Draft Clackamas County Climate Action Plan

Presented by: SSG

Presented to: Clackamas County Climate Action Plan Project Team

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DRAFT FOR INTERNAL REVIEW ONLY

Contents

Land Acknowledgement

What we now call Clackamas County is the traditional lands and waterways of the Clackamas, Chinook Bands, Kalapuya, Kathlamet, Molalla, Multnomah, Tualatin, Tumwater, Wasco, and many other tribes of the Willamette Valley and Western Oregon. We will never be able to name every tribe that visited or lived upon this land because these communities frequently traveled for trade and other reasons. The Indigenous people lived, traded, and navigated along great rivers and tributaries presently named the Clackamas, Molalla, Pudding, Sandy, and Willamette. Many of the original inhabitants of this land died from disease, war, and other conflicts. Those that survived these tragedies were forcibly removed and relocated by European settlers and the United States Government because of the land's value. Today, their descendants live on, still carrying on the traditions and cultures of their ancestors.

We honor the Native American people of Clackamas County as a vibrant, foundational, and integral part of our community. We respectfully acknowledge Wy'east, also known as Mount Hood, and Hyas Tyee Tumwater, also known as Willamette Falls, as sacred sites for many Native Americans. We thank those who have connection to this land and serve as stewards, working to ensure our ecosystem stays balanced and healthy.

Acknowledging the original people of the land is a simple, powerful practice that demonstrates respect by making indigenous people's history and culture visible. It is also a small step along the path toward reconciliation and repair. Please join us in taking this opportunity to thank and honor the original caretakers of this land.

Community Engagement Acknowledgement

The Community Advisory Task Force (CATF) and Youth Advisory Task Force (YATF) were formed with membership from a cross-section of residents, including representatives from various organizations, academic institutions, businesses, and sectors within Clackamas. Their participation, guidance, and feedback have been integral to the development of the Climate Action Plan and we gratefully acknowledge the time, dedication, and insights shared.

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Zach Henkin, community member
Name 2nd Unite member
Name 2nd CCAC member after Sally

Youth Advisory Task Force Membership

Pending

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Youth member from Canby
A. Condie
Youth member from Gladstone
Youth member from Gladstone
Youth member from Gladstone
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And many members of the community.

Abbreviations and Glossary of Terms

BAU: Business-as-Usual Scenario
BEV: Battery Electric Vehicle
CAFE: Corporate Average Fuel Economy
CAP: Climate Action Plan
CATF: Community Advisory Task Force
EPA: Environmental Protection Agency
EV: Electric Vehicle
GHG: Greenhouse Gas
GJ: Gigajoule
ICI: Institutional, Commercial, and Industrial
IPCC: Intergovernmental Panel on Climate Change
kWh: Kilowatt Hour
MTCO2e: Metric Tons Carbon Dioxide Equivalent
SDC: System Development Charge
MMBTU: Million British Thermal Units
MW: Megawatt
NZ: Net-Zero Emissions
O&M: Operations and Maintenance
PJ: Petajoule
PV: Photovoltaics
RNG: Renewable Natural Gas
SCC: Social Cost of Carbon
tCO2e: Tons Carbon Dioxide Equivalent
TJ: Terajoule
UNFCCC: United Nations Framework Convention on Climate Change
ZEV: Zero Emission Vehicle

A glossary of terms can be found in Appendix A.

Disclaimer

Reasonable skill, care, and diligence have been exercised to assess the information acquired during the preparation of this analysis, but no guarantees or warranties are made regarding the accuracy or completeness of this information. This document, the information it contains, the information and basis on which it relies, and the associated factors are subject to changes that are beyond the control of the authors. The information provided by others is believed to be accurate but has not been independently verified.

This analysis includes strategic-level estimates of data about Clackamas County that should not be relied upon for project-level implementation without verification. The authors do not accept responsibility for the use of this analysis for any purpose other than that stated above or for any third-party use, in whole or in part, of the contents of this document. The suggestions in this plan apply to Clackamas County and cannot be applied to other jurisdictions without the appropriate analysis. Any use by Clackamas County, its sub-consultants, or any third party, or any reliance on or decisions based on this document, are the responsibility of the user or third party.

Letter of Support

From the Clackamas County Implementation Team

Executive Summary

The Clackamas County Climate Action Plan is a strategic-level document that outlines the county's goals and objectives for addressing climate change, as well as the strategies and actions that will be taken to achieve them. The plan includes an implementation guide and incorporates a climate lens to support decision-making within the county. Climate change is a global issue that is causing significant social, economic, and environmental hardships worldwide, and the state of Oregon is no exception. Rising temperatures, changing precipitation patterns, and other effects of climate change are leading to increased frequency and severity of heat waves, droughts, and wildfires, and are affecting the state's water resources, agriculture, and forestry sectors. Given the significant impacts that climate change is having on the state, it is imperative that action is taken to address it.

Effective climate action can be thought of as a dance – in the sense that it involves different individuals, organizations, government and the private sector working together in a coordinated way to achieve a common goal. Just as dancers must move in unison to perform a dance routine successfully, individuals, organizations, government and the private sector must work together to address climate change. Additionally, just as a dance is a process that requires ongoing practice and adaptation to improve, climate action also requires ongoing effort and adaptation to be effective.

Clackamas County is facing the threat of climate change and its associated impacts. This report focuses on how the county can reduce community-wide emissions from the major non-consumption-based sectors in the community: buildings (residential, institutional, commercial, and industrial), transportation, and waste. To provide guidance on what actions and what scale of action would be necessary to reach carbon neutrality in Clackamas County, an understanding of the local context - current energy use and emissions, and plausible projections for energy use and emissions based on current practices, policies, and demographic projections - was developed - the "Business As Planned" (BAP) scenario.

The BAP illustrates a likely scenario of community energy use and greenhouse gas (GHG) emissions between 2018 and 2050 based on the community taking no additional action on climate change beyond current policies and practices that are in place or are guaranteed through government plans and committed funding. This scenario serves as a benchmark, or starting point, against which Clackamas County can measure the effectiveness of its emissions reduction efforts and communicate the county’s reduction strategy to interested and affected parties (stakeholders) and the general public.

Modeling was conducted to illustrate a low-carbon scenario (LCS) that contains actions that can be taken to reduce carbon emissions throughout the county. The financial costs and benefits of each action in the low-carbon scenario and the scenario as a whole were also estimated.

Carbon neutrality is achieved specifically through decarbonization of the economy which includes energy-use avoidance, energy efficiency, and the replacement of fossil fuels with renewable energy technologies and energy systems. To balance any remaining human-driven emissions, carbon removal or sequestration can be achieved through restoring or enhancing natural lands and soils or through direct air capture and storage technology. The strategy of avoid, reduce, replace, remove, offset is prioritized to tackle the problem at its source. The state of Oregon has also initiated regulations such as the Climate

Protection Program (CPP) and House Bill 2021 (HB2021) to reduce greenhouse gas emissions and these regulations align with the county's goal of a carbon neutral future.

The critical sectors for decreasing emissions in Clackamas County, which are included in this report are:

- Building Retrofits,
- Net-Zero New Construction,
- Renewable Energy Generation,
- Reducing Vehicle Emissions and
- Increasing Active Transportation and Transit Use.

All of the actions in the plan tackle these critical sectors to create the low-carbon scenario (LCS). To achieve the target is to reach carbon neutral, these actions cannot go unaddressed, nor can some actions be implemented while others are ignored.

This LCS shows that emissions would be reduced by 83% when the community fully implements the sector-based actions identified in the low-carbon pathway. Employing sequestration can take the County the rest of the way to reach carbon neutrality by 2050. The LCS scenario shows the following changes in emissions:

- Buildings, which represented half of the community's emissions in 2018 (nearly 2 million MtCo2e), will represent 0.1 million MtCo2e in 2050.
- Transportation emissions will be reduced by 93% below the baseline.
- Emissions from waste increase by 131%.[RE1]
- Agriculture-related emissions decrease by 9%.

The LCS shows overall community energy use decreasing by 43.5%, building energy use decreasing by 26% and transportation energy-use decreasing by 68%.

The actions recommended in the implementation guide reflect the high level outcomes of the LCS, as well engagement with the community; input from the Community Advisory Task Force (CATF), and County staff and department directors, and practices in many other communities.

An important component of this project was the high-level economic modeling of some of the low-carbon opportunities. Transitioning to a low-carbon economy will require investments in all sectors of the community. Implementing the low-carbon scenario is projected to generate a net return of $5.6 billion across the county above the business-as-planned (BAP) scenario. The net return is based on savings in operations and maintenance, savings in energy costs, and revenue generation. The overall investment across the county amounts to $11.7 billion while savings amount to $17.3 billion.

Implementing the LCS will also generate job growth in Clackamas County, with the estimated creation of 36,000 person-years of employment between 2023 and 2050.

The actual costs of mitigation to Clackamas County residents and businesses would in many cases be lower than the conservative assumptions made in this analysis, as incentives and rebates currently available through local, state, and federal programs are not included in the analysis. Investigating all financial tools available to the County and other community stakeholders will be critical for the implementation of the low-carbon actions.

Transitioning to a low-carbon economy is essential to addressing the effects of climate change and ensure a viable, sustainable future for Clackamas County. Implementing a low-carbon scenario will require investments in all sectors of the community, including residents, businesses, institutions, and government. However, these investments will yield significant returns in terms of energy savings, revenue generation and job growth. Climate action taken today will ensure that Clackamas County's carbon neutral future is a bright one.

How to Read this Climate Action Plan

Key Sections of This Plan

This plan is divided into the following key sections:

- The Climate Action Imperative: Clackamas County's Climate Action Plan (Overview)
- Outcome One: Reduce Community Wide Emissions
- Outcome Two: Reduce Consumption Based Emissions
- Outcome Three: Adapt to Climate Change and Reduce Climate-related Risk

What is a Climate Action Plan?

