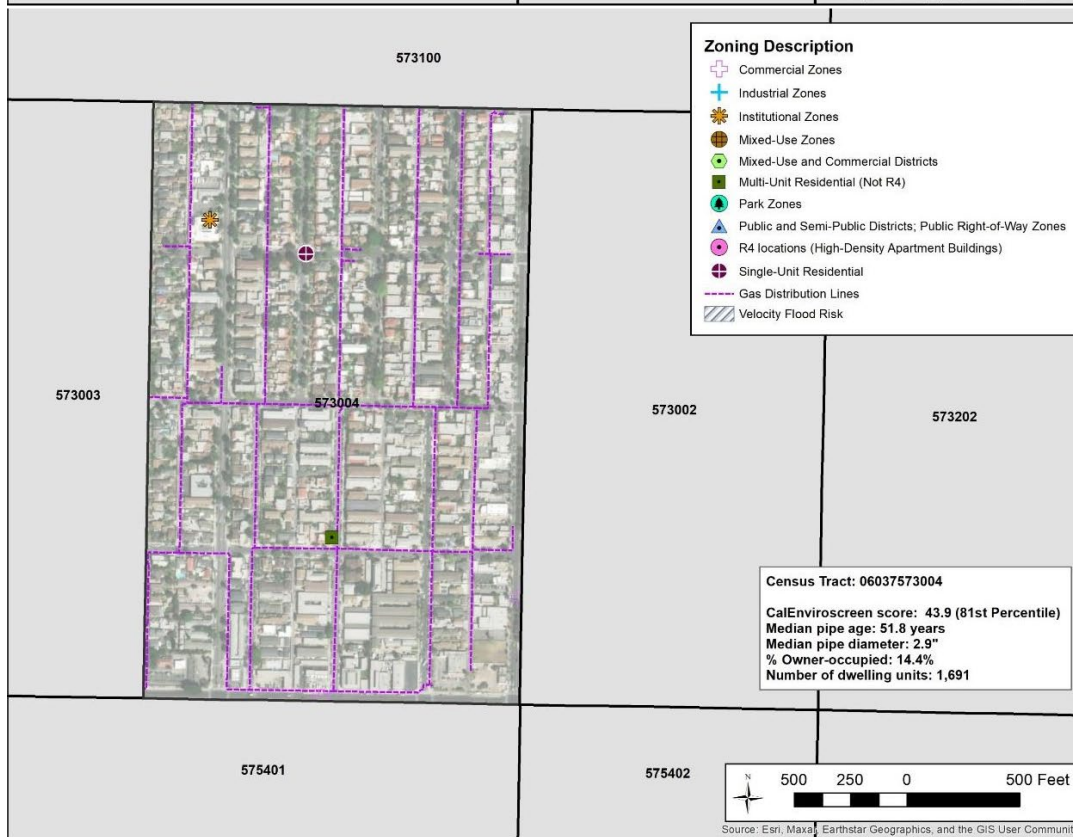
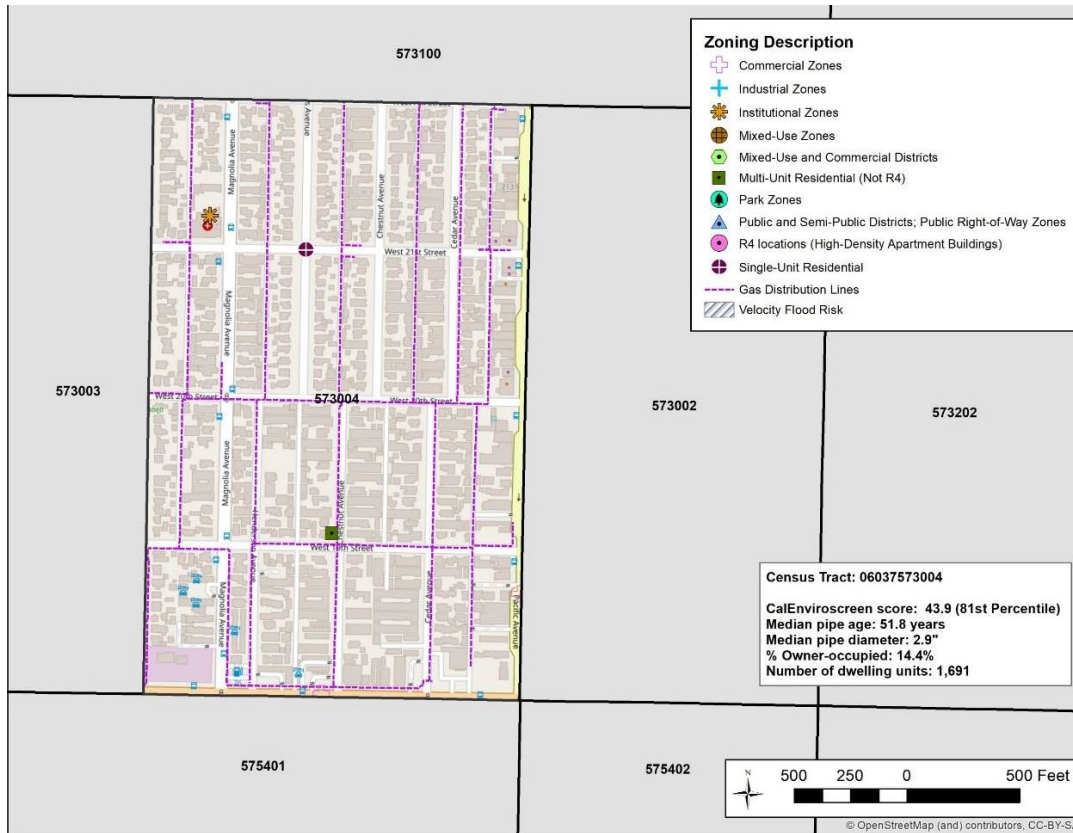


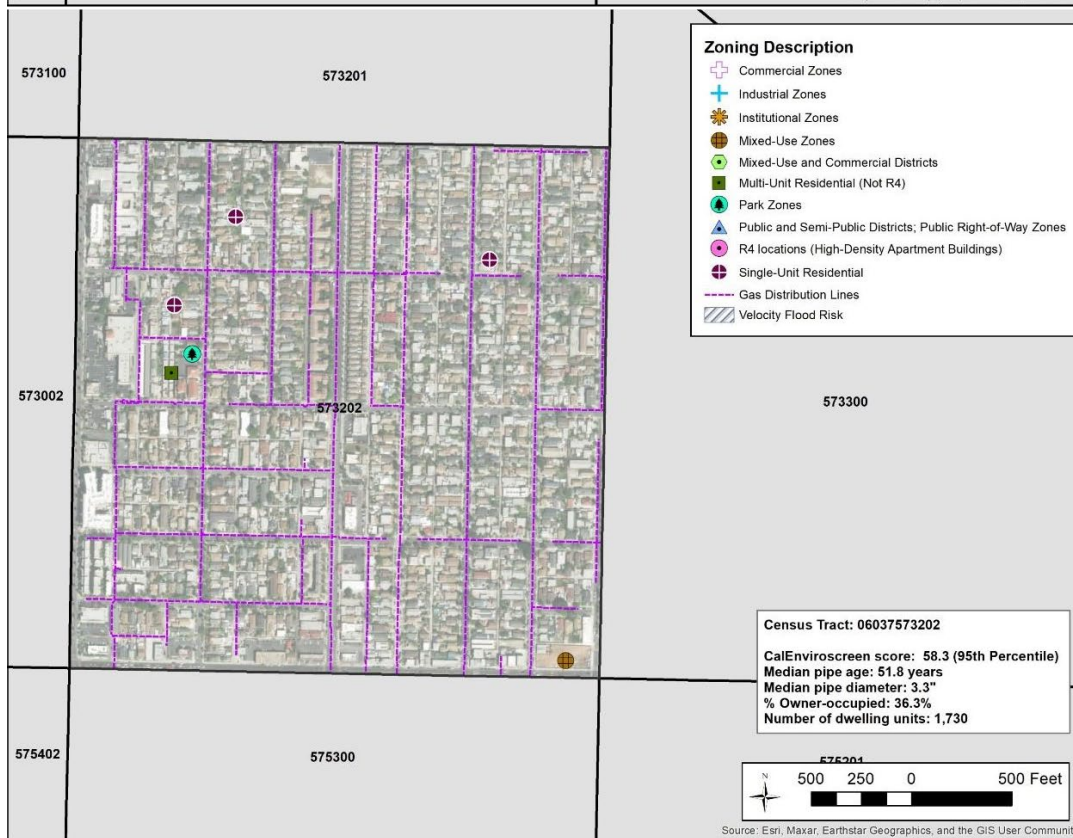


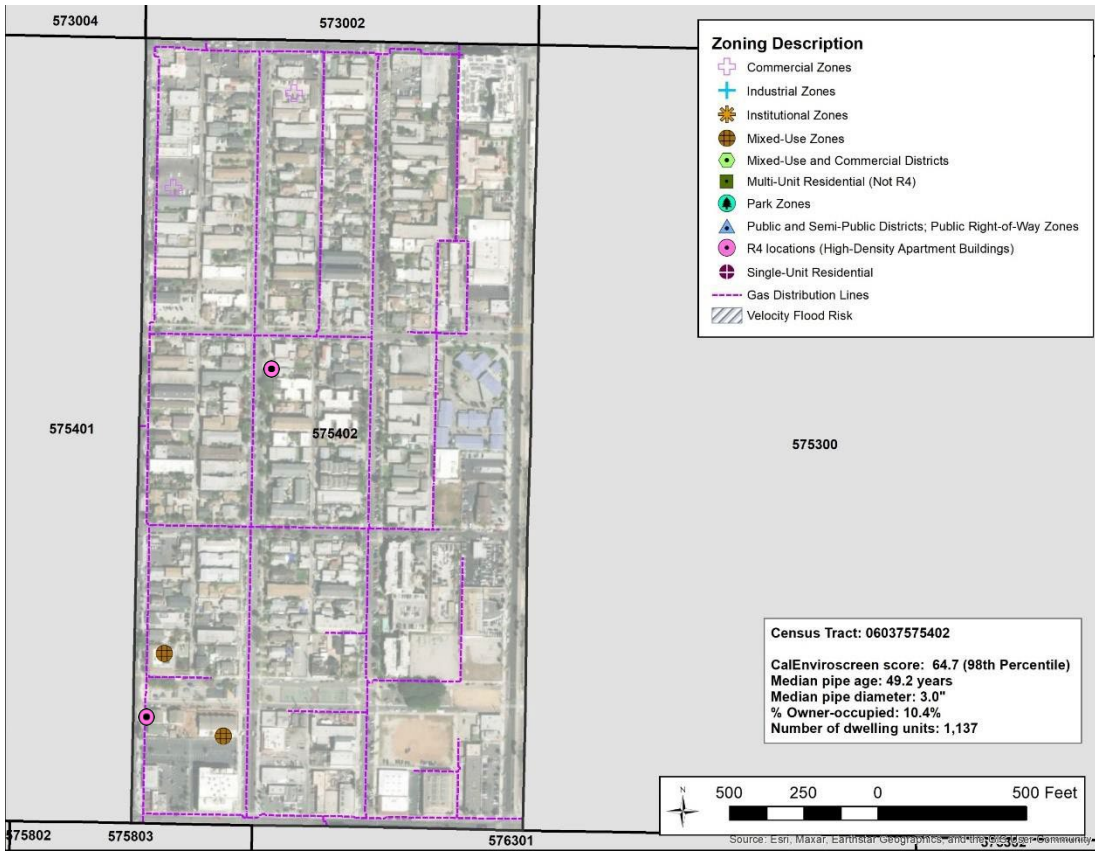
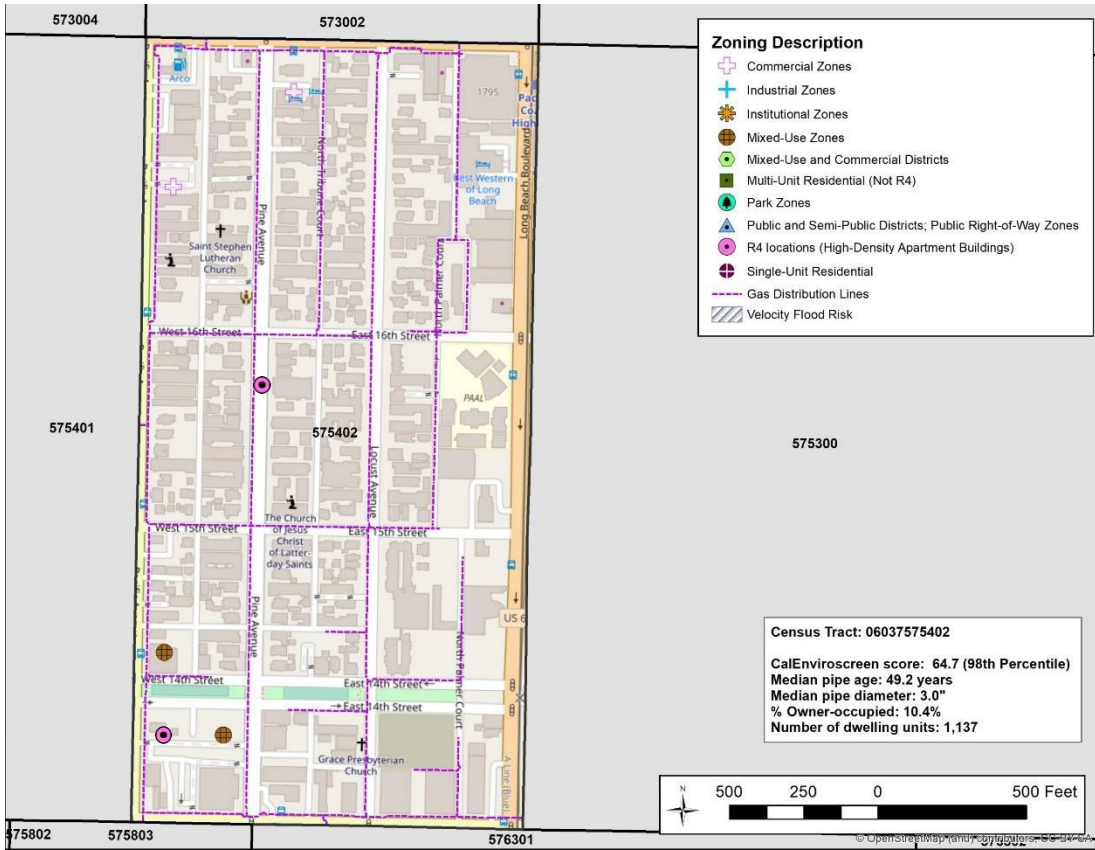


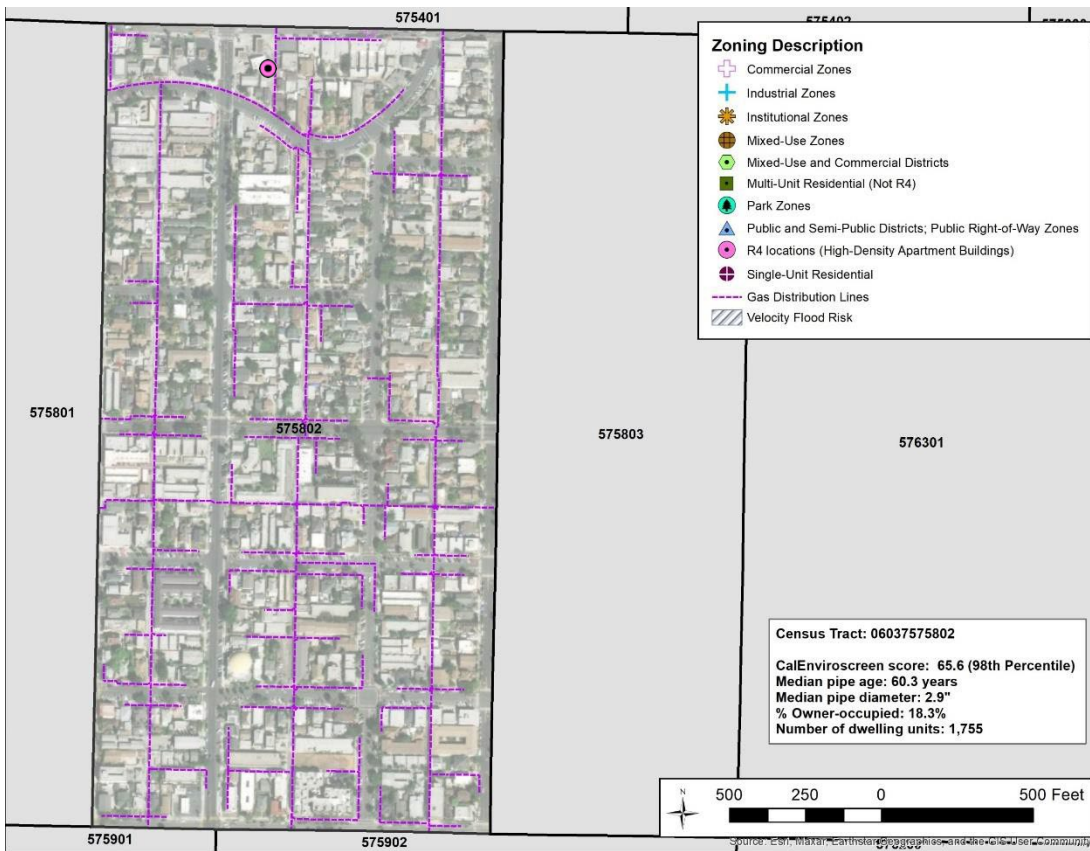
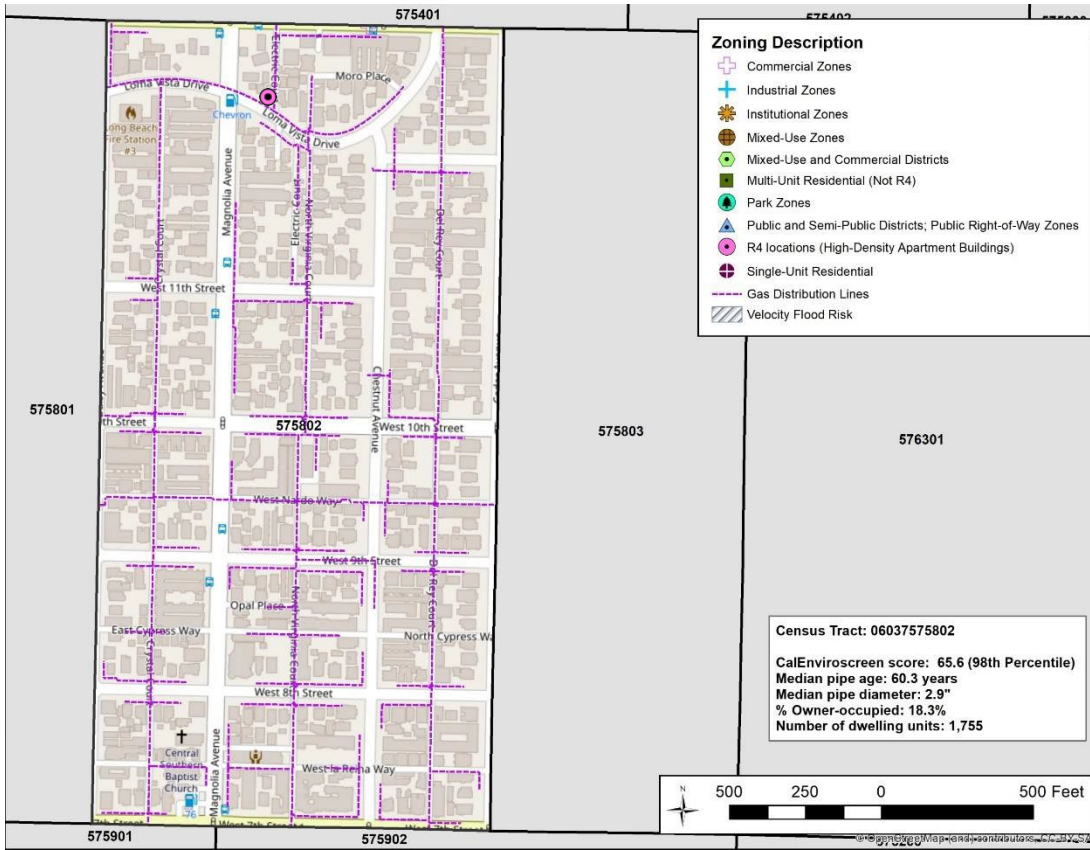


