Tacoma Community Building Decarbonization Strategy

Prepared For: City of Tacoma
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LAND ACKNOWLEDGEMENT

ʔukʷədiid čəɬ ʔuhigʷəd txʷəl tiiɬ ʔa čəɬ ʔal tə swatxʷixʷtxʷəd ʔə tiiɬ puyaləpabš. ʔa ti dxʷʔa ti swatxʷixʷtxʷəd ʔə tiiɬ puyaləpabš ʔəsɬaɬɬil tulʼal tudiʔ tuhaʔkʷ. didiʔɬ ʔa həlgʷəʔ ʔal ti sləx̌il. dxʷəsɬaɬlils həlgʷəʔ gʷəl ƛ̓ʼuyayus həlgʷəʔ gʷəl ƛ̓ʼuƛ̓ʼaǰʷad həlgʷəʔ tiiɬ bədədəʔs gʷəl tix̌dxʷ həlgʷəʔ tiiɬ ʔiišəds həlgʷəʔ gʷəl ƛ̓ʼuʔalalus həlgʷəʔ gʷəl ƛ̓ʼutxʷəlšucidəb. x̌ʷəla···b ʔə tiiɬ tuyəlʼyəlabs.

We gratefully honor and acknowledge that we rest on the traditional lands of the Puyallup People. The Puyallup people have lived on this land since the beginning of time. They are still here today. They live, work, raise their children, take care of their community, practice their traditional ways and speak the Twulshootseed language – just as their ancestors did.

We recognize that this land acknowledgement is one small step toward true allyship, and we commit to uplifting the voices, experiences, and histories of the Indigenous people of this land and beyond.

Source: Puyallup Tribe of Indians, Land Acknowledgement.
See the Puyallup Tribe's land acknowledgement spoken by Tribal members in their native

Twulshootseed language: https://youtu.be/KGnac8x-SIM.

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EXECUTIVE SUMMARY

To ensure a climate-safe and socially just future for Tacoma, we are committed to reaching net-zero emissions economy-wide by 2050. This is in line with targets being set by many other communities across the U.S., and the global target needed to increase our chances of avoiding catastrophic climate change. Residential and commercial buildings together contribute 19% of Tacoma's greenhouse gas emissions and must be decarbonized to meet our economy-wide goals.

The Tacoma Community Building Decarbonization Strategy (Strategy) provides a data-driven approach to gradually phasing out fossil-fuel appliances and maximizing co-benefits for our households and businesses. The Strategy aligns with the City's strategic objectives to become an antiracist, clean energy city with healthy, efficient, and affordable buildings in great neighborhoods. Realizing equitable building decarbonization and maximizing co-benefits will require a high-profile, whole-of-city approach and tight alignment with Tacoma's other strategic initiatives.

Tacoma is well-positioned for successful building decarbonization. However, we are a relatively small city with constrained resources. We will need to join forces with internal and external partners, build upon shared goals, and work quickly and collaboratively toward big wins within the larger policy and funding ecosystem in Washington state. The evolving suite of Washington state decarbonization policies and mandates can provide significant support for meeting Tacoma's building decarbonization goals. Federal funding from the Inflation Reduction Act and infrastructure bill can help drive building decarbonization, especially for low-income households.

Centering building decarbonization is fundamental to centering equity and affordability and ensuring a healthy, resilient, community and economy in the 21st century. The Strategy recognizes that decarbonizing Tacoma's building stock by 2050 will require broad and systemic change, and this change must be leveraged to deliver broad and systemic benefits to overburdened and frontline communities disproportionately impacted by climate change, including communities of color, low-income communities, elderly people, non-English speaking households, and immigrant communities. This bold transformation will require support for new resources and targeted, ambitious policy and technology solutions.

The Strategy identifies the technical and strategic pathway, targets, and milestones to equitably decarbonize Tacoma's homes and buildings by 2050. It includes five core strategies, summarized in the table below. The strategies and actions are structured to drive swift and transformational shifts in building decarbonization policy, the pace of market adaptation, the volume of funding and financing flowing into Tacoma's economy, internal and city-wide implementation capacity, and utility transition planning. Well-coordinated, collaborative, and aggressive action on each of these interdependent strategies is required to achieve Tacoma's building decarbonization goals.

BY CENTERING EQUITY AND AFFORDABILITY, BUILDING DECARBONIZATION CAN:

- Increase investment in underserved housing and correct for historic institutional disinvestment in specific communities,
- Improve health, safety, and resilience by targeting and prioritizing unhealthy or unsafe housing for upgrades—addressing ventilation, lead, mold, and structural or electrical issues,
- Develop an equitable workforce through accessible training and certifications to support a transition of the building sector with a focus on job opportunities for marginalized communities, and
- Stabilize neighborhoods by reducing energy costs and unhealthy living conditions.

Strategies	Actions
1. Adopt Comprehensive, Fast-Tracked Policies & Targets	• Adopt building decarbonization targets and milestones • Maintain current tenant protections in Tacoma's Rental Housing Code and ensure adoption of key actions from Tacoma's Anti-Displacement Strategy • Implement a Rental Housing Registry ordinance • Consider adopting a residential performance rating and disclosure ordinance • Advocate for a zero-emission appliance standard for WA state and/or Puget Sound with an effective year of 2030 • Advocate to update the WA Clean Building Performance Standard to align with Washington state's and Tacoma's building decarbonization targets and milestones • Advocate for updates to new construction and existing buildings requirements in the WA State Energy Code
2. Rapidly Transform the Market	• Develop and implement a broad and targeted communications and awareness campaign • Develop a City building electrification technology roadmap • Collaborate to align Tacoma Power conservation targets with building decarbonization targets • Implement zero-emissions retrofit programs for single-family housing, affordable and rental housing, large commercial buildings via a Clean Buildings Performance Standard Accelerator, and small commercial buildings • Collaborate in regional market transformation efforts • Increase workforce capacity • Reduce electrification costs • Reduce electrical service costs
3. Significantly Expand Funding and Financing	• Stack state and federal incentives to support City building decarbonization • Leverage Climate Commitment Act funds and federal grants • Investigate Tacoma Power authority to support income qualified customers with electrification • Develop and implement a plan for promoting performance-based contracting and financing mechanisms • Advocate for credit enhancements from the state green bank currently under development, and explore possible City funded credit enhancements
4. Develop Implementation Capacity and Collaboration	• Work with external stakeholders to align around shared goals and develop a collaboration framework to support strategy implementation • Identify and fund building decarbonization implementation capacity
5. Support Collaborative Utility Transition Planning	• Collaborate with Tacoma Power and Puget Sound Energy on communication, planning, and program design • Ensure Tacoma Power Integrated Resource Plan considers building decarbonization targets and milestones • Consider developing a neighborhood-scale decarbonization program

The Strategy is organized into three phases to sequence the strategies and actions and guide the development of more detailed implementation planning and timelines in 2024. The phases are designed to leverage a window of opportunity to move forward with early action and funding in 2024, which will position Tacoma to launch key initiatives in 2025, align with time-sensitive policies and funding, ramp up zero emission retrofits in low opportunity areas, and scale the pace of zero-emission retrofits across the city by 2030.

Figure-ES 1 Building Decarbonization Strategy Phased Timeline

Phase I 2024-2025 is a pivotal phase for implementing the Strategy and staying on track to meet 2030 milestones. By adopting and funding the Strategy in 2024, Tacoma will lay the groundwork to kick off a transformational 25-year project to modernize, optimize, and decarbonize its building stock by 2050.

Immediate next steps in 2024 include:

- Coordinate internally to establish roles and detailed action plans,
- Develop budget proposals to increase staff capacity and fund Strategy implementation,
- Collaborate with Tacoma community stakeholders, relevant Washington state departments, and other jurisdictions and organizations to align around shared goals, targets, and timelines,
- Develop a collaboration framework to increase collective impact and advocacy for critical, time-sensitive priorities—such as changes to the Washington State Energy Code, updates to the Clean Buildings Performance Standard, and a potential zero-emissions appliance standard—necessary to phase out new and replacement fossil-fuel space and water heating installations by 2030.

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1 | INTRODUCTION

In 2025, Tacoma will celebrate its 150th birthday. Homes and buildings are central to the very essence of the city. By adopting and funding the Tacoma Community Building Decarbonization Strategy (Strategy) in 2024, Tacoma will lay the groundwork to mark its 150th birthday by kicking off a transformational 25-year project to modernize, optimize, and decarbonize its building stock by 2050. The Strategy centers building decarbonization as fundamental to centering equity and affordability, and ensuring a healthy, resilient, community and economy in the 21st century. It aligns with the City's strategic objectives to become an antiracist, clean energy city with healthy, efficient, and affordable buildings in great neighborhoods. Realizing equitable building decarbonization and maximizing co-benefits will require a high-profile, whole-of-city approach and tight alignment with Tacoma's other strategic initiatives.

> *"This is our turning point. We are committed to action for climate justice. When we succeed, Tacoma will truly become the City of Destiny. We hope you will join us — and our companions and allies across the country and around the world — in this shared work."*
>
> - *Victoria R. Woodards*
>
> Mayor of Tacoma (from Tacoma's 2030 Climate Action Plan)

Context

To ensure a climate-safe and socially just future for Tacoma, we are committed to reaching net-zero emissions economy-wide by 2050. This is in line with targets being set by many other communities across the U.S., and the global target needed to increase our chances of avoiding catastrophic climate change. Residential and commercial buildings together contribute 19% of Tacoma's greenhouse gas emissions.

Tacoma is well-positioned for successful building decarbonization. However, it is a relatively small city with constrained resources. The evolving suite of Washington state decarbonization policies and mandates can provide significant support for meeting Tacoma's building decarbonization goals. Federal funding from the Inflation Reduction Act and infrastructure bill can help drive building decarbonization, especially for low-income households.

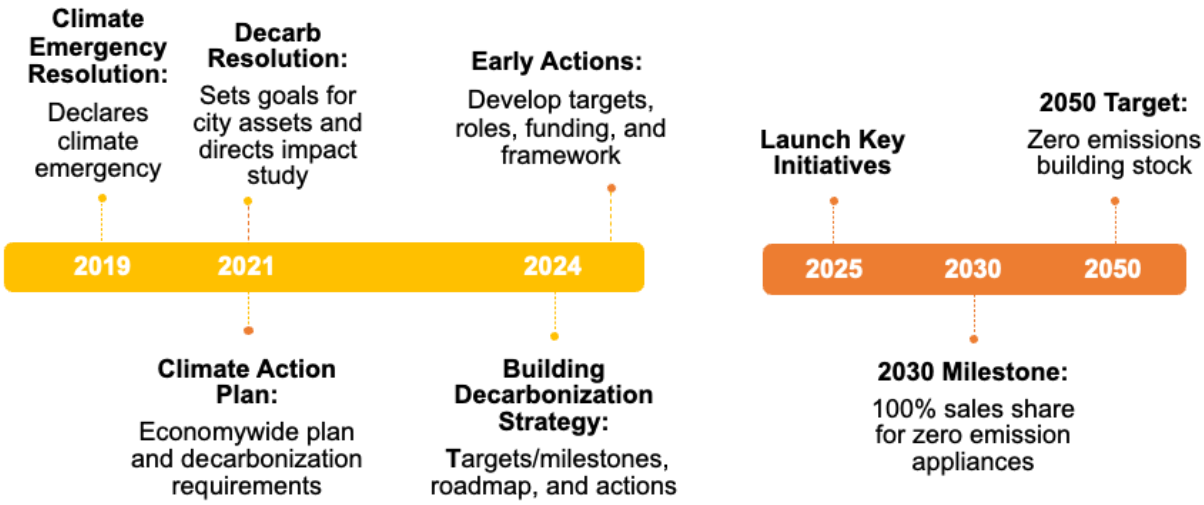
Tacoma has many important upstream and supportive plans, policies, and programs in place that are essential for building decarbonization, including but not limited to Tacoma's 2030 Climate Action Plan (CAP) emissions reduction goals and targets, various City resolutions, and programs to address housing affordability and equity, tools, and maps for assessing and addressing inequality within policies and programs. Tacoma also has a municipal electric utility that can contribute detailed building stock data, technical analysis, and potentially large-scale mobilization of programs and other support for building sector market development.

This Strategy is part of Tacoma's larger policy framework to decarbonize its economy. With City Council Resolution 40509,[1] Tacoma declared a climate emergency in 2019 and set a goal for a just transition to a carbon neutral economy for all sectors by 2050. In 2021, Tacoma's Climate Action Plan identified an economy-wide and sector-level approach to deliver the decarbonization required to meet the emissions limits established by Resolution 40509.

[1] City of Tacoma Resolution No. 40509 (https://cms.cityoftacoma.org/Planning/DevelopmentServices/TacomaPermitAdvisoryTaskForce/AgendasAndMinutes/TPATF_2020.01.09_Attachment_2.pdf)

In 2021, City Council also passed Resolution 40776[2] requiring the City to decarbonize its municipal buildings and study the impact of electrifying Tacoma's residential and commercial buildings. This Strategy includes the impact analysis (see Appendix A |) directed by Resolution 40776 and uses it to inform a data-driven, equity focused strategy for how the building sector must transform to meet Tacoma's statutory emissions limits.

Figure 1-1 Tacoma Building Decarbonization Policy Trajectory



The Strategy builds on the Climate Actin Plan by drawing on its extensive community engagement process and incorporating the building sector emissions reduction goals and actions. It provides a more granular picture of the scale and pace of building decarbonization required to meet the Climate Action Plan goals. It also clarifies the critical, time-sensitive steps necessary to ensure a gradual and just transition.

The Strategy describes the landscape of current emissions, a pathway and phased timeline to meet 2050 emissions limits, and detailed targets and milestones for the residential and commercial sectors that prioritize investments in very low and low-opportunity areas of Tacoma. The Strategy recommends a set of interconnected strategies and actions to meet the detailed targets and milestones and to realize the historic and holistic opportunities presented by an economy-wide decarbonization project.

Early Action Imperative

As described in more detail throughout this report, the turnover rate for fossil-fuel equipment in buildings is driving the overall timeline and the need to move quickly in 2024 and 2025 to position the building sector to scale zero-emission appliance replacements by 2030. To eliminate emissions from the building stock by 2050, there is an optimal point where Tacoma must stop installing fossil-fuel appliances in new or existing homes and buildings for space and water heating. The Impact Assessment[3] conducted for this Strategy indicates that the optimal year is approximately 2030. Fossil fuel appliances installed after 2030 will likely need to be replaced well before the end of their useful life, which increases costs and could make for a more chaotic and difficult to manage transition.

[2] City of Tacoma Resolution No. 40776 (https://cms.cityoftacoma.org/enviro/Sustain/Resolution-No-40776_Decarbonization.pdf)

[3] See Appendix A

This Strategy recommends early action in 2024 to adopt the recommended building sector targets and milestones, assign departmental roles to strategies and actions, fund the recommended actions and additional staffing, develop a building decarbonization collaboration framework to support detailed planning, and to maximize collective action with internal and external stakeholders and partners. Recognizing this window of opportunity to move forward with early action and funding in 2024 will position Tacoma to launch key initiatives in 2025, leverage state and federal funding, ramp up zero emission retrofits in low opportunity areas, and scale the pace of zero-emission retrofits across the city by 2030.

2 | STRATEGY TO TRANSFORM TACOMA'S BUILDING STOCK

The Strategy was developed in a multi-step process including granular building sector market and impact analysis and engagement with the Tacoma Building Decarbonization Steering Committee and a stakeholder group. This process informed the development of a 2050 vision for Tacoma's homes and buildings, building decarbonization goals, a three-phase implementation roadmap with targets, and a comprehensive set of strategies and actions designed to work synergistically to meet the roadmap targets. The Strategy is intended to be a bridge from the economy-wide goals and deep community engagement conducted for the Climate Action Plan to an inclusive, whole-of-city building decarbonization campaign to shape and implement the building sector transformation.

2050 Vision for Tacoma's Homes and Buildings

The 2050 vision for Tacoma's homes and buildings is:

Tacoma's homes and buildings are zero-emissions and provide critical infrastructure supporting economic development and an equitable, affordable, healthy, efficient, and resilient carbon-neutral community.

Guiding Principles

The following guiding principles have informed the development of equitable building decarbonization strategies and actions and will be used to guide implementation of this Strategy. Many of these guiding principles also guided development of the 2030 Tacoma Community Climate Action Plan[4] and the Tacoma Climate Adaptation Strategy.[5]

Table 2-1 Equitable Building Decarbonization Guiding Principles

Guiding Principle	The Tacoma Community Building Decarbonization Strategy will…
Lead with racial justice and equity.	• Prioritize strategies that **benefit frontline communities**—especially our Black, Indigenous, and communities of color and low-incomes communities—to ensure they have the access and resources to implement and realize the co-benefits of building decarbonization. • **Empower frontline communities** in decision-making and implementation to create an equitable future for all.
Build transformational solutions for long-term community building decarbonization.	• Be a **leading example for other cities** on how to decarbonize buildings in an ambitious and inclusive way. • Pave the way for a **prosperous and diverse community** for all Tacomans for today and future generations.
Be transparent and accountable.	• Build in accountability and transparency by **integrating building decarbonization goals across congruent plans** throughout all City departments. • Utilize **common language** so that everyone understands what is being done and why. • Track **key metrics** to ensure effective implementation and achievement of goals.

[4] https://www.cityoftacoma.org/cms/one.aspx?pageId=193914

[5] https://www.cityoftacoma.org/cms/One.aspx?portalId=169&pageId=213008

Make decisions based on science and data, including community expertise and input.	• Ground decisions in **best available science** to inform policies and choices that will affect future generations. • Respect and **learn from the past**. • **Listen to the community** to stay connected, relevant, and responsive to their priorities.
Prioritize health and other co-benefits.	• Ensure that all actions prioritize multiple co-benefits and support the **health, well-being, economy, social fabric, housing equity, and cultural diversity of Tacoma.**

Strategy Goals

The purpose of the Strategy is to:

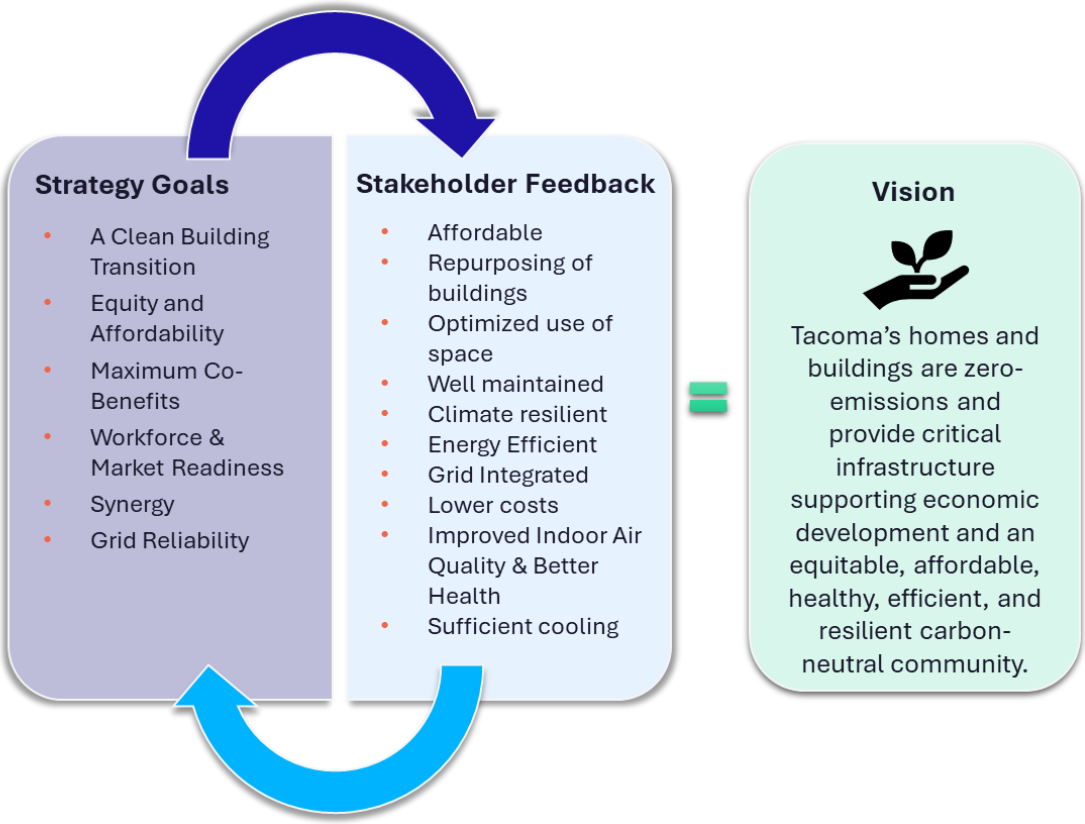
- Provide a pathway to reduce carbon emissions from existing and future building stock to meet climate action goals.
- Set a long-term vision with clear and compelling near-, medium- and long-term implementation strategies.
- Emphasize co-benefits and the intersection between climate, housing, public health, and equity.
- Include equitable stakeholder/community engagement in the development and implementation of the strategy.

The Strategy recommends strategies and actions to achieve the following goals:

- **A Clean Building Transition.** Decarbonize residential and commercial buildings by 2050.
- **Equity and Affordability.** Ensure clean building transition is equitable and affordable.
- **Maximum Co-Benefits.** Maximize co-benefits such as healthy, resilient, and affordable housing and commercial buildings.
- **Workforce & Market Readiness**. Ensure workforce and building sector market have a predictable path to ramp up staff, training, and capacity.
- **Synergy.** Maximize synergies across City departments and initiatives, other jurisdictions, and state, regional, and federal programs and funding.
- **Grid Reliability.** Minimize grid impacts.

Based on these goals, and in collaboration with stakeholders, the team developed a 2050 vision for Tacoma's homes and buildings (Figure 2-1 to help guide strategy development and implementation.

Figure 2-1 2050 Vision for Tacoma's Homes and Buildings



Strategy Process

The Strategy was developed iteratively with an in-depth technical analysis of emissions reductions, costs, and co-benefits. The project launched with a discovery and priority setting process with the Tacoma Building Decarbonization Steering Committee. Input from the discovery process was used to develop a strategy framework to guide and integrate the analytical work into the development of strategies and actions. Over the course of this work, the Steering Committee and a stakeholder group met for six workshops to review results and provide input on the strategy development. The project team also conducted 20 one-on-one outreach meetings with internal and external stakeholders to get more detailed input on goals, priorities, and partnership opportunities.

The results of the impact assessment directly informed the development of a building decarbonization pathway with targets and phases required to meet Tacoma's emissions limits. The strategies and actions align with the scale and pace identified in the decarbonization pathway. They are mutually reinforcing to deliver on the longer-term transition to a carbon-neutral building stock by

2050, while establishing an early action imperative to advance keystone building decarbonization policies and market transformation initiatives in 2024 and 2025.

Related Tacoma Strategies, Policies & Tools

The Strategy aligns with and leverages many climate and equity related strategies, plans, policies, and tools that Tacoma already has in place.

Figure 2-2 Tacoma Strategies, Policies, and Tools

Strategies	Policies	Tools
Climate Action Plan	2019 Climate Emergency Resolution	Tacoma Equity Index
Affordable Housing Strategy	2020 Anti-Racist Systems Transformation Resolution	Tacoma Urban Heat Map
Green Economic Development Strategy	2021 Decarbonization Resolution	Health Lens Analysis Tool
Tacoma Climate Adaptation Strategy	Pierce County Pacer	
Tacoma 2025 (Citywide Strategic Plan and Vision)		

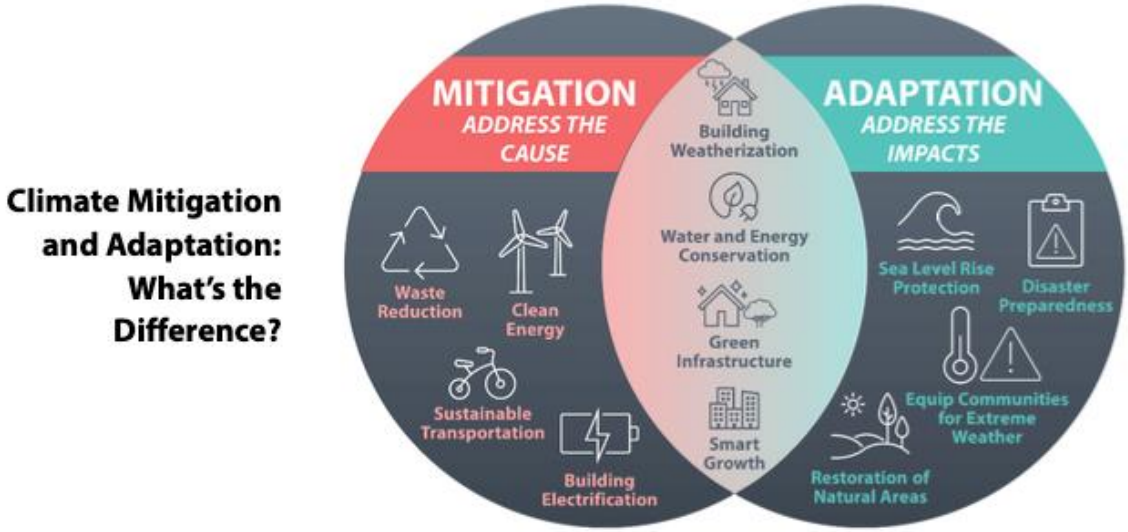
3 | CENTERING EQUITY AND AFFORDABILITY

Cities are on the frontlines of ensuring equity and affordability in their communities as all sectors of the economy rapidly decarbonize. Decarbonizing the building sector poses unique challenges and opportunities due to potential impacts on housing affordability and the potential co-benefits of providing cooling, improving energy efficiency, reducing energy bills, and removing sources of indoor and outdoor air pollutants such as fossil-fuel appliances.

This Strategy recognizes that decarbonizing Tacoma's building stock by 2050 will require broad and systemic change, and this change must be leveraged to deliver broad and systemic benefits to overburdened and frontline communities disproportionately impacted by climate change, including communities of color, low-income communities, elderly people, non-English speaking households, and immigrant communities. This bold transformation will require support for new resources and targeted, ambitious policy and technology solutions that leverage building decarbonization as a primary mechanism to achieve Tacoma's equity and affordability priorities.

One of the reasons building decarbonization is central to meeting other goals is that buildings are at the nexus of climate mitigation to address the causes of climate change, and adaptation to address the impacts. Building weatherization, energy conservation, green infrastructure, and smart growth—the key solutions where mitigation and adaptation overlap—are all building sector related. These solutions are integral components of successful building decarbonization and have significant equity and affordability implications.

Figure 3-1 Climate Mitigation and Adaptation: What's the Difference?[6]



Equity considerations arise in many aspects of building decarbonization. Procedural equity requires inclusive, accessible, and authentic engagement in developing, designing, and implementing building decarbonization programs, pilots, and solutions. Equity needs special attention within building decarbonization efforts to achieve equitable outcomes, including lowering costs, improving health and comfort, and job creation. Conversely, without planning for equity, building decarbonization could have unintended consequences and worsen inequalities by increasing energy burdens or providing inequitable access to new technologies. Solutions should also be developed to

[6] https://www.cityoftacoma.org/UserFiles/Servers/Server_6/File/cms/enviro/Sustain/Tacoma_Adaptation_Strategy_DRAFT.pdf

recognize and consider the historical and cultural structures that have routinely supported privileged groups in society and resulted in a chronic, cumulative disadvantage for some groups.

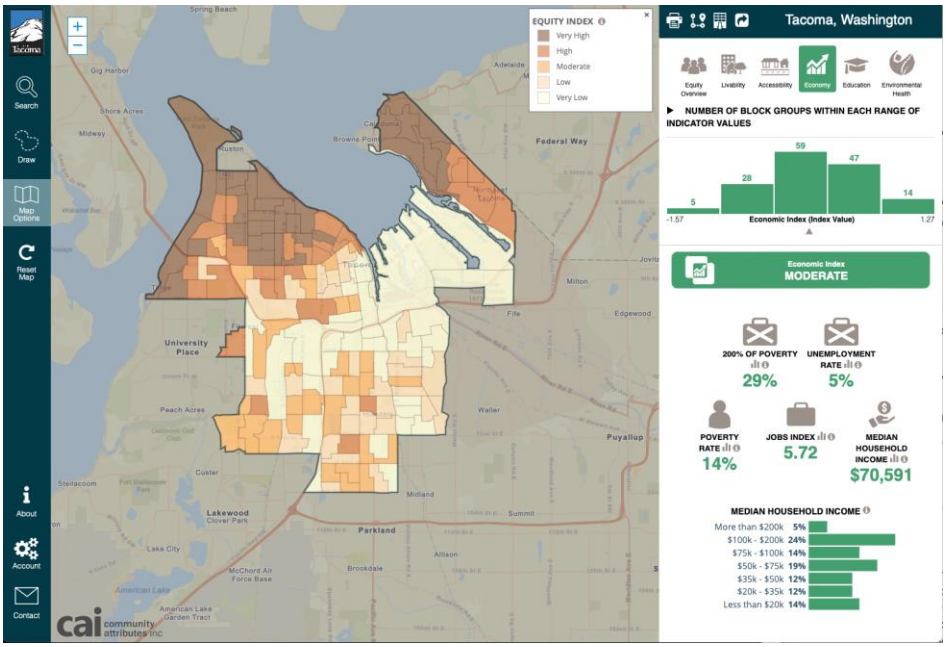
By centering equity and affordability, building decarbonization can:

- Increase investment in underserved housing and correct for historic institutional disinvestment in specific communities,
- Improve health, safety, and resilience by targeting and prioritizing unhealthy or unsafe housing for upgrades—addressing ventilation, lead, mold, and structural or electrical issues,
- Develop an equitable workforce through accessible training and certifications to support a transition of the building sector with a focus on job opportunities for marginalized communities, and
- Stabilize neighborhoods by reducing energy costs and unhealthy living conditions.

