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Technical Memorandum

DATE: August 30, 2024
TO: Cassie Lacy, Senior Management Analyst, City of Bend
FROM: Maddie Cheek and Tracy Lunsford, Parametrix
SUBJECT: Bend Building Stock Characterization
PROJECT NAME: Bend Electrification Policy Analysis

Purpose

This memo provides an overview of Bend's existing residential and commercial building stock characteristics, energy end uses, and greenhouse gas (GHG) emissions associated with residential and commercial buildings in Bend. It also provides an emissions forecast to illustrate the potential building emissions reduction associated with commercial and residential electrification.

Residential Sector

Residential Summary

- Most of Bend's current housing units are single-family homes (72%), followed by multi-family (25%) and mobile homes (3%). This is expected to change over time to a greater proportion of multifamily compared to single-family.
- About 23% of Bend's residential buildings were constructed prior to the establishment of Oregon's energy conservation requirements.
- A majority of homes use utility gas as their primary heating fuel (54%), followed by electricity (38%).
- The primary end uses for residential natural gas are space heating (55%) and water heating (38%), while the primary end uses for electricity are space cooling (37%), space heating (20%), and water heating (18%).
- Single-family homes have a disproportionate impact on residential building emissions: they drive 87% of residential building emissions but make only up 78% of Bend housing stock.

Building Stock Characteristics

In 2016, Bend conducted a Housing Needs Analysis[1] that found that, "Bend's current housing policies and regulations support the development of a mix of housing that is not consistent with Bend's needed mix for a larger percentage of single-family attached and multifamily housing types (relative to past trends) and a higher percentage of more affordable single-family detached housing types." Over the last eight years, Bend's residential building stock has begun to change as a result of the Housing Needs Analysis and subsequent local policy changes. Figures 1 and 2 below give a summary of Bend's existing housing stock as of 2023.

[1] City of Bend Housing Needs Analysis (2016)

Figure 1 presents a summary of Bend's housing stock by type from the City of Bend. As of 2023, Bend had over 47,200 total housing units. Most of Bend's housing units (72%) were single family (detached and attached). The remaining units are multifamily or ADUs (25%) and mobile homes (just under 3%). The *Energy Trust of Oregon City Report: Bend 2022*[2] reports that 62% of housing units were owned and 28% were rented in 2022.

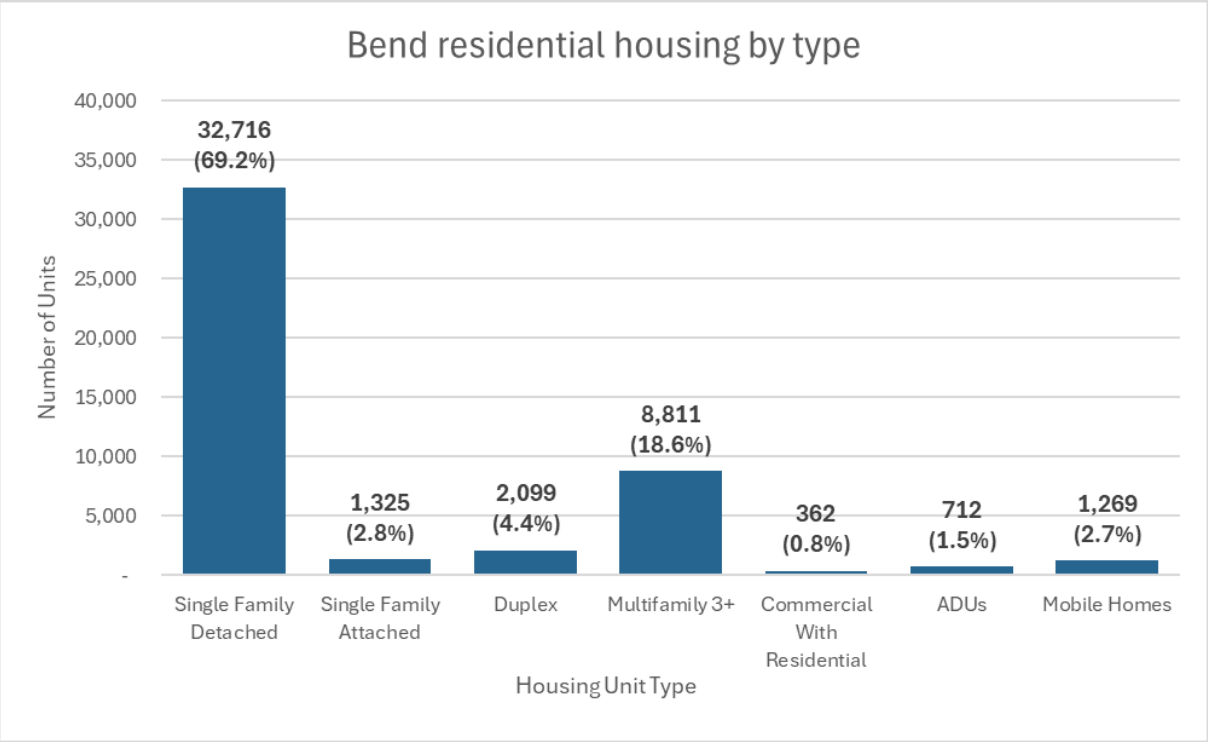

Figure 1: Bend residential housing by type

In addition to building type, building age matters because changes in building standards have tended to make buildings more efficient over time. Oregon's first energy conservation requirements were adopted with the first statewide building code in 1974 and were limited to residential-type occupancies (apartments, hotels, dwellings). With the original statewide code and all future codes, the provisions are mandatory statewide. This code was upgraded in 1978 and again in 1980 to reflect the new editions of the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) standards (90-75, 90A-80, 90B-75). Since 1980, the residential energy conservation requirements have been amended on a three-year cycle in sequence with the Oregon Residential Specialty Code (ORSC). The current code for one- and two-family homes, as well as townhomes is the 2023 ORSC, adopted in October 2023. The ORSC residential energy provisions were developed as Oregon-specific code. Since 2011, each new edition is compared to the current national model code (International Energy Conservation Code (IECC) residential).[3]

Figure 2 shows housing units by age. Roughly 77% of housing units were built after 1980, following the establishment of Oregon's first energy conservation requirements and initial upgrades to ASHRAE standards. About 25% of residential buildings were constructed after 2011, which is the first year that the ORSC was compared to the residential IECC to foster greater energy efficiency in

[2] The Energy Trust of Oregon provided the report to Parametrix upon request.

[3] Office of Energy Efficiency & Renewable Energy – Oregon State Profile

buildings. About 23% of Bend's residential building stock was constructed prior to the establishment of Oregon's energy conservation requirements. These older buildings are likely to be the least efficient in the residential sector.