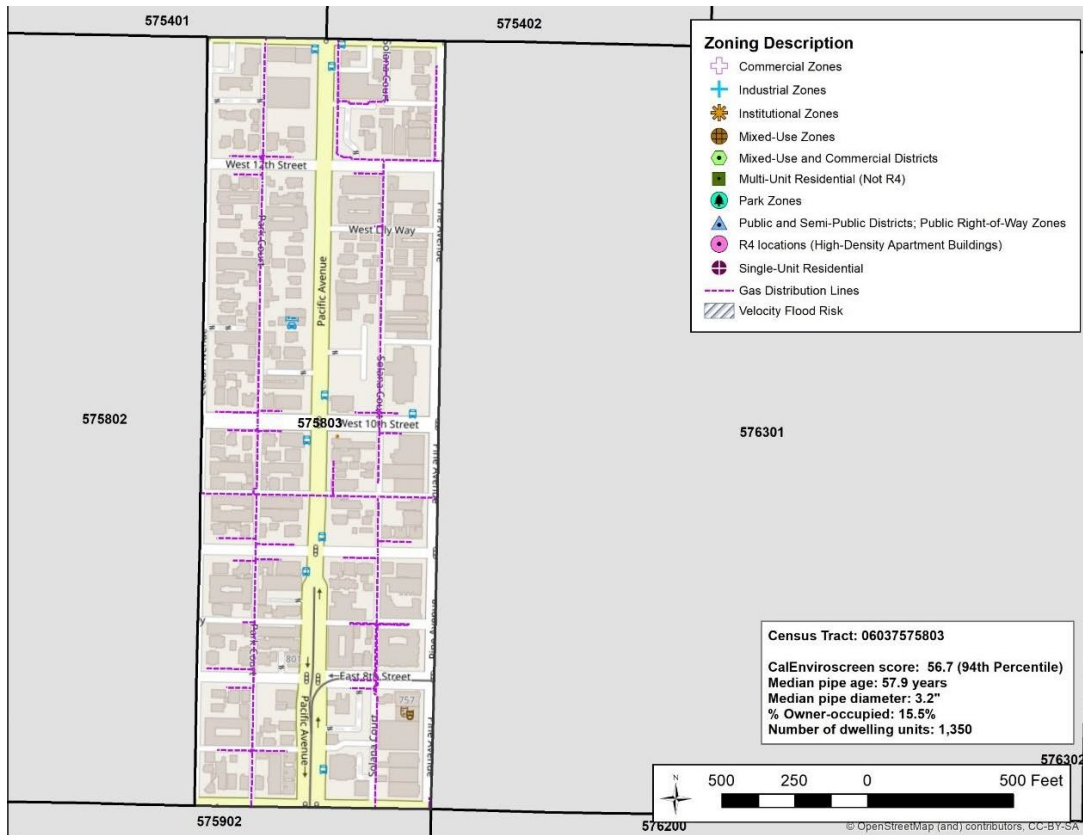


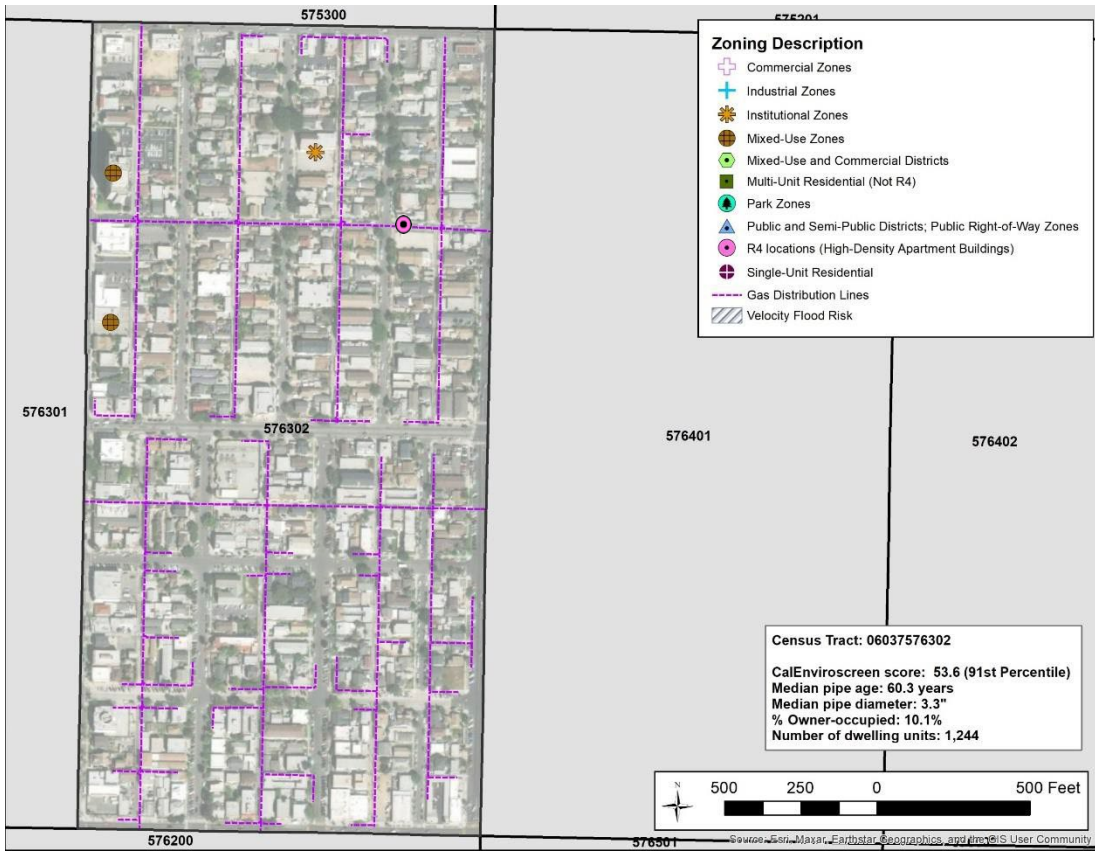
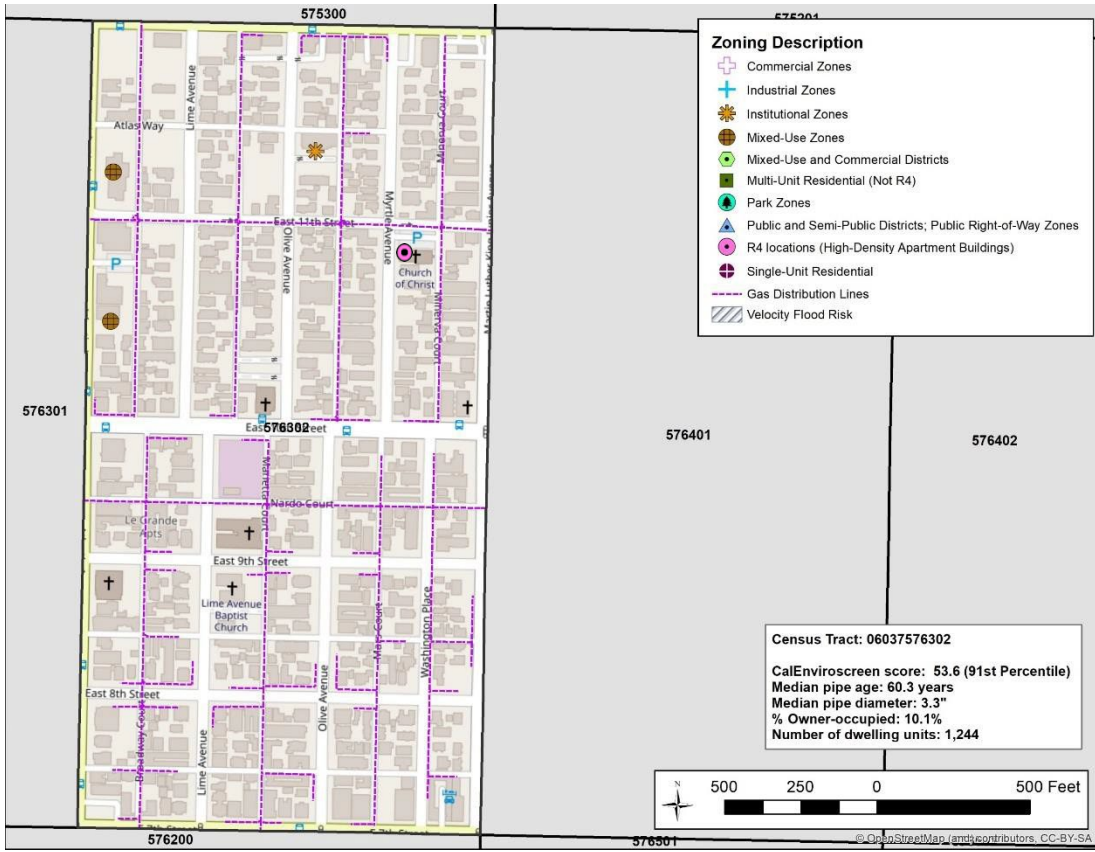














California
ENERGY COMMISSION



ENERGY RESEARCH AND DEVELOPMENT DIVISION

APPENDIX H: Results of Deliberations Workshops

May 2026 | CEC-500-2026-010

Appendix H:

Results of Deliberations Workshops

Recruitment and Participant Demographics

RAND sought to include community members engaged in, and impacted by, energy transition initiatives in the City of Long Beach and the City of Santa Monica with local knowledge of on-the-ground realities in each city, respectively. This included residents of areas prioritized for support in energy transitions due to comparatively higher environmental pollution burden and lower average household income, as well as individuals affiliated with city offices, local nonprofits, and local businesses.

Similar to the target population selection for the Scoping Workshops and interviews conducted earlier in this study, RAND sought to include a variety of perspectives by recruiting individuals with diverse demographic characteristics including age, age and race/ethnicity. These pools of community members were not intended to be representative of the general population, rather, their experiences and viewpoints were sought to prioritize perspectives of residents of target locations. Since RAND previously invited participants from other city offices including planning and utilities, RAND included them among invitees to continue to have representation from participants with some exposure to planning for, or participating in, energy transitions including consideration of social, economic and environmental impacts. RAND also asked the communities (City of Santa Monica, City of Long Beach), two community-based organizations (Community Corporation of Santa Monica, Century Villages at Cabrillo) and multiple utilities (Southern California Gas, Southern California Edison, and the City of Long Beach's municipal natural gas utility) to determine whether additional stakeholders should be invited.

Together with City partners and community-based organization partners in each location, RAND invited previous workshop invitees, and sought out representation from community groups in priority neighborhoods including members of business improvement associations, neighborhood associations, councilmembers, elected board members for local initiatives such as parks and local non-profit organizations, and community advocates.

106 potential participants were sent an invitation to participate in an in-person Deliberations Workshop. 37 invitees accepted invitations and 29 individuals participated in workshops, 13 people and 16 people in Long Beach and Santa Monica respectively, in November 2022. Table H.1 summarizes affiliation and demographics of participants in each workshop. In Long Beach, approximately one quarter of participants were female, slightly less than half were non-white race/ethnicity and around two thirds were 30-50 years of age. In Santa Monica, participants were roughly two thirds female, roughly one third were non-white race/ethnicity and half were in the 30-50 years of age.

To offer more detail, in Long Beach, guest participants included residents and representatives of city offices outside of the unit that was the research partner. Guest (i.e. non-partner) representation was 31% female and 58% non-white with representation from Black, Latino and Asian race/ethnic groups, 42% of residents were outside of the 30-50 age bracket, with

1 individual <30 and 4 individuals >50 years of age. In Santa Monica, guests were residents and there was not participation from representatives of city offices beyond the project partners. This was due to scheduling conflicts reported by invitees as opposed to any reported unwillingness to participate. Guest representation was 62% female and 44% non-white with representation from Black and Latino race/ethnic group, 37% of residents were outside of the 30-50 age bracket, with 1 individual <30 and 5 individuals >50 years of age. In both workshops, participants included formerly unhoused residents, tenants of verified low-income housing, and renters, owner-occupiers, and landlords of both smaller (<4 units) and larger (>12) multi-family housing.

Table H.1: Participant Demographics

Participant Type	Affiliation	Long Beach				Santa Monica			
		N	% male	% white	% age 30-50	N	% male	% white	% age 30-50
Partners	CBO	1	74%	58%	63%	1	41%	64%	50%
	City partners	2				2			
	Utility partners	3				3			
Guests	City affiliates	4				0			
	Residents	9				16			

Deliberations Workshop format

Two workshops were conducted in November 2022, one for each city respectively. The duration of each workshop was a half day, and participants were compensated for their time. Workshops were hosted and moderated by the study principal investigator and discussions were facilitated by study staff who were trained moderators. The same general format was used for Long Beach and Santa Monica workshops and city-specific content was developed for relevant activities. The workshops followed an agenda that included an introductory presentation from RAND and research partners that presented a decision support tool for identifying strategic decommissioning locations based on characteristics identified as important by stakeholders in earlier stages of this study. These included aspects of the natural gas distribution network, environmental pollution burden, household income, age of the housing stock, and potential costs to consumers of decommissioning natural gas. (See “Potential Decommissioning Pilot Sites Memorandum” for further information on the data included). Presentations were followed by three activities: by (A) small group discussions lead by facilitators in which participants discussed a decision support tool for selection priority areas for pilot decommissioning candidate sites, (B) a moderator-guided question and answer session, and (C) a second small group discussion to nominate potential candidate sites. There were 3 small group discussion tables, each with one facilitator and one note-taker.

Small Group Discussions of Decision Support Tool

Participants were assigned to heterogeneous small groups including residents, city officials, and utility representatives. Facilitators led discussions to seek feedback on the decision

support tool for prioritizing census tracts and provided annotated maps of priority census tracts in the respective cities. Topics that participants volunteered were similar to ideas and perspectives previously shared during stakeholder interviews and a previous workshop including, concern for who will bear costs and readiness of electrification as an alternative. An emergent theme in both Long Beach and Santa Monica was the importance of pilot decommissioning projects to be “good examples” of buildings in their city, and representative of future decommissioning sites.

Long Beach

In Long Beach small group discussions on the decision support tool, all groups were concerned with understanding capital versus recurrent costs, potential costs increases and who will be responsible for bearing costs. A participant in one group shared the following statement,

“In the pilot, is capital cost is funded. What do [owners and/or tenants] pay after that is not covered, as in, utility bills and maintenance? Overall cost has to be lower. Energy efficiency upgrades should be included in the plan.”

Two of three groups remarked that there was not enough detail in information and too much uncertainty given the ranges presented for the cost aspects of the decision support tool to be meaningfully discussed. Additional considerations for the decision support tool mentioned by one group included agreement that disadvantaged and vulnerable communities (DVC) is the most important criterion; the potential importance of considering natural hazard vulnerability; and other contextual vulnerabilities related to geology (soil erosion, sea water exposure).

Santa Monica

In Santa Monica small group discussions on the decision support tool, 2 of 3 groups mentioned inclusion of disadvantaged and vulnerable communities (DVC) as the most important criterion. Two of three groups talked about how energy costs can disproportionately affect low-income households. A participant in one group shared the following statement,

“Is there an equity focus? What are we considering - disproportionate exposure to air quality or disproportionate cost burden? Energy cost burden occurs when more than 10% of your cost goes to energy. We need to target cost burden. I am not sure we can do that [with the tool]. Does the tool allow us to isolate exposure and [health] vulnerabilities? I feel the sliders on the tool have a technical focus. Who experiences the energy cost burden?”

In Santa Monica small group discussions on the decision support tool, one group mentioned including considerations for resilience to natural hazards, another group talked about capital versus recurring costs who will be responsible.

Expert Panel Question and Answer Session

In each workshop, an expert panel consisted of representatives from each city, the community-based partner organization, RAND, and the gas and electric utilities. Each small group collaborated to formulate two questions to deliver to the panel. Per research agreements, the questions asked are summarized below and responses by panelists were not noted.

In Long Beach, the following questions were posed to the expert panel:

- *How will local buy-in factor into decommissioning specific sites? Willingness to decommission?*
- *What is the readiness and capacity of electrical grid to meet demand? What happens in a power outage?*
- *Are there plans for putting more back up power in the electricity grid?*
- *What might be the impacts on future construction at decommissioned sites?*
- *What might be ratepayer impacts after retrofitting?*
- *How does this extrapolate to the city overall? What is the big picture about decommissioning/electrification? What is the overall goal?*

In Santa Monica, the following questions were posed to the expert panel:

- *Is pipe diameter correlated to usage/type of use today?*
- *Would it make sense to decommissioning a bigger complex? How about a school or college?*
- *Where does health equity fit in?*
- *How will decommissioning affect residents' utility bills? Who bears the costs?*
- *What is the resident experience of conversion? What might the communication/incentivization for decommissioning look like?*
- *Will the grant cover electrification, and what aspects?*

Per prior agreement with the panelists, panelists' answers to these questions were not recorded.

Results

The workshops presented two main categories of findings: new additional topics raised, and candidate site nominations.

New Additional Topics Raised

Table H.2 summarizes the additional topics raised in smaller group meetings. These were topics that either expanded on previously flagged concerns, or were entirely new concerns.