This Strategy draws on existing Tacoma analysis and tools to center equity and affordability in the analysis, strategies, and actions. For example, the Tacoma Equity Index[7] is a data-driven tool to see where projects, policies, programs, or services can have the largest impact on addressing inequity, and where investment can provide the biggest improvement in factors that impact life outcomes. The City of Tacoma uses the Equity Index to identify, track, and close disparities, and prioritize investments based on where and who has access to opportunity. For example, opportunity to safely walk to school, opportunity to earn a living wage job, opportunity to access healthy food, and opportunity to have safe and healthy environmental interactions.

> *"The Equity Index is a significant part of our strategy to connect the City's strategic goals, council priorities, department initiatives, and other assessments to implement the community's vision."*

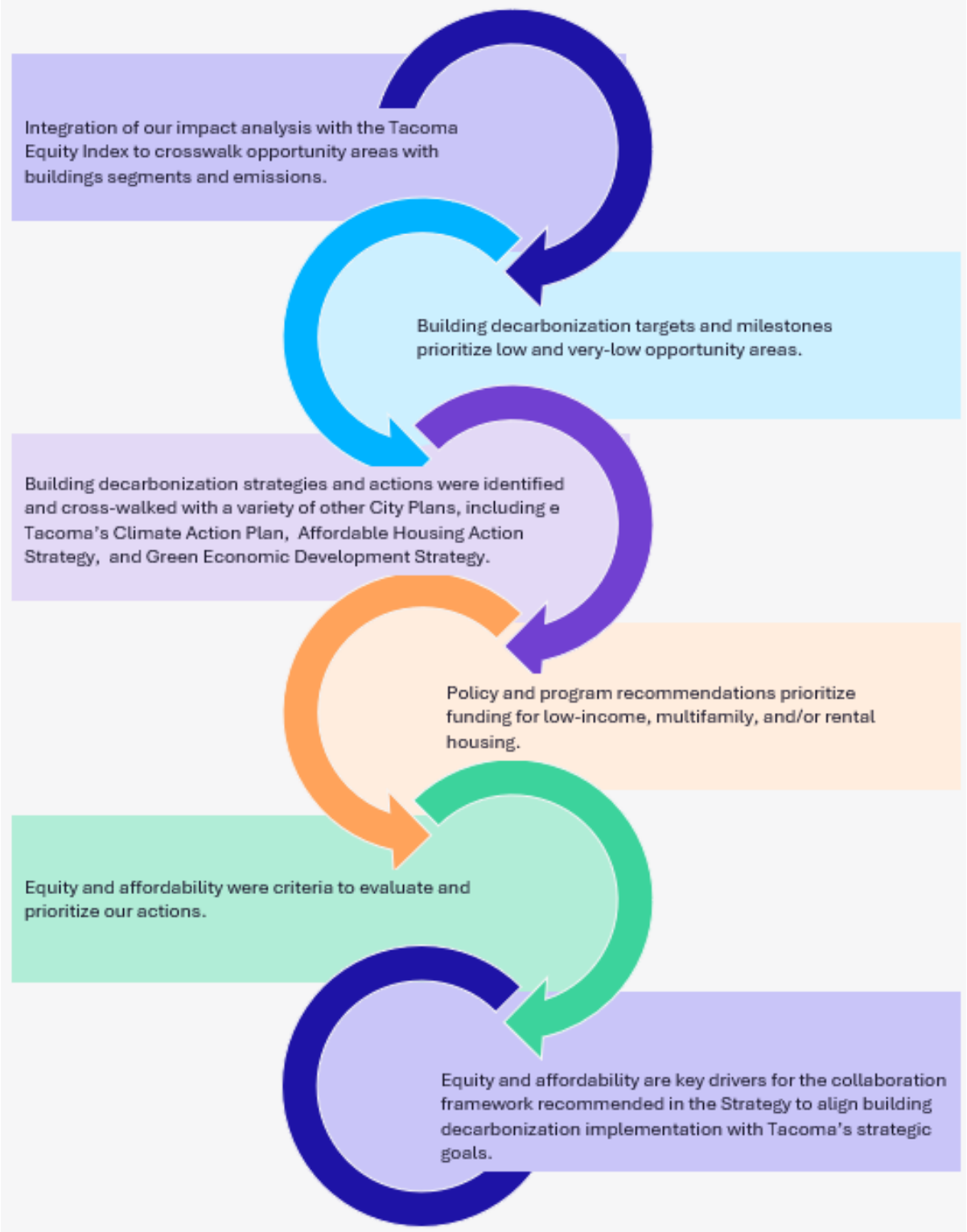
Figure 3-2 Tacoma Equity Index Map



[7] https://www.cityoftacoma.org/cms/One.aspx?portalId=169&pageId=175030]

In the list below, we illustrate how we centered equity and affordability in the Strategy.

Figure 3-3 How the Strategy Centers Equity and Affordability



4 | BUILDING DECARBONIZATION PATHWAY

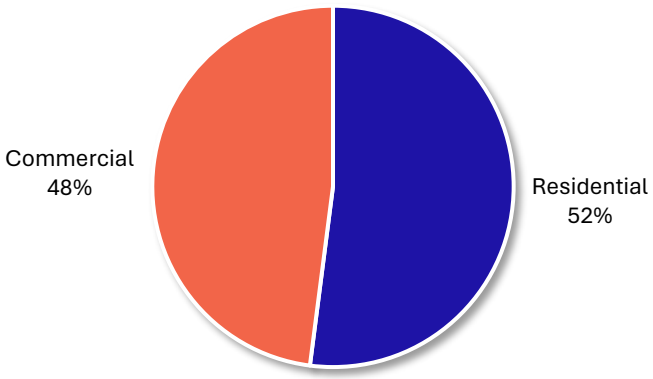
At an essential level, decarbonizing Tacoma's building stock requires that we stop installing fossil-fuel appliances in new buildings and replace fossil fuel appliances in existing buildings with zero-emission appliances. A key factor in developing the most strategic approach to accomplishing this by 2050 is understanding Tacoma's current building emissions landscape, the technical changes required to reduce emissions, and the scale and pace of those changes. A hyper-local technical understanding of building decarbonization is critical to align policies, programs, market development, and equity protections with the specific scale and pace of building decarbonization in Tacoma.

Current Emissions Landscape

Based on the results of Tacoma's Climate Action Plan, emissions from residential and commercial buildings account for approximately 19% of the total City greenhouse gas (GHG) emissions, 10% and 9% respectively. The largest two emitters are transportation (44%) and the industrial sector (30%). Residential and commercial building[8] are estimated to be responsible for 292,090 MTon of GHG emissions in 2022 based on their electric and natural gas use. This is roughly even in distribution between the two sectors, with 52% (152,012 MTon) in residential and 48% (140,078 MTon) in commercial.

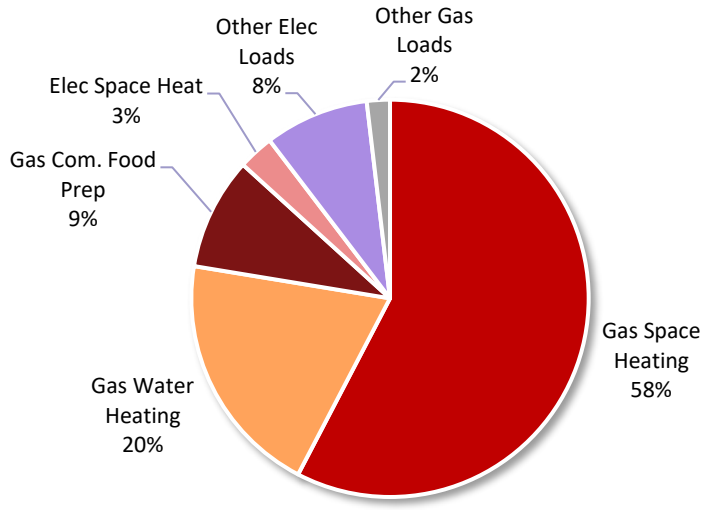
Natural gas space heating accounts for most of these emissions – 168,412 MTons or 58% of the total, with gas water heating and gas commercial food preparation equipment the second and third largest sources of emissions. Together these three gas end use loads account for over 85% of residential and commercial building emissions in Tacoma.

Figure 4-1 Sector-Level Share of Emissions in 2022



[8] Industrial facilities are not included in this analysis, which focuses on buildings decarbonization specifically; most of the energy use in industrial facilities is process loads which necessitate unique analysis and strategy.

Figure 4-2 Tacoma Emissions (MTons) by End Use and Fuels, 2022



Residential Sector

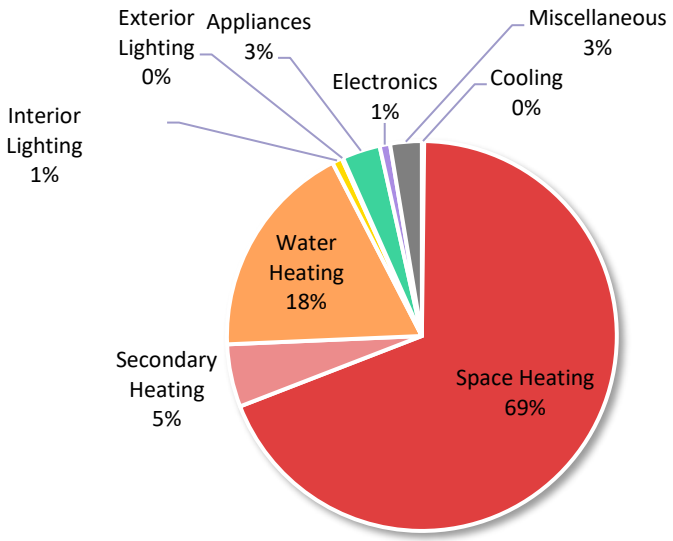
Tacoma has 102,957 residential units. More than 98% of the units are single family detached (one unit), single family attached (2-4 attached units), or low-rise multifamily (5 or more units and three stories or less). Less than 1% of the units are mid/high rise multifamily (4-6 stories or 7 or more stories). Nearly 35,000 residential units in Tacoma have gas service.

Table 4-1 Residential Sector Units and Emissions (2020)[9]

Segment	Number of Units	Units with Gas Service	Annual Emissions (MTon)
Single Family	65,919	22,018	114,080
Single Family 2-4 units	4,914	1,862	9,304
Low-Rise Multifamily	30,109	10,072	25,964
Mid/High-Rise Multifamily	774	257	662
Manufactured Home	1,241	411	2,002
Total	**102,957**	**34,620**	**152,012**

[9] Data development and sources for total number of units, units with gas service, and emissions are presented in Appendix A, Impact Assessment Data Development section. Note that data was supplied by Tacoma Public Utilities and Puget Sound Energy to support the assessment.

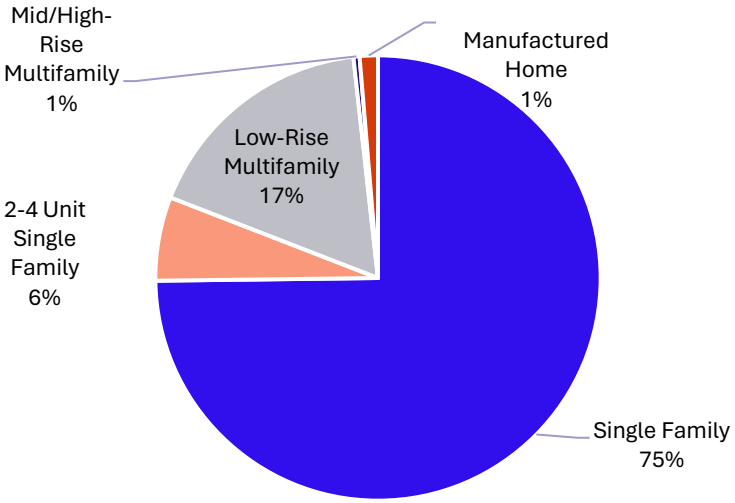
Figure 4-3 2024 Residential GHG Emissions by End Use



Space heating from natural gas furnaces and boilers account for nearly 70% of all residential emissions. Secondary heating from gas fireplaces accounts for an additional 5%. Natural gas water heaters account for an additional 18%. **The total emissions from space and water heat across the sector is 92%**

Figure-4-4 2024 Residential GHG Emissions by Housing Type

Single family homes contribute 75% of the total GHG emissions, with low-rise multifamily the next largest contributor at 17%. **The remaining home types contribute only 8% of all residential emissions.**

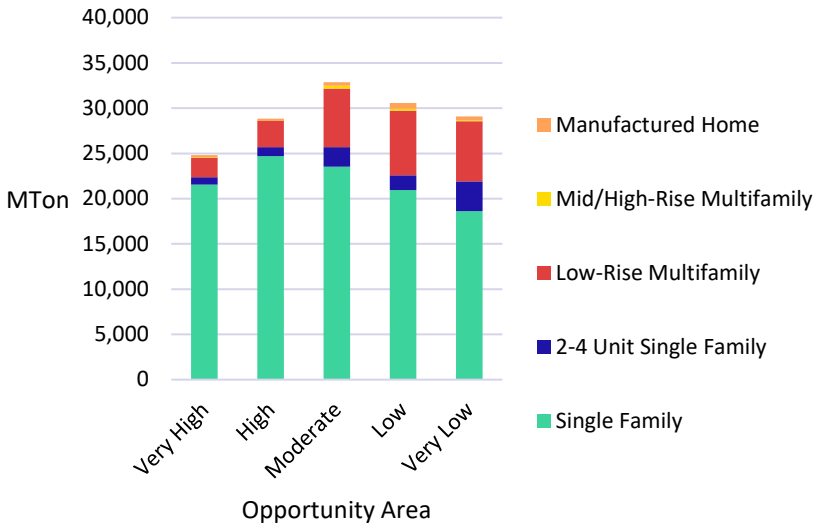


Opportunity Areas

Equity of the decarbonization process is of great concern to the City of Tacoma. Figure 4-5 and Figure 4-6 show how emissions are distributed across housing types and opportunity areas.[10]

[10] https://www.cityoftacoma.org/cms/One.aspx?portalId=169&pageId=175030

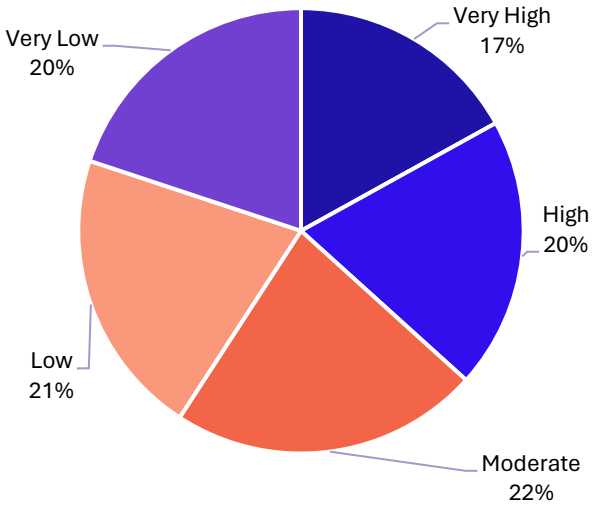
Figure 4-5 Residential GHG Emissions by Opportunity Area and Housing Type



Consistent with the graph above, most of the emissions come from single-family and low-rise homes. Further, as a result of the proportional allocation, **emissions per opportunity area are primarily a factor of the number of homes** within each opportunity area.

Figure 4-6 2024 Residential GHG Emissions by Opportunity Area

Here we **see a relatively equal break out of emissions by opportunity area**, with approximately 20% of the emissions attributed to each of the five area. Although, together the low and very low opportunity area account for more than 40% of residential emissions.



Residential takeaways include:

- Decarbonizing the residential sector should focus on zero emission appliances for space and water heating. These two end-uses account for 92% of total emissions in the sector.
- Secondary space heating, gas fireplaces, is the third largest end-use contributor to emissions at 5% of the total.
- Emissions are spread relatively evenly across opportunity areas. However, together the low and very low opportunity areas account for more than 40% of residential emissions and co-benefits may be larger in these opportunity areas.

- Single family homes have the largest concentration of emissions, at more than 75%. Single family plus low-rise multifamily account for 98% of emissions and, as such, should be the primary focus for the residential building decarbonization strategy.

Commercial Sector

Tacoma's commercial sector buildings include a total of just over 100 million square feet of commercial floor area. This floor area is spread out across more than a dozen building types. More than 60% of all commercial floor area is in offices, retail buildings, schools, and warehouses.

Table 4-2 Commercial Building Types, Floor Space, and Emissions

Business/Building Type	Floor Space (Million Sq Ft)	Market with Gas Service (Million Sq Ft)	Annual Emissions (MTon)
Office	21.5	6.2	13,887
Retail	17.2	5.0	18,123
Restaurant	3.7	1.1	32,436
Grocery	2.2	0.6	4,885
Hospital	4.5	1.3	9,610
Other Health	4.9	1.4	8,987
College	2.0	0.6	1,787
School	11.9	3.5	7,180
Lodging	2.6	0.7	3,739
Assembly	2.7	0.8	3,812
Warehouse	14.5	4.2	10,880
Data Center	0.2	1.5	2,657
MF Common Area	8.7	2.5	10,123
Misc - Classified[11]	6.2	3.3	10,902
Misc - Unclassified	1.0	0.3	1,069
Total Commercial	**103.7**	**33.0**	**140,078**

It is also important to consider how the commercial floor area is distributed across various size segments. The size segments presented in Table 4-3 align with the size cohorts of commercial and multifamily buildings that must comply with the Washington State Clean Buildings Performance Standard, which applies to buildings larger than 20,000 square feet.[12] 40% of Tacoma's commercial floor area is in buildings 20,000 square feet or less and therefore is not regulated by the building performance standard. Buildings 50,000 square feet or less are considered Tier 2 covered buildings. Tier 2 buildings must comply with benchmarking, energy management, and operations and maintenance requirements but are not currently required to meet energy use intensity targets. Buildings over 50,000 square feet are considered Tier 1 covered buildings. Tier 1 buildings must comply with all building performance requirements, including energy use intensity targets with compliance dates in 2026-2028 depending on size.

[11] Misc – Classified contains building/business types which were positively identified by Tacoma Power's dataset but do not fall into one of the other named categories (e.g., a pet groomer or bowling alley); Misc – Unclassified contains the consumption of properties which did not have identifying information – i.e. "Unknown"

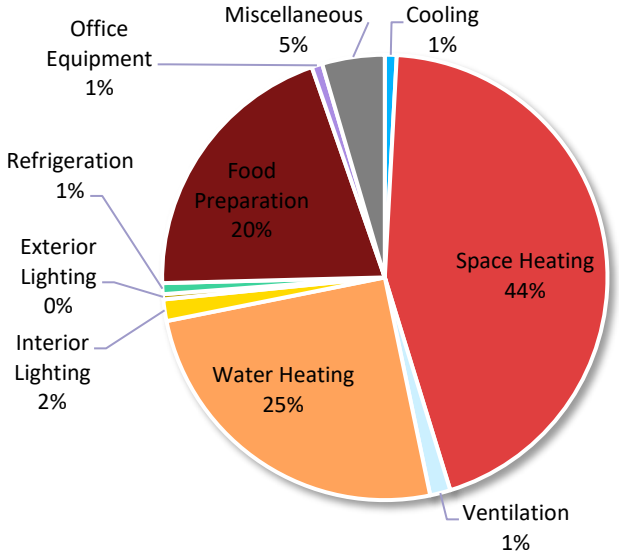
[12] https://www.commerce.wa.gov/growing-the-economy/energy/buildings/clean-buildings-standards/

Table 4-3 Commercial Building Size Segments, Floor Space, and Emissions (2020)

Segment	Floor Space (Million Sq Ft)	Market with Gas Service (Million Sq Ft)	Annual Emissions (MTon)
Sq Ft<= 20k	41.7	13.3	71,872
20k < Sq Ft <= 50k	21.8	6.9	29,467
50k< Sq Ft <= 90k	17.1	5.4	16,554
90k < Sq Ft <=220k	16.9	5.4	14,879
Sq Ft >220k	6.2	2.0	7,306
Total	**103.7**	**33.0**	**140,078**

Figure 4-7 and Figure 4-8 present the commercial GHG emissions in 2024 by both end use and building size below.

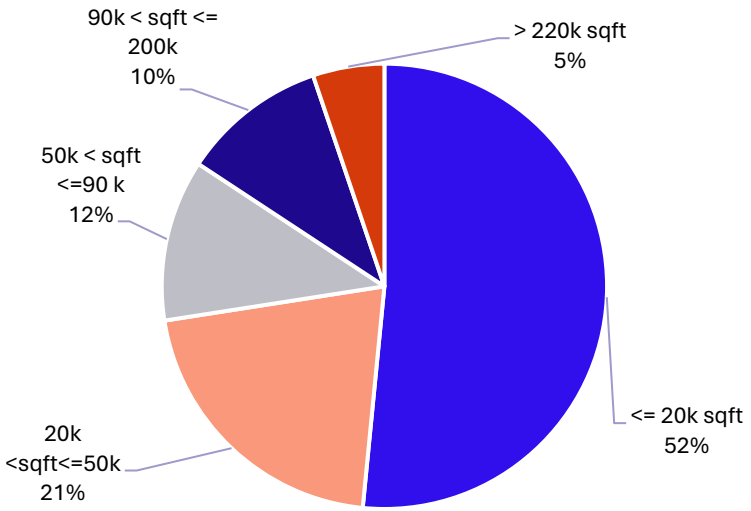
Figure 4-7 2024 Commercial GHG Emissions by End Use



Space heating from natural gas furnaces and boilers accounts for 44% of all commercial emissions, water heating accounts for 25%, and food preparation accounts for an additional 20%. **The total emissions from space and water heat across the sector is 69% and the total across all three end uses including food preparation is 89%.**

Figure 4-8 2024 Commercial GHG Emissions by Building Size

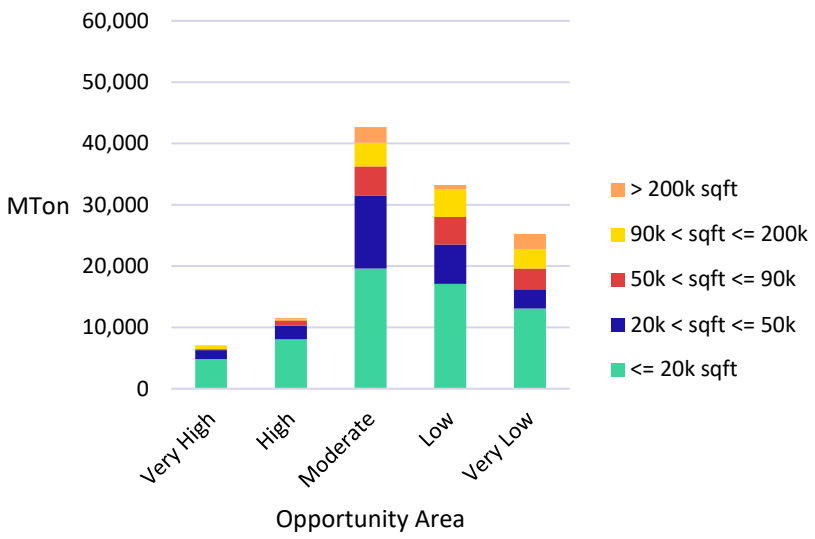
Over half of all the emissions in the commercial sector come from buildings up to 20k square feet, and an additional 21% come from those up to 50k square feet. **This is an important consideration for the strategy because small businesses tend to be the most difficult to reach.**



Opportunity Areas

Figure 4-9 and Figure 4-10 show how emissions are distributed across commercial building size and opportunity areas.

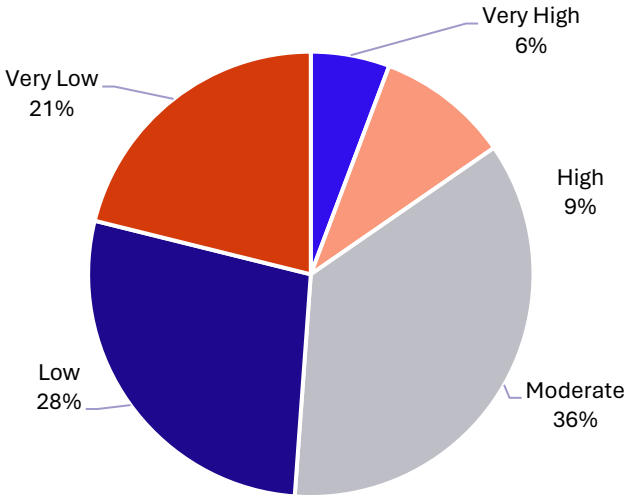
Figure 4-9 Commercial GHG Emissions by Building Size and Opportunity Areas



Consistent with the graph above, most of the emissions come from buildings under 50k Sq. Ft or less. Further, **most of the emissions are also spread across the moderate, low, and very low opportunity areas.**

Figure 4-10 2024 Commercial GHG Emissions by Opportunity Area

In this case, emissions are not spread evenly across areas. **Only 15% of commercial emissions are in high or very high opportunity areas.** Of the remaining 85%, **nearly 50% are in low or very low opportunity areas.**



Commercial takeaways include:

- Unlike the residential sector, the commercial sector cannot be decarbonized by focusing mostly on space and water heat. Food preparation is a major contributor to emissions with 20% of the sector total, and 9% of the overall total.
- Most, 73%, of the emissions are emitted from buildings 50k square feet or less. Given that commercial buildings in this size segment are not currently required to meet building performance standard energy use intensity (EUI) targets, this size segment should be a primary focus for the strategy.
- Nearly half of the commercial sector emissions are from low and very low opportunity areas, while only 15% occur in high and very high areas.

Pathway to Reduce Emissions

This section presents Tacoma's building decarbonization pathway recommended in the Implementation Roadmap (Roadmap)[13] developed to inform the Strategy. The Roadmap is a bridge between the technical analysis in the Impact Assessment and the holistic strategies, actions, and collaborative implementation in the Strategy.

Whereas the Impact Assessment analyzed multiple scenarios and possible paths, the Roadmap recommends a specific building decarbonization pathway with 2050 targets and 2030 milestones. It provides a framework for assessing implementation and investment options and tradeoffs to help policy makers prioritize and inform actions in the Strategy.

The Impact Assessment identified the scale and pace of fossil-fuel equipment replacements required to meet theClimate Action Plan emissions targets for 2050. It identified that nearly 80% of the emissions from Tacoma residential and commercial buildings is from onsite use of natural gas for space and water heating. Therefore, a central part of the building decarbonization path for Tacoma is to eliminate these onsite fossil fuel emissions. A key way to accomplish this is to replace fossil fuel

[13] See Appendix B Implementation Roadmap of this Strategy document for more information on the decarbonization pathway development, targets and milestones, and timeline phases.

space and water heater appliances with zero-emission appliances such as high-efficiency electric heat pump technologies.[14] Ideally, these replacements would be made as close as possible to the end of the useful life of the existing appliance. Current fossil fuel appliances used for space and water heating across Tacoma can be replaced by gradually increasing the percentage of zero-emission appliances sold and installed in new and existing buildings to 100%, and then sustaining that rate through 2050.[15]

The Impact Assessment showed that to meet Climate Action Plan goals, all fossil fuel appliances must be replaced with zero-emission appliances by 2050. Although the impact scenarios target gradual and complete rollover of all appliances in residential and commercial buildings by 2050, considering the average life of various appliances, there isn't enough time between now and 2050 for Tacoma to decarbonize the building sector on a purely natural replacement timeline. Therefore, the decarbonization strategy must accelerate replacements to ensure that each year, a certain percentage of appliances are replaced earlier. However, the analysis shows that the early replacements can be limited to appliances that are very close to burnout. The need for increasing the rate of replacements provides an opportunity to target early replacements to advance other goals, for example providing co-benefits such as cooling, more efficient heating systems, and better indoor air quality and health outcomes to homes in low-opportunity areas, including vulnerable populations.

According to the Impact Assessment, 2030 is the optimal year to reach 100% peak sales share of zero-emission appliances for new and replacement installations. This shift will require rapid market transformation and the development of targeted, high-impact policies and programs during a ramp-up period between 2024 and 2030. Delaying 100% peak sales share of zero-emission appliances dramatically increases the number of appliances that will need to be replaced early and, in some instances, well ahead of burnout. Tacoma has approximately 27 years to fully decarbonize its building stock. However, space and water heating appliances can operate for 15-30 years or more. As a result, every year that Tacoma continues to install new and replacement fossil fuel appliances, the overall number of fossil fuel appliances that must be replaced increases, but the decarbonization deadline remains 2050. Therefore, if the peak rate is delayed, the appliances will need to be replaced years before burnout in order to decarbonize by 2050.

[14] See Impact Assessment in Appendix A of this Strategy document for information on decarbonization technologies and strategies used in the scenario analyses.

[15] In rare cases, renewable natural gas may be an alternative solution to heat pumps.

5 | TARGETS & MILESTONES

The targets and milestones (shown in Table 5-1) were developed based on the optimal decarbonization pathway identified in the Impact Assessment, which includes electrification of most building sector end uses by 2050. They include the endpoint targets and interim milestones that are critical to achieving the Climate Action Plan goals for 2050. They are designed to:

- Gradually increase the sales share of zero-emission appliances each year between 2024 and 2030,
- Ramp up to 100% sales share of zero-emission appliances for new and replacement installations by 2030 and sustain this rate through approximately 2050 until the building sector is decarbonized,
- Transition to zero-emissions new construction by 2030,
- Replace fossil-fuel appliances in existing residential and commercial buildings by 2050,
- Provide an appliance replacement rate that can be used for policy and program design and to track progress.

In 2024, additional targets and milestones may be considered in coordination with Tacoma Power for energy efficiency, onsite renewables, and other distributed energy resources to ensure that building decarbonization implementation can help realize whole-building optimization opportunities and support grid reliability and health. For example, to minimize peak loads due to electrification, the utility can incentivize higher efficiency heat pumps and more air-tight and well insulated buildings.

