City of Tigard

Climate Action Report

CITY OF Tigard

SSG

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Executive Summary

The City of Tigard is developing a Climate Action Plan to provide strategies and actions for climate mitigation and adaptation, aligned with Tigard's Strategic Plan, Community Promise and City Council Goals. This Report represents the results of the City's first comprehensive climate action initiative, and provides a bold pathway for achieving carbon neutrality.

Reaching carbon neutrality will require ambitious and rapid action in several sectors across the community. This plan:

- Identifies 16 significant actions that constitute a pathway for Tigard, with its unique context and constraints to become a zero emissions community;
- Clarifies the role of the City as a leader - decarbonizing its own operations, and as a catalyzer - driving and supporting action from the whole community;
- Identifies how the broader community - from utility operators and local businesses to educators, and citizens of all ethnicities, genders and socio-economic groups - will need to be engaged, take responsibility for, and benefit from Tigard's transition to becoming a zero emissions community;
- Includes an analysis of the Plan's key co-benefits, co-harms and impacts on equity actions on se actions' negative impacts, benefits (in addition to reducing emissions), and effects on equity, particularly in the context of historically excluded communities most vulnerable to climate change.

The actions in this Plan were selected from the most effective approaches to decarbonization currently available. They were refined to be appropriate to Tigard's energy and climatic context to maximize reductions, address inequities, and to capitalize on the community's economic strengths and opportunities. Ultimately, 17 low-carbon actions were modeled for Tigard:

- Three actions affect Tigard's "Urban Form, Buildings and Industry";
- Five actions relating to Tigard switching to emissions-free "Energy";
- Six "Transportation" actions;
- Two "Waste" actions; and
- One "Sequestration" action.

These actions were then evaluated against a multi-criteria analysis with a specific emphasis on identifying co-benefits, co-harms and impacts on equity.

Table 1 describes the key elements of Tigard's Climate Action Report for the City of Tigard.

Table 1. Elements of this Community Energy and Emissions Plan.

ELEMENT	DESCRIPTION			
Current Energy and Emissions Trajectory	This is a modeled projection of the community's energy use and emissions out to 2035 and 2050 if current practices continue and no interventions are taken. These projections constitute the Business-as-Usual (BAU) scenario.			
	2035 Emissions (tonnes)	2035 Change Relative to 2019	2050 Emissions (tonnes)	2050 Reduction Relative to 2019
	585,756	+3%	655,699	+15%
Planned Energy and Emissions Trajectory	This is a modeled projection of the community's energy use and emissions if the strategies and requirements from existing approved government and corporate plans are implemented successfully and on schedule, but no further actions to reduce emissions are taken. This constitutes the Business-as-Planned (BAP) scenario.			
	2035 Emissions (tonnes)	2035 Reduction Relative to 2019	2050 Emissions (tonnes)	2050 Reduction Relative to 2019
	267,993	-53%	140,575	-75%
Low Carbon Energy and Emissions Trajectory	This is a modeled projection of Tigard's energy use and emissions if the BAP scenario occurs and the 16 actions outlined in this Plan are implemented. This constitutes the Low Carbon scenario, and Tigard's pathway to becoming a net zero community.			
	2035 Emissions (tonnes)	2035 Reduction Relative to 2019	2050 Emissions (tonnes)	2050 Reduction Relative to 2019
	121,138	-79%	4,368	-99%
Multi-Criteria, Co-Benefits, Co-Harms and Equity Analysis	This is an analysis of the actions to evaluate their impact on greenhouse gas emissions as well as co-benefits, co-harms, community equity, resilience, job creation and high-level financial returns. The criteria used were derived from City strategies, input from public engagement sessions and BIPOC focus groups, and SSG's and others' expertise about these climate actions.			
Implementation and Performance Monitoring Framework	This is a framework that allows the City of Tigard to rapidly turn from planning to implementing low-carbon actions. It provides: Key milestones that can inform the design of programs and be used to monitor and report on emissions reduction progress. Analysis of co-benefits, co-harms, equity, and other elements that may affect timing, involvement of the community, and other strategic elements of implementing the Plan. This framework should be used to identify the City roles that will have primary responsibility for implementing, monitoring and ultimately completing each action in the plan on schedule.			

Introduction

The City of Tigard is developing a Climate Action Plan to provide strategies and actions for climate mitigation and adaptation, aligned with Tigard's Strategic Plan, Community Promise, and City Council Goals. This will be the City's first comprehensive climate action strategy and will provide the pathway for achieving its goal of carbon neutrality by 2035.

Methodology

Engagement

The engagement portion of the Climate Action Report project was designed and carried out to gather input from key interested and affected groups, including industry and local business representatives, teachers, County and City staff, residents, youth, land developers, non-profit organizations, and representatives from the Black, Indigenous, and People of Color (BIPOC) communities. The objectives of the engagement included:

- To inform community members about the Climate Action Report;
- To involve them in documenting:
- Their experiences with and concerns about climate change; and,
- The challenges and opportunities they see in Tigard for taking action on climate change; and,
- To collaborate with members of Tigard's BIPOC communities to learn about barriers and issues related to racial equity, and to co-create an equity lens for climate planning and policy making.

Engagement activities included pre-engagement interviews followed by two Technical Advisory Committee workshops, two Community Advisory Committee workshops, two BIPOC focus group discussions, and a community survey. A total of 241 citizens of Tigard were involved in these activities and provided input to the Plan and the Racial Equity Toolkit.[1]

> *"When faced with how I am going to feed my kids and pay my rent, the issue of reducing carbon emissions may take a back seat. On my family's pyramid of needs, climate mitigation might not be the highest priority but that does not mean I'm not concerned about [climate change]."*

[1] The Tigard Racial Equity Toolkit is a separate deliverable that has been provided to the Tigard project team.

RECOMMENDATIONS GATHERED THROUGH ENGAGEMENT

The following recommendations and considerations were commonly heard in the engagement sessions:

1. The City should work to raise the community's awareness of climate change and climate actions by providing education on these topics. When communicating the co-benefits of climate actions, the City should focus on the lived experiences of community members
2. To understand opportunities for and barriers to implementation, the City should tailor engagement opportunities and techniques to meet the needs of different community members by providing additional translations, hosting community events, engaging with youth, etc.
3. To improve uptake of climate actions, the City should leverage and expand financial, employment and transit supports for all, with priority given to equity-denied and vulnerable community members.
4. To leverage existing opportunities and funding supports, the City should facilitate collaboration among utilities, non-profit organizations, the private sector and government.
5. To ensure successful implementation of the Climate Action Report, the City should work with Tigard's minority groups - including BIPOC communities, refugees, migrant workers and newcomers to the community - throughout projects, to understand the different cultural impacts of climate actions, and to address potential co-harms.

Engagement feedback on specific actions is included in the Low Carbon section of this document.

Technical Modeling

Employing the standard City InSights methodology, the project team used data from the City, the Federal Government, and other sources to establish a baseline of Tigard's community emissions in a given, recent historical year. Future emissions were then modeled out until 2050 for three different scenarios:

- In the first scenario (business as usual or BAU) only forecast population, employment and household growth were reflected; energy sources and consumption, transportation modes and patterns, and land use plans remained as they are currently and no additional emissions-reduction measures were applied;
- In the second scenario (business as planned or BAP), existing and approved plans, legislation, and targets affecting energy use and emissions were overlaid on the community's forecast growth;
- In the third scenario (low carbon or LC), additional actions were selected and modeled to ambitiously reduce the community's energy use and emissions, with a target of achieving carbon neutrality by 2035.

The baseline and these three scenarios are described in more detail in the subsequent sections. More details on the technical modeling have been provided to the Tigard Project Team.

Tigard's Current Emissions

2019 Baseline

Employing the standard City InSights methodology, the project team used data from the City, the Federal Government, and other sources to complete a community-wide greenhouse gas inventory for 2019. The year 2019 was used because it is the most recent year with a robust set of data.

In 2019, the community of Tigard emitted a total of 571,164 tonnes of emissions from the sectors shown below.

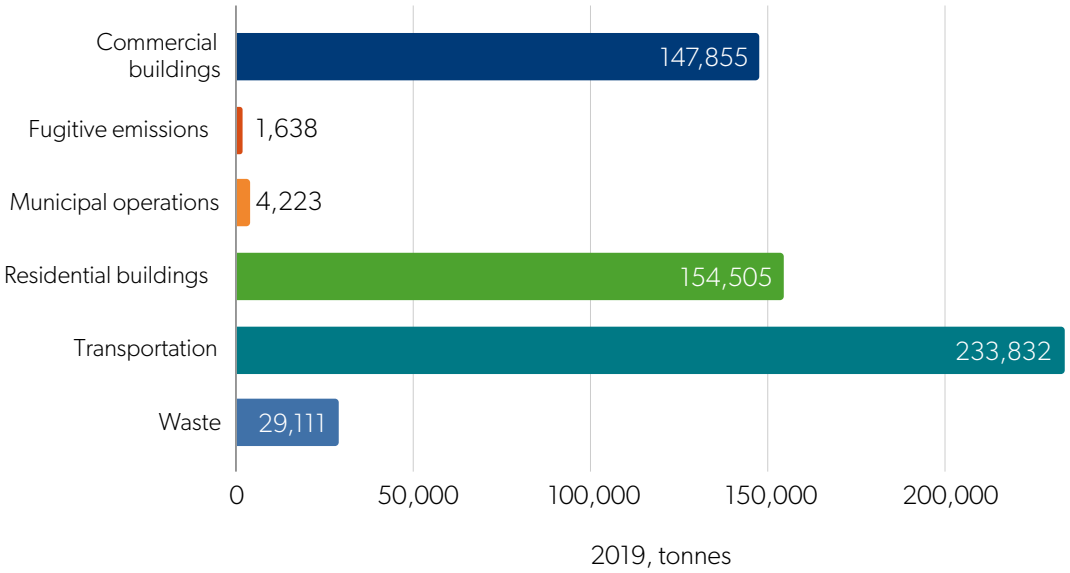

Figure 1. Tigard's 2019 Emissions by Source

In 2019, fossil fuels used to heat and cool Tigard's residential and commercial buildings produced over 302,000 tonnes of greenhouse gas emissions, constituting 53% of the community's total emissions. The second largest emissions sector that year was transportation, which produced over 233,000 tonnes, or 41% of total.

The remaining sectors - waste, fugitive emissions and emissions from municipal operations - together made up the remaining 6%.

Tigard's Future Emissions

Three versions of Tigard's future emissions were modeled - business as usual (BAU), business as planned (BAP), and low carbon (LC). These are described below.

Business as Usual

After the baseline inventory was completed, a BAU scenario was modeled to project population and economic growth, and forecast Tigard's energy use and emissions annually out to the years 2035 and 2050 if no changes are made to the city's housing energy efficiency, transportation patterns, technologies, and energy sources.

Data from the City and from other levels of government, industry, and organizations like TriMet all informed this work. Key assumptions in the BAU scenario included:[2]

- Non-residential building space will increase by 17%, and the number of dwellings will increase by 45%.
- The population will increase by 24% between 2020 and 2045, with the number of households increasing by 29% and employment increasing by 14%. The mix of building types in each zone of the city will remain the same as it is currently.
- On average, the energy efficiency of both new and existing buildings will not improve beyond current energy efficiency standards.
- The 2015 Oregon Clean Fuels standard[3] will reduce vehicle fuel emissions intensity by 10% by 2025.
- Personal transportation will continue to be dominated by cars with 87% of all trips being taken in personally-owned vehicles, and 49% of all trips taken in single-occupant vehicles (SOVs).
- Factors such as the following will increase in proportion to population growth: the number of vehicles registered, the total vehicle miles traveled (VMT), the amount of waste generated and diverted; and the total water used and wastewater generated.
- Factors such as the following will remain constant at their 2019 levels: the amount of on-site renewable energy, the proportion of the personal vehicle and transit fleets made up of zero emissions vehicles.
- Emissions from the production of grid electricity will remain at their 2019 level.
- Due to climate change, there will be approximately 250 more cooling degree days and 700 fewer heating degree days in 2050 than in 2019.[4]
- The number of cooling degree days describes how much buildings will need to be cool in a year. An increase in cooling degree days indicates that the city will experience hotter or

[2] Additional assumptions are documented in the Actions and Assumptions Spreadsheet developed as part of the project to create this Plan.