Table H.2: Topics Raised in Smaller Group Meetings

Topic Mentioned	Number of Mentions	
	Long Beach	Santa Monica
Replicability	3	3
Older vs. Newer Buildings (building codes)	3	2
Resident/ tenant experiences	2	3

Topic Mentioned	Number of Mentions	
	Long Beach	Santa Monica
Potential for increased energy costs after conversion	3	0
Larger or smaller residential buildings	1	2
Commercial buildings	1	2
Backup Power	2	0
Older Buildings	2	0
Public relations	1	1
Carbon footprint	1	1
Proximity to Freeway	0	2
Energy Efficiency	1	0
Downstream impacts on energy consumption	0	1

Pre- and post- Deliberations Workshop questionnaire

In addition to taking data at the workshop, RAND conducted a pre- and post- workshop questionnaire to determine the impact of the workshop on the stakeholders.

Methods

Before and after the workshop, participants were invited to complete a 13-item Likert scale questionnaire. Overall, 30 participants answered either the pre- or post-workshop questionnaire and 22 participants completed both questionnaires. Participants ranked their agreement with concepts on a 5-point scale (strongly disagree, disagree, neutral, agree, strongly agree). Concepts were derived from key findings from an earlier phase of community engagement and research on perspectives (See Memo 2.2).

To mitigate potential distortion of Likert scale responses due to central tendency bias (disfavor of extreme statements) and acquiescence bias (favor of agreeing with statements in general), statements that participants were asked to rate were reformulated between pre- and post-workshop questionnaires, to offer both "positive" and "negative" statements for each concept both in both pre- and post-workshop questionnaires. For example, a pre-workshop statement was "Residents of [CITY] are aware of issues related to decommissioning natural gas." and its corollary post-workshop statement was "Residents of [CITY] need to learn more about issues related to decommissioning natural gas". Answers were recoded to allow for comparison. To infer whether shifts in responses pre- and post- workshop were statistically significant, responses were coded with integers ranging from -2 to 2 ("strongly disagree" was coded as -2, "neutral" was coded as 0, and so on) and a Student's T-test was applied to assess differences in mean values.

Findings and Discussion

Pre- and Post-Workshop Comparisons

Table H.3 presents the concepts and how participants responded pre- and post-workshop, and the average scores pre- and post-workshop with statistical significance of the difference in means. Eleven concepts were rated in pre- and post-workshop questionnaires, with six demonstrating a statistically significant shift between pre- and post-workshop average scores summarizing the participants' perspectives.

Generally, workshop participants felt that residents are not aware of either potential issues or benefits related to decommissioning natural gas: 83% of participants disagreed or strongly disagreed that residents are aware of potential issues and 100% of participants disagreed or strongly disagreed that residents are aware of potential benefits. Following the workshop, a significantly greater share of participants agreed that residents are aware of potential benefits, with 32% agreeing or taking a neutral stance. This may indicate participants themselves, identifying as residents, felt more aware of potential benefits following the workshop. Both before and after the workshop participants indicated that they perceived residents as not aware of potential issues, potentially indicating a need for public education.

Participants indicated that they do not see transitioning from natural gas to electricity as a straightforward process. The most common responses pre- and post- respectively were disagreement and strong disagreement, with no significant change between pre- and post-workshop average scores. Pre- and post-workshop 73% and 86% of participants, respectively, disagreed or strongly disagreed that transitioning is straightforward.

Both pre- and post-workshop responses indicated that participants are neutral or agree that disruptions related to retrofitting would be tolerable, with no change in the average score between pre- and post-workshop questionnaire responses. Pre-workshop 72% were neutral or agreed that disruptions would be tolerable, post workshop 65% responded similarly. (This difference is not statistically significant given the sample size).

Perspectives on costs to households shifted significantly pre- and post-workshop. Overall, participants shifted from agreement to neutrality regarding potential for increased costs by converting to all-electric with 73% of participants agreeing or strongly agreeing pre-workshop, as opposed to 29% post-workshop. In other words, the workshop had the effect of leading people to believe electrification was not as costly as they previously thought. This shift may be indicative of changes in opinion based on small group discussions, however this result is somewhat surprising given that one might hypothesize observing an increase in agreement of the potential for increased costs given the inclusion of costs of retrofits and electrical upgrades associated with electrification that were included in workshop presentation materials. It may be that this shift reflects a shift in awareness that as gas becomes less common that it might be more expensive however this concept was not explicitly volunteered in small group discussions, nor was it included in probes related by facilitators.

Opinions also changed over the course of the workshop on cities' readiness for decommissioning natural gas in new and existing infrastructure. Pre-workshop, more participants disagreed or strongly disagreed (63%) that their city is ready to have new

buildings without natural gas, whereas afterwards the majority took a neutral stance (average score “0” and 39% disagreement) or strong disagreement). Similarly, participants on average disagreed that their city was ready to decommission natural gas in existing buildings before the workshop, whereas afterwards, participants agreed that the city was ready; the proportion of participants in disagreement or strong disagreement went from 76% to 28%. These changes reflect the deliberative process and knowledge sharing through the workshop activities, including State of California commitments, local commitments, and discussions of feasibility around questions posed to an expert panel. There is also a potential bias introduced by asking participants to select a candidate pilot site, which may have influenced their perception of feasibility.

There was no change in average perspective on impact on cities’ fiscal resources pre- and post- workshop. In general, participants mildly disagreed that transitioning from natural gas to electricity will significantly impact [CITY] fiscal resources. Pre-workshop, 64% of participants were neutral or disagreed, and post-workshop 86% responded similarly. Given the difference in utility composition between Santa Monica and Long Beach, where Long Beach has a municipal gas utility and Santa Monica has an investor-owned gas and electric utility, it might be expected to see more sensitivity to city budget impact in Long Beach, however, as described in section 2 “Comparisons between cities” below, there was not a substantial difference between the two locations (in Santa Monica 31% then 8% and in Long Beach 25% then 15% agreed or strong agreed that city resources would be affected, pre- and post-workshop, respectively).

There was no change pre- and post- workshop in perspectives on affordability and impact on low-income residents. Both pre- and post-workshop, participants’ responses indicate an interest in support for electrification (e.g., grants, tax rebates) and attention to added burden on low-income households. Both pre- and post-workshop, more than 80% of participants indicated that support would be needed both pre-and post-workshop and more than 60% of participants indicated that low-income residents potentially face greater challenges to electrification than middle-income residents. That this did not change over the course of the workshop aligns with previous findings (Memo 2.2) that local constituents are cognizant of equity issues and challenges in affordability of electrification.

In general, participants’ opinions shifted from neutrality to agreement with the concept that they would need to seek expert advice on retrofits needed to decommission natural gas in their building. Pre workshop 47% agreed or strongly agreed that they would seek expert advice, post-workshop the proportion answering similarly grew to 75%. This shift may be indicative of changes in perspective based on discussions of retrofits and electrical upgrades associated with electrification.

Table H.3: Distribution of responses pre- and post- workshop

Concept	Distribution of responses pre-workshop N responses (Average score)	Distribution of responses post-workshop N responses (Average score)	Statistical significance of changes in average score pre- and post-workshop (p-value)
Residents are aware of potential issues.	14% strongly disagreed 69% disagreed 14% neutral 3% agreed 0% strongly agreed N=29 (-0.9)	57% strongly disagreed 32% disagreed 4% neutral 0% agreed 7% strongly agreed N=28 (-1.3)	Not significant (p=0.12)
Residents are aware of potential benefits.	62% strongly disagreed 38% disagreed 0% neutral 0% agreed 0% strongly agreed N=29 (-1.6)	18% strongly disagreed 50% disagreed 14% neutral 18% agreed 0% strongly agreed N=28 (-0.7)	Significant (p<0.01)
Transitioning from natural gas to electricity is a straightforward process.	33% strongly disagreed 40% disagreed 23% neutral 3% agreed 0% strongly agreed N=30 (-1.0)	54% strongly disagreed 32% disagreed 14% neutral 0% agreed 0% strongly agreed N=28 (-1.4)	Significant (p=0.01)
Disruptions due to retrofitting existing infrastructure would be tolerable.	3% strongly disagreed 17% disagreed 38% neutral 34% agreed 7% strongly agreed N=29 (0.2)	0% strongly disagreed 29% disagreed 29% neutral 36% agreed 7% strongly agreed N=28 (0.2)	Not significant (p=1.00)
A household might face increased costs by converting to all-electric.	0% strongly disagreed 0% disagreed 27% neutral 43% agreed 30% strongly agreed N=30 (1.0)	14% strongly disagreed 25% disagreed 32% neutral 25% agreed 4% strongly agreed N=28 (0.2)	Significant (p<0.01)

Concept	Distribution of responses pre-workshop N responses (Average score)	Distribution of responses post-workshop N responses (Average score)	Statistical significance of changes in average score pre- and post-workshop (p-value)
[CITY] is ready to have new buildings without natural gas.	40% strongly disagreed 23% disagreed 17% neutral 13% agreed 7% strongly agreed N=30 (-0.8)	21% strongly disagreed 18% disagreed 18% neutral 25% agreed 18% strongly agreed N=28 (0)	Significant (p<0.01)
[CITY] is ready to begin decommissioning existing infrastructure.	38% strongly disagreed 38% disagreed 14% neutral 7% agreed 3% strongly agreed N=29 (-1.0)	14% strongly disagreed 14% disagreed 25% neutral 32% agreed 14% strongly agreed N=28 (0.5)	Significant (p<0.01)
Transitioning from natural gas to electricity will significantly impact [CITY] fiscal resources.	7% strongly disagreed 43% disagreed 21% neutral 29% agreed 0% strongly agreed N=28 (-0.3)	4% strongly disagreed 50% disagreed 36% neutral 7% agreed 4% strongly agreed N=28 (-0.4)	Not significant (p=0.48)
Residents will not need help (e.g., grants, tax rebates, etc.) to switch over to all-electric.	62% strongly disagreed 34% disagreed 3% neutral 0% agreed 0% strongly agreed N=29 (-1.6)	54% strongly disagreed 29% disagreed 14% neutral 0% agreed 4% strongly agreed N=28 (-1.3)	Not significant (p=0.20)
Low-income residents will be as equally burdened as middle-income residents when switching to all-electric.	45% strongly disagreed 28% disagreed 24% neutral 3% agreed 0% strongly agreed N=29 (-1.1)	36% strongly disagreed 25% disagreed 18% neutral 18% agreed 4% strongly agreed N=28 (-0.7)	Not significant (p=0.17)

Concept	Distribution of responses pre-workshop N responses (Average score)	Distribution of responses post-workshop N responses (Average score)	Statistical significance of changes in average score pre- and post-workshop (p-value)
I would ask an expert to tell me how many retrofits will be needed to decommission natural gas my building.	10% strongly disagreed 33% disagreed 10% neutral 27% agreed 20% strongly agreed N=30 (0.1)	0% strongly disagreed 7% disagreed 18% neutral 43% agreed 32% strongly agreed N=28 (1.0)	Significant (p<0.01)

In addition to the 11 concepts assessed both pre- and post-workshop, there were four concepts that were asked in only one questionnaire (Table H.4), as such, pre-/post- statistical inferences are not possible. Pre-workshop, the majority of respondents were evenly divided between neutral stance (32%), agree (34%) or disagree (31%) on whether retrofitting existing building infrastructure is too expensive. Roughly half (54%) of participants stated that electrification would save money in the long run following the workshop.

Regarding willingness to pay and affordability, 30% of respondents had a neutral stance on willingness to buy electric appliances while 50% agreed or strongly agreed that they were willing. Half of respondents (50%) agreed that they are concerned about being able to afford the cost of converting from natural gas to electric appliances, with another 29% strongly agreeing.

Table H.4: Distribution of responses to questions only asked once.

Concept	Distribution of responses N responses (Average score)	Questionnaire
Retrofitting existing building infrastructure is too expensive.	0% strongly disagreed 31% disagreed 32% neutral 34% agreed 3% strongly agreed N=29 (0.1)	Pre

Concept	Distribution of responses N responses (Average score)	Questionnaire
Retrofitting existing infrastructure will save money in the long run.	0% strongly disagreed 18% disagreed 25% neutral 43% agreed 14% strongly agreed N=28 (0.5)	Post
I am willing to buy electric appliances to replace those that use natural gas.	10% strongly disagreed 7% disagreed 30% neutral 27% agreed 20% strongly agreed N=30 (0.5)	Pre
I am concerned about being able to afford the cost of converting from natural gas to electric appliances.	0% strongly disagreed 7% disagreed 14% neutral 50% agreed 29% strongly agreed N=28 (1.0)	Post

Comparisons between cities

Generally, there were more similarities than differences between responses from Long Beach and Santa Monica participants, with a handful of notable divergences around cost and readiness. Among 15 respondents in Long Beach and 17 respondents in Santa Monica, the following differences were observed. In Long Beach, 62% of respondents agreed that retrofitting existing building infrastructure is too expensive, whereas 19% of respondents in Santa Monica agreed or strongly agreed. In Santa Monica, 93% of respondents agreed or strongly agreed that retrofitting existing infrastructure would save money in the long run, whereas 27% of Long Beach participants offered similar responses. Regarding readiness to begin to decommission existing infrastructure, 69% of Santa Monica participants agreed or strongly agreed that the city is ready, whereas 27% of Long Beach participants answered accordingly. Lastly, 93% of Long Beach participants disagreed or disagreed strongly that residents are wealthy enough to switch over to all-electric on their own, as compared to 69% of Santa Monica participants. Small sample sizes preclude statistical inferences on differences between responses, though the observations noted have differences between average values that were >2 standard deviations from the mean. It may be these differences reflect local characteristics of each city including age of building stock, utility arrangements, and city demographics. It will be important for the guidelines to take into account local differences.

Comparison of individuals' pre- and post-workshop responses

Among 19 participants who completed both a pre- and post-workshop questionnaire and provided an answer for every statement, there was one individual for whom their average responses exhibited a noticeable shift (data not shown, see supplementary Excel spreadsheet). While the sample size precludes statistical inference, this one individual's change in average response score between pre- and post-workshop questionnaires was >2 standard deviations from the mean. This lack of substantial individual shifts indicates that changes in knowledge and attitudes over the course of the workshop were not flippant, which is an aim of the deliberative process, it also indicates that the questionnaire items were appropriately worded as not to evoke polarized responses.



California
ENERGY COMMISSION



ENERGY RESEARCH AND DEVELOPMENT DIVISION

APPENDIX I: Data Visualization Tool

May 2026 | CEC-500-2026-010

Appendix I:

Data Visualization Tool

Description of Visualization Tool

The [visualization tool](#) is available to use at the link below:

https://public.tableau.com/views/CECPIR20-008VisualizationToolBeta/TractExplorer?:language=en-US&publish=yes&:display_count=n&:origin=viz_share_link

There are two visualizations: 1) Identifying Census Tracts of Interest (“Tract Explorer”), and 2) Exploring Post-Meter Costs to Building Owner to Decommission (“Cost Explorer”). Each panel is described below and is accessible from a tab at the link above.

Visualization 1: Identifying Census Tracts of Interest

This visualization helps users interact with factors that shape tract selection. The visualization shows in three panels the following factors in Santa Monica and Long Beach:¹

- Average Pipe Diameter (upper left)
 - While the data exist, our non-disclosure agreement does not allow us to show the pipe geometry for the full city regions. RAND instead calculated average pipe diameter and used this as a proxy for identifying areas where there are a lot of branches in the gas line. The smaller the average pipe diameter, the more likely it will be to find terminal branches in the census tract that would be easier and cheaper to decommission (and also affect fewer other customers).
- Average Pipe Age (upper middle)
 - RAND were not able to obtain maintenance or planned replacement data. RAND instead calculated the average age of the pipe and used this as a proxy for identifying areas where pipes might be nearing the end of their life cycle. The older the average pipe age, the more likely it will be to find older pipes in the census tract that would be replaced soon anyway.
- DVC (disadvantaged and vulnerable community, lower left)
 - One of the sponsor’s requirements is that at least one pilot site is in a DVC. This approach used the DVCs as defined at the census tract level and provided in the CalEnviroScreen (version 4.0²). The required minimum threshold was the 75th percentile of the tool.

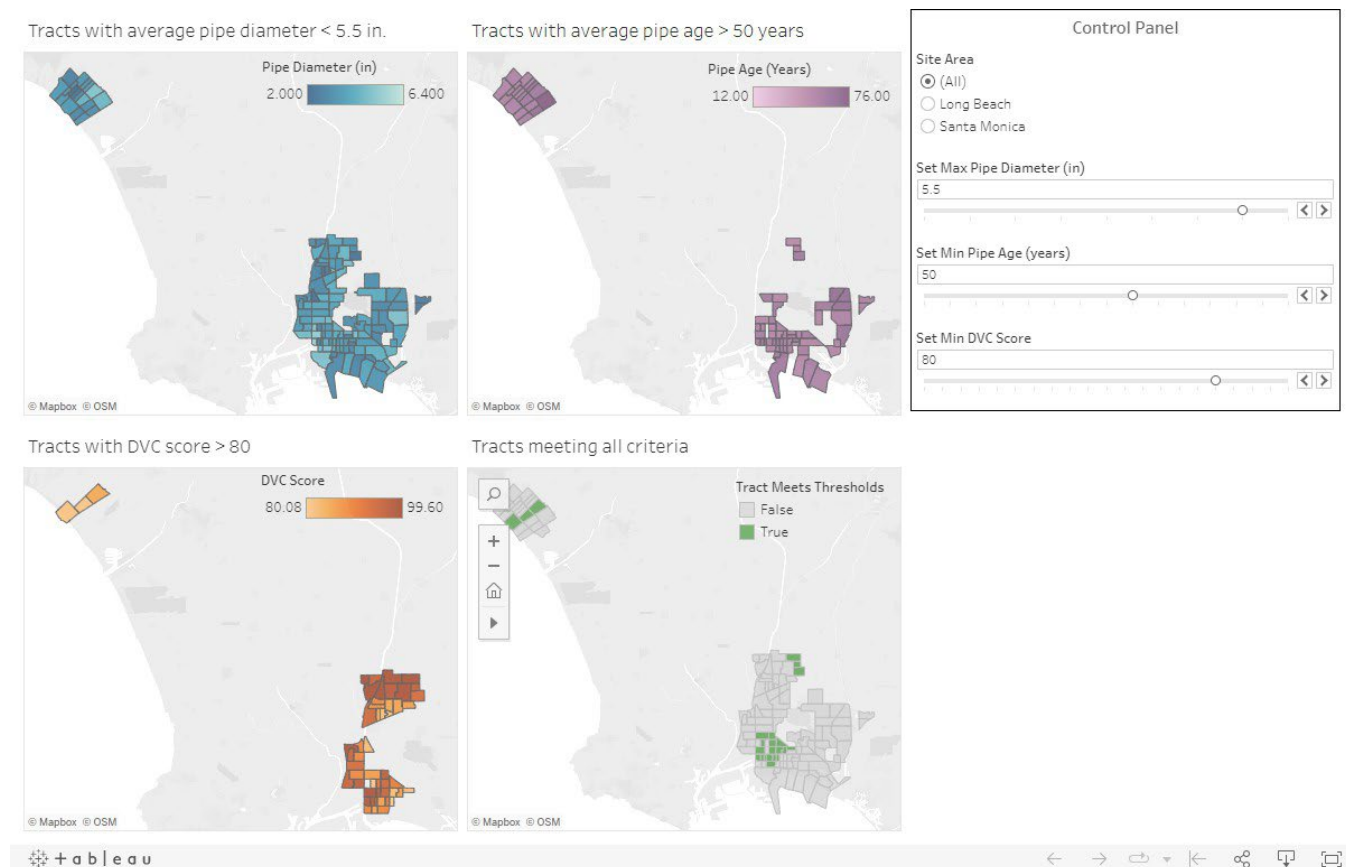
¹ Data existed for all census tracts in the City of Santa Monica, and the majority of census tracts in the City of Long Beach. The panel on the bottom right shows as either green or grey all of the tracts for which data existed.

