



Eugene City Council

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EUGENE CITY COUNCIL AGENDA

October 26, 2022

12:00 p.m. CITY COUNCIL WORK SESSION

As the state and community recover from the COVID-19 pandemic, City Council meetings will continue to be held in hybrid format using in person and virtual meeting technology. Information about online or other options for access and participation will be available at <https://www.eugene-or.gov/3360/Webcasts-and-Meeting-Materials>

Meeting of October 26, 2022; Her Honor Mayor Lucy Vinis Presiding

Councilors

Greg Evans, President
Mike Clark
Randy Groves
Jennifer Yeh

Matt Keating, Vice President
Emily Semple
Alan Zelenka

12:00 p.m. CITY COUNCIL WORK SESSION

1. WORK SESSION: Decarbonization of Existing Buildings

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EUGENE CITY COUNCIL AGENDA ITEM SUMMARY



Work Session: Decarbonization of Existing Buildings

Meeting Date: October 26, 2022
Department: Public Works
www.eugene-or.gov

Agenda Item Number: 1
Staff Contact: Ian Penn
Contact Telephone Number: 541-682-5513

ISSUE STATEMENT

The purpose of this work session is to share the findings of the draft final report “City of Eugene Community Decarbonization by 2045 for Existing Residential, Commercial, and Industrial Buildings Energy Use.”

BACKGROUND

The City’s Climate Recovery Ordinance ([Ordinance No: 20567](#)) includes the following goals: 1) the City organization to be carbon neutral by 2020, 2) the City organization to reduce fossil fuel use by 50 percent by 2030 compared to 2010 levels, 3) community-wide reduction of fossil fuel use by 50 percent by 2030 compared to 2010 levels, and 4) reduce community-wide greenhouse gas emissions by 7.6 percent annually through 2100. The City’s Internal Climate Action Plan and the CAP2.0 are roadmaps to reaching CRO goals.

The CAP2.0 was approved by City Council in July 2020 and is the City’s roadmap to achieving goals three and four of the CRO. The full document can be found here: <https://www.eugene-or.gov/4284/Climate-Action-Plan-20>.

In consideration of furthering work towards CAP 2.0 goals to reduce community fossil fuel use and greenhouse gas emissions, Council directed the City Manager to prepare a roadmap for how the City can achieve decarbonization of the existing commercial, industrial, and residential building stock by 2045 with particular consideration for how low-income and historically marginalized households will be impacted and included in this process. The roadmap will include strategies for decarbonization of rental housing stock.

This work session is to present parts 2 and 3 of the draft final report, completed by sustainability consulting firm The Good Company on behalf of the City. Parts 2 and 3 of the report focus on commercial and industrial building stock and energy use respectively. Part 1, focusing on residential buildings, was presented to Council in July.

The data in this report is based on the best available data at the time of research and analysis. Northwest Natural recently released a DRAFT version of its updated 2022 Integrated Resource Plan (IRP) which includes how Northwest Natural intends to comply with the State’s Climate

October 26, 2022 Work Session – Item 1

Protection Program requirements of 90% reduction of greenhouse gas emissions by 2050. While the decarbonization report has relied on information from various sources, information from this draft IRP has been incorporated to help inform commercial and industrial decarbonization considerations including updated forecasts on natural gas pricing to comply with Climate Protection Program goals.

PREVIOUS COUNCIL DIRECTION

[January 16, 2019, Work Session](#)

Staff presented an overview of Home Energy Scores and related programs.

[July 29, 2020, Work Session](#)

City Council approved the CAP2.0.

[December 9, 2020, Work Session](#)

City Council directed staff to put together a CAP2.0 Implementation Plan.

[September 22, 2021, Work Session](#)

Staff provided an overview of the CAP2.0 12 Additional Strategies.

[September 27, 2021, City Council /EWEB Board Joint Work Session](#)

This Joint Work Session with City Council and EWEB's Board of Directors included staff presentations on the CAP2.0 and EWEB's Electrification Study.

[November 17, 2021, Work Session](#)

Council passed a motion to Direct the City Manager to provide Council with a roadmap for how the City can achieve decarbonization of the existing commercial, industrial, and residential building stock by 2045 with particular consideration for how low-income and historically marginalized households will be impacted and included in this process. This roadmap must include strategies for decarbonization of rental housing stock. A draft of this roadmap shall be provided to Council before June 30, 2022.

[April 13, 2022, Work Session](#)

On April 13th City Council held a work session on new building electrification and passed a motion to Direct the City Manager to schedule the next work session before July 31 to answer the questions brought forth in this work session and other questions submitted by councilors.

[July 20, 2022, Work Session](#)

On July 20th City Council held a work session that included presentations on preliminary findings of the Draft Report "City of Eugene Community Decarbonization by 2045 for Existing Residential, Commercial, and Industrial Buildings Energy Use – Part 1 Residential" as well as an update on state level GHG modeling from the Global Warming Commission's Roadmap to 2035 project.

[July 25, 2022, Work Session](#)

As follow-up to the April 13, 2022 work session, City Council held a work session to discuss changes to City code that would be needed if it was required that all newly constructed residential,

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commercial, and industrial buildings be electric-only.

MOTION AND VOTE: Councilor Syrett, seconded by Councilor Keating, moved to postpone the vote to the Wednesday, July 27 work session.

PASSED 8:0

July 27, 2022, Work Session

On July 27, 2022, City Council held a continuing discussion to the July 25 work session to further consider building electrification and reduction of fossil fuel usage in Eugene. Council passed 5 motions.

MOTION AND VOTE: Councilor Syrett, seconded by Councilor Keating, moved to direct the City Manager to draft an ordinance prohibiting natural gas and other fossil fuel infrastructure in all low-rise residential buildings for which permits are submitted after June 30, 2023 and schedule a public hearing on the ordinance in the fall.

PASSED 5:3

MOTION AND VOTE: Councilor Syrett, seconded by Councilor Keating, moved to direct the City Manager to schedule a work session in the fall to discuss prohibiting natural gas and other fossil fuel infrastructure in all new commercial buildings including as part of that work session a potential waiver process for buildings or uses that may not have feasible access to electric-only options, including a discussion of applicability to certain building types.

PASSED 7:1

MOTION AND VOTE: Councilor Syrett, seconded by Councilor Keating, moved to direct the City Manager to bring back a revision to the Climate Action Plan that formalizes as a City goal the decarbonization of residential and, as feasible, commercial buildings by 2035 and industrial buildings by 2050.

PASSED 6:2

MOTION AND VOTE: Councilor Syrett, seconded by Councilor Keating, moved to direct the City Manager to return to Council in the Fall with a proposal for engaging the community in developing a plan for the transition of buildings to be decarbonized that has at its foundation social, environmental, and economic equity with the emphasis on engagement of historically marginalized communities and their representatives.

PASSED 6:2

MOTION AND VOTE: Councilor Zelenka, seconded by Councilor Keating, moved that prior to the drafting of an electrification ordinance the City Manager engage the business community with an outreach process to discuss and solicit their input.

PASSED: 7:0

COUNCIL OPTIONS

This work session is for informational purposes.

CITY MANAGER'S RECOMMENDATION

This work session is for informational purposes.

SUGGESTED MOTION

This work session is for informational purposes.

ATTACHMENTS

- A. City of Eugene Community Decarbonization by 2045 for Existing Residential, Commercial, and Industrial Buildings Energy Use

FOR MORE INFORMATION

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Telephone: 541-682-5513

Staff E-Mail: ipenn@eugene-or.gov



City of Eugene Community Decarbonization by 2045 for Existing Residential, Commercial, and Industrial Buildings Energy Use

*Policy and Program Best Practices Review and
Recommended Roadmap - Existing Building Stock
October 2022*



Acknowledgements

Consulting Team

Good Company is a sustainability consulting firm based in Eugene, OR. Josh Proudfoot, principal, served as the project manager and provided project guidance, interviews of business owners and operators. Aaron Toney, senior analyst, served as the analytical lead and is the primary author of this report. Claudia Denton and Beth Miller, analysts, provided technical analysis and research and are supporting authors.

Other Acknowledgements

Good Company consulted with many experts while producing this report. Good Company are grateful for their time and insight.

Melissa Murphy, Regional Solutions Specialist, Business Oregon

Lou Hunter, Managing Director, PACE Equity

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Kevin Young, Senior Urban Planner, DLCD

Travis Reader and Eli Volem, EWEB major accounts

Kandi Young, Public Information Officer, OPUC

Mark Wyman, Energy Trust of Oregon

Genevieve Middleton, City of Eugene

Kristen Karle, St. Vincent de Paul

Dan Elliott, OHCS

Esteban Montero Chacon, Homes for Good

Samantha Roberts, Eugene Chamber of Commerce

Twyla Miller, City of Eugene

Good Company also spoke with ten business owners and industry representatives that asked to remain anonymous. Their time was very much appreciated.

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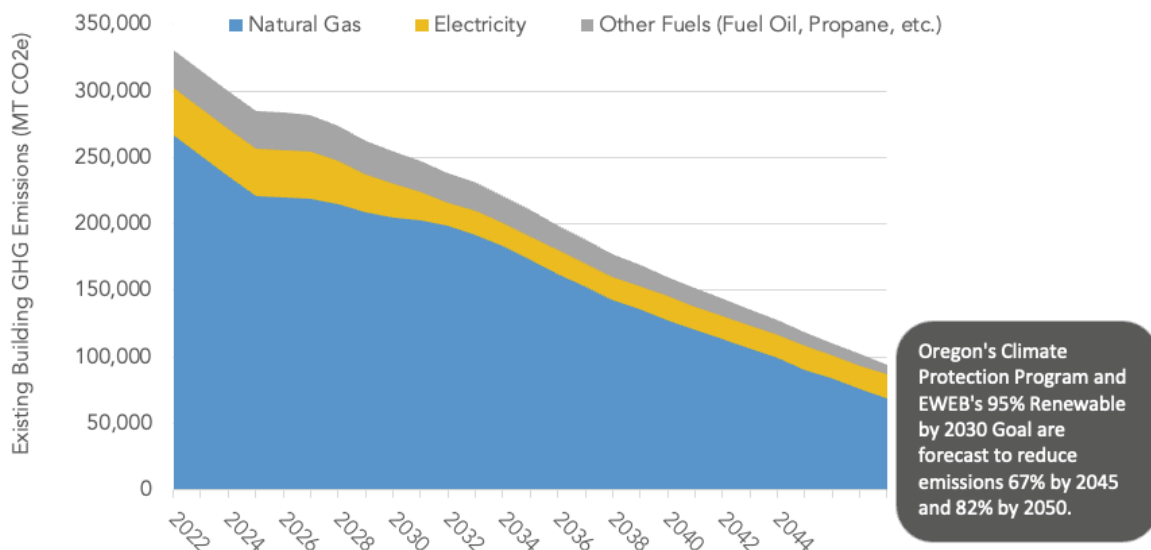
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Executive Summary

This report investigates the possible actions the City of Eugene and the Eugene community can take to achieve decarbonization of residential, commercial, and industrial buildings' energy use by no later than 2045. The report summarizes local building stock characteristics, sources of existing buildings greenhouse gas (GHG) emissions in the community, best technology solutions, related costs, and recommended actions to fill local gaps in local programs. The information contained in this report is from a combination of interviews with local experts and businesses combined with a review of existing literature (see bibliography). This information is intended to provide decision makers with a summary of baseline climate impacts from existing buildings, current decarbonization best practices, how much it might cost, and when acting early makes sense without undue hardship to our businesses and households.

A goal of 100% decarbonization by 2045 may seem like an insurmountable task, but the good news is that the State of Oregon and local utilities are required through the Climate Protection Program (natural gas and other fuels) or have voluntary goals (electricity) to significantly reduce energy demand and the climate impacts of the fuels and energy supplied to Eugene. See Figure ES-1. These existing policies will reduce emissions from the Eugene community's existing buildings, but alone will not reach a 100% by 2045 goal – additional and/or accelerated decarbonization actions will be needed locally to fill the gaps to reach a 100% decarbonization by 2045 goal.

Figure ES-1: Eugene's forecast emissions from existing regulatory and voluntary climate policies.



Summary of Findings

- Existing buildings make up 32% of local Community emissions (11% res, 21% comm/ind). Largest local source of community GHG emissions is transportation fuels (53%).
- Natural gas is the largest source of existing building climate impacts in Eugene because of low carbon electricity provided by EWEB.
- Residential/commercial sectors consume similar quantities of gas and combined represent 70% of total community use.
- Cost-effective energy efficiency options to address natural gas emissions in the residential sector include – space and water heating electrification, space heating controls (such as programmable thermostats), and weatherization of building envelopes. For heat pump conversions, the lifecycle cost differential is (~\$500)¹, over 15-years.
- Cost-effective options for electricity include the same with the addition of LED lighting.
- Electric heat pump technologies are available now for almost all circumstances and will be bolstered by Federal support from the Inflation Reduction Act along with regional support from ETO and the State. Residential electrification offers the greatest promise for rapid near-term decarbonization, supplied with the northwest's low-GHG electricity, even if combined with an existing natural gas system for back up (dual-fuel system).
- Cost-effective energy efficiency options to address natural gas in the commercial sector include – space and water heating electrification, space heating controls (such as programmable thermostats), various food service upgrades, and weatherization of building envelopes.
- Cost-effective options for electricity include the same with the addition of LED lighting upgrades, refrigeration (specifically in food sales) and electronics.
- Replacing commercial buildings' natural gas roof-top units and furnaces with heat pumps are cost effective over the 15-year equipment life. Segments include offices, strip malls, food service (non-cooking equipment), laboratories, nursing, and lodging.
- Electrification of boilers in commercial buildings is not cost effective for any segment.
- Cost-effective efficiencies to address natural gas in the industrial sector include – strategic energy management, manufacturing process heat re-capture, and space and water heating controls and equipment.
- Cost-effective options for electricity include the strategic energy management, pumps, fans and blowers, refrigeration, and lighting.
- Decarbonization opportunities for industrials include heat pumps for common building space and water heating systems. For production equipment – it should be a case-by-case basis with existing equipment (life up to 50 years) with highly customized and

¹ From EWEB electrification study for ducted natural gas system to standard heat pump. See Figure 30 for details.

integrated system components. Onsite hydrogen production and use is likely the future of industrial/process heat.

Residential Sector Recommendations

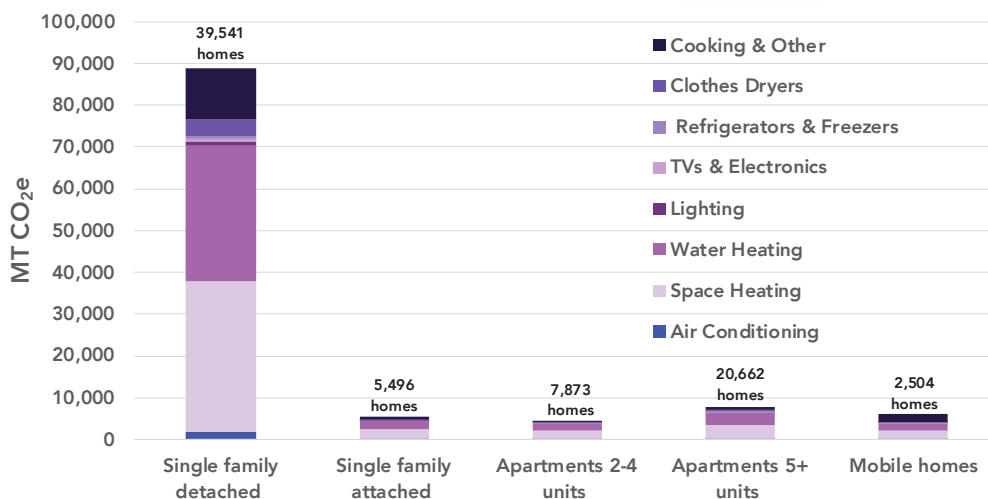
Prioritize actions for existing buildings to decarbonize where it's needed the most

Existing buildings represent a large proportion of Eugene's current emissions and will continue to do so for the foreseeable future. All future buildings will be built to higher standards so there is less opportunity for measures to reduce emissions.

Focus City decarbonization programs on single-family and mobile/manufactured homes

Existing single-family homes represent the largest climate impact, by housing type, for the Eugene community and should be the focus of City decarbonization programs. Specifically for those households currently using natural gas. Mobile/manufactured homes have the largest per unit and per square foot emissions, due largely to their inefficiently insulated building envelopes. Retrofitting these homes also serves a sizeable low-income population and therefore should also be a focus of City programs. See Figure 15 for additional details.

Figure ES-2: Estimated breakdown of 2019 GHGs by end use and housing type



Amplify outreach, integrate services, and manage the program to accelerate adoption

Coordinated outreach amongst all services is needed. There are many agencies and service providers doing great work, but they need and integrated outreach effort to support them. Outreach should include outreach to building equipment installers to provide education about community climate goals and the role they play is helping educate customers toward making decisions that support the goals.

Secure future debt and grant financing that is flexible to maximize implementation

Make financing easy to apply for and flexible to use. For leased units, financing should transact directly with landlords and not base it on tenants' income; simply have the landlord fill out an application.

Include a focus within City decarbonization programs on permanent, energy-efficient cooling from heat pumps for existing multifamily units for resiliency and safety

EWEB expects that as temperatures shift and air conditioning load is added they will move from a winter-peaking utility to become a dual-peaking (winter and summer) utility to serve the Eugene Community. Providing efficient permanent cooling solutions to energy cost burdened households and rental properties is essential for safety and reducing future peaks.

Align timelines (but not goals) with the State

Eugene should maintain the end point goals but aligning the timepoints with the state timelines will make analysis and planning more cost-effective.

Commercial Sector Recommendations

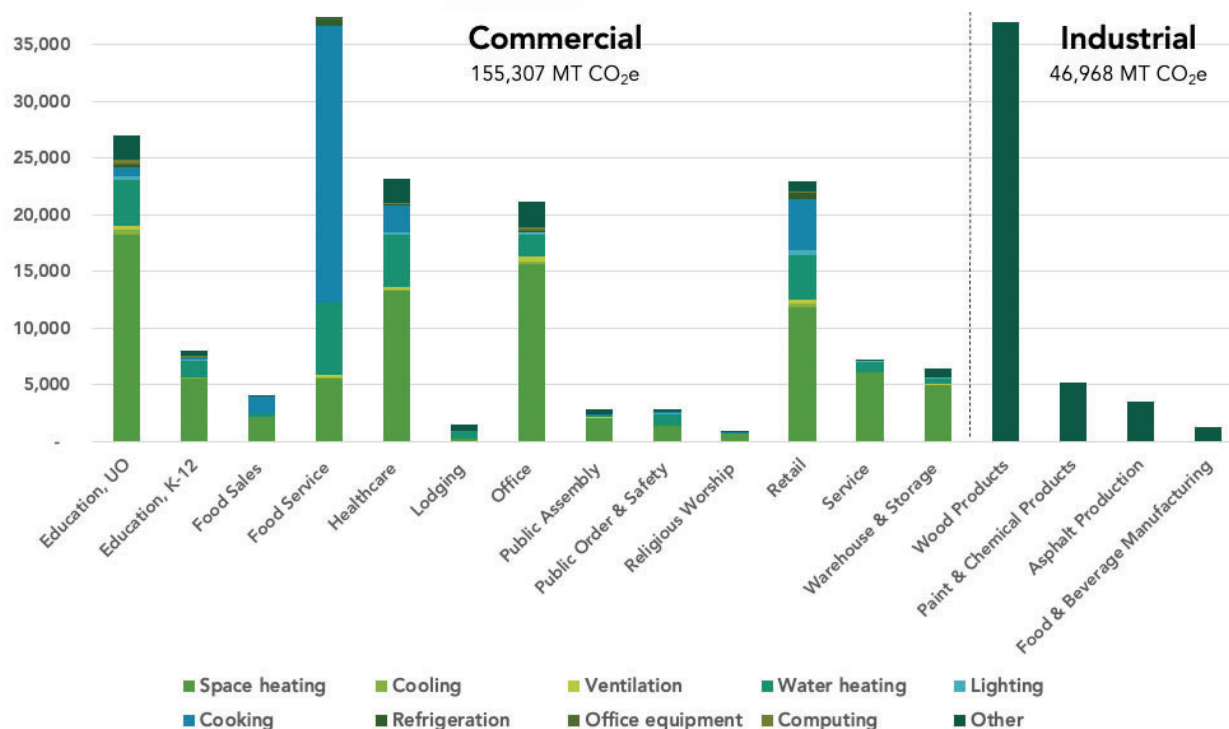
Prioritize actions for existing businesses with older existing buildings

As in the residential sector, existing commercial buildings represent Eugene's current emissions and will continue to represent the largest proportion between now and 2045.

Prioritize offices, strip malls, government, and healthcare that are easier to convert

Space heating equipment in offices, schools, government buildings, hotels and strip malls currently require significant local energy use. See Figure ES-3. Many of these same buildings have readily available technology to decarbonize space heating/cooling in these spaces (including dual-fuel heat pumps) for specific types of heating systems (rooftop units and furnaces). Replacement of natural gas furnaces with ductless heat pumps offer advantages for almost all segments.

Figure ES-3: Estimated breakdown of 2019 GHGs by end-use and segment (MT CO₂e)



City of Eugene should lead by example and decarbonize its office buildings

Interviews with local business owners expressed that the city might lead by example and begin the decarbonization process within its own facilities' before requiring it of others.

Engage deeply with managers and owners of food service and buildings with boilers

Commercial enterprises use significant energy for production of food and goods, such as the use of natural gas use for cooking, and commercial buildings that utilize natural gas boilers. Engagement could include additional interviews and/or creation of a working group with businesses to ensure the city fully understands the nature of the challenges and appropriately addresses them in any future community decarbonization programs and related requirements.

Prioritize businesses with low profit margins and historically underserved

Businesses with lower profit margins are less likely to afford new equipment, especially if at a premium. Businesses with less profit can benefit significantly from updated equipment, especially those that result in financial savings. This is especially true for employers that do not pay a living or family wage. Ensure that outreach is initially focused on underserved businesses owners and veterans.

Implement a Commercial Energy Reporting Program to benchmark building energy use

Detailed commercial energy use data is not readily available for the Eugene community. A Commercial Energy Reporting Program will provide information to inform decarbonization opportunities and planning by benchmarking and tracking commercial building energy use.

Partner with local job training groups to serve the equipment distributors and installers

Lane Community College has been a leader in the nation by offering programs for those interested in pursuing a career in decarbonization, such as Energy Management Technician - Building Controls. This segment will have large, sustained growth for multiple decades. Consider specific outreach to those providing efficiency and electrification services about community climate goals and their pivotal role in achieving those goals.

Amplify existing programs' outreach, program management, and funding sources

As with the residential sector, provision of financing for commercial emissions reduction projects, programs to perform aggressive outreach, and project management to implement large scale programs is needed. To facilitate an accelerated transition the City could take on these roles, partner with other agencies, or contract for provision of these services. EWEB suggests that the city could support existing programs with greater engagement and coordination with small business owners and contractors.

Industrial Sector Recommendations

Amplify existing Energy Trust of Oregon programs and incentives with City-led outreach

ETO reports that since 2016, the largest reductions in natural gas use in the last 5 years have come from energy efficiency upgrades by the industrial sector. However, ETO also reports that only about 20% of local industrial sites are ETO program participants. This indicates the need for additional City-supported outreach to encourage additional participation.

For industrial operations, in particular wood products, invest in understanding what technology, financial support and timeframes are reasonable

Replacing natural gas in heat intensive industries that are built around high-heat and steam will take time and careful planning. For production equipment conversions, City programs should begin with listening and learning to determine a reasonable path forward business by business.

Partner to support local development of renewable natural gas and clean hydrogen

Northwest Natural is pursuing a pilot program in Eugene for green electrolytic hydrogen production and injection into its pipeline. The project is being coordinated with EWEB to facilitate future expansion if NW Natural, EWEB, or other interested party wants to increase production that could be applied to various use cases. While this technology exists and is in use in industry, comfort and understanding of the equipment will take many demonstration projects. Partnerships could include major producers, utilities, Oregon State University, University of Oregon, Lane County, Biz Oregon, Energy Trust of Oregon, and the US Department of Energy distributing funds for hydrogen infrastructure development as part of the Inflation Reduction Act (IRA).

Lobby for alignment of State programming and funding to support decarbonization

Oregon Economic and Community Development, Oregon Department of Energy, Oregon Department of Agriculture and Oregon Department of Environmental Quality have all been active in the promotion of decarbonization or regulations for climate pollution. Their agendas have been very full, yet there is still a strong need for alignment of programs and funding to support the transition our community needs without hurting employment or our local economic base.

Introduction

This report investigates the possible actions the City of Eugene and the Eugene community can take to achieve decarbonization of residential, commercial, and industrial buildings' energy use by no later than 2045. This report summarizes local building stock characteristics, sources of existing greenhouse gas (GHG) emissions in the community, best technology solutions, related costs for various actions policy practices, and recommended actions to fill local gaps in programs.

Information reported herein is a combination of 1) listening/interviews of business owners and operators and professional program managers related to business support services, energy and building use, and funding organizations (see Contributors section) and 2) a literature review of public domain studies and programs to summarize best practices and approaches for existing building decarbonization.

This report is intended to provide decision makers with an explanation of what the Eugene community has, what the community can do, how much it might cost, and when acting early makes sense without undue hardship to Eugene's businesses and households.

This goal may seem like an insurmountable task, but the good news is that the State of Oregon and local utilities are required through the Climate Protection Program to produce or have voluntary produced plans to significantly reduce the climate impacts of energy supplies in Eugene and reduce energy demand. That said – these existing commitments alone will not reach 100% decarbonization by the Eugene 2045 goal across the residential, commercial, and industrial sectors, but they do provide significant benefits toward that goal and highlight what must be done locally to fill the gaps to reach the goal.

Eugene Community – Existing Building GHG Emissions

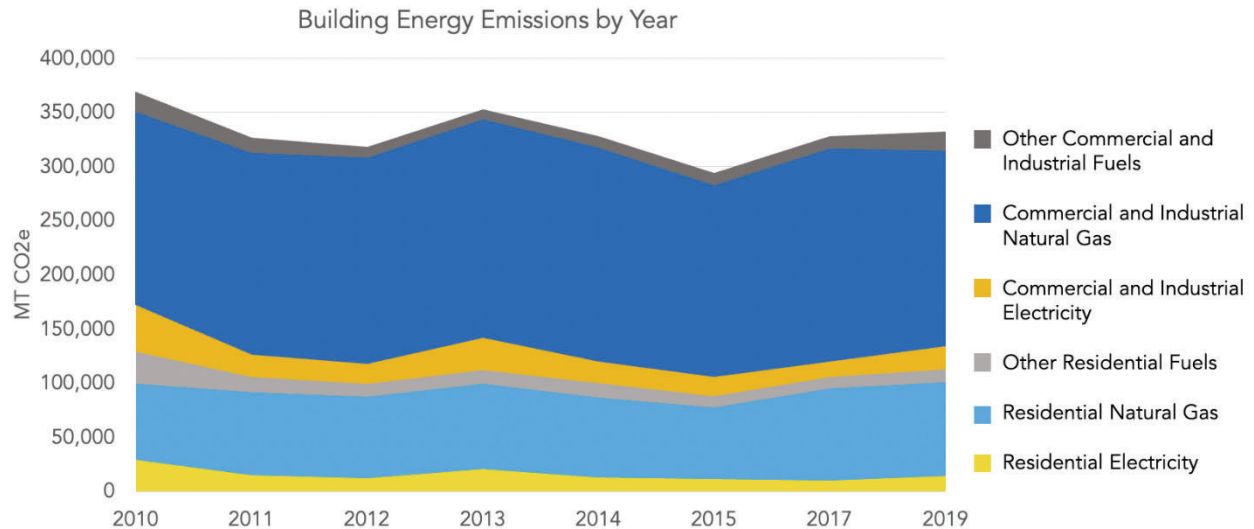
The City of Eugene has a long history of measuring local sources of community climate pollution (community greenhouse gas emissions inventory), which include the emissions from existing residential, commercial, and industrial buildings.²

Building emissions in the most recent 2019 community GHG inventory totaled **331,525 MT CO₂e (32% of the community total)**, primarily coming from local methane combustion and imported electricity consumption locally. Electricity use (kilowatt-hours consumed) decreased by 1.3% between 2010 and 2019 despite population growth. During this same period, total methane use and the associated emissions increased by 7% (across the residential, commercial, and industrial sectors). The residential sector led the increase, which is attributed to population

² For details visit https://www.eugene-or.gov/DocumentCenter/View/59286/2019-Eugene-Community_GHG.

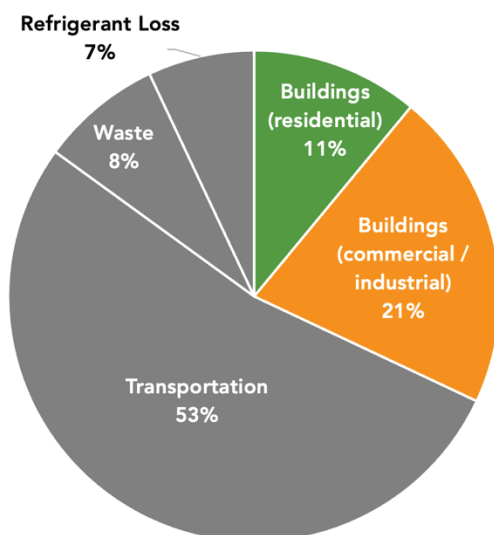
growth and varying winter temperatures and the need for additional heating in certain years. See Figure 1³ for a summary of building GHGs.

Figure 1: Eugene Community Greenhouse Gas Emissions for Buildings, 2010-2019



Eugene's 2019 sector-based sources of GHG emissions total just over 1 million MT CO₂e. The largest sources of community emissions include passenger and freight transportation (53%) followed by commercial and industrial buildings (21%) and residential buildings (11%).

Figure 2: Eugene's GHG inventory emissions breakdown



³ The 2019 Community GHG Inventory is available on the [City's website](#).

Four Pillars of Deep Decarbonization

This report reviews a variety of existing building decarbonization plans and related documents. Many used a common set of high-level strategies or “pillars” summarized in Figure 3. Deep decarbonization can be summarized by four, high-level categories common to all the decarbonization studies reviewed for this report. This report considers the following strategies:

- Energy Efficiency
- Electrification
- Low-Carbon Energy

Note: The fourth “pillar”, Reduce Non-Combustion GHGs, is being considered in a separate City of Eugene project that will convene local stakeholders in the second half of 2022 to determine readily available and cost-effective actions to reduce loss of **refrigerants** by building systems. This report is focused on decarbonization of building energy. Likewise, the transportation sector and specifically electric vehicles are not addressed in this report which is focused on existing building energy use.

Figure 3: Four pillars of deep decarbonization

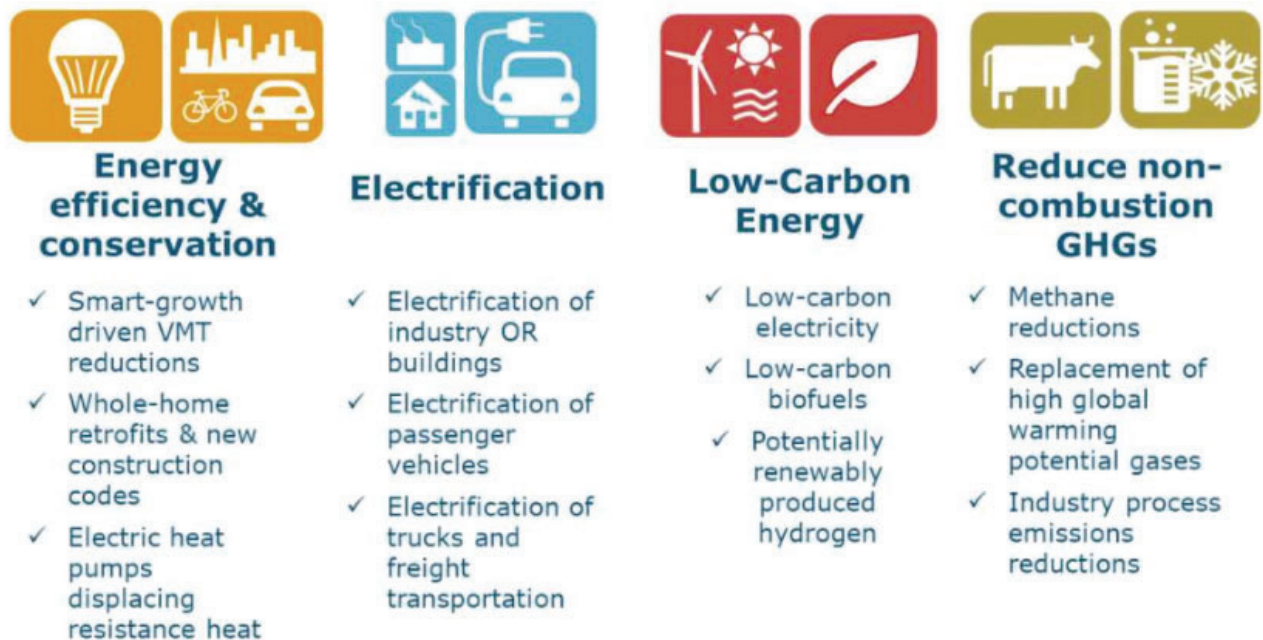


Figure Credit: Energy + Environmental Economics, Four Pillars of Deep Decarbonization

Low-Carbon Energy – Existing Policy Context

A consistent supply of renewable electricity and other renewable fuels will be critical to reach a goal of decarbonization of existing buildings by 2045. Eugene is fortunate that our electricity supply is already 90% generated by carbon-free resources (hydro, biomass, and wind). The recent Oregon Climate Protection Program rules will require our community's future emissions from fossil natural gas and other fossil fuels to be reduced by 90% between now and 2050.