[3] State of Oregon, Department of Environmental Quality. Oregon Clean Fuels Program. https://www.oregon.gov/deq/ghgp/cfp/Pages/default.aspx. Accessed August 11, 2022.

[4] National Oceanic and Atmospheric Administration. The Climate Explorer. https://crt-climate-explorer.nemac.org/climate_graphs/?city=Tigard%2C+OR&county=Washington%2BCounty&area-id=41067&fips=41067&zoom=7&lat=45.4269289&lon=-122.7783874&id=hdd_65f. Accessed August 11, 2022.

longer summers.

- The number of heating degree days describes how much buildings will need to be heated in a year. A decrease in heating degree days indicates that the city will experience warmer or shorter winters.

Based on these assumptions, Tigard's annual energy use and emissions between the present and 2050 are expected to be as follows:

- Total energy use will decrease by 4% in 2035 and by 5% in 2050 relative to 2019;
- Total emissions will increase by 3% by 2035, and by 15% by 2050; and
- Per capita emissions will decrease by 18% in 2035 and by 20% by 2050.

All three of these numbers are small improvements over 2019 numbers. This improvement can be credited primarily to the combined impacts of the Oregon Clean Fuel standard and, ironically, the reduced need for heat (measured as 700 fewer heating degree days) as the climate warms.

Business as Planned

A BAP scenario was then modeled to forecast Tigard's emissions if the existing City plans, as well as plans and orders at other levels of government and within corporations achieve their goals on schedule. This scenario included the federal, state and utility emissions reduction goals that, if met, will impact Tigard's emissions without the City's intervention.

Some key differences between the BAU and BAP scenarios are:

- The Tigard Triangle, Washington Square and Downtown are densified by allowing duplexes, tri- and fourplexes in single family zoned areas.[5]
- Energy efficiency in new buildings improves every 5 years in alignment with the Energy Efficiency Speciality Code.[6]
- Solar PV capacity increases by 14 MW by 2050 to reflect potential impact of the Oregon Solar and Storage Rebate Program.[7]
- The transit fleet becomes 100% electric by 2040.
- By 2030, 50% of new vehicles sold are zero emissions vehicles, rising to 90% by 2035.
- Emissions from the production of grid electricity will be eliminated by 2040.
- Beginning in 2022, 75% of methane from waste handled by Pride will be flared.

In this scenario, Tigard's annual energy use and emissions was forecast to change as follows:

- Energy use will decrease by 14% in 2035 and by 24% in 2050 relative to 2019;
- Total emissions will decrease by 53% by 2035, and by 75% by 2050; and

[5] City of Tigard. Community Development Code. http://qcode.us/codes/tigard/. Accessed August 11, 2022.

[6] State of Oregon. 2021 Oregon Energy Efficiency Specialty Code. https://www.oregon.gov/bcd/codes-stand/Documents/2021oeesc.pdf. Accessed August 11, 2022.

[7] Oregon Department of Energy. Oregon Solar + Storage Rebate Program. https://www.oregon.gov/energy/Incentives/Pages/Solar-Storage-Rebate-Program.aspx. Accessed August 11, 2022.

- Per capita emissions will decrease by 18% in 2035 to approximately 4 tonnes / person, and by 20% to 1.8 tonnes / person by 2050.

WHY IS ACTION REQUIRED?

The BAP modeling results illustrate how supportive ambitious federal and state legislation can be to Tigard in its efforts to become emissions neutral. In 2019, emissions from electricity used in Tigard constituted 218,011 tonnes (38%) of the community's total emissions. If Oregon's House Bill 2021[8] (HB 2021) succeeds in transitioning to emissions-free electricity on schedule, these emissions will be completely eliminated by 2040.

However, it would be an error for municipalities to step back from emissions-reduction efforts in the belief that others will fix the problem. There are several reasons why bold action is still required from Tigard and from cities in general:

1. **Not all emissions are addressed by legislation:** A significant portion (62%) of Tigard's emissions will not be addressed by legislation such as HG2021 or the 2015 federal Clean Power Plan.[9] Other actions are still required to address these emissions.
2. **The success of legislation is not guaranteed:** HB 2021 for example does not dictate how utilities are to achieve the required reductions. This puts the onus on the many participants in the electricity grid to forecast production capabilities for 'new' technologies, retire old assets, invest in and construct new ones, adapt generation, storage, transmission, and distribution networks, and then finally to coordinate sufficiently to ensure that the grid will continue to provide stable, affordable and reliable electricity to agreed service levels. Although there are financial penalties for failure, this in itself does not guarantee success.
3. **Without improving efficiency, energy costs will increase significantly:** Because the grid will require major investments both in renewables and in distribution due to population growth and increased demand from 'clean' technologies like heat pumps and electric vehicles, if energy efficiency does not improve in parallel, electricity is likely to become much more expensive. The 'efficiency first' paradigm at the heart of this Plan and much municipal climate action decreases electricity consumption (encouraging walking and cycling instead of driving, subsidizing building retrofits, and requiring high energy efficiency standards for new buildings). This reduces the incremental burden on the grid and therefore improves electricity affordability. It also decreases the likelihood or frequency of times when demand for electricity will exceed supply.
4. **Co-Benefits:** Along with addressing climate change, the transition to non-emitting energy sources brings with it many other benefits to cities and their citizens. New opportunities for business development, increased local employment especially in construction and building renovation, better air quality both indoors and outdoors, and the associated health benefits, and better long-term home affordability are all demonstrated benefits of taking action to reduce emissions.

[8] Oregon State Legislature. House Bill 2021. https://olis.oregonlegislature.gov/liz/2021R1/Downloads/MeasureDocument/HB2021. Accessed August 8, 2022.

[9] U.S. Environmental Protection Agency. Clean Power Plan. http://www2.epa.gov/cleanpowerplan. Accessed August 12, 2022.

Low-Carbon

To identify the most effective way for Tigard to become carbon neutral, potential actions were selected from SSG's extensive catalog of climate actions, identified within the City's existing plans, and researched specifically for Tigard. SSG used a variety of factors to determine the appropriate level of ambition and timing for each action. These factors included but were not limited to:

The necessity of the action (in the sense of there being no alternatives) to reduce emissions and to optimize the potential impact of other actions;

The "Avoid, Reduce, Replace, Remove and Offset" prioritization philosophy described in Appendix A (this includes the quantity and speed of emissions reductions);

The City's authority to carry out the action;

The co-benefits, co-harms, and equity impacts of the action;

Suggestions and concerns from engagement participants;

Alignment with state and national targets and regulations, the City's plans, and those of shared services operators, including TriMet, Northwest Natural, and PGE.

Together, the selected actions constitute Tigard's modeled LC scenario. These actions were modeled using the following steps:

1. Scheduling them to optimize their cumulative impact, and
2. Positioning them geographically to interact with Tigard's urban form, industrial and economic base, demographic growth, planned development areas, and commuting patterns.

The result reflects the Low-Carbon scenario's cumulative impacts on annual energy use and emissions out to 2035 and 2050 in a way that is spatially accurate to Tigard and its future development.

SUMMARY RESULTS

The total impact of the LC Scenario on community-wide emissions is represented by the green line in Figure 2. In essence, the modeled LC Scenario will reduce Tigard's annual emissions by 79% by 2035 and by 99% by 2050 relative to 2019. The cumulative total greenhouse gas emissions eliminated by these actions over the period would be 3.2 million tonnes.

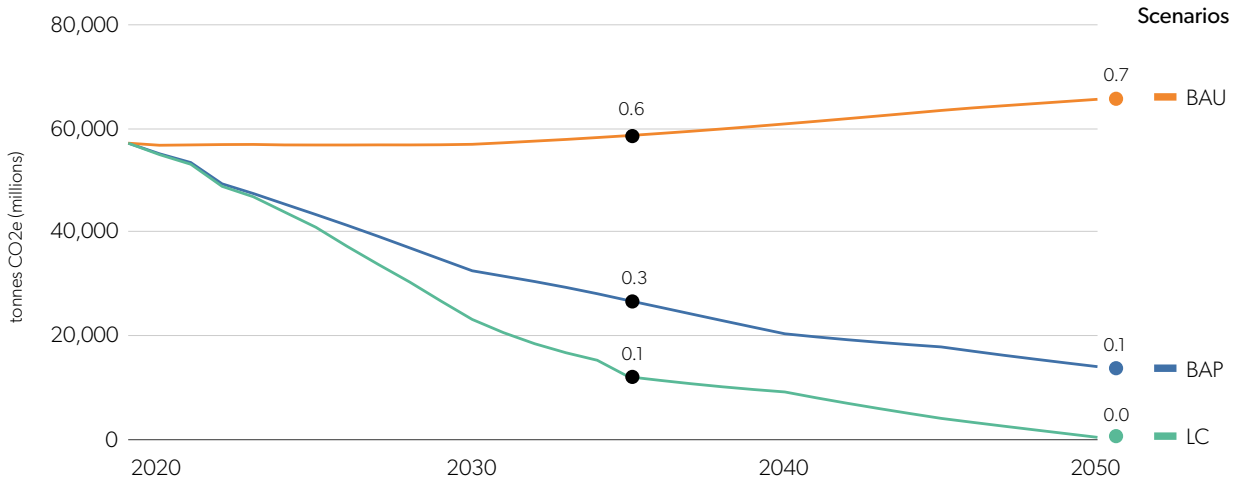

Figure 2. Tigard's emissions in Business as Usual, Business as Planned and Low-Carbon scenarios from 2019 to 2035 and 2050.

The gradual decrease in emissions over time is a result of all modeled actions, carried out in a specific order, in some instances in specific areas of the city.

Figure 3 breaks this summary out into its components. It is a wedge diagram depicting the impact of each modeled action as one wedge of emissions reductions over time. Following the growth of an individual coloured wedge from the left to right shows how each action begins early and on a small scale, and increases in impact over time.

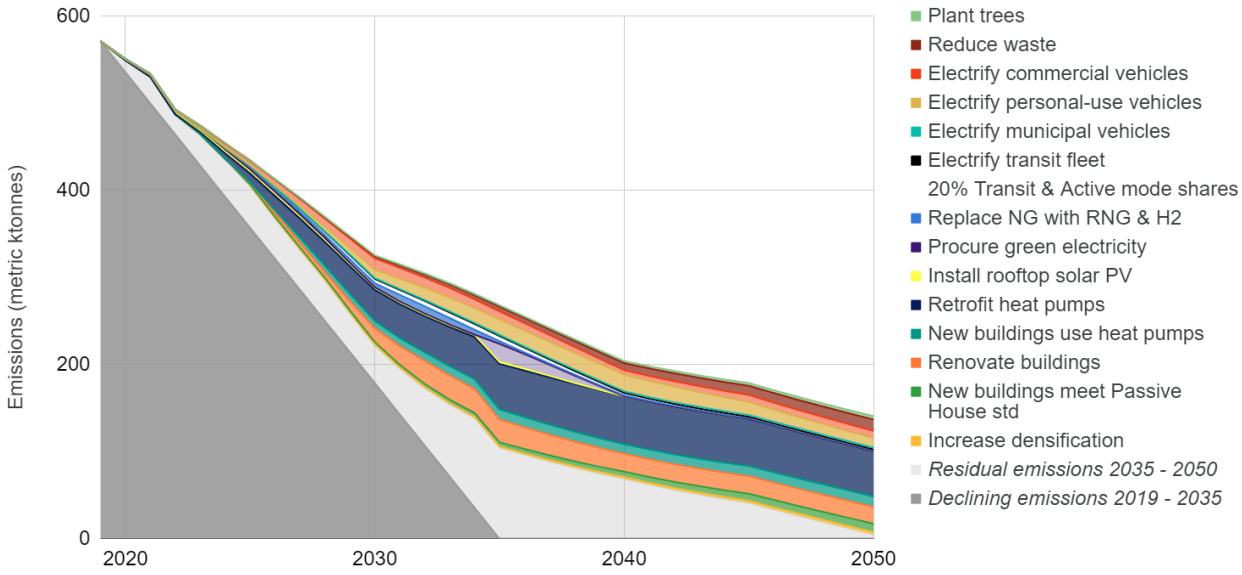

Figure 3. The Emissions Reduction Impact of Each Action in the Low Carbon Scenario.

Note that because many of the actions are integrated, if the ambition is reduced or the timeline delayed for any one action, the impact of other actions will also be reduced.