² California Office Of Environmental Health Hazard Assessment. “[CalEnviroScreen 4.0](https://oehha.ca.gov/calenviroscreen).” <https://oehha.ca.gov/calenviroscreen>. Accessed October 19, 2022. Note as of April 10, 2026, 4.0 is no longer available online and has been superseded by 5.0.

A screenshot of the tool is shown in Figure I.1. The control panel in the top right allows users to zoom in to a single area if desired, and to set thresholds for each of these factors that can reflect their selection preferences. The panels will show only tracts that meet those threshold criteria, hiding those tracts that do not. This helps users see which tracts fall into the user-specified constraints for pipe age, size, and DVC score.

The panel on the bottom right shows which tracts (if any) meet all three criteria. Here, if tracts do not meet the criteria, their outline is kept but they are not displayed in color.

Figure I.1: Identifying census tracts of interest



Visualization 2: Exploring Post-Meter Costs to Building Owner to Decommission

This visualization helps users understand how costs to the building owner might vary depending on various factors.

As described in the Methods Chapter, costs to decommission consist of costs to the utilities, costs to the ratepayers, and costs to the building owner. This tool focuses solely on residential buildings characteristic of the southern California region, and thus other types of natural gas usage (e.g., for commercial, industrial, specialty buildings, etc.) are not included.

A screenshot of the tool is shown in Figure I.2. The left side of the visualization allows a user to select variables related to decommissioning. The right side shows the resulting cost, broken

out by cost components listed in the Task 5.1 memo. The control panel allows the user to select from the following variables:

- The number of housing units in the building
- The size of each unit (which determines costs such as HVAC that scale with the size of the unit)
- The cost components that apply to the building
- Whether the low, medium, or high estimates of those costs should be shown
- And whether costs should be shown for the whole building (all units included) or for each housing unit in the building. This option is the same for single family homes which would have just one housing unit in the building.

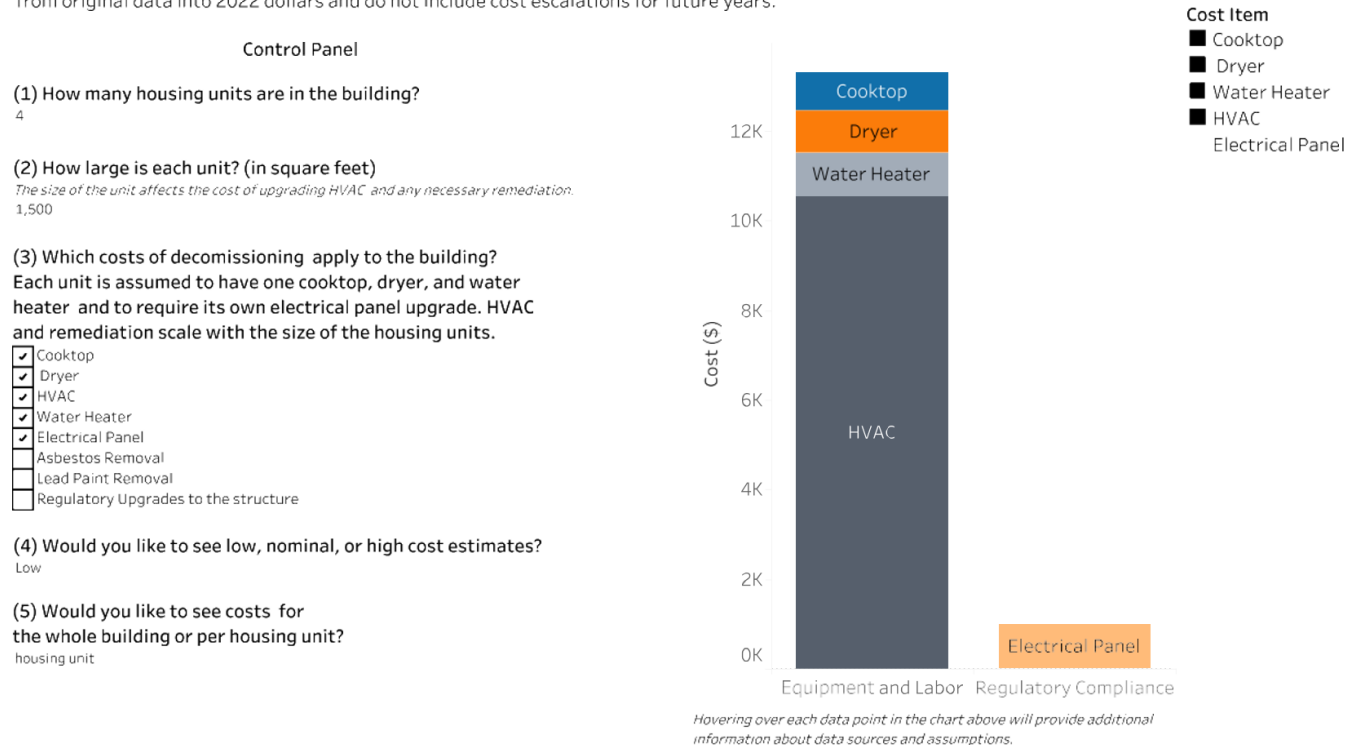
The stacked bar chart separately shows the equipment and labor costs for cooktops, dryers, hot water heaters, and HVAC systems in one column, and regulatory upgrades of electrical panels, asbestos and lead remediation, and other regulatory upgrades in a second column. By default, remediation and other regulatory upgrades are not included.

Finally, in the interactive version, users can hover over the cost elements in the bar chart to see specific information on the value of the cost component and the data sources and methodology used to calculate it.

Figure I.2: Exploring Post-Meter Costs to Building Owner to Decommission

Post-Meter Cost Explorer

This bar chart on the right shows estimated costs per housing unit to transition from natural gas to electricity given the selections in the control panel on the left. Note that this assumes an equivalent level of service before and after transition. Costs are converted from original data into 2022 dollars and do not include cost escalations for future years.



user group prior to finalizing a decision. This tool should only be used to help identify census tracts of interest; several additional rounds of analysis are needed prior to determining a site.

- Note that there are many limits of data (e.g., from non-disclosure agreements). While this tool was created with the limitations known at the time, at least Project Technical Advisory Board member noted that California Public Utility Commission (CPUC) could order changes on data availability.



California
ENERGY COMMISSION



ENERGY RESEARCH AND DEVELOPMENT DIVISION

APPENDIX J: Pilot Project Sites Chosen in Workshop

May 2026 | CEC-500-2026-010

Appendix J:

Pilot Project Sites Chosen in Workshop

Our community partners recommended three sites in Santa Monica and two in Long Beach. Three of these are multi-family housing complexes ranging from 12 to 91 units with an average of 62 units per site; one is a single family building; and one is 27 acre area. They have a mix of electrification requirements. All of them use gas for stoves, water heating, and clothes drying; while space heating is a mix of gas, both hydronic and wall heaters, or electric with heat pumps. As a result, there is significant scope in end-use equipment replacement and potential scope for behind-the-meter upgrades such as subpanel upgrades.

City of Santa Monica sites

The City of Santa Monica deliberations workshop identified three pilot sites of multi-family residential apartment buildings owned by Community Corporation of Santa Monica.¹ In addition, there was a request to consider a single family home near the freeway; this option was not pursued since it is unlikely a single family home owner could apply for subsequent funding. Rather, the authors considered a third, much smaller building owned by the same CBO. The CBO indicated that for these buildings, they did not anticipate the need for a) upgrades due to building codes or b) asbestos remediation.²

Southern California Gas conducted hydraulic modelling for these sites, and determined that there would be no effect on neighboring communities. In addition, Southern California Gas indicates ratepayer impacts will be negligible since these project sites are so small in comparison to the ratepayer region.

Case Study 1: High Place (Santa Monica, CA)

Location Description

This project, “High Place”, is a multi-building apartment complex owned by the CBO Community Corporation of Santa Monica. It is comprised of High Place East & High Place West located at 2401 and 2345 Virginia Ave., respectively (see Figure J.1). Together, this site encompasses 91 residential units across 12 buildings. The natural gas utility is Southern California Gas, and the electricity utility is Southern California Edison.

High Place is located in a census tract designated as a DVC. While not designated as a low-income census tract, the CBO reports 88 of 91 units are designated (and 55 are self-reported) as low-income customers qualifying for the California Alternate Rates for Energy (CARE) or Family Electric Rate Assistance Program (FERA) assistance programs.

Pre-meter costs: According to natural gas infrastructure data provided by the municipal utility, this location is located near to, but not at the end of, a terminal branch in the natural

¹ Community Corporation of Santa Monica is an affordable housing provider that restores, builds and manages apartment buildings in Santa Monica. Community Corp. has built or restored more than 100 properties offering nearly 1900 affordable homes.

² The CBO was not able to share whether or not asbestos was in these buildings. Due to this, we assumed minimal construction in the units (i.e., use methods that do not disturb asbestos).

gas distribution network. Given the need to serve the other buildings on the terminal branch, so is anticipated to be relatively easier for pre-meter costs to decommission. We estimate that approximately 250 linear feet of natural gas pipe would be decommissioned. At the average cost of \$48.10 per foot, this is approximately \$12,000. More information would be needed from the natural gas utility to identify any other costs that would be pre-meter for the location.

Post-meter costs: The CBO has provided the following preliminary data indicating what needs to be decommissioned, allowing for a preliminary estimate of cost to decommission the property (Table J.1). Estimates in change of utility bill indicate that it is unlikely electric panel upgrades are needed for this location. Thus, the current estimate to decommission the buildings and replace by electrification is **\$410K-590K**.

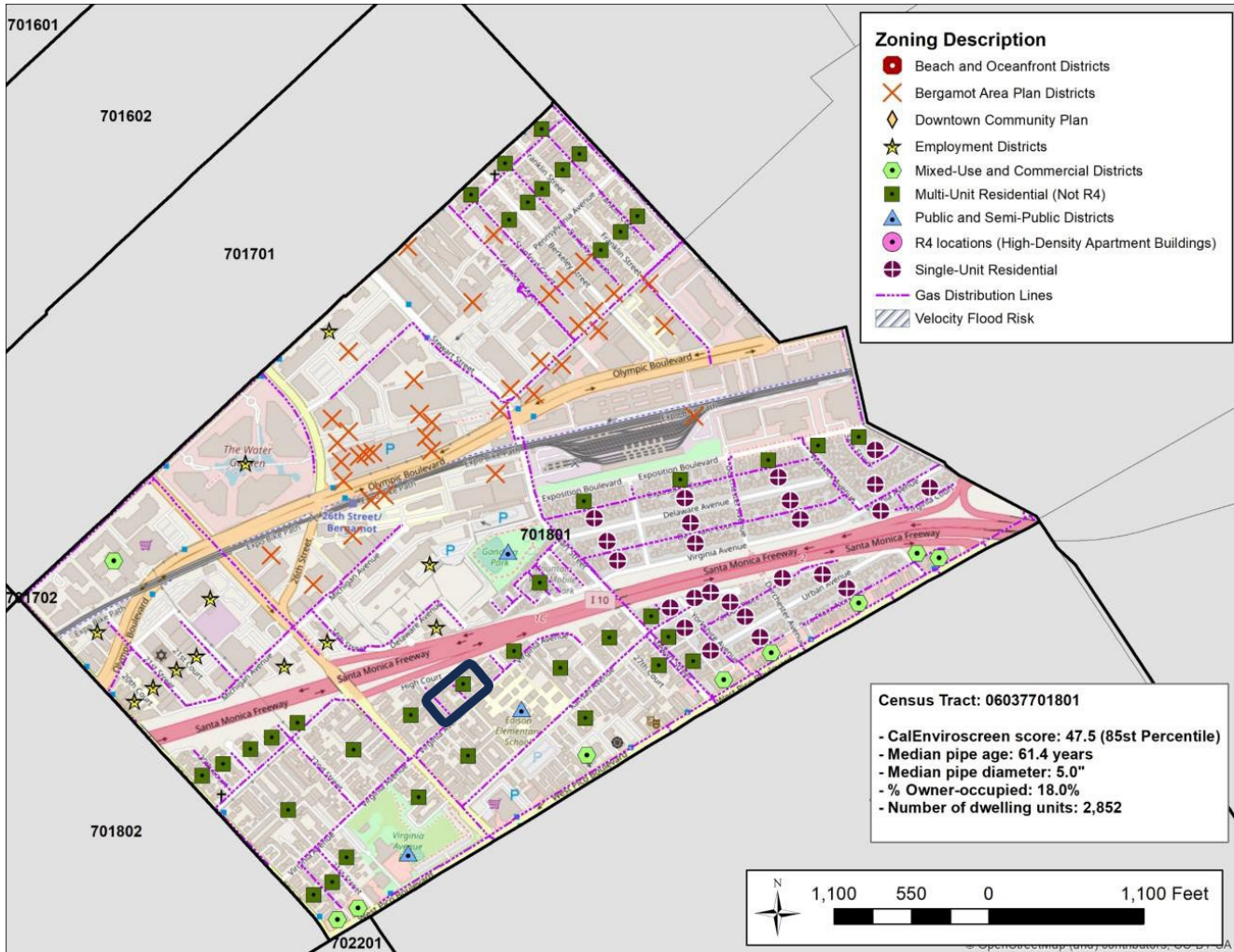
The average estimate of increase in annual utility bill is \$278 per family of four ranging from \$221-\$416/yr which is a change in GHG of -1,919 lbs CO₂ per year ranging from -1,535 to -2,878 lbs CO₂. For CARE customers, the average utility bill increase is \$155/yr ranging from \$115/yr to \$232/yr and for those first-time adopting CARE rates would have a utility bill increase of \$76/yr ranging from \$36/yr to \$123/yr. Rate structures do not impact CO₂ emissions as these are dependent on energy usage and emissions are on average annual basis per unit of energy. Switching from natural gas to electric stoves would eliminate indoor methane sources from cooking appliances and would keep NO₂ levels below the 1-hour exposure national standard particularly for smaller kitchens with poor ventilation.³ More data will be needed (e.g., customer usage data; data on square footage; any hoteling requirements; etc.) in order to reduce the uncertainty range. Next steps after this report are to work with the CBO to reduce uncertainty, and write a pilot project application for future funding.

Ratepayer impacts for natural gas customers: Southern California Gas conducted hydraulic modeling for this sites and determined that there would be no effect on neighboring communities. In addition, Southern California Gas indicates ratepayer impacts will be negligible since these project sites are so small in comparison to the ratepayer region.

Ratepayer impacts for electricity customers: Southern California Edison indicates ratepayer impacts will be negligible since these project sites are so small in comparison to the ratepayer region.

³ Eric D. Lebel, Colin J. Finnegan, Zutao Ouyang, and Robert B. Jackson. "Methane and NO_x Emissions from Natural Gas Stoves, Cooktops, and Ovens in Residential Homes" *Environmental Science & Technology*. Volume 56, Issue 4, p. 2529–2539. January 27, 2022

Figure J.1: Census Tract Maps of “High Place”



Note: Solid dark blue rectangle is the location of this study.

Table J.1: Post-Meter Equipment Identified to be Transitioned

	Quantity
<i>Demolition</i>	
Water Heater	93
Stoves	93
<i>Kitchen</i>	
Upgrade NG stove to electric stove	93
<i>Space Heating</i>	
<i>Water Heating</i>	
Upgrade NG water heater to electric	93
<i>Laundry</i>	
Building-scope	

Quantity	
TOTAL UNIT COSTS	
Building Costs	
<i>Kitchen</i>	
<i>Space Heating</i>	
Upgrade Water Boiler	93
<i>Water Heating</i>	
<i>Laundry</i>	
Upgrade gas dryers	10

HPE (2401 Virginia Avenue, Santa Monica) has had access to solar energy through the solar panels installed in 2014, and HPW (2345 Virginia Avenue, Santa Monica) has had access to solar energy since 2012. HPE has one single port level 2 EV charger, and HPW has one dual port level 2 EV charger and one single port level 2 EV charger. HPE and HPW have access to Wifi near the community room on the first floor and a large electrical setup for additional capacity.

Potential risks, environmental issues, or policy issues

This site is in a census tract designated as DVC, and many of the existing residents qualify for the California Alternate Rates for Energy (CARE) or Family Electric Rate Assistance Program (FERA) assistance programs. Thus, decarbonization at this site will require prioritizing policies that promote equity considerations. Further, as per CBO information, this site doesn't require asbestos remediation and infrastructural upgrades to comply with codes and regulations. We thus anticipate no additional costs for potential risks.

Both the sites are located on Virginia Avenue, which is right next to I-10. Given its location, we may need temporary permits for street and sidewalk closures, as well as the implementation of a temporary traffic management plan. Virginia Avenue also directly connects Cloverfield Blvd, a feeder road to the I-10 Freeway. Consequently, we may also need supplementary traffic management strategies and street closure plans to accommodate the demands of this high-traffic location.

An environmental impact assessment will need to be conducted prior to work. We estimate **\$7,000-13,500 for the environmental impact assessment.**⁴ This will include detailed site investigations to check for potential contaminations.

There will be the need to file some building permits to meet local regulations. We estimate **\$5,000 - \$7,500 for the building permits.**⁵

⁴ Butala, S. "[Phase 1 vs Phase 2 Environmental Assessment?](https://rsbenv.com/phase-1-vs-phase-2-environmental-assessment#:~:text=Phase%201%20Environmental%20Assessments%20provide,contaminants%20or%20hazards%20on%20site)" March 16, 2023. <https://rsbenv.com/phase-1-vs-phase-2-environmental-assessment#:~:text=Phase%201%20Environmental%20Assessments%20provide,contaminants%20or%20hazards%20on%20site>. Last Visited: October 25, 2023.

Novick, I. "[Phase 1 Environmental FAQs: How Much, How Long, and Why?](https://www.lev.com/blog/phase-1-environmental-site-assessments)" November 18, 2021. <https://www.lev.com/blog/phase-1-environmental-site-assessments>.