A climate action plan (CAP) is a strategic document that outlines actions that a government, business, or organization plans to take to reduce greenhouse gas emissions (GHGs) and address the impacts of climate change. It typically contains a set of specific, measurable, and time-bound goals and actions to reduce emissions, as well as strategies for adapting to the impacts of climate change that are already happening or projected to occur.

Climate action plans may also include information on how the organization will engage with interested and affected parties[1], monitor progress, and report on progress. Essentially, a CAP is a strategic-level document that contains a framework to guide administrative bodies in addressing the specific impacts of climate change in their communities.

CAPs are important because they can be applied at different institutional levels, from city and regional governments and educational institutions, to the administration of federal programs. A climate plan's emissions targets and goals are usually decided on and approved by a governing body. Creation and adoption of the plan is often completed in collaboration with interested and affected members of the public.

While CAPs can differ in scale, according to the community or region they are addressing, several sections are consistently included in order to identify and track progress against climate targets. These sections are:

- A greenhouse gas emissions inventory;
- Modeled scenarios that project future emissions in a "business-as-usual" or "business-as-planned" (BAP) by sector and by fuel type;
- A modeled pathway, often called a "low-carbon pathway" or "low-carbon scenario" (LCS) that shows the size, scale, and timeline for emissions reductions as guided by the target;
- A model of financial details for the actions associated with the low-carbon pathway;
- A target for reaching carbon neutrality or net-zero emissions;
- Strategies and mechanisms for implementation that include various recommendations such as policies, proposed regulations, partnerships, opportunities for advocacy, and programs.

[1] Often referred to as 'stakeholders'. Interested and affected parties is a newer way of speaking of these members of the public who have an interest in or are affected by a particular decision a governing body is making.

Begin Box

Strategic-level Plan vs. Feasibility Plan

A strategic-level plan is a high-level document that outlines an organization's overall goals and objectives, and the strategies and actions that will be taken to achieve them. It typically covers a longer time horizon and provides a broad overview of the organization's direction and plans.

A feasibility study, on the other hand, is a detailed analysis of a specific project or proposed course of action to determine if it is viable and likely to be successful. It typically includes a thorough examination of the technical, economic, and operational aspects of the project, as well as an assessment of any risks or challenges that may need to be addressed.

The bottom line: a strategic plan is a high-level view of the overall direction and objectives of an organization, while a feasibility study is a detailed examination of a specific project or proposal to determine its viability. This document is a strategic-level plan that will guide the implementation of actions and provide guidance for future feasibility studies related to actions where viability needs to be determined for implementation to be successful.

End Box

Clackamas County's Climate Action Plan is accompanied by a detailed *Climate Action Plan Implementation Guide* that has also been developed with input from County staff and community members.

Clackamas County's Board of Commissioners directed the development of this Climate Action Plan to ensure it:

- addresses greenhouse gas mitigation and adaptation,
- Includes an implementation guide, and;
- a climate lens to support County decision-making.

The Climate Action Imperative

Climate change is a global issue that is receiving increasing attention and concern from governments, organizations, and individuals around the world. In response, many countries have implemented policies and initiatives to reduce greenhouse gas emissions and transition to renewable energy sources.

Changes to global climate patterns, collectively known as 'climate change'[2] have been accelerating over the past century. These changes have disrupted Earth's natural systems and are causing social, economic, and environmental hardships that are only beginning. To take just one example of the rising cost of climate change: there were 20 climate-related disasters in the United States in 2021 that exceeded one

[2] Also referred to as 'global warming'.

billion dollars in damages each. Together, these events resulted in $148 billion in damages and at least 724 lives lost, adding to 323 events since 1980 with 15,347 deaths, and nearly $2.2 trillion in damages.[3]

Similar events, costs, and losses of life are being experienced around the world. Projections show vast increases in climate-driven events over the coming decades, leading the World Economic Forum to identify the lack of climate action as the greatest social, economic, and environmental risk of 2022.[4] These risks will continue to mount as local and global greenhouse gas (GHG) emissions increase and the Earth continues to warm at an unprecedented rate.

Begin Box

The global community is responding to this challenge at its own pace. In December 2015, 196 countries adopted the Paris Agreement at the Conference of the Parties (COP) 21. Signatories of the Paris Agreement agreed to curb GHG emissions to limit global warming to well below 2°C above pre-industrial levels, and preferably less than 1.5°C. At COP26, held in Glasgow, Scotland in October and November 2021, the 1.5°C target was confirmed by the majority of participants as being necessary to avoid the most catastrophic impacts of climate change.

Many countries are also setting targets to increase the use of renewable energy. For example, the European Union has set a target of 32% renewable energy by 2030[5], and China plans to increase the share of non-fossil fuels in its primary energy consumption to around 20% by 2030[6].

In addition, governments and organizations are investing in research and development of new technologies to reduce emissions and adapt to the impacts of climate change. For example, the United States government has invested in research in clean energy technologies through the Department of Energy's ARPA-E program[7], while private companies are investing in electric vehicles, energy storage, and carbon capture technologies.

Individuals and businesses are also taking action to reduce their carbon footprint and promote sustainability. For example, more and more companies are setting science-based emissions reduction targets[8], and many individuals are making changes in their daily lives, such as using public transportation, eating less meat, and consuming less energy, to reduce their carbon footprint.

End Box

[3] NOAA National Centers for Environmental Information (NCEI). (2022). *U.S. Billion-Dollar Weather and Climate Disasters* https://www.ncei.noaa.gov/access/monitoring/billions/, DOI: 10.25921/stkw-7w73

[4] World Economic Forum. (2022). *Global Risks Report 2022*. https://www.weforum.org/reports/global-risks-report-2022

[5] "Renewable energy progress report" European Commission, https://ec.europa.eu/energy/en/data-analysis/renewable-energy-progress-report

[6] "China's Climate Change Policies and Actions" National Development and Reform Commission, https://en.ndrc.gov.cn/newsrelease/201803/t20180328_669367.html

[7] "Advanced Research Projects Agency-Energy (ARPA-E)" Department of Energy, https://www.energy.gov/arpa-e

[8] "Science Based Targets" https://www.sciencebasedtargets.org/

Here at home, climate change is having a significant impact on the state of Oregon. Rising temperatures and changing precipitation patterns are leading to increased frequency and severity of heat waves, droughts, and wildfires. These impacts are exacerbating existing environmental and economic challenges and putting communities at risk.

Climate change is also having an impact on the state's water resources, with changes in snowpack, streamflow, and sea level rising. This can lead to water scarcity in some areas, and flooding and landslides in others.

The agriculture and forestry sectors are also being effected, with crop yields and timber productivity declining as a result of increased pests and diseases, and more extreme weather events.

Given the significant impacts that climate change is having on the state of Oregon, causing harm to the environment, economy, and communities, it is imperative that government bodies take action to address it. This includes implementing policies and programs that reduce greenhouse gas emissions, increase resilience and adaptation to changing conditions, and support the transition to a low-carbon economy.

Now, more than ever is the time to act to meet these targets. Two things have become abundantly clear over the past two decades of global GHG emissions target-setting and climate change action:

1. Targets can be set and missed. Clear, achievable, and localized plans are needed so targets can be met.
2. Climate change is a global problem for which local solutions are critical. All levels of government need to participate in leading and supporting the reduction of GHG emissions, but it is local governments that understand the unique demographics, physical landscapes, and opportunities and challenges in their communities. Local governments cannot bear the whole burden of mitigating and adapting to climate change but they are powerful catalysts for change. They are in a unique position to lead, support, and advocate.

Clackamas County is not alone in taking climate action; with this plan it joins a growing group of US municipalities working to accelerate net-zero emissions. In 2021, a bipartisan group of U.S. mayors representing more than 54 million Americans have pledged to put equity at the heart of climate action, while doing their fair share to help the United States reach its goal to halve emissions by 2030 and achieve net-zero by 2050.[9]

For its part, Clackamas County has set a community-wide GHG emissions reduction target and a goal to increase climate resilience. The Board of Commissioners directed the development of this Climate Action Plan that addresses greenhouse gas mitigation and adaptation, an implementation guide, and a climate lens to support long-term County decision-making.

[9] C40 Cities. Press Release, 25 October 2021. *More than 100 American Cities Make Historic Pledge to Accelerate Net-Zero Emissions, Deliver Action Needed to Meet National Climate Goals.* https://www.c40.org/news/american-cities-net-zero-climate-goals/

Begin Box

In Clackamas County, we believe that climate action means...

Economic benefits such as:,

- Keeping our community members' money in the community
- Creating huge savings in energy costs for buildings and transportation
- Creating local jobs and economic value
- Capturing federal and state funding opportunities

Community benefits such as:

- Improved air quality and public health
- Greater resilience to climate-related disasters
- Supporting a greater variety of transportation options
- Healthier soil and water quality, and more resilient agriculture
- Protecting and enhancing natural resources like streams and forests
- Reducing waste
- Stimulating creative solutions, innovation, and social capital around climate action

End Box

Clackamas County's Climate Action Plan

In response to climate change, this *Climate Action Plan* (CAP) is designed to set the stage to achieve the following community-wide outcomes:

- Reduce GHG emissions to carbon neutral by 2050;
- Reduce community-wide consumption-based emissions; and
- Adapt to climate change and reduce climate-related risk.