Although the reductions achieved by this scenario are sizable, they are not sufficient on their own to achieve Tigard's net-zero emissions goal by 2035, when the community would still be emitting approximately 121,000 tonnes of residual greenhouse gas emissions.[10] By 2050 however, emissions would be down to approximately 4,400 tonnes. Potential approaches for dealing with these emissions are discussed in the "Addressing Residual Emissions" section of this document.

From an energy perspective, the Low Carbon scenario reduces Tigard's total energy use by 45% by 2035 and by 56% by 2050. The sources of energy shift from 71% fossil fuels in 2019 to 85% electricity (22% locally-generated and 63% from the grid), and less than 1% coming from residual propane and RNG use.[11]

Figure 4 shows the energy sources in 2019 compared to the Low Carbon Scenario in 2050.

[10] Addressing this gap is discussed in the Residual Emissions section of this document.

[11] The remaining 14% is a result of the efficiency of heat exchange units being greater than 100%.

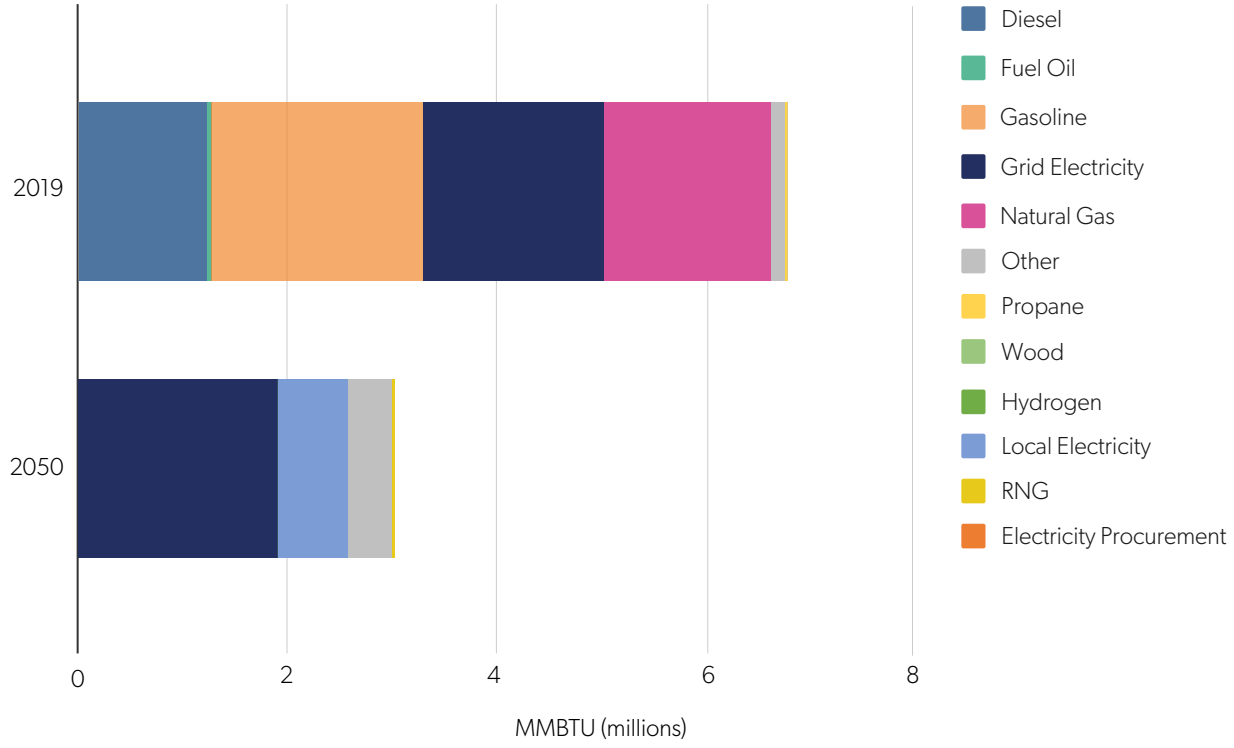

Figure 4. Fuel Sources in 2019 and 2050 in the Low Carbon Scenario.[12]

RESULTS AND RECOMMENDATIONS

The actions modeled and their results can be divided into five groups based broadly on the sector they target - urban form and buildings, energy, transportation, waste, and sequestration. Figure 5 shows the portion of total emissions reductions in Tigard attributable to each group of actions over time.

[12] The "Other" category identifies the energy provided 'for free' by air and ground source heat exchange systems when they are operating at more than 100% efficiency.

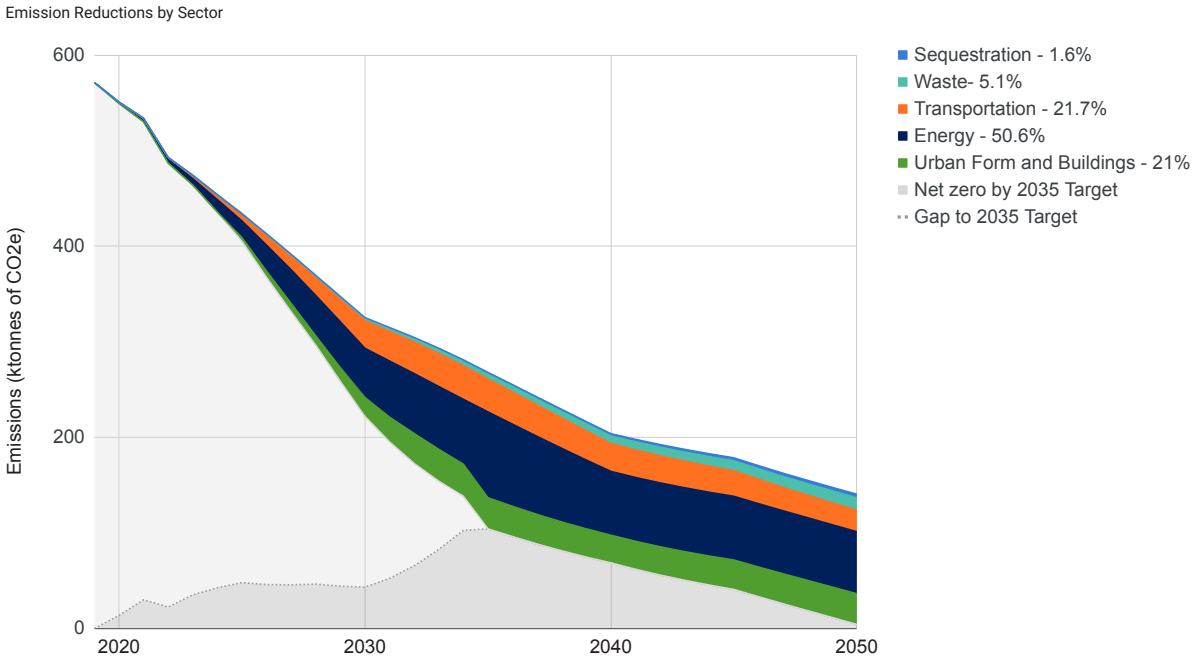

Figure 5. Emissions Reductions by Action Group over Time.

Low-Carbon Actions for Urban Form and Buildings

In 2019, buildings were responsible for 44% of Tigard's energy use and 54% of Tigard's total emissions. If current trends continue (i.e. in the BAU scenario), building energy use will increase by 12% by 2035 and by 24% by 2050. Even if the heating and cooling systems in buildings are electrified, such a large increase in energy use will make transitioning to zero emissions even more challenging, requiring that even more emissions-free electricity generation and transmission infrastructure be built. To avoid this, improving energy efficiency through changes to urban form and building energy efficiency will need to be a significant element of Tigard's decarbonization pathway.

As a result, three actions were modeled to reflect the impact of densifying Tigard's urban development, and raising the energy efficiency of both new and existing buildings. These changes reduced the total energy required in Tigard's buildings, and the resulting reduction in emissions, before the energy sources in the buildings are changed to zero-emissions systems. Table 1 describes the cumulative emissions impact of these actions in Tigard.

Table 2. Emissions reductions from Urban Form and Buildings Actions in Tigard.

2023-2035		2023-2050	
Total Emissions Eliminated (tonnes)	Proportion of all Emissions Eliminated to 2035	Total Emissions Eliminated (tonnes)	Proportion of all Emissions Eliminated
222,000	20%	681,000	21%

The total emissions eliminated by these actions over time is represented by the green wedge in Figure 6.

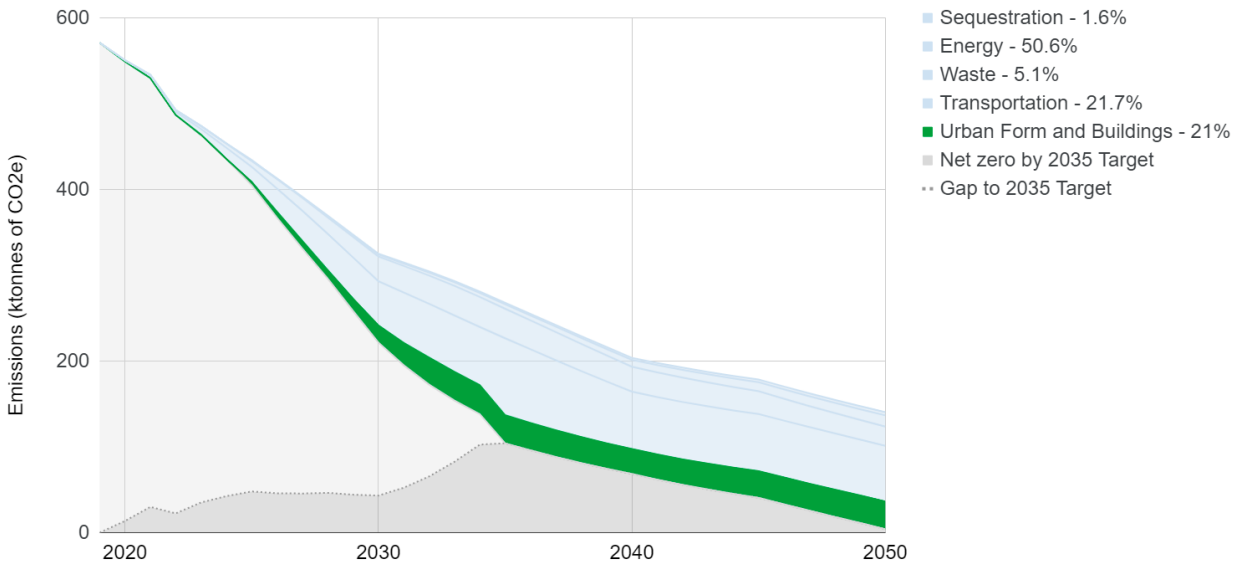

Figure 6. Total Emissions Reduced by the Low Carbon Actions for Urban Form and Buildings.

Each of these actions is described below.

Action 1: Beginning in 2023, increase the density of Tigard's new dwellings by shifting 80-90% of expected new, single-family homes to be duplexes while keeping the same distribution of building types (both residential and non-residential) among and within zones.[13]

A community's urban form is a foundational element of a good emissions mitigation plan. Increasing a community's density includes increasing the proportion of buildings with multiple tenants, both residential and non-residential. Buildings like these, with shared walls, lose less thermal energy than those that are free-standing, and so are naturally more energy efficient.

Increasing density can also include diversifying the types of buildings within small areas. Communities with services, places of work, schools, and businesses mixed in with residential areas allow people to carry out the majority of their tasks near their homes. The phrase "15-minute communities" refers to the ability to live largely within 15 minutes of one's residence. This approach results in citizens taking fewer long vehicle trips, which reduces transportation emissions and frees up land that would have been made into roadways for other purposes.

[13] Specifically, in the Tigard Triangle, Washington Square and Downtown areas, 90% of new, single-family homes were changed to duplexes; outside this area, 80% were changed to duplexes.

Green space and infrastructure for biking or walking connected to hubs providing express public transit to other parts of the city can take advantage of this available space.

Emissions Impact:

- Low but enabling: This action will eliminate 53,740 tonnes (1.7% of total reductions) of Tigards emissions cumulatively between 2023 and 2050.

Although increasing the density of a city's urban form may not reduce emissions as directly as switching from natural gas to solar power does, it establishes a structure that optimizes the impact of the other Low Carbon actions in reducing emissions. The modeling reflects this dependency by beginning the action in 2023, and modeling it before any other actions are modeled. If Tigard's urban form does not densify this quickly, the impact of other actions will be reduced.