Understanding the fundamental scale and pace required to decarbonize the building stock by 2050 is a critical first step in addressing equity, affordability, and opportunities for co-benefits. As shown below, to decarbonize Tacoma's residential sector by 2050, 100% of new residential units must be zero emissions and 100% of fossil-fuel space and water heating replacements must be zero-emissions by 2030. Achieving a 100% sales share for zero-emission space heating appliances by 2030 translates to 1,185 households every year starting in 2030, and this number must be maintained through 2050 to gradually replace all fossil-fuel appliances upon or close to burnout. This number of households is 200-300 more appliance replacements per year than the natural replacement rate for space-heating appliances. Approximately, 507 of the 1,185 households would be in low- and very-low opportunity areas. The strategies and actions in this Strategy are designed to realize these targets while ensuring an equitable and affordable transition for Tacoma.

Table 5-1 Roadmap Targets and Milestones

Target/Milestone	2030	2050
Residential Sector		
Residential Sector Emissions Reduction	19%	96%
New Residential Construction: Zero-Emissions Units	100%	100%
Residential Zero-Emissions Appliance ***Stock*** Share	16%	100%
Residential Zero-Emissions Appliance ***Sales*** Share	100%	100%
Residential Zero-Emissions Appliance Replacement Rate (space heating for all households)	1,185 households/year	1,185 households/year
Residential Zero-Emissions Appliance Replacement Rate in Regular Opportunity Areas	678 households/year	678 Households/year
Residential Zero-Emissions Appliance Replacement Rate in Low and Very Low Opportunity Areas (as a subset of all households)	507 households/year	507 households/year
Commercial Sector		
Commercial Sector Emissions Reduction	18%	94%
New Commercial Construction: Zero-Emissions Buildings	100%	100%
Commercial Zero-Emissions Appliance ***Stock*** Share	11%	100%
Commercial Zero-Emissions Appliance ***Sales*** Share	100%	100%
Commercial Zero-Emissions Appliance Replacement Rate	41 buildings/year	41 buildings/year

6 | PHASED TIMELINE

The Strategy is organized into three phases to inform the strategies and actions and to guide more detailed implementation planning and timelines in 2024. The phases are designed to meet the proposed targets and milestones with policies, programs, and market transformation phased to align with time-sensitive Tacoma, federal, and state policies, codes, standards, and funding.

Achieving the building decarbonization targets and Tacoma's goals to maximize co-benefits, equity, and affordability will require Tacoma to act quickly to establish the groundwork to ramp up zero-emission appliance installations to 100% sales share by 2030. The approach must be front-loaded with most policy, programmatic, and market transformation work put into place by 2030. It will require close collaboration among City departments. In addition, the City may need to rely on a regulatory framework and funding from state and federal policies and programs. In this case, the City's strategic role will include providing building decarbonization leadership across City departments and collaborating with stakeholders and other jurisdictions to advocate for energy codes, building performance standards, and other mandates at the regional and state level to ensure that all segments of the commercial and residential sector have a clear trajectory to eliminate emissions by 2050.

Figure 6-1 Building Decarbonization Strategy Phased Timeline

Phase I (2024-2025): Build a Policy and Rapid Market Transformation Platform

The initial phase includes a major push to get all policies in place at all levels of government by the end of 2025. The City establishes a collaborative rapid market transformation platform to ramp up replacement rates. The platform should leverage and align with the timing of other key actions in other City strategies, such as the Affordable Housing Action Strategy,[16] the Green Economic Development Strategy,[17] Tacoma Power's Integrated Resource Plan,[18] and the influx of federal incentives and tax credits through 2030 and beyond. During this phase, the City has opportunities to influence the development of keystone policies such as the 2024 Washington State Energy Code, the 2030 Washington Clean Building Performance Standard (BPS), and other standards and regulatory mechanisms that may be necessary to cover gaps in current mandates that likely can't be covered completely by the energy code and BPS in time to meet 2030 milestones. During this phase, the City should also build staff capacity to implement the decarbonization strategy, explore contracting opportunities with nonprofit and other partners, and ensure key tenant and anti-displacement policies recommended in Tacoma's Affordable Housing Action Strategy are adopted.

[16] https://www.cityoftacoma.org/cms/one.aspx?portalId=169&pageId=148642
https://cms.cityoftacoma.org/cedd/CED_Main/Tac_Green_Econ_Dev_Strat.pdf

[18] https://www.mytpu.org/about-tpu/services/power/integrated-resource-plan/

Phase II (2026-2030): Ramp Up Equitable Decarbonization

The second phase builds upon the platform in Phase 1 to implement a focused, rapid ramp-up of new and replacement zero-emission equipment. This effort involves increasing market demand, workforce, and manufacturing capacity while dramatically reducing costs and removing systemic barriers. The City should target high ratios of low-opportunity area homes and buildings, especially rental properties, to maximize and deal-stack incentives to ensure rapid decarbonization, other efficiency measures, and home repairs for these segments.

Phase III (2031-2050): Sustain Scale and Pace

At this point, all policies and mandates required to decarbonize Tacoma's building stock have become effective. Most segments and end uses have transitioned to 100% zero-emission new and replacement appliances as the default. Transition planning for both Tacoma Power and Puget Sound Energy is complete and considers the required replacement rates and associated grid and gas distribution system impacts at the local level. During this phase, the City mostly focuses on adaptive management, programmatic and market transformation support, and cross-departmental leadership and monitoring necessary to ensure an equitable, gradual, and steady transition to healthy, affordable, zero-emission homes and buildings across Tacoma.

7 | STRATEGIES & ACTIONS

Local governments have limited resources relative to the scale and pace of decarbonization. This Strategy recommends a collaborative approach and actions to help Tacoma realize the most essential, highest-leverage opportunities with the lowest administrative burden. It includes five interdependent strategies to deliver a gradual and permanent modernization, optimization, and decarbonization of Tacoma's building stock. The strategies are designed to work together to form a holistic approach to meet the targets, milestones, and timeline required to phase out fossil-fuel appliances in homes and buildings by 2050. Each strategy includes priority actions to guide this historic investment in Tacoma's buildings, community, and economy. There are 32 actions, with each action indicating which building segments it addresses. Actions were designed to ensure that all segments have regulatory, programmatic, and market transformation guidance for their decarbonization journey to 2050.

> *"We cannot do this work alone. Tacoma must share resources and collaborate with local, regional, and national partners to achieve the pace and scale of transformation required."*
>
> *-Tacoma Climate Action Plan*

The innovation in this Strategy stems from specific strategies, policies, and programs but is also largely driven by tight alignment and interconnectivity across strategies, funding mechanisms, and implementation actors, which will maximize the effectiveness of each strategic element.

As with our Climate Action Plan, all actions provide opportunities to inform, educate, and engage with our communities. We must use these and other tools available to us, like regulations and incentives, to be effective. All actions must contribute to our anti-racist, just transition away from fossil fuels, and must be implemented to increase benefits to and decrease burdens for our BIPOC and other frontline communities.

Many of these actions will require further City Council action, whether that be approving funding or developing and approving legislation. This is just the list of prioritized high impact actions that will help the City Council achieve our climate goals. But implementing these actions will require additional authorization from our leaders and a high level of regional collaboration.

Figure 7-1 Five Interdependent Strategies to Decarbonize Tacoma's Buildings

Strategy 1: Advance Comprehensive, Fast-Tracked Policies & Targets

ID	Actions	Timing
1.1	**Targets and Milestones**	
	Adopt building decarbonization targets and milestones (including for low opportunity areas) with formal adoption of this Strategy. Use targets and milestones to track progress and make updates to the CAP and other associated plans. Use to align internal and external stakeholders around Tacoma's building decarbonization pathway and timeline.	2024
	Building segments: all residential and commercial.	
1.2	**Tenant & Anti-Displacement Protections**	
	Maintain current tenant protections in Tacoma's Rental Housing Code and ensure adoption of key actions from Tacoma's Anti-Displacement Strategy, such as a Right-of-First-Refusal policy, Tenant Opportunity to Purchase Act, a Preservation Fund, and regulating short-term rentals. These upstream regulations are critical to mitigate potential building decarbonization impacts on vulnerable communities.	2024-2025
	Building segments: all residential.	
1.3	**Rental Housing Registry**	
	Implement a Rental Housing Registry ordinance to require annual licensing and registration of rental properties, and periodic energy audits and health and safety inspections.[19] Use the Registry to identify property owners and tenants to target rental housing retrofit programs and improve unsafe housing conditions. (See Action 2.4).	2024
	Building segments: residential rental properties.	
1.4	**Residential Performance Rating & Disclosure**	
	Consider adopting a residential performance rating and disclosure ordinance to provide homeowners and renters with asset-based energy and emissions estimates, energy costs by fuel type, the most significant energy efficiency improvements, and to support home energy audit training that aligns with IRA auditor training. Phase in requirements for point-of-sale and point-of-lease energy and emission reductions. This action will help build the contractor base for audits and retrofits. The WA state legislature is considering a bill[20] in the 2024 legislative session to standardize home energy labeling using the Home Energy Score (developed by the United States Department of Energy) and to allow cities and counties to require home energy performance reports prior to advertising the property for sale. If passed, Tacoma should align its residential performance disclosure ordinance with the state Home Energy Score requirements.	2025
	Building segments: single-family residential.	
1.5	**Zero-Emission Appliance Standard**	

[19] The City of Olympia is developing a similar program. For more information see https://www.olympiawa.gov/community/housing___homelessness/tenant_protections.php

[20] https://app.leg.wa.gov/billsummary?Year=2023&BillNumber=1433

	Advocate for a zero-emission appliance standard for WA state and/or the Puget Sound region with an effective year of 2030 to align with Tacoma's 2030 milestone for 100% zero emission appliance sales share. Governor Inslee has committed to exploring adoption of a zero-emission appliance standard for new and replacement space, water heating, and other appliances in homes and commercial buildings. This type of point-of-sale regulation would mean all appliances being sold or installed in WA and/or the Puget Sound region after a specified date must comply with the zero-emission requirement. These regulations apply to manufacturers, installers, retailers, and sellers. The rules do not require proactive retrofits, but rather would impact appliance replacements and new construction.	2024-2025
	Building segments: all residential and commercial.	
1.6	**WA Clean Building Performance Standard**	
	Advocate to adapt the WA Clean Building Performance Standard to align with Washington state's and Tacoma's building decarbonization targets, including adding greenhouse gas emissions intensity targets, a final performance standard and milestone targets for energy and GHG intensity, and public disclosure of benchmarking data so that cities can assess progress and target programs.	2025
	Building segments: commercial and multifamily >20k sq.ft.	
1.7	**WA State Energy Code - New Construction**	
	In the 2024 code cycle (estimated effective date of July 1, 2026), support progressively more efficient new residential and commercial buildings in accordance with WA state law to reduce energy use in new construction 70% by 2030, including a progressive shift to electric space/water heating and other equipment. Where permitted under State law, consider adopting a voluntary all-electric stretch code[21] for new construction and incentivize it with an opt-out program tied to state/federal incentives for electrification (see Strategy 2 below).	2024-2025
	Building segments: new residential and commercial.	
1.8	**WA State Energy Code - Existing Buildings**	
	In the 2024 code cycle (estimated effective date of July 1, 2026), support the adoption of more stringent energy and emissions reducing measures for existing residential and commercial buildings. If WA does not adopt these then, where permitted under State law, consider adopting them as an amendment to Tacoma's energy code or adopt a voluntary all-electric stretch code for existing buildings and incentivize with an opt-out program tied to state/federal incentives for electrification (see Strategy 2 below).	2024-2025
	Building segments: existing residential and commercial.	

[21] For more information and examples of cities and states with stretch codes see https://newbuildings.org/code_policy/utility-programs-stretch-codes/stretch-codes/

Strategy 2: Rapidly Transform the Market

ID	Actions	Timing
2.1	**Communications & Awareness Campaign**	
	Develop and implement a broad and targeted communications and awareness campaign to promote decarbonization retrofits and to increase visibility and buy-in for the building decarbonization strategy, including co-benefits and how the Strategy supports a 25-year project to modernize, optimize, and decarbonize the entire Tacoma building stock by 2050.	2024-2030
	Building segments: all residential and commercial.	
2.2	**Building Electrification Technology Roadmap**	
	Develop a City building electrification technology roadmap to identify key technologies, solution sets, and high-level design and installation priorities by building segment to ensure building electrification policies and programs maximize efficiency and co-benefits, ensure grid integration, and reduce costs.	2024-2025
	Building segments: all residential and commercial.	
2.3	**Tacoma Power Conservation Targets**	
	Collaborate with Tacoma Power to explore how conservation targets can account for the scale and pace of zero-emission equipment replacements for both fossil-fuel and electric resistance space and water heating required to meet building decarbonization targets, milestones, and equity considerations within the context of existing State law and guidelines that govern conservation target setting. Conservation targets should reflect anticipated increases to electrification.	2024
	Building segments: existing residential and commercial.	
2.4	**Affordable & Rental Housing Retrofit Program**	
	Consider developing a City whole-building residential retrofit program focused on affordable and rental housing. Base on the design of Tacoma Power's Income Qualified Rental Program (IQRP) but include electrification, leveraging federal and state incentives and subsidies for replacing fossil-fuel appliances with heat pumps. Integrate with Rental Registry (Action 1.3) and Residential Disclosure Ordinance (Action 1.4). Alternative if utility implemented: Explore authority and options to augment Tacoma Power's Income Qualified Rental Program (IQRP) when property owners change fuel types. Explore how to leverage federal and state incentives and subsidies for replacing fossil-fuel appliances with heat pumps. Integrate with Rental Registry (Action 1.3) and Residential Disclosure Ordinance (Action 1.4).	2025-2030
	Building segments: existing affordable and rental residential.	
2.5	**Residential Retrofit Program**	
	Explore authority to incorporate rate-based rebates and incentives for fuel switching in existing utility residential conservation programs. Leverage federal and state incentives and subsidies for replacing fossil-fuel appliances with heat pumps. Integrate with Residential Disclosure Ordinance (Action 1.4) and All-Electric Stretch Code (Action 1.8).	2025-2030
	Building segments: existing residential.	

2.6	**Clean Buildings Performance Standard Accelerator Retrofit Program**	
	Explore developing a City administered whole-building EUI and GHG intensity focused accelerator program to support Clean Buildings Performance Standard compliance for commercial and multifamily buildings >20k sq.ft. Leverage WA state BPS accelerator, federal, and state incentives and subsidies for replacing fossil-fuel appliances with heat pumps. Ensure a strong focus on larger, difficult to electrify buildings such as campuses, hospitals, universities, buildings with boilers, and tall office buildings. Integrate with All-Electric Stretch Code (Action 1.8). Alternative if utility implemented: Tacoma Power to consider a whole-building EUI based accelerator program to support Clean Buildings Performance Standard compliance for covered buildings >50k sq.ft. Such a program could help building owners leverage WA state BPS accelerator, federal, and state incentives and subsidies for electricity conservation. Explore how to include larger, energy intensive buildings such as campuses, hospitals, universities, and large office buildings.	2025-2030
	Building segments: existing commercial and multifamily >20k sq.ft.	
2.7	**Small Commercial Retrofit Program**	
	Explore developing a City administered whole-building EUI and GHG intensity focused program to support electrification for small commercial buildings 20k sq.ft. and smaller. Leverage federal, and state incentives and subsidies for replacing fossil-fuel appliances with heat pumps. Ensure a strong focus on low-cost, electrification solutions sets, including heat pump rooftop units with or without energy recovery ventilation and dedicated outside air systems. Integrate with All-Electric Stretch Code (Action 1.8). Alternative if utility implemented: Tacoma Power to consider a whole-building EUI based program for commercial buildings 50k sq.ft. and smaller. Such a program could help building owners leverage WA state BPS accelerator, federal, and state incentives and subsidies for electricity conservation.	2025-2030
	Building segments: existing commercial <=20k.	
2.8	**Regional Market Transformation Collaboration**	
	Collaborate with the Northwest Energy Efficiency Alliance (NEEA), WA Department of Commerce, and Puget Sound utilities and local governments to dramatically scale building decarbonization market development and transformation investments to align with Tacoma and Washington state's targets and milestones. Efforts should include pilot projects, standardized specifications and design guidelines for heat pump technologies and solution sets, coordination with manufacturers and distributors to streamline supply chains, joint efforts to reduce installation costs, and workforce development and training. Prioritize equity, diversity, affordability, and health.	2025-2030
	Building segments: all residential and commercial.	
2.9	**Green Economic Development**	
	Coordinate building decarbonization strategy implementation with Tacoma's Green Economic Development Strategy to ensure economic development action aligns with and supports building decarbonization. For example, aligning investments in green building technologies (a priority sector in the Green Economic Development Strategy) with the technologies, scale, and pace of building decarbonization. In turn, the Building Decarbonization Strategy seeks to maximize state and federal incentives, which will drive significant amounts of external funds into the Tacoma economy with multiplier effects if Tacoma businesses are well positioned to supply and install the retrofits.	2025-2030

	Building segments: all residential and commercial.	
2.10	**Workforce Capacity**	
	Partner with Pierce County WorkForce Central to develop a targeted workforce development plan that prioritizes equity, diversity, and the intersection of contractor and manufacturing workforce needs. Coordinate effort with Tacoma's Green Economic Development Strategy.	2025-2030
	Building segments: all residential and commercial.	
2.11	**Reduced Installation Costs**	
	Tacoma Power can explore upstream and midstream strategies to reduce installation costs as part of retrofit program designs and implementation, for example equipment buy downs, bulk purchases of equipment, and/or flat-rate installations.	2025-2030
	Building segments: all residential and commercial.	
2.12	**Reduced Electrical Service Costs**	
	Identify and reduce electricity connection and system upgrade barriers.	2024-2030
	Building segments: all residential and commercial.	

Strategy 3: Significantly Expand Funding and Financing

ID	Actions	Timing
3.1	**State & Federal Incentives**	
	Develop and implement a plan to stack state and federal incentives to support City building decarbonization efforts and to help fund electricity conservation to mitigate the impacts of electrification within Tacoma Power's residential and commercial electricity conservation programs.	2024-2030
	Building segments: all residential and commercial.	
3.2	**Climate Commitment Act Funds**	
	Research and develop a plan to apply for WA Climate Commitment Act (CCA) funds to support building decarbonization incentives and market development required to decarbonize Tacoma's low and very low opportunity areas.	2024-2025
	Building segments: all residential and commercial.	
3.3	**Federal Grants**	
	Tacoma is participating in a joint regional application for Phase 2 Climate Pollution Reduction Grant (CPRG) funding authorized by the Inflation Reduction Act for planning and implementing ambitious greenhouse gas reductions. As part of the Power Forward Communities coalition, Tacoma applied for a Greenhouse Gas Reduction Fund (GGRF) grant to support residential decarbonization and electrification with 80% of financial assistance funds going to low-income and disadvantaged communities.	2024-2025
	Building segments: all residential and commercial.	
3.4	**Utility Incentives for Low-Income Electrification**	
	Investigate Tacoma Power authority to support income qualified customers with electricity conservation support as household stock electrifies along with a greater emphasis on supporting customer access to income qualified bill payment assistance programs.	2024
	Building segments: all residential and commercial.	
3.5	**Performance-Based Financing Mechanisms**	
	Develop and implement a plan for promoting performance-based contracting and financing mechanisms and integrating them into City retrofit programs. For example, ESCOs, energy service agreements (ESA) or managed energy service agreements (MESA).	2025
	Building segments: all residential and commercial.	
3.6	**Credit Enhancements**	
	Advocate for credit enhancements (e.g., loan loss reserves and interest rate buy-downs) from the state green bank currently under development. Assess the impacts and limitations for the City to offer credit enhancements. Credit enhancements can improve financing options and terms for building owners and encourage private lenders to finance building decarbonization and energy efficiency retrofits.	2024-2025
	Building segments: all residential and commercial.	

Strategy 4. Develop Implementation Capacity and Collaboration

ID	Actions	Timing
4.1	**Collaboration Framework**	
	Work with external stakeholders, such as neighborhood councils, the Tacoma Anchor Network, community-based organizations, regional organizations and local governments, and the building industry to co-develop key elements of a collaboration framework and strategy implementation timeline, discuss opportunities for engagement, potential roles for external stakeholders, and a coordination and communication strategy for 2024/2025 implementation. Implement the collaboration framework, including a Building Decarbonization Collaborative to plan and harmonize external and internal efforts throughout Phase I 2024-2025 and Phase II 2026-2030.	2024
4.2	**Coordination with Internal Stakeholders**	
	Work with internal stakeholders to prioritize actions, address potential implementation barriers, identify a lead for each strategy, confirm and assign roles for each action, and develop 2024/2025 work plans for each strategy.	2024
4.3	**Implementation Capacity**	
	Take immediate steps to add a building decarbonization position to OEPS for the 2025-2026 budget biennium. Identify and address longer-term staffing and budget requirements across Tacoma departments for 2026-2030 rapid market transformation actions. Consider developing a building sector strategy and transformation team to coordinate the building decarbonization strategy implementation as it relates to Tacoma's strategic goals and building related work across Tacoma's departments. As part of the collaboration framework outreach (Action 4.1) coordinate with external partners to identify staffing and budget gaps that may be a barrier to their engagement and essential role in championing and realizing the building decarbonization goals.	2024

Strategy 5: Support Collaborative Utility Transition Planning

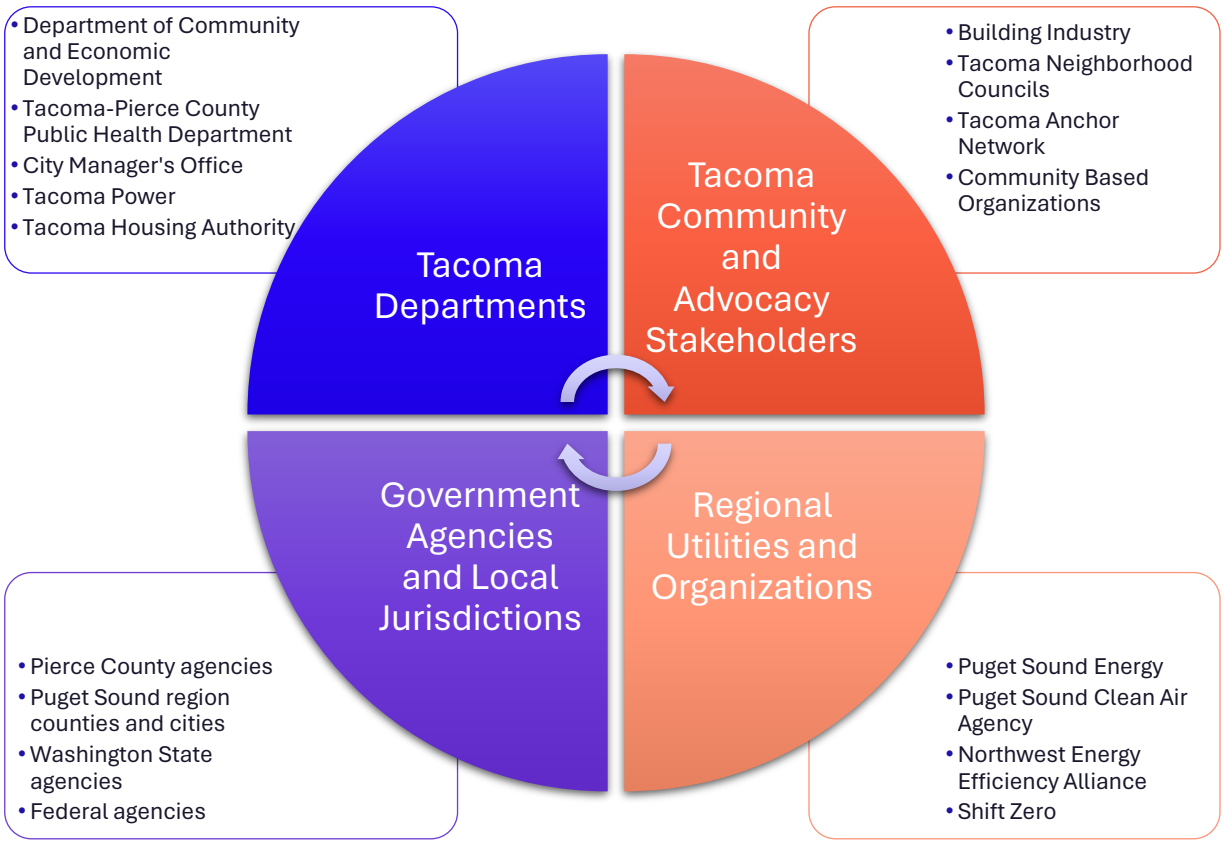
ID	Actions	Timing
5.1	**Utility Implementation and Transition Planning**	
	Collaborate with Tacoma Power and Puget Sound Energy on communication, planning, and program design. Meet on a periodic basis to track and inform implementation. Coordinate with Tacoma Power and Puget Sound Energy to inform utility infrastructure planning given building decarbonization strategy targets and electrification development over time and the time-intensive nature of asset planning and development. Explore how to include localized electrification within Tacoma Power's Transmission and Distribution planning exercises.	2024-2030
5.2	**Tacoma Power Integrated Resource Planning**	
	Ensure Tacoma Power integrated resource plan considers scenarios that align with the building decarbonization strategy targets and milestones. This action connects to Action 7 from Tacoma's Climate Action Plan: Include in 2024 Tacoma Power Integrated Resource Plan analysis of a scenario consistent with the City of Tacoma's "Net-Zero Scenario" to ensure adequate electricity supply for transportation electrification, electrification of building heating, and electrification of industrial process load.	2024
5.3	**Neighborhood Scale Decarbonization**	
	Consider developing a neighborhood-scale decarbonization program to target accelerated replacements by electrifying whole neighborhoods (especially in low to very low opportunity areas), leveraging economies of scale, and supporting a managed utility transition for Tacoma Power and Puget Sound Energy (e.g., to gradually and strategically reduce the size of gas infrastructure while modernizing Tacoma Power's grid, increasing electric supply-side resources, and ramping up demand-side resources such as energy efficiency, demand response, and onsite solar). Explore vendor options for implementing neighborhood scale decarbonization such as BlocPower and Elevate, and opportunities to integrate innovative financing and performance guarantees.	2024

8 | COORDINATED IMPLEMENTATION

This Strategy identifies the technical and strategic pathway, targets, and milestones to equitably decarbonize Tacoma's homes and buildings by 2050. It includes five core strategies to drive swift and transformational shifts in building decarbonization policy, the pace of market adaptation, the volume of funding and financing flowing into Tacoma's economy, internal and city-wide implementation capacity, and utility transition planning. Well-coordinated, collaborative, and aggressive action on each of these interdependent strategies is required to achieve Tacoma's building decarbonization goals.

2024-2025 is a pivotal phase for implementing the Strategy and staying on track to meet 2030 milestones. Immediate next steps in 2024 include coordinating internally to establish roles and detailed action plans, developing budget proposals to increase staff capacity and fund Strategy implementation, and collaborating with Tacoma community stakeholders, relevant Washington state departments, and other jurisdictions and organizations to align around shared goals, targets, and timelines. Developing a collaboration framework will help Tacoma increase collective impact and advocacy for critical, time-sensitive priorities—such as changes to the Washington State Energy Code, updates to the Clean Buildings Performance Standard, and a potential zero-emissions appliance standard—necessary to phase out new and replacement fossil-fuel space and water heating installations by 2030.

Figure 8-1 Collaboration with Tacoma Departments and Other Stakeholders Delivers on Shared Goals



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A | IMPACT ASSESSMENT

This appendix presents the Impact Assessment developed to inform the City of Tacoma (Tacoma) Community Building Decarbonization Strategy (Strategy). The Impact Assessment is one of three deliverables developed as inputs to the Strategy to meet the Climate Action Plan (CAP)[22] goals by dramatically reducing greenhouse gas emissions from residential and commercial buildings.

The Impact Assessment was designed to achieve the following objectives:

- Build an understanding of the technical changes required for decarbonization.
- Develop analyses that describe the scale and pace at which technical changes must occur.
- Quantify key impacts of these changes, including:
  - Change in Electricity consumption and demand,
  - Change in Natural gas consumption,
  - Change in GHG emissions,
  - Total and incremental costs of technical change,
  - Total number of units by segment affected by technical change,
  - Bill impacts associated with changes in consumption and/or demand.
- Discuss and quantify, when possible, impacts associated with technical change, including:
  - Electrical infrastructure stability,
  - Health and safety,
  - Labor and workforce,
  - Housing affordability,
  - Equity, and
  - Legal implications.

The remainder of this appendix is structured as follows:

- Analysis Approach
- Data Development
- Market Characterization Results
- Impact Results
- Limitations of the Impact Assessment

[22] https://www.cityoftacoma.org/UserFiles/Servers/Server_6/File/cms/enviro/Sustain/CAP%20Final/Tacoma%20CAP%20Sections.pdf

Analysis Approach

This section describes the analysis approach taken for the study. For this analysis, AEG used its Load Management Analysis and Planning tool (LoadMAP™) to develop the baseline and scenario projections. AEG developed LoadMAP in 2007 and has enhanced it over time. LoadMAP is currently used by Tacoma Power for their Conservation Potential Assessments (CPAs), and the Tacoma Power 2024-2043 CPA was used as a starting point for this analysis to ensure consistency where appropriate. Built in Excel, the LoadMAP framework is both accessible and transparent and has the following key features.

- Embodies the basic principles of rigorous end-use models (such as EPRI's REEPS and COMMEND) but in a more simplified, accessible form.
- Includes stock-accounting algorithms that treat older, less efficient appliance/equipment stock separately from newer, more efficient equipment. Equipment is replaced according to the measure life and appliance vintage distributions defined by the user.
- Balances the competing needs of simplicity and robustness by incorporating important modeling details related to equipment saturations, efficiencies, vintage, and the like, where market data are available, and treats end uses separately to account for varying importance and availability of data resources.
- Isolates new construction from existing equipment and buildings and treats purchase decisions for new construction and existing buildings separately.
- Uses simple logic for appliance and equipment decisions instead of complex algorithms. The LoadMAP approach allows the user to drive the appliance and equipment choices year by year directly in the model. This flexible approach allows users to import the results from diffusion models or to input individual assumptions. The framework also facilitates sensitivity analysis.
- Can accommodate various levels of segmentation. Analysis can be performed at the sector level (e.g., total residential) or for customized segments within sectors (e.g., housing type or opportunity area).
- Natively outputs model results in a detailed line-by-line summary file, allowing for review of input assumptions, cost-effectiveness results, and potential estimates at a granular level.