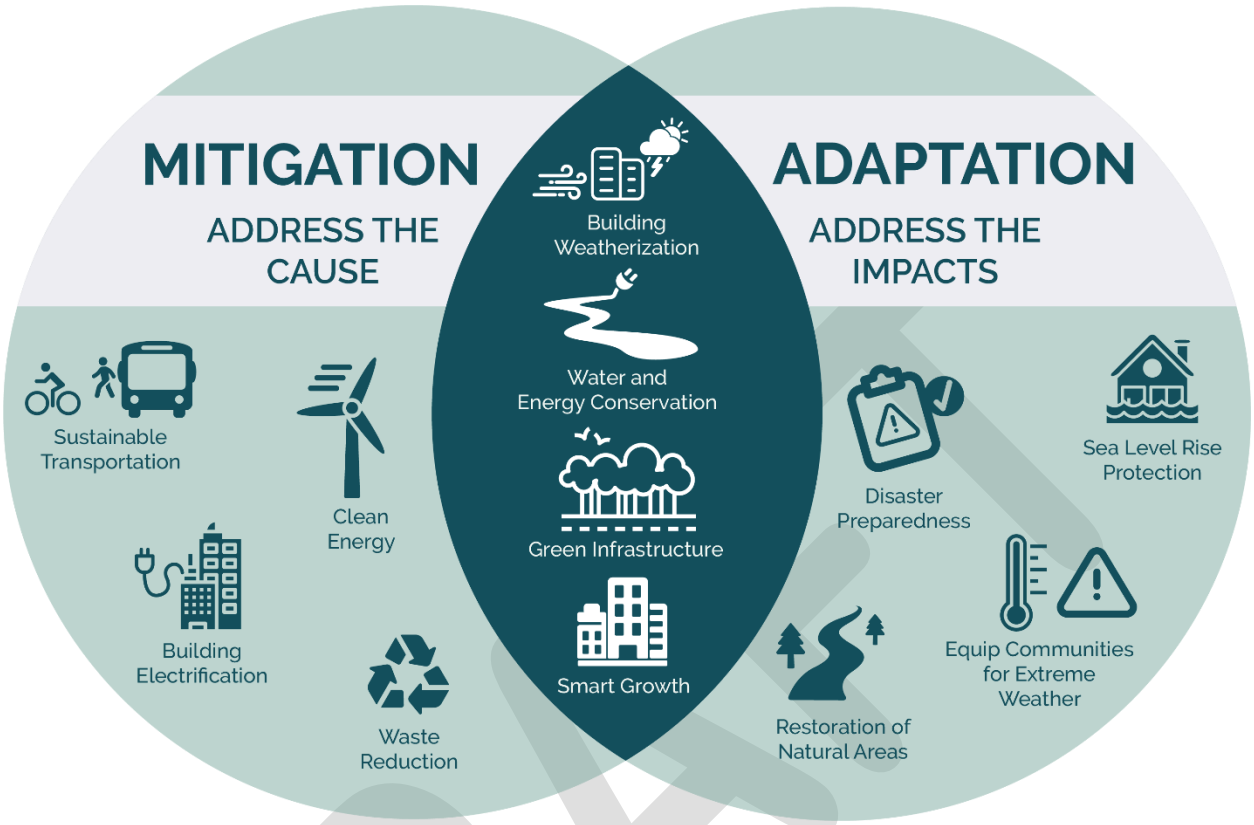

Figure x. Adaptation and mitigation actions comparison.

The development of this Climate Action Plan included a four-pronged approach:

1. Targeted engagement with interested and affected parties (stakeholders) engagement, both with County staff and the community;
2. Data analysis and some technical modeling to inform targets, pathways, and recommendations;
3. Review the local context including current plans, policies, legislation, demographics, and climate action readiness and a review of best practices; and,
4. Broad public engagement.

These approaches were iterative[10] and worked in concert to provide a robust analysis and recommendations that reflect the local context in and unique needs of Clackamas County.

Begin Box

What is Climate Change Mitigation versus Climate Change Adaptation?

Mitigation focuses on taking action to reduce human-caused GHG emissions to limit changes in the climate.

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[10] An iterative approach to planning is a method of problem-solving that involves repeatedly refining and updating a plan until the desired outcome is achieved. This approach allows for flexibility and adaptability, as it allows for adjustments and improvements to be made as new information becomes available. It also allows for the gradual refinement of a plan, rather than expecting a perfect plan from the start.

Adaptation focuses on adjusting infrastructure and practices to decrease risk and build resilience to expected changes in climate.

Addressing both mitigation and adaptation recognizes that emissions need to be reduced to avoid the most catastrophic impacts of climate change, but also that some changes are already underway and will be unavoidable, so we must prepare and adapt to minimize the impact of those changes.

End Box

The actions identified in the CAP, and in the more detailed *Climate Action Plan Implementation Guide*[11], describe how Clackamas County will:

- **Lead** its community by example through changes to its own infrastructure, services, and internal policies;
- **Support** its community through programs, education, incentives, and pilot projects, and
- **Advocate** for its community through partnerships and dialogue with other decision-makers and service providers.

Table x. Major outcomes addressed in the Climate Action Plan

Outcome	**Description**	**Method**
Reduce community-wide emissions	Community-wide GHG emissions reach carbon neutral by 2050.	Identify local actions to address emissions-producing sectors (buildings, land use, energy generation, transportation, waste), leveraging community engagement, data analysis, and modeling.
		Identify sequestration actions through engagement, research, and data analysis, to close the gap between the target outcome and the emissions that can be reduced through direct sector action.
Reduce community-wide consumption-based emissions	Consumption-based emissions decrease over time.	Identify consumption-based emissions through engagement, research, and data analysis, to reduce consumption-based emissions at a community scale.
Adapt to climate change and reduce climate-related risk	Climate-related risk is reduced through policy, infrastructure, and planning changes as well as through preparedness and education.	Identify actions that will reduce climate-related risk and vulnerability to people, the economy, and the environment within Clackamas County through engagement, research, and data analysis.

[11] The Climate Action Plan Implementation Guide is an accompanying document to the Climate Action Plan that identifies how the County can implement the CAP through leadership, support, and advocacy functions, including governance, policies, regulations, programs, pilots, incentives, education, and direct advocacy. The Implementation Guide can be accessed via the County's website xxx or by contacting the County's xxx office.

Begin Box

What are Additional Climate Benefits and Risks of Action (also known as co-benefits and co-harms)? What about equity?

Additional climate benefits, also known as co-benefits are positive effects that a policy or measure might have, beyond its primary objective. One distinction, made by the Organization for Economic Co-operation and Development (OECD), is that co-benefits are effects that are valued in the mitigation (emissions reduction) costs of a policy or action, whereas ancillary or additional benefits are effects that are incidental and are not accounted for in that analysis.[12] In this analysis, co-benefits are assumed to be any potential or anticipated benefits of the action in addition to its impact on GHG emissions.

Not all co-benefits and risks of action (co-harms) are equal

Not all co-benefits nor co-harms are equal. One set of criteria by which to consider the co-benefits of actions to reduce greenhouse gas emissions follows:[13]

- **Synergies:** Many low carbon actions have multiple socio-economic benefits, including improving transit, energy efficiency, and compact urban design.
- **Urgency:** Some actions are associated with a higher degree of urgency in order to avoid loss of inertia on action already taken, lock-in effects,[14] irreversible outcomes, or deferred costs that become even more elevated as a result of deferment. And then there are some low-carbon actions that require time to be effective, which makes immediate implementation all the more important.
- **Costs:** The cost of early action is generally lower than the cost of later action, in particular because delayed action involves ongoing investments in infrastructure, activities, and utilities that have higher emissions than low carbon solutions. Examples include renewable energy infrastructure, transit, and energy efficiency.
- **Longevity:** Related to urgency, the longevity of investment decisions locks society into their effects for decades[15], if not centuries.

[12] IPCC. (2014). Annex II: Glossary [Agard, J., E.L.F. Schipper, J. Birkmann, M. Campos, C. Dubeux, Y. Nojiri, L. Olsson, B. Osman-Elasha, M. Pelling, M.J. Prather, M.G. Rivera-Ferre, O.C. Ruppel, A. Sallenger, K.R. Smith, A.L. St. Clair, K.J. Mach, M.D. Mastrandrea, and T.E. Bilir (eds.)]. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Barros, V.R., C.B. Field, D.J. Dokken, M.D. Mastrandrea, K.J. Mach, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1757-1776. p. 1762.

[13] Adapted from (Fay et al., 2015).

[14] Lock-in effect refers to implementation of a strategy or action that improves performance of an object or activity in the short term but is prohibitive to future change. Lock-in effect can refer to building upgrades or land use for example. As an example. where quick building retrofits are undertaken, no additional improvements in the equipment installed can be expected over the course of its lifetime without considerable additional expense. In this way, lower levels of energy reductions can be locked in for a long period.

[15] For example: when a new building is constructed, if it does not have low-carbon design built in from the beginning, it is an infrastructure choice with a multi-decade set of consequences (as most buildings are built to last 50+ years).

- **Distribution effects:** Low-carbon actions have different impacts on different subsets of the population, including income levels, generations (including future generations), race, and ethnicities.

Examples of additional/co-benefits

Energy Efficiency

Initiatives that lead to greater energy efficiency in households may also have the benefit of reducing the burden of household energy costs; however, only some energy efficiency programs may specifically benefit low-income community members, depending on how they are designed. For example, if household energy efficiency incentives are limited to rebates offered after retrofits, these may be out of reach for low-income households. Low-income households would, over time, disproportionately bear the fixed costs of maintaining the energy utility.

Improving Outdoor Air Quality

One of the most beneficial and immediate health co-benefits of actions to reduce GHG emissions is improved air quality. Improving air quality reduces premature death, improves equitable health outcomes for all Oregonians, and will save the state and its residents billions of dollars per year in avoided costs.

Climate change is bringing hotter temperatures to Oregon, leading to more frequent heat waves, drier conditions, more wildfires and wildfire smoke, and elevated ozone levels.[16] At the same time, while air quality in Oregon has been improving steadily over recent decades, climate change will increase the likelihood of conditions that exacerbate poor air quality. In 2020, nearly all areas of Oregon experienced multiple days of "unhealthy," "very unhealthy" and "hazardous" Air Quality Index scores due to record high temperatures and wildfire smoke.[17]

Burning fossil fuels such as gasoline, diesel, and natural gas releases air pollutants, such as sulfur dioxide, nitrogen oxides, particulate matter, carbon monoxide, polycyclic aromatic hydrocarbons, mercury, volatile organic compounds, and others, all of which have adverse impacts on human health.[18]

Air pollution does not affect everyone in Oregon equally. In 2017, approximately 1 in 10 adults in Oregon reported having asthma, making them more sensitive to poor air quality.[19] Low-income communities and communities of color experience a greater burden of air pollution across the entire state; due to historic and ongoing inequities and discrimination, they are more likely to live in neighborhoods with close

[16] "2020 - 2020 Biennial Report to the Legislature.Pdf," accessed October 30, 2021, https://static1.squarespace.com/static/59c554e0f09ca40655ea6eb0/t/5fe137fac70e3835b6e8f58e/1608595458463/2020-OGWC-Biennial-Report-Legislature.pdf.