Co-Benefits, Co-Harms and Equity Impacts:

- Increasing urban density can also make life more affordable. In 15-minute communities, it is easier to live without a personal vehicle. Similarly, energy costs associated with home ownership in a multi-unit building are less than those for a single-family home.
- A densified urban form can also support the growth of the unique spirit and character of smaller communities within a city. The Blue Zones Project describes additional social, and health benefits of these types of communities.[14]
- Informed and careful planning is vital to ensuring that denser communities are designed well and have the right infrastructure for people to feel safe and healthy making greater use of active transportation networks and interacting with their neighbors. In contrast, poorly-designed, higher-density communities can result in poorer air quality, and a reduction in social resilience.

Action 2: Require that by 2028, new buildings of all types be required to meet Passive House Standard. This means that on average they will require no more than 15 kWh / sq. yard for heating, cooling and plug use.

Emissions Impact:

- Medium: This action will eliminate 139,000 tonnes (4.3% of total reductions) of Tigard's emissions cumulatively between 2023 and 2050.

This is achieved by reducing the amount of energy required to heat and cool buildings, and to run appliances within the buildings, regardless of the fuel source providing the energy.

Co-Benefits, Co-Harms and Equity Impacts:

- As of 2020, requiring a Passive House Standard increased the initial cost of most buildings by approximately 4%. However, the reduced energy consumption results in significantly more affordable building ownership over the longer term.
- Achieving a Passive House Standard requires careful planning of a building's air exchange and ventilation. This planning also results in fewer drafts, less temperature fluctuation, and an overall improvement in the air quality and comfort inside the building.
- Tigard should consider updating the Middle Housing Revolving Loan Fund (established

[14] Oregon Blue Zones Project. https://oregon.bluezonesproject.com/. Accessed August 29, 2022.

with funds received from the American Rescue Plan Act) to include a) a requirement for the homes to be built to a Passive House standard, and b) a grant that will cover the incremental cost of building to this standard.

Action 3: Renovate all existing buildings to reduce required electricity by 10%, and thermal load, by 40% in pre-1984 buildings, and by 30% in post-1983 buildings. Begin in 2023, and complete 20% of all residences and 20% of non-residential square footage by 2028, a further 30% by 2030, and the remaining 50% by 2035.

Emissions Impact:

- High: This action will eliminate 488,000 tonnes (15% of total reductions) of Tigard's emissions cumulatively between 2023 and 2050.

Strategy and Design Considerations:

- Thermal energy needs can be reduced with changes such as improved insulation, air sealing, window replacement, and roof repairs.
- The work required varies by building type and often by building. Energy audits ensure that the correct work is done in an order that will optimize efficiency improvements.

Co-Benefits, Co-Harms and Equity Impacts:

- Begin the work in disadvantaged and BIPOC communities so that long-term energy and home ownership become more affordable in these communities first.
- In buildings requiring significant maintenance or repairs, and often also in buildings constructed with lower-quality materials, it is recommended that basic, structural repairs are completed before addressing energy efficiency. This helps ensure that the benefits of the energy efficiency changes persists. As these types of buildings are often found in lower-income and disadvantaged communities where affordability is a significant problem, governments should consider providing grants for these repairs.
- Renovating buildings used by disadvantaged communities improves the air quality in these buildings and reduces the chances of mould growing in the building and causing illnesses.
- Every $1 million of capital investment in renovating buildings generates an estimated 5.5 direct jobs and an additional 10.9 indirect jobs.[15]

Community Engagement Feedback:

- 94% of community survey respondents expressed an interest in making energy efficiency improvements to their property.
- The CAC and TAC recommended that the City prioritize improving energy efficiency in rental buildings, in buildings in blue zones, and in buildings housing aging community members and vulnerable people.

Low-Carbon Actions for Energy

In 2019, Tigard's energy consumption amounted to 129 MMBTU / person. Half of this was used for transportation, and the other half was divided between energy used in commercial and

[15] Bivens, Josh. Updated employment multipliers for the U.S. economy. Economic Policy Institute, 23 Jan 2019, https://www.epi.org/publication/updated-employment-multipliers-for-the-u-s-economy/. Accessed August 29, 2022.

residential buildings. 84% of all energy consumed came from burning fossil fuels.[16]

If Tigard is to become a net zero emissions community, not only must the community's total energy use be reduced, but all[17] energy used must be changed to come from zero emissions energy sources. As a result, the four Low Carbon Actions for Energy focus on changing from fossil fuel furnaces to ground and air source heat exchange, switching to zero emissions sources of electricity, and eliminating the use of fossil-fuel-based natural gas.[18]

Table 3. Emissions reductions from Low Carbon Actions for Energy in Tigard.

2023-2035		2023-2050	
Total Emissions Eliminated (tonnes)	Proportion of all Emissions Eliminated to 2035	Total Emissions Eliminated (tonnes)	Proportion of all Emissions Eliminated
581,300	52%	1,670,000	51%

The total impact of the Low Carbon Actions for Energy over time is shown as the turquoise wedge in Figure 7 below.

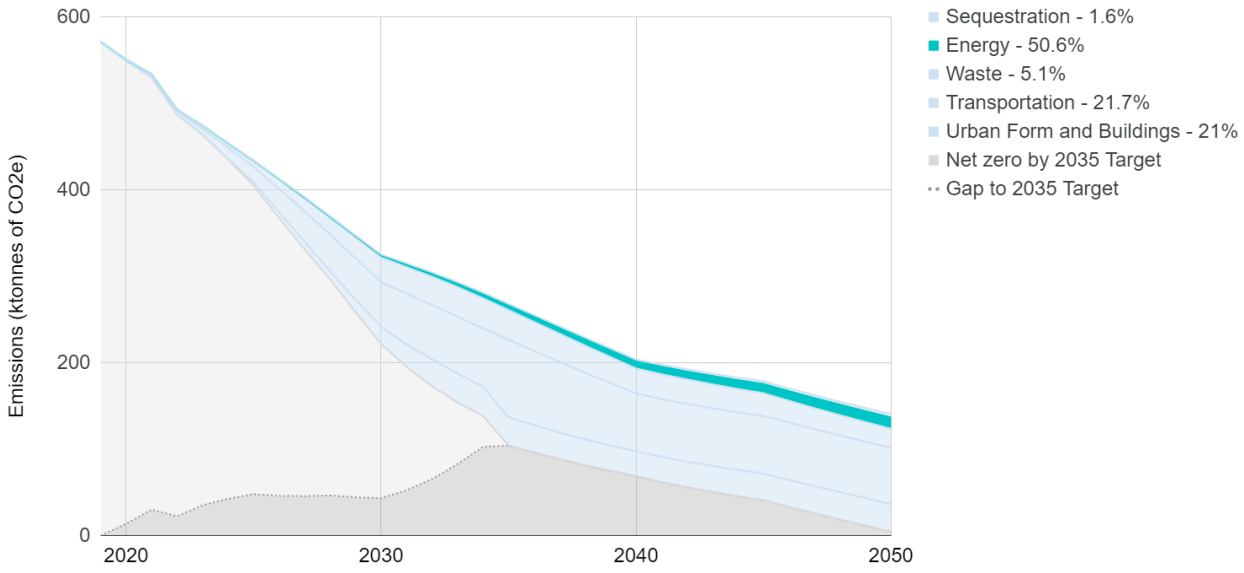

Figure 7. Total Emissions Reduced by the Low Carbon Actions for Energy.

Each of these actions is described below.

Action 4: By 2028, require all newly-constructed buildings to use zero emissions systems for space and domestic water heating and cooling.

The modeling of Tigard's transition to zero emissions energy sources used ground- and air-source heat exchange systems for all thermal building energy in the city. Although these are not the only options available, they were determined to have the best potential for the community.

[16] This includes 52% fossil-fuel-based electricity in 2019, as presented in Oregon Clean Fuels Program: Updated Electricity Carbon Intensity Values for 2021. Accessed August 29, 2022.

[17] Strictly speaking, to be a net zero emissions community, energy from fossil fuels can still be used; however, all of the emissions from these fuels must be absorbed or sequestered in the same year in which they are produced.

[18] The electrification of vehicles is discussed under the Transportation section.

Emissions Impact:

- High: This action will eliminate 260,000 tonnes (8% of total reductions) of Tigard's emissions cumulatively between 2023 and 2050.

Strategy and Design Considerations:

- Both air- and ground-source heat exchange systems are upwards of 300% efficient. This means that for every unit of electricity required to power the system, upwards of three units of heating or cooling are delivered. Ground-source heat exchange is even more efficient than air-source, meaning that these buildings provide excellent long-term energy affordability. For this reason, the modeling included ground-source heat exchange for all new construction in the Tigard Triangle to ensure this benefit is targeted at this community. Air source heat exchange systems were modeled in all remaining areas of the city.

Co-Benefits, Co-Harms and Equity Impacts:

- Switching from fossil fuel-based energy to heat exchange systems protects environmental capital by eliminating the spatial footprint and subsoil disturbance caused by fossil fuel extraction.

The exceptional efficiency of heat exchange systems constitutes much of the reason why in the LC scenario we see a decrease in total electricity used in the LC scenario relative to the BAU and BAP scenarios despite switching 85% of the energy used in the city to electricity. This is vital to ensuring the overall stability of energy supplies.

Figure 8 shows the LC scenario's overall decrease in total energy used and the increased proportion of energy needs being met by electricity, relative to the BAP scenario.

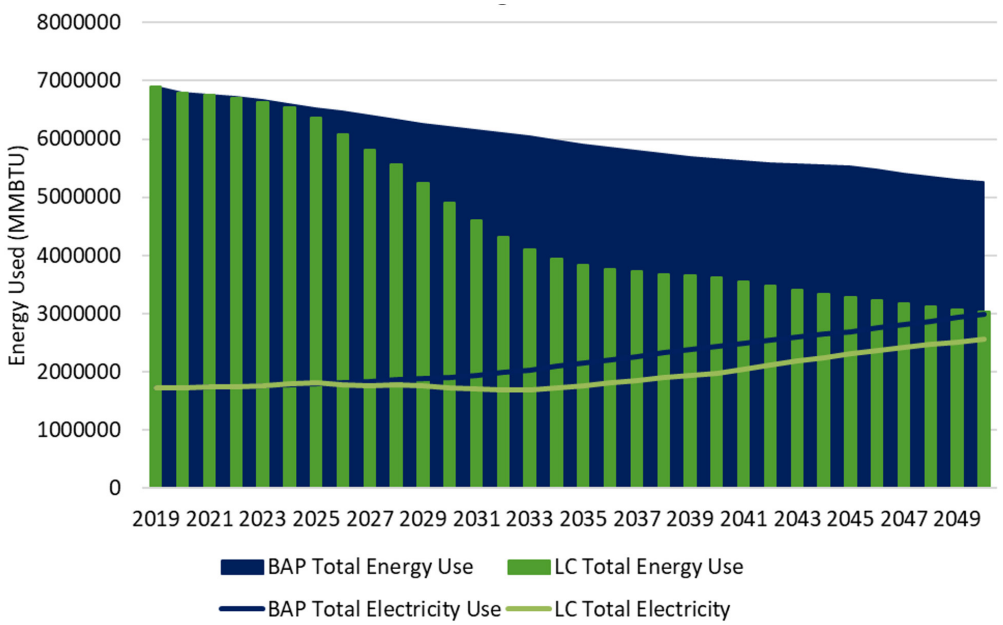

Figure 8. LC vs BAP Scenarios: Total Energy Used and Proportion Electrified.

Action 5: Replace all space and domestic water heating and cooling systems in existing buildings with zero emissions systems by 2035.

Emissions Impact:

- High: This action will eliminate 1,182,000 tonnes (36.5% of total reductions) of Tigard's emissions cumulatively between 2023 and 2050.
- This is the highest single-impact action in the Plan.

Strategy and Design Considerations:

- Begin in 2023 in disadvantaged and BIPOC neighborhoods, so that long-term energy and home ownership become more affordable for these communities first.

Co-Benefits, Co-Harms and Equity Impacts:

- Although heat exchange systems have a high up-front cost, their efficiency will be realized as significant reductions in energy costs for all Tigardians.
- Switching to a reliance on electricity - especially locally-generated electricity - will buffer citizens from increasingly expensive and unpredictable fossil fuel supplies.
- Retrofitting many individual buildings' heating and cooling systems will be disruptive to residents and building operations.