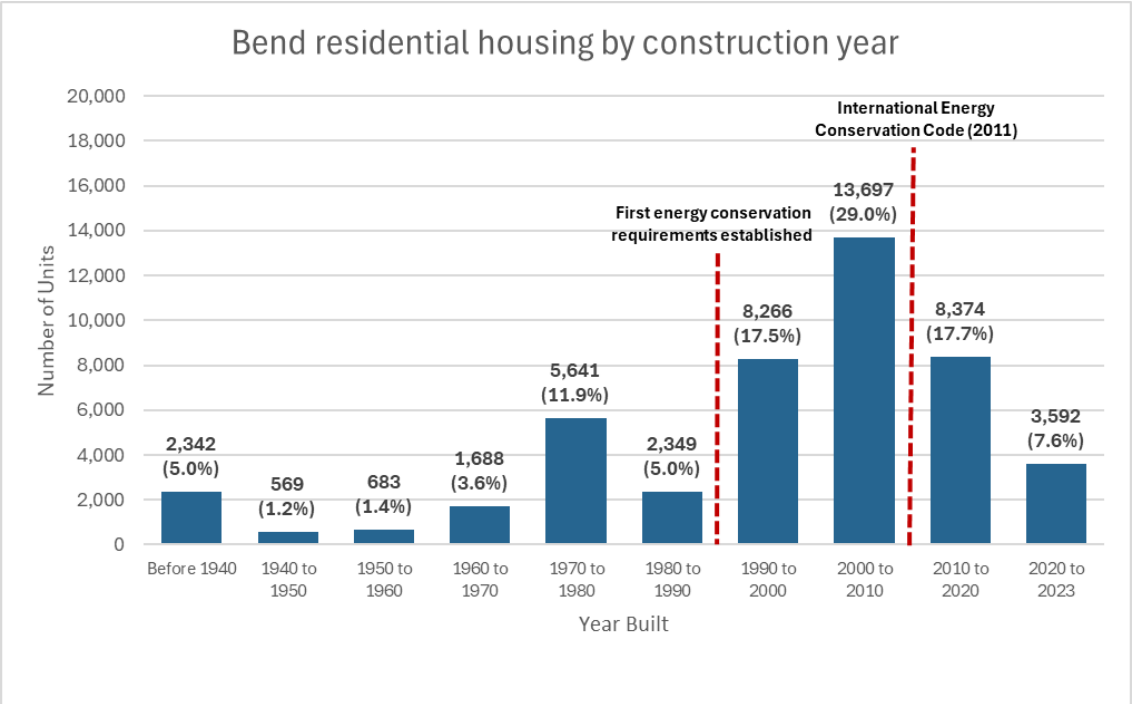

Figure 2: Bend residential housing by construction year

Figure 3 illustrates the breakdown of primary heating fuel in Bend, using data from the Energy Trust of Oregon (ETO)[4]. ETO reports that 54% of housing units (22,468 units) in Bend use natural gas as the primary heating fuel (compared to 38% statewide); while electricity is the primary heating fuel for about 39% of housing units (53% statewide); wood represents 4%; and other fuels (e.g. propane, fuel oil) total 3%.

[4] Note: The ETO report is based on data from the American Community Survey and number of housing units will not match up exactly between ACS data and data from the City of Bend shown in Figures 1 and 2.

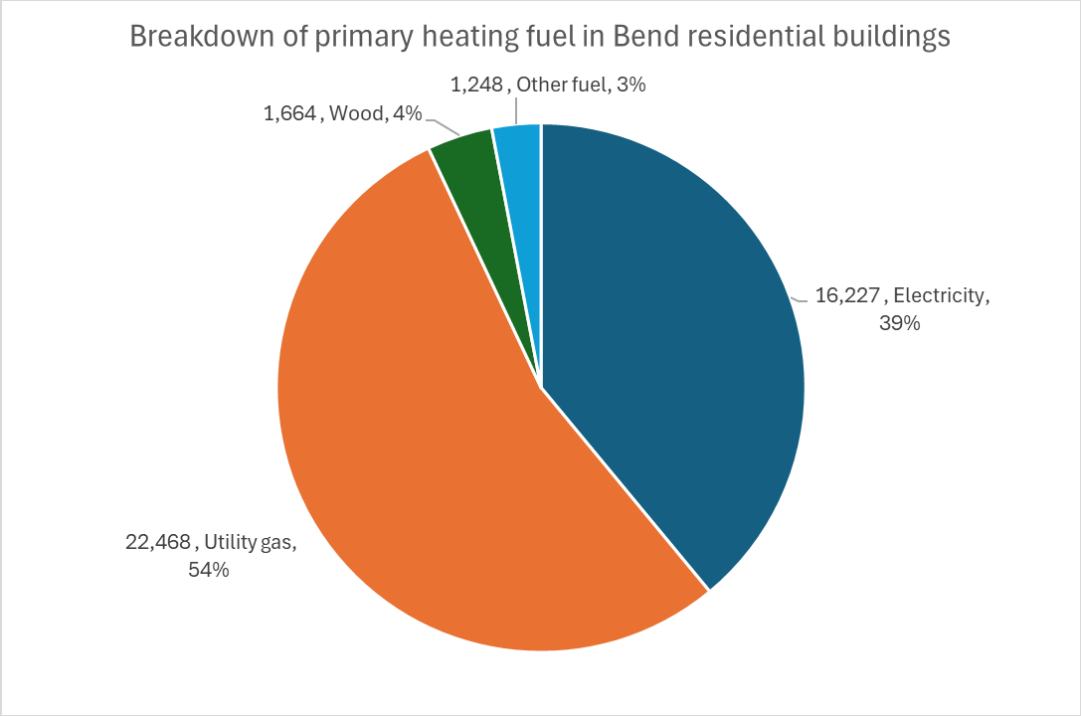

Figure 3: Percent breakdown and number of housing units by primary heating fuel in Bend

Energy End Uses and Greenhouse Gas Emissions

Figure 4 and Figure 5 show the various end uses of natural gas and electricity at residential properties. For electricity, the largest end uses are for space cooling (37%), space heating (20%), and water heating (18%). Other uses include lighting, clothes dryers, humidity equipment, and EV charging.[5] Cooking with electric ovens and stoves is not captured in this data.

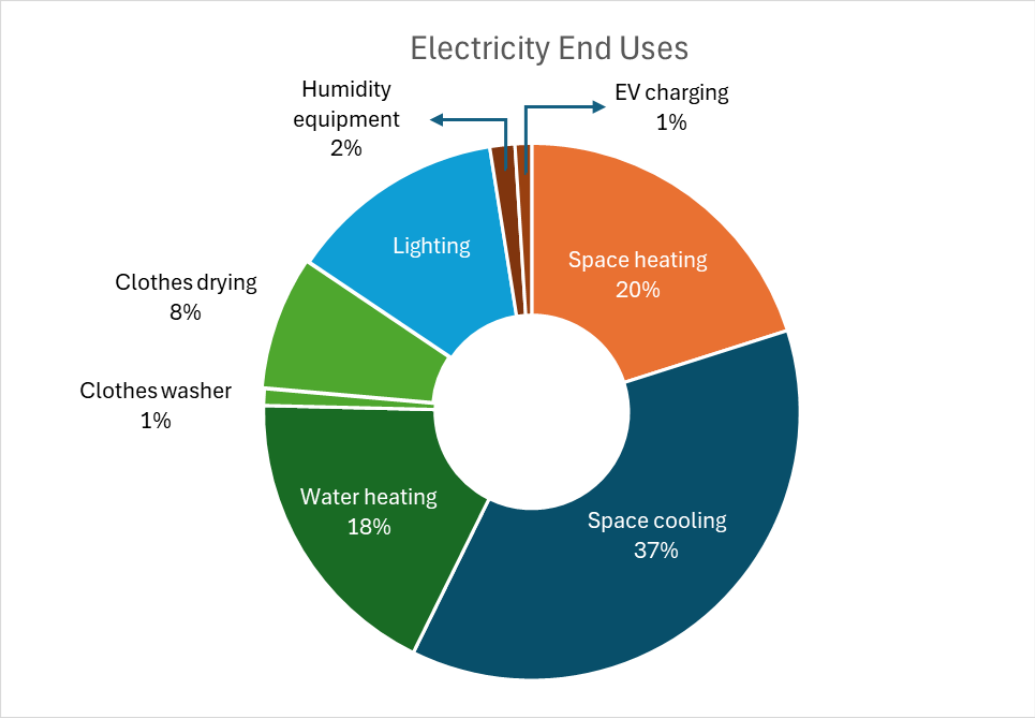

Figure 4: Residential electricity end uses

For natural gas the dominant uses are space heating (55%) and water heating (38%). Cooking, clothes drying, and heating water for hot tubs and pools play a relatively smaller role, although it is unknown from the data how many homes have hot tubs and pools.