⁵ RS Means Line Number 014126500010

Required (and Optional) Incentives

Given any decommissioning will adversely affect the building owner or residents during the construction, there is a need to work with these stakeholders and determine their lower bar of acceptable incentives to offset the construction inconvenience. Table J.2. contains a checklist of Incentives that were determined by the authors to be Required or optional for this project. The project will not proceed without support for Required Incentives in place.

Table J.2: Incentives Identified for this Project

Incentive Category	Incentive	Level of Need	Explanation/ Notes
Appliance Upgrade	Induction stove	Optional	The building owner has indicated that they would like updating the cooktop stoves to induction stoves.
	Cookware compatible to induction stove	Optional	The residents have indicated that they would like new cookware compatible to an induction stove. This includes a standard set of pots and pans, and as optional either a wok or a tortilla pan.
Other Energy	Solar panels	Optional	The building owner would like to install solar panels to offset the change in utility bills.
	Batteries	Optional	Batteries are needed as backup to the solar panels.
	Propane Tank	Not required	Not applicable.
	Generators	Not required	Not applicable.
Resident Needs	Hoteling	Not required	Not applicable.
	Other monetary incentive	Not required	Not applicable.
Other	None	Not required	Not applicable.

The costs for each of these is estimated below.

Required

None.

Optional Induction stove

This site contains 93 natural gas-operated cooktops, which will be replaced with an electric stove. This incentive pertains to replacing the natural gas cooktops with induction stoves for electrification. Induction stove has several advantages over traditional natural gas and electric stoves. Induction stoves are more energy efficient, allow better temperature control for

cooking, and are better for indoor air quality. It will cost approximately between \$126,000 - \$175,000 to replace 93 natural gas cooktops with an induction stove.

Cookware compatible to induction stove

Induction stoves utilize electromagnetic energy to heat cookware directly, necessitating the use of magnetic material in the cookware. As a result, switching from natural gas cooktops to induction stoves requires the acquisition of new cookware. This incentive is designed to offer cookware that is compatible with induction stoves, such as pots and pans. Furthermore, we can broaden this incentive's range to encompass additional items like woks and tortilla pans.

It will cost approximately between \$17,000 - \$23,500 to provide 93 sets of induction-compatible cookware.

Solar panels

Solar energy is a clean, effective, and renewable energy source that can help reduce emissions associated with the energy sector. Solar panels are beneficial for multifamily housing as they help reduce energy bills and the carbon footprint of the building. This incentive pertains to installing solar panels on the building as a part of the decarbonization strategy.

A solar panel costs approximately \$3 per watt (W). Therefore, a 4 kW (4000 W) solar panel will cost approximately \$12,000.

Batteries

Renewable energy sources, such as solar power, are inherently variable. Unlike conventional power plants, their energy production depends on weather conditions, resulting in output fluctuations and intermittent supply. Energy storage systems, specifically batteries, are employed to mitigate these challenges. This incentive aims to supply batteries that enhance the dependability of the energy generated by the on-site solar panels.

To provide battery coverage for 93 units, with an estimated requirement of 10 kWh per unit, the total cost, including ancillary expenses, is projected to be approximately \$991,000.

Equity Considerations (Other than CARE and FERA)

Site selection was conducted by our Community-Based Organization (CBO) Partners. We worked with CBOs to engage different stakeholders to ensure that the needs and concerns of underrepresented and vulnerable community members are adequately captured and identified. Stakeholder engagement highlighted a few equity concerns that must be addressed to ensure successful site electrification. A chief concern among stakeholders is how decommissioning natural gas might impact vulnerable and disadvantaged communities, potentially burdening them disproportionately. Consequently, we must identify various policy incentives and financial support structures to address the potential financial burden on the residents.

Since the availability of rebates/incentives varies with policy changes, we note that if this pilot application is submitted, the applications should review availability and place into their cost estimate. We place a placeholder in the Estimated Budget table to address this.

Other Considerations

All data and costs presented in this are preliminary estimates, and are subject to change upon project award. Given the uncertainties reflected in this application, **a 20% contingency placeholder** has been added to the overall estimated budget.

Key planning decisions

Key planning decisions will be tied to award date and calendar date. These will include:

Step 1. Design Phase

- Determine the scope of work (this may require a site inspection and review of existing drawings)
- Hire design consultants (e.g., engineer, architect, etc.)

Step 2. Get an estimate for the Scope of Work

- Solicit bids from contractors for retrofit work

Step 3. Select a contractor to perform the work

- This will require a written contract

Step 4. Obtain necessary permits

- Permits can be the responsibility of the owner, designer, or contractor.

Step 5. Conduct retrofit work

- Contracts will typically include schedule and estimated costs. The owner may have to periodically check in to ensure work is performed according to schedule and budget.
- Retrofit work will also need to be coordinated with existing building occupants.

Step 6. Inspections

- Conduct necessary inspections and testing

Step 7. Commissioning

- Ensure building systems are functioning properly and as intended

Step 8. Certificate of Occupancy and Turnover

Once the certificate of occupancy is achieved, the building can be turned over to the owner.

Estimated Budget

The estimated budget is shown in Table J.3.

Table J.3: Estimated Budget

Item	Notes/ Key Planning Decision Milestone	Cost
Pre-meter & Post-meter costs		\$410,000 - \$590,000
Required Incentives	Induction stove; Cookware compatible to induction stove	\$ -
Optional Incentives	Solar panels; Batteries	\$1,146,000 - \$1,201,500
Other Site-Specific Considerations	To be revisited at time application is submitted to a funding call; none identified at this time.	\$ -
Known Rebates, Incentives, or other Equity Considerations	To be revisited at time application is submitted to a funding call.	\$ -
Environmental Impact Assessment (Phase I)	Step 1	\$2,000 - \$5,000
Environmental Impact Assessment (Phase II)	Step 2	\$5,000 - \$8,500
Permit (Building Permit & Construction Permit)	1% for the building permit and 1.25 % for the construction permit	\$9,500 - \$13,500
Project Management Cost for A&E (Design and construction Phase) and Design contract Fees	1% for design phase, 3%- 6% for construction phase, 3% for design contract costs	\$29,000-\$59,000
General Requirement	4.25% for Contractor PM cost, 4% for safety and security, 1% for temporary services and utilities, 0.5% for quality control, 0.5% for submittal	\$60,500 – \$87,000
Compliance & Local Review Fees	4.5%-20% for ADA compliance and 1% for plan review fees	\$22,500 – \$124,000
Margin & Overhead	7.70% for general contractor overhead, 3.30% for general contractor's insurance, payment, and performance bond, 3%-10% contractor profit	\$57,000 – \$124,000
Contingency	20% for Design Contingencies, 1%-4% for access, storage, and staging contingencies, and 2% to 20% for FEMA design contingencies	\$94,000 - \$260,000
Total		\$1,835,500 - \$2,472,500

The estimated budget for this project (including optional incentives) is \$1,835,500 to \$2,472,500. Without the optional incentive (of solar panels with battery backup and of induction stoves and cookwear), the estimated budget is \$689,500 to \$1,271,000. At the time of the proposal submission, the team will revisit current rebate opportunities (e.g., California's Solar on Multifamily Affordable Housing [SOMAH] Program) to determine whether it is possible to leverage other funds.

Case Study 2: Cloverfield (Santa Monica, CA)

Location Description

This project, "Cloverfield", is a single-building apartment complex owned by the CBO Community Corporation of Santa Monica. It is located at 1959 Cloverfield Blvd (see Figure J.2) and includes a communal swimming pool. This site has 62 residential units. The natural gas utility is Southern California Gas, and the electricity utility is Southern California Edison.

Cloverfield is in a census tract designated as a DVC. While not designated as a low-income census tract, the CBO reports 35 of 62 units are designated (and 26 are self-reported) as low-income customers qualifying for the California Alternate Rates for Energy (CARE) or Family Electric Rate Assistance Program (FERA) assistance programs.

Pre-meter costs: According to natural gas infrastructure data provided by the municipal utility, this location is at a terminal branch in the natural gas distribution network. Given the need to serve the other buildings on the terminal branch, this building would be decommissioned without any changes to the natural gas infrastructure (merely a shutting off of the valve leading to the building). More information would be needed from the natural gas utility to identify any other costs that would be pre-meter for the location.

Post-meter costs: The CBO has provided the following preliminary data indicating what needs to be decommissioned, allowing for a preliminary estimate of cost to decommission the property (Table J.4). Estimates in change of utility bill as well as discussion with the CBO indicate that it is likely that electric panel upgrades are needed for this location, and so these are included in the cost. The current estimate to decommission the buildings and replace by electrification is **\$89K-\$122K**.

The average estimate increase in annual utility bill is \$180 per family of four ranging from \$144/yr to \$269/yr, which is a change in GHG of -86 lbs CO₂ per year ranging from -69 lbs CO₂ per year to -129 lbs CO₂ per year. For CARE customers, the utility bill increase is \$121/yr ranging from \$97/yr to \$181/yr and for those first-time adopting CARE rates would have a utility bill increase of \$111/yr ranging from \$89/yr to \$166/yr. Rate structures do not impact CO₂ emissions as these are dependent on energy usage and emissions are on average annual basis per unit of energy. Switching from natural gas to electric stoves would eliminate indoor methane sources from cooking appliances and would keep NO₂ levels below the 1-hour exposure national standard particularly for smaller kitchens with poor ventilation.⁶ More data

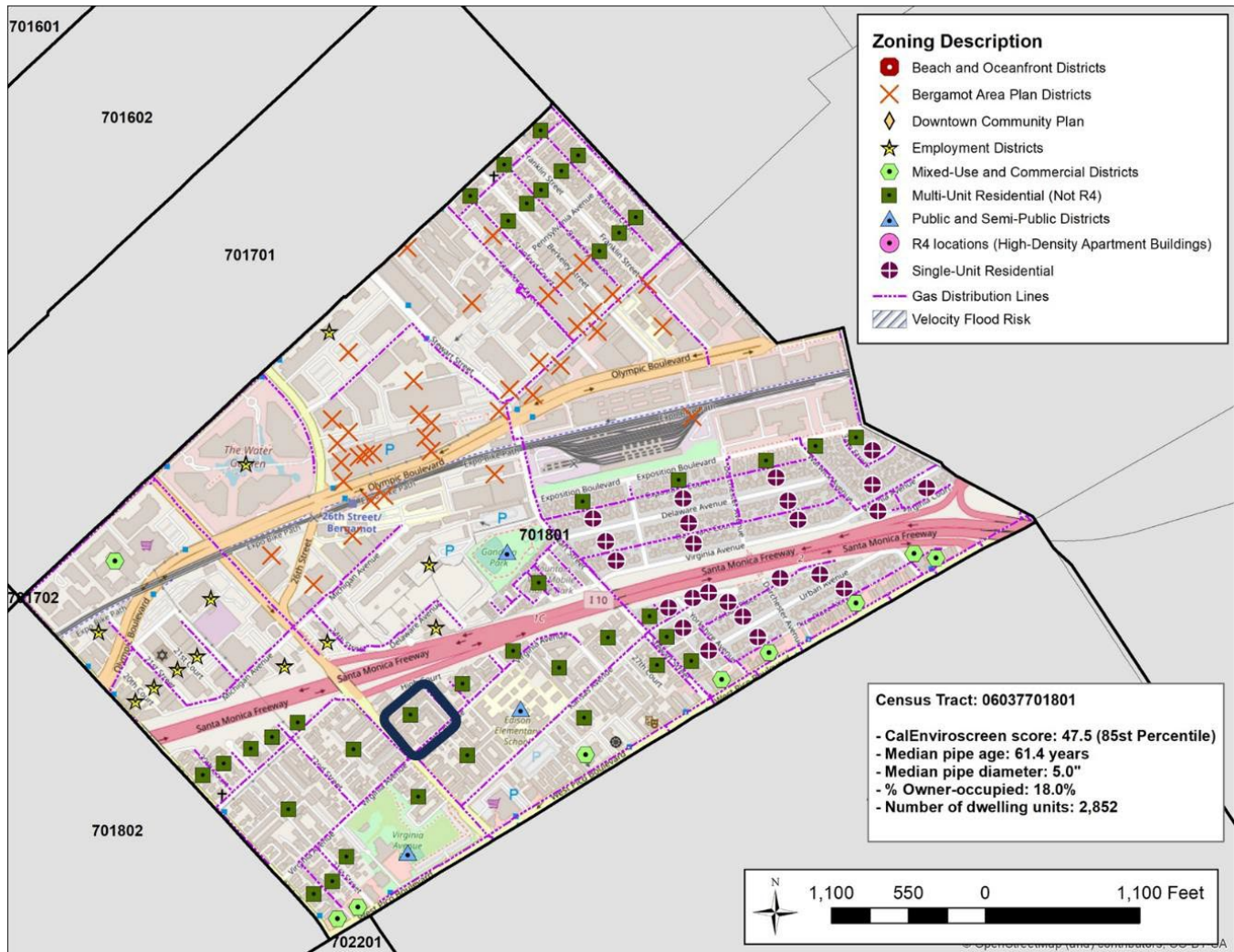
⁶ Eric D. Lebel, Colin J. Finnegan, Zutao Ouyang, and Robert B. Jackson. "Methane and NO_x Emissions from Natural Gas Stoves, Cooktops, and Ovens in Residential Homes" *Environmental Science & Technology*. Volume 56, Issue 4, p. 2529–2539. January 27, 2022

will be needed (e.g., customer usage data; data on square footage; any hoteling requirements; etc.) in order to reduce the uncertainty range.

Ratepayer impacts for natural gas customers: Southern California Gas conducted hydraulic modeling for this site and determined that there would be no effect on neighboring communities. In addition, Southern California Gas indicates ratepayer impacts will be negligible since these project sites are so small in comparison to the ratepayer region.

Ratepayer impacts for electricity customers: Southern California Edison indicates ratepayer impacts will be negligible since these project sites are so small in comparison to the ratepayer region.

Figure J.2: Census Tract Map for “Cloverfield”



Note: Solid dark rectangle is the location of this study.

Table J.4: Post-Meter Equipment Identified to be Transitioned

	Quantity
<i>Demolition:</i> Water Heater	3
Stoves	62
Space Heater	124
<i>Kitchen:</i> Upgrade NG cooktop to electric stove	62
<i>Space Heating:</i> Replace with electric wall heaters	124
<i>Water Heating</i>	
<i>Laundry:</i> Building-scope	

TOTAL UNIT COSTS	
Building Costs	Quantity
<i>Kitchen</i>	
<i>Space Heating</i>	
<i>Water Heating:</i> Upgrade water heater	3
<i>Laundry:</i> Upgrade gas dryers	6

This site has access to solar panels through the California Multifamily Affordable Solar Housing (MASH) program, and an additional capacity installation request is under review under the Solar On Multifamily Affordable Housing (SOMAH) program. There are three electrical meters on-site with capacities of 100 Amp, 140 Amp, and an unknown capacity. The site has also applied for EV chargers via REACH 2.0 and offers Wi-Fi access in the parking area near the manager's office.

Potential risks, environmental issues, or policy issues

This site is in a census tract designated as DVC, and many of the existing residents qualify for the California Alternate Rates for Energy (CARE) or Family Electric Rate Assistance Program (FERA) assistance programs. Thus, decarbonization at this site will require prioritizing policies that promote equity considerations. Further, as per CBO information, this site required asbestos remediation and may need infrastructural upgrades to comply with codes and regulations. We thus anticipate no additional costs for potential risks.

This site is located at the intersection of Cloverfield Blvd and Virginia Ave. Given its location, it may need temporary permits for street and sidewalk closures and a temporary traffic management plan. Cloverfield Blvd, where the site is situated, is a feeder road to the I-10 Freeway. Consequently, it may also need supplementary traffic management strategies and street closure plans to accommodate the demands of this high-traffic location.

An environmental impact assessment will need to be conducted before work. We estimate **\$7,000-13,500 for the environmental impact assessment.**⁷ This will include detailed site investigations to check for potential contaminations.

⁷ Butala, S. "[Phase 1 vs Phase 2 Environmental Assessment?](https://rsbenv.com/phase-1-vs-phase-2-environmental-assessment#:~:text=Phase%201%20Environmental%20Assessments%20provide,contaminants%20or%20hazards%20on%20site)" March 16, 2023. <https://rsbenv.com/phase-1-vs-phase-2-environmental-assessment#:~:text=Phase%201%20Environmental%20Assessments%20provide,contaminants%20or%20hazards%20on%20site>. Last Visited: October 25, 2023.

Novick, I. "[Phase 1 Environmental FAQs: How Much, How Long, and Why?](https://www.lev.com/blog/phase-1-environmental-site-assessments)" November 18, 2021. <https://www.lev.com/blog/phase-1-environmental-site-assessments>.

There will be the need to file building permits to meet local regulations. We estimate **\$1,100 to \$1,600 for the building permits**, calculated as 1.25% of pre- and post-meter costs.⁸

The site requires asbestos remediation. We estimate **\$10/SF to \$30/SF** on average for asbestos remediation.⁹ This includes an initial site survey, plan development, sample analysis, setup, and remediation. Given this site is described as 63,207 sq ft, this is a total of \$63-189K.

Required (and Optional) Incentives

Given that any decommissioning will adversely affect the building owner or residents during the construction, it is necessary to work with these stakeholders and determine their lower bar of acceptable incentives to offset the construction inconvenience. Table J.5. contains a checklist of Incentives that were determined by the authors to be Required or optional for this project. The project will not proceed without support for Required Incentives in place.

Table J.5: Incentives Identified for this Project

Incentive Category	Incentive	Level of Need	Explanation/ Notes
Appliance Upgrade	Induction stove	Optional	The building owner has indicated that they would like updating the cooktop stoves to induction stoves.
	Cookware compatible to induction stove	Optional	The residents have indicated that they would like new cookware compatible to an induction stove. This includes a standard set of pots and pans, and as optional either a wok or a tortilla pan.
Other Energy	Solar panels	Optional	The building owner would like to install solar panels to offset the change in utility bills.
	Batteries	Optional	Batteries are needed as backup to the solar panels.
	Propane Tank	Not required	Not applicable.
	Generators	Not required	Not applicable.
Resident Needs	Hoteling	Not required	Not applicable.
	Other monetary incentive	Not required	Not applicable.
Other	None	Not required	Not applicable.

⁸ RS Means 2019

⁹ RS Means 2019

The costs for each of these is estimated below.

Required

None.

Optional Induction stove

This site contains 62 natural gas-operated cooktops, which will be replaced with an electric stove. This incentive pertains to replacing the natural gas cooktops with induction stoves for electrification. An induction stove has several advantages over traditional natural gas and electric stoves: they are more energy efficient, allow better temperature control for cooking, and are better for indoor air quality. It will cost between \$84,000 - \$116,700 to replace 62 natural gas cooktops with induction stoves.

Cookware compatible with induction stove

Induction stoves use electromagnetic energy to heat cookware directly, which requires magnetic material in the cookware. As a result, switching from natural gas cooktops to induction stoves requires purchasing new cookware. This incentive is designed to offer cookware that is compatible with induction stoves. Furthermore, this incentive could be broadened to encompass additional items like woks and tortilla pans.