Action 6: Scale up electricity generation from solar PV installations on both residential and non-residential building rooftops such that 50 MW of capacity are installed within the city boundary by 2035, and this increases to 160 MW by 2050.

Emissions Impact:

- Medium: This action will eliminate 64,000 tonnes (2% of total reductions) of Tigard's emissions cumulatively between 2023 and 2050.

Strategy and Design Considerations:

- The benefits of small-scale solar PV systems can be increased by adding on-site energy storage. These types of battery systems capture excess power produced by the solar PV system during sunny periods, and store it for later use. This further reduces the building owner's need to draw power from the grid, and provides localized resilience during power outages.

Co-Benefits, Co-Harms and Equity Impacts:

- Solar PV systems have a high up-front cost, but on average they pay for themselves within approximately 10 years, after which electricity for the building owner is free.
- Grids can be intelligently interconnected with small-scale solar PV systems to allow them to provide backup power when larger-scale generation goes down.

Action 7: Establish community-based power purchase agreements, cooperative power generation opportunities, or purchase enough renewable energy credits (RECs) for all remaining (i.e. not generated by local solar PV) electricity used by the community to be produced from zero emissions sources. This action will be required to offset Tigard's remaining electricity emissions until 2040.

Emissions Impact:

- Medium: This action will eliminate 63,000 tonnes (2% of total reductions) of Tigard's emissions cumulatively between 2023 and 2040, when the grid is required to be 100% emissions-free.

Strategy and Design Considerations:

- There is insufficient vacant land within Tigard's for the community to install enough emissions-free power generation within to meet 100% of its power needs. As a result green electricity will need to be imported from outside the city.
- There are many ways that a community can purchase emissions-free power generation. Regardless of the approach selected, Tigard should prioritize investing in net new zero emissions power generation, to ensure its investment expedites the greening of the grid for all Oregonians.
- It is recommended that Tigard do an assessment of the options available and then moving quickly to pursue the following:
- Making annual purchases of emissions-free electricity equal to the amount of electricity the City expects to use corporately, evaluating the benefits, risks and impacts of a variety of approaches (e.g. power purchase agreements, renewable energy credits, and others), and working with PGE to find or develop the best option for the City.
- Supporting community-level green electricity purchases by incentivizing them through property tax relief or rebates, or making green electricity the default option for new connections. PGE offers a number of programs designed to allow citizens and businesses in Tigard to offset their own power use by supporting larger-scale green power initiatives.

Co-Benefits, Co-Harms and Equity Impacts:

- Purchasing zero emissions power from outside the city results in the jobs associated with the installation of new power generation facilities going to areas outside the city. However, it will still support the reduction of emissions and economic development for other areas near Tigard.
- The work for this Plan included modeling the purchase of green electricity for City operations and the community, between 2035 and 2040. However, one administratively easy and effective way of accelerating the community's progress to net zero and demonstrating municipal leadership would be to begin these purchases immediately. Between 2023 and 2035, this would amount to purchasing approximately 500 GJ of emissions-free electricity (42 GJ / year) and reducing total community emissions by an additional 13,300 tonnes (approximately 1,100 tonnes / year).

Community Engagement Feedback:

- A majority (58%) of the 203 citizens who responded to the community survey fully supported increasing the renewable energy supply through either rooftop solar systems or

community-scale wind and solar power.

Action 8: By 2030, ensure at least 10% of current fossil-fuel natural gas used in Tigard is replaced with renewable natural gas. Increase this to 90% by 2035 and replace the remaining 10% with hydrogen.

Emissions Impact:

- Medium: This action will eliminate 71,000 tonnes (2% of total reductions) of Tigard's emissions cumulatively between 2023 and 2050.

Strategy and Design Considerations:

- This action was developed in cooperation with representatives from NW Natural to align with their commitments and timeline to blend RNG into the natural gas supply.
- It is recommended that Tigard work with NW Natural to continue to develop alternatives to this action for the following reasons:
- The most optimistic projections from industry-influenced studies indicate that there will only be enough source material to replace a maximum of 16% of the natural gas used nationwide in the United States.[19]
- Short supplies of RNG are likely to make it expensive.
- Best practice is to reserve RNG for situations with no feasible alternative source of energy, such as industrial processes.

Co-Benefits, Co-Harms and Equity Impacts:

- The construction of anaerobic digesters to produce RNG could be an opportunity for Tigard to both eliminate residual waste emissions and benefit from the forecast high cost of RNG.
- The high cost of RNG will make it an inaccessible alternative to Tigardians with low incomes.

Low-Carbon Actions for Transportation

Transportation is the single largest emissions-producing sector in Tigard, currently making up over 40% of all community emissions. In 2019, rail, buses, cars, and light- and heavy-duty trucks generated 234,000 tonnes of greenhouse gas emissions within the boundaries of the City of Tigard.

If current trends continue and vehicle fuel efficiency improves as expected, transportation energy use and emissions from transportation will both fall by approximately 15%. However in 2050, they will still generate approximately 200,000 tonnes of emissions annually in Tigard. To reduce emissions from transportation in the Low Carbon scenario, five additional actions were modeled. The total impact of these actions over time is provided in Table 4, and represented by the dark blue wedge in Figure 9.

[19] Feinstein, L. and de Place, E. Sightline Institute. The Four Fatal Flaws of Renewable Natural Gas. 2021. https://www.sightline.org/2021/03/09/the-four-fatal-flaws-of-renewable-natural-gas/. Accessed August 31, 2022.

Table 4. Emissions reductions from Low Carbon Actions for Transportation in Tigard.

2023-2035		2023-2050	
Total Emissions Eliminated (tonnes)	Proportion of all Emissions Eliminated to 2035	Total Emissions Eliminated (tonnes)	Proportion of all Emissions Eliminated
285,900	26%	702,000	22%

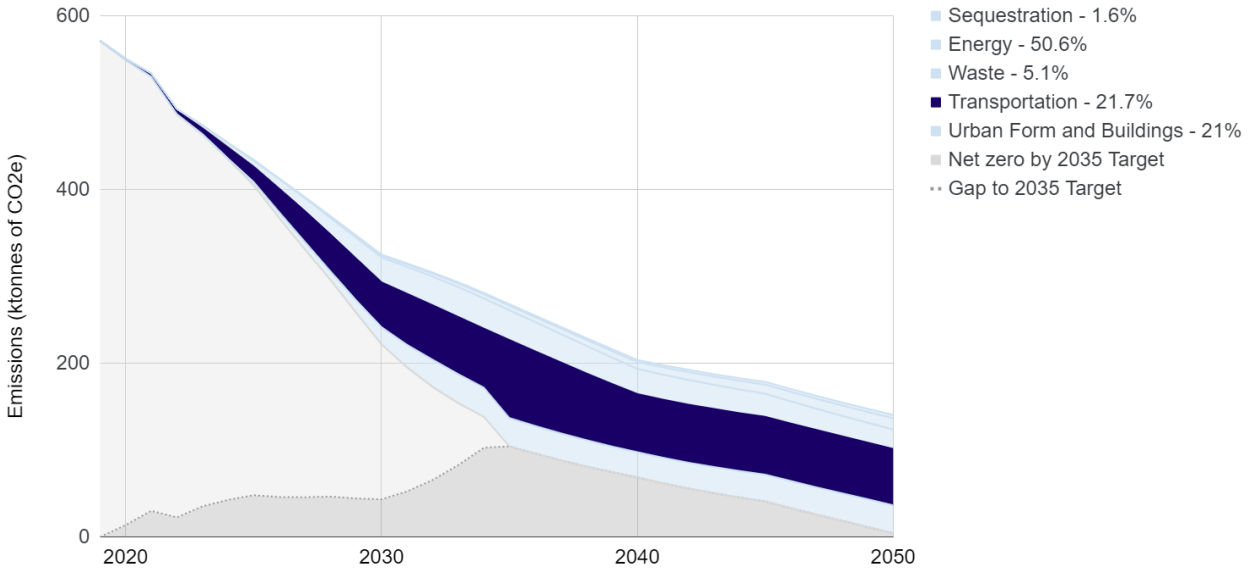

Figure 9. Total Emissions Reduced by the Low Carbon Actions for Transportation.

Each of these actions is described below.

Action 9: Increase the combined transit and active transportation mode share to 20% of all trips taken by 2035.

Emissions Impact:

- This combined action will eliminate 86,000 tonnes (3%) of Tigard's emissions cumulatively between 2023 and 2050.

Part 1: Increase the frequency and expand the transit network such that by 2035, 14% of all trips taken within and into/ out of Tigard are taken on transit.

Strategy and Design Considerations:

- Transit in Tigard is provided by TriMet, which is a separate entity that also serves other communities. As a result, increasing transit ridership will require collaboration and cooperation with TriMet as well as with Metro, ODOT, Washington County and neighboring cities within the larger region. Ideally transit service should be designed and constantly improved to support the City's Comprehensive Plan.[20] In turn, the City should leverage and support Trimet's strategic planning to further its own sustainability goals. Tigard City administration and City Council should actively promote strategic opportunities for regional reductions in transportation emissions through initiatives such as electric light

[20] City of Tigard. Comprehensive Plan. https://www.tigard-or.gov/your-government/departments/community-development/planning/comprehensive-plan. Accessed August 17, 2022.

rail transit and multi-modal transit hubs.[21]

- Work with TriMet to expand improved service into more affluent neighborhoods to ensure that as personal vehicle travel is discouraged, transit is a viable alternative.

Co-Benefits, Co-Harms and Equity Impacts:

- Ensure that transit provides excellent connectivity to hubs (including downtown, the Tigard Triangle and Washington Square), prioritizing early improvements in disadvantaged and BIPOC communities.
- Traveling using transit rather than a vehicle saves riders money and also improves their mood.
- Increasing transit mode share can include 'road diets', or intentional city design that reduces available roadways for personal vehicle use and reuses it for other purposes such as dedicated transit or active transportation infrastructure. The impact is faster transit service, a more complete active transportation network, and discouragement of personal vehicle use. It also reduces the surface land footprint dedicated to vehicle traffic, and the impermeable surface area within the city, lessening the impacts of overland flooding that will come with climate change and more frequent storm events.

Community Engagement Feedback:

- The Community Advisory Committee and the Technical Advisory Committee both consistently recommended that the accessibility of transit be improved and transit service enhanced.
- Work with disadvantaged and BIPOC communities and with TriMet to ensure service is improved to allow citizens with multiple jobs who are part of these communities to commute easily on transit.
- Engage with communities about how best to improve transit service in their neighborhoods so that their residents can use the service effectively for all their transportation needs.

Part 2: Expand and maintain active transportation infrastructure such that by 2035, 7% of all trips taken in Tigard are walked, biked, or made using another form of active transportation.[22]

Strategy and Design Considerations:

- Include community members in planning networks and designing supporting infrastructure to ensure they feel safe, able and willing to use the final infrastructure.
- Engage with communities about how best to implement active transportation infrastructure, bike share, bike and scooter re-use and repair, and other related opportunities in their neighborhoods so that their residents will use them.
- Some cities encourage active transportation by establishing car-free zones in areas of the city suitable for pedestrianization. This often includes university campuses, downtown, or historically or culturally-significant areas. Normally, emergency vehicles and sometimes

[21] This aligns with Tigard's 2035 Transportation System Plan.

[22] This aligns with Tigard on the Move: 2040 Transportation System Plan.

residents' vehicles and transit are still permitted into the area.

Co-Benefits, Co-Harms and Equity Impacts:

- People who bike and walk instead of commuting in a personal vehicle have been shown to be happier during their commutes, and take fewer sick days off from work.
- Invest in bike lanes that are physically separated from vehicle traffic. Women, people with children and immigrants are more likely to feel safe riding their bikes when the routes they take are physically separate from vehicle traffic. Speak to these groups to find out where they want to ride their bikes; then invest in protected lanes along these routes first.
- Research has shown that every $1 of investment in active transportation infrastructure generates $6 in avoided health costs for conditions resulting from inactivity.[23]
- Increasing bike ridership and walking by improving infrastructure reduces vehicle fatalities, and increases the physical activity levels of local residents, and the number of social interactions they have with their immediate neighbors. In turn, the social resilience of the community is also enhanced.