[5] From the U.S. Energy Information Administration's Residential Energy Consumption Survey for the Northwest https://www.eia.gov/consumption/residential/

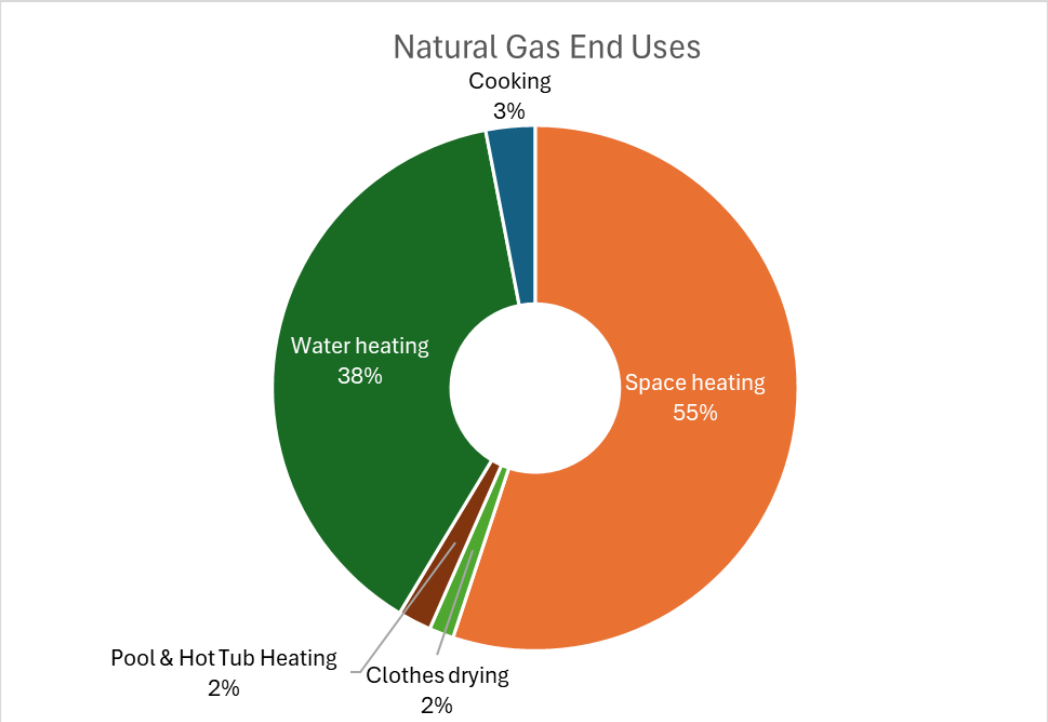

Figure 5: Residential natural gas end uses

Emissions by energy type and housing categories are estimated using data from Bend's 2021 Community GHG Inventory, the Energy Trust of Oregon's 2022 Bend City Report, the American Community Survey, and the Energy Information Administration's Residential Energy Consumption Survey. Housing type data used in Figures 6-9 is based on national datasets and thus differs slightly from the data used in Figures 1 and 2.

Housing categories considered include:

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

Figure 6 shows that residential emissions in the Bend community are overwhelmingly from electricity and natural gas use in single family (detached) homes. This is being driven by the fact that single family homes (detached) make up the vast majority (74%) of the housing units in Bend (Figure 7). Single family homes have larger square footage per unit than other housing types and require more fuels and energy to heat and cool the larger spaces. Additionally, multifamily and single-family (attached) units benefit from some energy conservation due to shared walls (Figure 8).

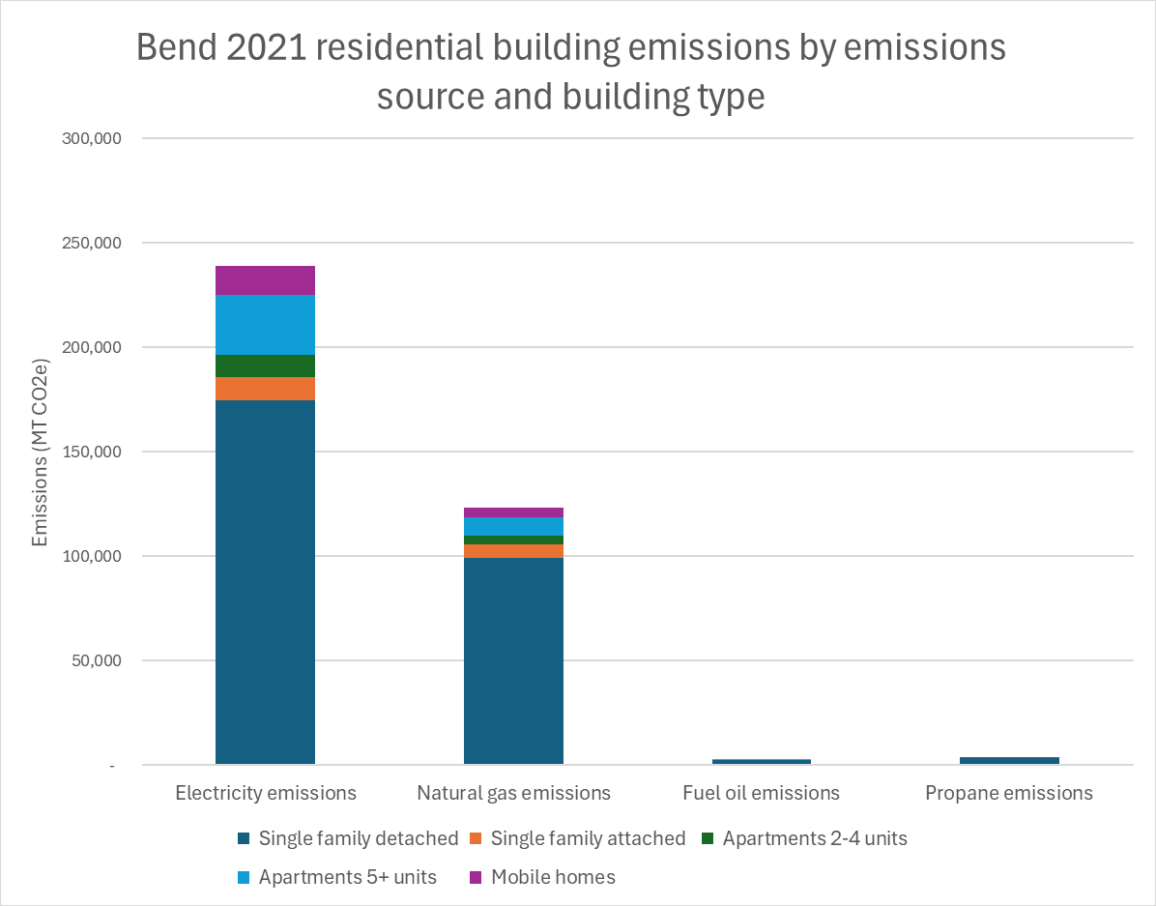

Figure 6: Bend's 2021 residential GHG emissions by energy type and housing category