Consistent with the segmentation scheme and the market profiles described below, the LoadMAP model provides projections of baseline energy use by sector, segment, end use, and technology for existing and new buildings. These energy use projections were converted to carbon values using a conversion factor outside the model.

Overview of Analysis Approach

To perform the impact assessment, AEG used a bottom-up approach following the major steps listed below. We describe these analysis steps in more detail throughout the remainder of this section.

- Developed the **Market Characterization**, which characterized the energy used in the City of Tacoma for both natural gas and electric customers.
- Developed a **Reference Case** of energy consumption by sector, segment, end use, and technology through 2050.
- Developed **Scenarios** that define the technical changes resulting in decarbonization.
- Estimated the **Impacts** of decarbonization efforts under three future scenarios.

Market Characterization

To estimate the savings potential from energy-efficient measures, it is necessary to first understand how much energy is used today and what equipment is currently in service. This market characterization begins with segmenting Tacoma's electricity footprint to quantify energy use by sector, segment, end-use application, and the current set of technologies in operation. For this analysis, we rely primarily on information from Tacoma Power, augmenting with secondary sources as necessary.

Segmentation for Modeling Purposes

This assessment first defined the market segments (building types, end uses, and other dimensions) that are relevant in the Tacoma Power service territory. The segmentation scheme for this project is presented in Table A-1.

Table A-1 Overview of Tacoma Analysis Segmentation Scheme

Segmentation Variable	Description
Sector	Residential or commercial
Segment	Residential: single-family, single-family 2-4 units, low-rise multifamily, mid/high-rise multifamily, and mobile homes Commercial: office, retail, college, school, grocery, hospital, other health, lodging, restaurant, assembly, warehouse, data center, multifamily common area, street lighting, classified miscellaneous, and unclassified miscellaneous
Vintage	Existing and new construction
End uses	Cooling, space heating*, ventilation, water heating*, appliances, commercial refrigeration, cooking equipment*, electronics and miscellaneous (as appropriate by sector) *indicates an end use targeted for decarbonization in the analysis
Fuel	Electric or natural gas
Appliances/end uses and technologies	Technologies such as lamp type, air conditioning equipment, motors by application, etc.
Equipment efficiency levels for new purchases	Baseline and higher-efficiency options as appropriate for each technology
Opportunity area[23]	While not a true segment, since sufficient data was not available to develop energy characteristics by area, final market profiles were developed by opportunity area using a proportional allocation based on addresses.

With the segmentation scheme defined, we then performed a high-level market characterization of electricity and gas sales in the base period. For the electric side, we used detailed Tacoma Power billing and customer data with minimal augmentation from secondary sources to allocate energy use and customers to the various sectors and segments such that the total customer count and energy consumption matched the Tacoma system totals from 2021 billing data. For natural gas, a count of customers and total gas sales within the city of Tacoma was provided from Puget Sound Energy via the City. This information provided control totals at a sector level for calibrating the LoadMAP model to known data for the base year.

[23] Sufficient data was not found to alter the energy use characteristics of a home among the opportunity areas established by the City in terms of either average energy consumption per household or presence of equipment – available data sources do not have this level of granularity. The modeling was therefore done at the building type level and distributed to opportunity areas based on the proportion of mapped addresses from Tacoma Power's billing data lying within each area, the results of which are presented in the market characterization section.

Market Profiles

The market profile is a base-year snapshot of an entire sector, summarizing energy use for each segment in the study and apportioning the annual energy into the various end uses and technologies. The market profile serves as the foundation for the reference case by defining the count of stock units that are available, and what the consumption of those units looks like in each segment.

Reference Case

The reference case serves as a reference point against which potential impacts of decarbonization are measured. For the electric modeling, AEG used the reference cases for the residential and commercial sectors from the Tacoma Power 2024-2043 Conservation Potential Assessment (CPA), also performed by AEG. For natural gas, the reference case assumes a flat population and tracks the turnover of units to provide opportunities for decarbonization.

Inputs to the reference case include:

- Customer growth projections.[24]
- Trends in fuel shares and equipment saturation.
- Existing and approved changes to building codes and equipment standards.
- Electric DSM impacts based on Achievable Economic potential from the Tacoma Power 2024-2043 CPA.
- Climate change projections – these projections assume normal weather conditions.

Scenario Development

AEG developed three scenarios to support the impact assessment as follows.

Scenario 1: Electrify Fossil Fuel Space and Water Heating Appliances on Burnout. This scenario was designed to better understand the natural rate of appliance replacement. For example, would Tacoma meet the CAP building decarbonization goals if all the fossil fuel space and water heating appliances that burn out between now and 2050 are replaced with electric heat pumps? This scenario was not intended to meet a specific goal but rather to assess whether the natural rate of replacement must be accelerated to meet CAP goals. Since it was a primarily directional scenario, it does not include a cost-benefit analysis.

Scenario 2: Scale and Pace of Fossil Fuel Replacement Optimized to Meet CAP Goals. This scenario builds on Scenario 1 results to explore how quickly fossil fuel appliances must be replaced to meet CAP goals. It also included options for the pace of ramp-up to a peak rate of replacement to sustain through 2050. For example, what are the emissions reduction and cost impacts of hitting the peak rate by 2030 versus 2040? This scenario also analyzed the impact of electrifying other residential end uses, such as natural gas stoves and fireplaces. Scenario 2 includes a cost-benefit analysis.

Scenario 3: Optimized Replacement + Grid Stability & Renewable Natural Gas (RNG). This scenario builds on Scenario 2 results and incorporates demand-side strategies such as control of high efficiency electric equipment and other Demand Energy Responses (DERs) to help offset the increased electricity load due to electrification. It also assesses the impacts of using renewable natural gas to decarbonize some remaining natural gas appliances and other equipment. Scenario 3 also includes a cost-benefit analysis.

The scenarios and the reference case are also summarized in the table below.

[24] The natural gas baseline assumes no new customers adding natural gas after the base year.

Table A-2 Scenario Definitions

Scenario	Definition
Reference Case	Quantifies expected GHG emissions along the study timeline without active decarbonization efforts, accounting for market turnover and normal customer purchase decisions
Scenario 1: Replace on Burnout	Replaces natural gas space and water heating systems with zero-emission technologies at the end of their useful life.
Scenario 2: Optimized Replacement	Includes additional end uses not targeted in scenario 1 – cooking and secondary heating/fireplaces. Accelerates the rate of replacement of all natural gas end uses so that CAP goals are reached by 2050.
Scenario 3: Optimized Replacement + Grid Stability & Renewable Natural Gas	Sets natural gas emissions to zero to represent a carbon-neutral mix of RNG. Adds capacity benefits resulting from increased grid stability facilitated by connected equipment.

Calculation of Impacts

This study used a stock-accounting turnover model to estimate the schedule of opportunities for transition to zero-emission equipment. The scenarios vary in the number of end uses targeted and the speed of turnover.

Estimating Customer Adoption

The LoadMAP model contains an economics-driven customer choice model derived from the US Department of Energy's Annual Energy Outlook modeling engine, the National Energy Modeling System (NEMS). At the time of equipment replacement, the desirability of each available option can be compared on an annualized cost-of-use basis, and calibrated to known customer behavior to inform future likelihood of purchase decisions.

To maximize the usefulness of the model's calculations, scenarios 1 and 2 use an assumption that all fossil fuel equipment in targeted end uses would change to zero-emission technologies at the end of life.

Data Development

This section details the data sources used in this study, followed by a discussion of how these sources were applied. In general, data were adapted to local conditions, for example, by using local sources for measure data and local weather for building simulations.

Data Sources

The data sources are organized into the following categories:

- Tacoma Power data
- Northwest regional data
- AEG's databases and analysis tools
- Other secondary data and reports

Tacoma Data

The highest priority data sources for this study were those that were specific to Tacoma.

- **Tacoma Power 2024-2043 Conservation Potential Assessment.** The electric market characterization and baseline come from the CPA and are based on account and demographic information, economic data, and forecast assumptions provided by Tacoma Power
- **Carbon Emissions Factors** to convert energy use values to GHG
- Electric emissions factors were provided by Tacoma Power
- Natural gas emissions factors were taken from the US DOE emissions factors for greenhouse gas inventories[25]
- **Gas Customer information** from PSE provided via the City of Tacoma
- **City of Tacoma Climate Action Plan**, https://www.cityoftacoma.org/UserFiles/Servers/Server_6/File/cms/enviro/Sustain/CAP%20Final/Tacoma%20CAP%20Sections.pdf
- **City of Tacoma Affordable Housing Action Strategy**, https://www.cityoftacoma.org/UserFiles/Servers/Server_6/File/cms/Office%20of%20Strategy/AHAS/AHAS%20Publication%20FINAL.pdf
- **Average electricity and natural gas rates** to support the bill impacts were sourced from the local electric and natural gas utilities that serve the City of Tacoma, Tacoma Power and Puget Sound Energy.

  https://www.mytpu.org/wp-content/uploads/All-Schedules-2023.pdf

  https://www.pse.com/-/media/Project/PSE/Portal/Rate-documents/Summary/summ_gas_prices_2023_05_01.pdf?sc_lang=en

Northwest Regional Data

The study utilized various local data and research, including research performed by the Northwest Energy Efficiency Alliance (NEEA) and analyses conducted by the Pacific Northwest Power and Conservation Council (Council). Most important among these are:

- **Regional Technical Forum (RTF) workbooks.** The Regional Technical Forum maintains regularly updated technical workbooks on measure data for use within the region, including Washington state. This was used as a primary data source when Tacoma Power-specific program data was not available.
- **Northwest Energy Efficiency Alliance, 2016-2017 Residential Building Stock Assessment II**, https://neea.org/data/residential-building-stock-assessment
- **Northwest Energy Efficiency Alliance, 2019 Commercial Building Stock Assessment,** https://neea.org/resources/cbsa-4-2019-final-report
- **Northwest Energy Efficiency Alliance, 2014 Commercial Building Stock Assessment**, https://neea.org/resources/2014-cbsa-final-report
- **RMI State level Building Electrification Factsheets, State of Washington.** https://rmi.org/insight/state-level-building-electrification-factsheets/

[25] https://www.epa.gov/system/files/documents/2023-03/ghg_emission_factors_hub.pdf

- **Net Zero Northwest Study.** https://www.nznw.org/

The NEEA surveys were used in this study primarily to characterize the natural gas market in terms of equipment presence and use per customer.

Other Secondary Data and Reports

Finally, a variety of secondary data sources and reports were used for this study. The main sources are identified below.

- **Annual Energy Outlook.** The Annual Energy Outlook (AEO), conducted each year by the U.S. Energy Information Administration (EIA), presents yearly projections and analysis of energy topics. For this study, we used data from the 2021 AEO.
- **Local Weather Data**. Weather from NOAA's National Climatic Data Center for Tacoma, WA (specifically from the McChord Air Force Base) was used where applicable.
- **GHG Values** Sourced from the Washington Transportation and Utilities Commission (WUTC). In Docket U-190730, the WUTC adopted cost estimates produced by the Interagency Working Group on Social Cost of Greenhouse Gases to comply with the package of clean energy legislation signed into law by Gov. Jay Inslee in 2019. The CO2 $ value per metric ton is applied to carbon saved through both electric and natural gas savings.
    - https://www.utc.wa.gov/regulated-industries/utilities/energy/conservation-and-renewable-energy-overview/clean-energy-transformation-act/social-cost-carbon
- **Other relevant resources.** These include reports from the Consortium for Energy Efficiency, the EPA, and the American Council for an Energy-Efficient Economy.

Application of Data to the Analysis

We now discuss how the data sources described above were used for each step of the study.

Data Application for Market Characterization

To construct the high-level market characterization of electricity consumption and market size units (households for residential, and floor space for commercial), we primarily used Tacoma billing data as well as secondary data from AEG's Energy Market Profiles database.

Data Application for Market Profiles

The specific data elements for the market profiles, together with the key data sources, are shown in Table A-3 To develop the market profiles for each segment, we used the following approach:

- Developed control totals for each segment. These include market size, segment-level annual electricity use, and annual intensity. Tacoma's customer account database, which includes estimates on square footage as well as consumption, was used as the primary data point for the calculation of intensities. These calculations were then compared with other regional sources and prior AEG studies in the region for reasonableness. Adjustments to customer segmentation and intensity were then made as necessary.
- Used Tacoma's 2018 Energy Use and Conservation Survey, the 2016 RBSA, 2014 and 2019 CBSA, 2014 IFSA, DOE's RECS 2015 and CBECS 2012, and AEG's Energy Market Profiles database to develop existing appliance saturations, appliance and equipment characteristics, and building characteristics.
- Ensured calibration to control totals for annual electricity sales in each sector and segment.

- Compared and cross-checked with other recent AEG studies.
- Worked with Tacoma general government and utility staff to vet the data against their knowledge and experience.

Table A-3 Data Applied for the Market Profiles

Model Inputs	Description	Key Sources
Market size	Base-year residential dwellings, commercial floor space, and industrial employment	Tacoma account database Tacoma Load Forecasting AEO 2019
Annual intensity	Residential: Annual use per household Commercial: Annual use per square foot	Tacoma account database 2016 RBSA, 2014/2019 CBSA, and 2014 IFSA AEG's Energy Market Profiles AEO 2019 Other recent studies
Appliance/equipment saturations	Fraction of dwellings with an appliance/technology Percentage of C&I floor space/employment with equipment/technology	Tacoma's 2018 Energy Use and Conservation Survey 2016 RBSA, 2014/2019 CBSA, and 2014 IFSA American Community Survey AEG's Energy Market Profiles Tacoma Load Forecasting
UEC/EUI for each end-use technology	UEC: Annual electricity use in homes and buildings that have the technology EUI: Annual electricity use per square foot/employee for a technology in floor space that has the technology	HVAC uses: BEST simulations using prototypes developed for Tacoma Engineering analysis AEG DEEM Recent AEG studies
Appliance/equipment age distribution	Age distribution for each technology	Recent AEG studies
Efficiency options for each technology	List of available efficiency options and annual energy use for each technology	NWPCC workbooks, RTF AEG DEEM AEO 2019 DEER Recent AEG studies
GHG Conversion factors for energy fuels	Values to translate electric use (MWh) or gas use (therms) into MTons of greenhouse gases	Tacoma Power planning dept US DOE

Data Application for Reference Case

Table A-4 summarizes the LoadMAP model inputs required for the reference case. These inputs are required for each segment within each sector, as well as for new construction and existing dwellings/buildings. In addition, assumptions were incorporated for known future equipment standards as of June 2023.

Table A-4 Data Applied for the Reference Case

Analysis Inputs	Description	Key Sources
Customer growth forecasts	Forecasts of new construction in residential and C&I sectors	Tacoma load forecast AEO 2017 economic growth forecast
Equipment purchase shares for reference case	For each equipment/technology, purchase shares for each efficiency level; specified separately for existing equipment replacement and new construction	Shipments data from AEO and ENERGY STAR AEO 2021 regional forecast assumptions[26] Appliance/efficiency standards analysis Tacoma program results and evaluation reports RTF UES workbooks for measures with a market baseline
Electricity and Gas retail prices	Retail cost of energy fuels to value customer savings	Tacoma Power electric rate data PGE gas rate
Utilization model parameters	Price elasticities, elasticities for other variables (income, weather)	Tacoma econometric coefficients EPRI's REEPS and COMMEND models
GHG Conversion factors forecast	Projection of known or expected changes to the GHG emissions of generation	Tacoma Power planning dept (Gas emissions rate kept flat)

Data Application for Impact Scenarios

Table A-5 summarizes the LoadMAP model inputs required for the reference case. These inputs are required for each segment within each sector, as well as for new construction and existing dwellings/buildings.

Table A-5 Data Applied for the Impact Scenarios

Analysis Inputs	Description	Key Sources
Avoided Electricity Values (Energy)		Tacoma Power CPA
Avoided Electricity Values (Capacity)		Tacoma Power CPA
Avoided Natural Gas Values		Northwest Natural CPA
GHG Values		Washington Transportation and Utilities Commission (WUTC)
Customer Bill Impacts		Tacoma Power and Puget Sound Energy
Electrification Costs		Tacoma Power CPA
Distribution Costs		Tacoma Power CPA
Co-Benefit Adders		Industry Standard

Market Characterization Results

In this section, we describe how customers in the Tacoma Power service territory use energy and the resulting emissions from this energy load in 2022. It begins with a high-level summary of energy use across all sectors and then delves into each sector in more detail. Annual emissions are derived from

[26] We developed baseline purchase decisions using the Energy Information Agency's *Annual Energy Outlook* report (2017), which utilizes the National Energy Modeling System (NEMS) to produce a self-consistent supply and demand economic model. We calibrated equipment purchase options to match distributions/allocations of efficiency levels to manufacturer shipment data for recent years and then held values constant for the study period.

the energy use according to factors provided by the City of Tacoma and consistent with other planning efforts for the city.

Key Takeaways

Based on the results of the market characterization, we identified several key takeaways that helped us to develop our scenarios and fed into the overall technical path and strategy.

Residential takeaways include:

- Decarbonizing the residential sector should really focus on zero emissions equipment or fuels for space and water heating. These two end-uses account for 93% of total emissions in the sector.
- Secondary space heating, gas fireplaces, is the third largest end-use contributor to emissions at 5% of the total.
- Emissions are spread relatively evenly across opportunity areas. However, together the low and very low opportunity areas account for more than 40% of residential emissions and co-benefits may be larger in these opportunity areas.
- Single family homes have the largest concentration of emissions, at more than 75%. Single family plus low-rise multifamily account for 98% of emissions.

Commercial takeaways include:

- Unlike the residential sector, the commercial sector cannot be decarbonized by focusing only on space and water heat. Food preparation is a major contributor to emissions with 20% of the sector total, and 9% of the overall total.
- Most, 73%, of the emissions are coming from buildings less than 50k square feet. Given that small and medium businesses are historically hard to reach and are not currently required to comply with the Washington State Clean Buildings Performance Standard,[27] this is an important consideration for the strategy.
- Nearly half of the commercial sector emissions are from low and very low opportunity areas, while only 15% occur in high and very high areas.

Overall GHG Summary

Based on the results of the City of Tacoma Climate Action Plan, emissions from residential and commercial buildings account for approximately 19% of the total City emissions, 10% and 9% respectively. The largest two emitters are transportation (44%) and the industrial sector (30%). When we look at only the emissions attributable to buildings, residential and commercial buildings[28] are estimated to be responsible for 292,090 MTon of GHG emissions in 2022 based on their electric and natural gas use. This is roughly even in distribution between the two sectors, with 52% (152,012 MTon) in residential and 48% (140,078 MTon) in commercial.

Natural gas space heating accounts for the majority of these emissions – 168,412 MTons or 58% of the total, with gas water heating and gas commercial food preparation equipment the second and third largest sources of emissions. Together these three gas end use loads account for over 85% of residential and commercial building emissions in the city of Tacoma.

[27] https://www.commerce.wa.gov/growing-the-economy/energy/buildings/clean-buildings-standards/

[28] Industrial facilities are not included in this analysis, which focuses on buildings decarbonization specifically; the majority of energy use in industrial facilities is process loads which necessitate unique analysis and strategy

Figure A-1 Sector-Level Share of Emissions in 2022

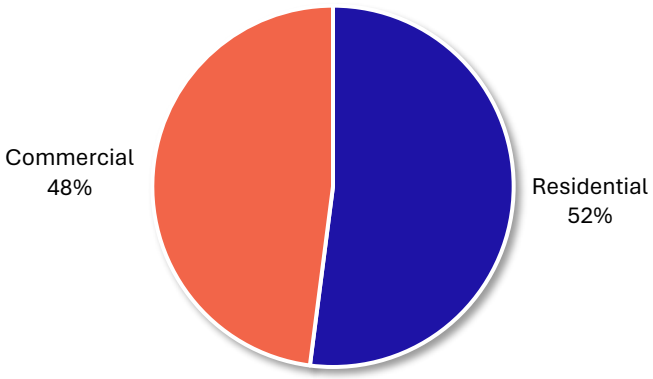
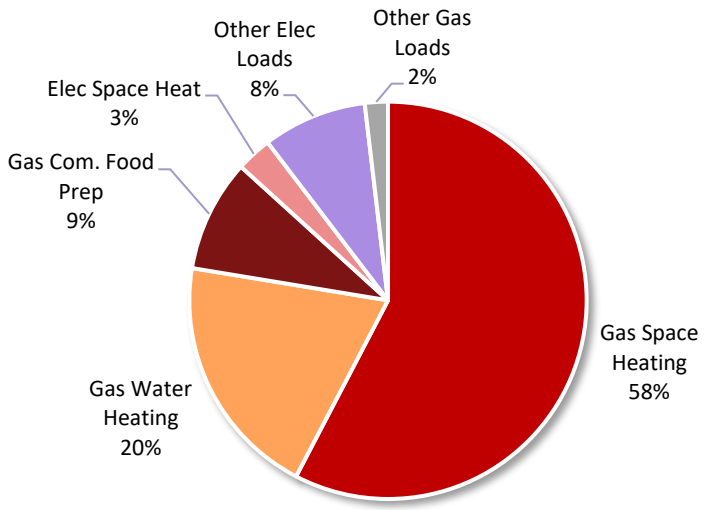


Table A-6 Tacoma Sector Emissions Totals (2022)

Sector	Number of Units/Buildings	Annual Electric Use (GWh)	Annual Natural Gas Use (mTherm)	Annual GHG (Mton)
Residential	102,957	1,195	24,736	152,012
Commercial	11,884	716	24,058	140,078
Combined	**114,841**	**1,911**	**48,794**	**292,090**

Figure A-2 Tacoma Emissions (MTons) by End Use and Fuels, 2022



Residential Sector

The total number of households and electricity sales within Tacoma city limits were obtained from Tacoma Power's customer database and combined with sector-level natural gas data provided by PSE

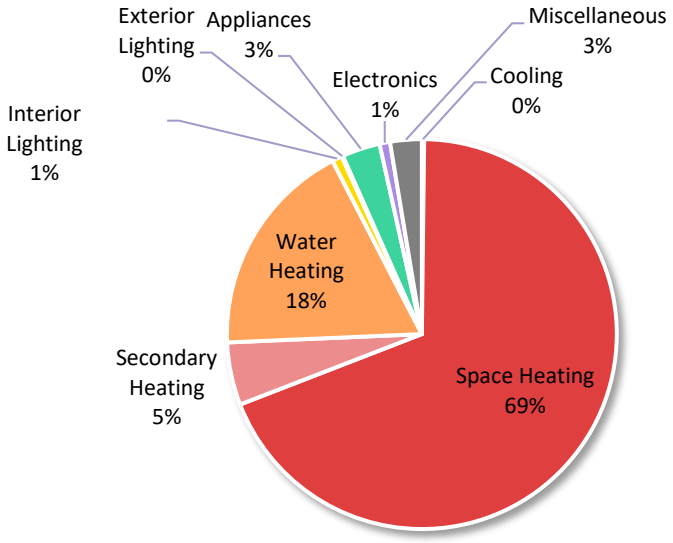
to the City of Tacoma in order to include gas in the analysis. We allocated these totals into five residential segments and the values are shown in Table A-7.

Table A-7 Residential Sector Control Totals (2020)

Segment	Number of Units	Electricity Use (GWh)	Units with Gas Service	Natural Gas Use (mTherms)	Annual Emissions (MTon)
Single Family	65,919	865	22,018	18,666	114,080
Single Family 2-4 units	4,914	53	1,862	1,579	9,304
Low-Rise Multifamily	30,109	249	10,072	4,078	25,964
Mid/High-Rise Multifamily	774	6	257	104	662
Manufactured Home	1,241	21	411	308	2,002
Total	**102,957**	**1,195**	**34,620**	**24,736**	**152,012**

As described in the previous chapter, the market profiles provide the foundation for the development of the reference case. Market profiles for electric usage were taken from the Tacoma Power 2024-2043 CPA models compiled by AEG. For the natural gas market profiles, AEG leveraged data on equipment presence from NEEA's Residential Building Stock Assessment survey (2016) for the Western Washington region and combined it with the existing data on average building age and shell characteristics for Tacoma's territory developed in the course of the electric CPAs.

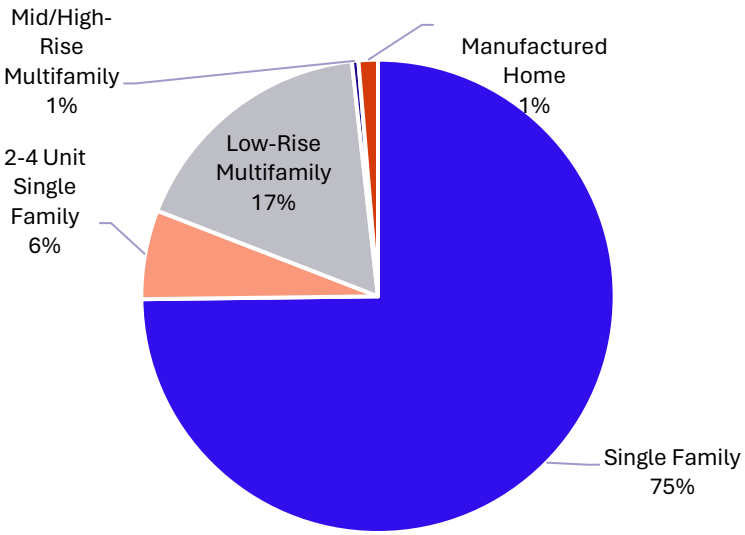
Figure A-3 2024 Residential GHG Emissions by End Use



Space heating from natural gas furnaces and boilers account for nearly 70% of all residential emissions. Secondary heating from gas fireplaces accounts for an additional 5%. Natural gas water heaters account for an additional 18%. **The total emissions from space and water heat across the sector is 92%**

Figure A-4 2024 Residential GHG Emissions by Housing Type

Single family homes contribute 75% of the total GHG emissions, with low-rise multifamily the next largest contributor at 17%. **The remaining home types contribute only 8% of all residential emissions.**



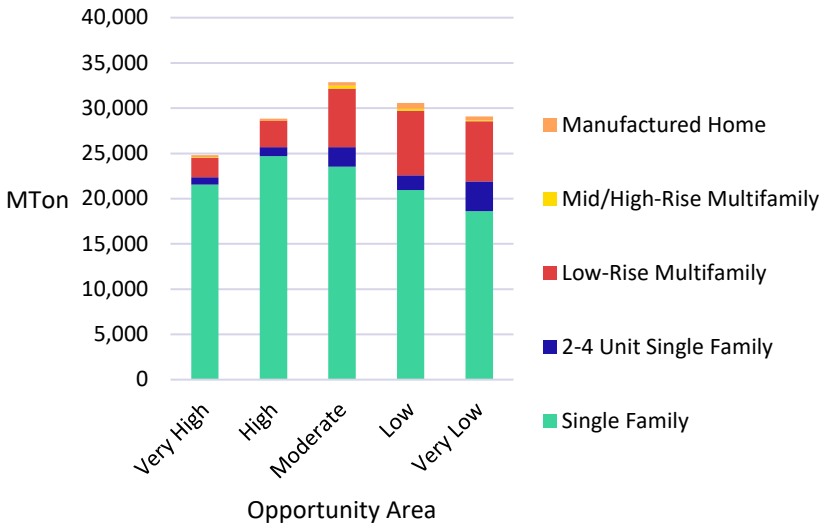
Opportunity Areas

Equity of the decarbonization process is of great concern to the City of Tacoma. To assist in this perspective of the planning roadmap, AEG disaggregated the residential loads into the opportunity areas that align with the equity index defined by the City of Tacoma[29]. However, sufficient data was not found to alter the energy use characteristics of a home among the areas. The modeling was therefore done at the building type level and distributed to opportunity areas based on the proportion of mapped addresses from Tacoma Power's billing data lying within each area.

Figure A-5 shows how emissions are distributed across housing types and opportunity areas under this method.

[29] City of Tacoma Equity Index Map https://tacomaequitymap.caimaps.info/CAILive/?location=Tacoma&layer=EquityLayer&tab=demo&searchType=city&area=EquityCalcTacoma

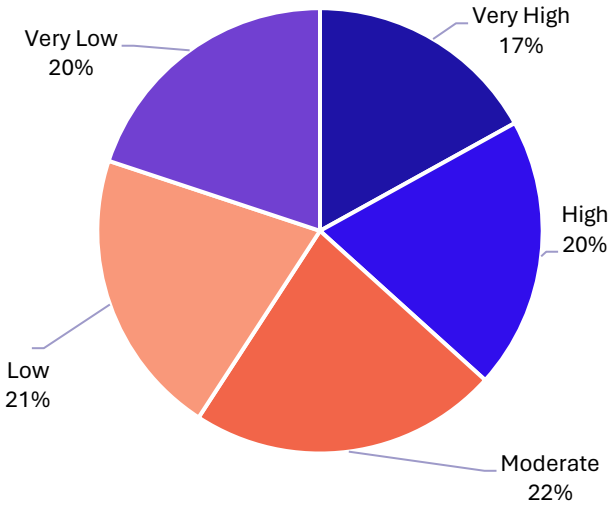
Figure A-5 Residential GHG Emissions by Opportunity Area and Housing Type



Consistent with the graph above, most of the emissions come from single-family and low-rise homes. Further, as a result of the proportional allocation, **emissions per opportunity area are primarily a factor of the number of homes** within each area.