[17] "Oregon Air Quality Monitoring Annual Report: 2020" (Portland, OR: Oregon Department of Environmental Quality, December 2021), https://oraqi.deq.state.or.us/Pagesfiles/2020%20Oregon%20Air%20Quality%20Monitoring%20Annual%20Report.pdf.

[18] Nicholas A. Mailloux et al., "Nationwide and Regional PM2.5-Related Air Quality Health Benefits From the Removal of Energy-Related Emissions in the United States," *GeoHealth* 6, no. 5 (2022): e2022GH000603, https://doi.org/10.1029/2022GH000603.

[19] Oregon Health Authority, Public Health Division, Health Promotion and Chronic Disease Prevention section, "Chronic Diseases among Oregon Adults, by County, 2014-2017," May 24, 2019, https://www.oregon.gov/oha/PH/DiseasesConditions/ChronicDisease/DataReports/Pages/index.aspx.

proximity to highways, railyards, polluting industries, lack of trees and green space, and urban heat islands.[20] People living in households with an annual income of less than $20,000, as well as American Indian and African American communities, experience higher rates of asthma and heart disease than other groups.[21] Outdoor workers and farmworker communities are also particularly at risk of exposure to air pollutants from transportation and industrial activities, in addition to wildfire smoke and ozone. Air pollution also increases cancer risk; according to the Environmental Protection Agency's 2014 National Air Toxics Assessment, the state of Oregon has the third-largest population at risk of excess cancer due to air pollution within the United States, behind California and New York.

Switching from fossil fuels to using cleaner energy sources can produce health benefits from improved air quality in the near term while also providing climate benefits in the longer term. Eliminating air pollutants from fossil fuel combustion would also have massive economic benefits, with researchers estimating up to $600 billion in annual benefits from avoided PM2.5-related illnesses and deaths each year in the U.S. as a whole.[22] Scenarios run in early 2022 using the Oregon Energy Policy Simulator, an online modeling tool, indicate that Oregon could see economic benefits between $3 and $5 billion in 2050, depending on the level of emissions reduced.[23] Researchers from Harvard University have concluded that a total decarbonization of the American energy sector would pay for itself through public health benefits alone, before even factoring in the cost-benefit analysis of reducing emissions.[24]

End Box

A Local Perspective

Located in north-central Oregon in the Willamette Valley, Clackamas County has a diverse landscape and settlement pattern, including urban, suburban, rural, and wild areas, spanning 1,879 square miles. The northwest part of the county includes part of the Portland Metropolitan Region while the eastern portion is in the Cascade Mountain Range. The county has several cities within both the urban metro area and its rural areas. The county encompasses rich forest and farmland, as well as many rivers, the Mount Hood National Forest and associated wilderness areas, the Clackamas River Watershed, which provides much of the water for residents in the County, and the Bull Run Watershed, which provides the primary drinking water supply for the nearby City of Portland.

The county's diverse economy includes professional business services; wholesale trade, transportation and distribution; high tech manufacturing/software and media; health care; advanced manufacturing; food and beverage processing; agriculture, nurseries & greenhouses, and wood manufacturing. The county's

[20] Emily York et al., "Climate and Health in Oregon - 2020 Report."
[21] Emily York et al.
[22] Mailloux et al., "Nationwide and Regional PM2.5-Related Air Quality Health Benefits From the Removal of Energy-Related Emissions in the United States."
[23] Shelley Wenzel, Megan Mahajan, and Eric Strid, "Oregon Policy Simulator Insights: Recent Developments, Policies to Meet Emissions Goals," n.d., 18.
[24] David Wallace-Wells, "Opinion | The True Cost of the Climate Stalemate in Congress," *The New York Times*, May 19, 2022, sec. Opinion, https://www.nytimes.com/2022/05/19/opinion/environment/build-back-better-joe-manchin.html.

largest employers include Providence Health & Services, a healthcare provider with several hospitals and clinics in the area, Kaiser Permanente, Clackamas County government, and the North Clackamas School District. The county's proximity to Portland and its growing technology sector also help to drive economic growth.

Climate Change in Clackamas County[25]

The impact of climate change is already being felt in Clackamas County. Average annual temperatures have increased by approximately 4°F (2.2°C) since 1901.[26] Just during the time this plan was developed, Clackamas County had a rare tornado that felled trees and damaged property; wildfires that burned homes and hundreds of thousands of acres of forest; floods, landslides and road closures caused by unusually heavy rains; a late-June heatwave that led to the deaths of at least 14 people; a snow and ice storm that led to fallen trees, property damage and widespread power outages; a late winter atmospheric river that broke daily rainfall records in several areas and led to urban flooding; the hottest October on record; and a severe drought that dried up wells and shortened agricultural growing seasons.

If, on a global scale, greenhouse gas emissions remain on a business-as-usual trajectory, a 5.4 to 9°F (3 to 5°C) increase in average temperature in Clackamas County is projected by 2100. The greatest temperature increases will continue to occur in the summer, increasing the risk and frequency of extreme heat and heatwaves, which put stress on human and ecological health, and agricultural output. Precipitation is expected to increase during the spring and winter and decrease in the summer months, increasing the risks for both flooding and drought. Extreme heat and drought, combined, increase the risk of forest fires. Between now and 2100 the snowpack, which is a key contributor to streamflow and health, also projected to decrease.

A more detailed review and analysis of climate change projections in Clackamas County can be found in an ancillary report to the Climate Action Plan, entitled *Technical Investigation Part One: The Context.*

A History of Action

The County's Board-adopted carbon-neutral target and desire to build resilience to climate change have guided the development of the Climate Action Plan.

Clackamas County has acknowledged the need to take steps toward greenhouse gas mitigation since 2008 when it adopted the U.S. Cool Counties Climate Stabilization Declaration and a resolution on climate change. That same year, the County appointed the Sustainable Clackamas County Task Force to develop a three to five-year sustainability action plan. The task force created the Action Plan for a Sustainable Clackamas County, which set a goal for the County to become carbon neutral and reduce its GHG

[25] The content in this section is largely derived from the summary and analyses of the Fifth Oregon Climate Assessment, published by the Oregon Climate Change Research Institute at Oregon State University in January 2021 - Dalton, M., and E. Fleishman (Eds.). (2021). *Fifth Oregon Climate Assessment*. Oregon Climate Change Research Institute, Oregon State University, Corvallis, Oregon. https://oregonstate.app.box.com/s/7mynjzhda9vunbzqib6mn1dcpd6q5jka

[26] Dalton, M., and E. Fleishman (Eds.). (2021). *Fifth Oregon Climate Assessment*. Oregon Climate Change Research Institute, Oregon State University, Corvallis, Oregon. https://oregonstate.app.box.com/s/7mynjzhda9vunbzqib6mn1dcpd6q5jka

emissions by 80% by 2050. Work was completed in the community through an Energy Efficiency Conservation Block Grant, staffing and other implementation support.

All these programs and support were later discontinued but have been reviewed for their impact on the community as one indicator for this plan. Other actions include:

- In 2017, the Board reaffirmed the County's climate goals. County staff developed a greenhouse gas emissions inventory for County operations and began exploring ways to reduce their GHG impact through actions such as fleet electrification, renewable electricity.
- In 2018, the Board directed staff to develop an updated countywide climate action plan.
- In 2018, the County formed the Clackamas County Climate Exchange, which brings together staff from across County departments several times a year to support the development of the Climate Action Plan and coordinate climate action. The six departments currently represented on the Climate Exchange are Transportation and Development; Water Environment Services; Health, Housing and Human Services; Disaster Management; Business and Community Services, and Public and Government Affairs.
- In 2019, the Climate Exchange Steering Committee was formed, made up of a small, focused group of Climate Exchange members, to provide direction and produce work to support the CAP. This group worked with the Institute for Sustainable Solutions from Portland State University to define the CAP scope of work.
- In 2019, the Board set a goal to adopt a climate action plan by January 2022, which was extended to 2023 in recognition of the delays created by COVID-19, historic wildfires in 2020, and a severe ice storm in 2021.

Additional information about climate action in Clackamas County, and at the State and Federal levels can be found in the ancillary report *Technical Investigation Part One: The Context*.

The County has also made changes to its own operations. Actions include purchasing nearly 100% renewable electricity for County operations beginning in the 2019-20 fiscal year, moving toward low-carbon County-owned vehicles and EV charging, and expanding opportunities for commercial food scraps composting in the community. Community education initiatives include offering a climate change presentation for schools and hosting Repair Fairs for people to fix their broken appliances and tools instead of throwing them out.

Another ongoing effort is the Leaders in Sustainability program, through which staff trains and certifies local businesses, and recognizes them for their positive impact on our environment and community. The businesses demonstrate their commitment to sustainability through recycling and composting, energy and water efficiencies, sustainable transportation and community engagement.

The County has also been working diligently to address climate-related risks through its Natural Hazards Mitigation Plan (NHMP). The NHMP helps the county prepare for actions that can lessen the impact of disasters. The NHMP allows the county to identify risks associated with natural disasters and work on long-term strategies for protecting people and property. When it was last updated in 2019, emerging climate-related hazards including drought and extreme heat were included. A NHMP update in 2023 will continue to identify opportunities to mitigate and build resilience to disasters that are increasingly likely due to climate change.

Local Influence for a Local Plan

The low carbon scenario development was not simply a technical modeling process. It was influenced by public engagement throughout the CAP development process.