Community Engagement Feedback:

- The CAC and TAC recommended that the City support the creation of an electric bike program.

Action 10: Electrify the transit fleet providing trips to Tigardians in alignment with Trimet's goals to reduce emissions below 2019 levels by 70% in 2030, by 90% in 2040, and net zero by 2050.

This represents TriMet's commitments from their 2022 Climate Action Report.[24]

Emissions Impact:

- Low: This action will eliminate 3,000 tonnes (0.1%) of Tigard's emissions cumulatively between 2023 and 2050.

Strategy and Design Considerations:

- See Action 8, Part 1 for recommendations on how to support TriMet's achievement of these goals.

Action 11: Electrify the municipal fleet and equipment such that by 2028, 100% of new vehicles or equipment purchased by the City for its operations is electric.

Emissions Impact:

- Low: This action will eliminate 36,000 tonnes (1.1%) of Tigard's emissions cumulatively between 2023 and 2050.

Strategy and Design Considerations:

- The modeling for this project phased out the fossil fuel fleet at the end of vehicles' standard life expectancies of 16 years. Experts are now suggesting that the climate crisis

[23] Giles-Corti, Billie, et al. The co-benefits for health of investing in active transportation. https://www.phrp.com.au/wp-content/uploads/2014/10/NB10027.pdf. Accessed August 30, 2022.

[24] TriMet. TriMet Climate Action Plan FINAL 2022-04-15. https://trimet.org/bettertransit/pdf/TriMet-Climate-Action-Plan.pdf. Accessed August 17, 2022.

requires that fossil fuel vehicles be retired and replaced with zero emissions vehicles after a maximum of 9 years. This is discussed further in the "Addressing Residual Emissions" section of this document.

- An increasing number of vehicle makers are now offering EV drivetrain kits for existing vehicle types. Replacing ICE drivetrains with electric ones has the potential to significantly reduce the initial investment, while reducing vehicle waste and contributing to a circular economy. This approach can also be used to retrain maintenance staff to work on EVs, proactively ensuring that they will not need to be laid off.
- Most municipal vehicle types are currently expected to be readily available by 2029.

Co-Benefits, Co-Harms and Equity Impacts:

- Electrifying the municipal fleet will provide the City of Tigard with significant operational savings, quickly. Electric vehicles have lower fuel costs, and less frequent and less expensive maintenance requirements. Although the initial investment will need to include not only vehicles but also charging infrastructure, modeling SSG has done for other cities consistently demonstrates that these investments are paid off quickly - often within three years. From this point on, an electrified municipal fleet consistently costs less than a fossil fuel fleet. This in turn frees up citizens' taxes to be used on other initiatives.
- Converting the City's municipal fleet is a visible demonstration of the City's commitment to becoming carbon neutral. Electric vehicles can be branded to advertise the City's progress in moving to a decarbonized fleet.

Action 12: Electrify personal and light-duty commercial vehicles such that by 2025, 30% of new vehicles purchased are electric, rising to 90% by 2030, and to 100% by 2035.

Emissions Impact:

- High: Achieving the shift to EVs as described in the action will eliminate 349,000 tonnes (10.8%) of Tigard's emissions cumulatively between 2023 and 2050.

Strategy and Design Considerations:

The electrification of privately-owned vehicles in the community is not a straightforward action for the City of Tigard to achieve. The cities transitioning most successfully to EVs are combining incentives for their use with disincentives for ICE vehicle use. Some approaches include the following, combined with active monitoring of uptake and adjustment of programs:

- Offering education to the public about electric vehicles and charging infrastructure, and grants and rebates available for EVs;
- Reducing the number of business licenses issued to gas, diesel and propane retailers in the City, and offering job-retraining for current owners;
- Providing free land for charging infrastructure, or paying EV charger businesses the charging costs so that there is no cost for drivers to charge their vehicles;
- Reducing taxes for businesses that offer EV chargers or electrify their corporate vehicles;
- Charging for residential parking permits, with higher costs for second, third, etc. vehicles in a household, and higher costs for ICE vehicles. Normally all of the revenue from such a program is kept out of the general budget and directed into active transportation development.

- Requiring (and raising the cost of) payment for all ICE vehicles and providing free parking to EVs at all public parking locations.
- Adding congestion charges for ICE vehicles entering certain zones of the city, while allowing EVs (and vehicles modified for handicapped drivers) to enter for free.

Co-Benefits, Co-Harms and Equity Impacts:

- Reducing the number of ICE vehicles improves a community's air quality and reduces noise pollution.
- Electric vehicles and chargers generally pay for themselves within 3-5 years[25], after which they are significantly less expensive than ICE vehicles. This is because they require much less and less frequent maintenance, and their fuel is less expensive.
- Encouraging and incentivizing the purchase of EVs can reduce people's inclination to use transit and active transportation, as they would prefer to make use of the new vehicle they have invested in.
- New electric vehicles are currently more expensive than ICE vehicles, making them difficult for lower income people to purchase. These costs are expected to drop until they reach parity with ICE vehicles in the 2030s. Changing the drivetrains in ICE vehicles to EV drivetrains is one way in which EV vehicles can be provided to lower income households at a more reasonable cost.

Action 13: By 2025, ensure that 10% of all new medium and heavy-duty commercial vehicles purchased produce zero emissions (meaning they are replaced with electric or hydrogen models). By 2030, this should rise to 90% of new vehicle sales, and to 100% by 2035.

Emissions Impact:

- High: Achieving this shift to zero emissions vehicles will eliminate 228,000 tonnes (7%) of Tigard's emissions cumulatively between 2023 and 2050.

Strategy and Design Considerations:

Successful approaches that have been used in other cities to decarbonize commercial vehicles include:

- Establishing emissions-free commercial delivery zones in downtown or business areas of the city. This normally includes creating delivery hubs at locations around the perimeter of the area at which ICE delivery vehicles can deposit their deliveries, and from which small e-bikes or e-delivery vans take the item the remainder of the way to the recipient. The benefits of this include reducing congestion and the problems of delivery vehicles blocking building entryways.
- Establishing delivery hubs at the perimeter of the city and requiring all commercial trucks to drop off their deliveries at one of these hubs. Electric vehicles complete the delivery into the city.
- Requiring that all construction projects for city facilities use zero emissions construction vehicles and equipment.

[25] Depending on the specific prices of gasoline, diesel and electricity.

Co-Benefits, Co-Harms and Equity Impacts:

- Decarbonizing commercial vehicles currently lags slightly behind the progress being made to decarbonize personal vehicles. Cities that adopt progressive policies and approaches to address this gap are seen as municipal climate leaders.
- Municipalities and counties can also be effective at getting vehicle manufacturers to commit to faster production of these types of vehicles by banding together and offering to set up sole source agreements with makers who can provide the vehicles they need on a schedule.

Low-Carbon Actions for Waste

Emissions from waste consist primarily of methane being released from landfills and from wastewater treatment. In 2019, Tigard's waste produced over 29,000 tonnes (5%) of its total greenhouse gas emissions. Without intervention (i.e. in the BAU scenario), these emissions are forecast to increase by over 240% by 2050. Only a small part of this is due to population growth. The majority comes from historical waste slowly decomposing and releasing methane over time. Today's waste effectively becomes tomorrow's emissions, and the emissions of years to come, if left in an open landfill.

The BAP scenario included two improvements:

1. Flaring 75% of the methane generated from the waste handled by Pride, beginning in 2022; and,
2. The impact of Executive Order 20-04 on landfill emissions overall, and specifically on food waste.

The impact of these improvements is shown in the BAP scenario's modeled waste emissions, which will fall by approximately 30%, to just over 20,000 tonnes annually in 2050. To increase the reduction in emissions in the Low Carbon Scenario, two actions were modeled.

Emissions Impact:

- Medium: Adding the two Low Carbon actions described below will increase this to a total annual reduction of 75% in waste emissions. This amounts to 167,000 tonnes of emissions.
- While this is significant, it leaves Tigard with almost 12,000 annual tonnes of waste emissions in 2035, and over 7,000 tonnes in 2050.[26] The Strategy and Policy Considerations below Actions 14 and 15 include suggestions and resources which Tigard can draw upon to continue to reduce its waste-based emissions.

Table 5. Emissions reductions from Low Carbon Actions for Waste in Tigard.

2023-2035		2023-2050	
Total Emissions Eliminated (tonnes)	Proportion of all Emissions Eliminated to 2035	Total Emissions Eliminated (tonnes)	Proportion of all Emissions Eliminated
25,300	2.3%	167,000	5%

The impact of both low carbon actions for waste over time is shown as the orange wedge in Figure 10.

[26] Tigard's total emissions in the Low Carbon Scenario in 2050 are 4368 tonnes. The final "Plant Trees" action is responsible for absorbing a portion of the emissions and reducing it to this number.

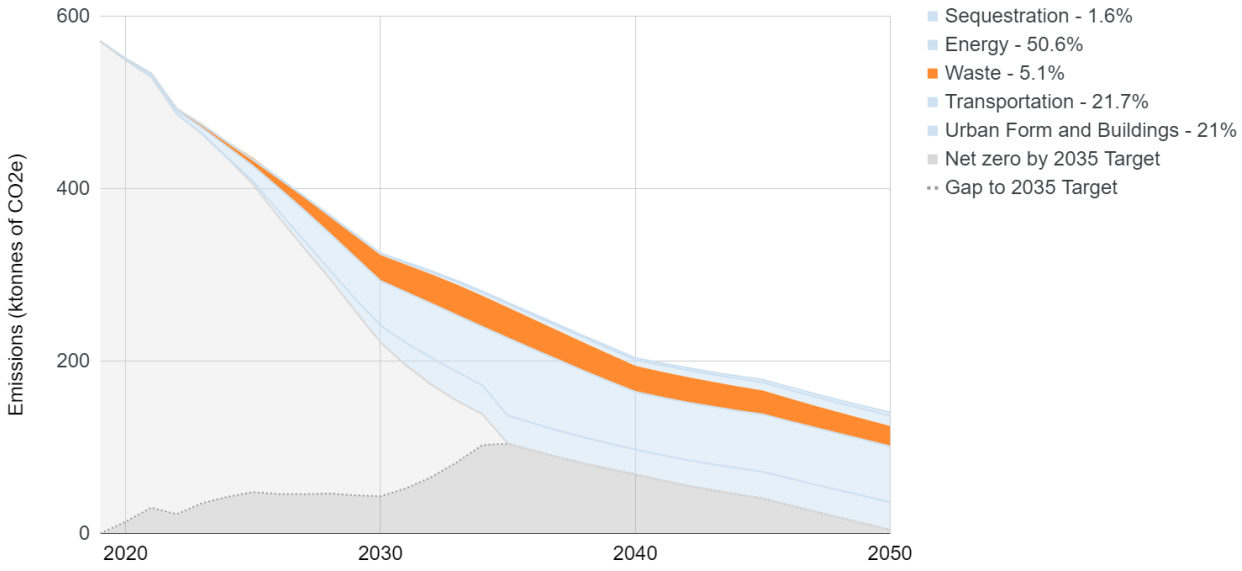

Figure 10. Total Emissions Reduced by the Low Carbon Actions for Waste.

Each of these actions is described below.

Action 14: By 2027, reduce total waste generated by 10%, concentrating on an overall reduction in residential waste, as well as the re-use of construction materials, recycling of scrap metal, and total reduction of food waste.

This action builds upon Goal 6.3 in Tigard's 2027 Comprehensive Plan[27] to reduce the amount of solid waste entering landfills.

Strategy and policy considerations:

- The specific areas targeted reflect input from businesses in Tigard, standard opportunities for waste reduction, and economic development opportunities that would build upon Tigard's existing expertise in material recycling.
- Fought & Company is a steel erection company based in Tigard. They advised the Climate Action Report Project Team that they do not currently send any remnants cut from the steel they use for recycling. This is an excellent opportunity for Tigard to pursue in cooperation with the company to help reduce the energy used and emissions produced smelting steel by reusing scrap pieces.
- The City of Tigard should actively resume administration of House Bill 2509[28] (Oregon's 2020 single-use plastic bag ban). Enforcement of the ban waned during the pandemic, but the launch of Tigard's Climate Action Report provides an excellent opportunity to reinvigorate efforts to eliminate single-use plastics.