Figure A-6 2024 Residential GHG Emissions by Opportunity Area

Here we **see a relatively equal break out of emissions by opportunity area**, with approximately 20% of the emissions attributed to each of the five areas. Although, together the low and very low opportunity areas account for more than 40% of residential emissions.



Commercial Sector

The foundation of the commercial market characterization is building-type level modeling that captures the end uses specific to each business type. This allows detailed capture of end use trends appropriate to each premise. However, because the Clean Buildings Performance Standard—a key Washington state policy regulating energy use in existing commercial buildings—is segmented by size cohort, AEG developed a weighted transition to a building size-perspective to apply as a post-process to distribute the resources. Also, in a similar process to the residential sector, Tacoma Power customer address information was used to map businesses to the opportunity areas throughout the City.

The first table below presents the control totals (the starting point for key metrics including floor space, electricity use, natural gas use, and emissions) for the commercial sector based on building type that align with the Tacoma Power CPA. The second table presents the control totals aligned with the building size that we used in this analysis.

Table A-8 Building Type Commercial Sector Control Totals (2022)

Business/Building Type	Floor Space (Million Sq Ft)	Electricity Use (GWh)	Market with Gas Service (Million Sq Ft)	Natural Gas Use (mTherms)	Annual Emissions (MTon)
Office	21.5	158	6.2	2,099	13,887
Retail	17.2	94	5.0	3,107	18,123
Restaurant	3.7	49	1.1	5,953	32,436
Grocery	2.2	35	0.6	807	4,885
Hospital	4.5	72	1.3	1,575	9,610
Other Health	4.9	23	1.4	1,619	8,987
College	2.0	20	0.6	272	1,787
School	11.9	54	3.5	1,177	7,180
Lodging	2.6	25	0.7	624	3,739
Assembly	2.7	19	0.8	655	3,812
Warehouse	14.5	49	4.2	1,891	10,880
Data Center	0.2	13	1.5	457	2,657
MF Common Area	8.7	47	2.5	1,754	10,123
Misc - Classified	6.2	49	3.3	1,896	10,902
Misc - Unclassified	1.0	9	0.3	173	1,069
Total Commercial	**103.7**	**716**	**33.0**	**24,058**	**140,078**

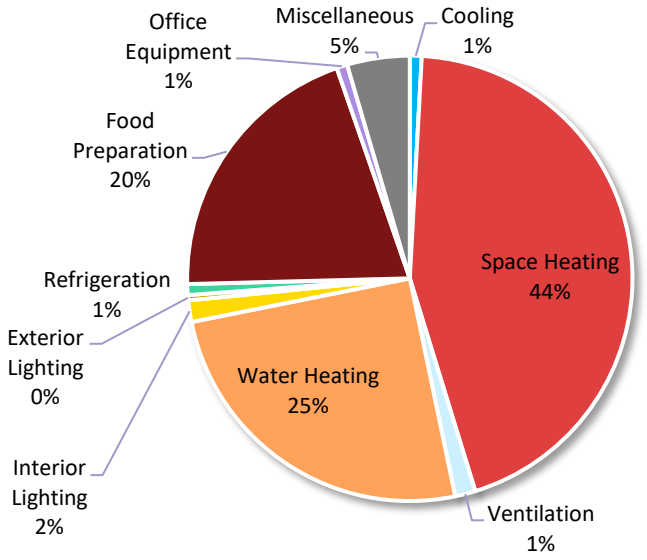
Table A-9 Building Size Commercial Sector Control Totals (2020)

Segment	Floor Space (Million Sq Ft)	Electricity Use (GWh)	Market with Gas Service (Million Sq Ft)	Natural Gas Use (mTherms)	Annual Emissions (MTon)
Sq Ft<= 20k	41.7	319	13.3	12,538	71,872
20k < Sq Ft <= 50k	21.8	153	6.9	5,049	29,467
50k< Sq Ft <= 90k	17.1	96	5.4	2,787	16,554
90k < Sq Ft <=220k	16.9	103	5.4	2,472	14,879
Sq Ft >220k	6.2	45	2.0	1,213	7,306
Total	**103.7**	**716**	**33.0**	**24,058**	**140,078**

The segments above were selected to align with the Tier1 and Tier2 buildings covered by the Washington Building performance standards.

Like the residential sector, commercial market profiles for electric usage were taken from the Tacoma Power 2024-2043 CPA models compiled by AEG. For the natural gas market profiles, AEG leveraged data on equipment presence from NEEA's Commercial Building Stock Assessment survey (2016) for the Western Washington region and combined it with the existing data on average building age and shell characteristics for Tacoma's territory developed in the course of the electric CPAs.

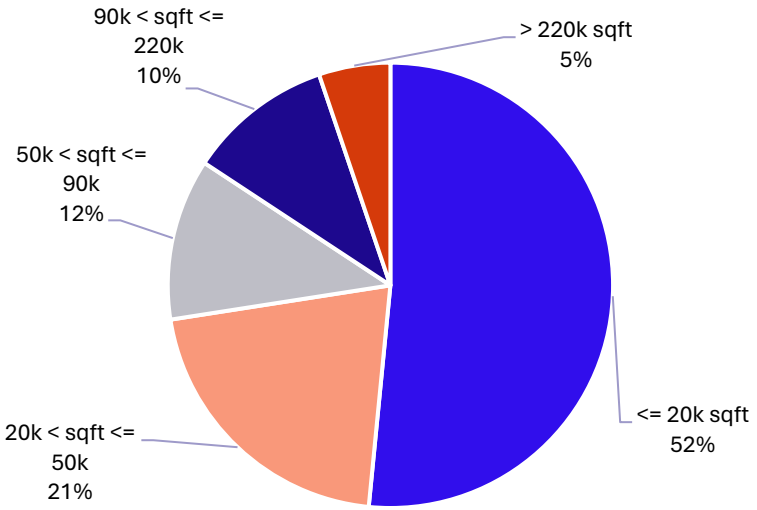
Figure A-7 2024 Commercial GHG Emissions by End Use



Space heating from natural gas furnaces and boilers accounts for 44% of all commercial emissions. water heating accounts for 25%, and food preparation accounts for an additional 20%. **The total emissions from space and water heat across the sector is 69% and the total across all three end uses including food preparation is 89%.**

Figure A-8 2024 Commercial GHG Emissions by Building Size

Over half of all the emissions in the commercial sector come from buildings up to 20k square feet, and an additional 21% come from those up to 50k square feet. **This is an important consideration for the strategy because small businesses tend to be the most difficult to reach, and they do not have to comply with the state building performance standard.**



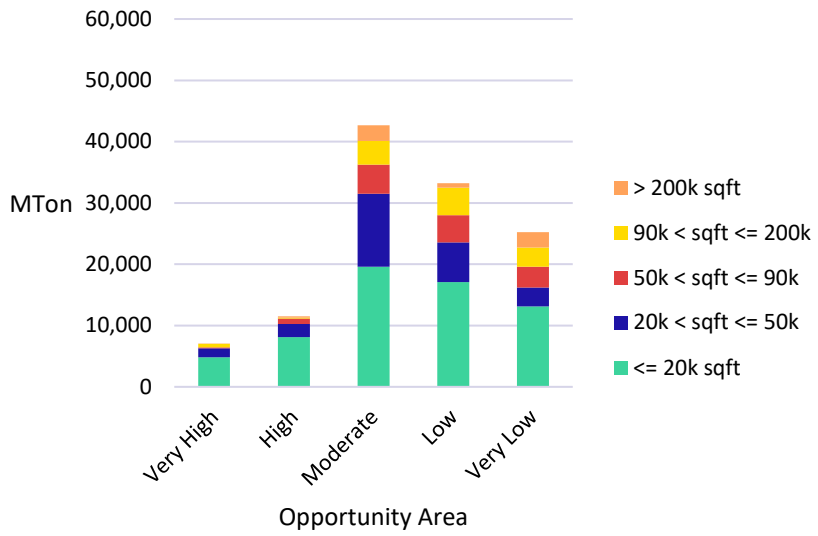
Opportunity Areas

AEG disaggregated the commercial loads into the opportunity areas defined by the equity index developed by the City of Tacoma[30]. However, sufficient data was not found to alter the energy use characteristics of a business among the areas. The modeling was therefore done at the building type level and distributed to opportunity areas based on the proportion of mapped addresses from

[30] City of Tacoma Equity Index Map https://tacomaequitymap.caimaps.info/CAILive/?location=Tacoma&layer=EquityLayer&tab=demo&searchType=city&area=EquityCalcTacoma

Tacoma Power's billing data lying within each area Figure A-9 shows how emissions are distributed across commercial building size and opportunity areas under this method.

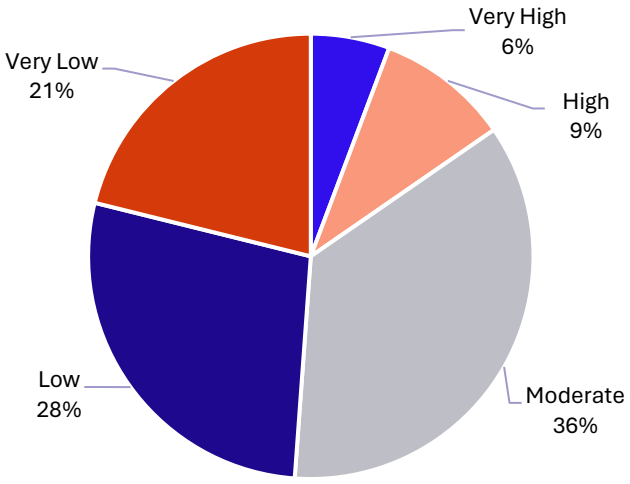
Figure A-9 Commercial GHG Emissions by Building Size and Opportunity Areas



Consistent with the graph above, most of the emissions come buildings under 50k Sq Ft. Further, **most of the emissions are also spread across the moderate, low, and very low opportunity areas.**

Figure A-10 2024 Commercial GHG Emissions by Opportunity Area

In this case, emissions are not spread evenly across areas. **Only 15% of commercial emissions are located in high or very high opportunity areas.** Of the remaining 85%, **nearly 50% are in low or very low opportunity areas.**



Impact Results

The market characterization shows that approximately 87% of the emissions from Tacoma residential and commercial buildings are from onsite use of natural gas for space and water heating. Therefore, a central part of the building decarbonization path for Tacoma is to eliminate these onsite fossil fuel emissions by 2050. A key emission reduction strategy will be to replace fossil fuel space and water heater appliances with zero-emission appliances, including high-efficiency electric appliances like heat pumps.

The impact assessment includes the development of a reference case and three analysis scenarios to explore the best timing for equipment replacements, as well as cost impacts, energy and emission reductions, and co-benefits. Ideally, equipment replacements would be made as close as possible to the end of the useful life of the existing appliance. This will require increasing the percentage of zero-emission appliances sold and installed in new and existing buildings to 100% and then sustaining that rate through 2050.

Below we summarize key takeaways from the reference case and the three analysis scenarios:

Reference Case. Absent a directed effort to decarbonize, the total emissions from electric and natural gas consumption start at 280,000 MT CO2 in 2022 and cut to 216,000 (22%) in 2050. Overall, the 22% reduction by 2050 remains far short of the 88% reduction needed in order to meet the CAP goal of about 32,000 MT CO2 by 2050.

Scenario 1. In Scenario 1, we explored whether CAP goals could be met through the replacement of all fossil fuel equipment with zero emissions equipment upon burnout. The results showed there simply is not enough time between now and 2050 for Tacoma to decarbonize the building sector on a purely natural replacement timeline. Under this scenario, the total reduction in emissions is approximately 75%, much closer to the 88% required but still short about 43,000 MT CO2 by 2050.

Scenario 2. In Scenario 2, we explore options for the acceleration of replacements to meet the CAP goals. Accelerated replacements ensure that each year, some appliances are replaced early while limiting those replacements to appliances that are very close to burnout. We found that the optimal timing for reaching 100% peak sales share of zero-emission appliances for new and replacement installations is 2030. Delaying 100% peak sales share of zero-emission appliances dramatically increases the number of appliances that will need to be replaced early and, in some instances, well ahead of burnout, thereby increasing the costs of decarbonization.

Scenario 3. In Scenario 3, we explore the impacts of increased grid stability due to the presence of more controllable load, and the additional potential offsets related to renewable natural gas. We find that the increase in electric load due to decarbonization is 11% and can likely be offset by load management. We also show that while RNG does have the capacity to reduce emissions, recent research does not support it as a viable building decarbonization option for the state of WA.

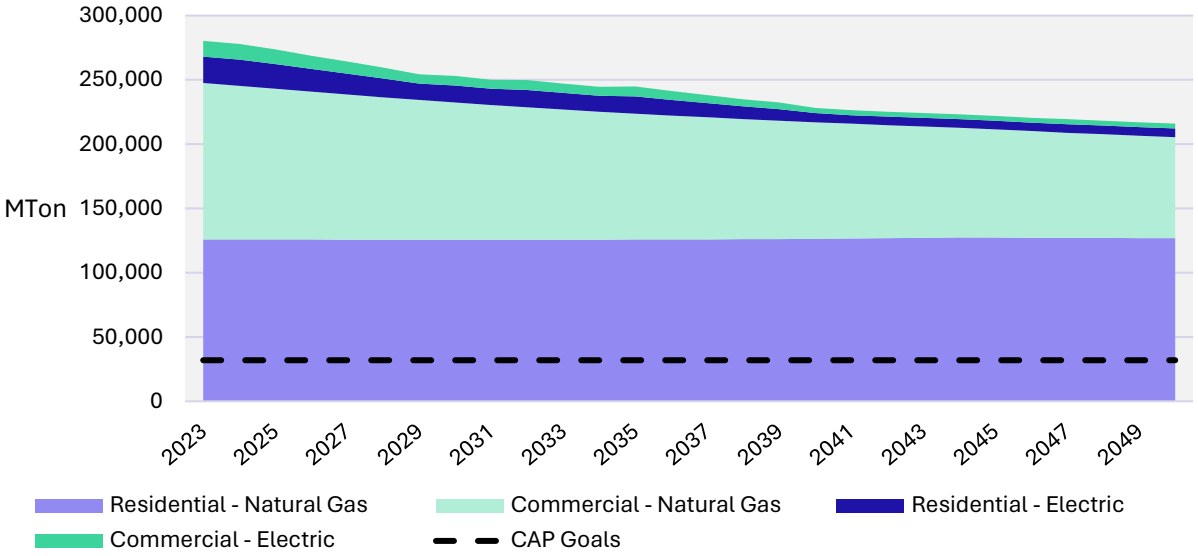
In the subsections that follow, we present the detailed results of the reference case and each of the three scenarios.

Reference Case

The reference case emissions through 2050 could be summarized as “more of the same”. Total emissions from electric and natural gas consumption start at 280,000 MT CO2 and will decline to 216,000 (22%) in 2050 due to a combination of cleaner generation and some energy efficiency. Slightly declining reference case gas load, particularly in the commercial sector, also reduces emissions, but comparatively little. Overall, the 22% reduction by 2050 remains far short of the 88% reduction needed in order to meet the CAP goal of about 32,000 MT CO2 by 2050.

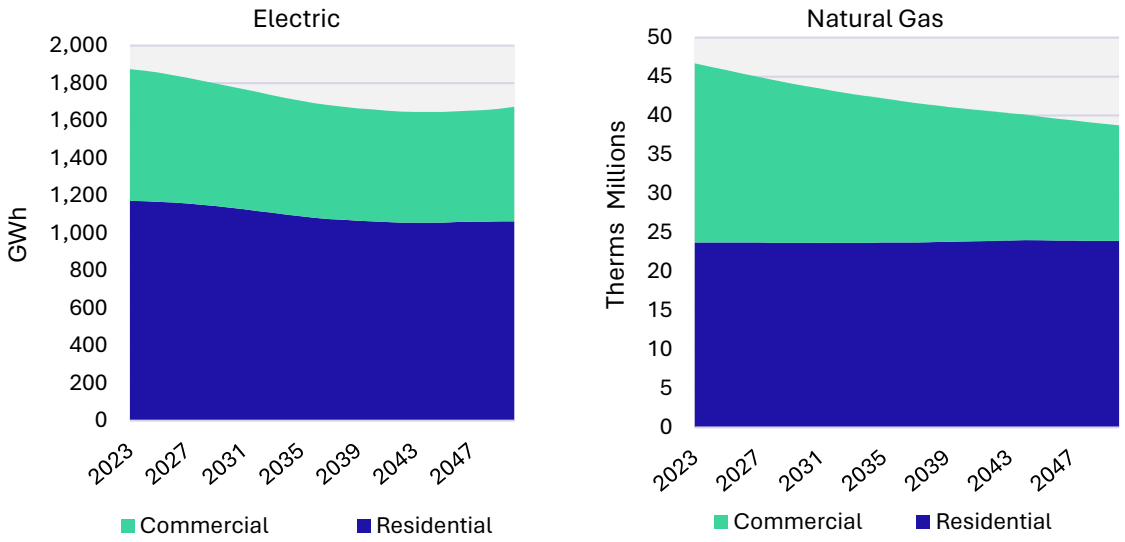
Figure A-11 presents the combined total emissions resulting from electric and natural gas consumption across the residential and commercial sectors.

Figure A-11 Reference Case GHG Emissions



In the figure below, we also show the energy loads for electricity and natural gas that underlie those GHG estimates. In the figure on the left, we show the electricity consumption by sector. In this case, the residential consumption decreases slightly, while the number of homes increases, demonstrating the effects of efficiency. Commercial electricity consumption meanwhile stays relatively flat. In the figure on the right, we can see that natural gas consumption is decreasing pretty steadily in the commercial segment as a result of both natural electrification and increasing efficiency, while residential consumption stays the same over time.

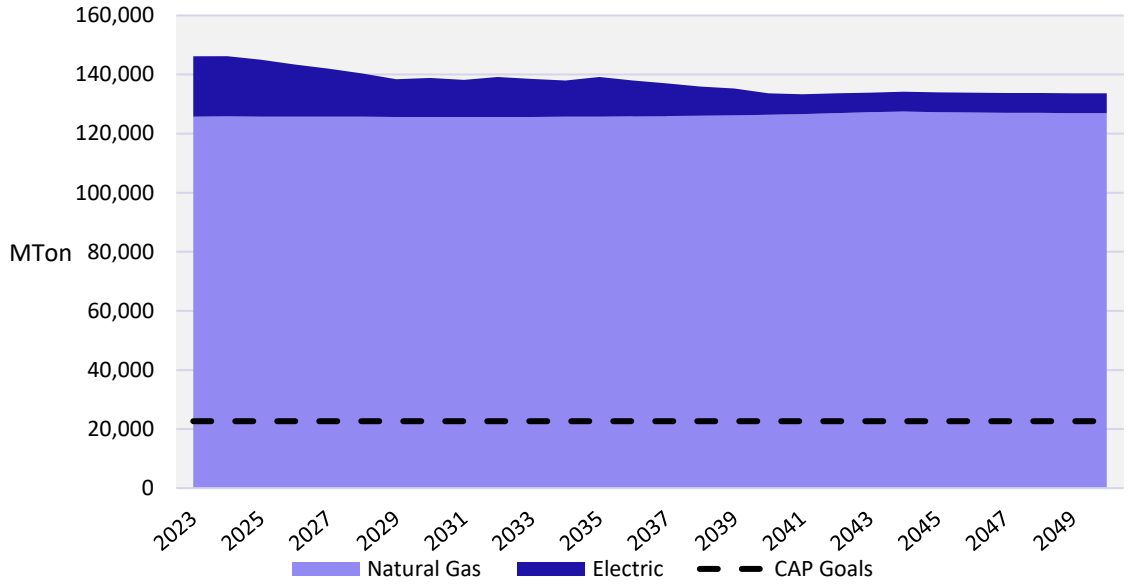
Figure A-12 Reference Case Electric and Natural Gas Consumption by Sector



Residential Sector

The residential reference case is almost completely flat aside from the above mentioned changes to electric GHG conversion factors. Residential existing construction only slowly turns over to renovated spaces and more state code-compliant equipment, and current language within Washington State Energy Code still allows natural gas heated homes to replace their existing equipment. By 2050, little has changed in the landscape of emissions.

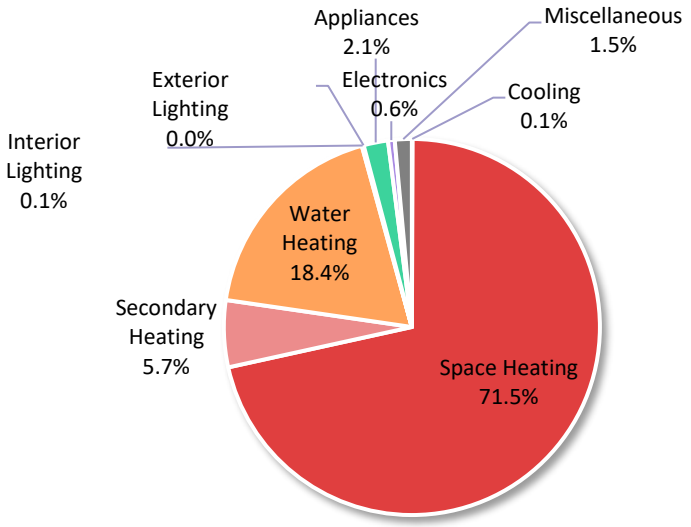
Figure A-13 Reference Case Residential GHG Emissions by Fuel Type



As shown in Figure A-14, the end use contribution to these emissions is very similar to the starting emissions: while electric contributions have declined, they were a minority of emissions in the first place, and the natural gas loads have barely moved.

Figure A-14 Reference Case 2050 Residential GHG Emissions by End Use (Electric and Gas)

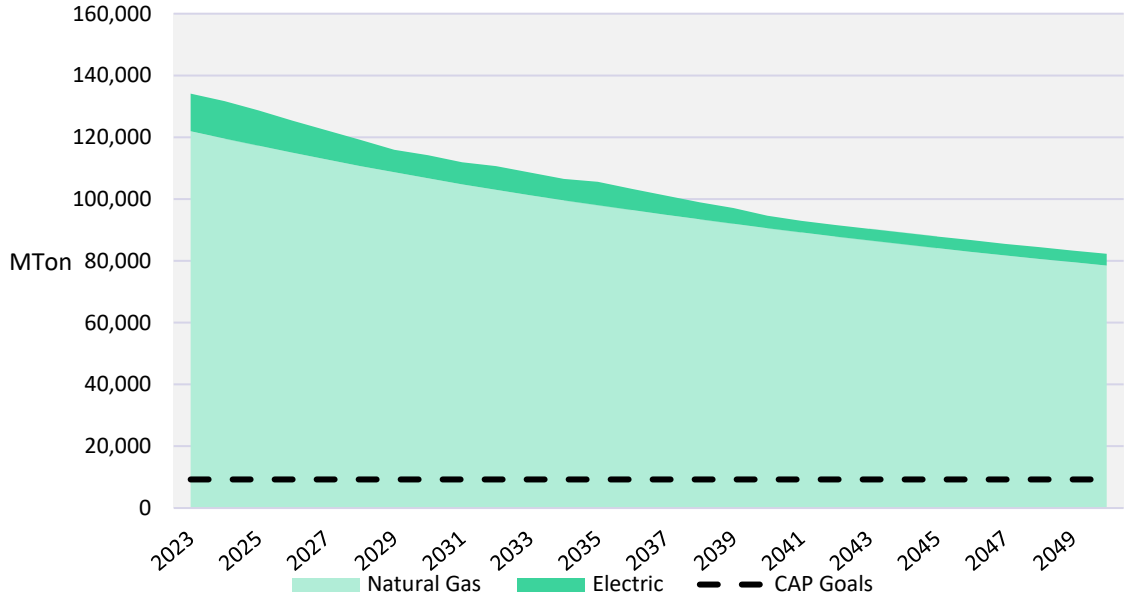
When we look at the distribution of emissions across end-uses in 2050, the proportion of emissions attributable to electric end-uses has decreased, leaving the remaining natural gas end-uses with bigger pieces of the pie. **Space heating increased from 69% to 72%, and secondary heading from 5 to 6%.**



Commercial Sector

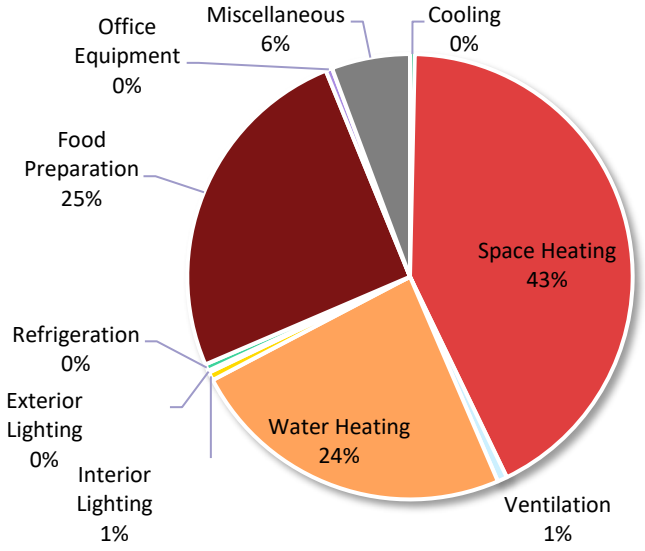
The commercial reference case natural gas load declines more over time mainly because commercial space turns over faster than residential properties and can be captured by renovation, reducing energy consumption and complying with state energy codes.

Figure A-15 Reference Case Commercial GHG Emissions by Fuel Type



Still, much like the residential sector, the landscape of commercial emissions without decarbonization efforts is similar in 2050 to that in 2024, as shown in Figure A-16.

Figure A-16 Reference Case 2050 Commercial GHG Emissions by End Use (Electric and Gas)



Like residential, the proportion of emissions attributable to electric end-uses has decreased, while the distribution of natural gas end-uses has changed and increased overall. **Space heating and water heating decrease by 1% each, while food preparation increases from 20% to 25%.**

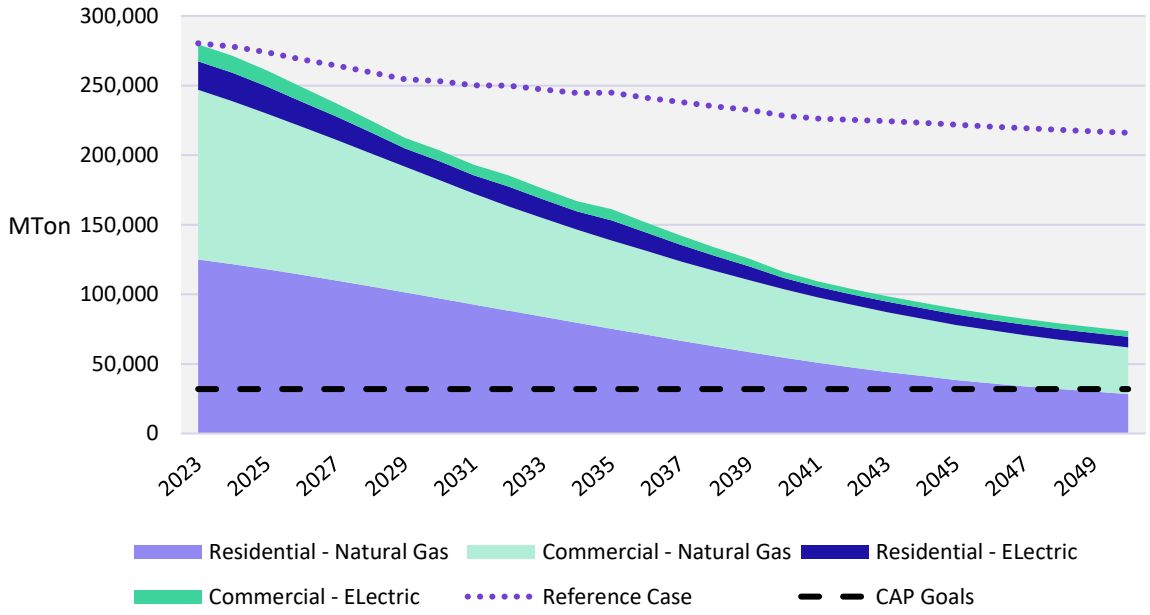
Impact Scenario 1: Natural Gas Space & Water Heat Replacement on Burnout

In Scenario 1, we explored whether CAP goals could be met through the replacement of all fossil fuel equipment with zero emissions equipment upon burnout. The results showed there simply is not enough time between now and 2050 for Tacoma to decarbonize the building sector on a purely natural replacement timeline. Under this scenario, the total reduction in emissions is approximately 75%, much closer to the 88% required, but still short about 43,000 MT CO2 by 2050.

GHG Emissions

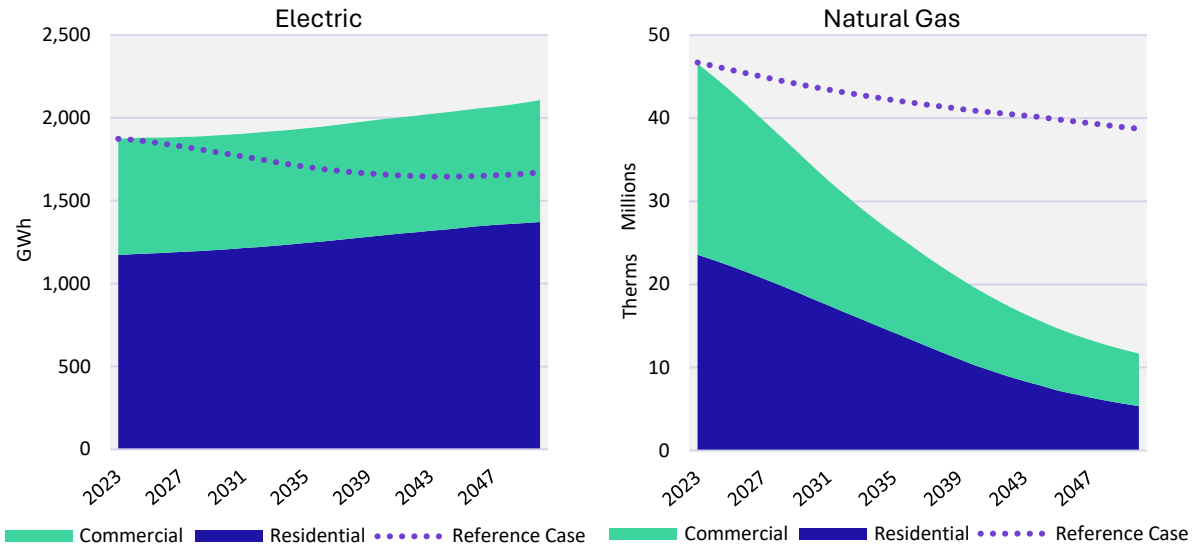
Figure A-17 presents the combined total emissions resulting from electric and natural gas consumption across the residential and commercial sectors under the replacement on burnout scenario.