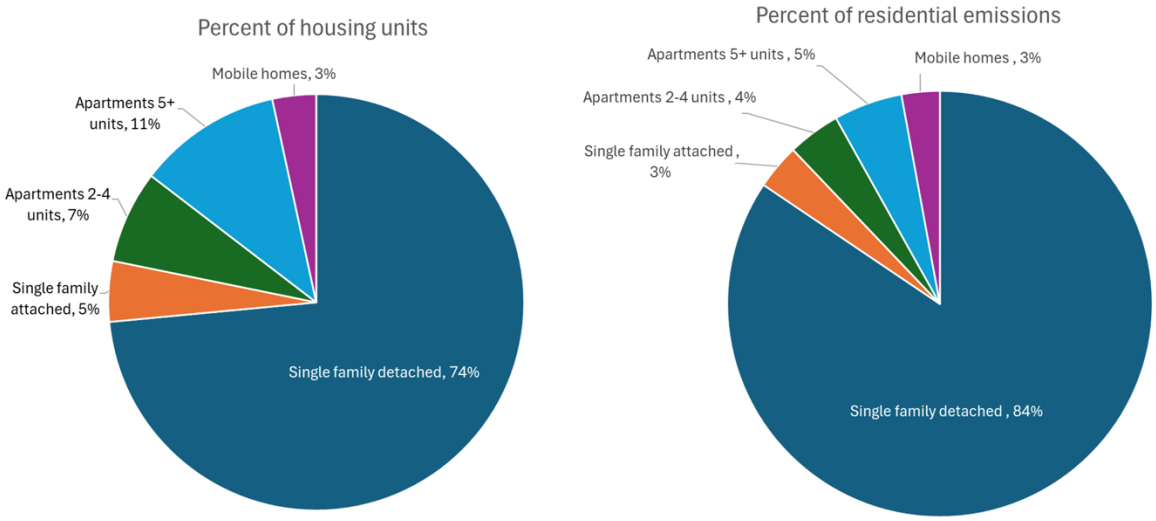

Figure 7: Comparison of housing units by category to GHG emissions by category

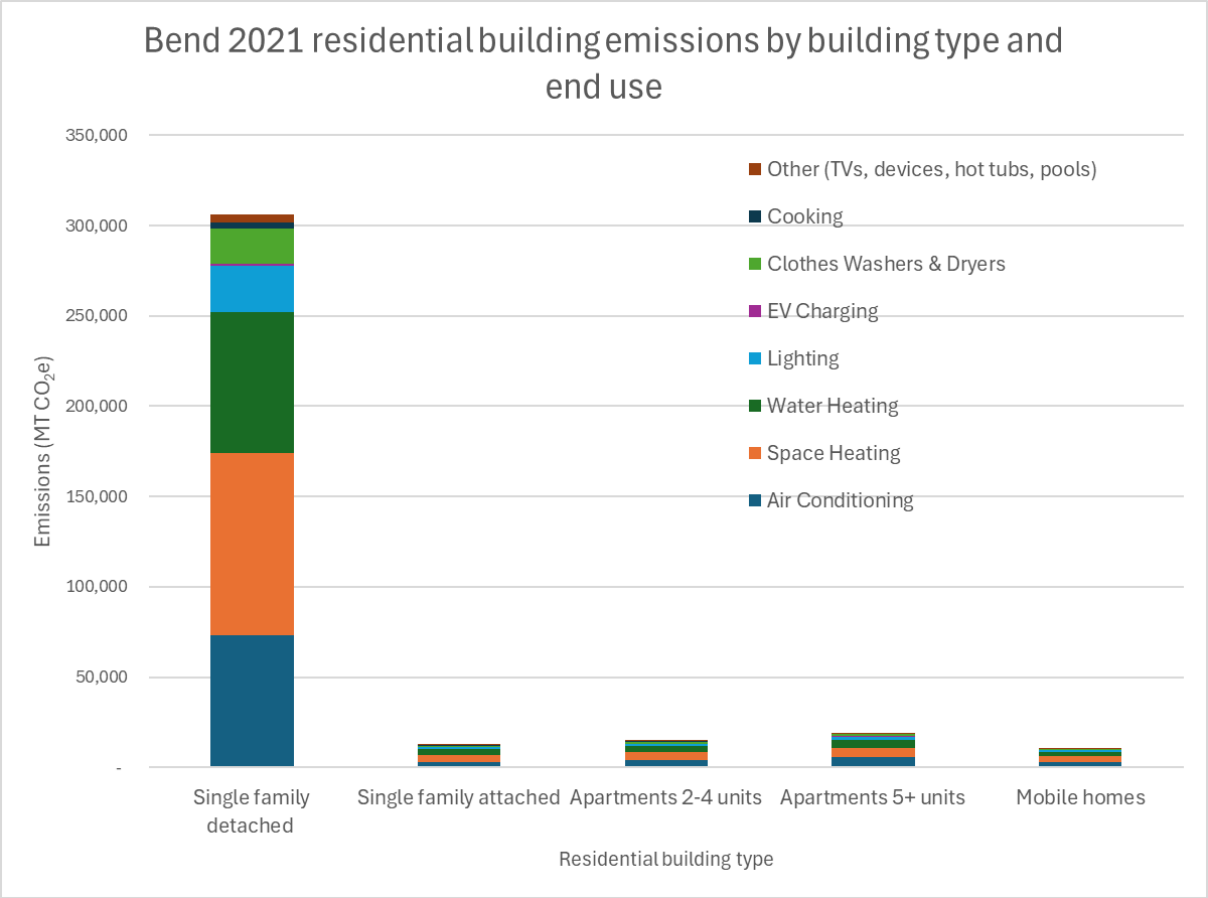

Figure 8: Bend's 2021 residential building emissions by building type and end use

Figure 9 compares average 2021 emissions per type of housing unit. Based on their prevalence – it is unsurprising that single family homes represent large average emissions per home. What is more surprising is the average emissions per square foot 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 building envelopes.