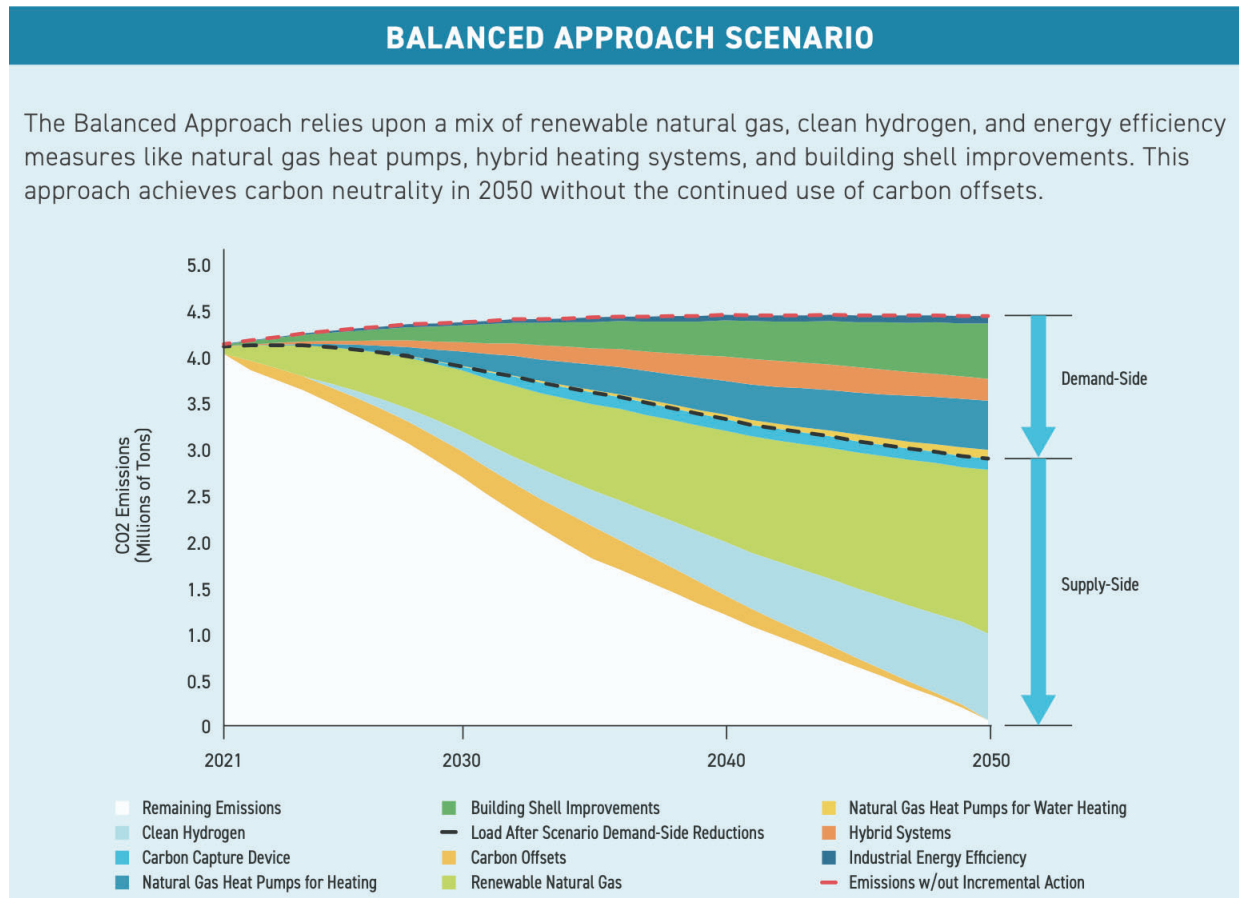
Natural Gas Supply

- In 2021 Oregon completed rulemaking for the Climate Protection Program (CPP) which will require natural gas utilities (including Northwest Natural) to reduce emissions by 90% by 2050 – through a combination of actions that reduce demand (with more efficient equipment) and increase supply of renewable substitutes that displace fossil gas. CPP reductions benefit everyone, but the specific interventions may or may not be deployed at an equal rate per capita throughout Oregon, so local benefits are difficult to assess accurately. In March 2022, Northwest Natural Gas joined other natural gas providers, businesses, and the Oregon Farm Bureau to challenge the authority of Oregon Department of Environmental Quality to regulate climate pollution under Oregon's Climate Protection Program.⁴
- Beyond the CPP, Northwest Natural Gas is exploring additional opportunities to exceed the requirements of the CPP and reach zero GHG emissions by 2050. Figure 4 summarizes the actions in *NWN Vision 2050 Destination Zero*⁵ - *Balanced Approach Scenario* which include benefits from an ever increasing substitution of fossil methane supply with biomethane and clean hydrogen, natural gas heat pumps for space and water heating, hybrid heating systems (electric heat pump added to minimize use of existing natural gas furnaces), industrial energy efficiency (beyond current ETO expectations), weatherization of building shells, certified carbon offsets (prior to the 2050 goal), and installation of carbon capture equipment.

⁴ For details visit <https://www.nwnatural.com/about-us/the-company/march-2022-customer-letter>

⁵ For details visit <https://www.nwnatural.com/about-us/the-company/destination-zero>

Figure 4: Northwest Natural's Balanced Approach Scenario to reach zero by 2050



Electricity Supply

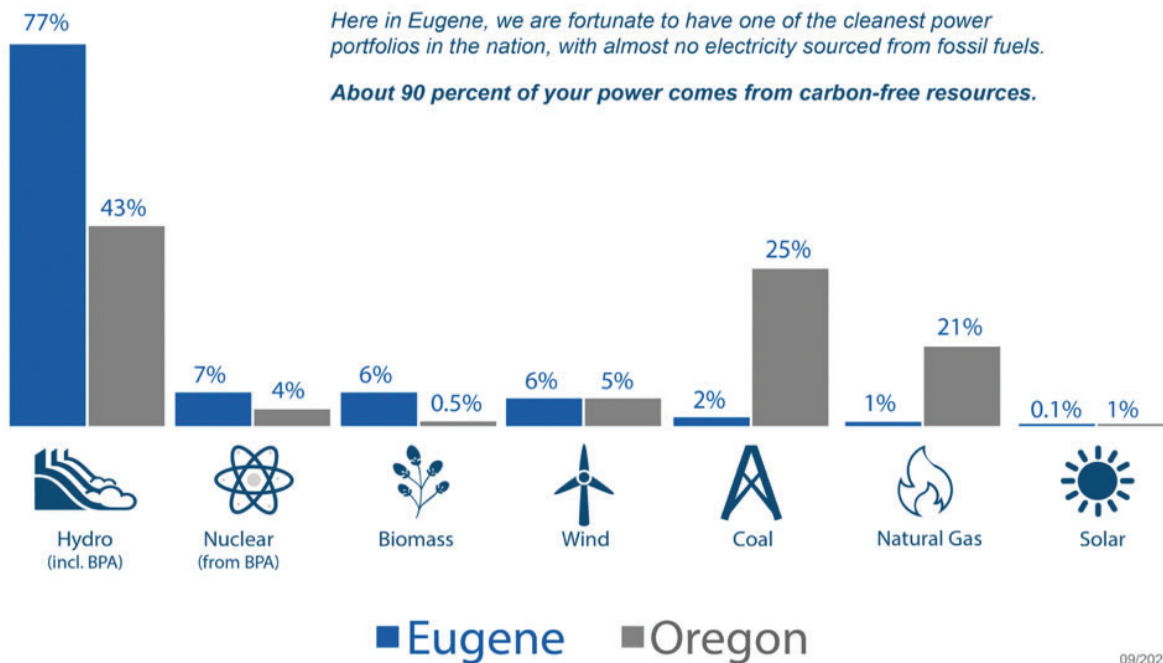
- EWB's Board has committed to supporting a low-carbon electric power portfolio that maintains, on a planning basis, over 90% of annual energy from carbon-free resources⁶ and targets over 95% of annual energy from carbon-free resources by 2030 to the extent possible and practical without distinct adverse impacts to customer-owners Figure 5⁷.
- EWB's Board has directed the General Manager to participate in local, state, and regional efforts to encourage, develop and **enact measures to minimize and/or mitigate GHG emissions** that contribute to climate change. And to **assist customers with achieving their GHG emission reduction goals** through partnerships, technical assistance, resources, and programs that support, but are not limited to, energy efficiency, alternative fuels, electric and water conservation, electrification, and carbon offsets and sequestration.

⁶ For details visit <https://www.eweb.org/about-us/power-supply>.

⁷ For details visit <https://www.eweb.org/about-us/power-supply>

- Oregon recently completed rulemaking on the Clean Energy Targets Bill (HB2021)⁸ that requires Portland General Electric, PacifiCorp and Electricity Service Suppliers in Oregon to meet the following targets. EWEB is not regulated under this legislation, but as of this writing, already meets the 2035 requirements with its existing owned generation resources and supply contracts.
 - 80 percent below baseline emissions levels by 2030.
 - 90 percent below baseline emissions levels by 2035; and
 - 100 percent below baseline emissions levels by 2040

Figure 5: EWEB--Where does your power come from graphic



⁸ For details visit <https://www.oregon.gov/deq/ghgp/Pages/Clean-Energy-Targets.aspx>

Future Climate Benefit from Existing Policies

Figure 6 is a forecast of community emissions from the policies described in the previous sections through 2045 (Eugene's goals currently correspond to 2045, while the states correspond to 2050). All other fossil fuels used in buildings by the community (fuel oil, propane, etc.) are also regulated by Oregon's CPP and reductions are assumed equal to CPP goals. Figure 6 illustrates that Oregon's existing policies – as aggressive as they are – alone will not result in 100% decarbonization by 2045.

Figure 6: Eugene's forecast emissions from existing regulatory and voluntary policies

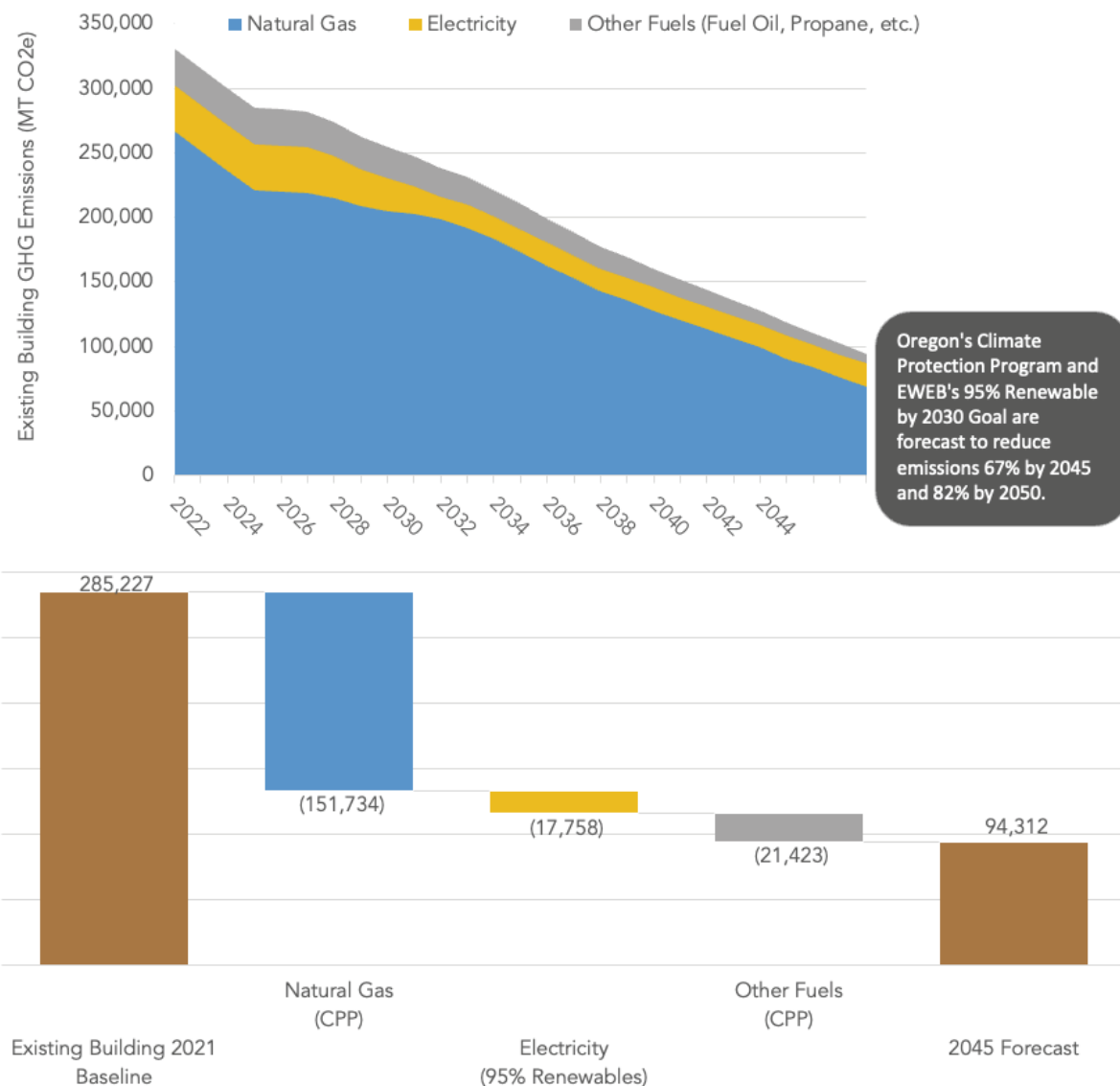
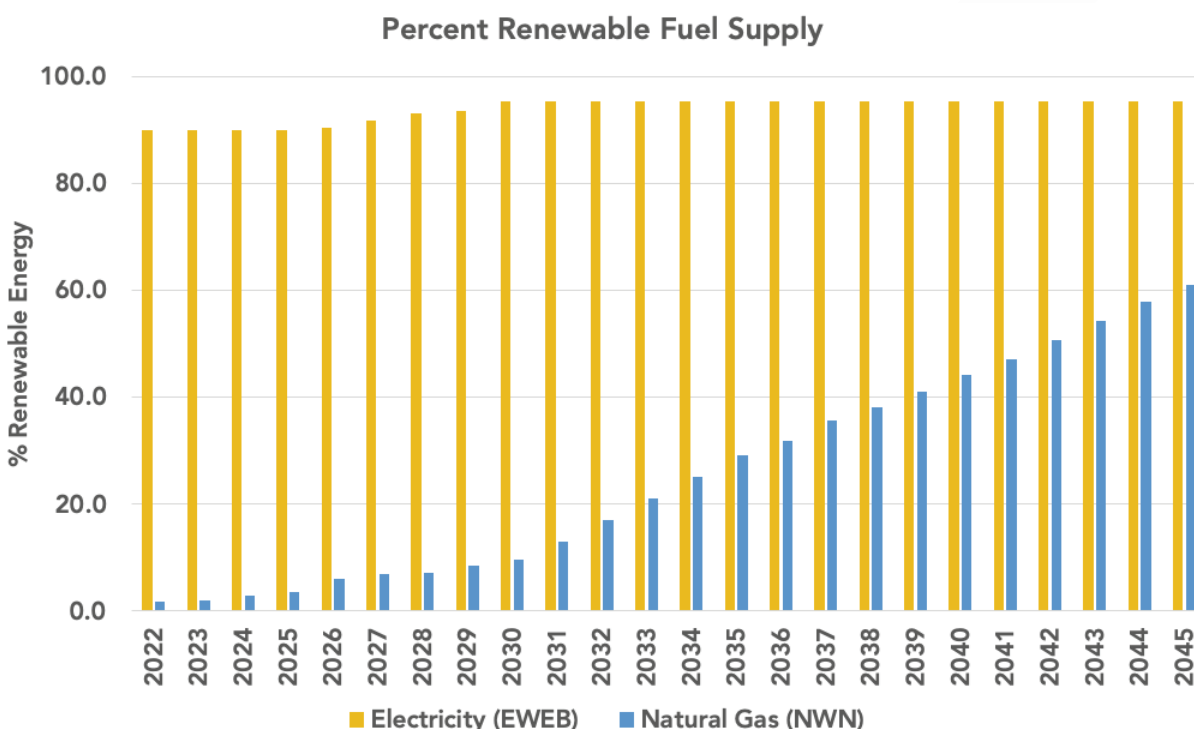


Figure 7: Comparison of renewables in EWEB electricity and Northwest Natural Gas forecasts and compares the percentage of renewables for local supplies of electricity and gas through 2045. Neither electricity nor gas reaches 100% renewables/low carbon during that time. Northwest Natural anticipates achieving 61% renewables by 2045 and 83% by 2050 (the shortfall is made up through purchased credits from DEQ). EWEB reports 90% renewable and low carbon currently and has a voluntary goal of 95% by 2030. Note that while gas gets to 83% renewables by 2050, NWN has voluntary goals to reduce the rest of the GHGs from its products via a reduction in use from efficiency measures to get to 90% by 2050 and will continue sourcing low carbon gas and efficiency beyond 2050.

Figure 7: Comparison of renewables in EWEB electricity and Northwest Natural Gas



Part 1: Residential Sector

Building Stock Characteristics

The figures in this section give a summary of the existing housing stock as of 2019.

Figure 8 presents a summary of Eugene's housing stock by type from [American Community Survey](#). As of 2019, Eugene's total housing units equal to 76,076 total housing units with 59% single family; 38% multifamily; and 3% mobile homes. *Energy Trust of Oregon City Report: Eugene 2021⁹* shows that 51% of housing units are owned and 49% are rented.

Figure 8: Eugene residential housing by type

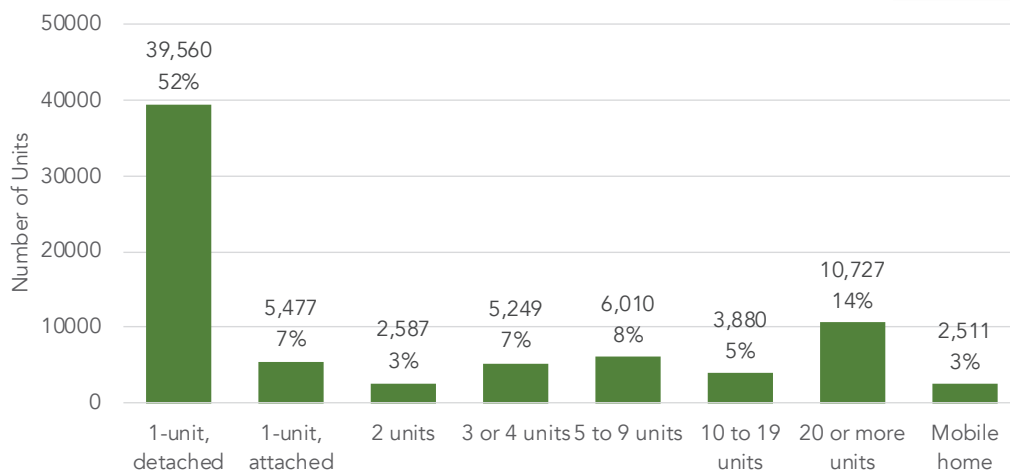
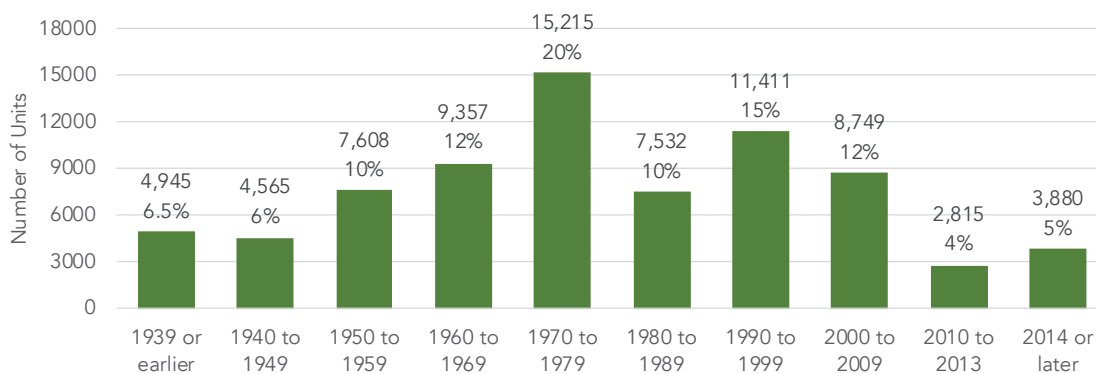


Figure 9 shows housing units by age. Roughly 65% of housing was built before 1990 which is the first year the model energy conservation standards for the residential sector were established.

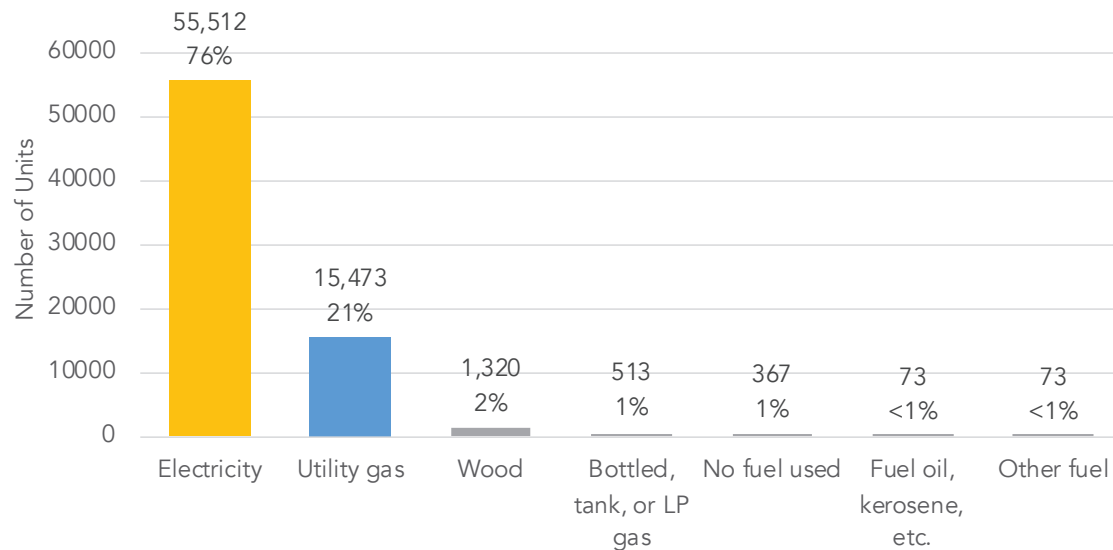
Figure 9: Eugene residential housing by construction year



⁹ Report is not available online. ETO provided the report to City staff upon request.

Figure 10 compares primary heating fuel in Eugene. Most houses use electricity, followed by natural gas, wood and other fuels. Energy Trust of Oregon reports that more than 73% of housing units in Eugene use electricity as the primary heating fuel (compared to 51% Oregon-wide); while natural gas makes up about 22% (38% Oregon-wide); wood represents 3%; and other fuels (propane) total 1%. Totals do not sum to 100% due to rounding up of the percentages.

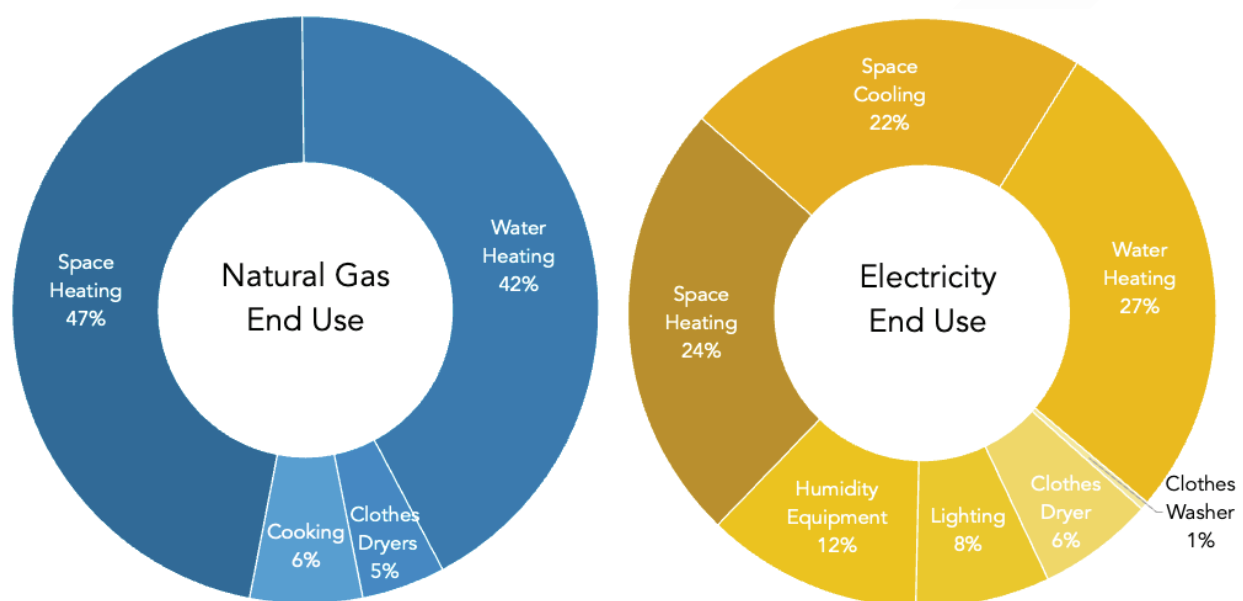
Figure 10: Eugene residential housing by primary heating fuel



Common Energy Uses

Figure 11 (blue, left) compares the various end uses of natural gas at residential properties. The dominant uses are space and water heating. Water heating plays a larger role in residential energy use for homes with pools and hot tubs, but it is unclear from available data how many homes in Eugene include these amenities. Cooking and clothes drying play a relatively smaller role but represent a larger fraction of the total for homes without pools. Figure 11 (gold, right) shows the wide variety of electricity end uses across households. As with natural gas the largest end uses are for space heating and cooling and water heating. Other uses include lighting, clothes dryers, and fans.¹⁰ Cooking is not captured in this data.

Figure 11: Natural gas and electricity end uses



Greenhouse Gas Emissions

Emissions by energy type and housing categories are estimated using data from [Eugene's Community GHG Inventory](#), [American Community Survey](#), and the [Energy Information Administration's Residential Energy Consumption Survey](#).

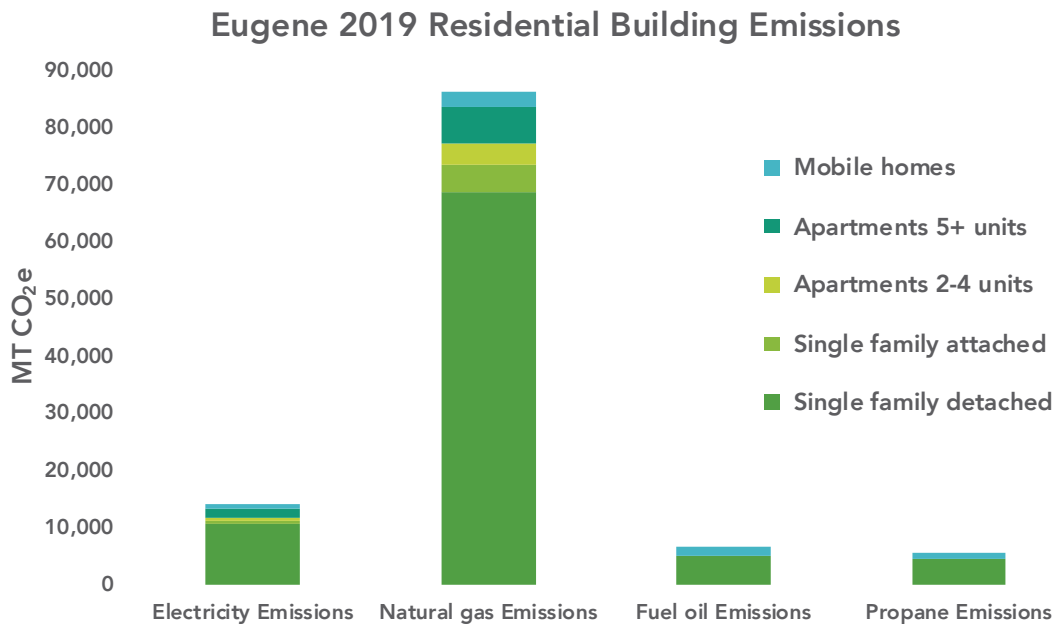
Housing categories considered include:

- Single family – detached and attached
- Multifamily – 2-4 units and 5+ units
- Mobile homes

¹⁰ From U.S. Energy Information Administration's Residential Energy Consumption Survey for the Northwest <https://www.eia.gov/consumption/residential/>

Figure 12 shows that residential emissions in the Eugene community are overwhelmingly from single family (detached) homes and more specifically, fossil natural gas consumption.

Figure 12: Eugene's 2019 residential GHG emissions by energy type and housing category



This is being driven by the fact that single family homes (attached + detached) represent almost 60% housing units in Eugene (Figure 13) and have larger square footages per unit than other housing types and therefore require more fuels and energy to heat and cool the larger spaces.

Figure 13: Comparison of housing units by category to GHG emissions by category

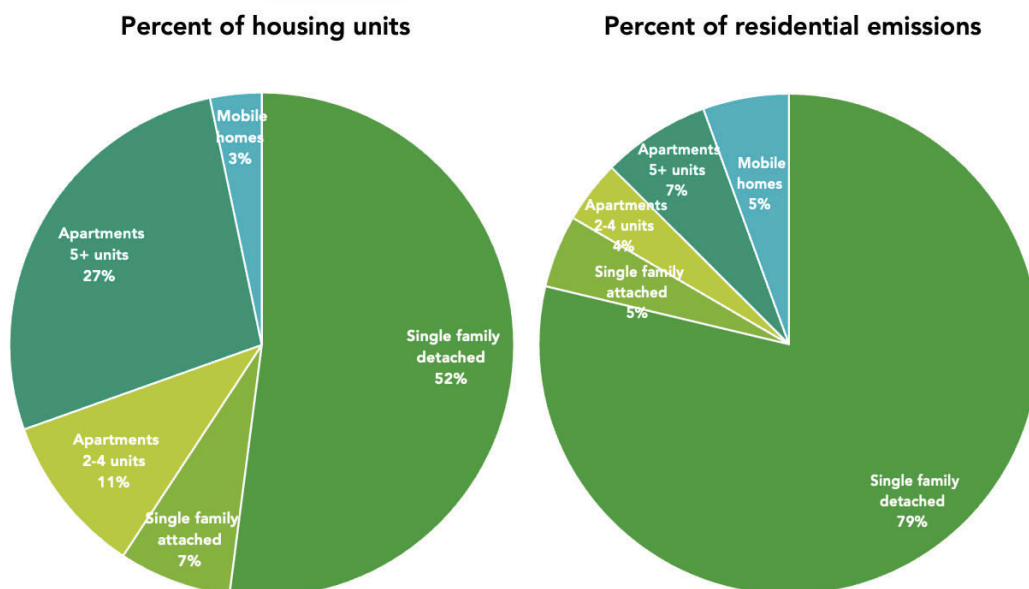


Figure 14 compares the end-uses driving the energy use and related emissions. Like the prior graphics, this shows that single family homes are the largest sources of emissions and specifically space conditioning (heating / cooling), water heating and cooking end uses represent the largest sources of emissions. It's important to note that for homes with pools – natural gas use increases on average by 25% with hot tubs adding another 8%.

Figure 14: Comparison of housing units by category to GHG emissions by category

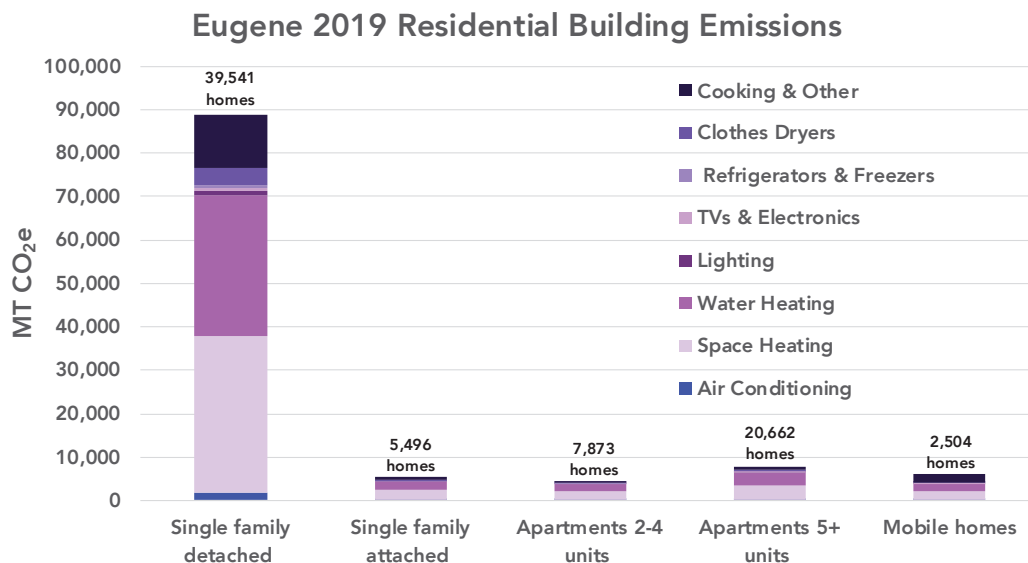


Figure 15 compares average 2019 emissions per type of housing unit. From previous results – it is unsurprising that single family homes represent large average emissions per home. What is more surprising is average emissions per unit for mobile homes. Unfortunately for the residents – mobile homes consume significantly more energy per square foot than other types of housing due to under-insulated envelopes.