[27] City of Tigard. 2027 Comprehensive Plan. https://www.tigard-or.gov/home/showpublisheddocument/1270/637861268512930000. Accessed August 17, 2022.

[28] State of Oregon. Department of Environmental Quality. "Single-Use Bag Ban." 2021. https://www.oregon.gov/deq/mm/production/Pages/Bags.aspx#:~:text=What%20do%20businesses%20need%20to%20know%3F&text=After%20Jan.,fee%20higher%20in%20their%20jurisdiction. Accessed August 30, 2022.

Action 15: By 2025, 64% of waste is diverted. This rises to 75% by 2030, and to 100% by 2050.

This action builds on the recovery goal for the wasteshed that includes Clackamas, Multnomah and Washington Counties. That goal is to achieve a collective waste recovery rate of 64% by 2025 and to maintain that rate.

Strategy and Design Considerations:

- The CIty of Tigard should embrace the responsibilities and capitalize on the opportunities provided to it by State Bill 582 (Modernizing Oregon's Recycling System).[29] This should include not only providing the required local recycling services and facilities, but also recognizing local business recycling achievements relative to the Bill's targets, and working to support a community recycling culture.
- The City of Tigard should draw upon resources such as those offered by the Ellen MacArthur Foundation[30] to develop local, circular economy opportunities.

Low-Carbon Actions for Sequestration

The final action is unique in that it absorbs greenhouse gasses from the atmosphere. It also provides numerous other benefits, some of which are discussed below. The impact of this action over time is represented by the medium blue line in Figure 11 below.

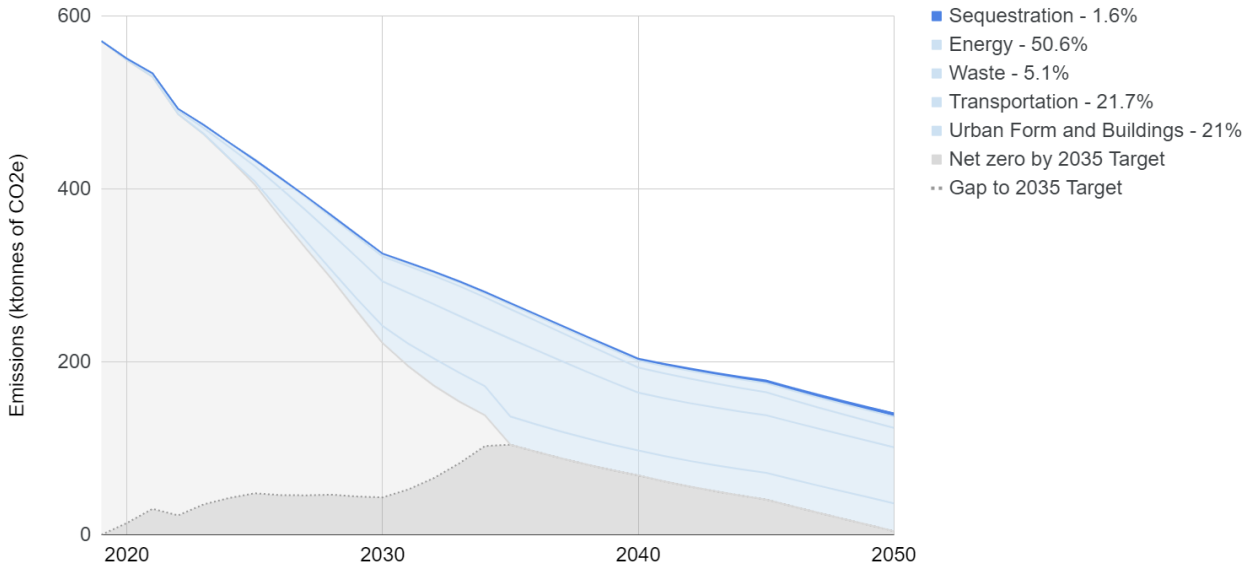

Figure 11: Total Emissions Reduced by the Low Carbon Actions for Sequestration.

This action is described below.

Action 16: Beginning in 2023, plant and maintain 7,000 trees / year within Tigard, such that by 2035 there are at least 91,000 more (and by 2050, 189,000 more) healthy trees than there were in 2019.

[29] Oregon State Legislature. Senate Bill 582. https://olis.oregonlegislature.gov/liz/2021R1/Downloads/MeasureDocument/SB582. Accessed August 31, 2022.

[30] Ellen MacArthur Foundation. The Circular Economy in Cities: resources suite. 2019. https://ellenmacarthurfoundation.org/circular-economy-in-cities. Accessed August 31, 2022.

This action builds upon previous tree planting efforts in Tigard which increased the number of trees on riparian corridors.

Emissions Impact:

- Between 2023 and 2050, these trees will remove over 3,200 tonnes of emissions. The impact of this action will grow not only as more trees are planted, but as the trees themselves grow and are able to absorb more emissions. Initially, 7000 new trees will sequester only a few tonnes of emissions annually, but by 2035 this will have increased to over 160 tonnes.

Equity and design considerations:

- Prioritize early plantings in areas where people have limited access to cooled buildings, and will benefit the most from shade as climate change brings more heat waves.
- Ensure the tree species selected reflect the needs and desires of the community, whether by emphasizing species important to local indigenous people, or by providing edible crops or other useful materials.
- Involve community members deeply in the design and maintenance of the areas to instill pride and a sense of ownership and accomplishment. This helps ensure the new trees are valued by the community, and so protected and cared for.
- Ensure the species selected are resilient to the expected impacts of climate change and new pests.
- Develop an Urban Forest Management Plan to ensure that the trees and other plants and naturalized areas survive, and are monitored and maintained both to ensure their health and to ensure that the risk of forest fires is mitigated.[31]

Co-Benefits, Co-Harms and Equity Impacts:

- The shade provided by trees provides a cooling effect both outdoors, and in nearby buildings, which can experience a reduced need for energy-intensive air conditioning.
- Trees reduce air pollution, lowering health problems and healthcare costs associated with conditions such as asthma.
- Trees help manage rain runoff by preventing soil erosion, providing surface area where rain water lands and evaporates, and also by absorbing water and supporting infiltration into the soil.[32] Climate change is already increasing the number and severity of storm events experienced in many communities. In this context, increasing trees can reduce the impact of these storms on drainage infrastructure.[33]
- Vegetation provides habitat for a variety of species, including the pollinators required to fertilize many of the foods we eat. More broadly, it supports the biodiversity that is fundamental to sustaining life on earth.

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[31] This recommendation aligns with achieving Goals 2, 5 and 7 of Tigard's 2007 Comprehensive Plan.

[32] United States Environmental Protection Agency. Soak Up the Rain: Trees Help Reduce Runoff. https://www.epa.gov/soakuptherain/soak-rain-trees-help-reduce-runoff#:~:text=Trees%20are%20increasingly%20recognized%20for,the%20soil%20that%20promote%20infiltration. Accessed August 31, 2022.

[33] This supports achieving Goal 7 of Tigard's 2007 Comprehensive Plan.

ADDRESSING RESIDUAL EMISSIONS

The set of actions included in this Climate Action Report still leaves Tigard with approximately 121,000 tonnes of emissions in 2035 - the year by which Tigard has set a goal to be a net-zero community. These are referred to 'residual emissions' - emissions left after measures have been taken to transition to a net zero community.

Several options are available to Tigard to address these residual emissions:

1. **Tigard could change its goal, altering the amount of emissions it aims to eliminate and/ or the date by which it will reach this goal.**

This could be interpreted as the community lowering its ambitions. However, it is also true that the goals could be changed while still keeping Tigard aligned with guidance from the international scientific community.

The C40 has designed a methodology for determining municipal emissions reduction goals that is science-based and takes into consideration the concept of communities each doing their 'fair share'.[34] Based on this methodology, Tigard needs to reduce its emissions by 70-75% per capita (relative to 2019) by 2030. By 2050, it needs to be net zero. The LC scenario modeled for this project sees Tigard's per capita emissions fall by over 66% to 3.6 tonnes per person by 2030, and to 0.06 tonnes per person by 2050. By making key actions slightly more ambitious between 2023 and 2030, Tigard could reduce its per capita emissions by 70% (to 3.2 tonnes per person) by 2030, and take slightly longer to complete the remaining emissions reductions, while still remaining aligned with international guidance.

2. **Tigard could expedite the actions contained in this Plan, and / or add further actions.**

In 2035, the LC scenario forecasts Tigard emitting 121,138 tonnes, of which 53% will come from diesel fuel, 38% from gasoline, and 8% from waste.

a) **Based on this, one way of eliminating 91% of these residual emissions would be to retire all ICE vehicles registered in Tigard by 2035.**

Recent research suggests that earlier retirement of ICE vehicles is indeed something we need to become more intentional about achieving. Specifically, they suggest that we should begin retiring ICE vehicles after a maximum of 9 years rather than using them for an average of 16 years.[35]

As Tigard may not have the authority or administrative infrastructure to require the retirement of ICE vehicles from the roads, innovative approaches and ultimately intervention from other levels of government may be required for this to be achieved.

b) **Another approach would be to complete a second round of technical modeling, honed based on the results and learnings from the first round, and aimed at measuring the impact of additional changes in urban form, the addition of car-free zones, or increased use of hydrogen fuel.**

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[34] Science Based Targets Network. "Science-Based Climate Targets: A Guide for Cities". 2020. https://sciencebasedtargetsnetwork.org/wp-content/uploads/2021/04/SBTs-for-cities-guide.pdf. Accessed August 31, 2022.

[35] Edelstein, S. Green Car Reports. Are regulators focusing too much on EV sales and not enough on retiring ICE vehicles?

3. Residual emissions between 2035 and 2050 could be addressed through additional measures such as carbon sequestration, new regulations, or the development of new technologies. If such options do not become available by 2035, the City of Tigard could compensate for its outstanding emissions by purchasing offsets.

Offsets are useful in the broader context of reducing emissions because they are designed to fund carbon reduction strategies that are not yet independently financially feasible. In this sense, they fund changes that move another entity closer to decarbonization; however, they should not be viewed as equivalent to reducing emissions locally. The administration of offsets is complex and requires significant overhead and time. In the past, not all work funded by offsets has been equally successful in eliminating emissions. Offsets can also be seen as an easy alternative to making the changes required to reduce emissions locally. For these reasons, offsets should only be purchased in cases where there is no alternative.

If the City of Tigard chooses to purchase offsets, it is recommended that the City establishes a procedure that ensures:

a. They are only purchased as a last resort when alternatives are not available;
b. The number of offsets purchased accurately reflects 100% of the residual emissions;
c. The offsets are purchased from a reliable entity following best practices in managing offset inventories; and
d. The offsets purchased reflect the City's values and vision and any preferences it may have for supporting local versus non-local projects or other priority issues.

The same process could also be used to purchase offsets:

For necessary business travel; and,

For events sponsored by the City that would otherwise temporarily increase the City's emissions.

Next Steps

Much work is required for the City of Tigard to respond to the climate emergency and sufficiently reduce its emissions. In the near term, the City will need to focus on:

1. Deciding how to address its residual emissions - whether by updating its goals, increasing its ambition, or purchasing offsets.
2. Establishing governance to ensure that the CAR is championed at the highest levels in the City and actively managed and reported on frequently and publicly until the Plan is completed.
3. Establishing and empowering the team to carry out the design, monitoring, and adjustment of the CAR effectively, in coordination with the rest of the City administration, the community, and other levels of government.
4. Developing plans and creating or updating policies to support this CAR.

Conclusions

We are living in unprecedented times; however, the current challenges we face also offer us a tremendous opportunity to be part of the "green recovery" after the COVID pandemic and during a climate crisis. How we respond to climate change will affect future generations and, increasingly, the livelihoods and well-being of people living around the world today.

This CAR outlines how the City of Tigard can seize this opportunity and embrace a responsible pathway to carbon neutrality. The actions in this CAR ensure that Tigard achieves net-zero emissions by:

- Demonstrating municipal leadership and integrity by acting quickly to reduce the City's corporate emissions;
- Maximizing direct local emissions reductions;
- Contributing to regional emissions reductions by investing in greening the state grid, supporting TriMet's transition, cooperating with other municipalities and counties, and advocating for further support and action from the state; and,
- Ensuring the benefits of Tigard's transition to zero emissions are equitably shared by all of Tigard's communities and citizens.