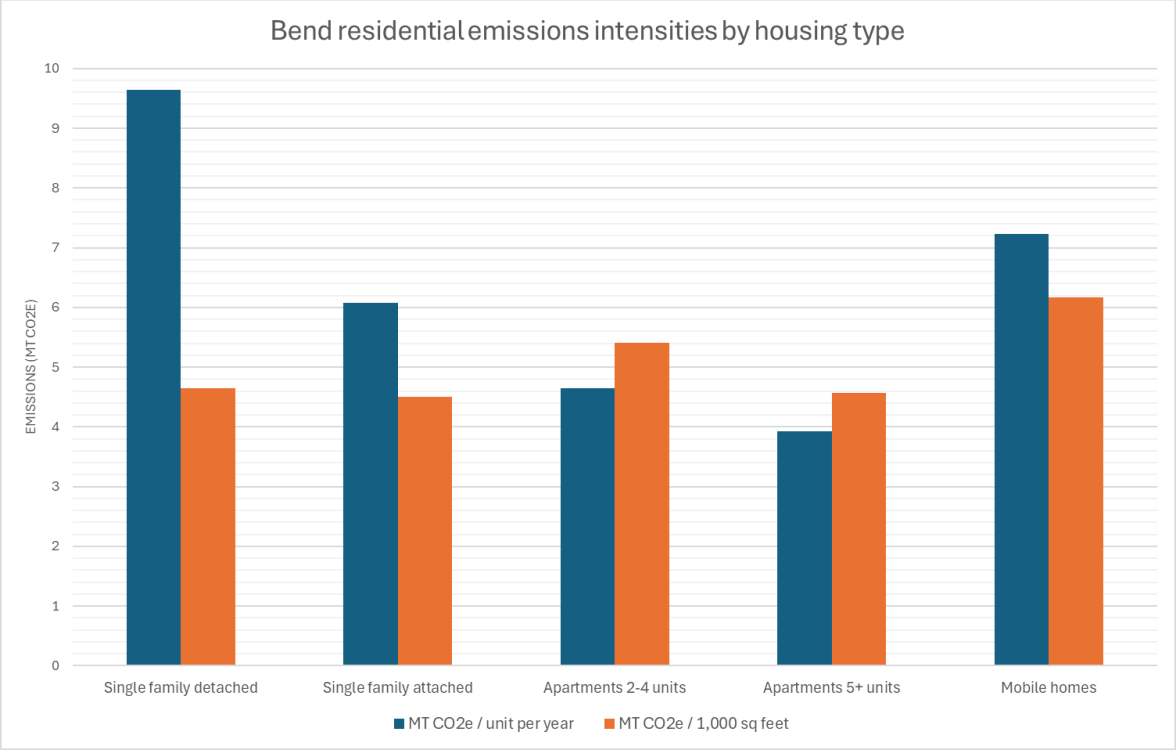

Figure 9: Bend 2021 residential building emissions intensities by housing type. Emissions per housing unit are shown in blue, and emissions per 1,000 square feet are shown in orange.

Commercial Sector

Commercial Summary

- The majority (71%) of commercial floorspace in Bend was built after 1980, when modern energy code standards came into effect.
- The majority (67%) of commercial building floorspace is between 5,000 and 50,000 square feet.
- 85% of commercial building energy emissions are from electricity, followed by 11% from natural gas combustion.
- The commercial segments with the highest emissions are office space (18%), retail space (15%), and education facilities (12%). Lodging and healthcare were also notable at 8% each.

Building Stock Characteristics

The City of Bend provided building stock data, including building types and total square footage. Building types were categorized as follows, in line with the U.S. Energy Administration's Building Type Definitions[6]:

[6] https://www.eia.gov/consumption/commercial/building-type-definitions.php

Building Type	Definition
Education	Buildings used for academic or technical classroom instruction.
Food sales	Buildings used for retail or wholesale of food.
Food service	Buildings used for selling prepared food and beverages.
Healthcare	Buildings used as diagnostic and treatment facilities for inpatient and outpatient care.
Lodging	Buildings used to offer multiple accommodations for short-term or long-term residents, including skilled nursing and other residential care buildings.
Office space	Buildings used for general office space, professional offices, or administrative offices.
Public assembly	Buildings in which people gather for social or recreational activities.
Religious worship	Buildings in which people gather for religious activities.
Retail	Buildings used for the sale and display of goods other than food. Includes shopping malls and strip malls.
Services	Buildings in which some type of service is provided, other than food service or retail sales of goods.
Warehouse & storage	Buildings used to store goods, manufactured products, merchandise, raw materials, or personal belongings (such as public self-storage).
Other	The other category includes laboratories and other miscellaneous buildings that do not fit into any other activity category (E.g., airplane hangars, data centers, public restrooms).

The energy conservation requirements for all buildings constructed under the commercial building code were developed in 1978 and upgraded in 1980. From 1980 until 2021, the energy conservation requirements have been upgraded in sequence with the Oregon Structural Specialty Code (OSSC). From 2011 until 2019, the commercial energy provisions were based on the latest edition of the IECC commercial provisions. Beginning with the 2019 building code, the Division moved to the use of the latest edition of Standard 90.1 as the energy code basis for the Oregon Energy Efficiency Specialty Code (OEESC). Each OEESC provides the administrative sections and Oregon-specific amendments as necessary for use of Standard 90.1 within Oregon's statutory framework. Beginning in 2021, adoption of the energy code is now out-of-sync with the building code adoption cycle. Energy provisions are adopted in alignment with the publication of the latest edition of Standard 90.1. The energy code was updated in 2021 with the to use Standard 90.1-2019.[7]

Additionally, the Oregon Department of Energy is currently in the rulemaking process to establish Building Energy Performance Standards for commercial buildings. The policy will address energy use and emissions from existing commercial buildings, which account for nearly 20% of energy use in Oregon. It will require many large commercial buildings to enhance energy management practices and implement efficiency measures to meet energy use targets. Rulemaking is expected to be complete by the end of 2024, and the new rules are anticipated to take effect in July 2025.

Bend's building stock data showed that 29% of commercial building square footage was built prior to 1980 (Figure 10), meaning that **the majority of commercial floorspace in Bend was built after modern energy code standards came into effect.**

[7] Office of Energy Efficiency & Renewable Energy – Oregon State Profile

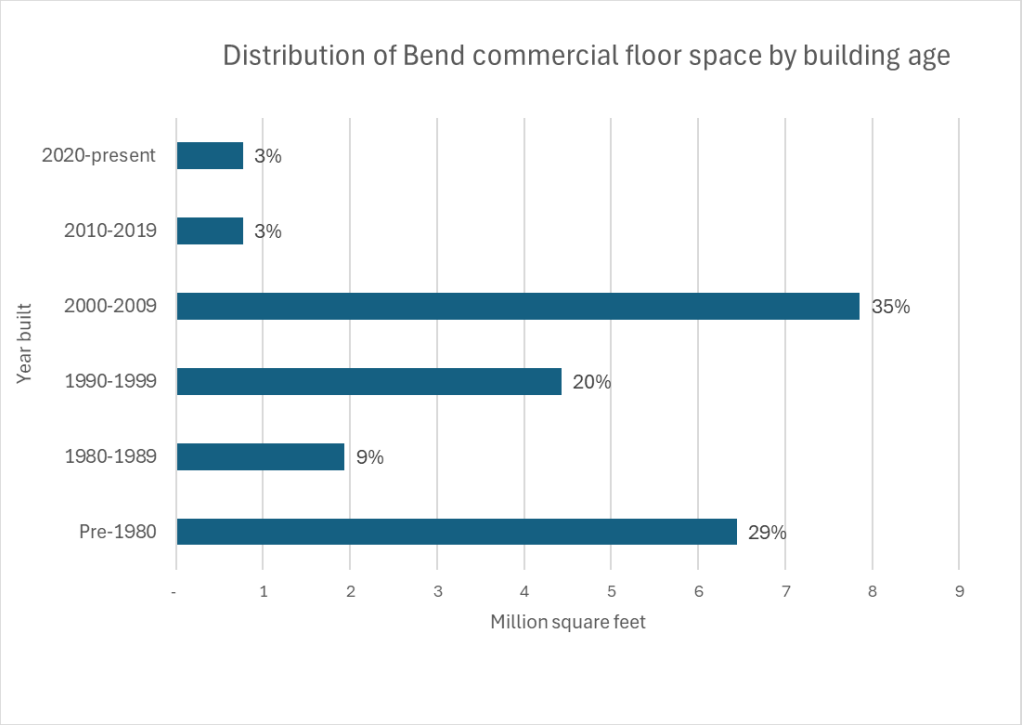

Figure 10: Distribution of Bend floor space by building age

Figure 11 shows the distribution of commercial building square footage in Bend. **The majority (67%) of commercial building floorspace is between 5,000 and 50,000 square feet.**