Figure 15: Comparison of building energy GHG emissions in 2019 per housing unit (dark green) with GHG emissions per 1,000 square feet (light green), by housing category

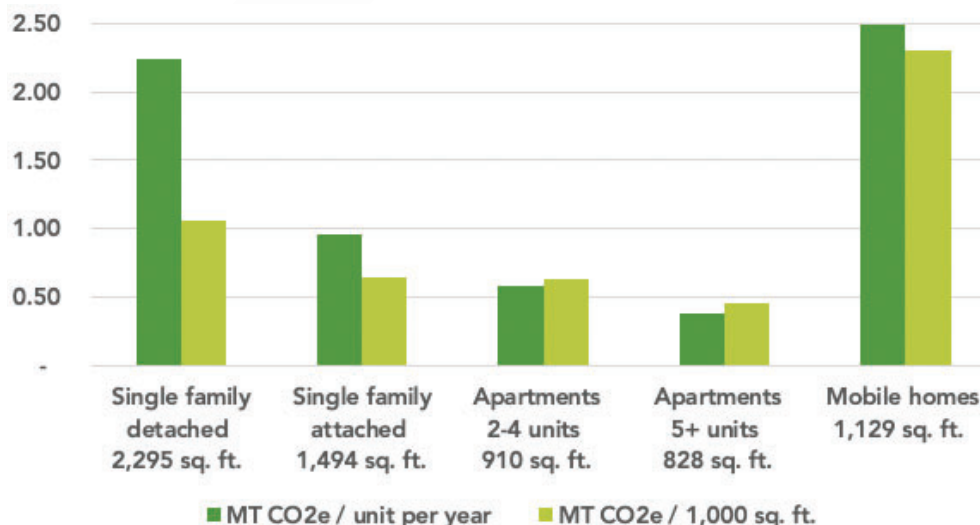
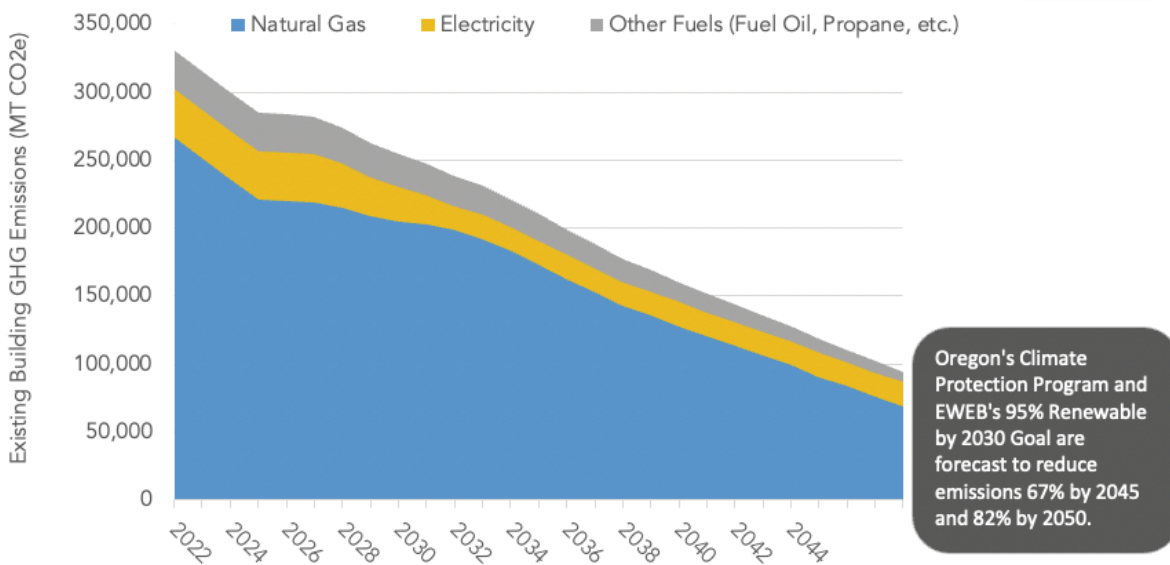


Figure 16 presents Eugene's forecast emissions for residential buildings within the urban growth boundary. Compared to other sectors (commercial, industrial, and transportation) residential emissions are projected to decline at a faster rate, driven by load reductions for natural gas. By 2045 residential emissions for all fuel types are anticipated to be reduced to about 30,000 MT CO₂e in 2045 compared to roughly 100,000 MT CO₂e. Emissions by 2050 are forecast be about 15,000 MT CO₂e because of continued Climate Protection Program compliance by Northwest Natural and other fuel distributors.

Figure 16: Eugene UGB residential forecast emissions reductions from existing policies



Technical Best Practices & Strategies

This section of the report reviews the best technical practices, including:

- Energy Efficiency
- Electrification (including dual-fuel systems)
- Renewable energy supplies

These three “pillars” of decarbonization for the residential sector are often combined and discussed within a combined approach towards the ideal of “Net-Zero Buildings” which have all cost-effective energy efficiency upgrades implemented; electrify all systems possible; and use renewable energy and fuel supplies for remaining needs which is ideally generated and stored onsite with solar photovoltaic panels and batteries. “Clean Heat Retrofit Programs” are also commonly discussed as a combination of efficiency upgrades and appliance electrification with other comfort and safety upgrades.

Energy Efficiency & Conservation

Energy efficiency and conservation include a wide-ranging suite of equipment upgrades and behavior changes that reduce the amount of energy required to do a given quantity of work.

Efficiency opportunities are often referred to as “measures” and can include individual technology upgrades or bundles of similar measures. These measures are focused on the largest energy uses and opportunities where a technological upgrade returns “cost effective” energy savings that at a minimum pays back the initial investment. ***The greatest return on energy efficiency investments almost always comes at the end of equipment life and moment of “natural replacement”.***

Natural Gas

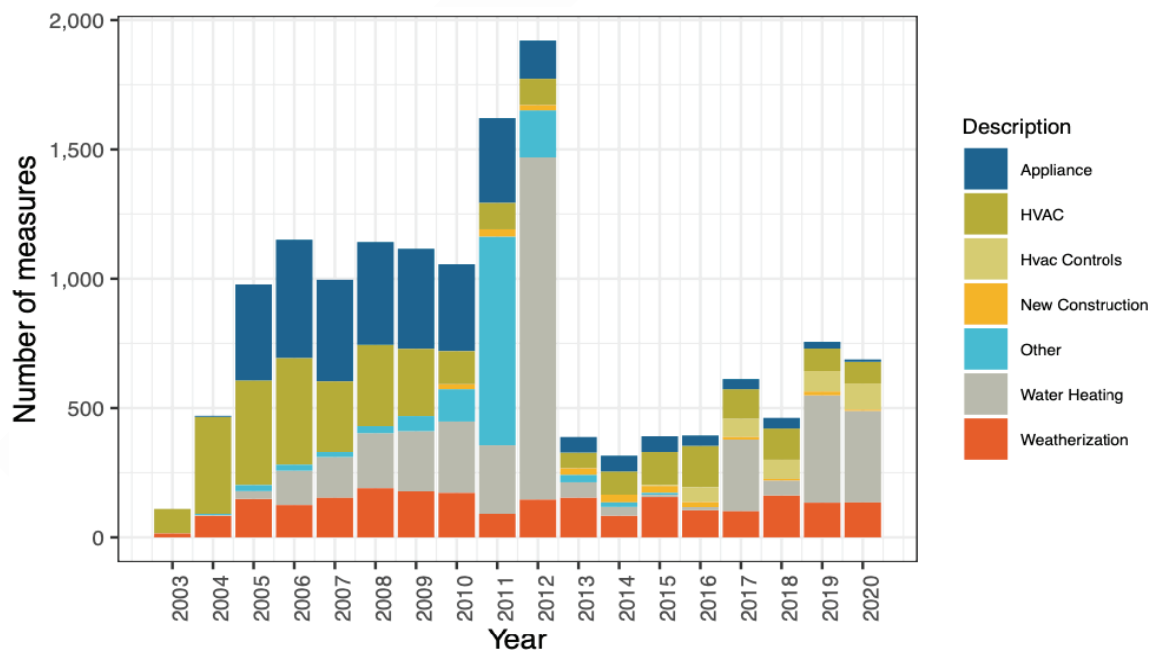
For natural gas, cost-effective energy efficiency measures for existing homes include:

- Water heating upgrades, including heat pumps
- Space heating upgrades, including heat pumps
- Space heating controls (such as programmable and smart thermostats)
- Weatherization of building envelopes

Historic energy efficiency installations in Eugene by Northwest Natural Gas through Energy Trust of Oregon (ETO) programs are shown in Figure 17. Installation over the past 5 years have focused on the measures listed above with a recent focus on water heating. *ETO data also shows that 32% of residential units in Eugene have already benefited from ETO programs as of 2020 (8,142 participants out of 25,651 total).* Energy Trust of Oregon offers a variety of financial incentives and other resources for natural gas appliances and weatherization at their website <https://www.energytrust.org/residential/>.

Emerging Technology: Natural-Gas Heat Pump

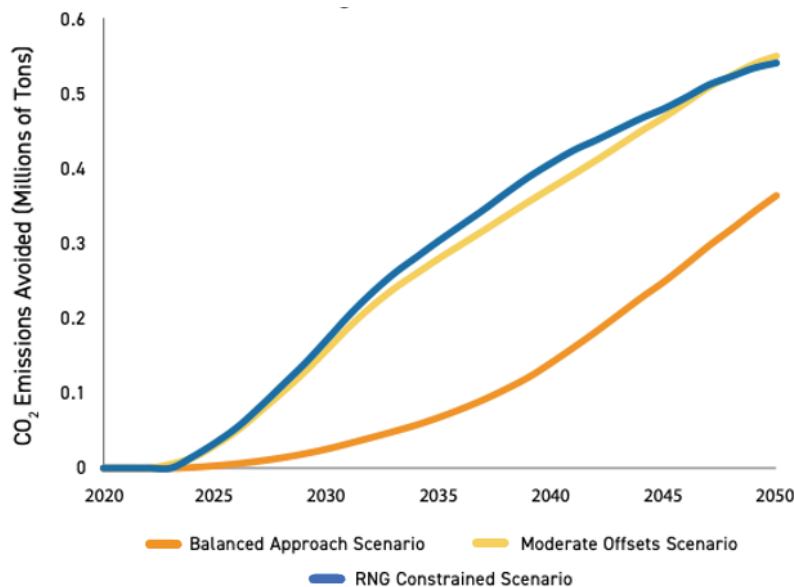
Figure 17: Residential natural gas measures installed as reported by ETO



Northwest Natural Gas states in their Vision 2050 - Destination Zero report that:

"Natural gas heat pumps offer the single greatest opportunity to reduce natural gas consumption while maintaining equipment performance in cold weather. A 2019 American Gas Foundation report prepared by Enovation Partners indicates that these new technologies have the potential to reduce energy use by 40% or more (replacing a split heating / cooling system), while maintaining a consistent level of service." The U.S. Department of Energy reports that this technology is mainly used in industrial and commercial setting, but also are available for large residential homes (>4,000 square feet).¹¹ It should be noted, however, that the use of natural gas heat pumps for cooling would increase consumer's use of natural gas in the summer relative to conventional electric air conditioners or heat pumps. Figure 18 offers NWN's forecast of emissions reductions and timing within their service territory.

Figure 18: Forecast GHG reductions and timing for gas heat pumps. Source: NWN Vision 2050

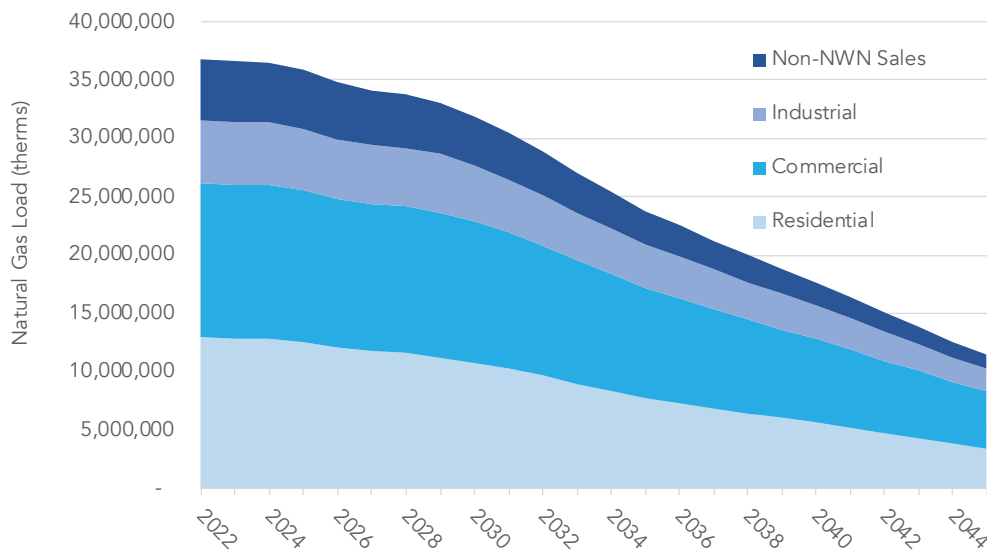


Demand Side Forecast

Northwest Natural Gas provided a high-level forecast of load by sector for this report. Figure 19 shows the results for the sector within the City of Eugene's geographic boundary.

Residential and non-NWN gas distributed through NWN pipes sectors provide the greatest reductions in load by 2045, 73% and 76% respectively. The commercial and industrial sectors are anticipated to both be reduced by 63% between now and 2045. Overall gas load is anticipated to be reduced by 69% across all sectors by 2045.

¹¹ For details visit <https://www.energy.gov/energysaver/absorption-heat-pumps>

Figure 19: NWN forecast of Eugene residential fossil methane consumption through 2045, by sector

Electricity

For electricity, “cost-effective” energy efficiency (EE) measures for existing homes include:

- Water heating and use upgrades, including heat pumps
- LED lighting
- Space heating and cooling (if it is already present) upgrades, including heat pumps
- Space heating controls (such as programmable and smart thermostats)
- Weatherization of building envelope

The recently released, 2021 Northwest Power Plan includes a detailed list of cost-effective electric equipment and appliance upgrades opportunities. shows specific types of equipment upgrades found to be most cost effective (equal to or provides savings over the equipment lifecycle – as compared to first costs for equipment and installation).

Significantly more achievable potential was identified by the Northwest Power Plan, particularly for HVAC systems, but at a greater cost per unit (>\$40 / average megawatt (MWa)). These measures include:

- Ductless heat pumps
- Weatherization
- Clothes dryers

For more details on the scale of residential efficiency measures by cost visit

https://www.nwcouncil.org/2021powerplan_residential-technical-achievable-efficiency/.

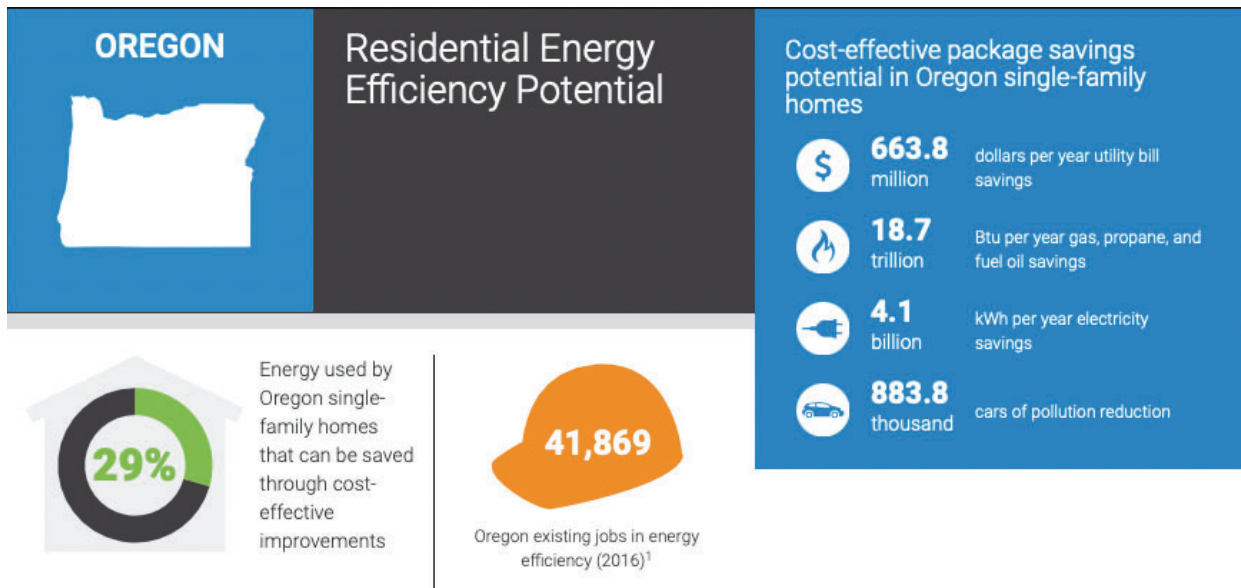
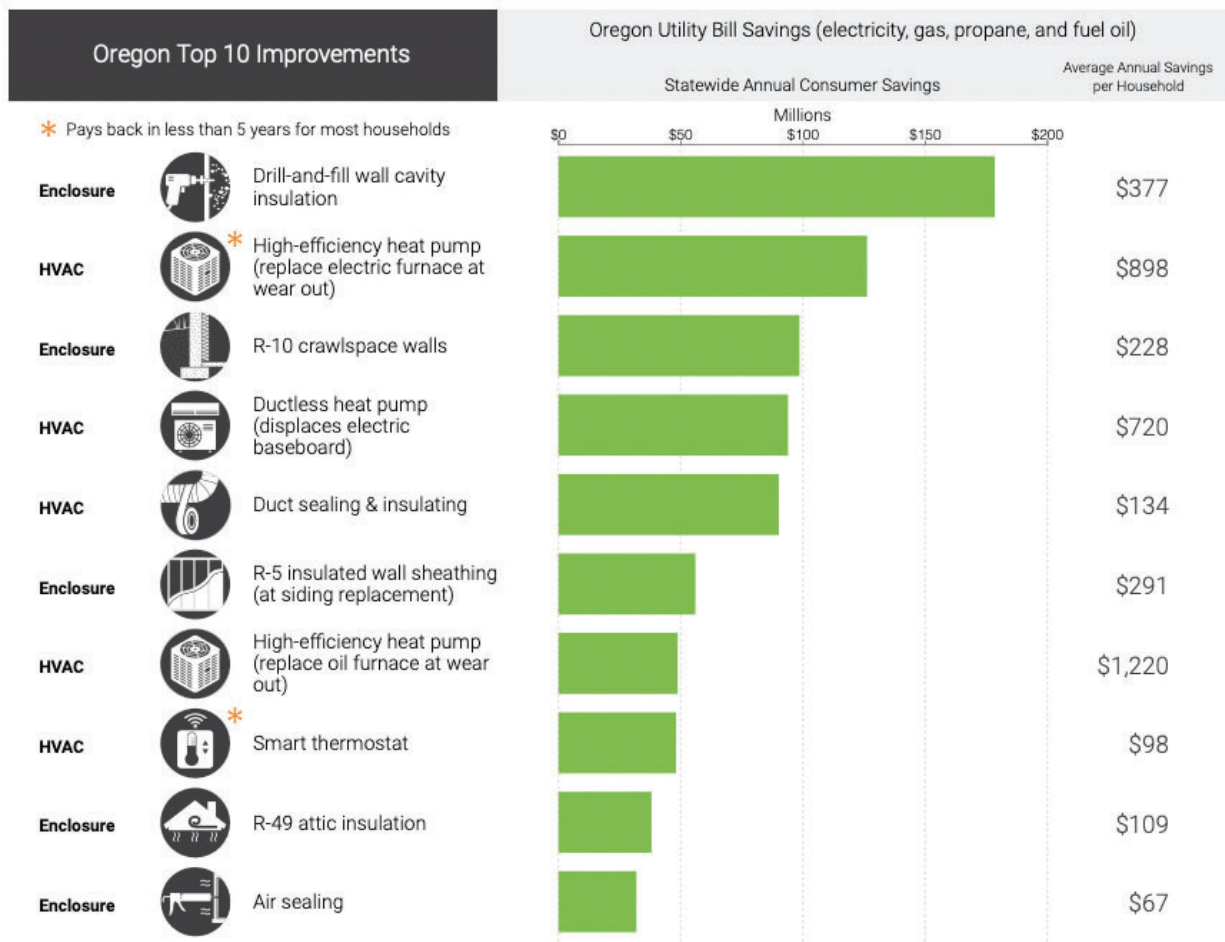
Figure 20: Cost effective residential electricity efficiency measures from Northwest Power Plan, values represent the potential average mega-watt reductions available in the northwest region

Cost-Effective EE Potential (aMW)				
End-Use Bundle	2027	2032	2041	Description
Clothes Washers	22	60	135	ENERGY STAR and CEE rated clothes washers
Lighting	13	41	88	LED screw-in and pin-based lamps and integral fixtures
Water Saving Devices	25	56	83	Showerheads, aerators, thermostatic restriction valves
Electronics	11	37	55	ENERGY STAR laptop computers and Efficient TVs
Dryer	8	22	42	ENERGY STAR dryer
Weatherization*	9.3	26	34	Insulation, duct sealing
Refrigeration	4.8	13	31	Certain ENERGY STAR refrigerator/freezers and chest freezers
Smart Thermostats	6.2	14	17	Thermostats installed in heat pump homes that have lockout temperature settings and occupancy controls
HVAC Equipment	0.6	3.1	11	Air source heat pump upgrades in manufactured homes and single family high efficiency air conditioners
Circulator Controls	0.2	1.2	4.7	Controls for domestic hot water circulator pumps
Food Preparation	0.1	0.5	2.3	High efficiency ovens

The U.S. Dept. of Energy's National Renewable Energy Lab (NREL) recently released a state-level study evaluating efficiency opportunities for electricity¹². Results for Oregon are shown in Figure 21. A notable difference between these findings and NWPP is that NREL's study found many opportunities for various weatherization measures and heating system upgrades. While these findings are different in prioritization from NWPP – it's important to note that NWPP also found significant opportunity for the same types of measures but used different means to test cost-effectiveness.

¹² For details visit <https://www.nrel.gov/docs/fy18osti/68670.pdf>

Figure 21: Oregon's top 10 energy efficiency measures from National Renewable Energy Laboratory assuming a cost of \$40/average megawatt hour



Source Document: <https://www.nrel.gov/docs/fy18osti/68832.pdf>

Supporting Action: Home Energy Score Program

A Home Energy Score (HES) is a value given to a home by a contracted inspector that estimates the energy-related use, associated costs, and cost-effective solutions to improve the home's efficiency. HES are used during a home's sales process to provide important cost and comfort information to all parties. **The adoption of a HES program has the potential to provide a market-based incentive for homeowners to invest in energy efficiency improvements.** Oregon Department of Energy provides technical support and community resources for local governments interested in a community-wide program (like Portland's) or for homeowners interested in getting their home scored.¹³ HES audits had a cost of \$150-200 in Portland (2019).

Beyond Portland there are other examples of cities and states requiring some form of energy or efficiency disclosure at the time of sale.¹⁴ See Figure 22 and the following bullets for examples.

Figure 22: Summary of other jurisdictions that require energy disclosures at the time of sale.

	Energy/ Utility Costs	Energy Efficient Characteristics	Home Energy Score	Energy Audit	Educational Information
Chicago, IL	✓				
Minneapolis, MN	✓	✓			
Kansas		✓			
South Dakota		✓			
Portland, OR			✓		
Berkeley, CA			✓	✓	
Montgomery County, MD	✓				✓
Alaska	✓				
Hawaii	✓				
Massachusetts					✓
Austin, TX				✓	
San Francisco, CA				✓	

- **Austin, TX – Energy Conservation Audit and Disclosure Ordinance** - The ordinance requires energy audits and disclosures for all homes and buildings at the time of sale which are served by Austin Energy and located within Austin city limits.
- **Berkeley, CA Energy Saving Ordinance (BESO)** - BESO requires exiting building owners to complete and publicly report comprehensive energy assessments to uncover energy saving opportunities at the time of sale. The assessments are conducted by registered

¹³ For details visit <https://www.oregon.gov/energy/save-energy/pages/heps.aspx>

¹⁴ From the Midwest Energy Efficiency Alliance https://www.mwalliance.org/sites/default/files/meea-research/energy-disclosure-fact_sheet.pdf

energy assessors who provide tailored recommendations on how to save energy and link building owners to incentive programs for energy efficiency upgrades.

- **Boulder, CO – SmartRegs for Rental Housing** - Requires all licensed rental housing in the City of Boulder to meet a basic energy efficiency standard. Approval depends on the results of required inspections that determine whether a property complies with standards for health/safety, mechanical systems, and energy efficiency. SmartRegs is the energy efficiency component of the inspection and approval process.
- **Chicago, IL Energy Cost Disclosure** - In July 2013, the City of Chicago became the first municipality in the country to disclose residential energy costs (gas and electric) when a home was listed for sale via a multiple listing service (MLS).
- **Minneapolis, MN - Truth in Sale of Housing** - In 2020, Minneapolis added energy efficiency to its disclosure requirements. This requirement applies to all 1–2-unit properties, townhomes, and first-time condo conversions.¹⁵

Renewable Energy

While adopting efficiency equipment and practicing conservation offer a tremendous opportunity to improve comfort, reduce costs, and offset future load from community growth and electrification – energy efficiency alone cannot decarbonize existing buildings by 2045. Developing renewable energy and fuel sources will be essential to achieving a goal of 100% decarbonization of existing buildings by 2045 is critical.

Electricity

Utility Supplied

EWEB currently delivers at least 90% renewable electricity and has an internal goal to reach 95% renewable generation by 2030 delivered to Eugene. EWEB plans to release a new Integrated Resource Plan in December of 2022 that will offer details and an assessment of various options for our community to further decarbonize. Based on what is known as of this writing – EWEB will need to acquire another 5-10% of low-carbon supply to allow for 100% decarbonization of existing buildings in Eugene by 2045. EWEB may also choose to pursue more aggressive and higher cost energy efficiency measures for existing buildings to further reduce electrical demand and allow for existing supply contracts to cover our community's demands with existing renewables.

Distributed Power (solar + battery storage)

EWEB's owned resources and contracted power are already generated with low carbon resources. Local generation and storage would also increase community energy resilience in the event of a major event (like earthquake, extreme weather, or fire). Northwest Power Plan

¹⁵ TISH energy efficiency guide <https://www.minneapolismn.gov/resident-services/property-housing/buying-selling/tish/energy-disclosure-report/>

found costs for a typical unattached single-family home for a 5.6 kWh solar PV system at roughly \$16,000 and \$28,000 with li-ion battery backup.¹⁶

Natural Gas

Renewable natural gas is already being produced within Eugene at MWMC's wastewater treatment plant and Short Mountain Landfill used for vehicle fuel production and electricity generation. Renewable natural gas and clean hydrogen have a carbon footprint that is significantly lower than fossil natural gas.¹⁷ As previously mentioned, Northwest Natural is regulated under Oregon's Climate Protection Program. To achieve compliance NWN will support efforts to reduce use of conventional natural gas, while providing ever more renewable gas supply. NWN will be releasing their latest IRP in August 2022 and may show more than what is shared in this report.

Wood

For this study – wood is assumed to be a carbon neutral fuel, which is aligned with the approach used in Oregon's Climate Protection Program and greenhouse gas protocols. That said – considerable effort has been taken in Oregon to convert heating away from wood to reduce sources of criteria air pollutants, like particulate matter. Criteria air pollutants do not include greenhouse gases – so wood represents a conundrum and a challenging trade off. During power outages, or after a major earthquake, this may be our only source of heat as nearly all linear infrastructure – roads, bridges, water and gas pipelines and power corridors will be broken in so many pieces that they will be inoperable for nearly a year.

Other Fuels

Renewable propane or renewable diesel provide a non-fossil option for households that use these fuels for home heating. Other fuels have greater impacts than natural gas and should be considered first for substitution with a heat pump. These two fuels are widely available in Oregon as of late 2022.

Electrification

Many communities around the U.S. are turning to electrification of new and existing residential buildings to reduce climate impacts. This action is supported by research from a wide variety of groups including State¹⁸ and Local Governments¹⁹, American Council for an Energy Efficiency

¹⁶ For details visit https://www.nwcouncil.org/2021powerplan_behind-meter-solar-battery/.

¹⁷ The carbon footprint of fuels can vary dramatically depending on the energy feedstock and processing.

¹⁸ Maryland Building Energy Transition Plan. Online at

<https://mde.maryland.gov/programs/Air/ClimateChange/MCCC/Documents/2021%20Annual%20Report%20Appendices%20FINAL.pdf>

¹⁹ Energize Denver Taskforce Recommendations. Online at <https://www.denvergov.org/Government/Agencies-Departments-Offices/Agencies-Departments-Offices-Directory/Climate-Action-Sustainability-Resiliency/News-Events/News/2021/Energize-Denver-Task-Force-Recommendations>

Economy, and the Sierra Club²⁰. This is particularly true for new residential construction as electrification costs for a new building versus retrofit are in favor of electrification. The economics of retrofitting older homes is different as there may be electric system upgrades needed as well as additional weatherization depending on the homes' age and features.

There are various heat pump technologies that increase the efficiency of space conditioning:

- Standard Heat Pump: Lower cost but may not perform on the coldest days of the year.
- Cold Weather Heat Pump: Higher cost, but greater performance at lower temperatures.
- Dual-Fuel Heat Pump: Standard electric heat pump with second fuel as back up for the coldest days of the year.
- Natural Gas Heat Pump: Heat pump that operates on natural gas for both heating and cooling needs. This technology – which is a good fit for industrial/commercial loads - is still emerging for general residential use but may be suitable for homes >4,000 sq. ft.

These systems may be ducted or ductless. Costs for ductless systems are typically less than a ducted system as there is less system complexity and components.

EWEB recently completed an electrification study that considers the costs and benefits of ducted electrification of homes space and water heating systems for existing single family and multi-family homes.²¹ See Figure 23 for a summary of findings. The report found that the greatest electrification benefits - across all stakeholders (EWEB participants, EWEB ratepayers, and Society) – are broadly from heat-pump water heaters and for single-family homes, heat pumps (electric heat pump with a backup fuel like natural gas or wood). Use of standard and cold weather heat pumps was found to be unlikely without additional financial incentives or mandates as electrifying will likely result in a net-cost increase for homeowners if pursued completely before 2030. Other findings include:

- A combination of ample, clean energy resources and a strong legacy of energy efficiency programs puts EWEB in a strong position to support electrification.
- While EWEB has near-term capacity to handle additional load from electrification, under the highest forecasted electrification rates, EWEB might have to purchase additional power resources or build additional infrastructure to meet electricity needs.
- Without significant policy incentives, upgrading gas space heating systems to electric has a net cost to the customer over the equipment lifetime, making it less likely that customers will retrofit existing buildings. However, all the heat pump technologies studied provide significant carbon reduction benefits, and some customers may feel that the climate benefits outweigh the costs.

²⁰ Building Electrification Action Plan. Online at

<https://www.sierraclub.org/sites/www.sierraclub.org/files/Building%20Electrification%20Action%20Plan%20for%20Climate%20Leaders.pdf>

²¹ For details download the report at <https://www.eweb.org/about-us/power-supply/electrification>

- Even with additional incentives, space heat electrification from current gas systems for existing multi-family dwellings and small offices is likely to remain financially prohibitive as lifecycle energy cost savings are not anticipated to payback over the equipment lifespan.

Figure 23: Summary graphic from EWEB's Electrification Study. Deep green colors indicate greater benefits, while red colors indicate lower benefit or cost.

Electrification Scorecard	Carbon Reduced	Aggressive Carbon Reduction 2030			1-in-10 Peak Adder	Peak Management Potential	EWEB Engagement Opportunities
		EWEB Participant	EWEB Ratepayer	Society			
Electric Vehicle							Encourage managed charging to avoid peak, increase public and workplace charging opportunities
Heat Pump Water Heater							Consider existing energy efficiency incentive program's influence on electrification of water heating
SFD - Standard Heat Pump							Influence customer space heating technology choices to mitigate peak impacts.
SFD - Cold Climate Heat Pump							Influence customer space heating technology choices to mitigate peak impacts.
SFD - Dual Fuel Heat Pump							Influence customer space heating technology choices to mitigate peak impacts.
Multi-Family Dwelling Space Heat							Participant benefits are lacking, making electrification unlikely. Possible incentive opportunity.
Small Office Space Heat							Participant benefits are lacking, making electrification unlikely. Consider rate design changes for commercial electrification.

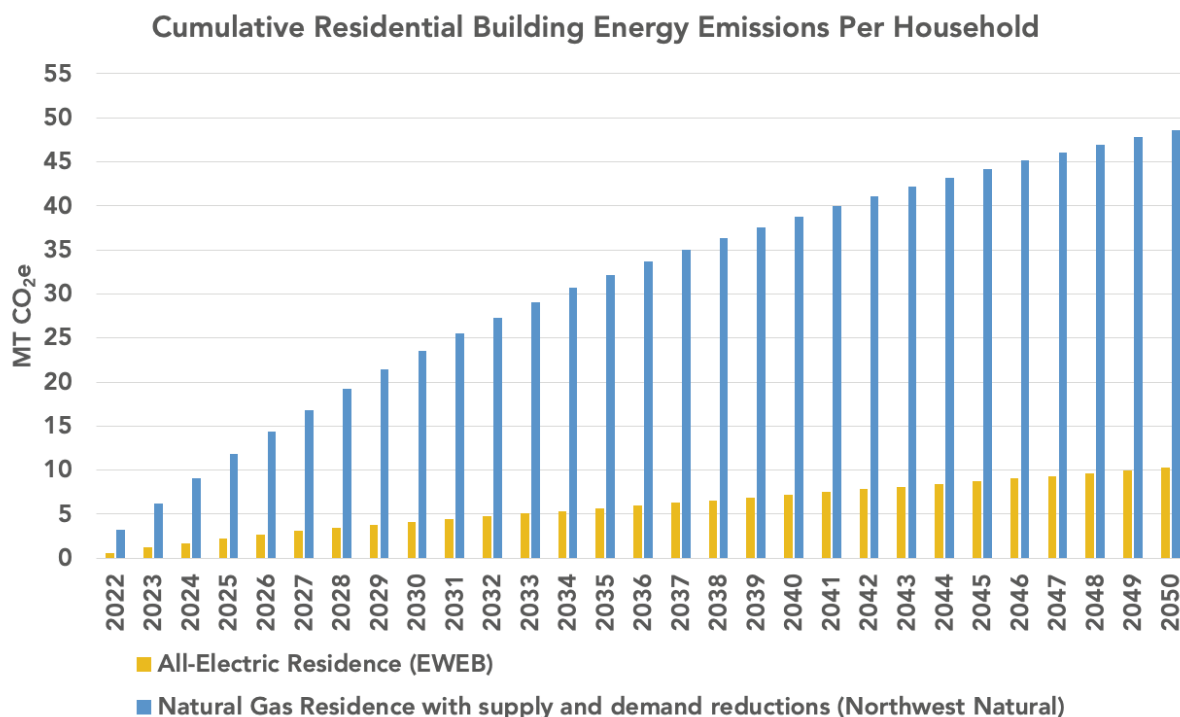
Existing Climate Policies, Electrification, and Timescale Urgency

The approach to this report is fuel neutral. Both of Eugene's local utilities have regulatory compliance requirements or voluntary commitments that will reduce the climate impact of their products between now and 2030 on the way to fewer emissions in 2050. It is not the intent of this study to give preference to one energy form over another – given that both suppliers are committed to sustained and significant GHG reductions. That said, the fastest route to reduced emissions is the safest route for the reduction of physical impacts from climate change. This must also be balanced with a transition that does not inadvertently harm many in the transition – whether that be individuals or groups of people that have been historically underserved, or the largest companies that keep an important number of families employed and taken care of.

The speed of a transition must be considered when considering residential decarbonization alongside other important factors. Eugene's electricity is already very low carbon (90% low carbon/renewable), and electrification equipment is already readily available. Heating equipment – the largest use of energy in the residential sector, has a lifespan of 15-20 years. Over the next 20 years significant cumulative emissions can be saved if electrification of homes is pursued instead of waiting for the Climate Protection Program requirements to achieve reductions in household gas use.

Figure 24 provides an example comparison of cumulative emissions for an average Eugene household served by electricity only versus a gas residence. A household electrified tomorrow would result in a savings of more than 40 MT CO₂e between now and 2050.