Figure A-17 Scenario 1 Total GHG Emissions



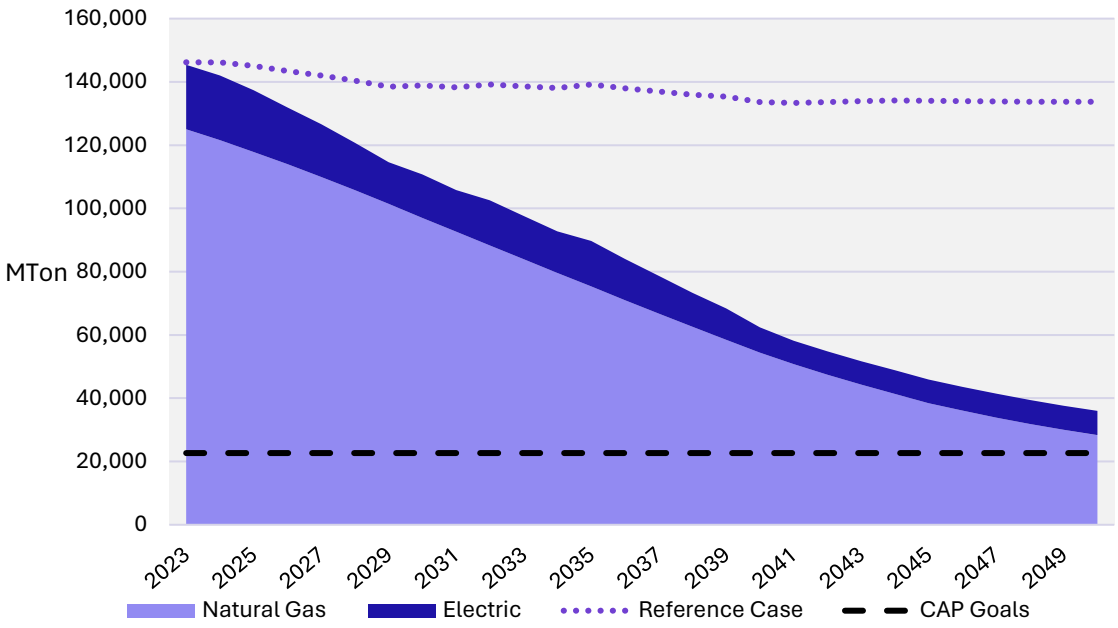
In the figure below (Figure A-18), we also show the energy loads for electricity and natural gas that underlie the GHG estimates above. In the figure on the left, we show the electricity consumption by sector. In this case, as expected, residential and commercial electricity consumption increase relative to the baseline due to the electrification of space and water heating loads. The increase in electric consumption amounts to approximately 25% of the reference case. In the figure on the right, we can see that natural gas consumption is decreases dramatically in the residential and commercial segments. The total decrease in gas consumption amounts to approximately 70% of the reference case.

Figure A-18 Scenario 1 Electric and Natural Gas Consumption by Sector



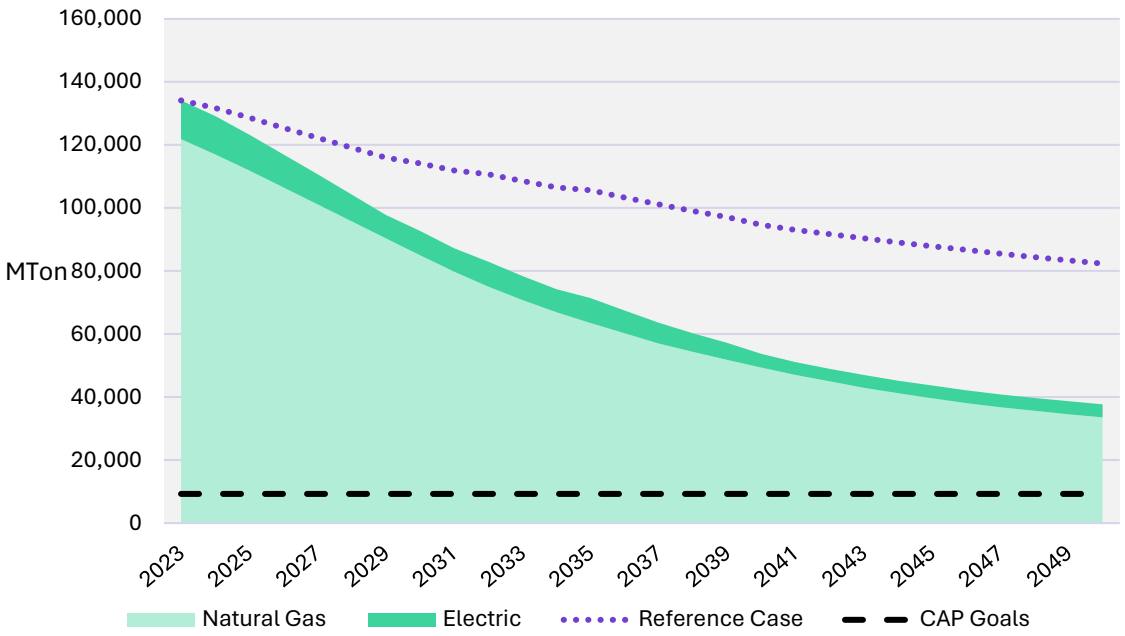
The next two figures show the residential and commercial emissions by fuel type relative to the reference case. In the residential sector, the natural replacement timeline results in emission levels that are close to the CAP goals and an overall reduction of more than 70%.

Figure A-19 Scenario 1 Residential GHG Emissions by Fuel Type



In the commercial sector, the natural replacement timeline results in an overall reduction of more than 60%, but they still fall well short of the CAP goals.

Figure A-20 Scenario 1 Commercial GHG Emissions by Fuel Type



Replacement Rates

Next, we explore the natural replacement rates across sectors to understand how each end-use is turning over (on burnout) in each year of the study.[31] In the figures and tables that follow we present the residential and commercial replacement rates.

Table A-10 Residential Replacement Rates (Units)

End-Use	Units/Yr. (2030)	Total Replaced	% Replaced
Furnaces	801	19,412	77%
Boilers	87	2,311	73%
Water Heaters	1,367	26,447	100%

[31] Effective useful life assumptions for the electric equipment align with the 2022-2024 Tacoma Power CAP assumptions. Effective useful life assumptions for gas equipment align with the Energy Information Administration Buildings and Technologies Reference Case Appendix A.

Figure A-21 Residential Replacement Rates (Units)

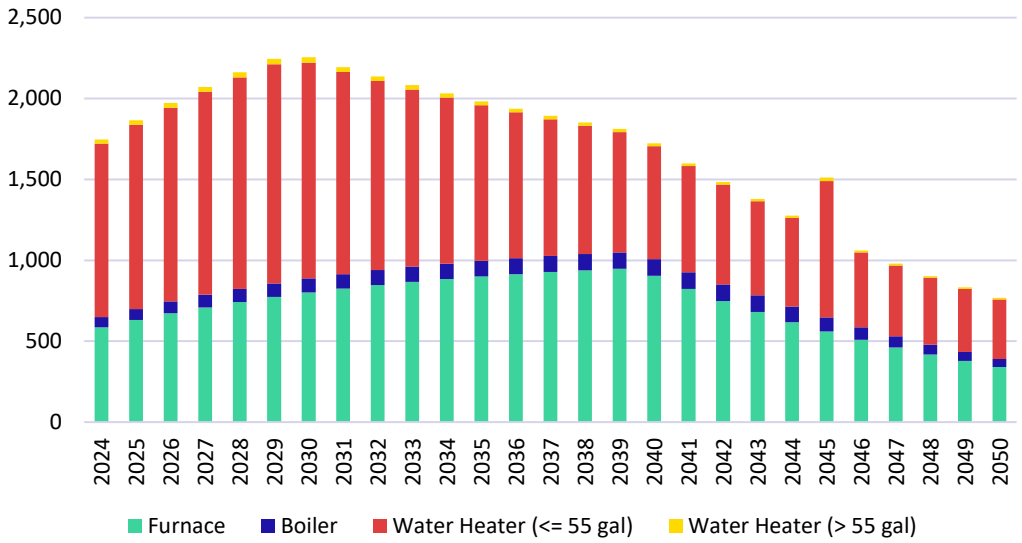
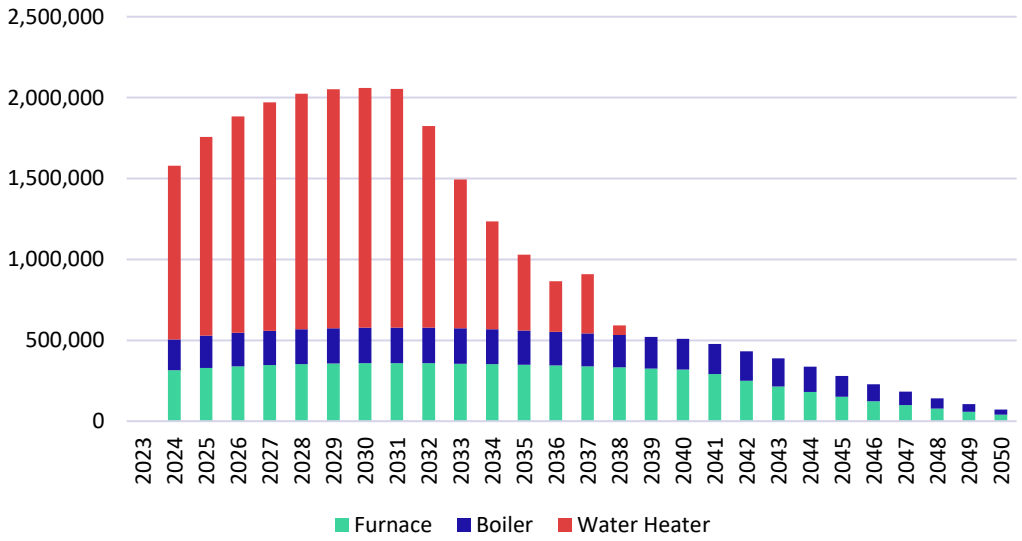


Table A-11 Commercial Replacement Rates (Sqft Served By)

End-Use	Sqft/Yr. (2030)	Total Replaced	% Replaced
Furnaces	358,152	7.3 Million	49%
Boilers	220,196	4.7 Million	48%
Water Heaters	1,482,031	15.0 Million	71%

Figure A-22 Commercial Replacement Rates (Sqft Served By)



Scenario 1 Takeaways

Space and water heating replacements are key drivers for decarbonization in existing buildings and they must be central to the strategy. However, the natural replacement timeline for space and water heating is too long to decarbonize by 2050.

Figure A-23 Residential 2050 Emissions Comparison Reference Case vs. Scenario 1

Scenario 1 gets very close to the CAP goal. Key end-uses that still contribute to emissions include space heat, secondary space heat, and water heat. These results indicate that **both acceleration of the natural replacement rate and inclusion of secondary heating (gas fireplaces) may be needed to meet the goal.**

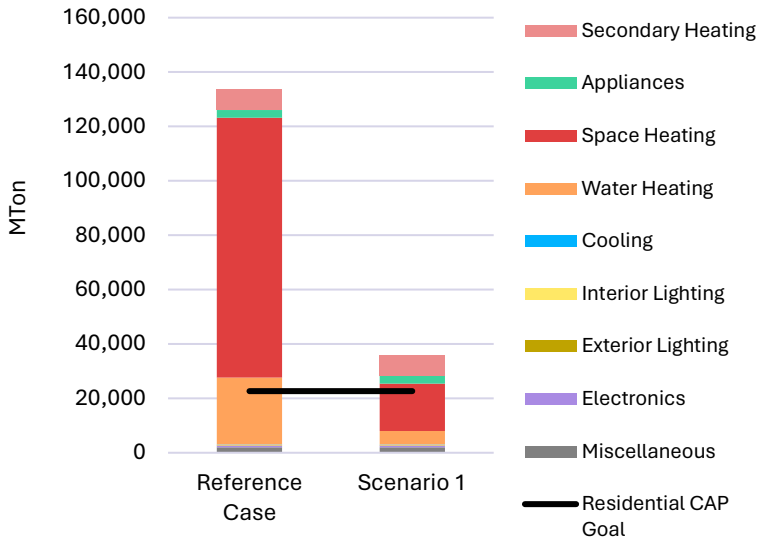
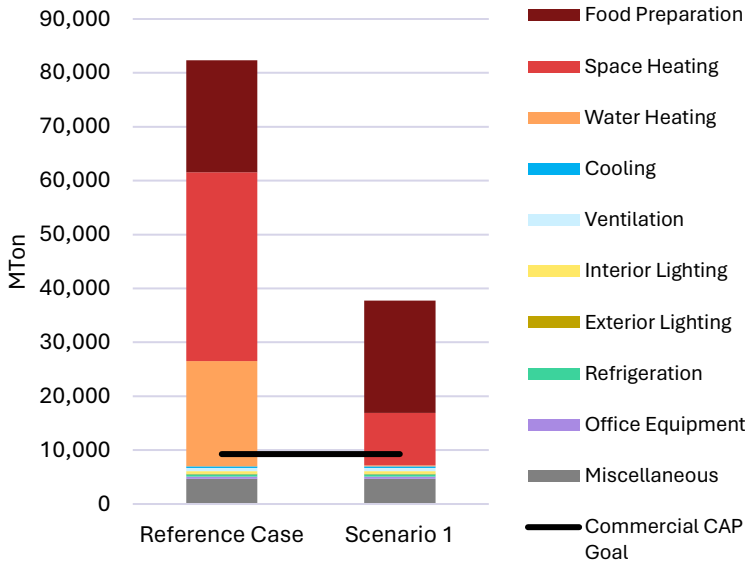


Figure A-24 Commercial 2050 Emissions Comparison Reference Case vs. Scenario 1



Scenario 1 still leaves a significant amount of emissions on the table. Key end-uses that contribute to remaining emissions include space heat, and food preparation, while water heat is almost entirely replaced. These results indicate that **both acceleration of the natural replacement rate and inclusion of food preparation will be needed to meet the goal.**

Impact Scenario 2: Optimized Natural Gas Replacement

Scenario 1 showed that the natural replacement schedule of space and water heating equipment was insufficient to reach the city's goals by 2050. Therefore, in Scenario 2 we assume the goal is reached by 2050 through two additional exploratory Scenarios 2a, and 2b. In Scenario 2a we use the analysis to discover landscape and schedule of decarbonized technologies required to meet the goals in 2050 and optimize the replacement rate over the entire timeframe. In Scenario 2b, we considered what effect delayed implementation of these plans might have on program costs and participant incentives.

Scenario 2a: Immediate Start, Decarbonizing all End Uses

Scenario 2a requires significant modifications from scenario 1:

- **Include cooking equipment for commercial buildings and gas fireplaces in residential buildings.** These end uses contribute significantly to the total GHG emissions in the city of Tacoma and are the key end uses in each sector (respectively) preventing Tacoma from reaching its goals after decarbonizing water and primary space heating. For the scenario, a phased-in approach to decarbonization is used, starting in 2025 and linearly accelerating to 100% of unit turnover by 2030.
- **Accelerate space heating decarbonization.** To reach the city's goals, the decarbonization of space heating technologies must occur significantly faster than the natural end of useful life: 33% faster in 2030 for Residential and 92% faster in 2030 for commercial. Ideally, the City could target such units by offering incentives for customers to convert working equipment of a reasonable age, such as 10-15 years old or more.

Scenario 2a: Residential Results

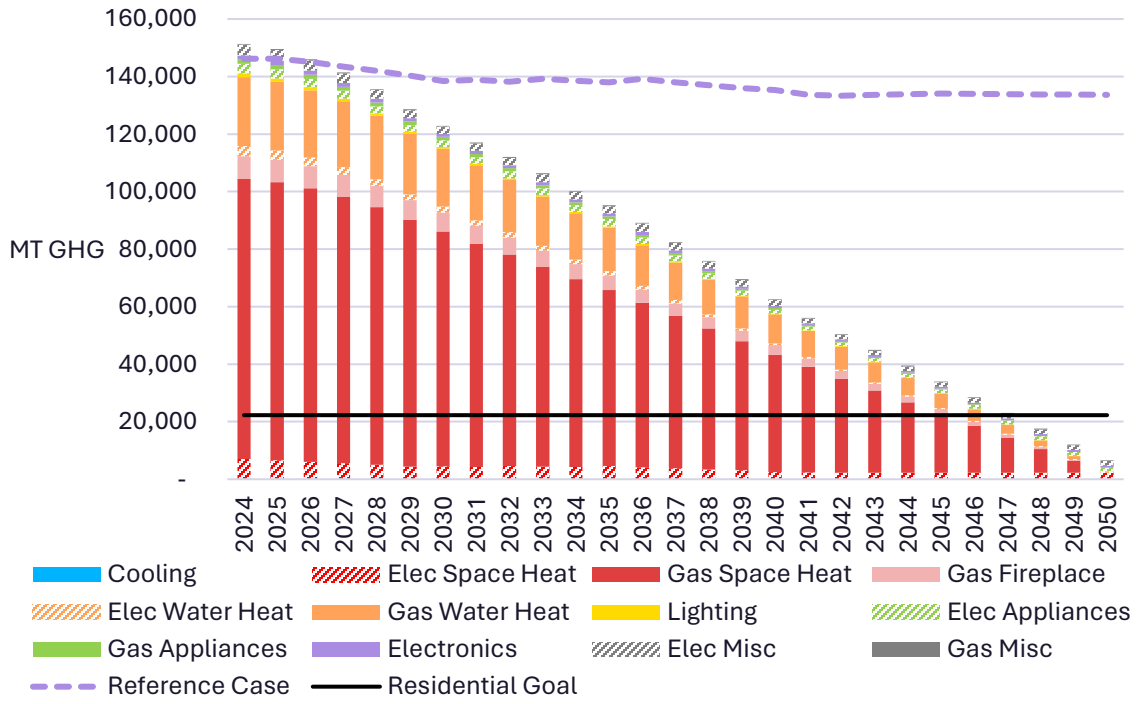
By decarbonizing all natural gas technologies and accelerating acquisition of these replacements, including residential cooking, and gas fireplaces it is possible to reach the city's GHG goals on schedule. This scenario is defined as follows:

- Takes all fossil fuel units that exist in the base year (2022) and electrifies them according to a ramped timeline resulting in 100% of units electrified by 2050.
- The first year of electrification is 2025.
- The maximum rate of electrification is achieved by 2030 and sustained through 2050.

Residential GHG Emission Results

The figure below presents the total emissions by end-use and year for the residential sector under these assumptions.

Figure A-25 Residential Decarbonization Schedule Under Scenario 2a



In the table that follows we present the replacement rates assumed under Scenario 2a and compare them to the replacement rates from Scenario 1 – the natural replacement rates.

- The **first column** shows the target replacement rate for each end-use; these target rates need to be achieved by 2030 and held constant through 2050. For example, for space heating, the total number of units replaced must reach 1,185/year by 2030 and stay there through the remainder of the timeframe.
- The **next two columns** present a comparison of the target rate and the natural replacement rate in 2030. Note here that space heat needs to be replaces at a rate about 33% faster than the natural rate, while water heating does not need to be accelerated.
- The **final two columns** illustrate the variability between the target rate and the natural rate. Because the number of equipment that reaches the end of its useful life each year varies based on the time it was installed and the technology the natural replacement rate varies fro m year to year. For residential, the maximum natural replacement rate of space heat is actually 1,049 furnaces each year, in that case the target rate is only 13% faster than the natural replacement rate.

Space heat needs to be replaced at a rate that is between 13% and 33% faster than the natural replacement rate. Water heat does not need to be accelerated. Keep in mind that this scenario also includes two additional end-uses not included in Scenario 1, gas fireplaces and cooking.

Table A-12 Residential Decarbonization Schedule Under Scenario 2a

End Use	Target Rate Units/Year 2030	Natural 2030 Replacement Rate	Accelerated vs. Natural Rate (% in 2030)	Natural Max Replacement Rate	Accelerated vs. Natural Rate (% at Max Rate)
Space Heating	1,185	888	33%	1,049	13%
Gas Fireplaces	300	0	NA	0	NA
Water Heating	1,108	1,367	-19%	1,388	-20%
Cooking	666	0	NA	0	NA

Residential Costs and Assumptions

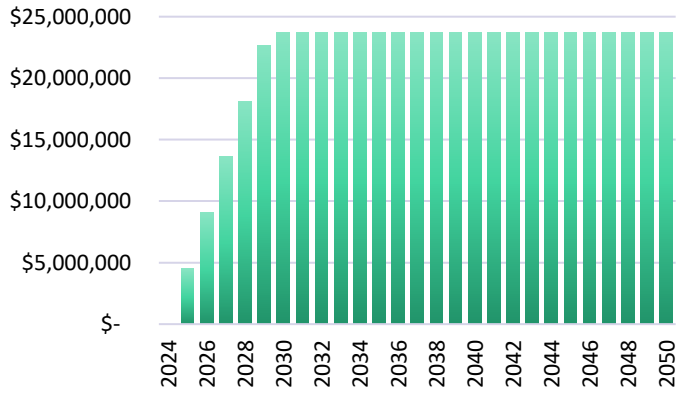
Representative assumed costs of converting each end use to decarbonized technologies is presented in Table A-13 below. For brevity, only data for single family detached homes is provided in this document, however the actual costs vary by housing type appropriately for the size of home. These assumptions include only costs of replacing the equipment itself, and not associated transmission/distribution impacts that may be needed on a localized level. While the overall annual energy impact of converting natural gas technologies to decarbonized solutions is modest compared to total energy loads already present in the City of Tacoma, there is a possibility that neighborhood-level distribution equipment may not be ready for increased loads, particularly at peak hours.

Table A-13 Unit Cost Assumptions for Residential Decarbonized Technologies

End Use	Decarbonization Technology	Conversion Cost (Single Family Home)	Electrification Costs (Single Family Home)	kWh per Year (Single Family Home)	Coincident Peak kW per year	Avg Lifetime (years)
Space Heating	Air-Source Heat Pump SEER 15 / HSPF 8.8	$14,000	$2,079	3,800 kWh	0.67 kW	18
Secondary Heating	Electric Fireplace (replacing gas fireplace)	$1,200	$0	1,350 kWh	0.25 kW	18
Water Heating	Heat Pump Water Heater (NEEA Tier 2 – CCE2.3)	$1,865	$250	1,200 kWh	0.24 kW	13
Cooking	Electric range w/ Induction stove	$1,800	$250	145 kWh	0.01 kW	16

In the figure and associated table below, we present the annual incremental conversion costs associated with scenario 2a.[32]

Figure A-26 Annual Conversion Costs and Conversion Details Table



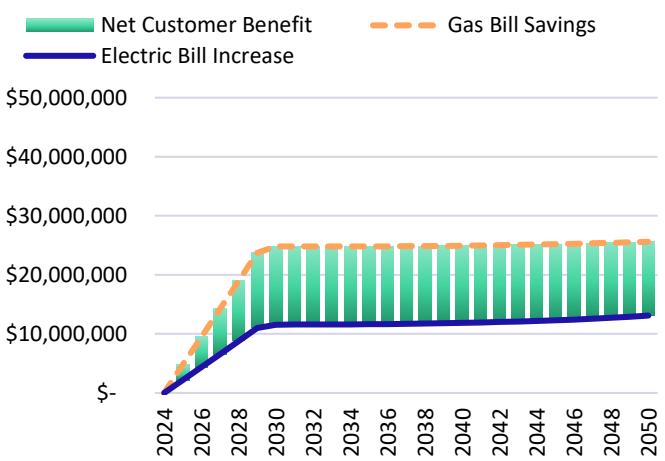
End Use	Full Rate Units/Year	$ per Year in max
Space Heating	1,185	$23,324,695
Gas Fireplaces	300	$11,533
Water Heating	1,108	$214,997
Appliances	666	$183,026

Residential Benefits and Assumptions

The assumed benefits associated with converting each end use to decarbonized technologies are as follows.

[32] All equipment costs are incremental over the cost of replacing equipment like for like. Note that particularly for natural gas furnaces, the cost of replacement is very low relative to the zero emission equipment.

- **Bill impacts.** We used average electric and gas bill rates to estimate the net benefits to the customer associated with electrification of equipment. The net benefits are presented in the figure to the right.



- **Avoided costs of energy.** This value represents the cost to the utility of providing the next incremental unit of energy to serve customers. This cost to the utility is avoided when customers reduce their energy use. The electric avoided costs were sourced from Tacoma Power while the gas avoided costs are currently a proxy value similar to what would be found in Washington State.
- **General health and safety.** We used a 10% adder to the overall benefits to represent health, safety, and comfort benefits to the customers. This is a common and accepted approach used throughout the industry to quantify these difficult to estimate benefits.
- **Avoided GHG emissions value.** This value was estimated using an annualized social cost of carbon $ value forecast developed by the Interagency Working Group on Social Cost of Greenhouse Gases in Docket U-190730.
- **Inflation Reduction Act (IRA).** The IRA program will be rolling out in 2024 and will provide funding to individuals and businesses to install energy efficient heat pump technology. A value was applied to residential home conversions of heating and water heating equipment based on the most accessible programs until 2030, when funds are anticipated to be exhausted.
- **Incentive dollars.** Incentive dollars paid to customers for their participation in energy efficiency programs by local utilities are a benefit to participants in the participant cost test (PCT) and represent a cost in the utility cost test (UCT).

These assumptions include only the benefits that were quantified in the cost benefit analysis. We address some of the other co-benefits in a qualitative manner in the final subsection Limitations of the Impact Analysis.

Cost Benefit Analysis Results

Cost-effectiveness (CE) testing is typically a required analysis for regulated utility energy efficiency programs in order to determine the economic attractiveness of an energy investment compared to a baseline of not making the investment. It helps determine whether the activities in a program represent a good investment from the stakeholder perspective of the given test(s) utilized. When the benefits of the investment exceed the costs and the test passes, it indicates a positive net benefit.

It is important to note that the results presented below are sensitive to the assumptions that underly the analysis and perhaps even more importantly the limitations of the analysis. For example, the cost-benefit ratios are very sensitive to the avoided cost of carbon, as the key benefit of zero-emission equipment, which have a wide range. The WUTC value we used in the analysis ranges from $87 to

$122 dollars between 2025 and 2050, while the 2022 CPUC Avoided Cost Calculator[33] value ranges from $163 to $1,004 dollars over the same timeframe.

After all CE cost and benefit assumptions were developed, an analysis was run to determine the overall CE levels across several commonly used CE tests. Table A-14 identifies and describes the tests run for this project and Table A-15 presents the results of the CE tests.

Table A-14 Summary of CE Tests Utilized in the Analysis

Test	Key Questions	Summary of Approach
Total Resource Cost Test (TRC)	Will the total costs of energy and emissions in the service area decrease?	Comparison of customer costs of conversion to the benefit value of avoided costs and GHG savings
Utility Cost Test (UCT)	Will utility bills increase?	Comparison of program incentive costs paid to participant to the benefit value of utility avoided cost savings
Participant Cost Test (PCT)	Will the participants benefit from the conversion?	Comparison of the costs of conversion for the participant to the benefits of energy bill savings and incentives received by utility

Table A-15 Summary of Residential CE Test Results Over the Study Timeline (2025-2050)

Decarbonization Technology Category	Value Defined	TRC	PCT	UCT
Space Heating	NPV Benefits	$265,976,289	$222,300,541	$92,070,278
	NPV Costs	$448,416,640	$448,416,640	$139,153,009
	TRC B/C Ratio	0.59	0.50	0.66
Secondary Heating	NPV Benefits	$11,957,084	$6,927,737	$3,144,440
	NPV Costs	$8,596,654	$8,596,654	$4,298,327
	TRC B/C Ratio	1.39	0.81	0.73
Water Heating	NPV Benefits	$40,928,431	$43,263,572	$13,503,635
	NPV Costs	$6,452,937	$6,452,937	$2,565,303
	TRC B/C Ratio	6.34	6.70	5.26
Appliances	NPV Benefits	$4,055,986	$3,300,645	$2,216,940
	NPV Costs	$8,343,116	$8,343,116	$2,183,838
	TRC B/C Ratio	0.49	0.40	1.02
TOTAL	NPV Benefits	$322,917,792	$275,792,494	$110,935,294
	NPV Costs	$471,809,348	$471,809,348	$148,200,477
	TRC B/C Ratio	0.68	0.58	0.75

Table A-15 Exhibits mixed scores for the TRC test for each technology type and the total. The TRC passes for secondary heating and water heating. The PCT test passes the water heating category only, and the UCT passes the water heating and appliances categories.

Table A-16 presents the results through 2030, vs the full 2025-2050 view. The first six years of this effort show stronger scores across the board and all categories pass the UCT test. The TRC and PCT reflect the same general pattern of scores as the full view through 2050, though higher. The UCT passes across the total range of categories, while the TRC and PCT are close at 0.93 and 0.92 respectively.