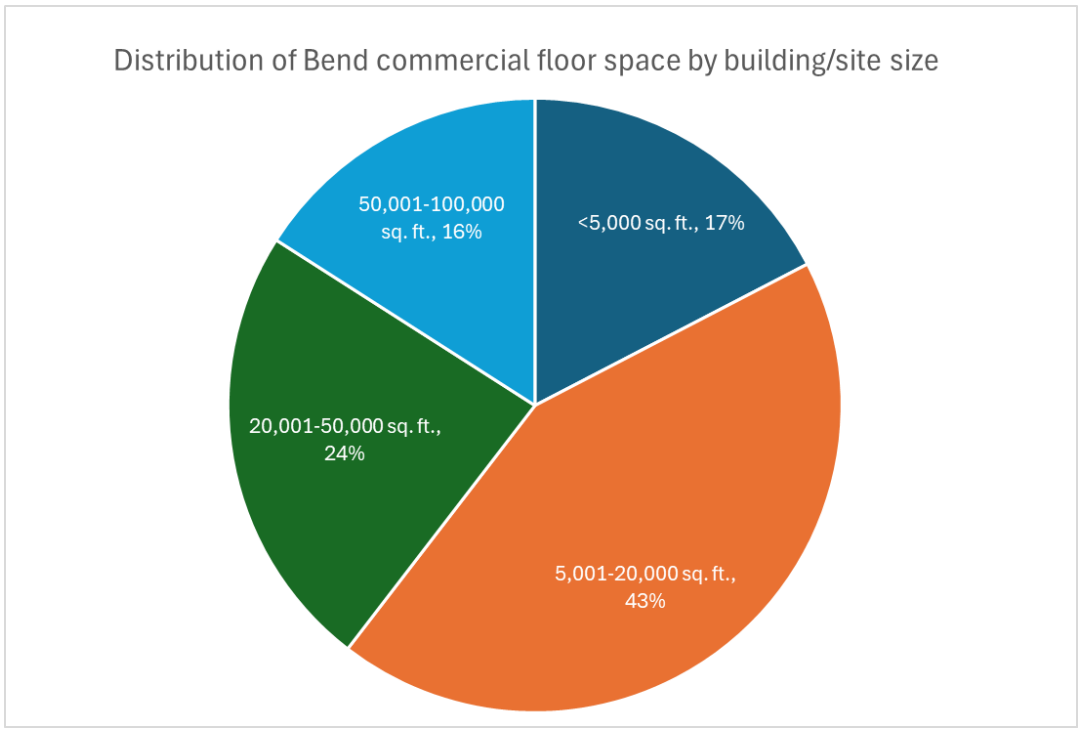

Figure 11: Distribution of Bend commercial floor space by building size

Energy End Uses & Greenhouse Gas Emissions

Based on the 2021 Bend Community Greenhouse Gas inventory, **85% of commercial building energy emissions are from electricity, followed by 11% from natural gas combustion** and 4% from fuel oil and propane combustion.

Office buildings (18%), retail buildings (15%), and educational facilities (12%) had the highest building emissions in the commercial sector (Figure 12). Note the graphic's legend for end use colors (e.g., space heating (dark blue) is the bottom-most segment in each bar).

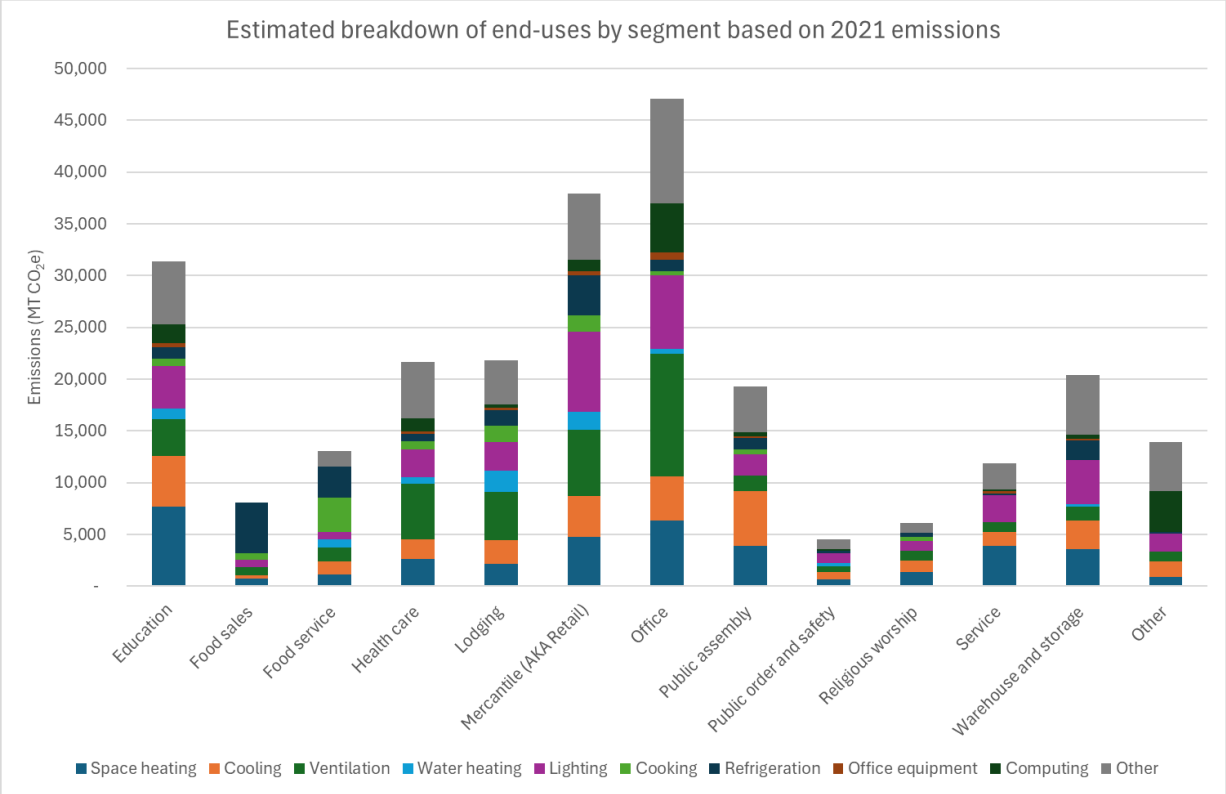

Figure 12: Estimated breakdown of end-uses by segment based on 2021 emissions, MT CO_2e

Figure 12 shows the estimated breakdown of emissions by end use for each segment in the commercial sector[8]. Ventilation, space heating, lighting, and space cooling were the end uses most responsible for driving commercial emissions across sectors. However, other uses were also significant in some commercial segments (e.g., education, office, retail).Other uses include things like air purifiers, digital display screens, décor, ceiling fans, and other miscellaneous uses not captured in the CBECS data.