Clackamas County has engaged the public in the development of the CAP through various means, including articles in county publications, emails to advisory boards and commissions, focus groups, newsletters, a community advisory task force (CATF) and a youth advisory task force (YATF). These efforts gathered input and feedback from a diverse range of community members and interested or affected parties (stakeholders).

The county has been actively promoting the CAP project through various county publications such as #ClackCo Monthly, #MyClackCo, and #ClackCo Weekly, which have featured articles and information about the project and opportunities for public input. Additionally, the county has sent emails to various advisory boards and commissions to inform them of the project and opportunities for input.

The county has also held focus groups in the Fall of 2022 to gather input from specific groups of residents, including seniors, small business owners, rural residents, migrant farmworkers, and members of minority communities, including Latino/Hispanic, African American, and Asian.

The Youth Advisory Task Force (YATF) was formed to gather input from youth under 25 years old. The YATF has held 15 monthly meetings from March 2021 through June 2022, where they discussed the most pressing climate issues and provided input on high-level action areas to the Community Advisory Task Force (CATF) in September 2021.

The CATF is made up of 24-people who represent various communities, stakeholder groups and areas of expertise from throughout the county. They are charged with helping to develop a climate action plan to meet the County's goal of reducing greenhouse gas emissions so the county can be carbon neutral by 2050. The group has met a total of 10 times to provide input and reviews of modeling, discuss experiences and share expertise, and advise the project team on the final report.

Additionally, the county has held various community conversations and meetings with key communicators, such as cities (including C4 – city and county elected officials, and a cities work group), rural residents, and businesses, to gather input and feedback on the CAP. Surveys were also conducted in spring 2022, which received 950 responses, to gather feedback on actions needed to respond to climate change and help achieve the county's goal of being carbon neutral by 2050. The county also utilized social media channels such as Facebook, Twitter, and NextDoor to share information about the project and provide opportunities for public input.

A comprehensive engagement summary for the CAP can be found in *Appendix B* and a summary of communications and awareness activities conducted by the County can be found in *Appendix C.*

Outcome One: Reduce Community-wide Emissions

Clackamas County, like communities all over the world, is facing the threat of climate change and the many associated social, economic, and environmental impacts.

This section focuses on how Clackamas County can act to reduce community-wide emissions from the major non-consumption-based sectors in the community:

- buildings (residential, institutional, commercial, and industrial buildings),
- transportation, and
- waste.

Understanding the Challenge

To provide guidance on what actions and what scale of action would be necessary to reach carbon neutrality in Clackamas County, we needed to develop an understanding of the local context - current energy use and emissions, and plausible projections for energy use and emissions based on current practices, policies, and demographic projections.

Modeling was conducted to illustrate a low-carbon scenario with actions that can be taken to reduce carbon emissions throughout the county. The financial costs and benefits of each action in the low-carbon scenario and the scenario as a whole were estimated and can be found in Appendix X.

What the Business As Planned (BAP) scenario showed is that GHG emissions were likely to decrease by 20% (Figure x) by 2050, with current policy (that does not include a low-carbon climate action plan). What this means is, without a climate action plan, emissions are not reduced to a low-carbon state. When the community fully implements the sector-based actions identified in the low-carbon pathway (LCS), emissions would be reduced by 83%. Employing sequestration can take the County to carbon neutral by 2050.

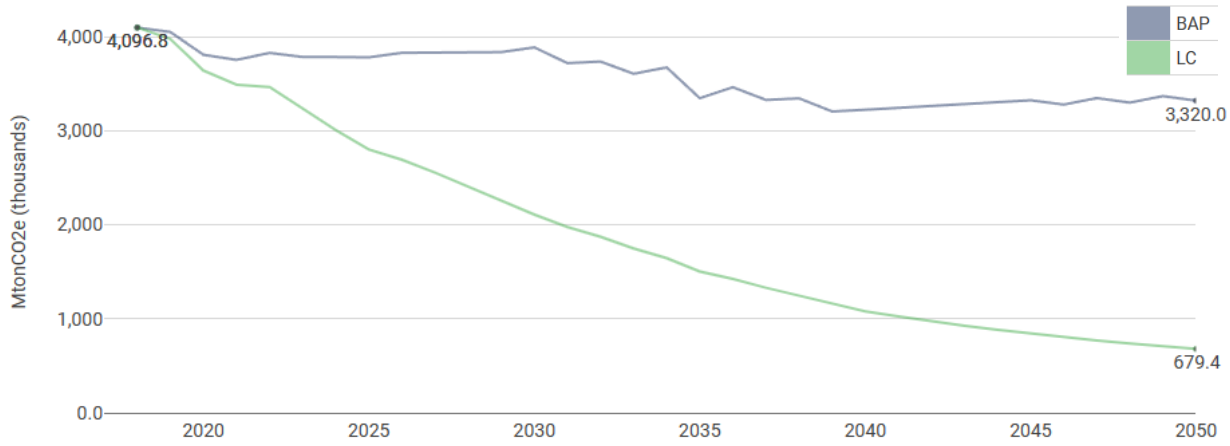


Figure X. The opportunity of the low-carbon pathway (sequestration not included).

A Future Clackamas County Without Further Climate Action

Begin Box

A Business As Planned (BAP) Scenario Explained

A "Business As Planned" (BAP) scenario for carbon emissions reductions projects Clackamas County's expected emissions levels if the county continues with current policies and practices, with no additional policy or climate action intervention. This scenario serves as a benchmark, or starting point, against which Clackamas County can measure the effectiveness of its emissions reduction efforts. It includes projections for energy consumption, emissions from transportation, emissions from industrial processes, and other sources of carbon emissions. The projections are based on locally available data including utility use records, transportation data, demographic data, and forecasts for population and employment changes. Policy implications at the local, state, and federal level, such as the federal electric vehicle target, are also considered.

This scenario essentially describes the size of the emissions reduction challenge the County faces and can be used to set emissions reduction targets and track progress towards achieving them. It can also be used as a way to communicate the county's reduction strategy to interested and affected parties (stakeholders) and the general public.

After this BAP was created, Oregon passed HB2021 (House Bill 2021 -- the Clean Energy Targets Bill) and the Climate Commitment Act, which would have normally been included. However, these pieces of legislation and their impacts have been factored into the low-carbon scenario (LCS) which is discussed in that section of this document.

End Box

A Business-as-Planned (BAP) scenario was developed for Clackamas County. The BAP illustrates a likely scenario[27] of community energy use and GHG emissions between 2018 and 2050 based on the community taking no additional action on climate change beyond current policies and practices that are in place or are guaranteed through government plans and committed funding. The scenario accounts for the County's population and demographics trends, and estimates and uses energy and emissions data and information from local, state, and federal governments to inform modeling assumptions about buildings, transportation, energy generation, and solid and liquid waste. The BAP assumptions were reviewed by County staff and the Community Advisory Task Force (CATF) before being modeled.

Clackamas County's BAP shows declining GHG emissions in the community, with emissions expected to decrease by 19%, from approximately 4.1 million metric of carbon dioxide equivalents (MtCO2e) in 2018 to approximately 3.3 million MtCO2e. Energy use is expected to increase slightly from 49 million

[27] A scenario is an internally consistent view of what the future might turn out to be. Because we can not know for certain how individual behavior, world events, policy changes, and technological advancements will unfold, it is not a forecast, but one possible future outcome based on what we know today. It is based on locally available data including utility use records, transportation data, demographic data, and forecasts for population and employment changes. Policy implications at the local, state, and federal level, such as the federal electric vehicle target, are also considered.

MMBTUs to 52 million MMBTUs, or six percent, over the same period. These opposing trends indicate that there will be a partial shift toward energy sources that are less emissions-intensive, resulting in fewer emissions per unit of energy used.

Business-as-Planned Emissions

In 2018, buildings in Clackamas County as a whole accounted for over half of community emissions. Residential buildings made up 25% of emissions, industrial operations were responsible for 15% and commercial buildings accounted for 11% of total community emissions. The transportation sector was responsible for a significant portion of the community's emissions as well, at 43%. Agriculture accounted for 4% of emissions, while emissions from garbage and sewage (waste) accounted for 2%.