It will cost between \$11,000-\$16,000 to provide 62 sets of induction-compatible cookware.

Solar panels

Solar energy is a clean, effective, and renewable energy source that can help reduce emissions associated with the energy sector. Solar panels are beneficial for multifamily housing as they help reduce energy bills and the carbon footprint of the building. This incentive pertains to installing solar panels on the building as a part of the decarbonization strategy.

A solar panel costs approximately \$3 per watt (W). Therefore, a 4 kW (4000 W) solar panel will cost approximately \$12,000.

Batteries

Renewable energy sources, such as solar power, are inherently variable. Unlike conventional power plants, their energy production depends on weather conditions, resulting in output fluctuations and intermittent supply. Energy storage systems, specifically batteries, are employed to mitigate these challenges. This incentive aims to supply batteries that enhance the dependability of the energy generated by the on-site solar panels.

To provide battery coverage for 62 units, with an estimated requirement of 10 kWh per unit, the total cost, including ancillary expenses, is projected to be approximately \$660,000.

Equity Considerations (Other than CARE and FERA)

Site selection was conducted by our Community-Based Organization (CBO) Partners. We worked with CBOs to engage different stakeholders to ensure that the needs and concerns of underrepresented and vulnerable community members are adequately captured and identified. Stakeholder engagement highlighted a few equity concerns that must be addressed to ensure successful site electrification. A chief concern among stakeholders is how decommissioning

natural gas might impact vulnerable and disadvantaged communities, potentially burdening them disproportionately. In turn, we identified several policy incentives and financial support structures to address the potential financial burden on the residents.

Since the availability of rebates/incentives varies with policy changes, we note that if this pilot application is submitted, the applications should review availability and place into their cost estimate. We place a placeholder in the Estimated Budget table to address this.

Other Considerations

All data and costs presented in this are preliminary estimates and are subject to change upon project award. Given the uncertainties reflected in this application, a **20% contingency placeholder** has been added to the overall estimated budget.

Key planning decisions

Key planning decisions will be tied to award date and calendar date. These will include:

Step 1. Design Phase

- Determine the scope of work (this may require a site inspection and review of existing drawings)
- Hire design consultants (e.g., engineer, architect, etc.)

Step 2. Get an estimate for the Scope of Work

- Solicit bids from contractors for retrofit work.

Step 3. Select a contractor to perform the work

- This will require a written contract

Step 4. Obtain necessary permits

- Permits can be the responsibility of the owner, designer, or contractor.

Step 5. Conduct retrofit work

- Contracts will typically include schedule and estimated costs. The owner may have to periodically check in to ensure work is performed according to schedule and budget.
- Retrofit work will also need to be coordinated with existing building occupants.

Step 6. Inspections

- Conduct necessary inspections and testing

Step 7. Commissioning

- Ensure building systems are functioning properly and as intended

Step 8. Certificate of Occupancy and Turnover

Once the certificate of occupancy is achieved, the building can be turned over to the owner.

Estimated Budget

The estimated budget is shown in Table J.6.

Table J.6: Estimated Budget

Item	Notes/ Key Planning Decision Milestone	Cost
Pre-meter & Post-meter costs		\$89,000 - \$122,000
Required Incentives	Induction stove; Cookware compatible to induction stove	\$ -
Optional Incentives	Solar panels; Batteries	\$767,000 - \$804,700
Other Site-Specific Considerations	This site has been identified to require asbestos remediation prior to decommissioning with electrification as a replacement	\$63,000 - \$189,000
Known Rebates, Incentives, or other Equity Considerations	To be revisited at time application is submitted to a funding call.	\$ -
Environmental Impact Assessment (Phase I)	Step 1	\$2,000 - \$5,000
Environmental Impact Assessment (Phase II)	Step 2	\$5,000 - \$8,500
Permits (Building Permit & Construction Permit)	1% for building permit and 1.25 % for construction permit	\$2,250-\$3000
Project Management Cost for A&E (Design and construction Phase) and Design contract Fees	1% for design phase, 3%- 6% for construction phase, 3% for design contract costs	\$6,000-\$12,000
General Requirements	4.25% for Contractor PM cost, 4% for safety and security, 1% for temporary services and utilities, 0.5% for quality control, 5% for submittal	\$13,500 - \$18,000
Compliance & Local Review Fees	4.5%-20% for ADA compliance and 1% for plan review fees	\$5,000-\$26,000
Margin & Overhead	7.70% for general contractor overhead, 3.30% for general contractor's insurance, payment, and performance bond, 3%-10% contractor profit	\$12,500 - \$26,000

Item	Notes/ Key Planning Decision Milestone	Cost
Contingency	20% for Design Contingencies, 1%-4% for access, storage and staging contingencies & 2% to 20% for FEMA design contingencies	\$20,000 - \$54,000
Total		\$985,250 - \$1,268,200

The estimated budget for this project (including optional incentives) is \$922,250 to \$1,079,200. Without the optional incentive (of solar panels with battery backup and of induction stoves and cookwear), the estimated budget is \$218,250 to \$463,500. At the time of the proposal submission, the team will revisit current rebate opportunities (e.g., California's Solar on Multifamily Affordable Housing [SOMAH] Program) to determine whether it is possible to leverage other funds.

Case Study 3: Virginia (Santa Monica, CA)

Location Description

This project, "Virginia", is a single building apartment complex owned by the CBO Community Corporation of Santa Monica. It is located at 2425 Virginia Ave (see Figure J.3.). This site encompasses 12 residential units. The natural gas utility is Southern California Gas, and the electricity utility is Southern California Edison.

Virginia is located in a census tract designated as a DVC. While not designated as a low-income census tract, the CBO reports 12 of 12 units are designated (and 7 are self-reported) as low-income customers qualifying for the California Alternate Rates for Energy (CARE) or Family Electric Rate Assistance Program (FERA) assistance programs.

Pre-meter costs: According to natural gas infrastructure data provided by the municipal utility, this location is located near to, but not at the end of, a terminal branch in the natural gas distribution network. Given the need to serve the other buildings on the terminal branch, so is anticipated to be relatively easier for pre-meter costs to decommission. We estimate approximately 180 linear feet of natural gas pipe would be decommissioned. At the average cost of \$48.10 per foot, this is approximately \$8,700. More information would be needed from the natural gas utility to identify any other costs that would be pre-meter for the location.

Post-meter costs: The CBO has provided the following preliminary data indicating what needs to be decommissioned, allowing for a preliminary estimate of cost to decommission the property (Table J.7.). Estimates in change of utility bill as well as discussion with the CBO indicate that it is likely that electric panel upgrades are needed for this location, and so these are included in the cost. The current estimate to decommission the buildings and replace by electrification is **\$17K-24K**.

The average estimate of increase in annual utility bill is \$278 per family of four ranging from \$221-\$416/yr which is a change in GHG of -1,919 lbs CO₂ per year ranging from -1,535 to -2,878 lbs CO₂. For CARE customers, the average utility bill increase is \$155/yr ranging from \$115/yr to \$232/yr and for those first-time adopting CARE rates would have a utility bill

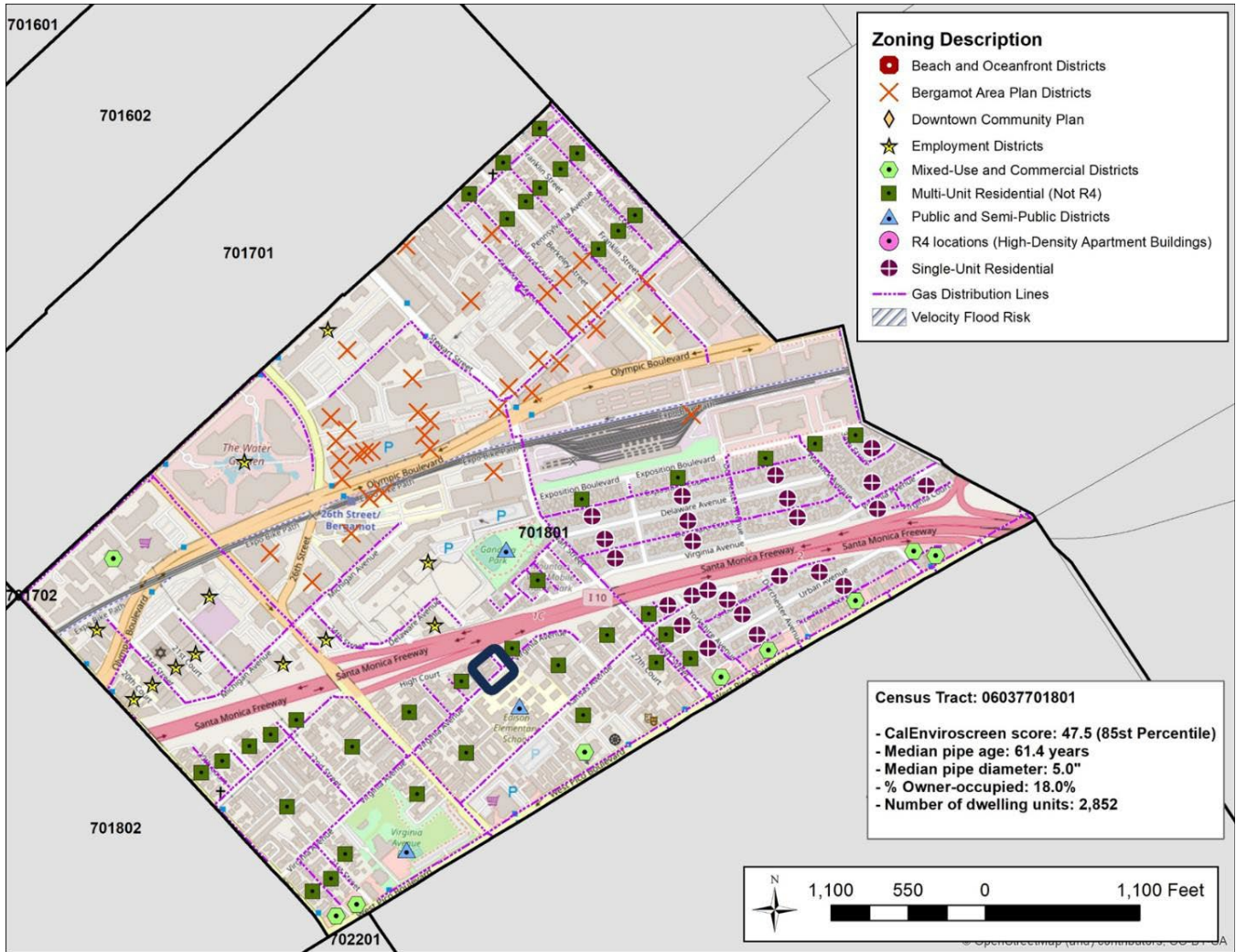
increase of \$76/yr ranging from \$36/yr to \$123/yr. Rate structures do not impact CO₂ emissions as these depend on energy usage and emissions are on average annual basis per unit of energy. Switching from natural gas to electric stoves would eliminate indoor methane sources from cooking appliances and would keep NO₂ levels below the 1-hour exposure national standard particularly for smaller kitchens with poor ventilation.¹⁰ More data will be needed (e.g., customer usage data; data on square footage; any hoteling requirements; etc.) in order to reduce the uncertainty range.

Ratepayer impacts for natural gas customers: Southern California Gas conducted hydraulic modeling for this sites and determined that there would be no effect on neighboring communities. In addition, Southern California Gas indicates ratepayer impacts will be negligible since these project sites are so small in comparison to the ratepayer region.

Ratepayer impacts for electricity customers: Southern California Edison indicates ratepayer impacts will be negligible since these project sites are so small in comparison to the ratepayer region.

¹⁰ Eric D. Lebel, Colin J. Finnegan, Zutao Ouyang, and Robert B. Jackson. "Methane and NO_x Emissions from Natural Gas Stoves, Cooktops, and Ovens in Residential Homes" *Environmental Science & Technology*. Volume 56, Issue 4, p. 2529–2539. January 27, 2022

Figure J.3: Census Tract Map for “Virginia”



Note: Solid dark rectangle is the location of this study.

Table J.7: Post-Meter Equipment Identified to be Transitioned

	Quantity
<i>Demolition:</i>	
Water Heater	12
Stoves	12
Space Heater	24
<i>Kitchen:</i>	
Upgrade NG cooktop to electric stove	12
<i>Space Heating:</i>	
Update wall heaters	24
<i>Water Heating:</i>	
Upgrade water heaters	12
<i>Laundry:</i>	
Building-scope	

Virginia has 1 building with 12 units. The equipment required to upgrade the site includes stoves, water heating, and space heating upgrades for all the units. The stove assumes a combined electric cooktop and oven. The water heaters include a replacement to the existing

gas water heater. The space heaters include 2 heat pump space heaters per unit. Furthermore, the scope includes a potential subpanel upgrade per unit to support the added electric load to each unit.

Potential risks, environmental issues, or policy issues

This site is in a census tract designated as DVC, and many of the existing residents qualify for the California Alternate Rates for Energy (CARE) or Family Electric Rate Assistance Program (FERA) assistance programs. Thus, decarbonization at this site will require prioritizing policies that promote equity considerations. Further, as per CBO information, this site doesn't require asbestos remediation and infrastructural upgrades to comply with codes and regulations. We thus anticipate no additional costs for potential risks.

Virginia Village is located across from the Edison Language Academy, a local elementary school. Since its adjacent street is a cul-de-sac against the 10 Freeway, there is limited through traffic near the site. Construction will need to be mindful of school traffic patterns as well as the limited parking in the area to stage work for the site. Virginia Village is also against the 10 Freeway, a large highway terminating in Santa Monica. As such, major construction may also have additional permitting requirements near the highway.

An environmental impact assessment will need to be conducted prior to work. We estimate **\$7,000-13,500 for the environmental impact assessment**.¹¹ This will include detailed site investigations to check for potential contaminations.

There will be the need to file some building permits to meet local regulations. We estimate **\$750 for the building permits**.¹²

Required (and Optional) Incentives

Given any decommissioning will adversely affect the building owner or residents during the construction, there is a need to work with these stakeholders and determine their lower bar of acceptable incentives to offset the construction inconvenience. Table J.8. contains a checklist of Incentives that were determined by the authors to be Required or optional for this project. The project will not proceed without support for Required Incentives in place.

Table J.8: Incentives Identified for this Project

Incentive Category	Incentive	Level of Need	Explanation/ Notes
Appliance Upgrade	Induction stove	Optional	The building owner has indicated that they would like updating the cooktop stoves to induction stoves.

¹¹ Butala, S. "Phase 1 vs Phase 2 Environmental Assessment?" March 16, 2023. <https://rsbenv.com/phase-1-vs-phase-2-environmental-assessment#:~:text=Phase%201%20Environmental%20Assessments%20provide,contaminants%20or%20hazards%20on%20site>. Last Visited: October 25, 2023.

Novick, I. "Phase 1 Environmental FAQs: How Much, How Long, and Why?" November 18, 2021. <https://www.lev.com/blog/phase-1-environmental-site-assessments>.

¹² RS Means Line Number 014126500010

Incentive Category	Incentive	Level of Need	Explanation/ Notes
	Cookware compatible to induction stove	Optional	The residents have indicated that they would like new cookware compatible to an induction stove. This includes a standard set of pots and pans, and as optional either a wok or a tortilla pan.
Other Energy	Solar panels	Optional	The building owner would like to install solar panels to offset the change in utility bills.
	Batteries	Optional	Batteries are needed as backup to the solar panels.
	Propane Tank	Not required	Not applicable.
	Generators	Not required	Not applicable.
Resident Needs	Hoteling	Not required	Not applicable.
	Other monetary incentive	Not required	Not applicable.
Other	None	Not required	Not applicable.

The costs for each of these is estimated below.

Required

None.

Optional Induction stove

This site contains 12 natural gas-operated stoves, which will be replaced with an electric heat stove. This incentive pertains to upgrading the natural gas replacement with induction stoves. Induction stove has several advantages over traditional natural gas and electric stoves. Induction stoves are more energy efficient, allow better temperature control for cooking, are safer with a cool cooking surface, and improve indoor air quality. It will cost approximately between \$16,000 - \$22,000 to replace 12 natural gas cooktops with an induction stove.

Cookware compatible with induction stove

Induction stoves utilize electromagnetic energy to heat cookware directly, necessitating the use of magnetic material in the cookware. As a result, switching from natural gas cooktops to induction stoves requires the acquisition of new cookware. This incentive is designed to offer cookware that is compatible with induction stoves, such as pots and pans. Furthermore, we can broaden this incentive's range to encompass additional items like woks and tortilla pans.

It will cost approximately \$2,000 - \$3,000 to provide 12 sets of induction-compatible cookware.

Solar panels

Solar energy is a clean, effective, and renewable energy source that can help reduce emissions associated with the energy sector. Solar panels are beneficial for multifamily housing as they help reduce energy bills and the carbon footprint of the building. This incentive pertains to installing solar panels on the building as a part of the decarbonization strategy.

Given the site's energy requirements and roofing space, we can install 4 kW of solar panel capacity. A solar panel costs approximately \$3 per watt (W). Therefore, a 4 kW (4000 W) solar panel will cost approximately \$12,000, and \$200 yearly to maintain it.

Batteries

Renewable energy sources, such as solar power, are inherently variable. Unlike conventional power plants, their energy production depends on weather conditions, resulting in output fluctuations and intermittent supply. Energy storage systems, specifically batteries, are employed to mitigate these challenges. This incentive aims to supply batteries that enhance the dependability of the energy generated by the on-site solar panels.

Given the energy requirements, this site needs 120 kWh with a minimum of 10 kWh for each unit. It will cost \$128,000 to install compatible batteries and ancillary systems.

Equity Considerations (Other than CARE and FERA)

Site selection was conducted by our Community-Based Organization (CBO) Partners. We worked with CBOs to engage different stakeholders to ensure that the needs and concerns of underrepresented and vulnerable community members are adequately captured and identified. Stakeholder engagement highlighted a few equity concerns that must be addressed to ensure successful site electrification. A chief concern among stakeholders is how decommissioning natural gas might impact vulnerable and disadvantaged communities, potentially burdening them disproportionately. Consequently, we must identify various policy incentives and financial support structures to address the potential financial burden on the residents.

Since the availability of rebates/incentives varies with policy changes, we note that if this pilot application is submitted, the applications should review availability and place into their cost estimate. We place a placeholder in the Estimated Budget table to address this.

Other Considerations

All data and costs presented in this are preliminary estimates, and are subject to change upon project award. Given the uncertainties reflected in this application, a **20% contingency placeholder** has been added to the overall estimated budget.¹³

¹³ RSMean Line Number 012116000000

Key planning decisions

Key planning decisions will be tied to award date and calendar date. These will include:

Step 1. Design Phase

- Determine scope of work (this may require site inspection and review of existing drawings)
- Hire design consultants (e.g. engineer, architect, etc)

Step 2. Get estimate for Scope of Work

- Solicit bids from contractors for retrofit work

Step 3. Select contractor to perform work

- This will require written contract

Step 4. Obtain necessary permits

- Permits can either be responsibility of owner, designer, or contractor.