[8] Using data from the Commercial Buildings Energy Consumption Survey (CBECS)

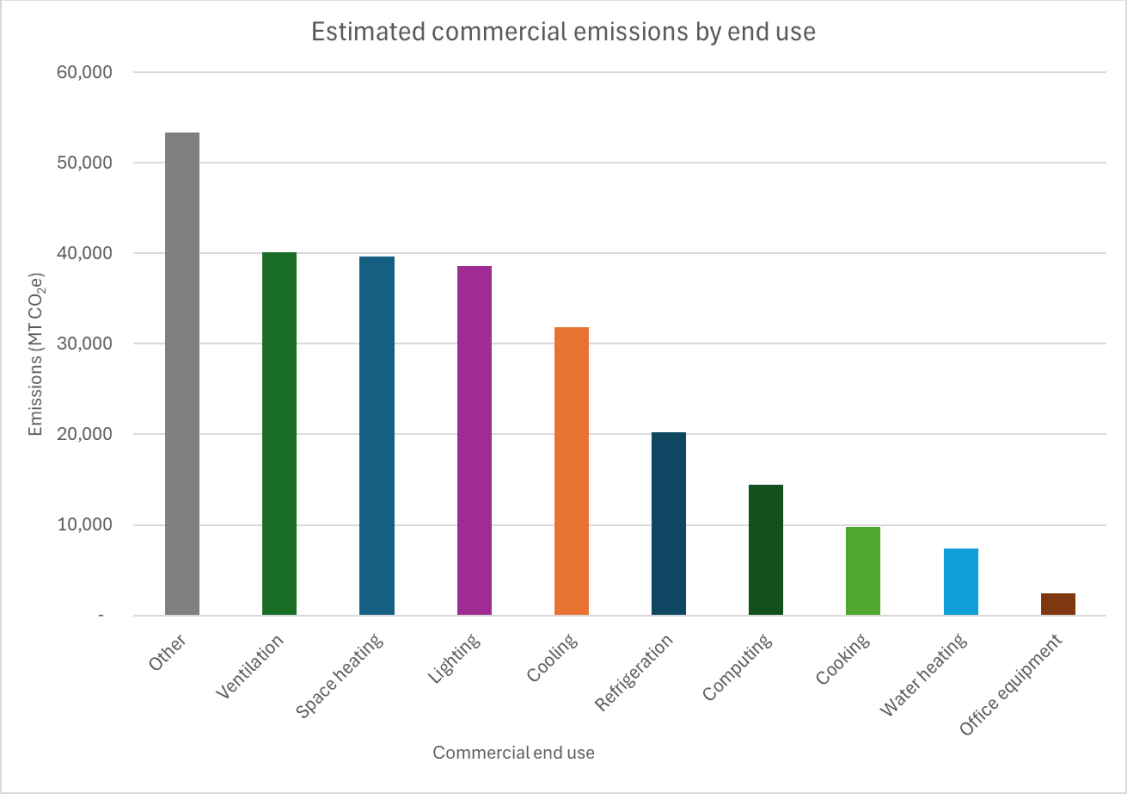

Figure 13: Estimated commercial emissions by end use, MT CO_2e

Commercial natural gas use is driven by space heating (69%), followed by cooking (17%), and water heating (10%). Commercial electricity use is driven by ventilation (18%), lighting (17%), and space cooling (14%). It is notable that miscellaneous other uses are also significant (24%), when added together. See Figure 14.

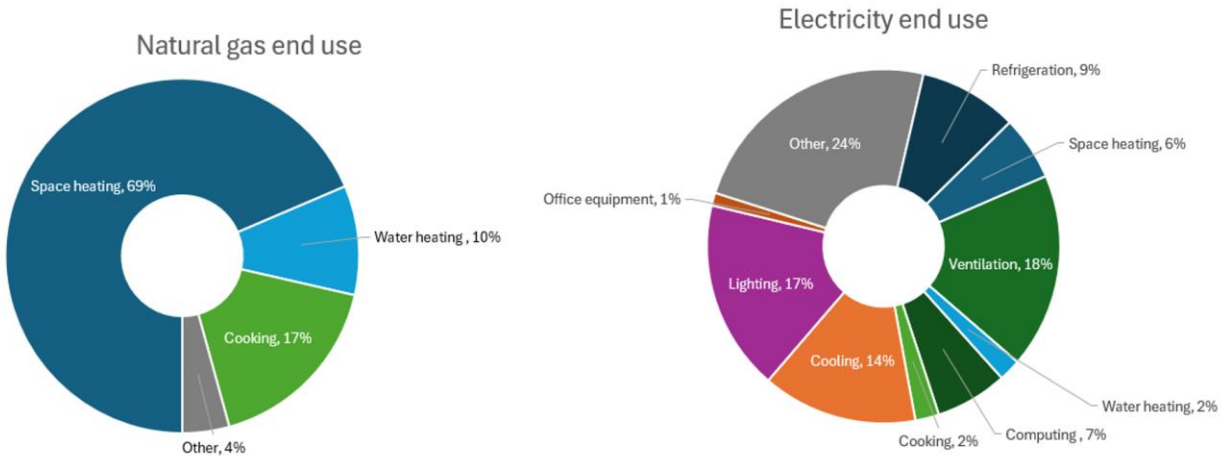

Figure 14: Estimated breakdown of end-uses for commercial natural gas and electricity

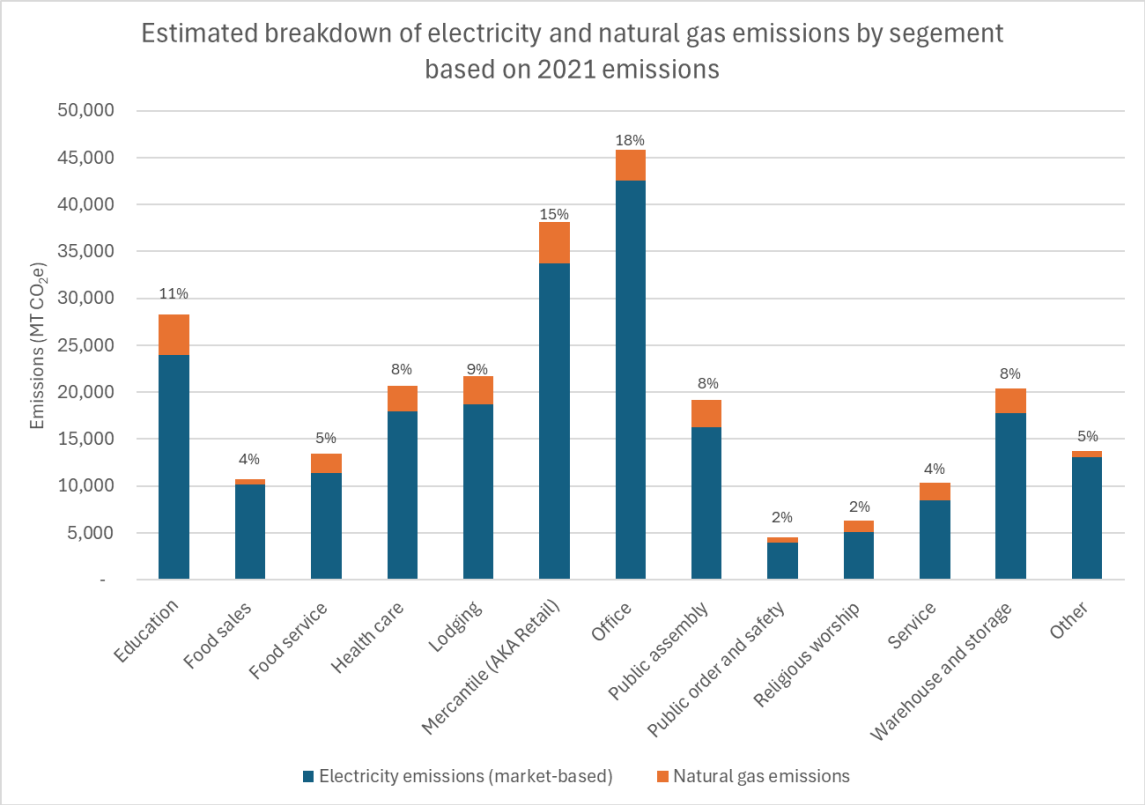

Figure 15: 2021 emissions breakdown for commercial electricity and natural gas use

When looking at fuels across segments, 85% of commercial building emissions are from electricity, 11% from natural gas, and 4% from fuel oil and propane. It is worth noting that electricity emissions will decrease over time in line with Oregon's Clean Energy Targets[9] which created targets for investor-owned utilities like Pacific Power to reduce the greenhouse gas emissions from electricity sold in Oregon to:

- 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

[9] https://www.oregon.gov/deq/ghgp/pages/clean-energy-targets.aspx

Electrification and Bend's Building Emissions

If Bend were to electrify the residential and commercial sectors by 2050, it could reduce emissions from buildings by over 90% compared to baseline.