[33] https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/demand-side-management/acc-models-latest-version/2022-acc-documentation-v1a.pdf

Table A-16 Summary of Residential CE Test results through 2030 (2025-2030)

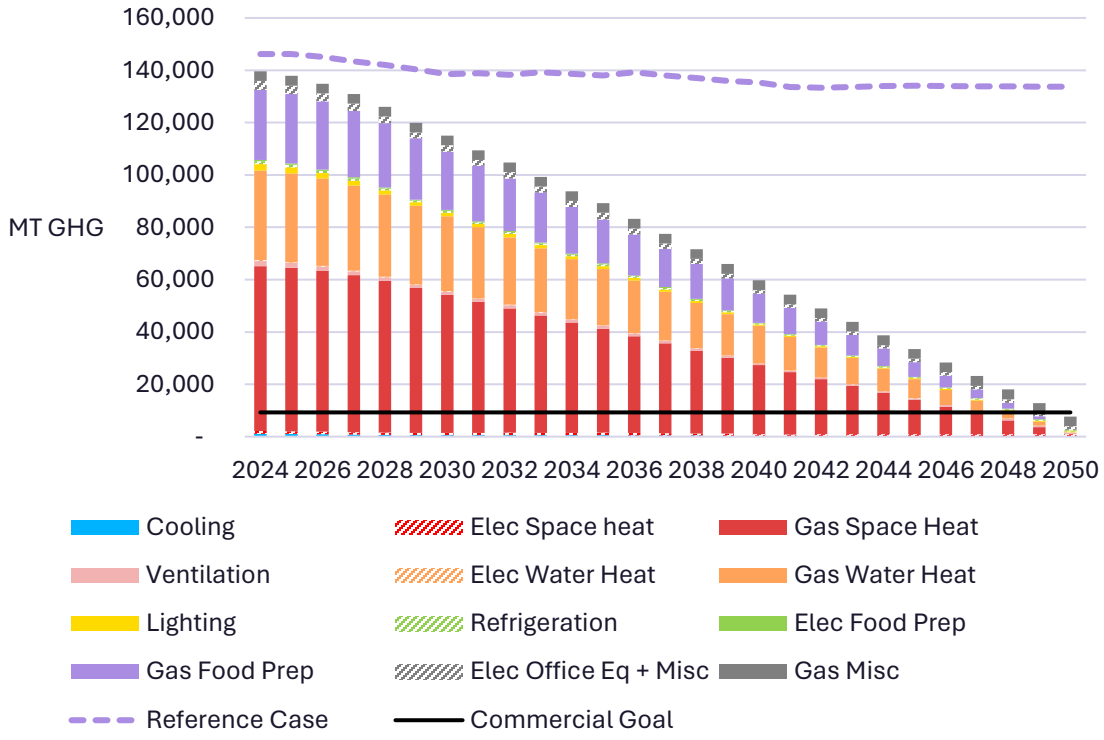
Decarbonization Technology Category	Value Defined	TRC	PCT	UCT
Space Heating	NPV Benefits	$60,583,985	$57,977,651	$33,864,170
	NPV Costs	$72,600,789	$72,600,789	$22,529,535
	TRC B/C Ratio	0.83	0.80	1.50
Secondary Heating	NPV Benefits	$2,332,079	$1,150,414	$1,041,414
	NPV Costs	$1,391,839	$1,391,839	$695,920
	TRC B/C Ratio	1.68	0.83	1.50
Water Heating	NPV Benefits	$7,404,180	$10,432,918	$3,420,979
	NPV Costs	$1,044,761	$1,044,761	$415,335
	TRC B/C Ratio	7.09	9.99	8.24
Appliances	NPV Benefits	$601,646	$794,727	$340,946
	NPV Costs	$1,350,790	$1,350,790	$353,574
	TRC B/C Ratio	0.45	0.59	0.96
TOTAL	NPV Benefits	$70,921,889	$70,355,710	$38,667,510
	NPV Costs	$76,388,180	$76,388,180	$23,994,363
	TRC B/C Ratio	0.93	0.92	1.61

Scenario 2a: Commercial Results

By decarbonizing all natural gas technologies that have viable non-gas alternatives and accelerating acquisition of these replacements, including commercial cooking, it is possible to reach the city's GHG goals on schedule. This scenario is defined as follows:

- Takes all fossil fuel units that exist in the base year (2022) and electrifies them according to a ramped timeline resulting in 100% of units electrified by 2050.
- The first year of electrification is 2025.
- The maximum rate of electrification is achieved by 2030 and sustained through 2050.

Figure A-27 Commercial Decarbonization Schedule Under Scenario 2a



In the table that follows we present the replacement rates assumed under Scenario 2a and compare them to the replacement rates from Scenario 1. We see that space heating needs to be replaced nearly twice as quickly as the natural replacement timeline, while water heat can be replaced at a slower rate. The target rate represents the rate that must be achieved by 2030 and maintained to achieve the goal by 2050. For example, for space heating, the total number of square feet electrified annually must reach 1,110,623 by 2030 and stay there through the remainder of the timeframe. Keep in mind that this scenario also includes one additional end-use not included in Scenario 1, food preparation.

Table A-17 Commercial Decarbonization Schedule Under Scenario 2a

End Use	Target Rate SqFt/Year 2030	Natural 2030 Replacement Rate	Accelerated vs. Natural Rate (% in 2030)	Natural 1 Max Replacement Rate	Accelerated vs. Natural Rate (% at Max Rate)
Space Heating	1,110,623	578,345	92%	578,966	92%
Food Preparation	832,768	0	NA	0	NA
Water Heating	884,660	1,482,031	-43%	1,482,031	-40%

Commercial Costs and Assumptions

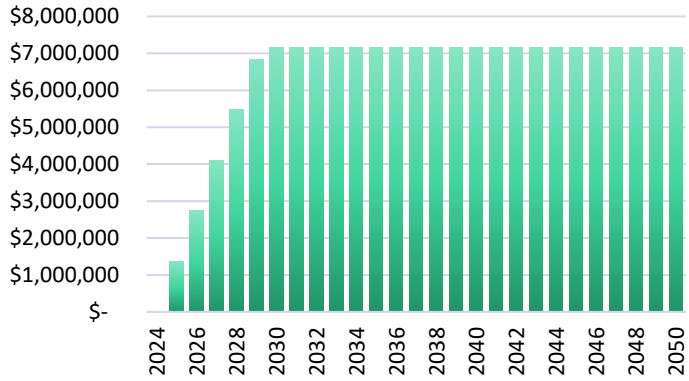
The assumed costs of converting each end use to decarbonized technologies is presented in Table A-18 below. These assumptions include only costs of replacing the equipment itself, and not associated transmission/distribution impacts that may be needed on a localized level. While the overall annual energy impact of converting natural gas technologies to decarbonized solutions is modest compared to total energy loads already present in the City of Tacoma, there is a possibility that local distribution equipment may not be ready for increased loads, particularly at peak hours.

Table A-18 Unit Cost Assumptions for Commercial Decarbonized Technologies

End Use	Decarbonization Technology	Conversion Cost	kWh per Year	Coincident Peak kW per year	Avg Lifetime (Years)
Space Heating	IEER 15.3 / COP 3.5 – ENERGY STAR	$1,322/ton	Avg. 3.7 kWh/sq.ft (varies by segment)	Avg. 1.4 kW per 1,000 sqft (varies by segment)	15
Water Heating	COP 3.0 Heat Pump Water Heater – ENERGY STAR	$7,542/unit	Avg. 0.60 kWh/sq.ft (varies by segment)	Avg. 0.3 kW per 1,000 sqft (varies by segment)	13
Food Preparation	Electric Steamer/warmer, Griddle, Hot Food cabinet, Broiler, and Fryer	$4,000 - $25,000 per unit depending on specific equipment	4,000 – 11,500 kWh per unit depending on specific equipment	1.0-3.0 kW per unit depending on equipment	9

In the figure and associated table, we present the annual conversion costs associated with scenario 2a.

Figure A-28 Annual Conversion Costs and Conversion Details Table



End Use	Full Rate Units/Year	$ per Year in max
Space Heating	1,110,623	$6,767,188
Food Preparation	832,660	$320,521
Water Heating	884,660	$80,422

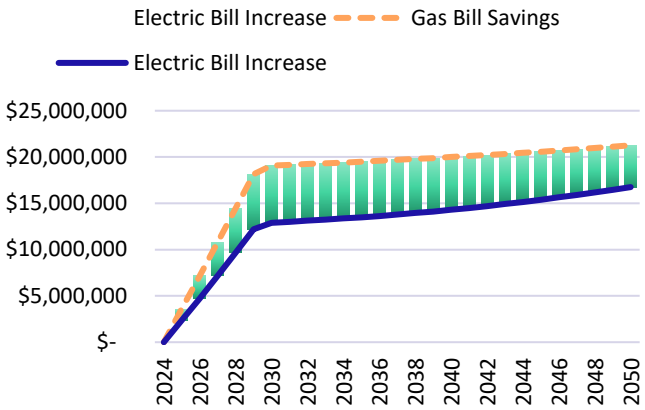
Commercial Benefits and Assumptions

The assumed benefits associated with converting each end use to decarbonized technologies are as follows.

- **Bill impacts.** We used average electric and gas bill rates to estimate the net benefits to the customer associated with electrification of equipment. The net benefits are presented in the figure to the right.
- **Avoided costs of energy.** This value represents the cost to the utility of providing the next incremental unit of energy to serve customers. This cost to the utility is avoided when customers reduce their energy use.
- **General health and safety.** We used a 10% adder to the overall benefits to represent health, safety, and comfort benefits to the customers. This is a common and accepted approach used throughout the industry to quantify these difficult to estimate benefits.

- **Avoided GHG emissions value.** This value was estimated using an annualized social cost of carbon $ value forecast developed by the Interagency Working Group on Social Cost of Greenhouse Gases in Docket U-190730.
- **Incentive dollars.** Incentive dollars paid to customers for their participation in energy efficiency programs by local utilities are a benefit to participants in the participant cost test (PCT) and represent a cost in the utility cost test (UCT). [34]

These assumptions include only the benefits that were quantified in the cost benefit analysis. We address some of the other co-benefits in a qualitative manner in the final subsection Limitations of the Impact Analysis.



Cost Benefit Analysis Results

Cost-effectiveness (CE) testing is typically a required analysis for regulated utility energy efficiency programs in order to determine the economic attractiveness of an energy investment compared to a baseline of not making the investment. It helps determine whether the activities in a program represent a good investment from the stakeholder perspective of the given test(s) utilized. When the benefits of the investment exceed the costs and the test passes, it indicates a positive net benefit.

It is important to note that the results presented below are sensitive to the assumptions that underly the analysis and perhaps even more importantly the limitations of the analysis. For example, the cost-benefit ratios are very sensitive to the avoided cost of carbon, as the key benefit of zero-emission equipment, which have a wide range. The WUTC value we used in the analysis ranges from $87 to $122 dollars between 2025 and 2050, while the 2022 CPUC Avoided Cost Calculator[35] value ranges from $163 to $1,004 dollars over the same timeframe.

After all CE cost and benefit assumptions were developed, an analysis was run to determine the overall CE levels across several commonly used CE tests. Table A-19 identifies and describes the tests run for this project.

[34] Note that there are state and/or federal incentives for non-residential building segments that were not included here – these incentives could change the numbers significantly if broadly applied.

[35] https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/demand-side-management/acc-models-latest-version/2022-acc-documentation-v1a.pdf

Table A-19 Summary of CE Tests Utilized in the Analysis

Test	Key Questions	Summary of Approach
Total Resource Cost Test (TRC)	Will the total costs of energy and emissions in the service area decrease?	Comparison of customer costs of conversion to the benefit value of avoided costs and GHG savings
Utility Cost Test (UCT)	Will utility bills increase?	Comparison of program incentive costs paid to participant to the benefit value of utility avoided cost savings
Participant Cost Test (PCT)	Will the participants benefit from the conversion?	Comparison of the costs of conversion for the participant to the benefits of energy bill savings and incentives received by utility

Table A-20 exhibits very strong scores for the TRC and UCT tests for each technology type and the total. The TRC is buoyed by the value of GHG, which is present in the TRC test but not in the PCT or UCT, while the strength of the UCT test is due to the relatively fewer incentive dollars being paid in comparison to the net value of avoided costs spent due to conversions from gas to electric. The PCT test passes the water heating and food preparation categories, though comes up short for the space heating category. This indicates that the bill savings and incentive dollars received for participating in the measure are outweighed by the costs of conversion.

Table A-20 Summary of Commercial CE Test results Over Study Timeline (2025-2050)

Decarbonization Technology Category	Value Defined	TRC	PCT	UCT
Space Heating	NPV Benefits	$435,937,733	$49,005,060	$297,161,924
	NPV Costs	$161,489,721	$161,489,721	$40,372,430
	TRC B/C Ratio	2.70	0.30	7.36
Water Heating	NPV Benefits	$103,709,249	$21,703,638	$65,000,890
	NPV Costs	$7,648,785	$7,648,785	$1,912,196
	TRC B/C Ratio	13.56	2.84	33.99
Food Preparation	NPV Benefits	$110,355,308	$38,692,041	$73,795,289
	NPV Costs	$1,919,173	$1,919,173	$479,793
	TRC B/C Ratio	57.50	20.16	153.81
TOTAL	NPV Benefits	$650,002,289	$109,400,739	$435,958,104
	NPV Costs	$171,057,679	$171,057,679	$42,764,420
	TRC B/C Ratio	3.80	0.64	10.19

Table A-21 presents the results through 2030, the first six years of this effort, and show a similar range of values, though generally slightly lower, with the exception of the PCT, which is increased. The lower values are likely due to the discounting of avoided costs and GHG being greater than the escalation of those values through time.

Table A-21 Summary of Commercial CE Test results through 2030 (2025-2030)

Decarbonization Technology Category	Value Defined	TRC	PCT	UCT
Space Heating	NPV Benefits	$64,719,317	$15,486,193	$44,804,665
	NPV Costs	$26,145,955	$26,145,955	$6,536,489
	TRC B/C Ratio	2.48	0.59	6.85
Water Heating	NPV Benefits	$14,562,500	$5,668,503	$9,116,876
	NPV Costs	$1,238,375	$1,238,375	$309,594

	TRC B/C Ratio	11.76	4.58	29.45
Food Preparation	NPV Benefits	$16,097,707	$8,196,147	$10,886,735
	NPV Costs	$310,723	$310,723	$77,681
	TRC B/C Ratio	51.81	26.38	140.15
TOTAL	NPV Benefits	$95,379,524	$29,350,842	$64,808,276
	NPV Costs	$27,695,053	$27,695,053	$6,923,763
	TRC B/C Ratio	3.44	1.06	9.36

Scenario 2b: Delayed Start

Most aspects of this alternative scenario are the same as scenario 2a, however this version assumes the ramp up of direct decarbonization efforts is delayed until 2030 and takes until 2040 to get going. We see in this scenario that any delay in decarbonization efforts results in further acceleration of the replacement rates over the natural replacement rate. The increased acceleration also translates to larger annual costs.

Figure A-29 Residential Decarbonization Delayed Schedule

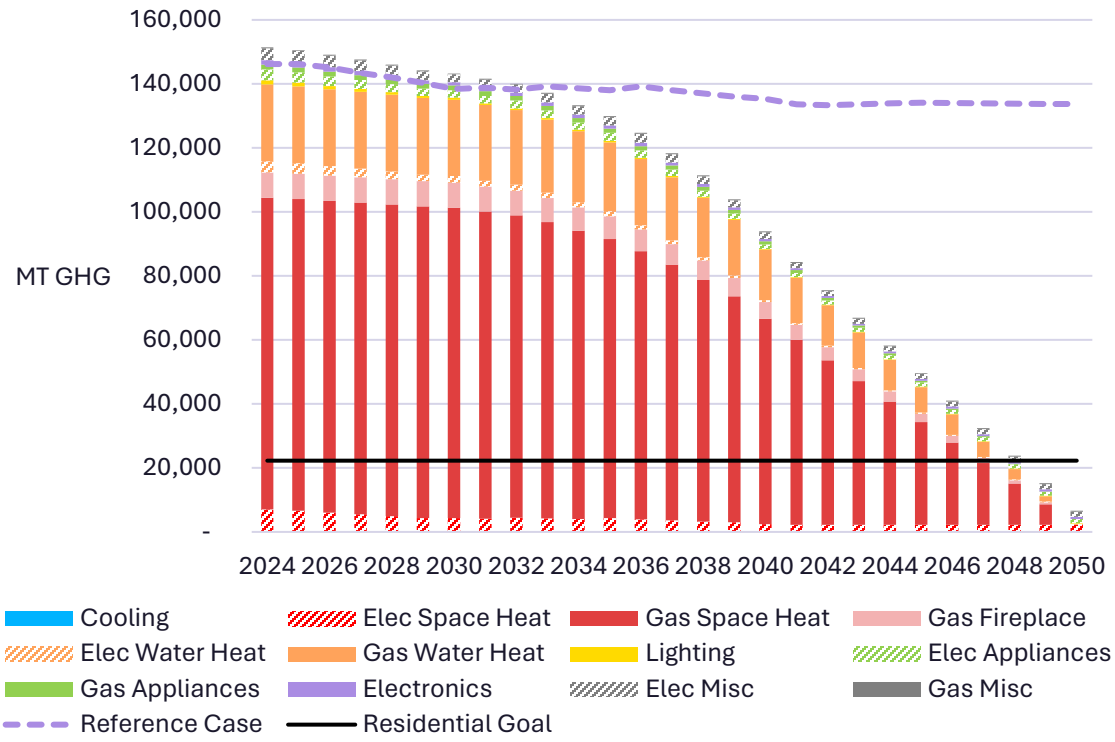


Table A-22 Residential Decarbonization Schedule Scenario 1, 2a, 2b Comparison

End Use	New Target Rate SqFt/Year 2030	Natural Max Replacement Rate	New Target vs. Natural Rate	Scenario 2a Target Replacement Rate	Accelerated vs. Scenario 2a Target
Space Heating	1,864	1,049	78%	1,185	57%
Gas Fireplace	472	0	NA	300	57%
Water Heating	1,743	1,388	26%	1,108	57%
Appliances	1,048	0	NA	666	57%

Under this scenario, target rate is now 1,864 space heating units per year, a 78% increase over the natural replacement rate and a 57% increase over the Scenario 2a replacement rate. This also represents an additional 679 units per year.

Figure A-30 Commercial Decarbonization Delayed Schedule

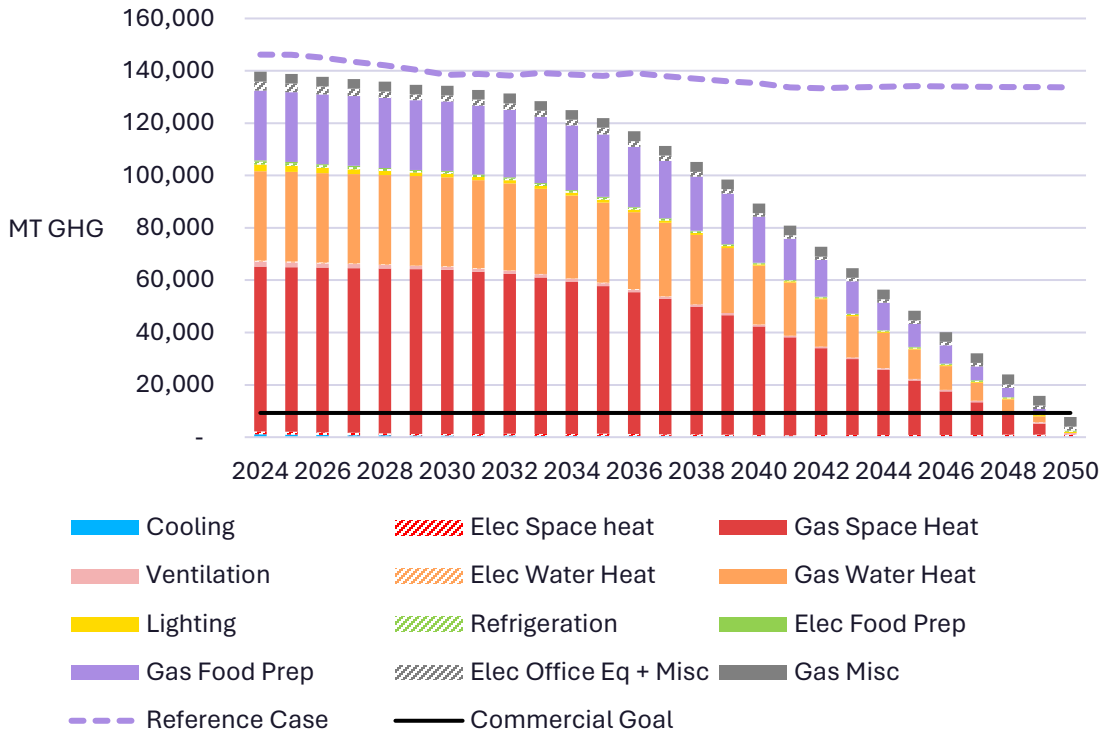


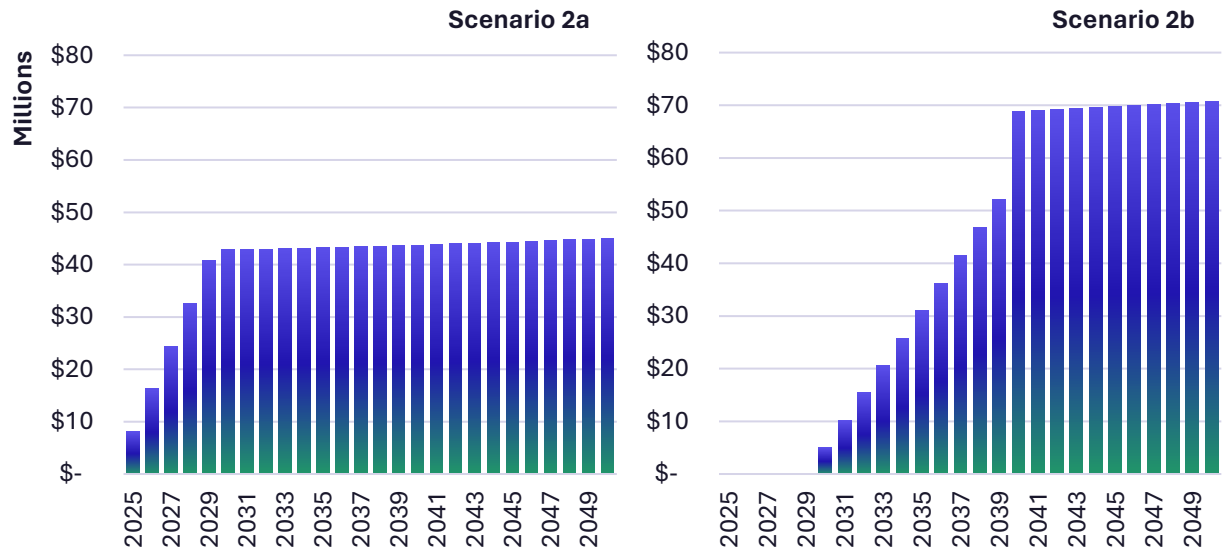
Table A-23 Commercial Decarbonization Schedule Scenario 1, 2a, 2b Comparison

End Use	New Target Rate SqFt/Year 2030	Natural Max Replacement Rate	New Target vs. Natural Rate	Scenario 2a Target Replacement Rate	Accelerated vs. Scenario 2a Target
Space Heating	1,746,822	578,966	202%	1,110,623	57%
Food Preparation	1,309,803	0	NA	832,768	57%
Water Heating	1,391,421	1,482,031	-6%	884,660	57%

For Commercial the numbers are even more staggering. The new target rate for space heat replacement under scenario 2b represents more than a 200% over the natural replacement rate and a 57% increase over the Scenario 2a replacement rate.

Figure A-31 below, shows the annual conversion costs under each Scenario 2a and 2b. Note that under the delayed ramp up, annual costs exceed $70 million by 2050, an increase of nearly 60% over the annual costs in Scenario 2a, due to needing to convert all stock on an accelerated schedule.

Figure A-31 Annual Conversion Cost Comparison – Scenario 2avs. Scenario 2b



Impact Scenario 3: Considering Grid Stability and Renewable Natural Gas

In Scenario 3, we explore the impacts of increased grid stability due to the presence of more controllable load, and the additional potential reduction in emissions due to use of renewable natural gas.

Grid Stability

Decarbonization efforts will affect the electric grid in a variety of ways. While there are additional costs and risks, there are also benefits than help to ensure stability throughout the process. The impacts of beneficial electrification on Tacoma Public Utility's (TPU) Grid is being fully explored as part of TPU's Electrification Futures Study, which includes an assessment of the impacts, costs, and benefits. However, we include a couple of key considerations here.

- **Grid Capacity and Resilience.** It is important to assess the capacity of the existing grid to handle increased electricity demand from electrified technologies. Upgrading and reinforcing the grid may be necessary to prevent overloading of distribution equipment and ensure reliability.
- **Smart Grid Technologies**. Utilities may consider implementation of smart grid technologies to optimize energy distribution, monitor usage patterns, and enable two-way communication between utilities and consumers. This can enhance grid efficiency and responsiveness.
- **Distributed Energy Resources (DERs).** Encouraging the integration of distributed energy resources, such as solar panels, wind turbines, and energy storage systems can help balance supply and demand locally reducing strain on the grid.
- **Load Management.** Develop strategies for load management to distribute electricity demand more evenly throughout the day. Time-of-use pricing and demand response programs leveraging controllable equipment can incentivize consumers to use electricity during off-peak hours and provide ancillary services to support grid stability.

From the perspective of building decarbonization, we focus on load management opportunities and the potential demand flexibility benefits associated with the additional controllable equipment installed. While the increased costs to the utility are very real, building electrification is a relatively small part of the increased load on the grid relative to system upgrades required to support

comprehensive electrification (including transportation and industrial). As noted above, an electrification study designed to quantify these comprehensive impacts is currently underway and outside the scope of this assessment.

Load Management and Demand Flexibility Opportunities

In the figure below, we present the increase in winter peak demand relative to the reference case associated with the decarbonization of equipment in residential and commercial buildings under Scenario 2a.

Figure A-32 Winter Peak Demand – Scenario 2a vs. Reference Case

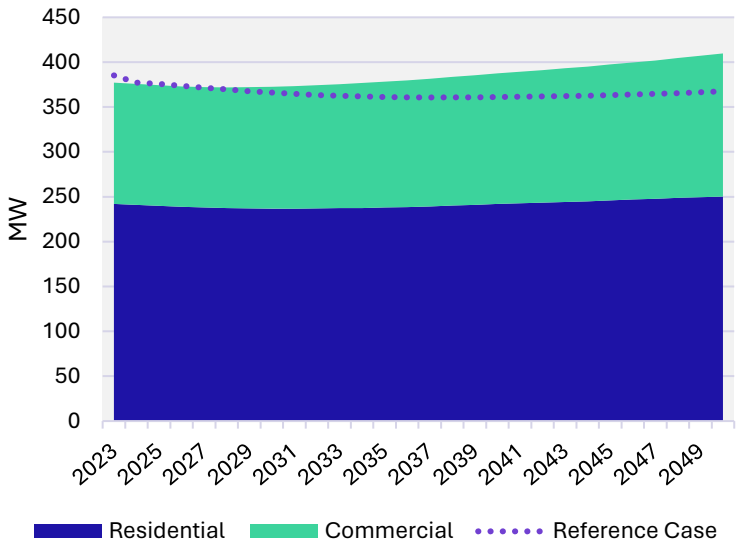


Table A-24 Winter Peak Demand Increase 2050

	Reference Case	Scenario 2a	% Increase in Demand
Residential MW	236	250	6%
Commercial MW	132	160	21%
Total	**368**	**410**	**11%**

In the residential sector the winter peak demand increase is moderate, only 6%, while the increase in demand among commercial customers is more substantial at 21%. However, the overall increase in demand in 2050 for the City as a whole is only 11%.

This is good news since it aligns with the average range of demand response potential that we see in most jurisdictions, between 8% to 12%. In addition, preliminary estimates from the ongoing TPU Demand Response Potential Assessment support a total potential within the typical range assuming the appliance mix associated with the reference case.[36] Under an electrification scenario, RMI estimates that grid interactive technology supported by electrified load could offset 20% of the projected demand by 2030 helping to manage grid growth from buildings and other sources such as electric vehicles.[37]

Renewable Natural Gas

Scenario 3 also explores the impact of renewable natural gas (RNG) on emissions. Alternatives to natural gas, often referred to as RNG include two main groups.

- **Biogas** is produced and harvested from organic sources. This biogas is then purified to pipeline-quality biomethane or "renewable natural gas".

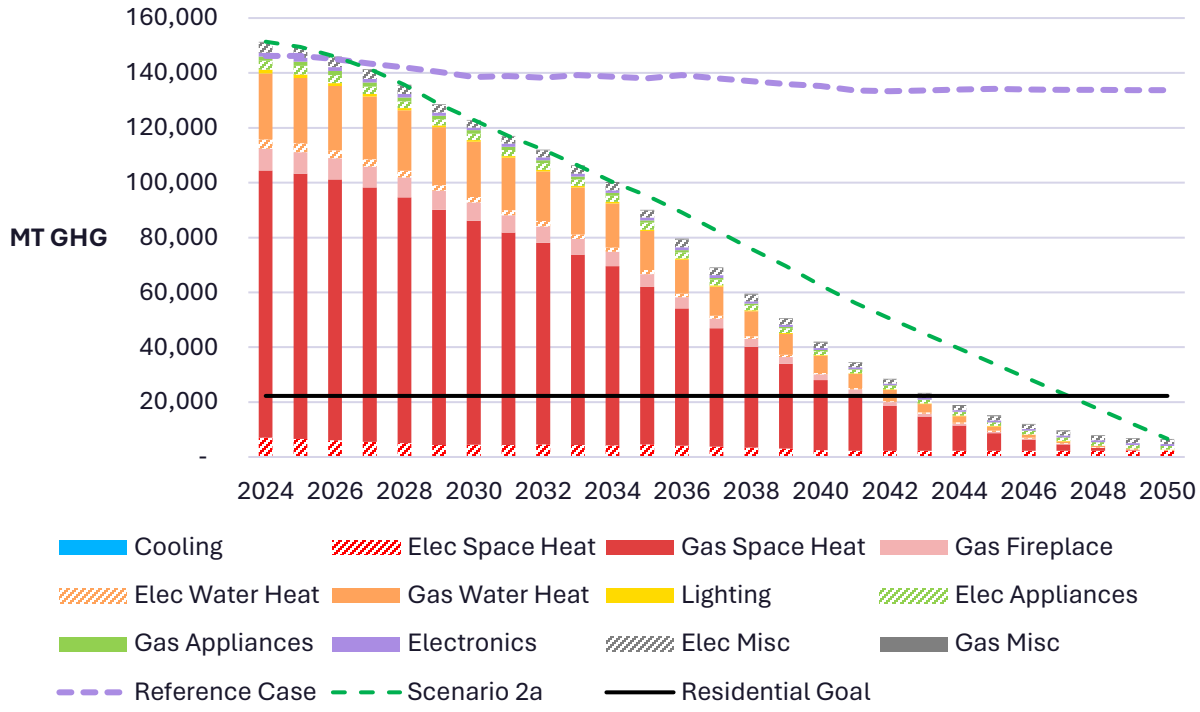
[36] As of December 2023, the TPU Demand Response Potential Assessment is an ongoing study with preliminary results only. The study is expected to be finalized early in 2024.