Figure 24: Residential building emissions through 2050



CASE STUDY – ITHACA, NEW YORK COMMUNITY-SCALE ELECTRIFICATION

Ithaca, New York recently secured private funding to retrofit 1,000 existing residential units and 600 existing commercial units to include enhanced weatherization; electrification of all building systems; ready the structures for EVs and solar PV; along with electric system upgrades needed to support these changes. A second phase will include another 3,500 residential units and 900 commercial units. To estimate funding needs – Ithaca assumed a maximum all-in cost of \$50k per residential upgrade but believe the average cost to range from \$35-40k per residential upgrade and \$70k per commercial upgrade. By doing such a large swath of the housing at once (more than half of existing buildings), Ithaca hopes to reach economies of scale and drive down prices further. Instead of providing loans and incentives to the homeowners, Ithaca found that it was a more efficient use of the money for the city to administer the retrofit service, and then recoup the cost of the loans across the homeowner's energy bills. One notable distinction with Eugene is that Ithaca has a single municipal utility that provides both electricity and gas service, and so the utility still collects revenue from the fuel switching and the savings to customers shows up on a single bill.

Carbon Offsets

Purchased carbon offsets provide financial support to projects that reduce or store additional carbon that would have not otherwise been financially viable. Carbon offset projects must follow existing protocols to establish the project, monitor its benefits, and verify the benefits for sale. There are a variety of carbon offset providers in the marketplace that produce credits of varying quality. The highest quality being regulatory grade credits like those used in the California Cap-and-Trade program. Project types vary and can be related to things like landfill gas capture, avoided deforestation, dairy methane capture and use, etc. Northwest Natural has partnered with a regionally respected offset provider, The Climate Trust, to offer on-bill carbon offsets from projects that capture renewable methane from dairies. In 2021, the Eugene community (individual households) voluntarily purchased offsets for over 15,000 MT CO₂e which is the equivalent for about 8% of total community natural gas emissions.

While there is much debate about the validity of carbon offsets and their place in decarbonization; what is true in climate action is that the technologies and policy tools are not always available fast enough, or now of replacement to meet the rapid pace required by climate goals. Until the availability and price of technologies keep pace with the GHG reductions required to reach climate goals – there will be a need for offsets. And even after all mitigation opportunities are maximized over time, there will still be a place for offsets and other forms of “negative emissions or removals.” These negative emissions from offsets will be needed to go beyond a zero-carbon future to maintain average global temperature increases within globally agreed upon goals and will be achieved through natural sequestration of trees or through new technologies. Our first need is to stop producing emissions, our second need is to start going negative with emissions through biological and technological means.

Implementation Costs

The following sections describes estimated costs for equipment and labor as well as projections for future energy costs.

Appliance and Installation Costs

Accurately estimating costs for community-scale electrification is challenging. The following high-level estimates are provided for sense of scale but are subject to significant change depending on the assumptions made. These calculations are purposefully kept at a high level to allow for full transparency and are meant to facilitate discussions of costs and the various components to be considered. These costs are large in scale and will have impacts on households across Eugene as they are implemented, but these costs also represent significant economic opportunity and job creation for local businesses who will support this massive transition over the next 20 years. Further, as any appliances age out, households will be replacing these systems anyway.

Costs were estimated for the various “pillars” of the decarbonization strategy, including:

- **Appliance upgrades (HVAC and hot water):** Costs for installed HVAC and hot water are aligned with EWEB's Electrification report.²²
 - Heating and Air Conditioning
 - Natural Gas Baseline
 - Gas Furnace: \$4,800
 - Split Air Conditioner: \$6,100
 - Gas Storage Hot-Water Heater: \$1,500
 - Electrification Options
 - Standard Heat Pump (ductless): \$7,000 (3 head)
 - Dual Fuel Heat Pump (ducted): \$11,000
 - Cold Weather Heat Pump (ducted): \$16,400
 - Standard Heat Pump (ducted): \$9,800
 - Electric Heat-Pump water heater: \$2,700
- **Electric service upgrades:** A cost of \$2,000 per household is aligned with EWEB's electrification report. This cost is assigned to households currently using natural gas and other fuels as their primary heating fuel. Households currently using electricity as a primary heating fuel are assumed to have the circuits required for heat pump upgrades.
- **Weatherization upgrades:** A cost of \$7,800 was provided by Homes for Good as the average cost of per household efficiency upgrades as of 2020. Values in other studies were similar or less than this value as an average per household, but do not consider the recent inflation on construction goods. Weatherization cost is allocated to the number of households built prior to 1990 and further adjusted based on the number of households that have already participated in Energy Trust of Oregon programming. These costs are assigned to all fuel types.

Figure 25 below compares costs for Baseline natural gas systems replacement with electric heat pumps (HP) for space heating / cooling (HP) and Heat Pump Water Heaters (HPWH) along with costs for electric panel upgrades (to support electrification) and weatherization. Appliance costs are focused on the largest energy end uses within residential – space and water heating. *Weatherization will not be needed in all households – adjustments are made in the following figures to focus on homes built prior to 1990 that have not already participated in Energy Trust of Oregon programs and incentives.* The electrification scenarios, which include electric panel upgrades and weatherization, range in per household cost compared to baseline natural gas split systems (with no envelope upgrades), between \$5,600 (standard HP + HPWH) to \$16,500 (cold weather HP + HPWH).

²² For details visit <https://www.eweb.org/about-us/power-supply/electrification>

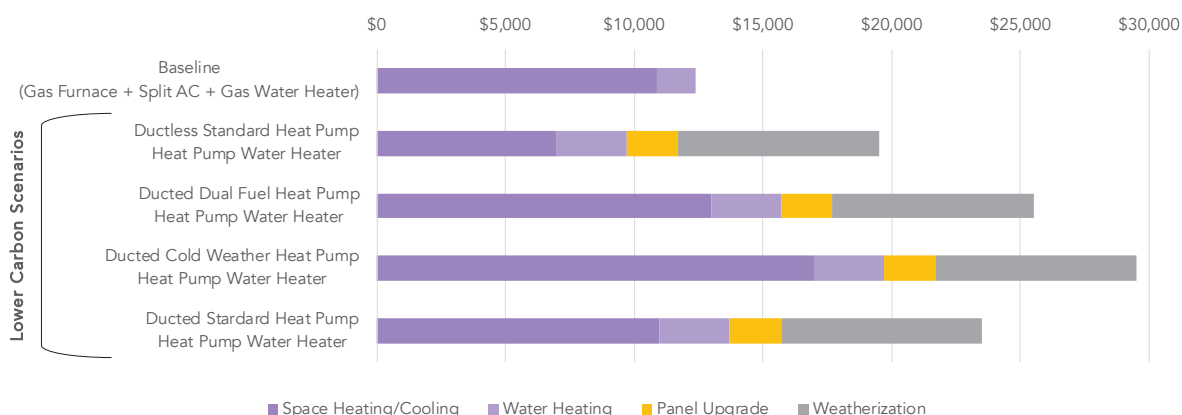
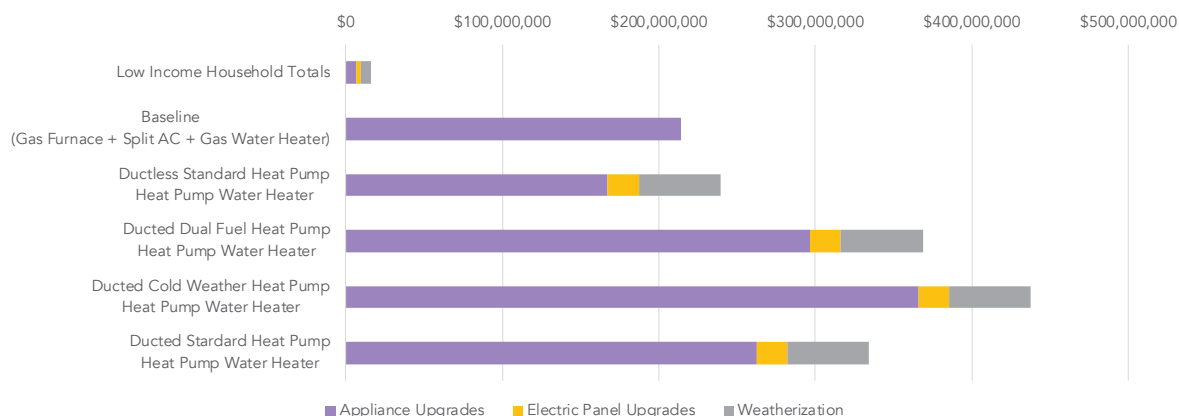
Figure 25: Per household cost to install Gas and AC system or other alternatives

Figure 26 presents the cost for retrofitting all households currently on gas or other high-carbon fuel all at once. Figure 27 shows marginal costs per household for these components. Costs for low-income households on these graphics are split from all other households, note that this only includes those low-income households currently using gas or other high-carbon fuel and assumes standard ductless heat pumps and heat pump water heaters.

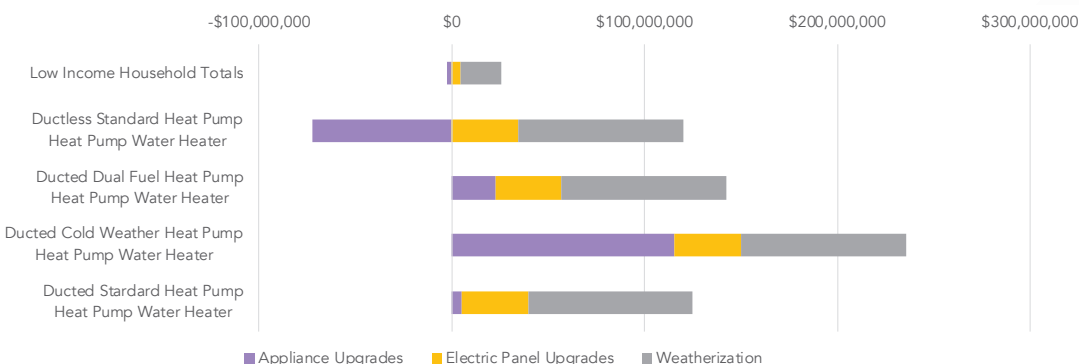
Total costs include appliance and installation costs. Marginal costs assume appliance upgrades are made at the point of natural replacement of the existing systems (e.g., furnace with split air conditioner and gas water heater) and therefore costs for the baseline system are subtracted from the costs of the other appliance technology options.

There are 570 households that receive public assistance and have gas or other carbon fuel as their primary heat source. The total costs for these low-income households equal roughly \$16 million dollars (in 2021 dollars) and between \$240 million and almost \$440 million dollars for all 17,249 other households depending on the heat pump technology installed.

Figure 26: Total cost for all at once clean heat retrofits for all low-income and all other households, by heat pump technology type.

Marginal costs are reduced significantly relative to total costs, between \$130 to \$220 million (or about \$6 - \$10 million per year over the next 22 years). Not all clean heat retrofit component costs have an incremental benefit – electric panel upgrades and weatherization expenses are not included in the original system cost. Weatherization expenses will vary from home to home significantly and are expected to be cost effective and payback over time (depending on the type of measure installed).

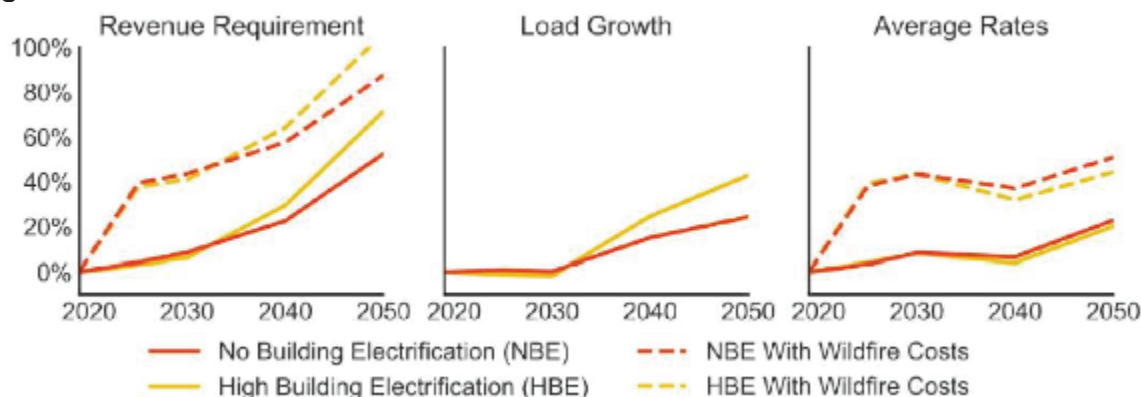
Figure 27: Total marginal costs for clean heat retrofits for low-income and all other households, by heat pump technology type, at natural time of replacement.



Energy and Fuel Costs

Future energy prices are difficult to accurately forecast with a myriad of possible futures that may come to pass. Regarding forecasting future rates, EWEB's electrification study references a report titled *The Challenge of Retail Gas in California's Low Carbon Future*.²³ This report found that electricity rate increases in California were forecasted to be moderate because of increasing renewable energy and fuels for the electric sector (20 – 40% by 2050) while natural gas rates could increase by 300% over the same period. Figure 28-29 summarize the findings through 2050 for natural gas and electricity. Note that in Figure residential and commercial

Figure 28: Forecast EWEB rate increases

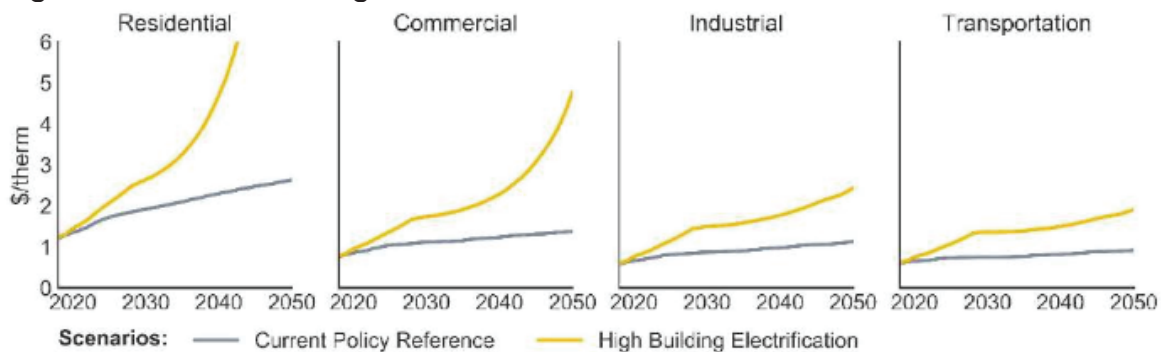


²³ "The Challenge of Retail Gas in California's Low Carbon Future", authored by E3 and University of California, Irvine, Advanced Power and Energy Program Engineering Laboratory Facility for the California Energy Commission, April 2020, CEC- 500-2019-055-F.

natural gas rates are anticipated to increase significantly more through 2050 because of building electrification.

Recently, natural gas utilities (including Northwest Natural) were required by public utility commission to model the impacts of potential future policy scenarios and bundles to determine how each might impact residential rates.²⁴ Northwest natural found similar residential rate increases (i.e., between 300% – 400%). These rate increases were attributed to high-electrification assumptions in the modeling and the associated customer losses which results in increased distribution system charges spread across a smaller customer base.

Figure 29: Forecast natural gas rate increases



Net Costs for Homeowners

A variety of studies that consider the first, incremental and net-lifecycle costs have come to similar conclusions – *that electrification retrofits will likely result in a small, but net cost to homeowners.*

EWEB's Electrification study found that costs outweigh savings across all the space heat pump technologies (Figure 30). If costs for electric panel upgrades (over 20 years) combined with equipment costs *additional costs for households are on the order of between \$2,800 - \$5,800 (\$180 to \$380 per year over 16 years) without additional financial support and incentives or a decrease in equipment costs over time.* Weatherization costs are assumed to be 100% cost effective over the equipment lifespan and are only installed if they payback. Another important aspect of heat pump technology is that it includes relatively inexpensive cooling, increasingly necessary as recent heat waves have proven deadly.

²⁴ For details visit UM 2178 - Natural Gas Fact Finding Draft Report
<https://edocs.puc.state.or.us/efdocs/HAH/um2178hah155046.pdf>

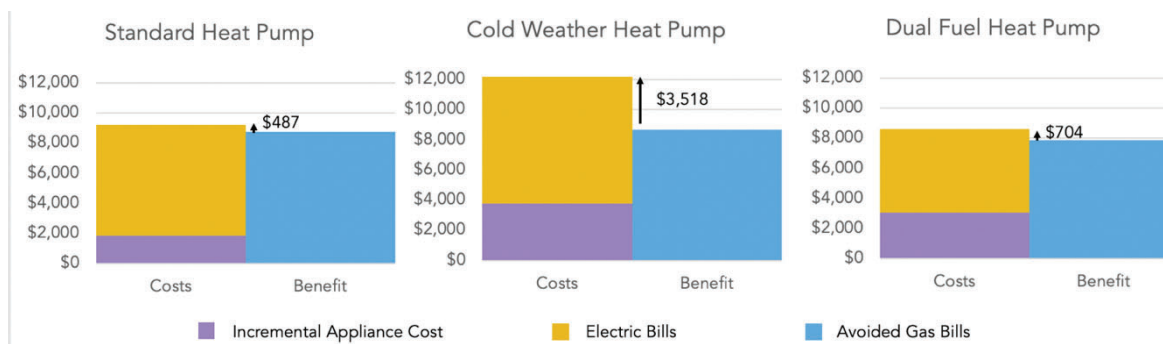
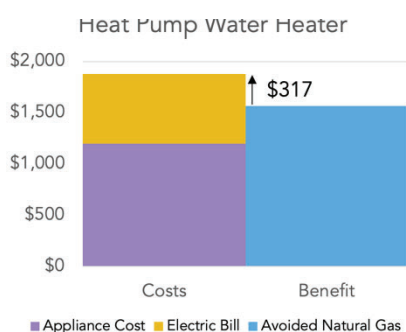
Figure 30: Comparison of Costs for Decarbonization of HVAC Systems

Figure 31 compares costs and benefits for a heat pump water heater. Like the previous, heat pump water heaters (using 2021 costs) result in a net cost to the homeowner until equipment costs decrease and/or natural gas residential rate's increase relative to electricity rates.

Figure 31: Cost Comparison for Heat Pump Water Heater

Funding Options

Depending on the city's policy choices, the funding structure could either come directly to the city to fund existing building decarbonization or be implemented in a more diffuse manner to aid homeowners in decarbonization projects. The city need not be the sole (or primary) administrator of a decarbonization program, an alternative program manager could be entrusted with the funding.

Community-Scale Decarbonization of Existing Buildings

Without a larger scale intervention, it is likely that decarbonization will rely on consumer choice, individual homeowner motivation, natural turnover rate, and market forces. This could be slow and inefficient; it also runs the risk of not reaching all residents. Instead, the city could follow the path of Ithaca, NY and take a broader scale proactive approach that would decarbonize much more quickly without requiring homeowners to pay upfront for the upgrades. The increased speed of decarbonization comes from upgrading many homes at once, without waiting for existing gas appliances to reach the end of their natural life. Ithaca's program

modeling found it to be a more efficient use of funds to finance the efficiency and electrification directly instead of providing incentives and rebates to homeowners.

Taking this option would require bringing on experts such as AMERESCO, Johnson Controls, McKinstry, Siemens, or a similar [Energy Services Company](#) (ESCO) to administrate a large-scale program. Such a program would also avoid the equity challenges associated with requiring individual homeowners to finance all or part of their electrification/efficiency upgrades. Residents are responsible for repaying the debt-financed upgrades, but repayment schedules can be spread equitably among residents without being strictly governed by the cost for any building. By aggregating 1000+ homes at once, the risk of insufficient energy savings to help repay the loan is spread among the different homes, thereby decreasing the risk for investors. Further, with a prescribed set of interventions that are known winners, the ESCO can achieve economies of scale that reduce the costs of equipment and installation. This approach would also be a significant job creating program for our community.

The following describe various approaches for funding community-scale programs:

- **Energy Efficiency and Conservation Block Grant Program**

The US Department of Energy is awarding \$550 million in block grants to communities for a variety of energy efficiency programs. They expect to open applications by Q4 2022. Its purpose is “To assist states, local governments, and Tribes to reduce energy use, reduce fossil fuel emissions, and improve energy efficiency.” This program would align well with Eugene’s needs, providing funding for all parts of the residential program discussed in this report including developing a strategy, retaining technical assistance, conducting audits, establishing financial incentive programs, providing grants to nonprofits, developing programs for energy efficiency in buildings and transportation, developing building codes, community interest raising, onsite renewable generation for government buildings, and financing retrofit and energy efficiency programs.

- **Sales Tax or Surcharge**

Denver, CO instituted a 0.25% sales tax to fund their building decarbonization project. This tax provides about \$40 million a year to the city’s Climate Protection Fund. The funds will offset electrification costs by 80%. This funding provides up-front rebates that cover a large proportion of the price of electrification upgrades. Rebates are up to \$9,000 for a heat pump, \$3,200 for a heat pump water heater, \$4,000 for home solar, \$2,750 for battery storage, \$2,000 for electrical panel upgrades, \$1,000 for EV charging, and \$400 for an ebike. Many of these sums are increased for income-qualifying residents.

CASE STUDY: PORTLAND, OREGON CLEAN ENERGY FUND

Portland’s Clean Energy Fund is supported by a 1% surcharge on large retailers (such as Target or Lowes). To be subject to the surcharge a business must have \$1 billion or more in U.S. sales and at least \$500 thousand in Portland sales (excluding grocery, medicine,

health care services, and other exemptions). This is not intended to be a sales tax, but many retailers are adding a fee to customer's purchases. Portland uses these funds to support small projects that advance clean energy development for underserved communities. The anticipated revenue for this in Portland is between \$44 - \$61 million per year. The fund is currently awarding small (\$5,000) grants to non-profits to advance clean energy projects that center marginalized communities. NOTE: State of Oregon legislation, passed in early 2022, may not allow other jurisdictions to pass similar taxes.²⁵

- **Private Equity Funds (Ithaca, New York)**

Ithaca, NY did not have access to existing finance (like a Property Assesses Clean Energy (PACE) program, see description below), so instead they gathered private equity funds to finance a weatherization and electrification retrofit program for residential and commercial buildings. They employed an investment firm to secure funding and an ESCO, Bloc Power, to manage the installation. In addition, the project improved the city's debt rating, making borrowing cheaper for project participants.

- **Climate/Green Bonds**

A financial instrument designed to raise money for climate and environmental projects, which function the same as other government-issued bonds. They are verified by a third party (such as the [Climate Bonds Initiative](#)) to assure their climate benefit and the buyer often gets a tax benefit for investing. \$50 billion in green bonds were issued domestically in 2020. The term "climate bonds" is sometimes used interchangeably with "green bonds", but "climate bonds" also implies direct climate benefits, and greenhouse gas reductions. Tesla Motors issued \$600 million in green bonds in 2013. The city of Asheville, NC issued green bonds in 2016 to pay for infrastructure upgrades and water system improvements.

- **Social Impact Bonds**

Social impact bonds are like Climate/Green bonds but are intended to finance social change. The bond pays for better social outcomes that result in desired savings (lower correctional spending or energy savings) and pays back investors out of those savings. The bonds only repay if the desired results are achieved. Therefore, these bonds have greater risk for the investor. Santa Clara, CA issued social impact bonds to reduce homelessness in their community. Salt Lake City, UT issued bonds to pay for early childhood educational interventions to increase educational achievement and decrease

²⁵ For details see 317A.158 Local taxes preempted here https://www.oregonlegislature.gov/bills_laws/ors/ors317A.html

the need for later interventions. Find a database of social impact bonds around the world here: <https://sibdatabase.socialfinance.org.uk/>

Funding for Home and Building Owners

Utility Sponsored Energy Efficiency Programs

- EWEB offers rebates and zero interest loan programs for ducted and ductless heat pumps, heat pump water heaters, and efficiency. They offer both standard rebates and loans and low-income loans which offer up to **\$3,800** in rebates and up to **\$4,000** plus **\$1,500** per head in zero interest loans for ductless heat pumps. Visit this link for current incentives: <https://www.eweb.org/residential-customers/rebates-loans-and-conservation>.
- Northwest Natural offers rebates for the installation of new gas furnaces and water heaters including a **\$1,000** incentive for a 90% annual fuel utilization efficiency gas furnace for eligible moderate-income households. All current incentives can be found here: <https://www.energytrust.org/residential/incentives/>.
- **On Bill Financing/Repayment:** This is a system whereby the utility pays for all/part of an upgrade and then the recipient pays it back over time by paying a charge on their electricity bill per kwh saved that is less than the market rate.
 - *Example: If the upgrade saved 100kwh/month then the customer would pay some amount that is more than their actual energy usage, but less than they would have paid without an upgrade.*
 - There are variations on this theme depending on who invests the initial money. See ESPC (below) for a more general definition. For example, an ESCO company may provide the financing

Property Assessed Clean Energy (PACE) Financing

PACE loans are backed by the local government or some other partner to pay upfront costs for energy upgrades. Then the loan is repaid with property taxes. The financing remains with the property, not with the borrower, so selling will also transfer responsibility for repayment. This kind of financing can present obstacles to selling a house. Both commercial and residential PACE programs are legal in Oregon, but there are no residential programs currently offered. There is some concern that PACE financing ties people to high interest loans and because the loan is tied to property taxes it can increase the risk of foreclosure. For this reason, residential PACE is rare (only California, Florida and Missouri have active programs).

Energy Savings Performance Contract (ESPC)

An energy service company (ESCO) coordinates installation and maintenance of energy efficiency equipment in a customer's facilities and is paid from the associated energy savings. The ESCO typically provides a savings guarantee. The improvements are usually owned by the customer and may be installed with little or no upfront cost if the ESPC is financed. ESPCs are

suited for larger (\$1 million+), more complex projects with high upfront costs, though they have sometimes been used for smaller projects. ESPCs are also called energy performance contracts (EPCs).

OHCS Cooling Funding

Recently passed in House Bill 1536, the state appropriated \$15 million dollars to go toward a residential heat pump fund to aid landlords and homeowners in getting permanent cooling into low-income homes. The program is not yet deployed, but it is intended to come online in the 2023.

Local Best Practice Programs and Funding Opportunities

Figure 32 summarizes local organizations that provide financial assistance for low-income residents and other community members for energy efficiency and weatherization and appliance upgrades.

- More local, flexible funding for low-income household programs is needed
- Interviews noted that a central staff person coordinating services between groups and programs would make the local system more efficient.

Follow the links below for a wealth of additional information about programs, specific opportunities, eligibility, applications, and program contact information.

- City of Eugene: <https://www.eugene-or.gov/852/Emergency-Minor-Home-Repair-Program>;
- Eugene Water and Electric Board (EWEB): <https://www.eweb.org/residential-customers/rebates-loans-and-conservation>
- Habitat for Humanity: <https://habitatlane.org/home-repair/>
- Lane County/Homes for Good: <https://homesforgood.org/programs/weatherization>
- Low Income Home Energy Assistance Program (LIHEAP): <https://www.lanecounty.org/cms/One.aspx?portalId=3585881&pageId=4213698>
- Northwest Natural / Energy Trust of Oregon: <https://www.energytrust.org/residential/>
- Oregon Department of Energy: <https://www.oregon.gov/energy/Incentives/Pages/default.aspx>
- Oregon Health and Community Services (OHCS): <https://www.oregon.gov/ohcs/energy-weatherization/Pages/weatherization-services.aspx>
- St. Vincent De Paul of Lane County: <https://www.svdpc.us>
- State Home Oil Weatherization Program: <https://www.oregon.gov/ohcs/energy-weatherization/Pages/show.aspx>

Figure 32: Summary of local organizations/programs that support best practices through technical assistance and financial support

Local Agency or Program	Low-Income Programs	Energy Costs	Home Repairs	Energy Audit	Building Envelope	Heating / Cooling Systems	Water Heating	Electric Panel Upgrades	Onsite Renewables + Storage	Mobile Home Upgrades
City of Eugene	✓		✓	✓						✓
EWEB / BPA	✓	✓		✓	✓	✓	✓	✓	✓	✓
Habitat for Humanity	✓		✓							✓
Lane County / Homes for Good	✓		✓		✓	✓		✓		✓
Low Income Home Energy Assistance Program	✓	✓	✓		✓					✓
Northwest Natural Gas / Energy Trust	✓				✓	✓	✓			✓
Oregon Department of Energy	✓					✓			✓	✓
Oregon Health and Community Services	✓		✓		✓	✓	✓			✓
St. Vincent de Paul of Lane County	✓									✓
State Home Oil Weatherization Program					✓	✓				✓
Catholic Community Services/ Oregon Energy Fund		✓								

Equity Considerations

Equity is an important consideration for community programming, especially given rising housing costs in the community and beyond. Rental single-family homes are less energy efficient than others, on average consuming 15% more energy per square foot than owner-occupied homes, per the American Council for an Energy-Efficiency Economy (ACEEE). According to the Eugene Springfield Comprehensive Plan, households paying more than 30% of household income toward housing are considered to have a 'housing cost burden', with 55% of all renters in Eugene considered housing cost burdened, and 27% of Eugene homeowners considered housing cost burdened. **Overall, 46% of all Eugene households are housing cost burdened.**

In addition to household income, equity considerations include race and ethnicity, particularly BIPOC community members; age, including seniors and youth; health and disability; LGBTQIA+ people, and more. These communities may have lower assistance/adoption rates, need more assistance, or face higher risks related to their housing situation (e.g., heat wave health risks, wood smoke health risks, or exposure to environmental hazards). In addition, renters and mobile home residents face additional challenges.

Manufactured and Mobile Homes Highlight

The roughly **2,500 mobile homes in Eugene represent 3% of all homes, but 6% of residential building emissions.** As shown in Figure 33, single family homes account for the largest portion of GHG emissions from residential buildings. Mobile homes, on the other hand, make up a small proportion of the total emissions, but have a very high per unit and per square foot intensity as seen in Figure 34. This data highlights an opportunity to expand programs to reduce energy use and associated costs for people living in mobile homes while increasing comfort and resilience to heat events – which generally means total replacement due to modern insulation standards.

Figure 33: Absolute emissions associated with different housing types

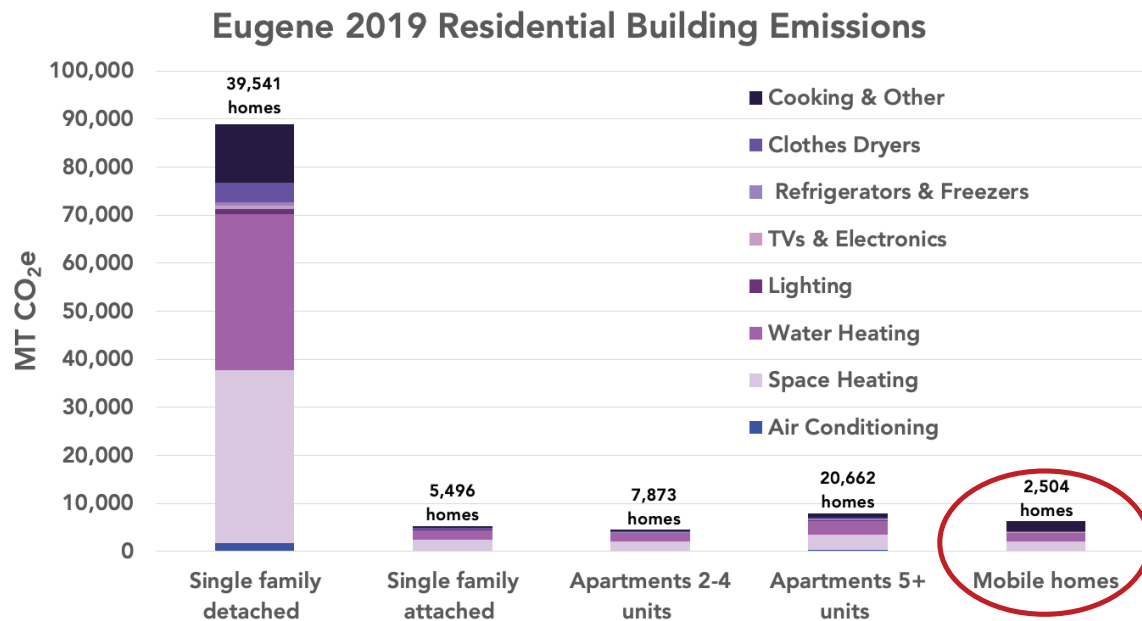
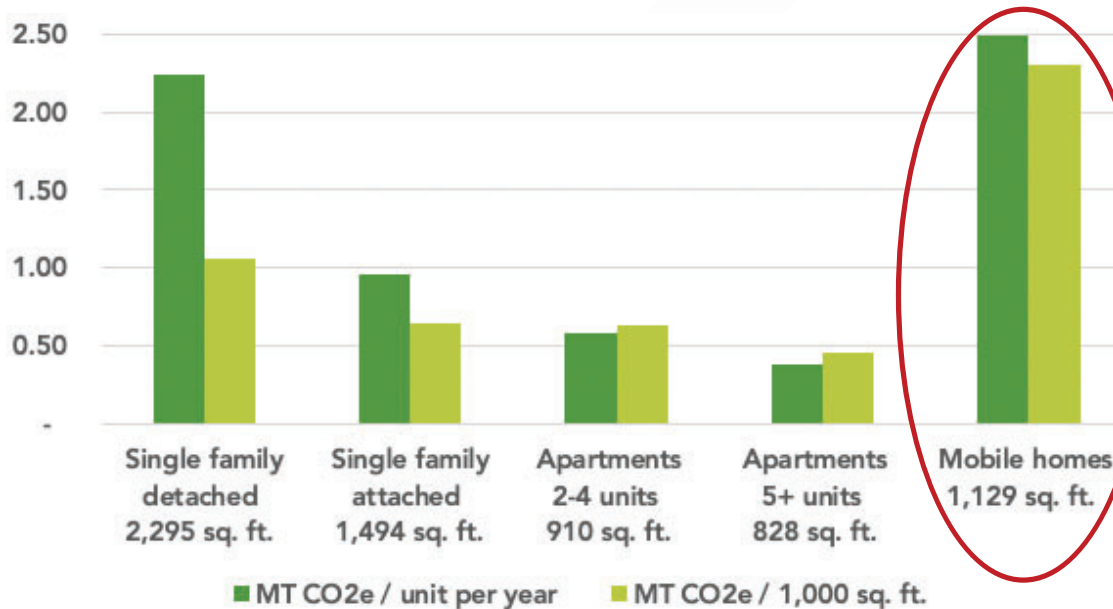


Figure 34: Emissions per unit and per 1000 sq. ft. by housing type



Mobile homes use more total energy and energy per square foot compared to an average sized single-family home, creating high utility bills which in turn can increase need for energy assistance programs. Per OHCS, in FY2018, 32% of Lane County homes receiving Low Income Weatherization Assistance were mobile homes.