The actions described in this CAR will contribute to a global resolution to the climate crisis, provide financial savings to citizens and businesses in Tigard, improve the community's resilience to the impacts of climate change, and provide cleaner air quality, more comfortable and affordable buildings, and better transportation options that are accessible to everyone.

The work required to complete this CAR will allow Tigard to become a zero emissions community that is environmentally, financially, and socially healthier and more sustainable for all of its citizens.

Appendix A: Avoid, Reduce, Replace, Remove, Offset Paradigm

Although there are many decarbonization initiatives a city can pursue, they typically fall into one of five strategic approaches: Avoid, Reduce, Replace, Remove, and Offset.

- Avoid strategies are important to use as much as possible both for financial reasons and to avoid overtaxing individual fuel sources. Avoid strategies also often come with significant co-benefits, such as better health, less absenteeism, and even a greater sense of community and safety.
- Reduce strategies include traditional energy efficiency improvements, such as improving insulation and reducing heat loss by replacing old windows and automated doors.
- Replace initiatives include switching from fossil fuels to non-emitting fuels. These approaches are necessary and often involve new technologies such as solar photovoltaic (PV) systems, but they can be costly.
- Remove initiatives include using natural systems or technologies that sequester greenhouse gases. The most common projects involving natural systems are tree-planting initiatives and increasing and protecting wetlands and other ecosystems that naturally sequester CO2. The most familiar technology in this category is carbon capture, use, and sequestration (CCUS). This involves the physical capture of carbon generally produced during the combustion of fossil fuels in industrial or building heating contexts and then the storage of that carbon in solid forms, such as soap products, or by sequestering it in pipelines or underground caverns.
- Offsets involve paying another entity for taking eliminated emissions that the City of Tigard is not currently able to eliminate from its own inventory. It is priced as a cost per tonne of CO2e and is intended to compensate the receiving entities for investments required to eliminate those emissions. Offsets are regarded as a "last resort" only to be purchased when all other methods of local emissions reduction have been exhausted.

Avoiding the use of high-carbon energy altogether is the top priority, followed by reducing the amount of energy used through efficiency improvements, then switching to zero-carbon energy sources to satisfy the remaining demand. Offsets should only be used to address remaining emissions. They should also only be purchased until a better option is found. This Plan contains examples of all of these approaches.

Appendix B: Glossary

- BAU - Business as usual scenario
- BAP - Business as planned scenario
- CAR - Climate Action Report
- Co-benefits - Co-benefits of actions are positive consequences other than the emissions reductions. There are co-benefits for many emissions reduction actions, such as improving air quality and reducing traffic congestion.
- Co-harms - Co-harms of actions are negative consequences to actions that occur in addition to the reduction of emissions. An example of a co-harm is associated with citizens switching to zero emissions vehicles: electric and hydrogen vehicles require much less maintenance, and less frequently. As a result, there will be fewer jobs for vehicle mechanics as the proportion of zero emissions vehicles in the community fleet increases.
- Equity considerations - In the context of this plan, equity considerations are qualities of the actions that will impact the equity of citizens either positively or negatively. Examples include increased long-term housing affordability due to significantly reduced energy costs, and increased and improved, city-wide transit and active transportation infrastructure, reducing the need to own a personal vehicle.
- ICE - Internal combustion engine, or fossil fuel vehicle.
- EV - Electric vehicle.
- LC - Low carbon scenario

Appendix C: Multi-Criteria Analysis Results

Tigard's low carbon actions were evaluated against each of the following criteria. 36They were assigned an 'Impact' for each, to reflect the extent to which they would further either the benefit or the harm represented:

1. Reduce GHG Emissions: Actions were assigned one of the following four 'Impact' ratings based on how many tonnes of Tigard's community-wide emissions they would eliminate between 2023 and 2050:
    a. Low Impact: Actions that would eliminate between 0-50,000 tonnes of emissions.
    b. Low but Enabling Impact: Actions that would eliminate between 0-50,000 tonnes of emissions on their own, but that increase the 'Reduce GHG Emissions' Impact of other actions.
    c. Medium Impact: Actions that would eliminate between 50,000 and 200,000 tonnes of emissions.
    d. High Impact: Actions that would eliminate more than 200,000 tonnes of emissions.
2. Improve Air Quality: Actions were assigned one of the following 'Impact' ratings depending on the extent to which they improve air quality:
    a. No Impact: No perceivable impact on air quality would be expected.
    b. Implementation Dependent: The impact on air quality would depend on how the action was implemented.
    c. Medium Impact: The action will improve air quality in the immediate vicinity but would not result in broader, community-level impact.
    d. High Impact: The action will improve air quality at a community-level.
3. Increase Physical Activity: Actions were assigned one of the following 'Impact' ratings depending on the extent to which they would result in Tigardians increasing their levels of physical activity:
    a. No Impact: No impact on physical activity levels would be expected.
    b. Implementation Dependent: The impact on physical activity levels would depend on how the action was implemented.
    c. Medium Impact: The action could be expected to increase physical activity levels, but the connection is indirect and other factors would also come into play.
    d. High Impact: The action can be expected to significantly increase the amount of physical activity at a community-level.

[36] The criteria were selected based on citable scientific studies and based on suggestions from Tigardians who participated in engagement activities. The Impact rankings were assigned using quantifiable data where possible, and on qualitative assessments where quantifiable data was not available.

4. Reduce Vehicle Fatalities: Actions were assigned one of the following 'Impact' ratings depending on the extent to which they could be expected to result in a decrease in the number of vehicle fatalities:
    a. No Impact: No reduction in vehicle fatalities would be expected as a result of the action.
    b. Implementation Dependent: A reduction in vehicle fatalities could occur, depending on how the action was implemented.
    c. Medium Impact: The action could be expected to increase physical activity levels, but the connection is indirect and other factors would also come into play.
    d. High Impact: The action can be expected to significantly increase the amount of physical activity at a community-level.
5. Increase Employment: Actions were assigned one of the following 'Impact' ratings based on a combination of the number of local annual jobs they would be expected to generate per $1 million dollars of capital spending the total amount of capital spending:
    a. Low Impact - The action will generate 0-4 job years / million dollars spent.
    b. Medium Impact - The action will generate 4.1-8 job years / million dollars spent.
    c. High Impact - The action will generate 8+ job years / million dollars spent.
6. Improve Affordability: Actions were assigned an 'Impact' rating of "High", "Low" or "Mixed" based on the extent to which costs (particularly for energy) for citizens would be reduced as a result of the action.
7. Demonstrate municipal leadership: Actions were assigned an 'Impact' rating of "High" or "Medium" based on the extent to which carrying out this action would positively affect Tigard's profile as a municipal, climate change leader.
8. Improve social resilience: Actions that supported an improvement in social resilience were assigned an 'Impact' rating of "High". Actions that did not do so received a rating of "Low" in this category.
9. Increase Environmental Capital: Actions were assigned an 'Impact' rating of "High", "Medium" or "Low" depending on the extent to which they did any of the following: reduced the city's surface-level, spatial footprint, reduced its subsoil spatial footprint, reduced subsoil extraction, reduced energy sprawl, reduced the area dedicated to roadways, or reduced the area required for landfills and sub-surface pollution. Actions could also be assigned values of "Implementation Dependent" or "Mixed Impact".
10. Co-Harms: Co-harms were articulated in text for each action.

Table 1. Tigard's Low Carbon Actions with Impact Ratings

	REDUCE GHG EMISSIONS	IMPROVE AIR QUALITY	INCREASE PHYSICAL ACTIVITY	REDUCE VEHICLE FATALITIES	INCREASE EMPLOYMENT	IMPROVE AFFORDABILITY	LEADERSHIP	IMPROVE SOCIAL RESILIENCE	INCREASE ENVIRONMENTAL CAPITAL	CO-HARMS
1. Increase densification	Low but enabling impact	Implem. Dependent	Implem. Dependent	Medium Impact	Medium Impact	High Impact	High Impact	High Impact	High Impact	If not done well, can reduce safety and air quality.
2. New buildings meet Passive House standard as of 2028	Medium Impact	High Impact	No Impact	No Impact	Medium Impact	High Impact - +4% initial cost, w/ long-term affordability	High Impact		Medium Impact - reducing 'energy sprawl'	4% increase in initial cost to build
3. Renovate existing buildings for energy efficiency	High Impact	Medium Impact	No Impact	No Impact	High Impact	High Impact - high initial cost w/ long-term affordability	Medium Impact	High Impact	Medium Impact - reducing 'energy sprawl'	High up-front cost, and disruptive.
4. New buildings use heat pumps	High Impact	Medium Impact	No Impact	No Impact	Medium Impact	High Impact - high initial cost, w/ long-term affordability	High Impact		Low Impact, reducing subsoil spatial footprint and extraction	Until grid is 100% green, increase in electricity use will still cause emissions but trend is still down.
5. Replace existing systems with heat pumps	High Impact	Medium Impact	No Impact	No Impact	Medium Impact	Medium Impact - high capital cost and long-term affordability	Medium Impact		Low Impact, reducing subsoil spatial footprint and extraction	High up-front cost, and disruptive.
6. Install rooftop solar PV	Medium Impact	Medium Impact	No Impact	No Impact	Low Impact	High Impact - high initial costs and long-term affordability	Medium Impact		Mixed Impact	

	REDUCE GHG EMISSIONS	IMPROVE AIR QUALITY	INCREASE PHYSICAL ACTIVITY	REDUCE VEHICLE FATALITIES	INCREASE EMPLOYMENT	IMPROVE AFFORDABILITY	LEADERSHIP	IMPROVE SOCIAL RESILIENCE	INCREASE ENVIRONMENTAL CAPITAL	CO-HARMS
7. Procure green electricity	Medium Impact	Medium Impact	No Impact	No Impact	Low Impact - may not be local	Co-Harm - higher cost without long-term savings	High Impact		Mixed Impact	Jobs are not local, and savings of on-site electricity are not realized.
8. Replace natural gas with RNG and H2	Medium Impact	Medium Impact	No Impact	No Impact	Medium Impact	Mixed Impact - higher fuel cost and higher economic opportunity	Medium Impact		Implementation dependent	High fuel cost and very limited fuel source supply. Energy-intensive to produce.
9. Expand and increase transit service and active transportation infrastructure to achieve a combined 20% mode share	Medium Impact	High Impact	High Impact	High Impact	Medium Impact	High Impact	High Impact	High Impact	High Impact, reducing area dedicated to roadways	None. Be aware of safety issues and community concerns.
10. Electrify transit fleet	Low Impact	Medium Impact	No Impact	No Impact	Low Impact	High Impact - high initial costs and long-term affordability	Medium Impact		Low Impact, reducing subsoil spatial footprint and extraction	Chargers can over-extend electricity distribution capacity if not planned.
11. Electrify municipal fleet	Low Impact	Medium Impact	No Impact	No Impact	Low Impact	High Impact - high initial costs and long-term affordability	High Impact		Low Impact, reducing subsoil spatial footprint and extraction	Need to replace vehicles earlier than their natural life.

	REDUCE GHG EMISSIONS	IMPROVE AIR QUALITY	INCREASE PHYSICAL ACTIVITY	REDUCE VEHICLE FATALITIES	INCREASE EMPLOYMENT	IMPROVE AFFORDABILITY	LEADERSHIP	IMPROVE SOCIAL RESILIENCE	INCREASE ENVIRONMENTAL CAPITAL	CO-HARMS
12. Electrify personal use vehicles	High Impact	High Impact	Implementation Dependent	No Impact	High Impact; Potential Co-Harm as Nbr of Mechanics required drops	High Impact - high initial costs and long-term affordability	Medium Impact		Low Impact, reducing subsoil spatial footprint and extraction	Can reduce inclination to use active transportation and transit.
13. Electrify light duty commercial vehicles	High Impact	High Impact	No Impact	No Impact	Medium Impact	High Impact - high initial costs and long-term affordability	Medium Impact		Low Impact, reducing subsoil spatial footprint and extraction	
14/15. Reduce waste generated and increase waste diverted	Medium Impact	High Impact	No Impact	No Impact	Low Impact	Low Impact	Medium Impact		High Impact, reducing area required for landfills and sub-surface pollution	
16. Plant trees	Medium Impact	High Impact	Medium Impact	No Impact	Medium Impact	Low Impact	Medium Impact	Medium Impact	High Impact	