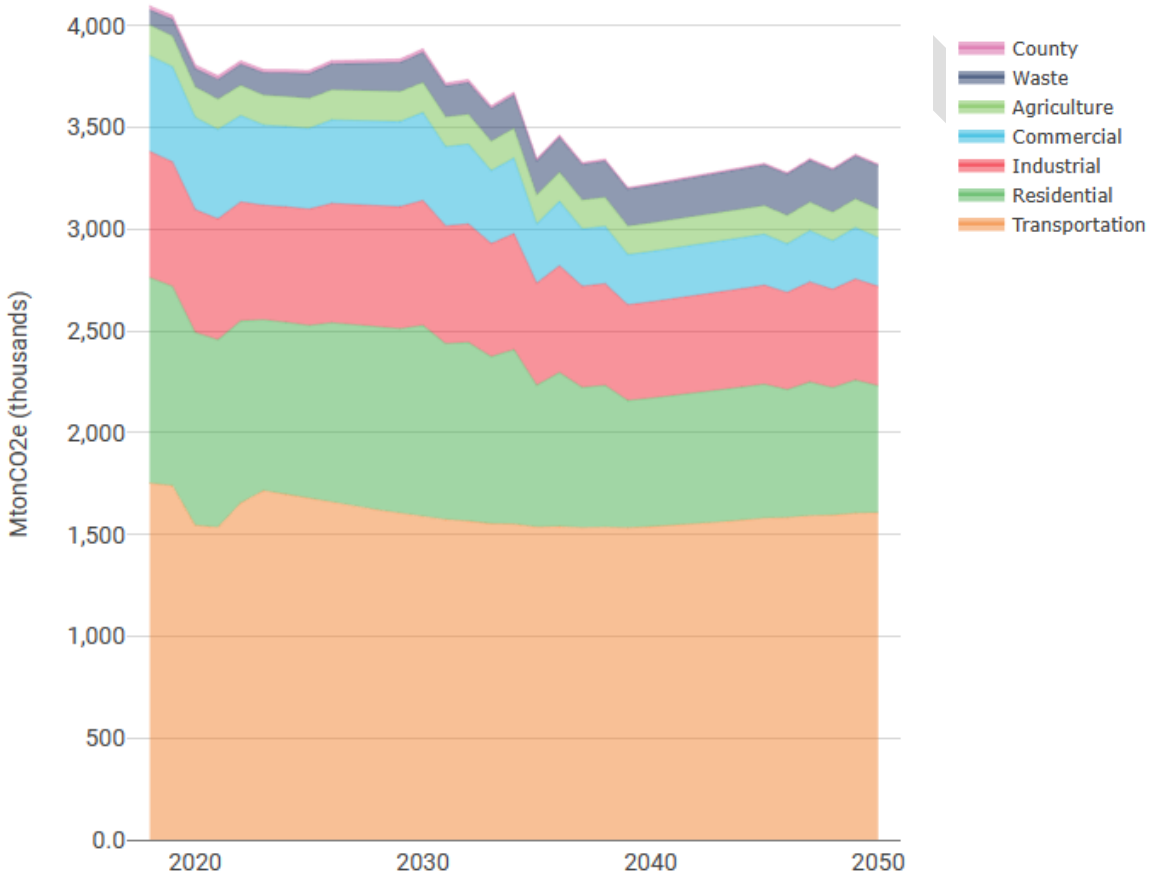


Figure x: Emissions by sector in the business-as-planned scenario

By 2050, buildings make up 41% of overall community emissions. These decreases in emissions in the building sector are largely due to a decrease in the grid electricity factor, meaning electricity is coming from cleaner sources than it was in 2018.

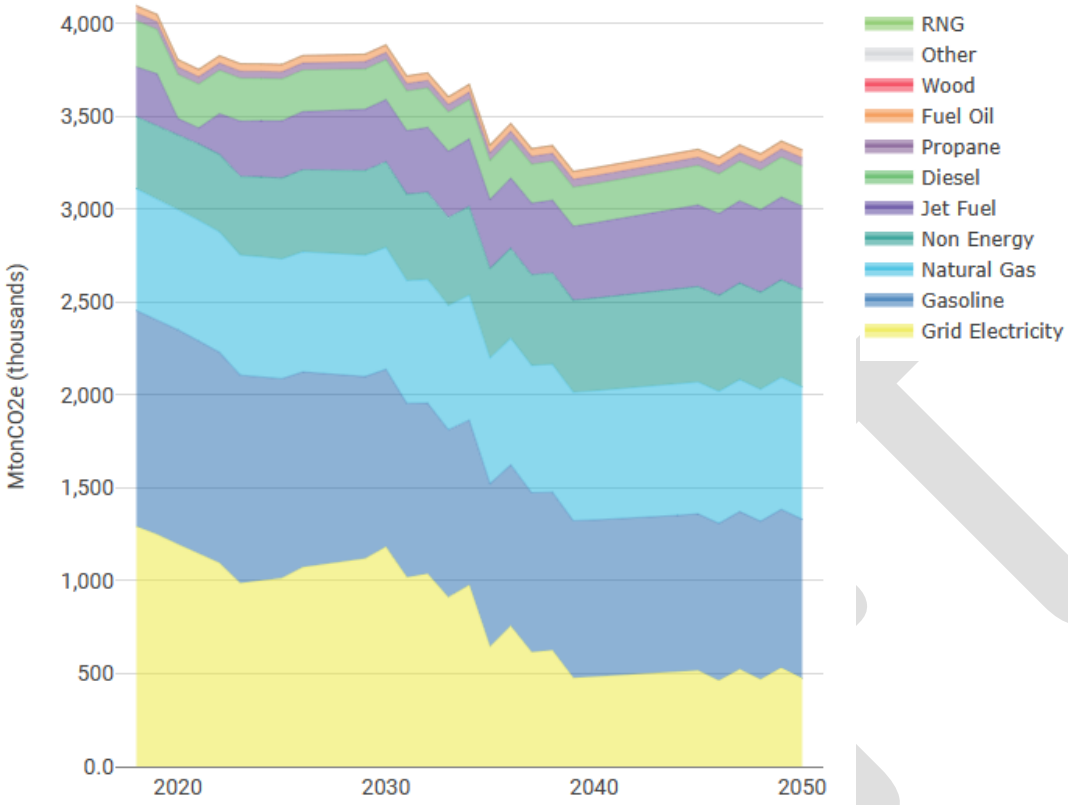
Transportation accounts for 48% of emissions in 2050, 5% more than in 2018, despite a slight decrease in emissions overall. In this sector, vehicles are expected to become more efficient over time and increasingly rely on cleaner sources of energy, but the number of vehicles on the road is expected to increase significantly with population growth.

Emissions from the agriculture sector stay nearly constant between 2018 and 2050, while emissions from the waste sector double, mostly due to an increase in population without a change in waste and diversion programs.

On a per capita basis, from 2018 to 2050, emissions decrease by 42% from 9.8 million metric tons (MT) of CO2e to 5.7 million MTCO2e.

In terms of the energy sources of emissions:

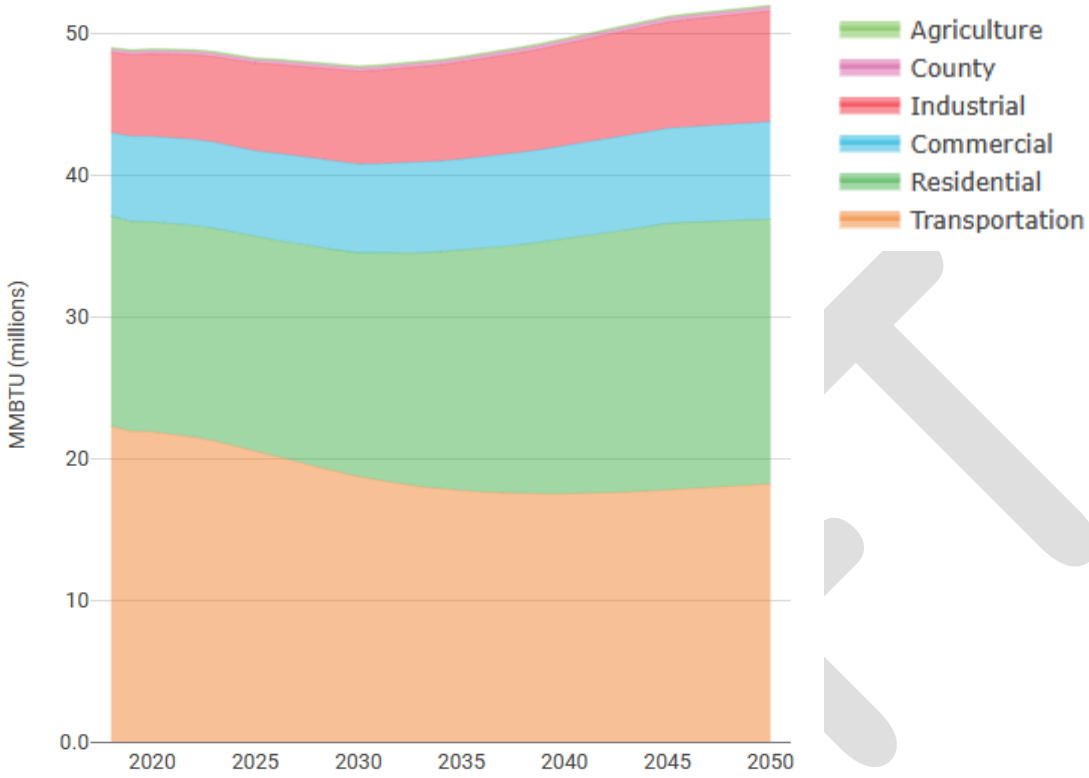
- In 2018 grid electricity is responsible for 33% of emissions and gasoline is responsible for more than a quarter of emissions;
- By 2050:
    - Grid electricity is responsible for only 16% of community emissions, a reduction of over 60% in real terms, due which is a testament to the impact of a clean electricity grid;
    - Emissions from gasoline decrease by 26%, reflecting a move toward electric vehicles;
    - Emissions from diesel decrease at a slower rate, 13%, as efficiency increases and alternatives enter the market;
    - Emissions from natural gas use increase by 8%, reflecting an increase in use due to population growth;
    - Emissions from waste also increase due to population growth, with a 36% jump;
    - Emissions from jet fuel are expected to increase by 67% as population and travel increase; and
    - Emissions from wood decrease by 10% as wood as a heating source continues on a downward trend, while emissions from oil and propane increase by 10% and 6% respectively, as the population grows.



Business-as-Planned Energy

In 2018, the buildings sector accounted for 54% of energy use in the community. Overall, 20% of energy use was in residential buildings, and 12% each came from commercial and industrial buildings. The transportation sector accounted for 45% of all energy use.

Due to the projected increase in dwelling units, residential sector energy use is expected to rise the most, by 26%, accounting for one-third of Clackamas County's total projected energy use in 2050. Transportation is expected to use 18% less energy compared to 2016, as vehicle efficiency standards increase and new vehicle purchases are increasingly electric models. There are also increases of 38% in industrial energy and 17% in the commercial sector due to the employment increase that will follow population increase trends. Together these sectors continue to contribute approximately one-third of the total energy consumption split evenly between them.



A Pathway to a Carbon Neutral Clackamas County

Carbon neutrality is achieved when decarbonization of the economy reduces carbon emissions to as close to zero as possible through energy-use avoidance, energy efficiency, and the replacement of fossil fuels with renewable energy technologies and energy systems. Any remaining human-driven emissions are balanced out by an equivalent amount of carbon removed from the atmosphere. Carbon removal or sequestration can be achieved by restoring or enhancing natural lands and soils or through direct air capture and storage technology.