The **Energy Trust of Oregon** has used fixed-price campaigns in partnership with vendors, outreaching to mobile home manufacturers and parks, and considers this a growing strategy.

This strategy creates economies of scale to update many small homes in a small area. ETO puts out requests for pricing in trade ally network, vendors respond and get zero-cost customer acquisition with some built-in advertising. There is a struggle with price commitment amid inflation and supply chain issues, but overall, this strategy is working well.

Many existing programs rely on community awareness of the programs, and homeowner initiative to start a process. Documentation can be cumbersome and income thresholds strict. Eugene should focus on targeted outreach, using the information in this report to approach older, energy burdened, manufactured, and single-family homes in the census tracts in need. Equity cannot rely on underserved groups coming to the table; rather, the city must join them at their table.

Equity disparities in Eugene

Disparities become more challenging over time as the Eugene community address the physical impacts of climate change. For example, as the climate changes there will be increased demand for cooling. Housing with poor weatherization and no cooling will not only experience higher energy needs and utility bills but will also be at increased risk for negative health impacts. The following maps were provided by Oregon Housing and Community Services²⁶ and show various housing and energy disparities within the City of Eugene by census tract that help us see which neighborhoods should be made a priority for support. Figure 35 Figure 36 show the census tracts where residents of color and with low income live, respectively. Figure 37 shows the census tracts where the residents are at a disproportionate risk of rising energy costs, a function of need for cooling and socio-economic factors. Finally, Figure 38 shows the census tracts where energy efficiency will be most cost effective in low-income housing, giving a guide to where the city could begin to focus attention. (Maps on following page.)

²⁶ Maps accessed at

<https://osugisci.maps.arcgis.com/apps/webappviewer/index.html?id=189e21ea4f694168ad519a18ef99ef60> and <https://njcep.maps.arcgis.com/apps/webappviewer/index.html?id=18c4e8f1082e4a039f69401386e06e32>

Figure 35: Percent people of color by census tract

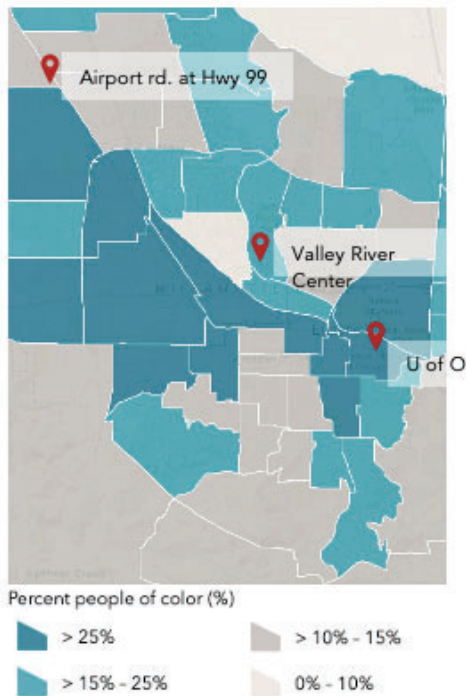


Figure 36: Percent low-income households by census tract

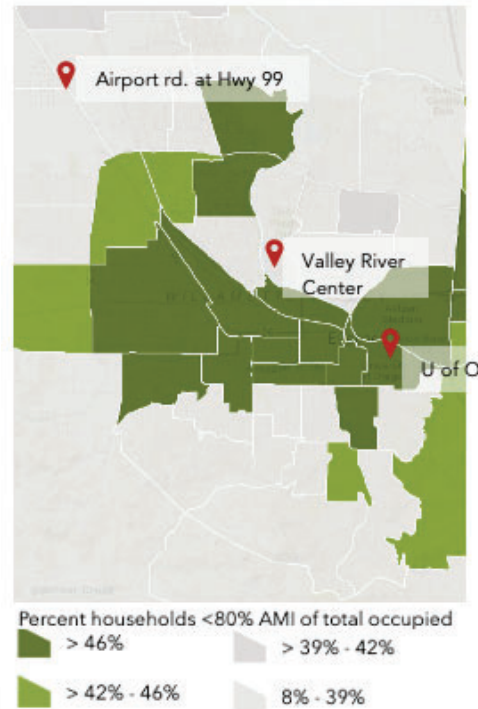


Figure 37: Census tracts experiencing energy cost risk based on Energy Use Intensity, income, and racial makeup

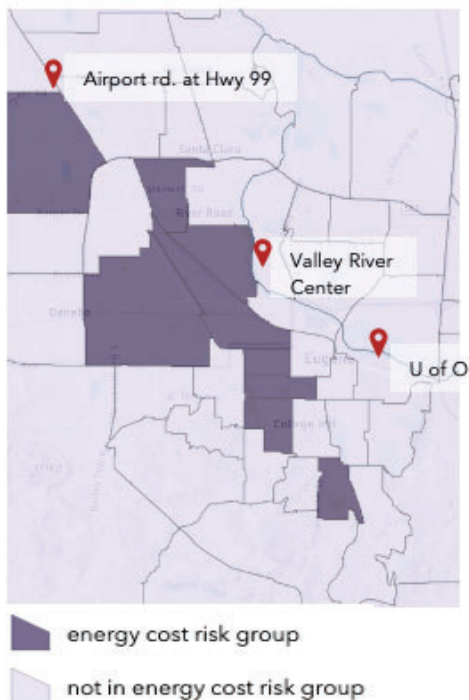
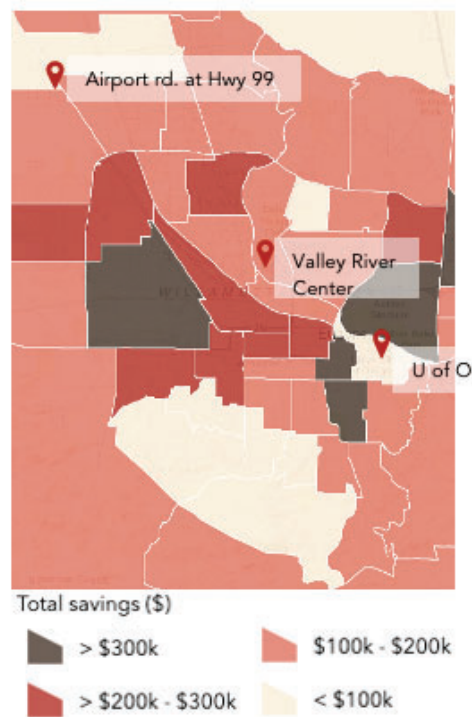


Figure 38: Cost-effective energy savings in low-income housing



Barriers and gaps

- **Limitations on which houses can get funding**
 - OHCS and other partners can't provide services on **homes with lead and asbestos**, meaning no work on homes **built before 1976**. These older homes are likely to be less efficient and require more updates
 - **Some programs aren't available in Eugene**. Saint Vincent de Paul has a Regional Housing Rehabilitation Loan Program for home repairs for health and safety but is only available to rural households.
- **Limitations on which people can get funding**
 - **While the focus on low-income households is good, there are strict all-or-nothing cutoffs for state and federally funded programs.** Lower-income households making just \$20 over the thresholds don't qualify for any assistance through most programs. The funding requirements are too rigid **and require a lot of documentation** with no tiered assistance. **Sample requirements include household income max 200% of federal poverty level (FPL), 60% of state median income (SMI), or 80% of SMI depending on the funding source**
 - **Renters are not able to apply for assistance programs.** Rental units are underserved as there is little incentive for landlords
 - OHCS's **Manufactured Home Replacement Program** for mobile homes built before 1980 currently **can only serve landowners**, not those that lease the land the home is on.
- **Funding**
 - **Existing programs need funding – flexible, local funding.** Each situation is unique and may not fit into a one size fits all program. Federal and state funding is often too restrictive and leaves out a lot of homes, and federal funding can typically only go to existing federal projects, not private housing.
- **Difficulties applying and long waits**
 - **Programs exist, but the need exceeds available funding and creates long waiting lists.** For example, OHCS funding can currently only serve 17.8% of eligible households. Their score-based program focuses on elderly, disabled, families with young children, and households with high energy burden
- **Duplexes and single-family homes** are historically **slow to participate in energy efficiency programs**. These homes use more energy both per unit and square footage than other housing types, other than mobile homes.

Best Practices from local stakeholders and research

- **Designate future funding to where it is needed.** This applies both to energy users and equity needs, which are not always in alignment.
 - The City of Ithaca designated at least 50% of the economic, social and environmental benefits to **disadvantaged communities**. Similarly, OHCS's score-based system for programs focuses on elderly, disabled, families with young children, and households with high energy burden.
- **Reaching more households**
 - In order to serve **low to middle income households that don't meet income or documentation requirements (such as tax returns)** for home repairs, energy efficiency, and weatherization, **different rates for the private costs** based on income instead of an all-or-nothing approach can include more people in need.
 - Incentives are typically based on income, which doesn't work with **rental homes**. **Transact directly with landlords and don't base it on tenants' income.** Simply have the landlord fill out an application.
 - **Create private financing convenience.** Options include on-bill financing, where costs are billed with their utility bill. Agencies can work with local lenders to provide loans with better terms for electrification or home efficiency projects, especially those that will provide utility bill savings.
- **Protecting our community members**
 - **Address the need for permanent, effective cooling.**
 - **Protect Naturally Occurring Affordable Housing (NOAHs).** Have a goal to maintain existing housing stock while preserving against blight. Work against increasing rents and real estate prices while improving existing building stock. The city has several Housing and Human Services Plans that align with building energy equity.
 -

Recommendations for the City to Act

Prioritize actions for existing buildings to decarbonize where it's needed the most

Existing buildings represent a large proportion of Eugene's current emissions and will continue to do so for the foreseeable future. All future buildings will be built to higher standards so there is less opportunity for measures to reduce emissions. Even with the substantial emissions decreases expected from the Climate Protection Program, the bulk of the emissions are in the current housing supply up until 2050, which is two full appliance replacement cycles away.

Focus City decarbonization programs on single-family and mobile/manufactured homes

Mobile/manufactured homes have the largest per unit and per square foot emissions, due largely to their building envelopes. Retrofitting these homes also serves a sizeable low-income

population. Single family homes make up the largest portion of emissions, with the second highest per unit and per square foot emissions. Although in general these homeowners are middle and upper income, **low-income single-family homes** represent a significant equity and emissions reduction opportunity. All other types of dwellings are both more efficient and a lower portion of the total housing stock. Multi-family homes are generally much more efficient than other housing types, but HVAC retrofit programs that provide heat pumps for summer cooling is an important safety and health measure.

Amplify outreach, integrate services, and manage the program to accelerate adoption

Coordinated **outreach** is lacking. There are many agencies and service providers, but they do not coordinate in messaging or in practice. This leaves residents scrambling for information and services. A central messaging resource would let residents, HVAC companies, and contractors know about all the potential financial and practical services available for low-carbon retrofits.

Project management is crucial. A central project manager would streamline and troubleshoot the application processes, increasing access. It could also connect consumers and contractors to accelerate the current ad-hoc process or take a greater managerial role as in the Ithaca example. The **financing** required for administering such a large acceleration in decarbonization will likely have to come from private debt financing, not necessarily administered by the city. An ESCO organization could aid in securing funding.

Secure future debt and grant financing that is flexible to maximize implementation

Make financing easy to apply for and flexible to use. For leased units, financing should transact directly with landlords and not base it on tenants' income; simply have the landlord fill out an application.

Include a focus within City decarbonization programs on permanent, energy-efficient cooling from heat pumps for existing multifamily units for resiliency and safety

EWEB expects that as temperatures shift and air conditioning load is added they will move from a winter-peaking utility to become a dual-peaking (winter and summer) utility to serve the Eugene Community. Providing efficient permanent cooling solutions to energy cost burdened households and rental properties is essential for safety and reducing future peaks.

Align timelines (but not goals) with the State

Eugene should still press ahead with more ambitious total decarbonization goals but aligning the timepoints will make compliance and reporting easier for companies and agencies. By setting the goal at 100% by 2050, Eugene would still be pushing beyond the State's goal of 80% by 2050 but with greater access to relevant data and less time required to adjust information to a different timeline.

Part 2: Commercial Sector

While there are many studies related to decarbonization of the residential sector – there are far fewer examples of existing plans and guidance for the commercial and industrial sectors. The commercial sector includes a wide range of business types and related energy needs. For this section of the report – information is broken into commercial “segments”, primarily as defined by the U.S. Energy Information Administration’s *Commercial Building Energy Consumption Survey*:

- Education, split for the University of Oregon and K-12
- Food sales (includes grocery stores)
- Food service
- Healthcare
- Lodging
- Office
- Public assembly
- Public order and safety
- Religious worship
- Retail
- Service
- Warehouse and storage

To help guide this project, for the commercial and industrial sectors, City staff directed our research team to coordinate with the Chamber of Commerce to interview business owners and building related service providers to help us understand the interests of the business community. Good Company interviewed 10 business owners and operators (Office, retail, food processing and wood products) and 7 building trades professionals (architects, engineers, contractors), but do not feel that those interviews were enough to adequately hear the voice of the business community and strongly recommend more deliberate and thorough engagement going forward.

Here are the key takeaways from the business owner and manager interviews:

- The business owners, building owners and the business operators must be involved in the discussion of regulations as major shifts that can make or break their businesses. If regulations are aimed at them, the city must engage them, so the city fully understands the risk and costs the transition poses to companies, employees, and their families.
- Many of owners and businesses have already made the personal and corporate commitments to decarbonize but have deemed some of the major equipment transitions to be too costly or not ready for deployment. These include solar electric, solar hot water, LED lighting and ductless heat pumps.
- Transitions to new equipment can happen cost effectively when the production systems are designed and capitalized, or at the natural time of replacement due to failure or the end of the equipment’s life cycle. An early/forced equipment transition may cause hardship or business closure. Production equipment ranges from 10-year lifecycles to 50-year lifecycles.

- Financial support is needed where the technology exists to make a decarbonization transition.
- Will the downtown power grid support the conversion of thermal loads for large government, office, housing, and hotel space?
- Will there be enough electrical generation capacity available to support electrification or the production of RNG/clean hydrogen to replace fossil natural gas?
- Will the City lead by example and manage the transition of City-owned building as fast as is being asked of the businesses?

Here are the key takeaways from the building trades professionals' interviews:

- Building remodels are usually focused on making the space functional before taking on heating and cooling. Lighting upgrades happen frequently because they are driven by space reconfiguration.
- Leasing tenant improvements rarely touch building energy systems because tenants don't want to upgrade a building they may not occupy for the life of the system. Further, building owners are less inclined to invest in a new building heating and cooling system when the tenants usually pay the utility bills.
- Very few clients look at total costs of ownership due to the increased capital costs to avoid the operating costs over time. Most need to work within the capital budgets and do not consider operating costs. This is the case for both private business and government operations.
- Local businesses report that their clients prioritize avoiding habitat impacts from sourcing of materials and avoiding toxic substances over reducing the impacts of climate change.
- Building trades professionals recommend Green Power/Wind and Smart Energy (NWN's offset gas program) to reduce greenhouse gas emissions when clients lack interest and/or budget to make energy system conversions until system failure or end of life for their existing systems. HVACs and lighting systems all have 15–30-year lifecycles and are matched with warranties of a similar timeframe.
- New energy codes for new buildings are moving quickly in the right direction. (New buildings)
- Operations and maintenance folks are often slow to adopt new technologies as they don't know from first-hand experience the reliability and true cost of operation and maintenance, so they tend to default to the technologies they know.
- Industrial heat pumps with CO₂ as the heat transfer medium (instead of water, steam, glycol, or refrigerants) can get to 160/170-degree F for industrial boilers but are not commonly used yet due to costs and technological limitations. In other words, existing heat pump technologies cannot achieve the high heats required for some applications.
- In this era of multiple year covid disruptions to global supply chains, followed by an attempt to rebound from it have made labor and equipment more expensive and scarcer.

Building Stock Characteristics

Local sources of detailed commercial building stock were not available given the timing and scope of this project. However, the Northwest Energy Efficiency Alliance Commercial Building Stock Assessment 4 (2019)²⁷ was recommended by Energy Trust of Oregon as the most regionally relevant, publicly available, and detailed data set publicly available.

The 2019 NEEA survey assessment found that 64% of commercial buildings surveyed in the Pacific Northwest region were built pre-1990 (Figure 39). The first commercial building energy conservation codes came into effect in the 1980s with updates on the 3-year development cycle and a notable change in 2007 as Oregon adopted ASHRAE Standard 90.1. The majority of commercial floorspace in the region was built prior to modern energy code standards.

Figure 39: Distribution of PNW floor space by building age in the 2019 NEEA survey.

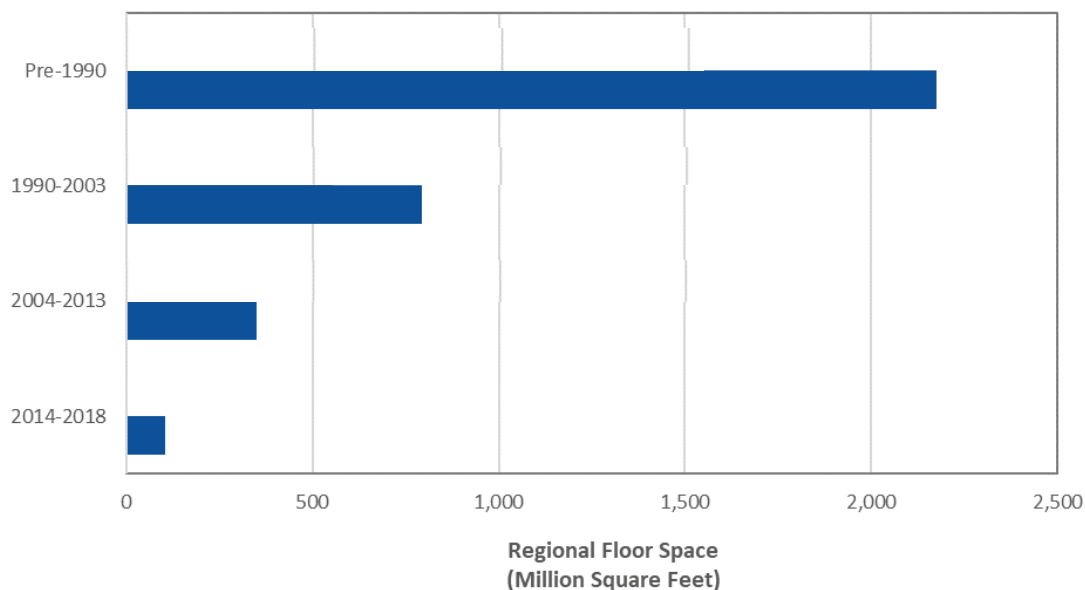


Figure 40 shows the distribution by building square footage in the PNW region. The majority (>50%) of commercial building floorspace is between 5,000 and 50,000 square feet.

²⁷ For details visit <https://neea.org/data/commercial-building-stock-assessments>

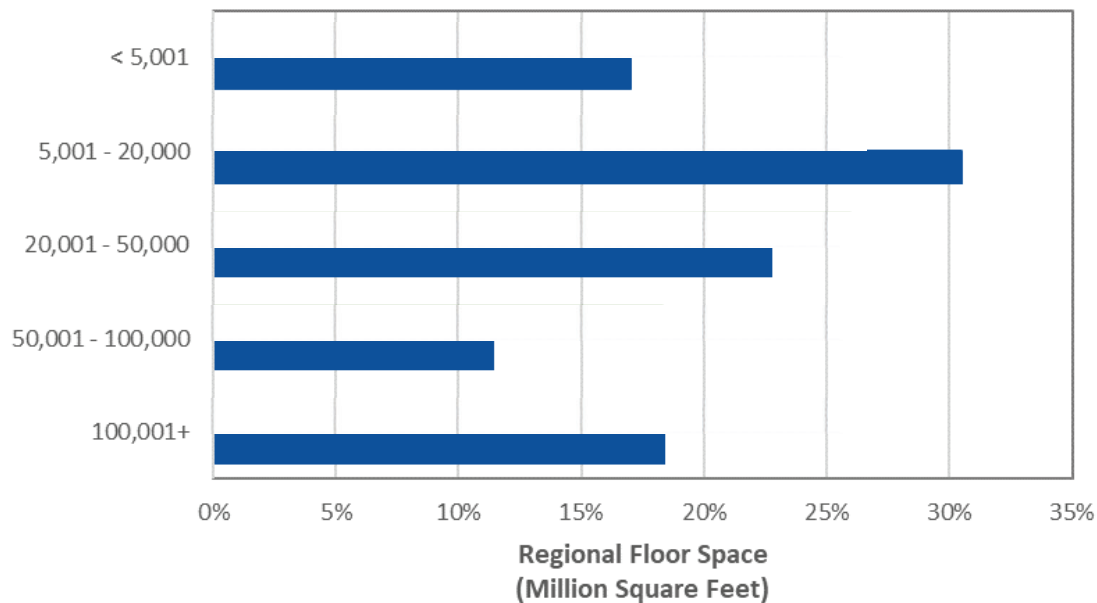
Figure 40: Distribution of PNW Regional Floor Space by Building/Site Size in 2019 NEEA survey.

Figure 41 shows the distribution by primary space heating system by building type. Electric heat represents greater than 50% of primary heating for lodging, with all other building types primarily being heated with gas furnaces, roof-top units, and boilers.

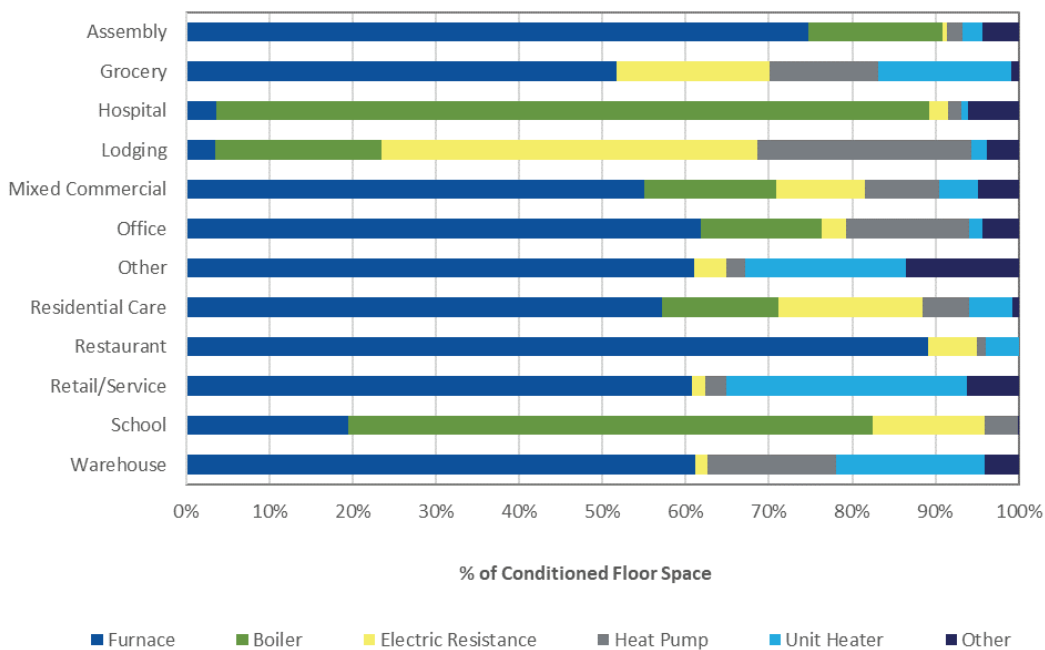
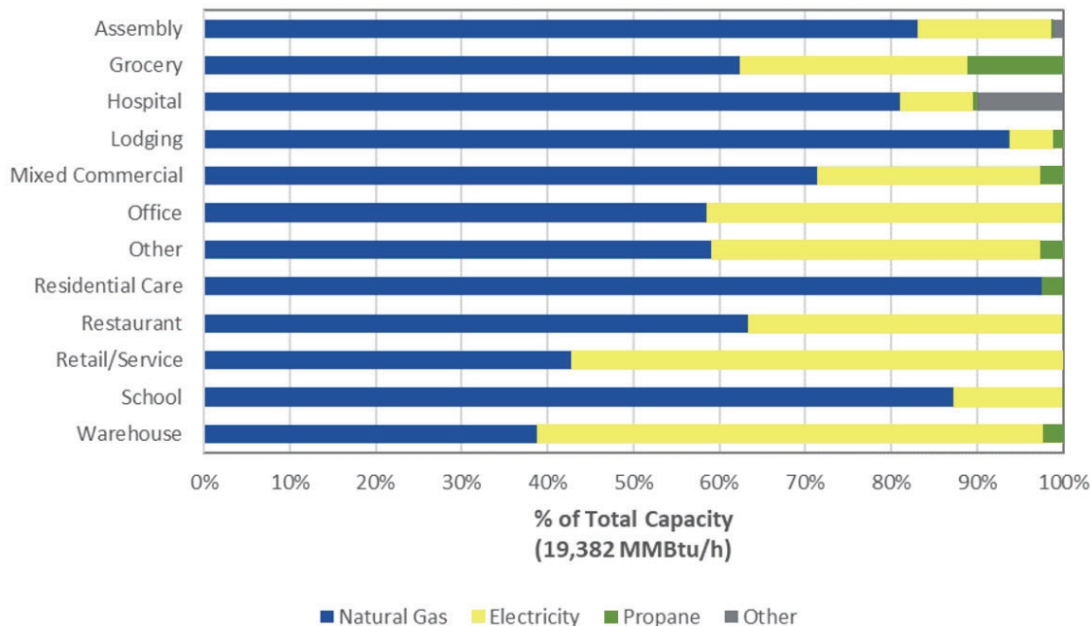
Figure 41: Primary heating system by building type

Figure 42 shows the distribution by primary water heating system by building type. Electric heat represents greater than 50% of primary heating for warehouse and retail buildings. All

other building types are heated primarily with natural gas, with some relatively small usage of propane and other fuels. Figure 42 is also taken from NEEA's 2019 to leverage the most recent, regionally relevant data publicly available.

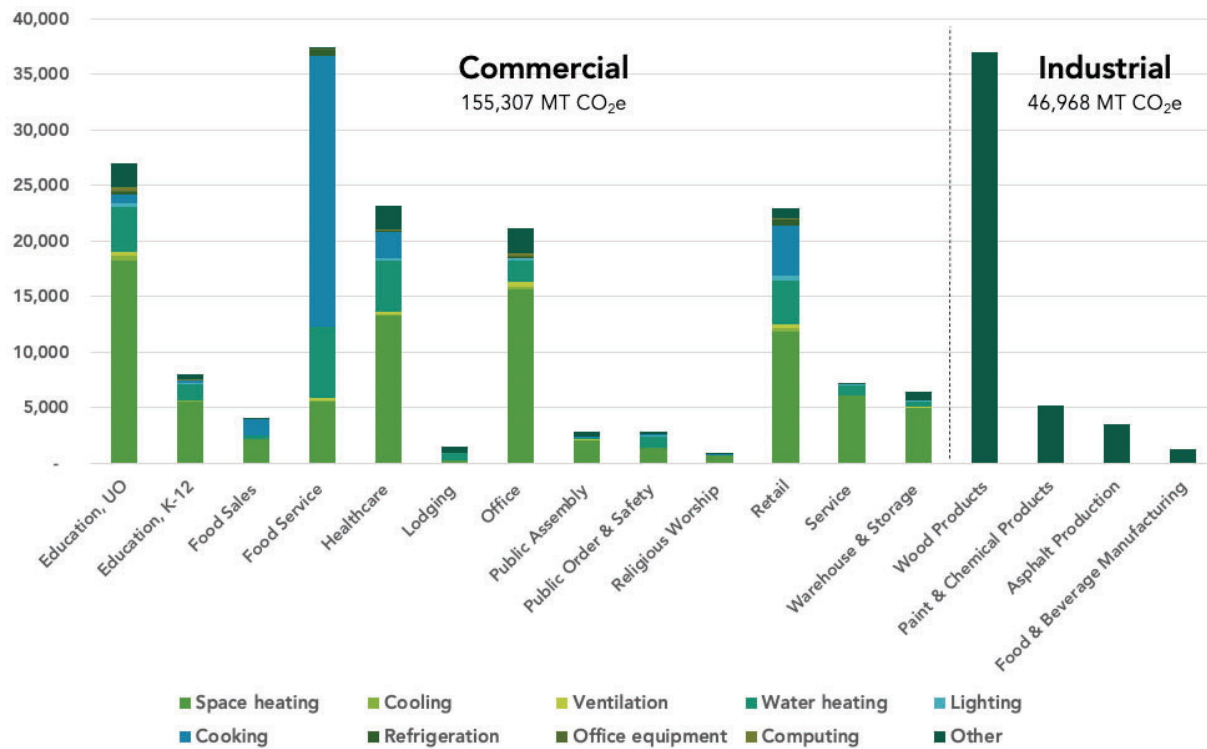
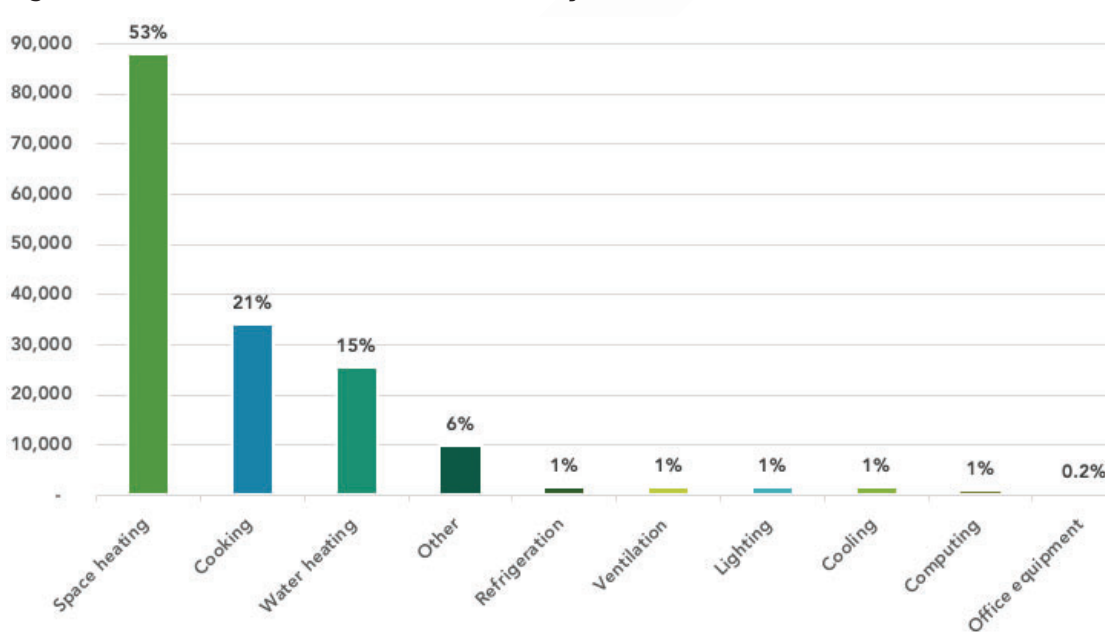
Figure 42: Service water heating fuel by building type



Common Energy End-Use GHG Emissions

Based on the 2019 Eugene Community Greenhouse Gas inventory, 84% of commercial building energy emissions are from natural gas combustion. Additionally, 10% are from fuel oil and propane combustion with only 6% from electricity production. In Eugene, food service, retail & grocery, healthcare, office, and the education are the largest commercial segments and are responsible for 78% of emissions.

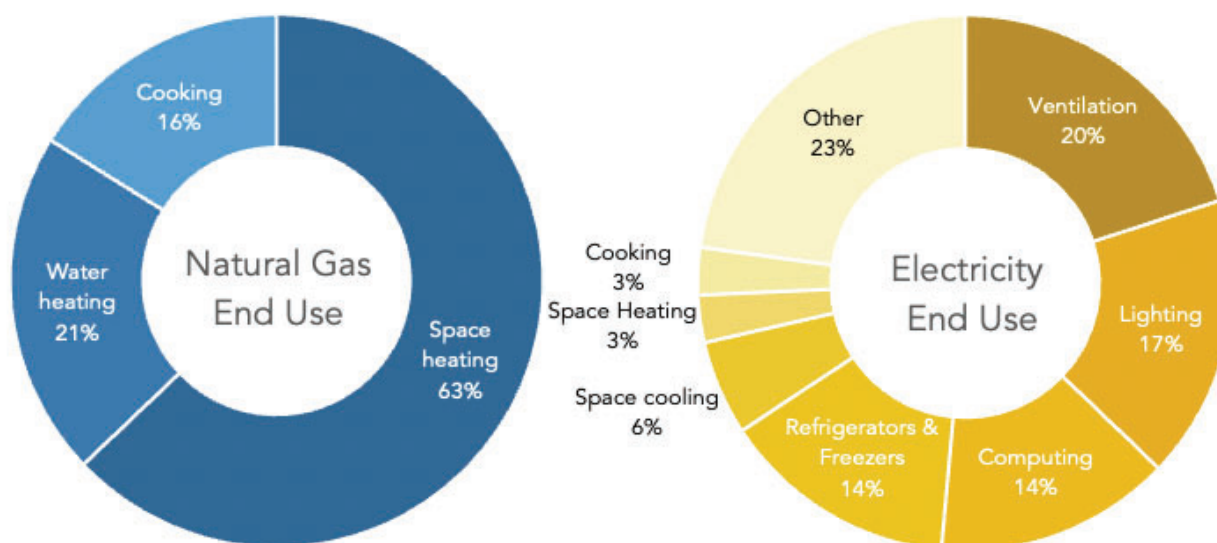
Eugene's food service segment (23%) has the highest emissions of any segment, primarily from cooking. The University of Oregon (16%), healthcare (14%), retail (14%), and office (13%) are notable emissions segments with over 10% each, all primarily from space heating.

Figure 43: Estimated breakdown of end-uses by segment based on 2019 emissions, MT CO₂e**Figure 44: Estimated commercial emissions by end-use, MT CO₂e**

Space heating (53%), cooking (21%), and water heating (15%) are the main commercial end-uses for all energy sources combined. Commercial space heating, water heating, and cooking is primarily through natural gas use. Other uses account for 6% while cooling, ventilation,

lighting, refrigeration, office equipment, and computing make up the remaining 5%. Industrial emissions are shown in Figure 45 for context and scale.