[37] https://rmi.org/insight/state-level-building-electrification-factsheets/ The Brattle Group https://bit.ly/3JAFl2h

- **Synthetic gas** also known as synthetic methane, is manufactured by combining hydrogen with carbon oxides. Blended hydrogen, is created by mixing gas with a small amount of hydrogen.

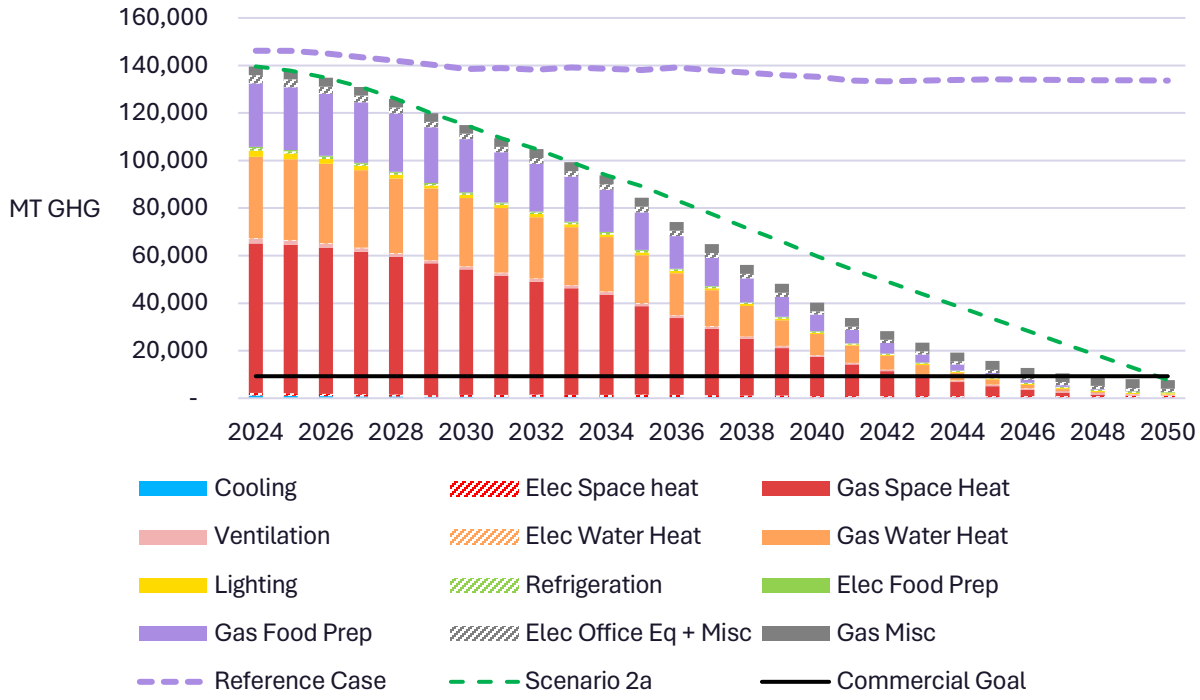
The analysis starts with Scenario 2a, but then assumes that the City would be able to transition remaining gas consumption to carbon neutral RNG, or biogas, starting in 2035 with all natural gas emissions ultimately moving to zero by 2050.[38] In the figures below we present the change in GHG after adding in the impacts of RNG. The purple dashed line still represents the reference case, and the green dashed line represents Scenario 2a.

Figure A-33 Residential GHG Emissions with RNG vs. Scenario 2a



[38] We assumed a linear reduction in emissions beginning in 2035 forcing them to zero by the year 2050.

Figure A-34 Commercial GHG Emissions with RNG vs. Scenario 2a



While theoretically RNG has the potential of offset emissions from gas burning appliances and accelerate or facilitate achieving the CAP goals, it is important to note that current gas industry analysis presented by RMI in their State level building electrification fact sheets show that biogas could only meet 6-12% of current gas demand in Washington by 2040.[39] Further the RMI analysis states that biogas powered heating is more expensive than a heat pump powered by electricity, with a total cost of $109/MWh of delivered biogas heat vs. $39/MWh of electric heat pump delivered heat.[40] RMI also proposes that the biogas and hydrogen that is available should be reserved for other elements of the clean energy transition including fuels for shipping and aviation, industrial processes, and fuel cell backup.

Limitations of the Impact Assessment

As with any analysis, this impact assessment has limitations that are important to consider when looking at the results. Limitations are primarily a result of either data availability or project scope and budget. Key limitations fall into three main categories: assessment of impacts on the electrical infrastructure (or grid), assessment of co-benefits, and lack of a whole building approach to electrification. Each is described in more detail in the subsections that follow and in some sections recommendations for future research have been provided.

Electrical Infrastructure Stability

Decarbonization efforts will affect the electric grid in a variety of ways. While there are additional costs and risks, there are also benefits than help to ensure stability throughout the process. The

[39] https://rmi.org/insight/state-level-building-electrification-factsheets/ RMI analysis; graph shows the average of high and low biogas potential for the Pacific region. American Gas Foundation, 2019, https://bit.ly/3PzTHUb; US Energy Information Administration (EIA), 2023, https://bit.ly/3Xur3pD.

[40] RMI analysis assuming [%] heating season-weighted efficiency. US EIA, 2023, https://bit.ly/3XzJucu.RMI analysis assuming 80% combustion efficiency. American Council for an Energy-Efficient Economy, 2023, https://bit.ly/46rSS63.

impacts of beneficial electrification on Tacoma Public Utility's (TPU) Grid are being fully explored as part of TPU's ongoing Electrification Futures Study which includes an assessment of the impacts, costs, and benefits. As such, this impact assessment did not attempt to fully characterize the costs associated with decarbonization of buildings since it would not be appropriate to look at those impacts, or benefits, without looking at the full electrification picture, particularly the inclusion of transportation electrification which will be much more impactful than the decarbonization of buildings.

Recommendation. Revisit and assess the impacts of electrification on electric infrastructure stability through the comprehensive electrification assessment currently being conducted by TPU.

Assessment of Co-benefits

Co-benefits and their impacts are an important consideration for the decarbonization of buildings. While a tremendous amount of research has been conducted around co-benefits, most of the research results do not lend themselves directly to quantification in a typical cost-benefit framework or are not specific or granular enough to be applied with confidence to a particular jurisdiction. As such, the impact assessment was limited in its ability to quantify the co-benefits. In the sections below, for each co-benefit, we discuss how we accounted for it in the impact assessment, if possible, and provide some context and considerations for the strategy.

Health and safety

The impact assessment included a 10% co-benefit adder for improvements in health and safety within homes and businesses. Using adders as a % of avoided costs to represent these benefits is a common approach within the industry. This approach is a proxy to account for the health and safety benefits including reduction of indoor emissions and the associated improved health particularly among children and the elderly.[41] In addition, some jurisdictions also use varying adders for low income vs. regular income to account for incremental benefits of attributable to smaller living spaces, older appliances, and poor ventilation which can expose low-income residents to higher concentrations of pollutants. Higher co-benefits for these groups could imply changes to the roll outs that target low opportunity areas first to take advantage of those benefits early in the roll-out.

Recommendation. We recommend exploring the development of more granular adders or other methods to quantify health and safety co-benefits by opportunity area in in order to ensure those that benefit most are served first by the City's decarbonization efforts.

Labor and Workforce

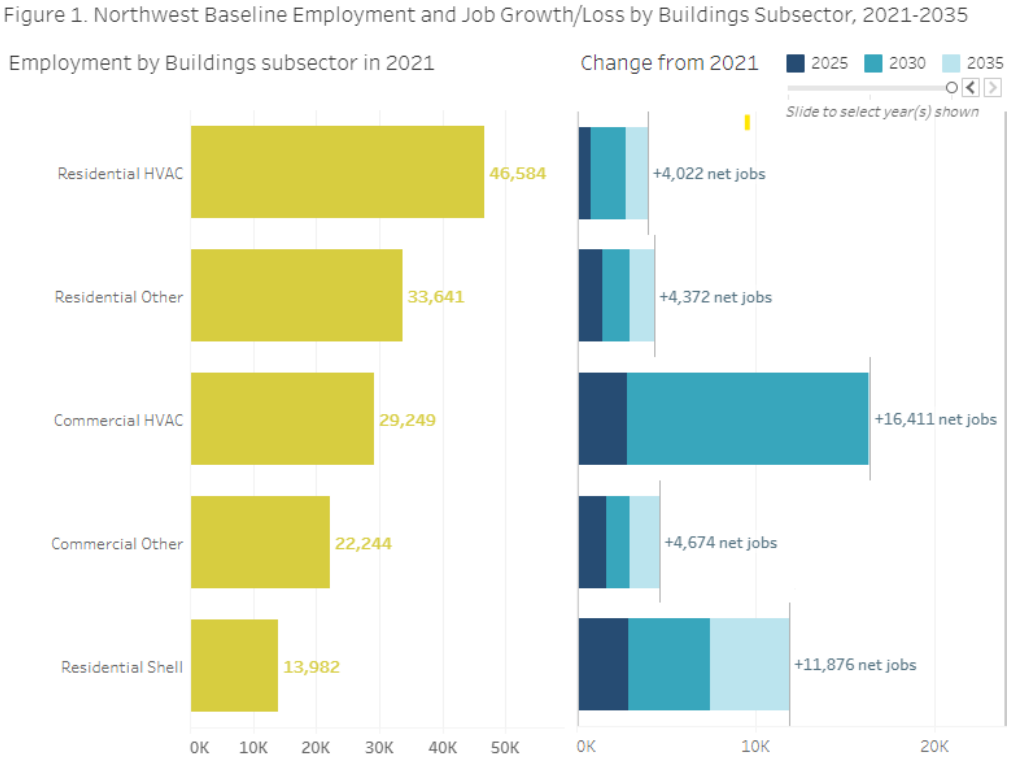
The impact assessment did not quantify the impacts of labor and workforce changes because the data to support an accurate estimate within our cost-benefit framework was not available. We have however, included some information from the Net Zero Northwest study regarding general impacts in the workforce below.[42]

As noted in the study, the decarbonization of buildings provides enormous opportunity for workforce development to ensure there are enough workers trained to meet the growing demand for electrification, energy efficiency activities, and retrofits in residential and commercial buildings. The study estimates that employment in all buildings subsectors could increase by 22% between 2021 and 2030. The image below summarizes the research and is available on their website.

[41] Gas Stoves are a Health and Climate Problem, RMI, 2023, https://rmi.org/gas-stoves-health-climate-asthma-risk

[42] https://www.nznw.org/workforce/buildings

Figure A-35 Northwest Employment and Job Growth, 2021-2035, Net Zero Northwest Study



Source: BW Research Partnership. *Net-Zero Northwest Workforce Analysis Technical Report*, November 2023.

Housing Affordability

While the impact assessment quantified the net benefits to participant in the form of reduction in energy costs, we did not address other potential benefits related to housing affordability that could be realized as a result of decarbonization.

Equity

Equity can have many interpretations, for the purpose of this study we are define it as having equitable access to reliable, safe, affordable, and clean energy. We have already discussed how the impact assessment addresses reliability, health and safety, workforce, and affordability. However, it is important to note that the data underlying the impact assessment does not support detailed or granular bottom-up estimates customized to each opportunity area. Our current estimates reflect energy consumption and presence of energy-using equipment based on regional and city-wide data collection, but these data sources do not have specific point estimates to differentiate the equity areas. For example, there is no current source of survey information to distinguish whether detached single-family homes in opportunity area 1 are more or less likely to have a gas furnace than single family homes in other equity areas, or whether such a furnace would be used more or less in different areas as a result of area-specific building age, condition, or occupancy schedules.

Legal Implications

The impact assessment did not attempt to quantify or assess the legal implications of the City's potential decarbonization efforts. The costs are completely unknown at this time and could vary widely depending on how the City of Tacoma moves forward, including whether codes, incentives, or

bans are pursued, and how both the community and courts across the country respond to such actions.

Recommendation: We recommend that the City investigate legal actions currently ongoing in other municipalities pursuing aggressive electrification efforts. Many cities in California's Bay Area including Berkely are aggressively attempting to electrify buildings and facing legal implications. The outcomes of these efforts could help the City of Tacoma make informed decisions regarding their own policies.

Whole Building Approach to Electrification

The energy, emissions, and cost impacts in this impact assessment assume equipment replacements as individual discreet measures. However, whole building design strategies and solution sets can reduce costs and increase performance, particularly for HVAC systems in commercial buildings. Building decarbonization policy, program, and market development actions should prioritize and support strategic decarbonization planning for larger and more complex buildings. This approach will help building owners anticipate decarbonization opportunities, align capital planning with building performance standards, and maximize the benefits of whole building designs and solution sets.

B | IMPLEMENTATION ROADMAP

This appendix presents the Implementation Roadmap (Roadmap) developed to inform the Tacoma Community Building Decarbonization Strategy (Strategy). The Roadmap is one of three deliverables developed as inputs to the Strategy to meet the Climate Action Plan (CAP)[43] goal of net-zero emissions by 2050. Achieving the CAP goal will require Tacoma to dramatically reduce greenhouse gas emissions from residential and commercial buildings in less than three decades.[44]

The three input deliverables for the Strategy include:

1. **Context and Best Practices Research.** Review of the relevant policy ecosystem in Tacoma and Washington state as well as best practices from other jurisdictions, regionally, and across the nation.
2. **Impact Assessment.** Analysis of costs, savings, and co-benefit impacts of electrifying Tacoma's new and existing buildings to meet the CAP goal.[45]
3. **Implementation Roadmap.** High-level approach and timeline for decarbonizing Tacoma's building sector by 2050.

The Roadmap is a bridge from the technical analysis in the Impact Assessment to the holistic strategies, actions, and collaborative implementation in the Strategy report. It aligns with CAP building sector actions and includes a more granular and targeted approach. The Impact Assessment includes multiple scenarios and possible paths, while the Roadmap recommends a specific building decarbonization pathway with 2050 targets and 2030 milestones. It provides a framework for assessing implementation and investment options and tradeoffs to help policy makers prioritize and inform the development of detailed actions in the Strategy.

Impact Assessment Considerations

A key factor in developing an approach to decarbonizing the building sector is understanding the technical changes that must happen and the scale and pace of those changes. This understanding is critical for aligning policies, programs, market development, and equity protections with the scale and pace. It provides the basis for a common understanding of the technical foundation of the transition.

The Impact Assessment identified that nearly 80% of the emissions from Tacoma residential and commercial buildings is from onsite use of natural gas for space and water heating. Therefore, a central part of the building decarbonization path for Tacoma is to eliminate these onsite fossil fuel emissions. A key way to accomplish this is to replace fossil fuel space and water heater appliances with zero-emission appliances such as high-efficiency electric heat pump technologies.[46] Ideally, these replacements would be made as close as possible to the end of the useful life of the existing appliance. Current fossil fuel appliances used for space and water heating across Tacoma can be replaced by gradually increasing the percentage of zero-emission appliances sold and installed in new and existing buildings to 100%, and then sustaining that rate through 2050.

[43] See the 2030 Tacoma Climate Action Plan (CAP) at https://www.cityoftacoma.org/cms/One.aspx?portalId=169&pageId=193914

[44] Ibid

[45] See Appendix A of this Strategy

[46] See Impact Assessment in Appendix A of this Strategy for information on decarbonization technologies and strategies used in the scenario analyses.

The Impact Assessment included the following three analysis scenarios to explore the best timing for the replacements relevant to the type and age of space and water heating equipment in Tacoma's building stock, as well as cost impacts, energy and emission reductions, and co-benefits:

- **Scenario 1: Natural Gas Space & Water Heat Replacement on Burnout.** This scenario was designed to better understand the natural rate of appliance replacement. For example, would Tacoma meet the CAP building decarbonization goals if all the fossil fuel space and water heating appliances that burn out between now and 2050 are replaced with electric heat pumps? This scenario was not intended to meet a specific goal, but rather to assess whether the natural rate of replacement must be accelerated in order to meet CAP goals.
- **Scenario 2: Optimized Natural Gas Replacement.** This scenario builds on Scenario 1 results to explore how quickly fossil fuel appliances must be replaced to meet CAP goals, and how much the replacement rate must be accelerated beyond the natural replacement rate. Accelerated replacements ensure that each year, some appliances are replaced early while limiting those replacements to appliances that are very close to burnout. This scenario also included options for the pace of ramp-up to a peak rate of replacement to sustain through 2050. For example, what are the emissions reduction and cost impacts of hitting the peak rate by 2030 versus 2040? This scenario also analyzed the impact of electrifying other end uses, such as natural gas stoves, fireplaces, and commercial food preparation.
- **Scenario 3: Considering Grid Stability and Renewable Natural Gas.** This scenario builds on Scenario 2 results to explore the impacts of increased grid stability due to the presence of more controllable load, and the additional potential offsets related to renewable natural gas.

The Impact Assessment showed that to meet CAP goals, nearly all fossil fuel appliances must be replaced with zero-emission appliances by 2050. Although the impact scenarios target gradual and complete rollover of all appliances in residential and commercial buildings by 2050, considering the average life of various appliances, there isn't enough time between now and 2050 for Tacoma to decarbonize the building sector on a purely natural replacement timeline. Therefore, the decarbonization strategy must accelerate replacements to ensure that each year, a certain percentage of appliances are replaced early. However, the analysis shows that the early replacements can be limited to appliances that are very close to burnout. The need for increasing the rate of replacements provides an opportunity to target early replacements to advance other goals, for example providing co-benefits such as cooling, more efficient heating systems, and better indoor air quality and health outcomes to homes in low-opportunity areas, including vulnerable populations.

According to the Impact Assessment, 2030 is the optimal year to reach 100% peak sales share of zero-emission appliances for new and replacement installations. This shift will require rapid market transformation and the development of targeted, high-impact policies and programs during a ramp-up period between 2024 and 2030. Delaying 100% peak sales share of zero-emission appliances dramatically increases the number of appliances that will need to be replaced early and, in some instances, well ahead of burnout. Tacoma has approximately 27 years to fully decarbonize its building stock. However, space and water heating appliances can operate for 15-30 years or more. As a result, every year that Tacoma continues to install new and replacement fossil fuel appliances, the overall number of fossil fuel appliances that must be replaced increases, but the decarbonization deadline remains 2050. Therefore, if the peak rate is delayed, the appliances will need to be replaced years before burnout in order to decarbonize by 2050.

Roadmap Targets and Milestones

The Roadmap targets and milestones (Table B-1) were developed based on the optimal decarbonization pathway identified in the Impact Assessment, which includes electrification of most

building sector end uses by 2050. They establish the endpoint goal and interim milestones that are critical to achieving the 2050 CAP goals. They are designed to:

- Gradually increase the sales share of zero-emission appliances each year between 2024 and 2030,
- Ramp up to 100% sales share of zero-emission appliances for new and replacement installations by 2030, and sustain this rate through approximately 2050 until the building sector is decarbonized,
- Transition to zero-emissions new construction by 2030,
- Replace fossil-fuel appliances in existing residential and commercial buildings by 2050,
- Provide an appliance replacement rate that can be used for policy and program design and to track progress.

In 2024, additional targets and milestones may be considered in coordination with Tacoma Power for energy efficiency, onsite renewables, and other distributed energy resources to ensure that building decarbonization implementation can help realize whole-building optimization opportunities and support grid reliability and health. For example, to minimize peak loads due to electrification, the utility can incentivize higher efficiency heat pumps and more air-tight and well insulated buildings.

Understanding the fundamental scale and pace required to decarbonize the building stock by 2050 is a critical first step in addressing equity, affordability, and opportunities to maximize co-benefits. As shown in Table B-1 below, to decarbonize Tacoma's residential sector by 2050, 100% of new residential units must be zero emissions and 100% of fossil-fuel space and water heating replacements must be zero-emissions by 2030. Achieving a 100% sales share for zero-emission space heating appliances by 2030 translates to 1,185 households every year starting in 2030, and this number must be maintained through 2050 to gradually replace all fossil-fuel appliances upon or slightly prior to burnout. This number of households is approximately 200-300 more appliance replacements per year than the natural replacement rate for space-heating appliances. Approximately, 507 of the 1,185 households are in low- and very-low opportunity areas. The Roadmap recommendations in the following sections are designed to realize these targets while ensuring an equitable and affordable transition for Tacoma.

Table B-1 Roadmap Targets and Milestones

Target/Milestone	2030	2050
Residential Sector		
Residential Sector Emissions Reduction	19%	96%
New Residential Construction: Zero-Emissions Units	100%	100%
Residential Zero-Emissions Appliance ***Stock*** Share	16%	100%
Residential Zero-Emissions Appliance ***Sales*** Share	100%	100%
Overall Residential Zero-Emissions Appliance Replacement (200-300+ natural replacement)	1,185 households/year	1,185 households/year
Residential Zero-Emissions Appliance Replacement Rate in Regular Opportunity Areas	678 households/year	678 Households/year
Residential Zero-Emissions Appliance Replacement Rate in Low and Very Low Opportunity Areas	507 households/year	507 households/year
Commercial Sector		
Commercial Sector Emissions Reduction	18%	94%
New Commercial Construction: Zero-Emissions Buildings	100%	100%
Commercial Zero-Emissions Appliance ***Stock*** Share	11%	100%
Commercial Zero-Emissions Appliance ***Sales*** Share	100%	100%
Commercial Zero-Emissions Appliance Replacement Rate	41 buildings/year	41 buildings/year

Roadmap Timeline

The Roadmap approach and phases are designed to meet the proposed targets and milestones above with policies, programs, and market transformation phased to align with other Tacoma and Washington state policies and funding. The Roadmap is informed by the Context and Best Practices Research conducted as a part of the Strategy, Executive Steering Committee and stakeholder workshops, 1-on-1 outreach meetings with more than 15 internal and external stakeholders, and a series of six working sessions with Office of Environmental Policy and Sustainability (OEPS) staff.

Overview

Achieving the building decarbonization targets and Tacoma's goals to maximize co-benefits, equity, and affordability will require Tacoma to act quickly to establish the groundwork to ramp up zero-emission appliance installations to 100% sales share by 2030. The approach must be front-loaded with most policy, programmatic, and market transformation work launched in 2024-2025 and put into place by 2030. It will require close collaboration among City departments. In addition, the City may need to rely on a regulatory framework and funding from state and federal policies and programs. In this case, the City's strategic role will include providing building decarbonization leadership across

City departments and collaborating with stakeholders and other jurisdictions to advocate for energy codes, building performance standards, and other mandates at the regional and state level to ensure that all segments of the commercial and residential sector have a clear trajectory to eliminate emissions by 2050.

The Roadmap recommends six core strategies designed to optimize and guide the City's strategic investments to equitably decarbonize Tacoma's building sector. The Roadmap timeline below includes objectives and phases for these strategies, which will be the basis for developing targeted actions in Tacoma's overall Strategy. Note that the Roadmap strategies, objectives, and timeline included here are inputs to consider for the Strategy and may not align exactly with the final Strategy.

Roadmap recommended strategies:

- Adopt Comprehensive, Fast-Tracked Policies & Targets,
- Rapidly Transform the Market,
- Significantly Expand Funding and Financing,
- Develop a Community Collaboration Framework,
- Expand City of Tacoma Implementation Capacity, and
- Support Collaborative Utility Transition Planning.

Phases

The Roadmap is broken out into three key phases:

Phase 1: 2024-2025: Build a Policy and Rapid Market Transformation Platform. The initial phase includes a major push to get all policies in place at all levels of government by the end of 2025. The City establishes a collaborative rapid market transformation platform to ramp up replacement rates. The platform should leverage and align with the timing of other key actions in other City strategies, such as the Affordable Housing Action Strategy,[47] the Green Economic Development Strategy,[48] Tacoma Power's Integrated Resource Plan,[49] and the influx of federal incentives and tax credits through 2030. During this phase, the City has opportunities to influence the development of keystone policies such as the 2024 Washington State Energy Code, the 2030 Washington Clean Building Performance Standard (BPS), and other standards and regulatory mechanisms that may be necessary to cover gaps in current mandates that likely can't be covered completely by the energy code and BPS in time to meet 2030 milestones. During this phase, the City should also build staff capacity to implement the decarbonization strategy and ensure key tenant and anti-displacement policies recommended in the AHAS are adopted.

Phase 2: 2026-2030: Ramp Up Equitable Decarbonization. The second phase builds upon the platform in Phase 1 to implement a focused, rapid ramp-up of new and replacement zero-emission equipment. This effort involves increasing market demand, workforce, and manufacturing capacity while dramatically reducing costs and removing systemic barriers. The City should target high ratios of low-opportunity area homes and buildings, especially rental properties, to maximize and deal-

[47] See the Tacoma Affordable Housing Action Strategy (AHAS) at https://www.cityoftacoma.org/cms/one.aspx?portalId=169&pageId=148642

[48] See Tacoma's Green Economic Development Strategy at https://cms.cityoftacoma.org/cedd/CED_Main/Tac_Green_Econ_Dev_Strat.pdf

[49] See the Tacoma Power Integrated Resource Plan at https://www.mytpu.org/about-tpu/services/power/integrated-resource-plan/

stack incentives to ensure rapid decarbonization, other efficiency measures, and home repairs for these segments.

Phase 3: 2031-2050: Sustain Scale and Pace. At this point, all policies and mandates required to decarbonize Tacoma's building stock have become effective. Most segments and end uses have transitioned to 100% zero-emission new and replacement appliances as the default. Efficiency, on-site renewables, and demand response are scaled up to ensure grid reliability. Transition planning for both Tacoma Power and Puget Sound Energy is complete and considers the required replacement rates and associated grid and gas distribution system impacts at the local level. During this phase, the City mostly focuses on adaptive management, programmatic and market transformation support, and cross-departmental leadership and monitoring necessary to ensure an equitable, gradual, and steady transition to healthy, affordable, zero-emission homes and buildings across Tacoma.

Timeline

The following table includes recommended objectives, phases, and timing by year for each core strategy. These strategies, objectives, and timing will be used as the basis for refining strategies and developing detailed actions in the Strategy report.

Table B-2 Tacoma Building Decarbonization Roadmap Timeline

Key to Phase Colors: *Light Blue = Planning/Launching* *Dark Blue = Implementation*	**PHASE 1: BUILD POLICY & RAPID MARKET TRANSFORMATION PLATFORM**	**PHASE 2: RAMP UP EQUITABLE DECARBONIZATION**	**PHASE 3: SUSTAIN DECARBONIZATION SCALE, PACE, & EQUITY**
Strategies & Objectives	**2024-2025**	**2026-2030**	**2031-2050**
1. Adopt Comprehensive, Fast-Tracked Policies & Targets			
Develop policy strategy implementation plan			
Adopt detailed targets and milestones			
Align WA Clean Building Performance Standard with Tacoma targets			
Align WA State Energy Code with Tacoma targets			
Increase code compliance support strategically aligned with targets			
Adopt a residential performance disclosure ordinance			
Adopt a zero-emissions appliance standard for WA and/or Puget Sound			
Streamline permitting			
Adopt and implement tenant protections as part of AHAS			
2. Rapidly Transform the Market			
Develop rapid makret transformation strategy implementation plan			
Increase awareness and demand			
Increase workforce capacity			
Increase manufacturing capacity			
Reduce installation costs			
Address systemic barriers			
Ensure equitable market transformation and distribution of benefits			
3. Significantly Expand Funding & Financing			
Develop funding and financing strategy implementation plan			
Maximize federal and state incentives and programs			
Develop a targeted approach to LMI, multifamily, and rental decarbonization funding, financing, and incentives to maximize decarbonization by 2030.			
Leverage WA Climate Commitment Act (CCA) funds			
Support state level building infrastructure investments to address significant gap between available funding/incentives and electrification costs			
Consider Tacoma funding options such as municipal bonds/taxes			
Develop robust performance-based financing/contracting opportunities			
Advocate for zero to low-cost financing options			
4. Develop a Community Collaboration Framework			
Develop collaboration framework strategy implementation plan			
Collaboration framework to align and connect internal/external partners			
Collaboration/coordination strategy with internal City department partners			
Collaboration/coordination strategy with external partners at the city, regional, and state			
Education/outreach for community and stakeholder awareness of goals, timeline, and			
5. Expand City of Tacoma Implementation Capacity			
Develop staffing strategy implementation plan			
Develop a building sector strategy and market transformation team			
Expand staffing for key internal partners			
6. Support Collaborative Utility Transition Planning			
Develop utility transition strategy implementation plan			
Ensure TPU integrated resource and conservation planning aligns with targets			
Ensure TPU and PSE incentive programs align with targets			
Coordinate with TPU and PSE to align utility infrastructure planning with targets and replacement timing at the neighborhood level			

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Concord, CA 94520