Much like the reduce, reuse, recycle paradigm[28] in waste diversion, the avoid, reduce, replace, remove, offset paradigm in energy use and emissions reductions relies on prioritizing those actions that tackle the problem at its source. These actions often have the greatest impact by effort and/or cost (or generate a revenue), and are more certain.

Removal, due to its indirect and relatively small impact on overall emissions, and offsets, due to their cost and lack of return on investment, are considered after direct sector-based action, although they are necessary for some situations where approaches to eliminating emissions directly are not feasible.

[28] In general, a paradigm is a framework, a model, or a pattern that guides how people think and how they approach a particular subject.

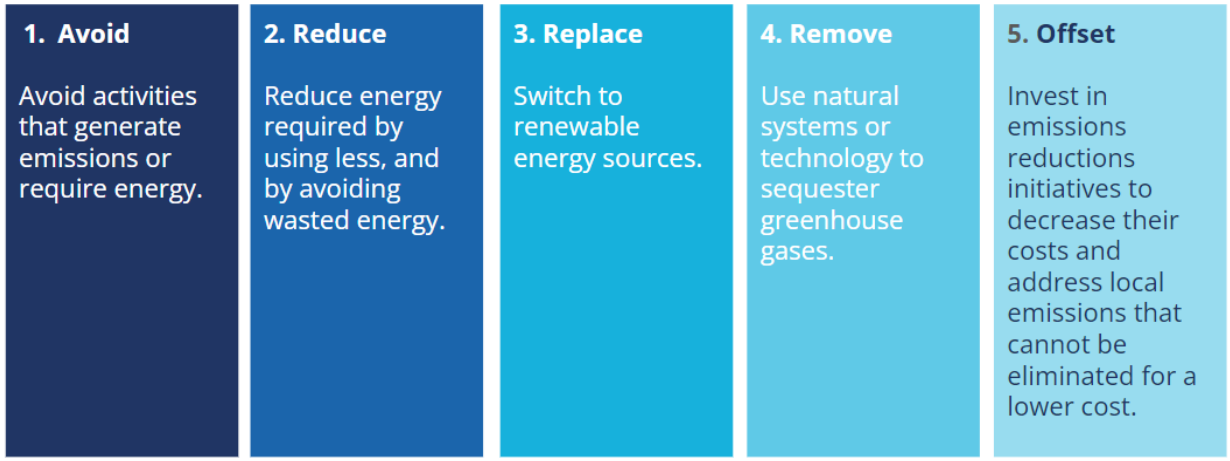


Figure x: The emissions reduction hierarchy

Begin Box

State Regulations Pushing Toward Low Carbon

The Climate Protection Program (CPP) is a regulatory program initiated by the State of Oregon in 2022. The goal of the CPP is to dramatically reduce greenhouse gas emissions in Oregon over the next 30 years. It sets a cap on greenhouse gas emissions from fossil fuels used throughout the state from diesel, gasoline, natural gas and propane, used in transportation, residential, commercial and industrial sectors. The program also regulates site-specific greenhouse gas emissions at manufacturing facilities, such as emissions from industrial processes.

House Bill 2021 (HB2021) requires retail electricity providers to reduce greenhouse gas emissions associated with electricity sold to Oregon consumers to 80% below baseline emissions levels by 2030, 90% below baseline emissions levels by 2035, and 100% below baseline emissions levels by 2040.

These regulations are key to the low-carbon scenario. Many of the outcomes being explored by the County complement work toward achieving the goals outlined by these regulations while also decreasing the burden on the County to find local renewable energy solutions to reduce emissions.

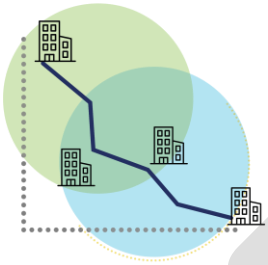
End box

Critical Sectors for Decreasing Emissions in Clackamas County

Building Retrofits

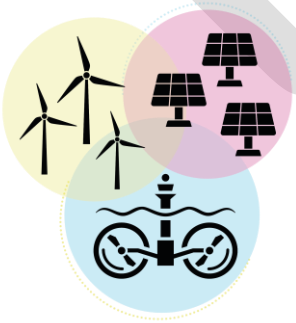
Energy use in buildings accounted for more than half of GHG emissions in Clackamas County in 2018 and is expected to decrease only slightly by 2050. Emissions from buildings result from heating and cooling spaces, lighting, and running appliances and equipment. Building emissions come from all types of buildings in the community including homes, schools, offices, stores, and industrial spaces. Retrofitting buildings makes buildings more efficient by replacing windows and doors, increasing insulation, replacing weather-stripping, and replacing inefficient heating systems with more efficient technologies (such as heat pumps). When buildings are retrofitted to be more efficient they use less energy overall, whether or not the energy comes from a renewable source. This decreases emissions from the baseline and decreases the amount of renewables required later to meet community needs.

Net-Zero New Construction



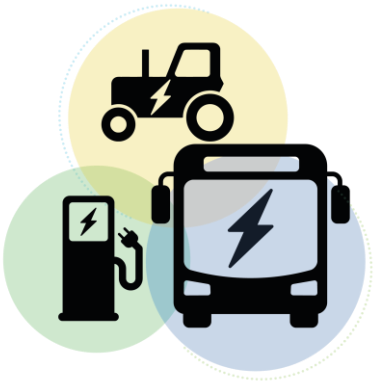
Buildings and the systems within them, such as heating and cooling systems, are long-lasting assets. They can also be significant sources of GHG emissions depending on how efficient they are and the types of energy that they use to operate. Constructing new buildings that do not meet net-zero standards creates an emissions burden now that will last well into the future unless there are costly retrofits to meet the GHG reduction target before the building systems are due to be renewed. Net-zero buildings eliminate that burden throughout the lifecycle of the building, right from the beginning. The upfront capital cost of more efficient construction is typically more than offset by utility savings over time. Currently, the Oregon Residential and Commercial Reach Codes are available for optional use by builders, consumers, contractors, and others to achieve between 5% and 10% improved performance over the statewide Oregon Energy Efficiency Specialty Code. At this time local governments in Oregon do not have the authority to require use of or adopt the Reach Code as the minimum construction standard.

Renewable energy generation



Renewable energy systems ensure that our buildings and transportation sectors can operate emissions-free. In Clackamas County, a mix of natural gas, electricity, gasoline, and diesel power day-to-day activities. By 2050, the same energy sources are expected and need to be replaced by renewable energy sources such as wind, solar, and renewable natural gas. As technologies and consumer products evolve, new energy sources such as green hydrogen may also come online. While the cost of renewables is decreasing year-over-year, efficiency measures such as building retrofits and net-zero construction will still contribute to their viability for widespread use.

Reducing Vehicle Emissions



Vehicle emissions result from travel in personal vehicles, commercial fleet vehicles, the movement of goods, agricultural vehicles, and mass transportation such as transit. There is an expected trend toward more electric vehicles. Electric vehicles (EVs) reduce emissions compared to gasoline or diesel vehicles because they are significantly more efficient, and can operate emissions-free if they are charged using infrastructure connected to renewable (e.g. solar, wind) energy sources. New technologies (e.g. renewable diesel) are also being refined for medium and heavy-duty vehicles to become non-emitting, but no target date for their uptake is currently outlined at the federal level

Increasing Active Transportation and Transit Use

Active transportation (walking and bicycling) and transit use can help reduce transportation emissions when single-occupancy vehicle trips can be avoided. Well-thought-out active transportation and transit networks with a supportive mix of land use, programming, operations, and maintenance can help decrease congestion, promote active and healthy lifestyles, and complement efforts to promote walkable and bike-able neighborhoods while decreasing emissions. Active transportation and transit networks are complex to implement in Clackamas County due to multiple municipalities and transit operations, and the mix of rural and urban spaces that have different transportation needs.

Reducing Waste Emissions

Waste (including solid waste) releases emissions, mostly methane, as it decomposes over time. The County has a plan in place to significantly divert food waste in the coming years, and most waste is sent to landfills that capture methane for energy use. However, even as per capita waste decreases, the growing population means there is a projected increase in waste overall, which means efforts need to be made to account for a growing population.

Begin Box

A Note on Low-Carbon Actions

All of the actions in the plan tackle these X critical sectors to create the low-carbon scenario. Because the target is to reach carbon neutral, sectors cannot go unaddressed, nor can some actions be implemented while others are ignored, in order to achieve the target. Said another way, in order to successfully achieve the target outlined in the low-carbon scenario, all actions must be implemented. For a full list of actions in the low-carbon scenario, see Appendix –.

End box

Begin Box

Engaging Utilities

Both Portland General Electric (PGE) and Northwest Natural (NWN)--the primary utilities in Clackamas County--participated in the County's Community Advisory Task Force (CATF). Both utilities have and continue to adapt and plan for shifts to renewable energy and new state regulations.

PGE is exploring opportunities to add more grid-scale renewables, while NWN is exploring different ways to generate renewable natural gas and adding new fuels such as hydrogen to its energy offerings.

Both utilities have stated that they are committed to meeting state regulations - and that it will require innovation within their operations, demand side management (energy efficiency), and government support.

End box

Low-Carbon Scenario Emissions

Begin Box

A Low-Carbon Scenario (LCS) Explained

A low-carbon scenario is a projected future situation in which the amount of carbon emissions is significantly reduced in order to mitigate the effects of climate change. This can be achieved through a combination of measures such as increasing the use of clean energy sources, improving energy efficiency, and reducing overall consumption of fossil fuels.

Low-carbon scenarios can be modeled using computer simulations that take into account different economic, technological, and policy factors to project how emissions will change over time under different assumptions. The assumptions used in Clackamas County's climate action plan were reviewed by county staff and the CATF. They are used to evaluate the effectiveness of different policy options for reducing emissions and to inform decisions about how to achieve a low-carbon future.

Low-carbon scenarios are used in the context of energy and power systems, transportation and mobility, buildings and urban systems, industry and manufacturing, and agriculture and land-use.