Figure 45: Estimated breakdown of end-uses for commercial natural gas and electricity use



When looking at fuels used across segments, 84% of emissions are from natural gas, with 10% from fuel oil and propane, and 6% from electricity. There is a greater degree of accuracy in natural gas and electricity data sets, and data may not align with a segment's total emissions.

Figure 46: Estimated breakdown of natural gas and electricity emissions by segment based on 2019 emissions, MT CO₂e

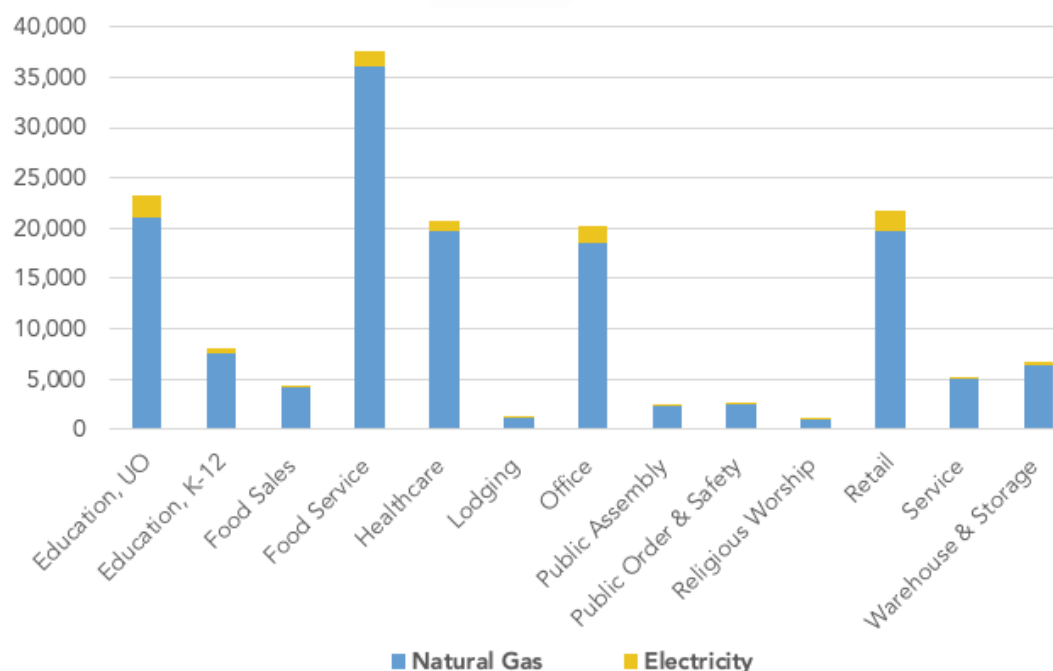
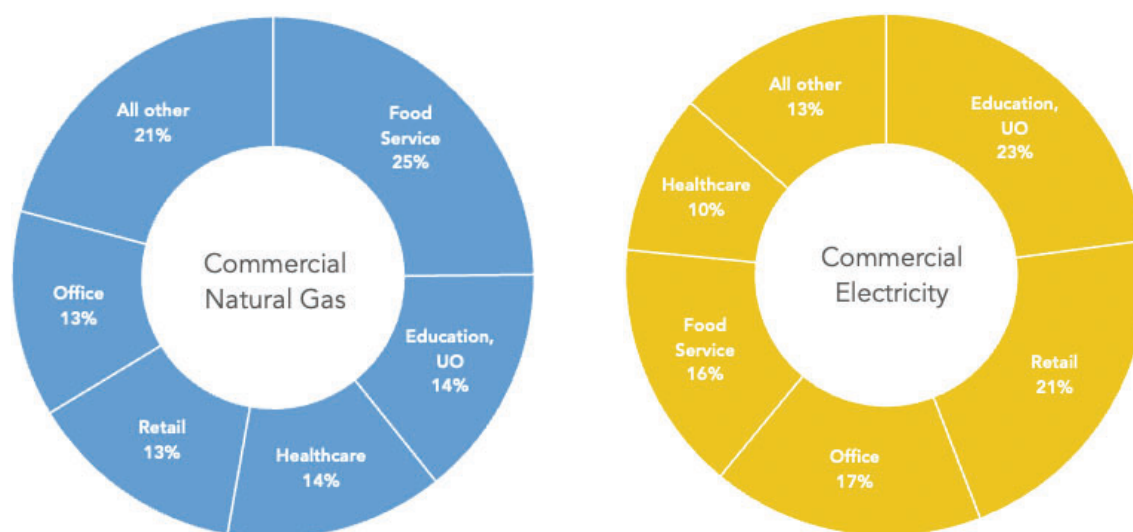


Figure 47: Eugene Community emissions by commercial segment and energy type

Commercial/Industrial Detailed Data Limitations: Local data to create Figures 43 through 47 are not readily available from local agencies in the splits that were requested for this project. Available data is highly accurate in totals for emissions by fuel type (natural gas, electricity, other fuels) from the 2019 Eugene Community Greenhouse Gas Inventory. Additional data from regional and U.S. survey's is available to estimate emissions by segment (education, food service, office, etc.) and each segment's expected end-uses, but have greater uncertainty compared to the totals. Emissions by end-use (space heating, cooking, lighting) has the lowest level of confidence in Figures 43 – 47.

To create the Figures a variety of sources were combined:

- The core data is energy and fuels data reported by local utilities (electricity and natural gas) and the State of Oregon (propane and fuel oil sales) for **Eugene's 2019 Community Greenhouse Gas Inventory**.
- Allocation to the various commercial segments uses employment data from **Bureau of Labor Statistics** for Eugene; combined with building floorspace statistics per employee used for a similar estimate in the **Northwest Power Plan**; and matched as closely as possible to the energy intensity data from EIA's **Commercial Building Energy Consumption Survey** (energy and fuel use per square foot by commercial segment). CBECS also provides data for specific energy/fuel end-use by commercial segment for our climate region. End use estimates are less certain than emissions by segment.
- **Oregon Department of Environmental Quality's Mandatory GHG Reporting Data** is used for the splits reported in the industrial sector. ODEQ requires reporting for operations producing over 2,500 MT CO₂e annually and identifies specific business,

commercial activity, and types of emissions for Eugene. This data allowed for estimates and grouping for various types of local industrial operations.

Results presented in these Figures are provided for sense of scale comparisons and planning purposes but should not be interpreted as highly precise. GHG inventory data was available for total commercial emissions by fuel (electricity, natural gas, propane, and fuel oil) but the same quality data was not supported by utility reporting for specific commercial segments or energy end uses.

Technical Best Practices & Strategies

This section of the report reviews commercial sector best technical practices, including:

- Energy Efficiency
- Electrification (including dual-fuel systems)
- Renewable energy supply

These three “pillars” of decarbonization for the commercial sector are often combined and discussed within a combined approach towards the ideal of “Net-Zero Buildings” which have all cost-effective energy efficiency upgrades implemented; electrified all systems possible; and use renewable energy and fuel supplies for remaining needs. “Clean Heat Retrofit Programs” are also commonly discussed as a combination of efficiency upgrades and appliance electrification with other comfort and safety upgrades.

Energy Efficiency & Conservation

Energy efficiency and conservation include a wide-ranging suite of equipment upgrades and behavior changes that reduce the amount of energy required to do a given quantity of work. Efficiency opportunities are often referred to as “measures” and can include individual technology upgrades or bundles of similar measures. These measures matter the most when the electricity or the heating fuel are higher in greenhouse gas emissions. In Eugene, EWEB’s electrical supply has historically been very low in greenhouse gas emissions intensity. So, for electricity, efficiency measures are generally less impactful in reducing emissions, except for during times of peak electricity needs. During peak electricity demand, the additional electricity is often generated from higher emissions sources such as natural gas combustion. So, electricity efficiency measures can be impactful by reducing the peak electricity demand and thus the need for higher emissions electricity production methods to supply power to handle the additional loads. For natural gas heated or served buildings, generally energy efficiency measures have a higher decarbonization impact as natural gas is a more greenhouse gas intensive fuel and reducing use during, or outside of, peak demand is equally effective. The following energy efficiency measures (for gas and electricity) are focused on the largest energy uses and opportunities where a technological upgrade returns “cost effective” energy savings that at a minimum pays back the initial investment. **The greatest return on energy efficiency investments almost always comes at the end of equipment life and moment of**

“natural replacement”, except for LED lighting which can provide financial benefit in the commercial sector before the end of useful life.

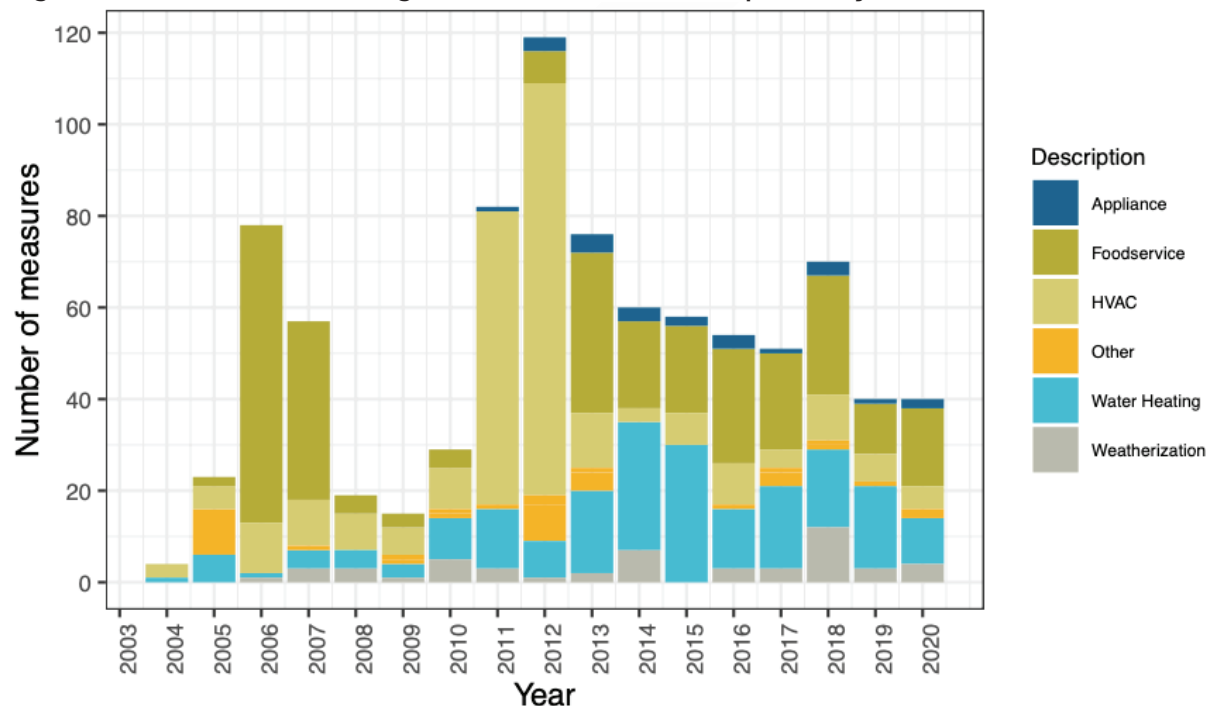
Natural Gas

For natural gas, cost-effective efficiency measures for existing commercial buildings include:

- Space heating upgrades, including heat pumps
- Space heating controls (such as programmable and smart thermostats)
- Water heating upgrades, including heat pumps
- Food service, various equipment upgrades²⁸
- Weatherization of building envelopes

Historic energy efficiency installations in Eugene by Northwest Natural Gas through Energy Trust of Oregon (ETO) programs are shown in Figure 48. Installation over the past 5 years have focused on the measures listed above with a recent focus on foodservice and water heating. ETO data also shows that 17% of commercial sites served by natural gas in Eugene have already benefited from ETO programs as of 2020 (477 participants out of 2,742 total). Energy Trust of Oregon offers a variety of financial incentives and other resources for natural gas appliances and weatherization at their website <https://www.energytrust.org/commercial/>.

Figure 48: Commercial natural gas measures installed as reported by ETO



²⁸ Current food service incentives include gas fryers, vent hoods (w/controls), gas broilers, electric food cabinets, electric combination ovens, electric fryers, gas steam cookers, dishwashers, and ice makers. For ETO incentive details for food service visit <https://www.energytrust.org/incentives/multifamily-foodservice-equipment/#tab-two>

Highlight: Commercial Water Heating

ENERGY STAR certified commercial natural gas water heaters are reported to use 15% less energy than conventional units. These units typically have competitive first costs and offer lifecycle costs savings.²⁹ For electric heat pump water heaters see section on page 63.

Highlight: Food Service Natural Gas Cooking Appliances

The California Energy Commission's report *Demonstration of High- Efficiency Commercial Cooking Equipment and Kitchen Ventilation Systems*³⁰ provides case studies for a wide variety of commercial foods service. The following table summarizes natural gas use for a variety of food service sites by equipment types. The report highlights operational benefits of wider adoption of high efficiency equipment. The report highlights broilers, ovens, and griddles are the largest consumers of natural gas in food service appliance types. The report found:

- Energy efficient appliances reduced natural gas use between 19% and 68%.
- Overall – average gas savings of 35% were achieved in the pilot projects conducted for the study across various types of sites and appliances.
- Commonly identified significant energy savings include replacing old convections ovens, consolidating convection ovens/steamers into electric combination ovens, and replacing broilers. Replacing old fryers provides a highly cost-effective and big savings option where they are used – but represent less overall total load in commercial kitchens and therefore provide less opportunity for large, community-scale reductions.
- Grocery stores were found to be at the high end (68% savings) of the spectrum realizing significant savings by adding a combination oven (which is more efficient and electric) to replace natural gas rotisserie ovens.
- Ventilation energy (energy required to condition the outdoor air required to replace air exhausted from commercial kitchens) was found to make up at least 50% of the total heating, ventilating, and air conditioning load at a commercial food service facility. E
- Exhaust hoods are commonly left on all day, even though they are not needed. The report found that significant savings from installation of available demand-controlled, programmable ventilation technology is available, but uptake has been slow.
- Staff are often uninformed about how their behavior effects energy use and operational costs. Advanced energy information systems are available for real time information and feedback but offers potential only with regular training and monitoring.

²⁹ Details at https://www.energystar.gov/products/commercial_water_heaters

³⁰ Available online at <https://www.energy.ca.gov/publications/2021/demonstration-high-efficiency-commercial-cooking-equipment-and-kitchen>

Emerging Technology: Natural-Gas Heat Pump

Northwest Natural Gas states in their Vision 2050 - Destination Zero analysis that: "Natural gas heat pumps offer the single greatest opportunity to reduce natural gas consumption while maintaining equipment performance in cold weather. A 2019 American Gas Foundation report prepared by Enovation Partners indicates that these new technologies have the potential to reduce energy use by 40% or more (replacing a split heating / cooling system), while maintaining a consistent level of service." The U.S. Department of Energy reports that this technology is mainly used in industrial and commercial setting.³¹ It should be noted, however, that the use of natural gas heat pumps for cooling would increase consumer's use of natural gas in the summer relative to conventional electric air conditioners or heat pumps.

Demand Side Forecast

Figure 19 (pg. 21 in residential chapter) presents Northwest Natural Gas' forecast of demand-side reductions across all sectors within the City of Eugene's geographic boundary. NWN predicts local commercial and industrial natural gas use will be reduced 63% between now and 2045 through interventions needed to comply with Oregon's Climate Protection Program. Overall gas load is anticipated to be reduced by 69% across all sectors by 2045.

Electricity

The recently released, 2021 Northwest Power Plan includes a detailed list of cost-effective electric equipment and appliance upgrades opportunities. For electricity, "cost-effective" energy efficiency (EE) measures for existing commercial include:

- LED lighting
- Space heating and cooling (including various types of related upgrades)
- Refrigeration (specifically in the food sales (grocery) sector)
- Motors and drives
- Water heating and use upgrades, including heat pumps, showerheads, and washers
- Electronics (servers, power supplies, and EnergyStar computers)

Figure 49: Cost effective commercial energy efficiency measures from NW Power Plan

Cost-Effective EE Potential (aMW)				
Measure Bundle	2027	2032	2041	Description
Lighting	230	406	506	Interior and exterior lighting
HVAC	40	112	245	Wide range of efficient HVAC systems and controls, AC upgrades, fans, windows, and chiller system retrofits
Refrigeration	40	106	176	Grocery refrigeration system improvements
Motors/Drives	20	54	89	Efficient pumps
Water Heating	9	24	56	Heat pump water heater, showerheads, and efficient clothes washers
Electronics	46	49	49	Efficient servers and power supplies and Energy Star laptops
Food Preparation	5	17	28	Primarily cooking equipment such as steamers and ovens
Process Loads	10	21	24	Engine block heater controls

³¹ For details visit <https://www.energy.gov/energysaver/absorption-heat-pumps>

Supporting Action for Energy Efficiency: Commercial Energy Reporting Program

A community-wide, commercial building energy use benchmarking program is one-way cities can better understand community energy use and emissions to craft programs and policies that reduce community GHG emissions. Commercial building energy benchmarking programs require buildings over a given size (e.g., >20,000 sq ft) to report their energy usage to the city on an annual basis. Alternatively, a benchmarking program might rely on utility (EWEB and NWN) reporting of data to reduce reporting burdens on local businesses. These types of programs would need to be discussed with local utilities to define opportunities and barriers. Typically, there are not business-type specific exemptions (for example commercial kitchens) because the requirements are only for reporting on relatively easy to obtain information, and many smaller businesses that might experience an undue burden from the reporting will fall below the size threshold.

Reporting focuses on natural gas and electricity use but may also include water use. The city uses this data to better understand energy use in its buildings, formulate potential energy efficiency programming and policies, provide targeted support for buildings needing efficiency upgrades, inform potential tenants and customers of the energy efficiency of different commercially leased units, and to set a baseline for related energy efficiency requirements and policy. The EPA has found that consistent benchmarking alone (without energy efficiency mandates) reduces building energy use by 2.4% per year on average. This reduction arrives due to the awareness building of the program.

In a separate study, Good Company interviewed managers of building energy benchmarking programs across the country in combination with a literature review of relevant sources. This work identified that the most important elements for a successful benchmarking program are:

- Defining the relevant stakeholders and engaging with them from the beginning to understand their needs and perspectives
- Outreach about the benefits of benchmarking and available energy efficiency programs
- Community education on how to report
- Getting the right software to manage the data for the City

There are several excellent resources for cities wishing to implement such a program, and all the interviewees encouraged planners to utilize them fully:

- The [Institute for Market Transformation](#) focuses on helping implement benchmarking
- The [EPA](#) has many free resources and guides
- The [City Energy Project](#) helps cities craft benchmarking ordinances with free resources

Electrification

The following sections describe electrification opportunities – one of the primary pillars of decarbonization – by the most significant end use impacts in the commercial sector.

- Space heating (including cooling)

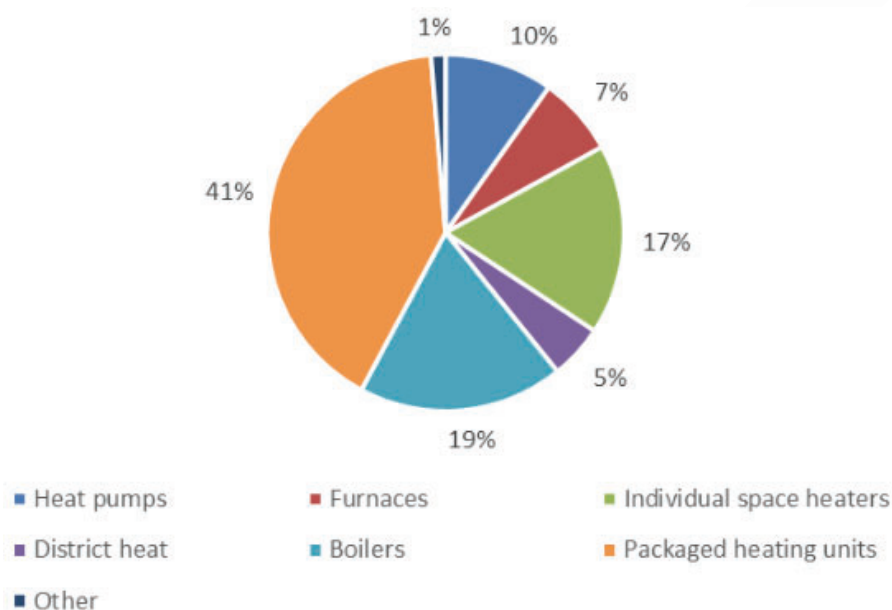
- Water heating
- Cooking

Space Heating Systems

Substituting electric appliances (including dual-fuel heat pumps) for direct combustion has been studied less, particularly for specific commercial segments, as compared to the residential sector and can be more challenging based on commercial construction, type of heating/cooling system, and available heat pump technologies as viable substitutes for existing commercial building systems.

For non-electric systems that use fossil fuels – the study found that the most common types of commercial heating system systems that rely on fuels are roof-top units (packaged heating unit)³²(37%); boilers (31%); space heaters (12%), district systems (11%), and furnaces (9%). When included in the total – electric heat pumps make up about 15% of commercial systems.

Figure 50: Total floor area by type of space heating system. Source: EIA



The American Council for an Energy Efficiency Economy (ACEEE) conducted a comprehensive study of space heating in existing commercial buildings that includes detailed finding by U.S. geographic region and commercial segments for each of the common types of commercial sector building heating systems which include:³³

- Packaged heating systems (i.e., gas-pack rooftop units)
- Boilers

³² A packaged rooftop unit, also known as a rooftop unit or RTU, is a type of HVAC system that provides heating and air conditioning within a single unit for commercial buildings.

³³ To download the report, visit <https://www.aceee.org/research-report/b2004>

- Furnaces

Given almost all commercial buildings use packaged/rooftop heating units – decarbonization of existing commercial buildings need to address emissions from this equipment– either through 1) system electrification or 2) a combination of energy efficiency upgrades and a low-GHG supply of renewable natural gas or other combustible fuels. The following commercial segments were identified as having the largest opportunity for electrification, by system type:

- **Rooftop Units to Electric Heat Pump:** Offices, strip shopping malls, food service, and education offer the greatest combination of energy savings; lifecycle costs savings; and shortest simple payback.
- **Boilers to Electric Heat Pump:** This type of heating equipment will be challenging to retrofit given the scale of renovations required to replace existing boilers with a new electric heat pump system. Replacing a boiler with a HP will often involve adding air conditioning (AC) load. This increase in energy use will detract from net carbon savings. This circumstance is especially true for schools currently without AC, which is common.
- **Furnaces to Electric Heat Pump:** Furnaces likely represent the smallest opportunity for energy savings as furnaces are the least likely heating system in the commercial sector. That said – furnaces offer significant cost savings and short payback periods across several segments including – offices, strip shopping malls, retail (other than malls), educations, food service, food sales, healthcare, laboratories, nursing, and lodging. Other segments offer a break-even lifecycle cost opportunity including – warehouses (non-refrigerated), public assembly, public order and safety, and malls.

Cooking

According to the Electric Power Research Institute (EPRI) only about 20% of all commercial cooking equipment uses electricity nationally.³⁴ There are many barriers to substituting electric for natural gas cooking including lack of adequate electric service (see next section for details related to cost), higher capital costs (in some, but not all cases), higher energy costs (in some cases), customer perception, and time to procure. They highlight three popular types of commercial food preparation equipment where there is opportunity for electrification.

- **Electric Combi-ovens** – Adopted for being able to cook large quantities and varieties of food at one time. They serve as a traditional convection oven or as a steamer and may operate in both modes simultaneously – steaming and baking. Electric combi-ovens cook foods faster because it heats quickly and does not need to stay on all the time. They are most common in education, healthcare, jails, hotels, and restaurants.
- **Electric Griddles** – Adopted primarily for non-energy benefits including faster heating, even cooking temperatures, higher quality products and increased production along with benefits that included increased workplace comfort and improved air quality.

³⁴ For details visit <http://mydocs.epri.com/docs/PublicMeetingMaterials/ee/Electrification-APR.pdf>

- **Electric Fryers** – Adopted for faster throughput due to design, allows for wider range of cooking temperatures along with benefits that include increased workplace comfort and improved air quality.

Hot Water

ENERGY STAR certifications are also available for electric heat pump water heaters. Heat pump water heaters (HPWH) can save significant energy and lifecycle costs over conventional designs. They are readily available for domestic scale applications and equipment in residential and commercial settings. That said – they can have large first and lifecycle costs, based on today's prices and forecast assumptions. EWEB found this to be the case in their recent Electrification study for small scale domestic systems as shown in the Figure 31.

The Better Buildings Challenge highlights the additional key considerations for transitioning existing natural gas fired boilers to heat pumps, particularly for large scale commercial needs.³⁵ These include first that costs for heat-pump water heater solutions may be considerably more expensive than natural gas-fired solutions; technology availability is limited that can meet system capacity needs; they have specific placement needs; they can be noisy; and rate of hot water production.

Given these considerations, they are likely ideally suited where cooling and dehumidifying is needed in addition to hot water, as heat pumps release cool dehumidified air. They are also best suited to facilities with consistent water demands as heat pumps take longer than gas to heat additional water compared to a gas boiler. They name specific segments that have high hot water loads including food service, laundry lodging, gyms, higher education dormitories, and inpatient health care.

Renewable Energy Supply

Electricity

Utility Supplied

EWEB currently delivers at least 90% renewable electricity and has an internal goal to reach 95% renewable generation by 2030 delivered to Eugene.

Natural Gas

Renewable natural gas is already being produced within Eugene at MWMC's wastewater treatment plant and Short Mountain Landfill used for vehicle fuel production and electricity generation respectively. Both renewable natural gas and clean hydrogen (in pilot phase in

³⁵ Additional details at

<https://betterbuildingssolutioncenter.energy.gov/sites/default/files/attachments/Decarbonizing%20HVAC%20and%20Water%20Heating%20in%20Commercial%20Buildings%2011.21.pdf>

Eugene) have a carbon footprint that is significantly lower than fossil natural gas.³⁶ As previously mentioned, Northwest Natural is regulated under Oregon's Climate Protection Program. To achieve compliance, NWN will support efforts to reduce use of conventional natural gas through efficiency measures, while providing ever more renewable gas supply. NWN released their draft Integrated Resources Plan (IRP) in August 2022.³⁷ Release date for final IRP is not currently posted on NWN's website.

Cost of Implementation

The cost of implementation will vary widely by building type and commercial activity. Given the variation – detailed costs for all potential decarbonization strategies and measures will not be undertaken here. This section will focus on costs for commercial building heating systems and cooking appliances.

- **Energy efficiency** measures outlined in the Technical Best Practices section assumed to be implemented for specific end uses and at a pace that maximize the cost and energy savings benefit. Therefore the cost of implementation is assumed to be equal or less than a net zero lifecycle cost.
- **Water heating** for large-scale commercial applications should focus in the near term on lowering demand and upgrading to more efficient natural gas equipment, in parallel with a transition to lower impact and renewable forms of natural gas. This finding should be revisited over time as electric heat pumps (including dual fuel) become commercially available and cost-effective. Small scale hot water needs for small scale commercial, such as for a small office, will have more opportunity with commercially available equipment in the marketplace now.

The following sections highlight cost savings opportunities by end use with details for high impact commercial sectors in our community. The sections provide lifecycle costs for various types of commercial heating systems for different types of equipment and conversions.

All the electric heat pump systems are assumed to lower energy use in buildings - so the payback period is determined by how long it takes those savings to recoup the relatively higher cost of the new systems compared to simply replacing the old system. The repayment time therefore is contingent on the price of electricity versus fossil fuel and the rate of energy usage. Higher energy users, buildings that are more consistently occupied, will pay back faster than those with lower usage. Drop in systems, such as rooftop packages and furnaces, are more likely to pay back than more complicated systems requiring custom designed solutions.

Costs for the commercial sector are typically discussed in \$/square foot rather than per building as in the residential sector to account for the extreme variation between various

³⁶ The carbon footprint of fuels can vary dramatically depending on the energy feedstock and processing.

³⁷ NWN's DRAFT IRP online at <https://www.nwnatural.com/about-us/rates-and-regulations/resource-planning>

segments, building age, and building size. The following sections highlight the largest impact segments in Eugene.

Offices Buildings (including Local Government)

Office spaces are like residential buildings in that they use energy primarily through space conditioning, water heating, and lighting. The solutions and costs are like those for residential buildings: heat pumps for space conditioning and for water heat, improved building envelope for efficiency, and high efficiency lighting. Because of the predictable schedule of many offices in use, there is a lot of efficiency that can be gained through scheduling and controls of lights and temperature at very low cost. Additional information is available from Better Buildings.³⁸

Summary of Implementation Costs:

- **Space heat/cooling systems:** American Council for an Energy Efficiency Economy (ACEEE) found that electrification of natural gas rooftop units pays back in about 10 years and offers a median lifecycle cost savings of \$0.25 / square foot. Natural gas furnaces offer a payback of 5 years and a median savings of slightly over \$1.00 per square foot.
- **Water heating:** Hot water heat pumps offer great promise in the future, but at present likely has higher first costs and lifecycle costs compared to conventional hot water appliances. EWEB found similar for hot water heaters in their recent electrification report where it was found that electric hot water heaters would cost about \$300 more than conventional systems over its lifecycle. Upgrading to conventional tank or tankless, EnergyStar certified systems offer significant energy savings. Heat pump water heaters should be considered but may not be appropriate for all commercial buildings.
- **Lighting:** Lighting is at the top of the cost-effective measures in the Northwest Power Plan as having large potential savings in the region with high lifecycle savings.

Retail

Many retail businesses *lease the space they occupy*, and so have relatively little control over their building energy footprint. At the same time, renters will often pay a flat energy fee and therefore have little financial incentive to invest in energy efficient upgrades. Commercial Benchmarking programs can give tenants the opportunity to factor in energy efficiency when they are choosing a space to lease. The EPA has *Green Lease and Tenant Energy Optimization* programs to incentivize energy efficiency in leased spaces.

- **Space heating/cooling:** Strip shopping malls offer the greatest opportunity at the lowest costs for use of electric heat pump (including dual fuel) systems. Replacement of rooftop units offer a payback of between 10 – 15 years and a savings of \$0.25 per square foot. Replacement of natural gas furnaces offers paybacks of between 5 – 15 years (depending on retail segment) and savings of between \$0.25 - \$1.50 per square foot.

³⁸ <https://betterbuildingssolutioncenter.energy.gov/sectors/commercial-real-estate>;
<https://betterbuildingssolutioncenter.energy.gov/sectors/local-government>

- **Refrigeration:** Grocery and convenience stores rely heavily on refrigeration. Refrigeration systems commonly use very high global warming potential chemicals, that when leaked during normal use, can cause significant climate harm. A 2020 study performed by DC engineering found that CO₂-based systems cost slightly less to install than conventional cooling systems, and overall came out to roughly the same cost as conventional systems³⁹. When a market starts new, or when it replaces old equipment, choosing a CO₂ based system is advised. Refrigeration also offers significant electricity savings by adding door to coolers.
- **Lighting:** Lighting is at the top of the cost-effective measures in the Northwest Power Plan as having large potential savings in the region with high lifecycle savings.

Healthcare

Outpatient healthcare facilities are like office spaces in that their primary energy needs are for space conditioning, water heating, and lighting.⁴⁰ Hospitals are unique and distinct from out-patience services in that they also have likely have large energy loads required for cooking and residences. Cafeterias will benefit from similar best practices as previously described in the food service segment. They can also benefit from increased efficiencies from scheduling lights and temperature controls. In addition, healthcare facilities, including hospitals, often take up a lot of physical space with ample room for on-site rooftop solar.

- **Space heating/cooling:** Healthcare includes a variety of distinct building types, considered in the ACEEE commercial electrification study, including inpatient healthcare, outpatient healthcare, and nursing. Replacement of rooftop units in inpatient and outpatient care facilities offer the greatest opportunities, with paybacks of between 5 – 10 years and a savings of \$0.50 and \$1.50 per square foot. Nursing facilities can benefit from significant savings if the existing system is natural gas furnaces with paybacks. Replacement of natural gas furnaces offers paybacks of between 5 – 10 years (depending on retail segment) and savings of between \$0.50 - \$4.00 per square foot.
- **Lighting:** Lighting is at the top of the cost-effective measures in the Northwest Power Plan as having large potential savings in the region with high lifecycle savings.
- **Cooking:** See food service section for details.

Education (including UO District Heating System)

Like the sectors listed above, K-12 education requires space conditioning, water heating, and lighting. Building envelope improvements can improve efficiency, while the large rooftop surface area provides opportunity for on-site solar.

⁴⁰For details visit <https://betterbuildingssolutioncenter.energy.gov/sectors/healthcare>

For large, multi-building campuses, district heating and cooling systems provide an efficient source of space conditioning and hot water. Campuses are unique in the commercial sector in that they also have large energy loads for cooking and residences. Campus cafeterias will benefit from similar best practices as the food service segment. Higher education typically also has a large energy footprint dedicated to computers and data systems. Thoughtful auditing of these systems combined with measures to decrease energy usage can contribute significant energy savings. For example: Community College of Allegheny County changed their automatic sleep settings on all campus computers and realized a 74% energy use decrease⁴¹.

- **Space heating/cooling:** Education facilities offer the greatest opportunity at the lowest costs for use of electric heat pump (including dual fuel) systems. Replacement of rooftop units offer a payback of between 10 – 15 years and a savings of \$0.25 per square foot. Replacement of natural gas furnaces offers paybacks of between 5 – 15 years (depending on retail segment) and savings of between \$0.25 - \$1.50 per square foot.
- **Lighting:** Lighting is at the top of the cost-effective measures in the Northwest Power Plan as having large potential savings in the region with high lifecycle savings.
- **Cooking:** See food service section for details.

Food Service

Food service is a particularly hard-to-electrify industry because of the heat output requirements and tight profit margins. All-electric equipment (ranges, ovens, woks) exists and performs well, but the price point varies substantially. Electric ovens are typically cheaper to buy and install than gas ovens, and so are electric resistance cooktops. These technologies, however, use electric resistance to generate heat and so can cost more to operate than gas equipment, particularly when the cost of electricity is high compared to gas⁴². Induction cooktops, on the other hand, can cost twice as much as their gas counterparts⁴³, but are much more energy efficient than either the gas or the more traditional electric technologies. Induction woks are similarly expensive to buy⁴⁴. Induction cooktops, however, have the benefit of being available as single, countertop burners for well under \$1,000 which can allow a restaurant to reduce its reliance on gas without complete equipment replacement. Another benefit of electric equipment, especially induction technology, is the reduced waste heat, leading to lower ventilation and space cooling requirement. Most of the decarbonization work in the food service segment is focused on energy efficient use and replacement of inefficient equipment with more efficient equipment.