Step 5. Conduct retrofit work

- Contracts will typically include schedule and estimated costs. Owner may have to periodically check in to ensure work is being performed to schedule and budget.
- Retrofit work will also need to be coordinated with existing building occupants.

Step 6. Inspections

- Conduct necessary inspections and testing

Step 7. Commissioning

- Ensure building systems are functioning properly and as intended

Step 8. Certificate of Occupancy and Turnover

- Once certificate of occupancy is achieved, building can be turned over to owner.

Estimated Budget

The estimated budget is shown in Table J.9.

Table J.9: Estimated Budget

Item	Notes/ Key Planning Decision Milestone	Cost
Pre-meter & Post-meter costs		\$17,000 - \$24,000
Required Incentives	Induction stove; Cookware compatible to induction stove	\$ -
Optional Incentives	Solar panels; Batteries	\$158,000 - \$165,000

Item	Notes/ Key Planning Decision Milestone	Cost
Other Site-Specific Considerations	To be revisited at time application is submitted to a funding call; none identified at this time.	\$ -
Known Rebates, Incentives, or other Equity Considerations	To be revisited at time application is submitted to a funding call.	\$ -
Environmental Impact Assessment (Phase I)	Step 1	\$2,000 - \$5,000
Environmental Impact Assessment (Phase II)	Step 2	\$5,000 - \$8,500
Permit (Building Permit & Construction Permit)	1% for the building permit and 1.25 % for the construction permit	\$1,000 - \$4,000
Project Management Cost for A&E (Design and construction Phase) and Design contract Fees	1% for design phase, 3%- 6% for construction phase, 3% for design contract costs	\$5,000 - \$7,000
General Requirement	4.25% for Contractor PM cost, 4% for safety and security, 1% for temporary services and utilities, 0.5% for quality control, 0.5% for submittal	\$8,000
Compliance & Local Review Fees	4.5%-20% for ADA compliance and 1% for plan review fees	\$3,000 - \$12,000
Margin & Overhead	7.70% for general contractor overhead, 3.30% for general contractor's insurance, payment, and performance bond, 3%-10% contractor profit	\$6,000 - \$11,000
Contingency	20% for Design Contingencies, 1%-4% for access, storage, and staging contingencies, and 2% to 20% for FEMA design contingencies	\$14,000 - \$26,000
Total		\$216,366 - \$260,866

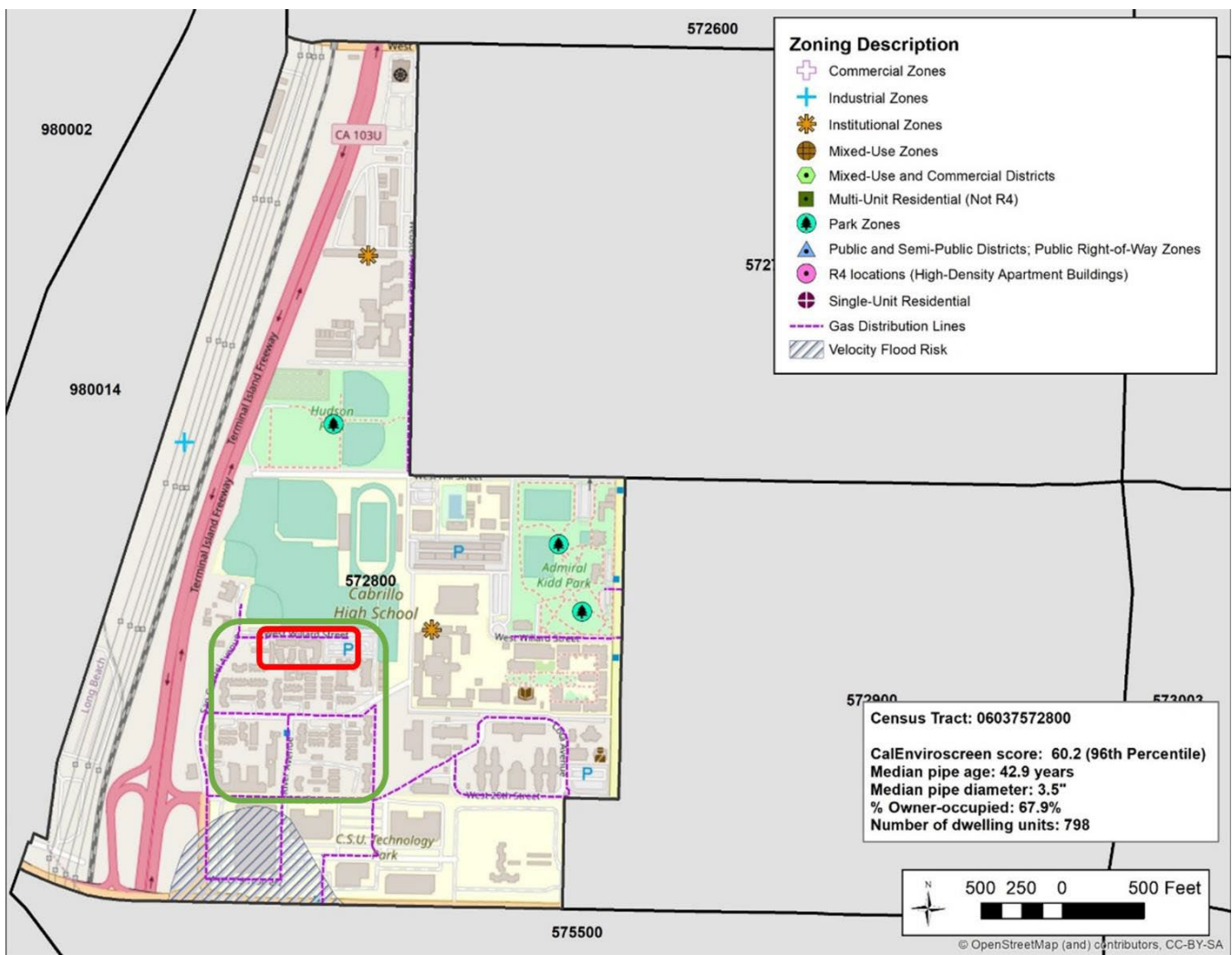
The estimated budget for this project (including optional incentives) is \$219,100 to \$270,500. Without the optional incentive (of solar panels with battery backup and of induction stoves and cookwear), the estimated budget is \$61,100 to \$105,500. At the time of the proposal submission, the team will revisit current rebate opportunities (e.g., California's Solar on Multifamily Affordable Housing [SOMAH] Program) to determine whether it is possible to leverage other funds.

City of Long Beach sites

The City of Long Beach deliberations workshop identified two pilot sites of multi-building areas, both at Century Villages at Cabrillo, see Figure J.4.¹⁴ The CBO indicated that for these buildings, they did not anticipate the need for a) upgrades due to building codes or b) asbestos remediation.

At the time of writing of this report, Long Beach Utilities has not yet conducted hydraulic modelling for these sites, nor determined ratepayer impact. This will need to be completed prior to initiating a pilot project application. In addition, Southern California Gas indicates ratepayer impacts of Case Study 4 will be negligible since these project sites are so small in comparison to the ratepayer region.

Figure J.4: Census Tract Maps for Case Studies 4-5



Note: Solid red rectangle is the location of Case Study 4: Family Commons. Solid green rectangle is the location of Case Study 5: Century Villages at Cabrillo.

¹⁴ Century Villages at Cabrillo provides permanent supportive housing to over 1600 formerly unhoused and high-risk populations including veterans. Supportive services are offered on site, with more than a dozen partner organizations delivering coordinated supportive services to residents of all ages.

Case Study 4: Family Commons (Long Beach, CA)

Location Description

This project, "Family Commons," is a multi-building apartment complex owned by the CBO Century Villages at Cabrillo. It is located in part of the 2100 block of Willard Street (see Figure J.4.). This site encompasses nine buildings with 81 residential units and 8000 sq. ft. of office and educational space. The natural gas utility is the Long Beach Gas & Water (the municipal utility), and the electricity utility is Southern California Edison.

Family Commons is in a census tract designated as a DVC and low-income (CalEnvironScreen 4.0 indicates this census tract is at a poverty percentile level 100). No information was gathered on California Alternate Rates for Energy (CARE) or Family Electric Rate Assistance Program (FERA) assistance programs. At the time of compiling this plan, Long Beach Utilities has not yet conducted hydraulic modeling for these sites, nor determined ratepayer impact. This will need to be completed upon project award.

Pre-meter costs: According to natural gas infrastructure data provided by the municipal utility, Family Commons is located at a terminal branch in the natural gas distribution network. We estimate approximately 750 linear feet would be decommissioned. The average cost of \$48.10 per foot is approximately \$36,000. More information would be needed from the natural gas utility to identify any other pre-meter costs for the location.

Post-meter costs: The CBO has provided the following preliminary data indicating what needs to be decommissioned, allowing for a preliminary estimate of the cost to decommission the property (Table J.10.). There is already a 220V electrical supply in place, so no new electrical panels are required. The current estimate to decommission the buildings and replace them by electrification is \$325K-470K.

The average utility bill impact is an increase of \$518 per family of four, ranging from \$369/yr to \$777/yr. For CARE customers, the utility bill increase is \$289/yr ranging from \$184/yr to \$433/yr and for those first-time adopting CARE rates would have a utility bill increase of \$289/yr with the same range since Long Beach's gas utility does not have a CARE program as a gas municipality. In terms of GHG, there is an average change of -1,919 lbs CO₂ per year for a family of four, and ranging from -1,535lbs CO₂ per year to -2878lbs CO₂ per year. Rate structures do not impact CO₂ emissions as these depend on energy usage, and emissions are on an average annual basis per unit of energy. Switching from natural gas to electric stoves would eliminate indoor methane sources from cooking appliances and would keep NO₂ levels below the 1-hour exposure national standard, particularly for smaller kitchens with poor ventilation.¹⁵ More data will be needed (e.g., customer usage data; data on square footage, any hoteling requirements; etc.) to reduce the uncertainty.

Ratepayer impacts for natural gas customers: Southern California Gas conducted hydraulic modeling for these sites and determined that there would be no effect on

¹⁵ Eric D. Lebel, Colin J. Finnegan, Zutao Ouyang, and Robert B. Jackson. "Methane and NO_x Emissions from Natural Gas Stoves, Cooktops, and Ovens in Residential Homes" Environmental Science & Technology. Volume 56, Issue 4, p. 2529–2539. January 27, 2022

neighboring communities. In addition, Southern California Gas indicates ratepayer impacts will be negligible since these project sites are so small in comparison to the ratepayer region.

Ratepayer impacts for electricity customers: Southern California Edison indicates ratepayer impacts will be negligible since these project sites are so small in comparison to the ratepayer region.

Table J.10: Post-Meter Equipment Identified to be Transitioned

		Quantity
<i>Demolition:</i>	Water Heater	84
	Stoves	84
	Laundry	12
<i>Kitchen:</i>	Upgrade NG cook top to electric stove	84
	<i>Space Heating</i>	
<i>Water Heating:</i>	Upgrade water heaters	84
<i>Laundry:</i>	Building-scope	

TOTAL UNIT COSTS		
Building Costs	Quantity	
<i>Kitchen</i>		
<i>Space Heating</i>		
<i>Water Heating:</i>	Panel upgrades	84
<i>Laundry:</i>	Upgrade gas Dryers	12

Family Commons has 9 buildings with 81 units. The equipment required to upgrade the site includes stoves and water heating upgrades for all the units. The stove assumes a combined electric cooktop and oven. The water heaters include a replacement to the existing instantaneous gas water heater. Since there is a gas water heater, there is a potential electric subpanel upgrade to support the incremental load to the units. There are additional stoves and laundry upgrades for the shared spaces. These are the same stove specifications for the units and electric laundry dryers to replace the existing gas appliances.

Potential risks, environmental issues, or policy issues

This site is in a census tract designated as DVC and as low income (CalEnvironScreen 4.0 indicates this census tract is at poverty percentile level 100). Thus, decarbonization at this site will require prioritizing policies that promote equity. Further, as per CBO information, this site doesn't require asbestos remediation and infrastructural upgrades to comply with codes and regulations. We thus anticipate no additional costs for potential risks.

The site is part of the larger Century Villages development in Long Beach. As such, it shares common resources with Century Villages like roads and other infrastructure. Century Villages has limited parking and access to main roads are funneled through one main gate. Major construction for upgrades to the Family Commons will require special considerations for managing traffic and to also assurance that electrical upgrades to Family Commons does not cause issues with other infrastructure at Century Village. Additionally, Family Commons is adjacent to Cabrillo High School and its athletic fields. Century Villages will need to coordinate with the high school to minimize disturbances from the construction at Family Commons.

An environmental impact assessment will need to be conducted prior to work. We estimate **\$7,000-13,500 for the environmental impact assessment.**¹⁶ This will include detailed site investigations to check for potential contaminations.

There will be the need to file some building permits to meet local regulations. We estimate **\$4,450 for the building permits.**¹⁷

Required (and Optional) Incentives

Given that any decommissioning will adversely affect the building owner or residents during the construction, it is necessary to work with these stakeholders and determine their lower bar of acceptable incentives to offset the construction inconvenience. Table J.11. contains a checklist of Incentives that were determined by the authors to be Required or optional for this project. The project will not proceed without support for Required Incentives in place.

Table J.11: Incentives Identified for this Project

Incentive Category	Incentive	Level of Need	Explanation/ Notes
Appliance Upgrade	Induction stove	Not required	Not Applicable
	Cookware compatible to induction stove	Not required	Not applicable
Other Energy	Solar panels	Optional	Although Family Commons did not provide their own incentives needed for their residents, we expect the learnings from the Santa Monica sites are indicative of potential needs in Long Beach.
	Batteries	Optional	Batteries are needed as a backup to the solar panels.
	Propane Tank	Not required	Not applicable.
	Generators	Required	Emergency generators, more extensive than earthquakes, deal with local outages.
Resident Needs	Hoteling and Per Diem	Required	Accommodation for residents impacted by decarbonization work in their apartments

¹⁶ Butala, S. "Phase 1 vs Phase 2 Environmental Assessment?" March 16, 2023. <https://rsbenv.com/phase-1-vs-phase-2-environmental-assessment#:~:text=Phase%201%20Environmental%20Assessments%20provide,contaminants%20or%20hazards%20on%20site>. Last Visited: October 25, 2023.

Novick, I. "Phase 1 Environmental FAQs: How Much, How Long, and Why?" November 18, 2021. <https://www.lev.com/blog/phase-1-environmental-site-assessments>.

¹⁷ RS Means Line Number 014126500010

Incentive Category	Incentive	Level of Need	Explanation/ Notes
	Other monetary incentive	Optional	This includes work from home, medical expenses, etc.
Other	None	Not required	Not applicable.

Although Family Commons did not provide their own incentives needed for their residents, we expect the learnings from the Santa Monica sites to be indicative of potential needs in Long Beach.

Required Hoteling

The decarbonization efforts at the site may cause inconvenience to residents due to associated construction activities. Some construction projects may require access to certain apartments, rendering them temporarily uninhabitable. This incentive aims to offer temporary lodging to families affected by the decarbonization work at the site.

This proposal assumes that each of the 81 units can be temporarily housed in one hotel room at the per diem rate. The per diem daily lodging rate is \$183 per unit, not including taxes.¹⁸ To accommodate all 81 units for one week, the cost is approximately \$103,800. For a one-month stay, the lodging expense amounts to approximately \$444,700. Please note that the costs do not include tax.

This proposal also assumes per diem rates for meals and incidentals, with an average of 3 persons per unit, or 243 persons total. The per diem daily meals and incidentals rate is \$74 per unit.¹⁹ To accommodate all persons for one week, the cost is approximately \$124,000. For a one-month stay, the lodging expense amounts to approximately \$532,000.

Generators

The site's decarbonization initiatives may disrupt the electrical supply for apartments and retail spaces. This incentive is designed to mitigate the inconvenience caused by potential electricity disruptions by offering electrical generators. The approximate daily electricity consumption for all residential units is around 420 kW. Assuming all the units need to draw power from the generator simultaneously, the site will need to buy two 250 kW electric generator diesel engines, which will cost approximately \$110,000 apiece,²⁰ or \$220,000 total. Diesel is not included in this estimate.

Optional Solar panels

Solar energy is a clean, effective, and renewable energy source that can help reduce emissions associated with the energy sector. Solar panels are beneficial for multifamily housing as they

¹⁸ U.S. General Services Administration. "[FY 2024 per diem rates for California](https://www.gsa.gov/travel/plan-book/per-diem-rates/per-diem-rates-results?action=perdiems_report&fiscal_year=2024&state=CA)." Last accessed April 10, 2026: https://www.gsa.gov/travel/plan-book/per-diem-rates/per-diem-rates-results?action=perdiems_report&fiscal_year=2024&state=CA.

¹⁹ U.S. General Services Administration. "[FY 2024 per diem rates for California](https://www.gsa.gov/travel/plan-book/per-diem-rates/per-diem-rates-results?action=perdiems_report&fiscal_year=2024&state=CA)." Last accessed April 10, 2026: https://www.gsa.gov/travel/plan-book/per-diem-rates/per-diem-rates-results?action=perdiems_report&fiscal_year=2024&state=CA.

²⁰ RSMMeans 2019

help reduce energy bills and the carbon footprint of the building. This incentive pertains to installing solar panels on the building as a part of the decarbonization strategy.

Given the site's energy requirements and roofing space, we can install 28 kW of solar panel capacity. This will cost \$41,000 - \$84,000 to install the solar panels and \$200 yearly to maintain it.

Batteries

Renewable energy sources, such as solar power, are inherently variable. Unlike conventional electricity sources, their energy production depends on weather conditions, resulting in output fluctuations and intermittent supply. Energy storage systems, specifically batteries, are used to mitigate these challenges. This incentive aims to supply batteries that increase the dependability of the energy generated by the on-site solar panels.

Given the energy requirements, this site needs 810 kWh with a minimum of 10 kWh for each unit. It will cost \$863,000 to install compatible batteries and ancillary systems.

Equity Considerations (Other than CARE and FERA)

Site selection was conducted by our Community-Based Organization (CBO) Partners. We worked with CBOs to engage different stakeholders to ensure that the needs and concerns of underrepresented and vulnerable community members are adequately captured and identified. Stakeholder engagement highlighted a few equity concerns that must be addressed to ensure successful site electrification. A chief concern among stakeholders is how decommissioning natural gas might impact vulnerable and disadvantaged communities, potentially burdening them disproportionately. Consequently, we must identify various policy incentives and financial support structures to address the potential financial burden on the residents.