Under the current scenario (known as "Business as Usual" or "BAU"), building emissions will fall from around 536,000 MT CO_2e in 2025 to just below 290,000 MT CO_2e by 2050. This reduction is driven by a decrease in electricity emissions due to Pacific Power meeting its Clean Energy Targets.

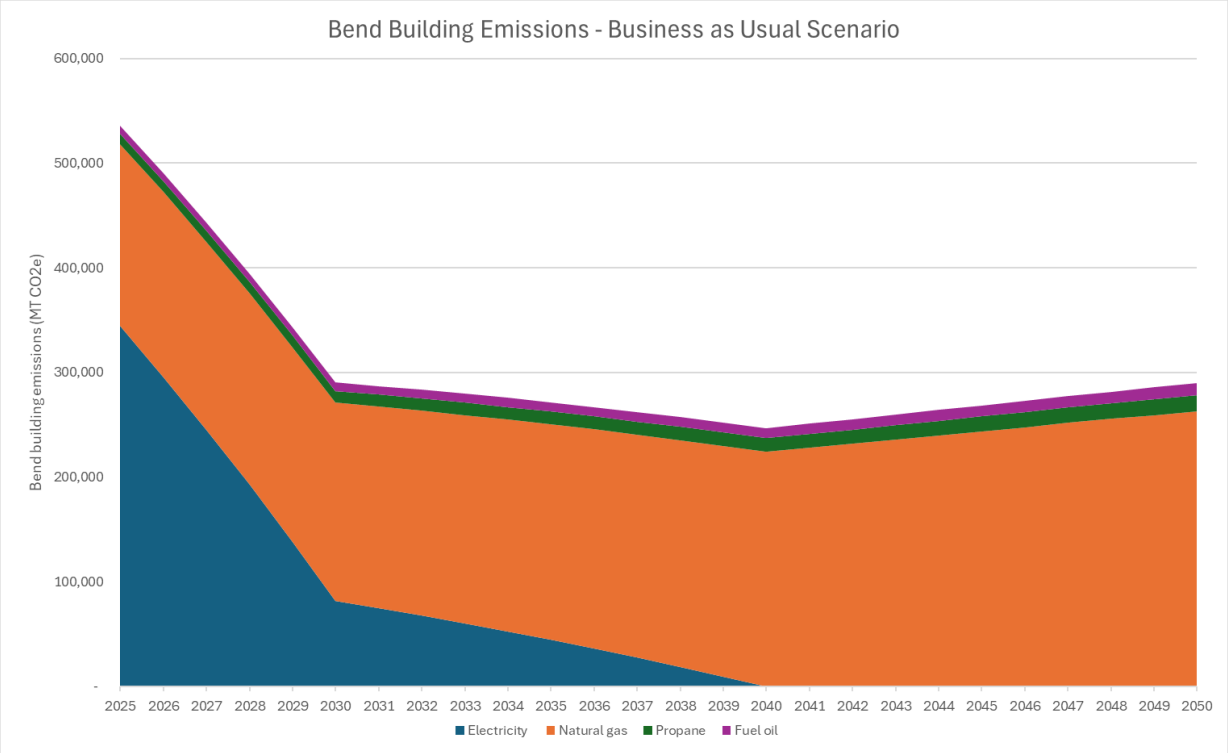

Figure 16: Bend building emissions 2025-2050, business as usual scenario

Alternatively, if Bend reduces residential and commercial natural gas use to zero by 2050, building emissions will fall from around 536,000 MT CO_2e to 14,000 MT CO_2e by 2050. This reduction would be driven by a decrease in electricity emissions due to Pacific Power meeting its Clean Energy Targets, as well as fuel switching from fossil fuels (natural gas, fuel oil, and propane) to low-to-zero-carbon electricity supply.

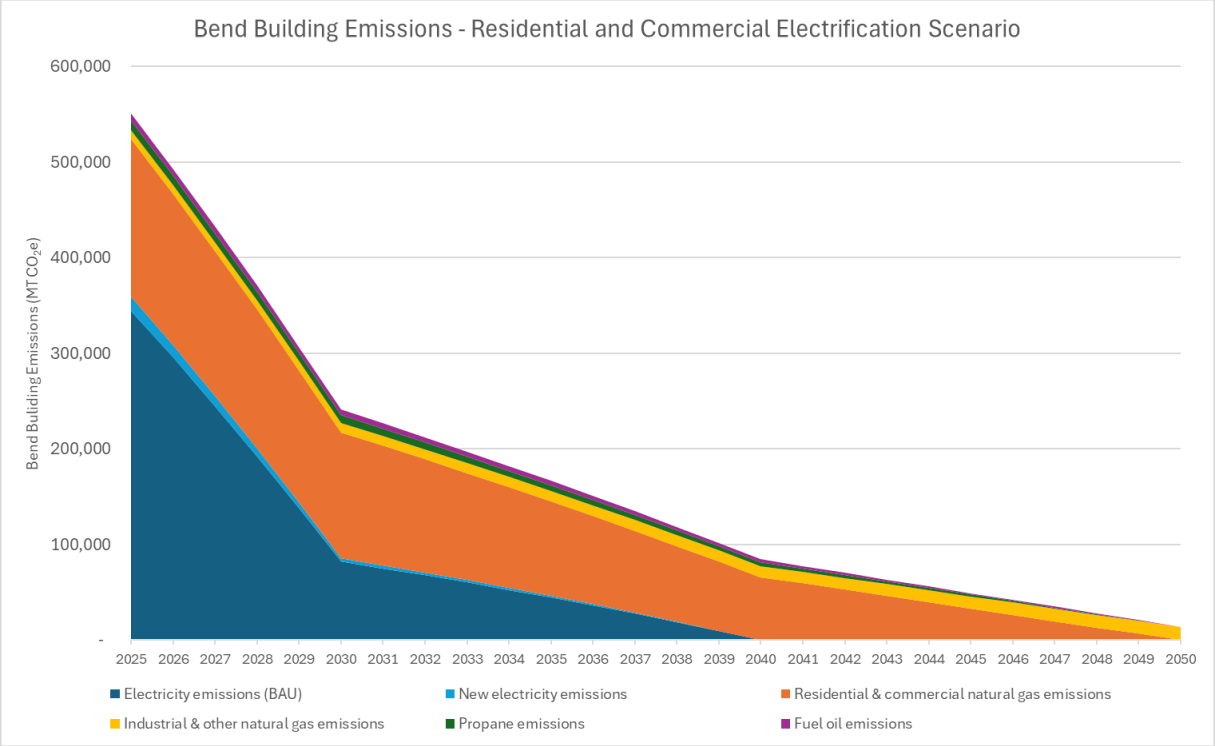

Figure 17: Bend building emissions 2025-2050, residential and commercial electrification scenario

This high-level analysis assumes the following:

- Pacific Power achieves its Clean Energy Targets set out by the Oregon legislature.
- All residential and commercial natural gas, fuel oil, and propane use is electrified by 2050 and electrification occurs linearly between 2025 and 2050.
- Industrial and other uses continue to use natural gas, fuel oil, and propane at the current rate, scaled with population growth over time.