⁴¹ For details visit <https://betterbuildingssolutioncenter.energy.gov/solutions-at-a-glance/ccac-computer-power-management-saves-significant-energy-use-and-costs>; <https://betterbuildingssolutioncenter.energy.gov/sectors/k-12-school-districts>; <https://betterbuildingssolutioncenter.energy.gov/sectors/k-12-school-districts>

⁴² <https://www.proservicessupply.com/blog/gas-vs-electric-range-which-one-is-better-for-commercial-kitchens>

⁴³ <https://www.forbes.com/home-improvement/kitchen/induction-vs-gas-cooktop/>

⁴⁴ <https://www.greenbiz.com/article/challenges-building-electrification-or-parable-flameless-wok-hei>

The Better Buildings Solutions Center recommends *training staff to turn off equipment when not in use and to choose the most efficient equipment possible when replacing old equipment*. They also have an energy efficiency strategies guide with tips on everything from patio heaters to cook line arrangement.

- **Space heating/cooling:** Food service offers the greatest opportunity at the lowest costs for use of electric heat pump (including dual fuel) systems. Replacement of rooftop units offer a payback of between 10 years and a median lifecycle cost savings of \$1.00 per square foot. Replacement of natural gas furnaces offers paybacks of between 5 – 10 years (depending on retail segment) and savings of between \$0.50 per square foot.
- **Cooking appliances:** Food service cooking is predominately served by natural gas appliances. Gas equipment is the standard in the industry to provide rapid heat in an industry where speed at peak serving time can have a significant impact on the bottom line. Commercial kitchen decarbonization will likely need to consider some appliance electrification combined with EnergyStar upgrades to old equipment combined with renewable natural gas offers the greatest decarbonization opportunities until new technology is realized.
 - Appliances:⁴⁵ Generally, less expensive for electric appliances and installation. In commercial kitchens the choice of natural gas versus electric appliances does not need to be an all or nothing proposition. Research conducted for this study found that some types of electric appliances offer advantages, while other are likely a better fit for natural gas.⁴⁶ Specifically, convection ovens, combination ovens, fryers, and steam tables. Regardless of the energy used, significant improvement can be made by upgrading to EnergyStar certified equipment.
 - Energy/fuel costs: Historically natural gas has provided a lower cost fuel for commercial cooking. Typically, natural gas provides heating energy at half the cost of electricity. Gas cooking equipment does produce a lot of unused heat that can require buildings HVAC system to use more energy. Commercial cooking – like industrial process heating needs – may not be well suited for electrification.
- **Startup/Shutdown training:** Commercial kitchens are an area where the literature shows significant potential to use employee training and behavior change to save energy around controls for ventilation system and shutdown of cooking appliances.

Note on Electric system upgrade costs: As previously discussed in the residential section – electric system upgrades can be very expensive depending on the equipment being replaced and its peak load requirements. Substituting 100% of natural gas appliances with electric will likely require upgrades to the building electrics system which are complicated by the fact that

⁴⁵ For details visit <https://betterbuildingssolutioncenter.energy.gov/technology-info-suite/decarbonizing-commercial-kitchen>

⁴⁶ For details visit <https://www.acitydiscount.com/info/Pick-one-Gas-vs-Electric-Restaurant-Equipment.349.1.htm>

many commercial buildings are not owned by the business and therefore would require cooperation and upgrade costs between building owner and tenant. In many cases, electrification will mean a sizeable increase in the electric load of a building (accompanied by a decrease in other fuels). This may mean a need to upgrade or install a new electrical panel. Sometimes this will merely mean installing a new breaker in the electrical panel if there is space, but if the panel is full or additional amperage or circuits are required to operate the equipment, upgrades or replacement will be required. The bulk of the cost for a “behind the meter” upgrade (i.e., an upgrade inside the building and not to the utility’s infrastructure) is in labor. It may take an electrician a full day’s work or more to upgrade or install a new 200-amp electrical panel, costing somewhere between \$1,000 and \$4,000.⁴⁷ Costs may be greater for commercial businesses with greater panel size and electric service needs.

For much bigger systems, for example very large office complexes or hospitals, electrification might require upgrades to the utility’s distribution system. Cost estimates for transformer upgrades⁴⁸ run from \$10,000 to \$15,000 for low voltage upgrade to \$37,000 to \$41,000 for higher voltages. If the increase in load is so large that substation upgrades are called for, prices can run from \$13,000 to \$67,000 depending on the load and the amount of work required.

Funding Options

Local Funding Opportunities

C-PACE

C-PACE (Commercial Property Assessed Clean Energy) financing is one way that commercial property owners can finance energy efficiency and fuel switching projects through a loan that is paid back on their property tax. Various improvements qualify for PACE financing including building envelope improvements, HVAC system improvements, lighting, building systems automation, and more.

Oregon has passed legislation that allows local government (cities and counties) to implement CPACE programs in their jurisdictions. Jurisdictions can pass a resolution to authorize CPACE, it does not require an ordinance. Currently, Multnomah County is the only jurisdiction with an active program, and they have done most of the hard work of breaking ground and amending the state legislation to ensure that the program works in Oregon. Many other counties and cities are looking into creating their own program, Lane County is one of them, Lake Oswego, Deschutes County, Benton County, and Washington County are others.

CPACE works by connecting borrowers with specialty lenders (not the usual banks). A program administrator helps owners through the loan process and in the event of a foreclosure, handles the administrative tasks. The administrator might also be responsible for vetting lenders and ensuring that proposed projects are likely to result in energy improvements. The loan is then

⁴⁷ <https://yoursuperinspector.com/repair-cost-guide-for-buyers/electrical-systems-repair-cost-guide/>

⁴⁸ PG&E industrial electrification cost estimator, 2022 PG&E Proposed Generator Interconnection Unit Cost Guide

paid back through a benefit assessment lien, which is like the property tax assessments common in other states but avoids some foreclosure loopholes specific to Oregon. In Multnomah County, the program is called Property Fit⁴⁹. It is a collaboration between Prosper Portland (the program administrator), the County (the tax assessor), and Energy Trust of Oregon (technical provider). The expert Good Company spoke to from Multnomah County (the sustainability director) urged Eugene to take advantage of all the work they've already done and model their program as closely as possible on Multnomah County's. They advised that it probably require at least one employee to work on the program, but that the administrative cost could be recouped through transaction fees. Prosper Portland currently makes money from administering Multnomah County's program.

Green Bonds

The above C-PACE model connects borrowers and lenders and specifies a method of repayment, it doesn't specify the source of the money. The city itself could raise some portion of the necessary funds by issuing bonds. It is possible that the City could raise some portion of the necessary funds by issuing bonds. Due to constitutional limitations on the use of general obligation (GO) bonds for private activity, a revenue bond rather than a GO bond pledging the full faith and credit of the city is a more likely option for this purpose. In this case the City would need to identify the revenue source for bond repayment, and the issue could be marketed as a green bond. Green bonds are certified to be for projects that provide some climate benefit, making them more appealing to some investors.

The certification process requires the issuer (in this case the City of Eugene) to appoint an approved verifier, usually a financial services firm, who ensure that the proposed use of the bonds will result in climate benefit. The Climate Bonds Initiative has a directory of such verifiers, searchable by region and project type⁵⁰. Once the bonds are certified they can be sold to investors⁵¹ on whichever bond market they choose. This money could then be loaned to building owners as a part of a C-PACE or other financing plan.

State Funding Opportunities

- Oregon Department of Energy offers incentives for community cooling centers (\$2 million), and community renewable energy grants (\$12 million program).
- Energy Trust of Oregon offers a variety of incentives for various commercial segments including lodging, food services, grocery, service shops, warehouses, and general

⁴⁹ <https://www.propertyfitoregon.com/>

⁵⁰ <https://www.climatebonds.net/certification/approved-verifiers>

⁵¹ <https://www.climatebonds.net/certification>

equipment incentives for HVAC, insulation, lighting, computers, and backup generators.⁵² EWEB also offer a variety of incentives.⁵³

Federal Incentives

- The Inflation Reduction Act will provide a variety of tax incentives aimed at the domestic manufacture and purchase of clean energy technologies. Financial incentives from the IRA will cover various decarbonization technologies including – energy efficiency retrofits, electricity generation from wind and solar, battery storage, and heat pumps.

Equity Considerations

Equity considerations for commercial businesses include both the business itself, as well as the upstream and downstream impacts to employees, contractors, customers, and community members. Based on the 2019 community greenhouse gas inventory, focus should be on natural gas emissions first in sectors where technology opportunities exist but may be financially limiting.

Local business considerations

Making smart decarbonization choices can be prohibitively expensive for businesses, particularly those without affordable electrification options. Large equipment is expected to last several years or decades and need to be incentivized in time to make decarbonization a reality by 2045.

Eugene's top commercial sectors by share of 2019 emissions – see the context by segment section earlier in this report for helpful context (Fig. 43, pg. 53).

- **Food service (22%)** will need to focus on efficiency and electrification, primarily through new cooking equipment, which can be a prohibitively expensive conversion.
- **Healthcare (14%)** will need to implement space heating, water heating, and lighting measures, but are likely to have opportunities for on-site solar.
- **Retail (13%)** will need to implement space heating, water heating, and cooking efficiency and electrification measures, primarily in tenant-landlord relationships.
- **Office (13%)** will also need to implement space heating, water heating, and lighting measures. Depending on facility size, this technology may or not be financially available or have a return on investment within a near timeframe.

⁵² Details at <https://www.energytrust.org/commercial/existing-buildings-oregon-cash-incentives/>

⁵³ Details at <https://www.eweb.org/business-customers/rebates-loans-and-conservation>

- **The University of Oregon (16%)** has its own Office of Sustainability and sustainability programming with dedicated funding, including a Climate Action Plan, and is not recommended for an equity focus despite having high emissions.

Business owner demographics

Much like the residential community, there are historic disparities among different demographics of business owners, particularly for people of color and women. Systemic barriers need to be addressed to support minority- and women-owned businesses, and State and federal policies exist to attempt to reduce these barriers. In Eugene, 51% of the population identify as female, but only 25% of employer firms (firms with employees) are women-owned. Similarly, 22% of the population identify as a minority through race, ethnicity, or both, but only 9% of employer firms are minority-owned. In addition to race, 10% of population identify as Hispanic, but only 4% of firms are Hispanic owned.

Figure 51: Population and employer firm demographics in Eugene, race

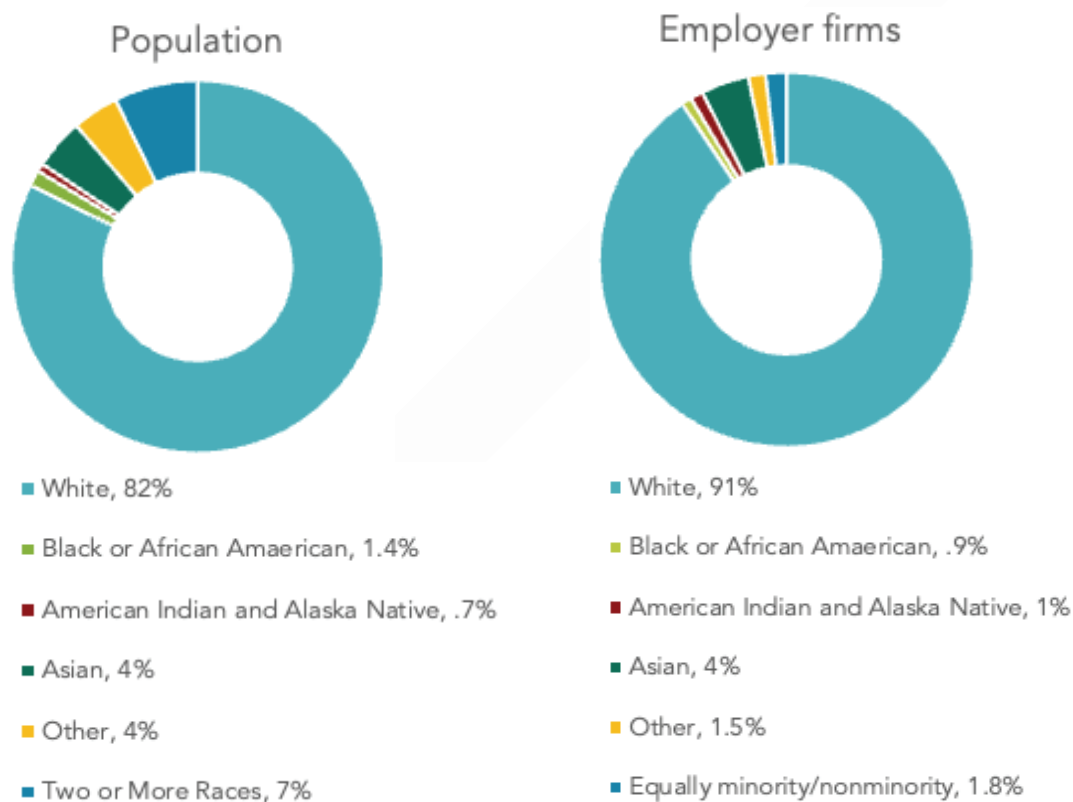


Figure 52: Population and employer firms demographics in Eugene, gender

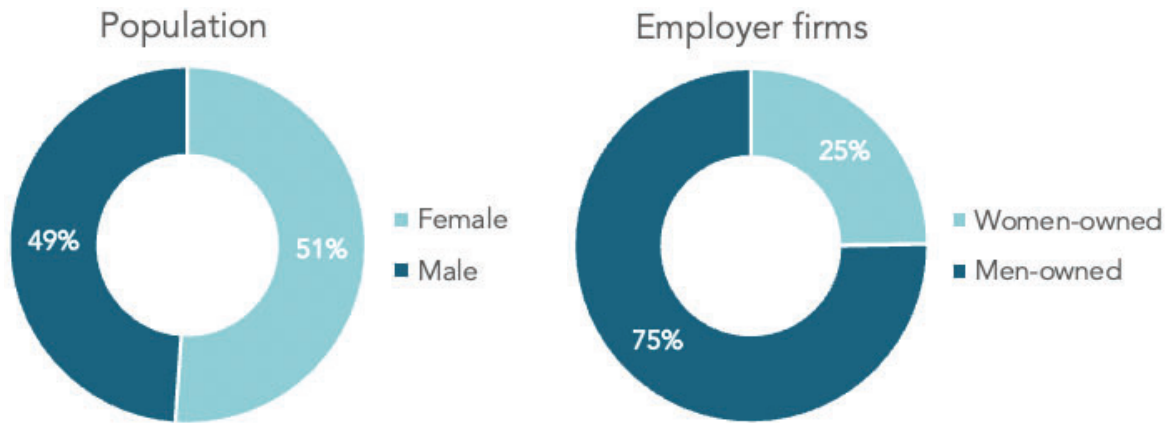


Figure 53: Population and employer firms demographics in Eugene, minority race

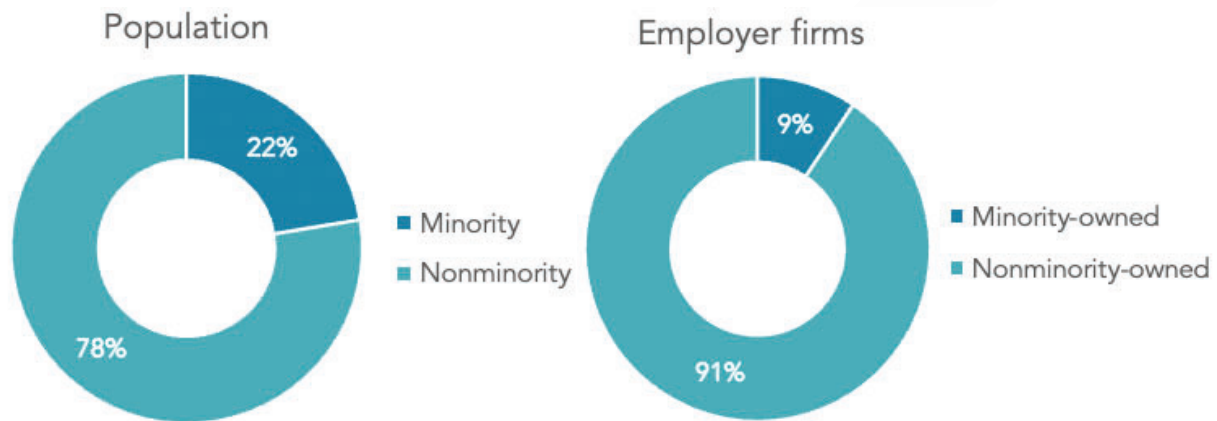


Figure 54: Population and employer firms demographics in Eugene, Hispanic ethnicity

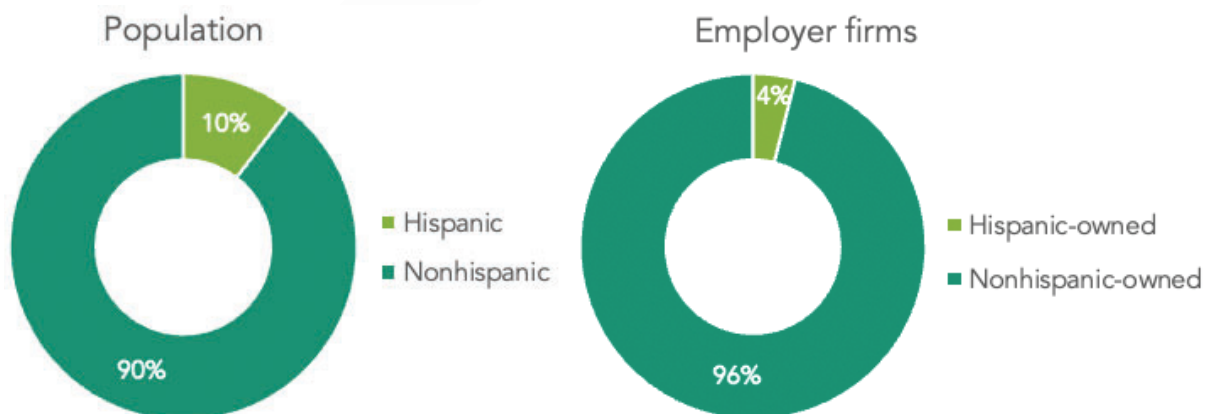
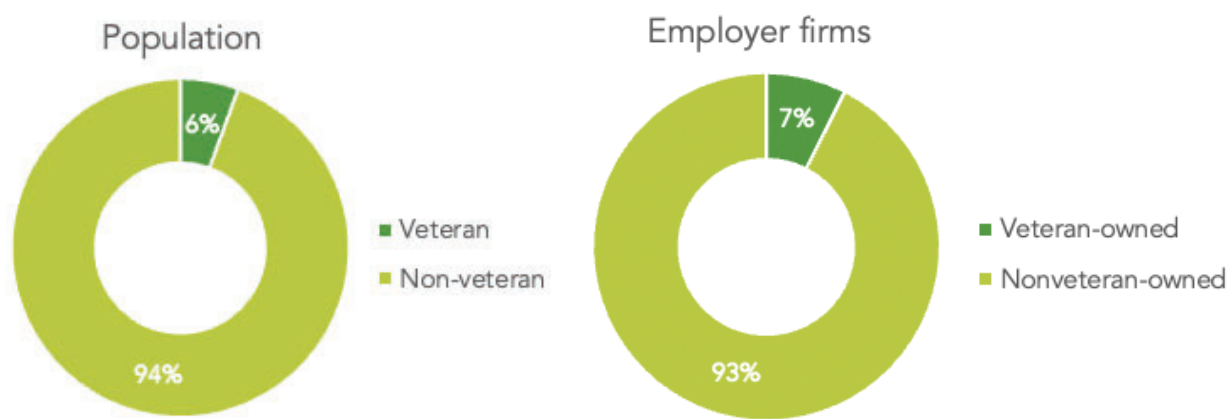


Figure 55: Population and employer firms demographics in Eugene, Veteran status**Data Sources:**

- All demographic data came from the U.S. Census Bureau and is specific to Eugene. Population data, veteran status, and women-owned status are from the 2020 Census. Hispanic-owned and minority-owned employer data came from a 2012 Employer dataset.

Green jobs workforce development partnerships

There are community benefits to large-scale decarbonization in addition to reducing emissions, such as developing a green jobs workforce with good paying jobs. This requires preparation, engagement, and relationship building. Local green jobs and training will meet the needs of a changing economy while benefiting the environment. Lane Community College has long had training programs that support decarbonization workforce development.⁵⁴ Many kinds of workers will be needed to implement this work: electricians, HVAC technicians, solar PV installers, and specialty equipment technicians for kitchens and grocery stores, and more. A significant local opportunity is to **develop partnerships to grow the workforce needed to support building energy management and transition**. For example, Lane Community College has programs and pathways available for those interested in some of these trades, and even offers programs such as *Energy Management Technician: Building Controls*.

Determining targeted commercial incentives

The best incentives target significant emissions reductions, but also consider the needs of businesses and needs of the community. Incentives should help local businesses make good triple bottom line choices – reducing energy use and environmental emissions; reducing business costs and supporting a thriving local economy; and improving conditions for workers and/or community members.

⁵⁴ For details visit <https://inside.lanecc.edu/science/energy-management-building-controls>

Recommendations for the City to Act

Prioritize actions for existing businesses with older existing buildings

As in the residential sector, existing commercial buildings represent Eugene's current emissions and will continue to represent the largest proportion between now and 2045. All future buildings will be built to higher standards so there is less opportunity for measures to reduce emissions.

Prioritize offices, strip malls, government, and healthcare that are easier to convert

Space heating equipment in offices, schools, government buildings, hotels and strip malls currently require significant local natural gas use. Many of these same buildings have readily available technology to electrify space heating/cooling in these spaces (*including dual-fuel heat pumps*) for specific types of heating systems (rooftop units and furnaces). Specifically, offices and strip malls with existing rooftop heating units and furnaces using natural gas offer the greatest emissions reduction benefits and cost savings. Replacement of natural gas furnaces with ductless heat pumps offer advantages for almost all commercial segments. Electrification challenges exist for buildings currently serviced by boilers and for buildings with large, open spaces like warehouses and public assembly spaces. See Appendix C for details.

Between now and 2045 there will be one or maybe two cycles of major equipment replacement for most commercial buildings, with major heating equipment lifespans between 10 – 25 years (depending on the equipment type). Maximizing decarbonization benefits through product selection at these moments of natural replacement are critical to maintain the lowest possible costs to achieve decarbonization goals.

City of Eugene should lead by example and electrifying its office buildings

Interviews with local business owners expressed that the city should lead by example and begin the decarbonization process within its own facility's before requiring it of others.

Engage deeply with managers and owners of food service and buildings with boilers

Commercial enterprises use significant energy for production of food and goods, such as the use of natural gas use for cooking, and commercial buildings that utilize natural gas boilers. Engagement could include additional interviews and/or creation of a working group with businesses to ensure the city fully understands the nature of the challenges and appropriately addresses them in any future community decarbonization programs and related requirements.

Commercial buildings have unique decarbonization challenges versus the residential sector, specifically that certain types of commercial enterprises use significant energy for production, such as the use of natural gas use for cooking, and commercial buildings that utilize natural gas boilers. Decarbonizing these types of energy end uses with electrification can be challenging for business owners as the upgrade costs can be substantial. City decarbonization programs and community support in the next few years should focus on upgrading common space and water heating systems where cost-effective electrification technologies are available and offer lifecycle cost savings for the business. For those with challenges – City decarbonization programming would benefit by starting with additional outreach to fully understand

operational limitations and the financial challenges required to fully decarbonize. One of these commercial segments is food service, where profit margins can be small, and production may be highly integrated with a specific fuel types, equipment, and related processes.

Prioritize businesses with low profit margins and historically underserved

Businesses with lower profit margins are less likely to afford new equipment, especially if at a premium. Businesses with less profit can benefit significantly from updated equipment, especially those that result in financial savings. This is especially true for employers that do not pay a living or family wage. Ensure that outreach is initially focused on underserved businesses owners and veterans.

Implement a Commercial Energy Reporting Program to benchmark building energy use

Detailed commercial energy use data is not readily available for the Eugene community. A Commercial Energy Reporting Program will provide information to inform decarbonization opportunities and planning by benchmarking and tracking commercial building energy use. This will provide decision making information for building owners and tenants about opportunities for equipment upgrades and to compare energy costs for similar rental properties. The City of Portland's program (along with others around the U.S.) can serve as a guide to support local program development.

Partner with local job training groups to serve the equipment distributors and installers

Lane Community College has been a leader in the nation by offering programs for those interested in pursuing a career in decarbonization, such as Energy Management Technician - Building Controls. This segment will have large, sustained growth for multiple decades. Consider specific outreach to those providing efficiency and electrification services about community climate goals and their pivotal role in achieving those goals.

Amplify existing programs' outreach, program management, and funding sources

As with the residential sector, provision of financing for commercial emissions reduction projects, programs to perform aggressive outreach, and project management to implement large scale programs is needed. While these services are provided by several agencies and organizations, there is currently no central organizing body. To facilitate an accelerated transition the City could take on these roles, partner with other agencies, or contract for provision of these services.

As previously mentioned, coordinated **outreach** and **project management** for local decarbonization is lacking. There are many agencies and service providers, but they do not coordinate in messaging or in practice. A central messaging resource would let commercial building owners, HVAC companies, and contractors know about all the potential financial and practical services available for low-carbon retrofits. Outreach and incentives should have a clear focus on supporting small, minority-owned, women-owned, veteran-owned businesses.

EWEB reports having relatively low participation on the commercial side in comparison to Residential, yet the commercial sector provides most of EWEB's annual energy savings. EWEB suggests that the city could support existing programs with greater engagement and

coordination with small business owners and contractors. EWEB is also working on a partnership with ETO to share - when relevant and beneficial to the customer's EE project - data to provide greater overall efficiency, savings, and incentives for local business.

The **financing** required for administering such a large acceleration in decarbonization will likely have to come from a combination of public agency incentives and private debt financing, not necessarily administered by the city. An ESCO organization could aid in securing funding and large-scale implementation. Another option may be for the City to issue bonds, but additional research will be required to determine local limitations. Funding from State of Oregon programs and the Federal Inflation Recovery Act (IRA) will also be available to support action.

Part 3: Industrial Sector

Wood products production represents roughly 60% of greenhouse gas emissions in Eugene's industrial sector. Given that, this section of this report focuses largely on the wood products industry. The following points outline decarbonization challenges unique to the industrial sector:

- Reducing emissions from industrial energy use is more challenging than other sectors because manufacturing commonly requires the use of high-temperature heat from direct combustion for process energy and steam that are challenging to electrify with existing technologies.
- Manufacturing systems are designed and invested in with the expectation of long lifetimes (50 years).
- Substitution of electricity for other types of combustion fuels would require significant changes to existing boilers and plant wide production systems which can have highly integrated components that are cost prohibitive to change.

Given these challenges, opportunities in the next 5 years could focus on maximizing cost-effective energy efficiency upgrades accelerated with targeted local outreach in partnership with Energy Trust of Oregon.

In parallel, local development for additional production of lower-impact, fossil natural gas alternatives can be explored. The Eugene community already has considerable experience producing renewable natural gas which is produced at Short Mountain Landfill and Eugene's wastewater treatment plant for energy. And Northwest Natural is planning a Eugene pilot project to produce clean hydrogen from renewable electricity for distribution in Oregon's natural gas system.⁵⁵

Building Stock Characteristics

Energy use in the industrial sector isn't correlated to employment or square footage as is the case with the residential and commercial sectors. High levels of energy use and production output can be gotten from a relatively small square footage and the specialty equipment operating inside of the building.

Given the lack of local, publicly available industrial building data, this section draws on greenhouse gas reporting data provided for the industrial section from local energy utilities (EWEB and Northwest Natural) for Eugene's Community GHG Inventory. Industrial sector types

⁵⁵ For details visit <https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M493/K760/493760600.PDF>

are estimated using greenhouse gas emissions reporting to Oregon Department of Environmental Quality.⁵⁶

Common Energy Uses

The U.S. EPA summarizes industrial energy use with the following,⁵⁷

“The United States’ industrial sector uses heat for a wide variety of applications, including washing, cooking, sterilizing, drying, preheating of boiler feed water, process heating, and much more. Altogether, the industrial sector uses and estimated 24 quadrillion Btu, or roughly one-third of the nation’s delivered energy supply.¹ Process heating applications alone account for approximately 36 percent of total delivered energy consumption within the manufacturing sector (a subset of the industrial sector).

According to a study of industrial heating in European countries, 30 percent of industrial heating applications require heat below 212°F, another 27 percent can be met with heat between 212 and 750°F, and the remaining 43 percent require heat above 750°F. Most existing renewable heating technologies can easily and cost-effectively supply heat within the lowest indicated temperature range. Often, the most valuable role that renewable heating technologies can play in industrial applications is to provide “pre-heating” before an existing conventional energy source is used. Major considerations for industrial renewable heating applications include cost, resource intermittency, and process integration and storage options.”

In Eugene, most local industrial energy demands are related to the production of wood products (based on ODEQ GHG reporting for Eugene). Specifically, production of reconstituted wood products (i.e., panel products made from wood chips and particles) and softwood veneer and plywood manufacturing. According to the EPA, processing heating requirements for these products are between 250F and 450F depending on wood type and production process (e.g., drying, pressing, etc.).^{58,59} Currently those energy needs are mostly met with natural gas. See the next section for related Oregon regulatory context.

Figure 56 from the U.S. Department of Energy’s, Advanced Manufacturing office illustrates the major sources of energy use and emissions in the wood products industry.⁶⁰ Process heating is overwhelmingly the energy load needed in the production of forest products.

⁵⁶ For details visit <https://www.oregon.gov/deq/ghgp/Pages/GHG-Emissions.aspx>

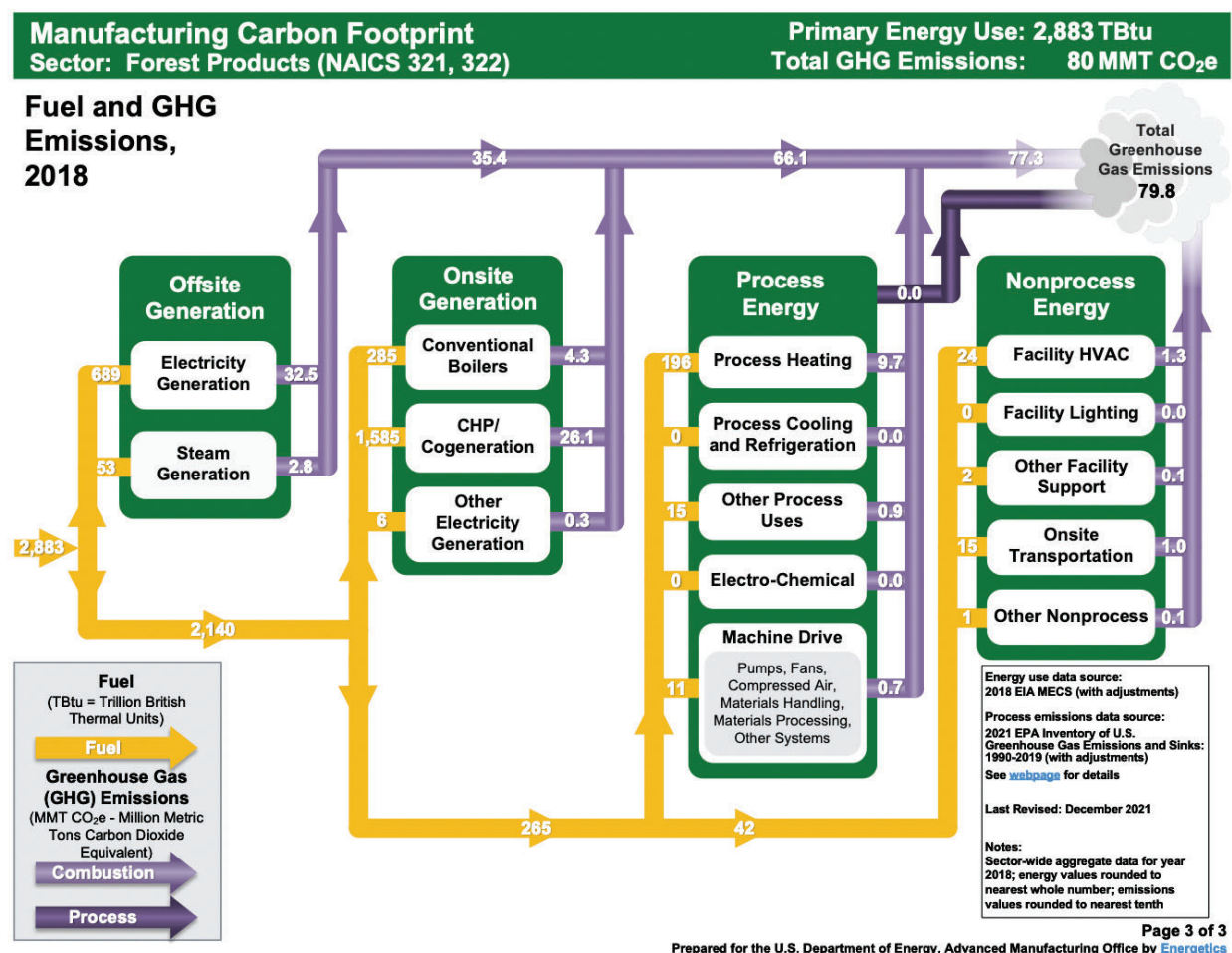
⁵⁷ For details visit <https://www.epa.gov/rhc/renewable-industrial-process-heat>

⁵⁸ Engineered wood products <https://www3.epa.gov/ttnchie1/ap42/ch10/final/c10s09.pdf>

⁵⁹ Plywood products <https://www3.epa.gov/ttnchie1/ap42/ch10/final/c10s05.pdf>

⁶⁰ Details online at https://uploads-ssl.webflow.com/5d8aa5c4ff027473b00c1516/628bab268021ac651201b640_Manufacturing%20Energy%20and%20Carbon%20Footprint_Forest%20Products_NAICS%20321%2C%20322.pdf

Figure 56: Energy use and GHG emissions from Forest Product industry. Graphic shows energy use (in BTUs) in yellow and GHGs in purple. Larger values indicate greater energy use and emissions by various energy needs in wood production for process/non-process energy needs.



Regulatory Context

In 2011, EPA implemented the *Industrial, Commercial, and Institutional Area Source Boilers: National Emission Standards for Hazardous Air Pollutants (NESHAP)* rule – often called the *Boiler MACT Rule*. This rule was introduced to address air toxics (criteria air pollutants, not GHGs) coming from the combustion of solid fuels (including wood and other biomass). Unfortunately, this set up a conflicting set of choices for the wood products industry. The choice was between cost effective compliance with the air toxics rule by replacing wood residuals as the heat source, with conventional, fossil natural gas – which is not considered carbon neutral.