Since the availability of rebates/incentives varies with policy changes, we note that if this pilot application is submitted, the applications should review availability and place into their cost estimate. We place a placeholder in the Estimated Budget table to address this.

Other Considerations

All data and costs presented in this are preliminary estimates, and are subject to change upon project award. Given the uncertainties reflected in this application (including that a rate payer impact analysis by the natural gas utility has not yet been completed), a **20% contingency placeholder** has been added to the overall estimated budget.²¹

Key planning decisions

Key planning decisions will be tied to award date and calendar date. These will include:

Step 1. Design Phase

- Determine scope of work (this may require site inspection and review of existing drawings)
- Hire design consultants (e.g. engineer, architect, etc)

²¹ RSMean Line Number 012116000000

Step 2. Get estimate for Scope of Work

- Solicit bids from contractors for retrofit work

Step 3. Select contractor to perform work

- This will require written contract

Step 4. Obtain necessary permits

- Permits can either be responsibility of owner, designer, or contractor.

Step 5. Conduct retrofit work

- Contracts will typically include schedule and estimated costs. Owner may have to periodically check in to ensure work is being performed to schedule and budget.
- Retrofit work will also need to be coordinated with existing building occupants.

Step 6. Inspections

- Conduct necessary inspections and testing

Step 7. Commissioning

- Ensure building systems are functioning properly and as intended

Step 8. Certificate of Occupancy and Turnover

Once certificate of occupancy is achieved, building can be turned over to owner.

Estimated Budget

The estimated budget is shown in Table J.12.

Table J.12: Estimated Budget

Item	Notes/ Key Planning Decision Milestone	Cost
Pre-meter & Post-meter costs		\$325,000 - \$470,000
Required Incentive	Hoteling (7 days to 3 months) and generators)	\$448,000 - \$1,197,000
Optional Incentives	Solar panels; Batteries	\$904,000 - \$947,000
Other Site-Specific Considerations	To be revisited at time application is submitted to a funding call; none identified at this time.	\$ -
Known Rebates, Incentives, or other Equity Considerations	To be revisited at time application is submitted to a funding call.	\$ -
Environmental Impact Assessment (Phase I)	Step 1	\$2,000 - \$5,000

Item	Notes/ Key Planning Decision Milestone	Cost
Environmental Impact Assessment (Phase II)	Step 2	\$5,000 - \$8,500
Permit (Building Permit & Construction Permit)	1% for the building permit and 1.25 % for the construction permit	\$9,000 - \$25,000
Project Management Cost for A&E (Design and construction Phase) and Design contract Fees	1% for design phase, 3%- 6% for construction phase, 3% for design contract costs	\$29,000 - \$40,000
General Requirement	4.25% for Contractor PM cost, 4% for safety and security, 1% for temporary services and utilities, 0.5% for quality control, 0.5% for submittal	\$49,000
Compliance & Local Review Fees	4.5%-20% for ADA compliance and 1% for plan review fees	\$16,000 - \$71,000
Margin & Overhead	7.70% for general contractor overhead, 3.30% for general contractor's insurance, payment, and performance bond, 3%-10% contractor profit	\$38,000 - \$63,000
Contingency	20% for Design Contingencies, 1%-4% for access, storage, and staging contingencies, and 2% to 20% for FEMA design contingencies	\$82,000 - \$157,000
Total		\$2,007,000 - \$3,032,500

The estimated budget for this project (including optional incentives) is \$2,007,000 - \$3,032,500. Without the optional incentive (of solar panels with battery backup), the estimated budget is \$1,003,000 to \$2,085,500, with the high upper end being a function of the length of hoteling needed for residents. At the time of the proposal submission, the team will revisit current rebate opportunities (e.g., California's Solar on Multifamily Affordable Housing [SOMAH] Program) to determine whether it is possible to leverage other funds.

Case Study 5: Century Villages at Cabrillo (Long Beach, CA)

Location 5, "Century Villages", is the entire Century Villages at Cabrillo campus, and owned by the CBO Century Villages at Cabrillo. It is a 27-acre campus community that encompasses residential, office, healthcare, educational spaces and a commercial kitchen multi-building apartment complex. Its headquarters are 2001 River Ave. Together, this site encompasses 41 buildings with 815 housing units spread across older and newer buildings (as well as a mix of owner- and renter-paid utilities). The natural gas utility is the Long Beach Utilities (the municipal utility), and the electricity utility is Southern California Edison.

Century Villages is located in a census tract designated as a DVC and as an LI (CalEnvironScreen 4.0 indicates this census tract is at poverty percentile level 100). No information was gathered on California Alternate Rates for Energy (CARE) or Family Electric Rate Assistance Program (FERA) assistance programs.

As of the writing of this report, the large geographic scope placed this outside the scope of additional work, and so no cost estimates have been made.



California
ENERGY COMMISSION



ENERGY RESEARCH AND DEVELOPMENT DIVISION

APPENDIX K: Guidelines for Strategic Decommissioning in Southern California

May 2026 | CEC-500-2026-010

Appendix K:

Guidelines for Strategic Decommissioning in Southern California

One goal of our research is to create a set of guidelines and criteria that enable decision makers to identify potential project sites for natural gas system decommissioning, quantify the avoided natural gas infrastructure costs associated with all-electric service, assess costs and benefits of electric system upgrades and building electrification, and evaluate expected cost increases or savings and customer acceptance.

Our research suggests that California may wish to adopt a three step process as guidelines for decommissioning in Southern California. These three-step guidelines are intended to be used by decision makers to achieve buy-in from all relevant stakeholders throughout the decommissioning process. They are designed to be considered during the initiation of any decommissioning effort, and are an initial step toward developing best practices for that process. These proposed guidelines cover issues the research process helped us identify as important, including: 1) defining project scope, 2) achieving buy-in from all stakeholders, and 3) conducting appropriate analyses. This three-step approach is a result of our learning throughout this project process. The specific items flagged within each of the steps were all mentioned directly by stakeholders ranging from technical experts to local community experts. Following these guidelines will increase likelihood of project completion, and may also decrease project cost and time to completion.

Three Step Guidelines

1. Define Project Scope

Decommissioning natural gas infrastructure represents a transformation of California's energy infrastructure that has costs and benefits spread across multiple stakeholders.

In any such effort, there is first a need to understand the motivations behind it. A funder could have many distinct objectives, such as seeking to fund a project that is attractive to all stakeholders; or seeking reputational enhancement via a monument, or other talking piece, similar to how Andrew Carnegie funded multiple buildings in his name; or seeking to demonstrate the ability to break down certain political barriers; or seeking maximum greenhouse gas emission reductions per person; or seeking state-wide decommissioning.

Based on our workshops, conversations with the project TAC, and with the sponsor, the authors identified the following set of considerations that may help define the project scope:

- Geographic extent (e.g., a few buildings, a few city blocks, an entire census tract, etc.)
- Type of weather, such as whether there are freeze/thaw concerns
- Project length and start date (which limits what alternatives can be considered)
- Number of customers in the project area

- Type of infrastructure decommissioned (e.g., residential, commercial, industrial, hospitals, schools, etc.)
- Who owns the infrastructure decommissioning (are building(s) are owned by multiple different entities?)
- Attributes of natural gas pipe in scope for decommissioning (terminal lines only? terminal regulators only? mains?)
- Whether alternatives other than electrification are in scope
- Whether regulatory compliance costs and effects (e.g., asbestos or lead remediation) are to be included
- Whether is it possible to offer incentives to building owners or renters, such as improving appliances, adding solar, adding air conditioning, changing to an induction stove and providing new pots & pans, etc.

2. Engage Stakeholders

Successful decommissioning requires input or data from many different groups prior to conducting the engineering and economic analyses associated with the site. Depending on the type of data available, the research and analysis approach will change. For example, if it is known ahead of time that the natural gas utility will provide detailed maps of distribution architecture limited to viewing in one census tract at a time (as in this study), that means the analysis must aggregate these data to census tract level or higher when using these data for decision-making. Similarly, if it is known ahead of time that both natural gas and electric utilities will be unable to provide detailed customer data (as common to protect customer information), and customers are also unwilling to provide these data (also as in this study), this means that the research is unable to use as a decision criteria the specific households that would most benefit from decommissioning.

Stakeholders to be considered include, but are not limited to:

The funder. The question “Who Pays” is going to be as important as “How much does it cost?” For example, electrification may be prohibitively expensive for lower income/vulnerable populations, or might inequitably distribute costs across property owners and renters. It is important to consider all the costs that might occur, and who will pay them. Funders may include, but are not limited to, governmental entities, charitable foundations, independent system operators, local utilities, building owners, and developers.

Government leadership. Buy-in from government leadership will help identify local community groups who will be affected by the project. It will also help provide assurance that the local government will work with stakeholders to ensure the appropriate permits are obtained and building codes met.

Local utilities. Most project scopes will require information on natural gas infrastructure to be decommissioned, as well as the hydraulic impact of this decommissioning. In cases where the alternative is electrification, there is a need to understand whether there is sufficient excess capacity on the line, and also what the change in customer utility bill will be.

Depending on the number of customers decommissioned, there may also be a need to understand ratepayer impacts.

Building owners & renters. Depending on the type of decommissioning, there may be a need to work with building owners and renters to determine willingness to experience a) interruption of service, b) changes in types of service or utilities as a function of the project scope, c) indirect changes to meet building code regulations, and d) noise and traffic changes from the decommissioning. It is also very likely that these stakeholders will want some sort of incentive to offset the inconveniences borne during decommissioning (e.g., adding solar, adding air conditioning, changing to an induction stove, and providing new pots & pans, etc.)

Neighboring entities. Even if only one building is decommissioned, there is the potential to affect neighbors via changes in traffic or noise during construction. For large projects, there is the potential to affect service via either decrease in natural gas or increase in demand above electricity capacity. It is important to conduct initial modelling to determine spillover effects, and then gain agreement from those entities.

As buy-in is gained from all stakeholders, equity values should be kept to the fore. In addition to the equity vignettes described in this report, potential topics to consider include:

- Examine the difference between care, standard, and low-usage customers (i.e., those who don't use gas due to prohibitively high price even when service is in place).
- Consider that a service area best suited for decommissioning might cut across all income levels, and consider what the consequences of that might be. For example, consider how to avoid a cost-shift burden on more vulnerable populations under the scenario of more rapid electrification by high income/wealth households.
- Consider the age of the household/neighborhood. There seem to be two parallel concepts here: the age & condition of infrastructure (i.e., pipelines), and the age & condition of buildings (i.e., asbestos remediation).
- Consider health outcomes as an equity metric. For example, it might be that electrification will improve health outcomes for low-income households due to change in indoor air quality.
- Consider the role of high electricity prices in shaping the natural demand for electrification. If electricity costs more than natural gas, the cost of switching will go up as people's electricity bill rises. This endogenous effect will have consequences on the cost of electrification, in addition to up-front costs.

3. Conduct a Tailored Analyses Under Conditions of Uncertainty

Step 3 is to conduct the appropriate analyses to determine the costs, benefits, and impacts of the project. Our work suggests that limitations in data availability and uncertainty in cost estimates can limit ability to conduct this analysis. Stakeholders and experts also disagree about what costs, benefits, and impacts of the project are important, and how tradeoffs among those values should be designed. Therefore, it is important to conduct analyses under

a range of future conditions (such as changes in utility pricing) and to iterate between analysis and stakeholder engagement.

Costs and benefits include, but are not limited to, pre-meter costs, post-meter costs and benefits, ratepayer impacts for natural gas utility customers, ratepayer impacts for electric utility customers, and other non-cost concerns such as equity. While the relative importance of each of these differs depending on project scale, it is likely that each of these will need evaluated. Regardless of project objective and scope, there will be some uncertainty with these calculations (e.g., due to lack of data availability). When costs or benefits are uncertain, one can turn to parameterizations, or information on ranges of costs. This includes characterizing how risks change under decommissioning natural gas, whether that be avoided risk of explosion or reduced health impacts from natural gas, or risk of electricity outages due to demand overload during heat waves.

Consider for example, a single-building project. In this case, it is likely that ratepayer impacts will be negligible, and it is likely that highly precise data can be obtained from the building owner about infrastructure needs (such as whether this particular building will need building permits, asbestos remediation, etc.). Furthermore, if the project covers only one building, it may be easier to identify projects able to begin requesting permitting in 1-3 years where uncertainties are quite low. Additional ease in cost calculations may obtain if the project objective is defined as “low-hanging fruit.” One might, for example, immediately focus on large buildings (e.g., R4 apartment buildings) with a single building owner that are located on terminal branches.

On the other hand, for large-scale projects the cost and benefit calculations become correspondingly more complex. There are more data to be gathered, and more uncertainties associated with these data. It is very likely that ratepayer impacts will be non-negligible, and hydraulic modelling may demonstrate that decommissioning natural gas within the target area may affect customers outside the project site. Furthermore, larger projects are likely to take longer to initiate and longer to finish; such a schedule may overlap with many other projects (e.g, projects transforming the energy grid such that the project baseline assumptions in year one, such as excess capacity available, may need updated).

Conclusion

These Guidelines for Strategic Decommissioning of Natural Gas Infrastructure were created from lessons learned in southern California. This is initial work, and best practices need to continue to be developed, documented, and tested as California stakeholders continue to explore decommissioning natural gas infrastructure with electricity as a replacement.



California
ENERGY COMMISSION



ENERGY RESEARCH AND DEVELOPMENT DIVISION

APPENDIX L: Knowledge Transfer Plan

May 2026 | CEC-500-2026-010

Appendix L:

Knowledge Transfer Plan

The knowledge, results, and lessons learned from this work are made available to the CEC and the public on request. Table L.1 gives the completed or anticipated events and publications related to knowledge transfer. Data that were provided to RAND by project partners is subject to a non-disclosure agreement and will thus not be transferred beyond the project staff.

Table L.1: Completed or Anticipated Events and Publications

Event or Publication	Description	Target Audience	Audience Size	Date
Briefing	CEC hosted public workshop where RAND and E3 discussed their projects	General Public	>50	November 2021
Publication - Report	Energy Equity Perspective. Note this was funded by a different group	Those interested in energy equity	N/A	January 2022
Workshop	January workshop (as part of research) While part of the research as described above, this was also a knowledge transfer activity to the communities	Stakeholders in City of Santa Monica and City of Long Beach	28	January 2022
Phone Call	Chat with City of Berkeley to help them inform workshops	Billi Romain	2	February 18, 2022
Phone Call	Advice to MS student Laura Lyons	Laura Lyons, UC Berkeley MS student, interning with Michael Colvin	1	Feb- March 2022
November 2022 Workshop	November workshop (As part of research) While part of the research as described above, this was also a knowledge transfer activity to the communities	Stakeholders in City of Santa Monica and City of Long Beach	29	November 2022
Phone Call	Chat with Berkeley; Discuss preliminary findings to inform future studies	Samuel Trachtman	1	March 6, 2023
Briefing	City of Santa Monica used some of our slides in a state wide presentation, Bay Area Regional Energy Network (BayREN) Forum	San Francisco Environment Department	2-3	March 21, 2023
Briefing	Briefed CPR 2 slides to Southern California Edison's Building Decarbonization Group.	Southern California Edison Decarbonization group	10	July 2023
Publication - Report	This document	CEC and general public	N/A	Draft submitted August 2023
Publication - Guidelines	Per this contract, write a set of Guidelines for Decommissioning	General public	N/A	Included as part of this document; draft submitted August 2023

Event or Publication	Description	Target Audience	Audience Size	Date
Publication - Pilot Project Applications	Per this contract, write at least 3 pilot project applications for CBOs to use	CBOs	3-4	Anticipated Winter 2023/2024
Advisory Board	Participation in TAC for the DNV project	CEC project team	5-20	Anticipated
Briefing	Additional briefings or conference presentations	As requested	N/A	Anticipated



California
ENERGY COMMISSION



ENERGY RESEARCH AND DEVELOPMENT DIVISION

APPENDIX M: Project Performance Metrics

May 2026 | CEC-500-2026-010

Appendix M:

Project Performance Metrics

Prior to the project start, the authors collaborated with the California Energy Commission (CEC) and the project’s Technical Advisory Committee (TAC) to define metrics for gauging the performance of this project (metrics, targets, and evaluation methods as shown in Table M.1). This project met at least the Low Target Performance for all Metrics (see “Description of Project Performance” Column).

Table M.1: Project Performance Metrics

Performance Metric	Description of Project Performance	Low Target Performance	High Target Performance	Evaluation Method	Significance of Metric
Average number of attendees of workshop(s) to elicit metrics and uncertainties	Met Low. On average, we had 14 participants (16 and 12 in Santa Monica and Long Beach, respectively)	>10	>50	We counted the number of attendees at each workshop, and calculated the average	Higher values indicate higher community engagement and levels of co-production of knowledge
Resident share of attendees in workshop(s) to elicit metrics and uncertainties	Met High. We were not allowed to collect home address of workshop participations. We instead assumed all except city employees were residents. We estimated 75% and 67% residents for Santa Monica and Long Beach, respectively	20%	40%	We counted the number of residents at each workshop, divided by the total number of attendees	Higher values indicate local higher community engagement
Numbers of decision criteria evaluated in the decision analysis	Met High. We considered 18 separate metrics in the visualization tool	>3	>10	We counted the number of decision criteria	Higher values indicate the decision analysis is considering more criteria of interest to stakeholders
Numbers of different sites and approaches considered for each pilot	Met Low. At the census tract Level, we considered 3 in Santa Monica and 17 in Long Beach. At the building level, we considered 4 in Santa Monica and 15 in Long Beach	3	>10	We calculated the average of the number of sites considered across both locations	Higher values indicate the decision analysis is considering more possible sites and suggests broader applicability to other locations

Performance Metric	Description of Project Performance	Low Target Performance	High Target Performance	Evaluation Method	Significance of Metric
Average number of attendees of deliberations workshop(s)	Met Low. There were an average of 14.5 attendees (16 and 13 in Santa Monica and Long Beach, respectively)	>10	>50	We counted the number of attendees at each workshop, and calculated the average	Higher values indicate higher community engagement and levels of co-production of knowledge
Resident share of attendees in deliberations workshop(s)	Met High. We were not allowed to collect home address of workshop participations. We instead assumed all except city employees were residents. We estimated 69% (and 100% for Santa Monica and Long Beach, respectively)	20%	40%	We counted the number of residents at each workshop, divided by the total number of attendees	Higher values indicate local higher community engagement across different level of stakeholders
Number of proposed pilot projects	Met High. This report described 5 pilot project sites	3	5	Count the number of proposed pilot projects	Higher values indicate the decision analysis method may be scalable, replicable, and attractive to stakeholders
Number of proposed pilot projects in DVCs and MUDs	Met Low. This report described 5 pilot project sites. All 5 are in DVCs. Two are in MUDs	1	5	Count the number of proposed pilot projects in a DVC or MUD	Higher values indicate the decision analysis method may be scalable, replicable, and attractive to stakeholders for DVCs and MUDs