Essentially the cost of stack pollution controls for wood-based heat was more expensive than a whole conversion from wood residuals to natural gas to serve facility heating loads. This is a logical result of an immediate regulatory change that required immediate compliance, versus a

delayed response to see how climate related regulations would arrive – when and if they did. So now we have a wood products industry that still combusts some residual wood for onsite heating loads – which is considered carbon neutral due to its being in the living carbon cycle, while fossil natural gas is additive to the natural carbon cycle. That said, most of the wood residuals since the 2011 Boiler MACT Rule, have been moved through contracts into other products as a fiber or as feedstocks to wood pellets for carbon neutral power in the EU or in other states in the US.

For this research, Good Company interviewed a few wood products representatives and a few wood products factory engineers. The main takeaway is that the industrial heating loads are generally too large to serve with electrical boilers (technically possible, but not practical or reasonably priced) and that no current wood product producer has enough electrical service onsite to serve an electrified concept. Upgrading this electric service may come with significant additional costs, beyond equipment substitutions, such as the development of a substation to bring a large enough electrical supply to the site. Further, the equipment in production facilities typically has up to a 50-year life – which threatens the business model if those are prematurely retired without substantial financial support.

Technical Best Practices & Strategies

The U.S. Dept. of Energy's Advanced Manufacturing Office has identified 4 key strategies to decarbonize industry⁶¹:

- Energy efficiency
- Substituting low-carbon fuels & material feedstocks (meaning use of renewable fuels and recycled or biogenic material feedstocks)
- Increasing electrification of equipment
- Capturing & utilizing or storing carbon dioxide (CO₂) emissions

There is no one set of decarbonization best practices that will work for all industrial facilities.

Energy Efficiency & Conservation

The U.S. Department of Energy finds that energy efficiency is a foundational decarbonization strategy and the most cost-effective option for GHG emissions reductions. Methods they highlight include:

- Strategic energy management to optimize performance of industrial processes
- Systems management and optimization for the use of process heating, boilers, and combined heat and power sources.
- Smart manufacturing and advanced data analytics to increase productivity

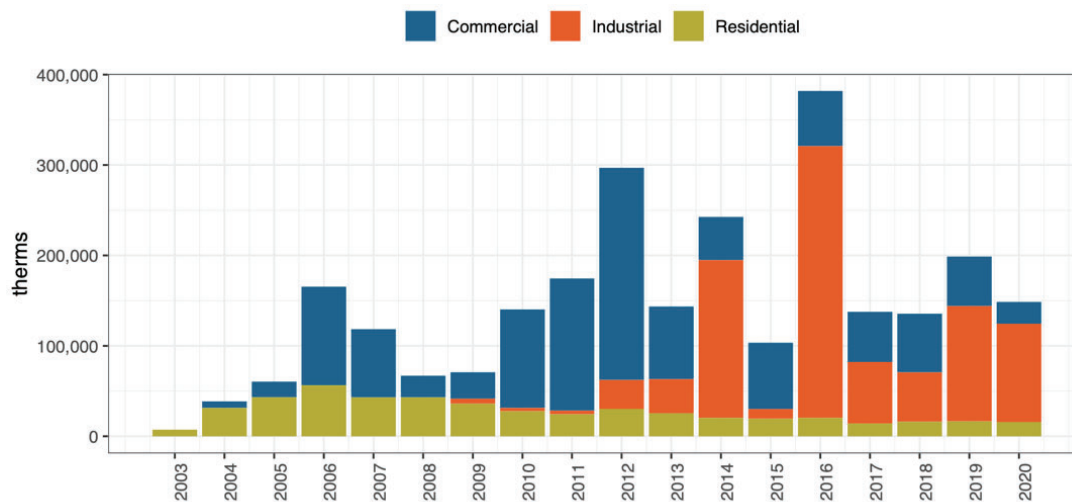
⁶¹ Details online at <https://www.energy.gov/eere/industrial-decarbonization>

Energy efficiency is a cost-effective way to reduce industrial emissions. According to McKinsey & Company, energy efficiency could result in 15 to 20% energy savings (depending on facility type and baseline conditions).⁶²

Natural Gas

Figure 57 presents energy efficiency savings for natural gas in Eugene and shows that in the recent past, energy savings in the industrial sector have been the largest fraction of local implementation work.

Figure 57: ETO industrial sector energy savings by project type.



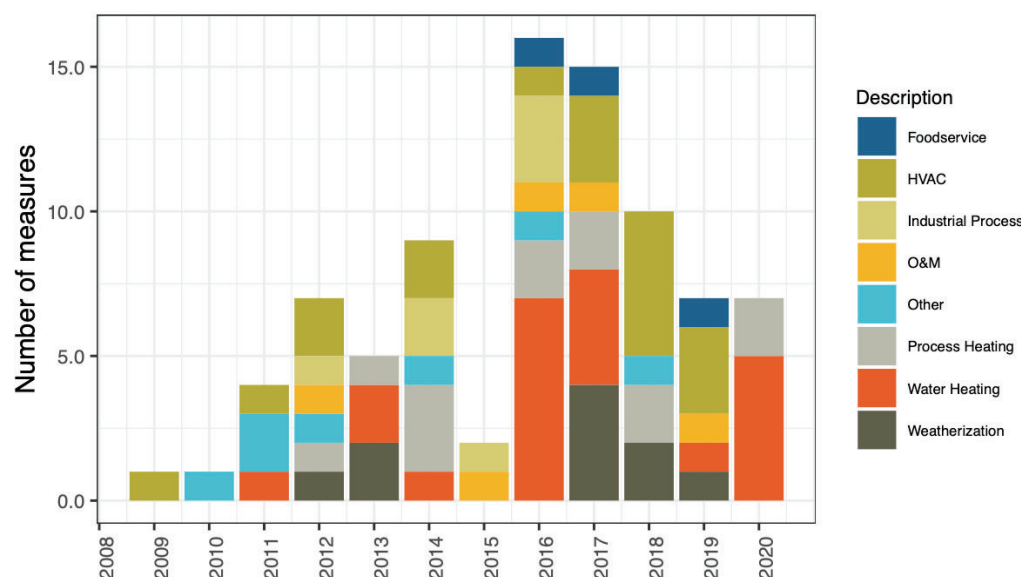
For natural gas, cost-effective efficiency measures for existing industrial buildings include:

- Space heating upgrades, including heat pumps
- Space heating controls (such as programmable and smart thermostats)
- Water heating
- Process heating

Figure 58 summarizes the historic benefit of Energy Trust of Oregon programing in Eugene to implement industrial energy efficiency. This data shows opportunities for natural gas upgrades within the industrial sector.

⁶² For details visit <https://www.mckinsey.com/business-functions/sustainability/our-insights/how-industry-can-move-toward-a-low-carbon-future>

Figure 58: ETO industrial sector energy savings by project type.



Electricity

For electricity, “cost-effective” energy efficiency (EE) measures for existing industrial facilities include:

- Strategic energy management
- Pumps
- Fans and blowers
- Refrigeration
- Lighting

The recently released, 2021 Northwest Power Plan includes a detailed list of cost-effective electric equipment and appliance upgrades opportunities. Figure 59 shows specific types of equipment upgrades found to be most cost effective (equal to or provides savings over the equipment lifecycle – as compared to first costs for equipment and installation).

Figure 59: Cost effective electric energy efficiency opportunities identified NW Power Plan.

Cost-Effective EE Potential (aMW)				Description
Measure Bundle	2027	2032	2041	
Energy Management	54	113	141	Strategic Energy Management and other optimization programs
Pumps	27	67	129	Efficient pump upgrades, variable speed drives, system optimization
Fans and Blowers	14	39	98	Efficient fan motors, upgrade to variable speed and trim applications
Refrigeration	24	41	64	Low and medium temperature refrigeration system improvements
Lighting	41	57	63	Lighting upgrades for 1, 2 and 3-shift operations
Material Handling and Processing	9	23	46	Efficient motor upgrades and addition of variable speed drives
Compressed Air	19	33	42	System optimization and compressed air demand reduction
HVAC	21	29	32	Heating, ventilation, and air conditioning of industrial spaces
Water/Wastewater	8	12	13	Water supply and wastewater treatment equipment optimization
Other	<1	1	3	Pollution control, new arc furnace, and industry-specific measures

Renewable Energy

U.S Dept of Energy finds that substituting low- and no-carbon fuels reduces emissions for industrial processes and that they are focused on:

- Development of fuel-flexible processes
- Integration of hydrogen fuels and feedstocks into industrial applications
- The use of biofuels (renewable natural gas) and bio feedstocks (note that this means wood residuals)

Electricity

Utility Supplied

EWEB currently delivers at least 90% renewable electricity and has an internal goal to reach 95% renewable generation by 2030.

Renewable Natural Gas & Clean Hydrogen

Northwest Natural (NWN) Gas is regulated under Oregon's Climate Protection Program and to be in compliance with CPP goals will be required to reduce GHG emissions 90% by 2050. This will be accomplished using a combination of demand-side (industrial energy efficiency, building shell improvements, heat pumps, etc.) and supply-side alternatives to fossil natural gas including - renewable natural gas, and clean hydrogen.

NWN's current forecast for the Eugene area indicates that demand-side improvements will reduce use of natural gas in the industrial sector will by 7% and 45% for gas transported through NWN pipelines on behalf of other suppliers to local customers by 2050 (24% decline for industrial/transport combined). Of the remaining gas, NWN forecasts that 83% will be from non-fossil fuel sources (RNG, green hydrogen).⁶³ In late 2021, NWN released an analysis of how they could go even further to reach carbon neutrality by 2050. NWN's DRAFT 2022 Integrated Resource Plan also includes information and planning about how they will meet compliance obligations under Oregon's Climate Protection Program.⁶⁴

Renewable natural gas (or biogas) is a common operational byproduct at landfills, wastewater treatment facilities, and livestock operations. RNG is already produced in Eugene at MWMC's wastewater treatment plant and Short Mountain Landfill and used for vehicle fuel and electricity generation respectively. In 2018, Oregon Department of Energy found that available RNG from existing sources and from developing new gasification facilities would total 17.5% of Oregon's total natural gas use.⁶⁵

⁶³ NWN (5/31/22). City of Eugene Emissions Memo - 2021

⁶⁴ For details and IRP download visit <https://www.nwnatural.com/about-us/rates-and-regulations/resource-planning>

⁶⁵ For details see <https://www.oregon.gov/energy/Data-and-Reports/Documents/2018-RNG-Inventory-Report.pdf>

Clean hydrogen is a likely future fuel option to replace fossil natural gas for several reasons. First, it can be made from excess renewable electricity in a way that produces very little climate pollution. When produced in this way it can be used to “store” energy from renewable electricity during times when that power is available, but not in demand for use later. Finally, combustion of hydrogen does not product toxic pollutants (criteria air pollutants) or climate pollution (greenhouse gases) during combustion at the tailpipe, only water.

Clean hydrogen is being supported in CA⁶⁶, Federally through existing programs⁶⁷ and via incentives on the near horizon resulting from the Inflation Reduction Act (IRA), as well as in the European Union⁶⁸. RNG and clean hydrogen offer an alternative to decarbonize difficult to electrify heating loads in industry. The State of Oregon, as part of Senate Bill 333, directs Oregon Department of Energy to conduct a study on potential benefits of, barriers to, production and use of clean hydrogen in Oregon. The study is due to the legislature in November 2022.⁶⁹

While clean hydrogen offers much promise, considerable technology and infrastructure development is still needed. Hydrogen is already in production and technologies for both stationery and transportation applications are already in use, but the mass deployment of site-based equipment or distribution infrastructure has yet to become ubiquitous. Further, as of this writing most hydrogen being produced globally comes from natural gas, not from renewable electricity.

While hydrogen can be stored in large, blended quantities in caverns that are currently used to store natural gas (methane), storing hydrogen in small quantities is energy intensive and can negate the carbon benefits or the cost effectiveness of the fuel if it must be stored. For this reason, Eugene industry are likely to see onsite hydrogen produced and consumed in real time to avoid the burdens of cooling the gas to a liquid and storing it until use. Hydrogen piping and burner tips may also need to be replaced and tuned with the balance of the industrial system to provide the gas leak free.

Both renewable natural gas and clean hydrogen (in pilot phase in Eugene) have a carbon footprint that is significantly lower than fossil natural gas.⁷⁰

⁶⁶ For details about California plans to develop a clean hydrogen hub. Details at <https://business.ca.gov/california-formally-announces-intention-to-create-a-renewable-hydrogen-hub/>

⁶⁷ US DOE's Earthshots program supports lowering the costs of clean hydrogen by for industrial and trasporation needs. Details at <https://www.energy.gov/eere/fuelcells/hydrogen-shot>

⁶⁸ European Union details at https://european-union.europa.eu/institutions-law-budget/institutions-and-bodies/institutions-and-bodies-profiles/clean-hydrogen-joint-undertaking_en

⁶⁹ Details online at: <https://www.oregon.gov/energy/energy-oregon/Pages/rh2.aspx>

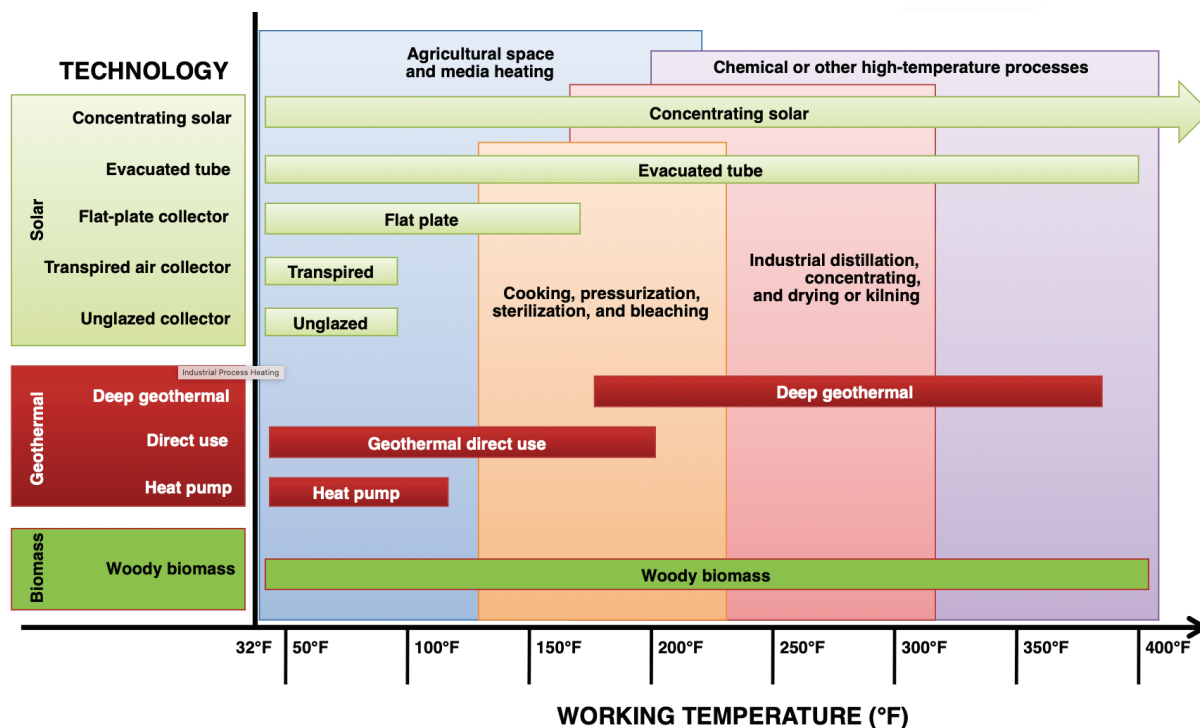
⁷⁰ See ODEQ clean fuels program reporting at <https://www.oregon.gov/deq/ghgp/cfp/Pages/Clean-Fuel-Pathways.aspx>

Other Renewables alignment with Industrial Process Heating Loads

The U.S. EPA offers guidance on substitution of renewable energy for industrial process heating needs.⁷¹ Figure 60 summarizes renewable options for various process temperature needs. As can be seen the options identified by EPA include concentrating solar, evacuated tube solar, deep geothermal, and woody biomass. Current solar technologies are cost prohibitive⁷² for industrial applications and deep geothermal resources are not available in and around Eugene like other location in Oregon⁷³. And given the regulatory context and recent facility upgrades, biomass does not present a likely option for facilities located in and around Eugene.

Figure 60: Industrial processing heating temperature and renewable energy alternatives.

Source: U.S. EPA at <https://www.epa.gov/rhc/renewable-industrial-process-heat>



Electrification (including dual-fuel systems)

U.S. Dept. of Energy finds that recent advancements in low-carbon electricity generation, from grid purchases and onsite generation, will be critical to industrial decarbonization, including:

- Electrification of process heat using induction, radiative, or advanced heat pumps
- Replacing combustion heating driven processes with electrochemical ones

⁷¹ For details visit <https://www.epa.gov/rhc/renewable-industrial-process-heat>

⁷² Details at <https://www.sciencedirect.com/science/article/pii/S2667113121000115>

⁷³ Details at <https://gis.dogami.oregon.gov/maps/gtilo/#>

As previously mentioned, the industrial sector, like portions of the commercial sector, have energy requirements for production that do not align with currently affordable electrification technologies. Cost of electrification challenges for industry include high-process heat demands, long equipment lifespans, and custom engineering of manufacturing systems that will be expensive to retrofit before the end of its natural lifespan. This was confirmed during interviews conducted with wood industry engineering professionals who indicated that they were not aware of any viable technologies commercially available to electrify the process heat needs for wood product manufacturing.

That doesn't mean it isn't possible to electrify industry, and specifically the wood products industry. Lawrence Berkely National Laboratory recently released a report titled *Electrification of Boilers in U.S. Manufacturing*.⁷⁴ The report illustrates that the technology exists to electrify boilers serving the energy needs of forest products manufacturing, but at a high cost of carbon reduction. See the Implementation Costs section for details.

Carbon Capture, Utilization, and Storage

U.S Dept of Energy finds that capture of carbon dioxide (CO₂) from a point source emissions stack to use in products or for long-term storage to avoid release into the atmosphere offers promise as a means of reducing industrial emissions. More research and funding will be required to demonstrate the potential of these technologies.

- Post-combustion chemical absorption of CO₂
- Development and manufacturing process optimization for advanced CO₂ capture
- Development of processes to utilize captured CO₂ to manufacture new materials

Implementation Costs

The previous sections of this report have highlighted cost-effective opportunities for energy efficiency and electrification and forecasts for energy and fuel costs. Recent Energy Trust of Oregon reporting indicates cost-effective opportunities in the industrial sector for energy efficiency. Likewise previous sections of the report have discussed opportunities for space heating and cooling retrofits (with heat pumps, including dual fuel) for buildings with rooftop units or furnaces. Along with opportunities related to hot water heating. **Cost effective space and water heating may be implemented in the industrial sector where applicable, particularly in the office space at industrial facilities.**

RNG / Clean Hydrogen

Northwest Natural, in its draft 2022 Integrated Resource Plan (IRP)⁷⁵, provides historical **conventional, fossil natural gas prices as mostly between \$2 – \$4 per million British**

⁷⁴ To download visit https://eta-publications.lbl.gov/sites/default/files/lbnl_2001436_boiler_final.pdf

⁷⁵ To download DRAFT 2022 IRP visit <https://www.nwnatural.com/about-us/rates-and-regulations/resource-planning>

thermal units (MMBTU), with a significant increase between 2021 and 2022 with prices reaching about \$9 / MMBTU in early 2022 (see IRP, Figure 2.9: Historic Natural Gas Prices). NWN's DRAFT IRP also provides forecast prices for RNG/clean hydrogen through 2050 (see IRP, Figure 6.9: Compliance Resource Price Paths):

- **RNG base prices** range from between \$14 - \$19/MMBTU⁷⁶ in the near term decreasing to slightly to 2050. This represents a significant increase (~300%) compared to average conventional natural gas prices over the last 10 years.
- **Hydrogen prices** are forecast as much greater between now and 2030 (average of \$15 \$20/MMBTU over the period) compared to conventional gas but are anticipated to decrease significantly between 2030 and 2050 (down to between an average of (\$6/ MMBTU by 2050, range of \$3-\$9/MMBTU) which is roughly equivalent to conventional natural gas since 2010.

Electrification

Electrification of the space and water heating needs at industrial facilities may be thought of in two groups: 1) common building systems, 2) production needs.

- Common building system. Industrial facilities can be made up of multiple different building types including office, warehouse, laboratory, etc. These types of spaces were addressed in the commercial section of this report. That section found cost effective HVAC electrification opportunities for offices, laboratories with existing natural gas rooftop units and furnaces. With payback periods less than 15 years and lifecycle savings per square foot over the life of the system.
- Production needs. For production energy demands, Lawrence Berkely National Laboratory released a report titled *Electrification of Boilers in U.S. Manufacturing*⁷⁷ that outlines the cost effectiveness for electrification of boilers for industrial segments common in Oregon:
 - Forest products: \$128 / MT CO₂e reduced
 - Food and beverage: \$130 / MT CO₂e reduced
 - Chemicals: \$147 / MT CO₂e

These cost effectiveness values may be compared to Oregon's Climate Protection Program Community Climate Investment as a price benchmark. The CCI credits are offered for \$107 each in 2023, and prices are set to increase to \$134/credit by 2050 (in 2021 dollars).⁷⁸ Values for boiler electrification are within the range of the CCI values, but this comparison indicates that boiler electrification might be an action taken after more cost-effective reductions are implemented.

⁷⁶ See NWN's DRAFT IRP, Table 6.4 for details by fuel type.

⁷⁷ For details visit https://eta-publications.lbl.gov/sites/default/files/lbnl_2001436_boiler_final.pdf

⁷⁸ For details visit <https://climatetrust.org/oregon-formally-adopts-climate-protection-program/>

Without electrification – lower-impact GHG natural gas substitutes will be needed to fill these energy needs. As previous sections in this report have indicated – sourcing these fuels will bring cost increases as well, on the order of a 300% increase. And the fuel costs may not accurately account for gas distribution system (pipe) upgrade costs that may be required to support ever greater use of RNG/clean hydrogen. This area of costs has not been well studied and further primary research is needed to make comparisons of future decarbonization options.

Carbon Capture, Utilization and Storage

The International Energy Agency considered the costs of carbon capture. The IEA states that without carbon capture, utilization, and storage (CCUS), achieving net-zero decarbonization goals will be nearly impossible. Additionally, CCUS enables the production of low-GHG hydrogen from fossil fuels. If CCUS is not utilized as part of an overarching decarbonization plan, costs will considerably increase for the renewable energy transition. Costs for CCUS vary widely depending on the application and technology, ranging from \$15 to 25 per metric ton CO₂ for highly concentrated CO₂ streams; \$40 to 120 for diluted CO₂ streams; and up to \$350 per MT for direct air capture of CO₂.⁷⁹

Given that carbon capture technologies are still in early stages of commercial-scale development, more work will be required locally to determine if CCS offer promise for Eugene for wood products and more broadly within the industrial sector. Northwest Natural's DRAFT 2022 IRP offers only a single reference to CCS as a combined aspect of hydrogen production but does offer any additional details or specifics related to roll out in Oregon.

As of 2021, EIA identified 20 CCUS facilities in operation globally, with plans for another 30 facilities. These pilot projects are focused on capture at the emissions stack for underground storage, but also include direct air capture and options to convert CO₂ into useful products. All these technologies are in the preliminary stages of research at commercial scale and still need significant additional funding for large scale implementation. None of the existing CCS commercial scale projects examples are related to fossil fuel combustion emissions to produce wood products. They are currently focused on facilities that produce fossil fuel energy products or hydrogen fuels produced from fossil fuels. The closest domestic examples are a large ethanol production plant located in the Midwest.

Funding Options

The following section focuses on Federal funding opportunities for clean hydrogen and carbon capture and sequestration. Previous sections of the report should be referenced for decarbonization opportunities for industrial buildings related to common building efficiency, space heating (and cooling) and water heating.

⁷⁹ For details visit <https://www.iea.org/commentaries/is-carbon-capture-too-expensive>

State Incentives and Resources

- Alternative Fuel Loans are administered by the Oregon DOE offers low-interest loans for qualifying projects which includes feedstock production, production facilities, fueling infrastructure.⁸⁰
- Business Oregon has a program to aid in upgrading the *public infrastructure* associated with industrial improvements. If heavy electrification required substantial upgrades to local substations, Business Oregon could be contacted to help fund the project.

Federal Incentives and Resources

- In June 2022 the US Dept. of Energy announced **\$8 billion of program funding to create networks of hydrogen suppliers, consumers, and local infrastructure** to accelerate production and use of clean hydrogen.⁸¹ This grant is currently open and is anticipated to be highly competitive between states and regions.
- Similarly, two programs will be funded by the U.S. Dept. of Energy with **\$2.6 billion to advance carbon capture demonstration projects**.⁸² The Carbon Capture Demonstration Projects Program will focus on a variety of industrial sources including those with energy generation, paper and pulp and certain types of chemical production facilities. Money for selected project will address technical, environmental, permitting, and financing challenges for deployment.
- U.S. DOE recently created a “Carbon Matchmaker” tool that will support development of regional hydrogen hubs to enable teaming; increase awareness of project development; provide maps to support projects; highlight previously funded U.S. DOE projects.⁸³

Recommendations for the City to Act

Amplify existing Energy Trust of Oregon programs and incentives with City-led outreach

Energy Trust reports that since 2016, the largest reductions in natural gas use in the last 5 years have come from energy efficiency upgrades by the industrial sector. However, only about 20% of local industrial sites have already participated in ETO programs. This indicates additional room for outreach and continued benefit.

⁸⁰ For details visit <https://www.oregon.gov/energy/save-energy/Pages/Help-With-My-Project.aspx>

⁸¹ For details visit <https://www.energy.gov/articles/doe-launches-bipartisan-infrastructure-laws-8-billion-program-clean-hydrogen-hubs-across>

⁸² For details visit <https://www.energy.gov/articles/biden-harris-administration-launches-26-billion-funding-programs-slash-carbon-emissions>

⁸³ For details visit <https://www.energy.gov/fecm/carbon-matchmaker>

For industrial operations, in particular wood products, invest in understanding what technology, financial support and timeframes are reasonable

Replacing natural gas in heat intensive industries that are built around process energy and steam will not be a quick or inexpensive switch. The city should focus early support on easy switches like lighting and break area heating and cooling, and white roofs to reduce building temperatures in heat waves (and the energy needed to cool them). For production equipment conversions, invest in understanding the sector's needs to determine a reasonable path forward for everyone on reasonable time frames – business by business.

Partner to support local development of renewable natural gas and clean hydrogen

Use of natural gas and other combustion fuels will likely be necessary through 2050, albeit at reduced volumes, for facilities with long-term infrastructure investments and high-process heat demands. While Northwest Natural forecasts significantly lower demand – a supply of renewable/fossil gas is still anticipated, even accounting for Oregon's Climate Protection Program. And while demand will be decreased by a projected 30% - remaining gas demand will be served by lower-impact projects.

Local development and enhancement of existing resources to meet those needs will provide the much-needed energy for local industry to continue production and provide local jobs. Partnerships could include local stakeholders, such as utilities, Lane County, and the wood products industry but could also include Biz Oregon, Energy Trust of Oregon, and the US Department of Energy distributing funds for hydrogen infrastructure development as part of the Inflation Reduction Act (IRA).

Lobby for alignment of State programming and funding to support decarbonization

Oregon Economic and Community Development, Oregon Department of Energy, Oregon Department of Agriculture and Oregon Department of Environmental Quality have all been active in the promotion of decarbonization or regulations for climate pollution. Their agendas have been very full, yet there is still a strong need for alignment of programs and funding to support the transition the Eugene Community's needs without hurting employment or our local economic base. Without well managed and sustained support from State agencies and programs, local decarbonization efforts may fall short of the action required to meet a decarbonization by 2045 goal. Likewise, without consistent and sustained on-the-ground action (i.e., number of annual space/water heat retrofits completed annually) by all communities in Oregon, the State will fall short of its targets as well.

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Appendix A: ACEEE – Electrification Policy Recommendations

American Counsel for an Energy-Efficient Economy (ACEEE) is well known and respected thought leader on many subjects related to energy. The following content is provided from their report, *Building Electrification: Programs and Best Practices*.

Typical utility-run electrification programs usually involve technology-based rebates to residential customers. Nonutility program administrators are more likely to offer more comprehensive program models, including whole-home retrofit programs, financing for upgrades, workforce training programs, low- and moderate-income programs, market development, and other strategies.

Where possible, electrification programs, measures, and incentives should be braided into existing energy efficiency programs to increase their reach and engagement with hard-to-reach customer groups such as low-income and multifamily households.

Contractors play a key role in building electrification. Expanding the workforce and educating and motivating contractors to install and service heat pumps is a critical strategy for scaling up capacity for electrification in buildings.

State legislatures

- *Include explicit building electrification targets within larger climate plans, and prioritize access to resources and support for marginalized communities when setting goals*
- *Provide consistent funding streams for building electrification programs, particularly whole-building retrofits for underserved communities*
- *Capture electrification opportunities in new buildings through building codes and standards, such as requiring new buildings to be all-electric or “ready to electrify”*
- *Enact a price on carbon via a tax or by joining a regional carbon cap-and-trade market. Utilize revenues to create sustainable funding streams for building decarbonization programs*

Regulators

- *Enable a rapid and smooth transition to a carbon-free power supply*
- *Ensure that the grid has adequate transmission/distribution capacity for additional load*
- *Allow program managers to offer fuel-switching measures and incentives*
- *Set targets for utilities to provide building electrification incentives to their customers, including performance-based incentives where appropriate*
- *Establish fuel-neutral impact tracking and reporting methods*
- *Consider nonenergy benefits (e.g., environmental impacts) in cost-effectiveness testing and evaluations for building electrification programs*
- *Encourage utilities to explore the integration of building electrification technologies with the grid in order to increase variable renewable energy resource utilization and reduce systemwide costs*

- *Develop a transition plan for gas utilities, including gas distribution system downsizing and zero net carbon alternatives to natural gas*
- *Consider impacts on electric rates, particularly for energy-burdened customers, and require utilities to offer programs specifically targeting hard-to-reach sectors*

Utilities

- *Incorporate building electrification into the integrated resource planning process*
- *Develop pilots and expand existing building electrification program offerings*
- *Incorporate demand response, distributed generation, energy storage, and other demand-side resources to mitigate grid impacts of electrification*
- *Combine electrification incentives with existing in-home energy efficiency programs to streamline the delivery progress*
- *Offer incentives for electric panel and service upgrades to support electrification*
- *Phase out incentive programs for fossil fuel equipment*

Manufacturers/ distributors

- *Expand production and distribution of building electrification technologies, particularly for whole-home systems designed for use in cold climates and for homes with hot-water distribution systems.*
- *Provide contractor education programs and work with installers to broaden understanding and expertise in heat pump technologies for buildings*
- *Ensure that heat pump equipment is widely available and stocked in distribution centers to allow replacement of fossil fuel equipment on an emergency basis*

Contractors, Builders, Architects, and Engineers

- *Participate in education, job training, and certification programs to incorporate building electrification technologies in building design and installations*
- *Develop specialized product and service offerings to integrate heat pump technologies into existing business models and sales processes*
- *Join business groups to share knowledge and receive support for building electrification*
- *Combine electrification with efficiency to reduce system and ongoing energy costs*
- *Educate customers on heat pump technologies, incentives, and benefits*

Homeowners and Property Managers

- *Learn about building electrification technologies and share this information with neighbors and peers*
- *Understand the local utility incentives for building electrification measures*

- *Plan to replace existing fossil fuel equipment as it nears the end of its useful life span to avoid an emergency replacement when existing equipment fails*
- *Implement energy efficiency measures, such as improving building envelopes, along with building electrification to reduce lifetime energy cost and improve comfort*

ACEEE provides multiple useful tools, guides, and research documents, including an Energy Equity for Renters, an initiative for affordable, energy-efficient housing for renters. They also provide a Policy Tracker and guide for local governments with actions governments can take and design, implement, and evaluate equitable policies.

- Tool: [Energy Equity for Renters Policy Tracker](#)
- Document: [A New Lease on Energy: Guidance for Improving Rental Housing Efficiency at the Local Level](#). Sections include [resources on best practices](#) to expand energy efficiency investments for households with low incomes and more.

Appendix B: NWN Vision 2050 Technologies & Measures

Figure 61 below is from Northwest Natural's Vision 2050 Analysis summarizes the rate of implementation of various technologies and measures. For example, they considered up to 40% dual-fuel heating systems by 2040 (33% by 2030) if RNG supplies are constrained; and 30% efficiency increases beyond ETO expectations for the industrial sector as well as 30% reduction as a result of weatherization and building shell improvements.

Figure 61: NWN assumptions for various technologies and measures through 2050

SUPPLY SIDE MEASURES				
	YEAR	BALANCED APPROACH SCENARIO	MODERATE OFFSETS SCENARIO	RNG-CONSTRAINED SCENARIO
Decarbonized gas supplies (dekatherms)	2050	52.2M	47.4M	35.2M
Renewable Natural Gas		34.2M	34.2M	14M
Clean Hydrogen or Clean Hydrogen Derived Synthetic Gas		18M	13.2M	21.2M
DEMAND SIDE MEASURES				
Natural gas heat pumps as a percentage of natural gas space heating equipment installed in year	2025	3%	4%	3%
	2030	17%	12%	17%
	2050	72%	55%	60%
Hybrid heating systems as a percentage of natural gas space heating equipment installed in year	2025	9%	8%	18%
	2030	16%	8%	33%
	2050	0%	0%	40%
Natural gas heat pumps for water heating as a percentage of new gas-fired water heating equipment installed in year	2025	7%	4%	7%
	2030	36%	15%	36%
	2050	91%	65%	91%
Industrial energy efficiency increase (percentage) beyond current Energy Trust of Oregon expectations	2050	23%	13%	30%
Percentage reduction in building heating requirements, due to building shell improvements	2050	21%	13%	30%
CARBON OFFSETS AND CARBON CAPTURE				
Certified carbon offsets used to account for conventional gas supply not yet decarbonized	2025	4.2%	7.1%	2.7%
	2030	7.5%	11%	8%
	2050	0%	25%	0%
Natural gas supplies decarbonized with CARBiN-X carbon capture equipment (dekatherms)	2025	38k	37k	38k
	2030	0.8M	0.8M	0.8M
	2050	2.3M	2.8M	1.7M