The most common low-carbon scenarios are those that are consistent with the Paris Agreement's target of limiting global warming to well below 2°C above pre-industrial levels, and pursuing efforts to limit warming to 1.5°C.

End box

An important component of this project was the economic modeling of some of our low-carbon opportunities. The intent of this component of the project was to identify how far a mix of high-level

actions could go towards the carbon neutral goal, and to support an analysis of costs and savings to the local economy at the same time.

By 2050 the actions considered in the LCS would achieve an 83% reduction in GHG emissions through direct mitigation actions. Emissions would fall from 4.1 million MtCO2e in 2018 to less than 0.7 million MtCO2e in 2050.

The actions include a 98% reduction in total buildings emissions including:

- 98% reduction in residential buildings,
- 52% reduction in industrial (both buildings and processes) operations, and
- 99% reduction in commercial, institutional, and County-owned buildings.

Overall, the buildings, which represented nearly 2 million MtCo2e, or half of the community's emissions in 2018, will represent 0.1 million MtCo2e in 2050.

Transportation emissions are reduced by 93% below the baseline figure. Small amounts of emissions remain from gasoline in cars and light-duty trucks as the transition to clean fuels is completed and some diesel remains in rail. In addition, some emissions continue to result from aviation despite significant reductions if emissions fall in line with targets set by the International Air Transport Association.

Emissions from waste increase by 131%. This is considerably less than the 190% waste emissions would have increased in the BAP scenario, but still an area of concern.

Agriculture-related emissions decrease by 9%.

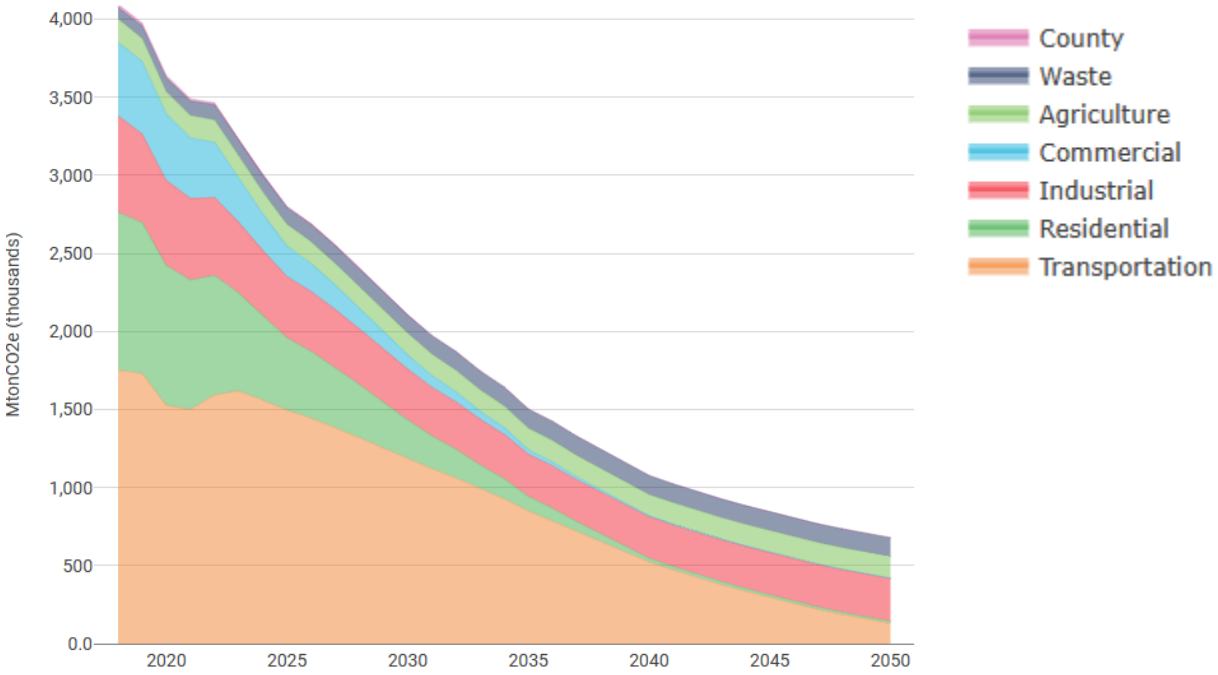


Figure x: Emissions by sector in the low-carbon scenario

In this scenario, the energy sources responsible for remaining emissions in 2050 include a small amount of natural gas in the residential, commercial, and industrial sectors; fuel oil and propane used in industrial

processes; small amounts of diesel, gas, and jet fuel in the transportation sector, and non-energy (methane-related) emissions in the industrial, agriculture, and waste sectors.

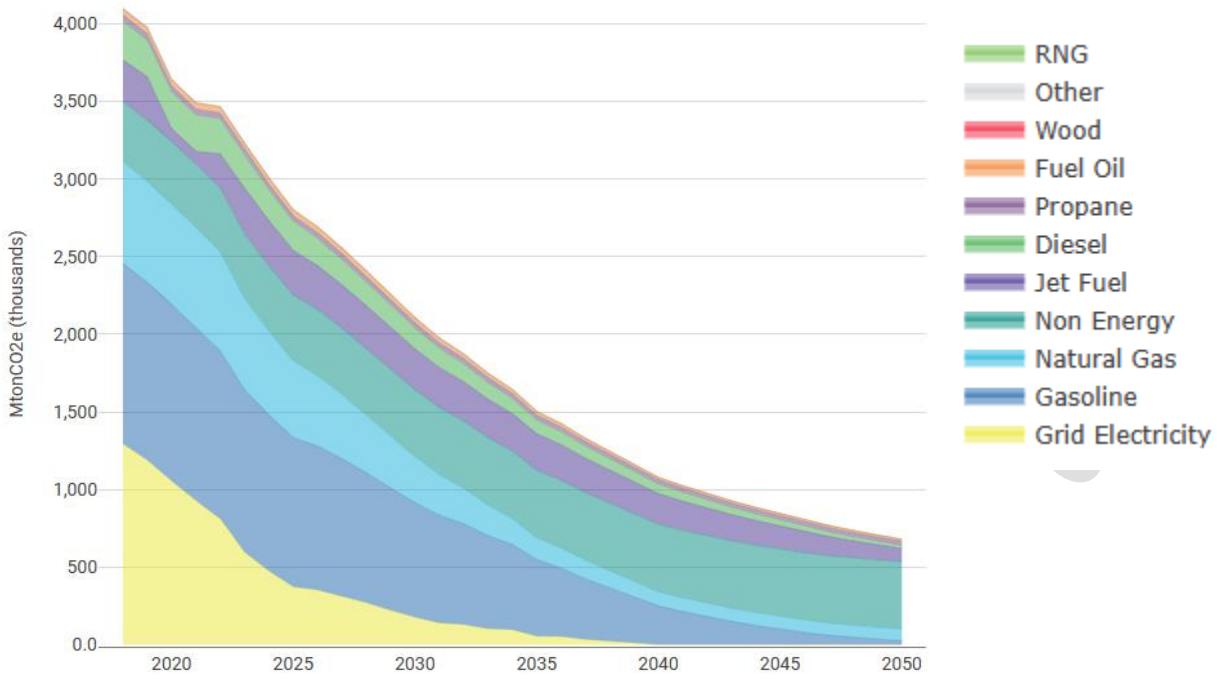


Figure x: Emissions by fuel type

The actions considered in the low-carbon scenario were not specific recommendations. Instead, the actions served as an illustration of the need for reductions across all sectors and as a way to identify the economic benefits of climate action. Recommended implementation actions in the guide are informed by the high level actions of the low-carbon scenario, as well as consideration of practices in many other communities, engagement with the community, the CATF, and County staff and department directors.

Energy Use in the Low-Carbon Scenario

Overall, community energy use decreases by 43.5%, with building energy use reduced by 26% and transportation energy use reduced by 68%. These decreases are due to 'avoid' activities -- energy waste reduction and 'reduce' activities, such as using more efficient technologies and assets like electric vehicles and heat pumps.

Making the Difference with Sequestration

Much of the remaining community emissions can potentially be removed from the atmosphere via sequestration. The Oregon Global Warming Commission has a statewide goal of sequestering an additional 5 million MTCO2e per year by 2030 and 9.5 million MTCO2e per year by 2050 relative to 2019 activity[29]. These were not modeled in the low-carbon scenario (which only modeled direct reductions). Strategies for implementation related to sequestration are included in the implementation guide.

[29] (2021). *Natural & Working Lands Proposal*. Oregon Global Warming Commission. https://static1.squarespace.com/static/59c554e0f09ca40655ea6eb0/t/6148a9d36431174181e05c7c/1632152029009/2021+OGWC+Natural+and+Working+Lands+Proposal.pdf

Begin Box

Natural Lands Working Group

Oregon's natural and working lands — including forests, grasslands, rangelands, farmlands, tidal and subtidal wetlands, and the parks and open spaces in urban environments — provide a range of environmental, social, health, and economic benefits statewide including opportunities to increase carbon sequestration to reduce Oregon's overall greenhouse gas emissions.[30]

In Executive Order 20-04, Oregon Governor Kate Brown directed the Oregon Global Warming Commission (OGWC) to work in coordination with the Oregon Department of Agriculture, Oregon Department of Forestry, and the Oregon Watershed Enhancement Board to develop and submit a proposal for setting a carbon sequestration and storage goal for Oregon's natural and working lands.[31]

In response, these groups convened a natural and working lands advisory committee at the end of 2022. Previous to this committee's formation the OGWC identified four broad strategies to achieve its proposed goals:

1. Position the state to leverage federal lands and investments in climate-smart natural and working lands practices.
2. Investigate options and create a sustained source of state funding to increase sequestration in natural and working lands.
3. Fund and direct the agencies to take actions to advance natural and working lands strategies.
4. Invest in improvements to Oregon's natural and working lands inventory.

In addition, to help the state evaluate progress the OGWC recommended the state establish activity based metrics which would include activities such as the number of acres with adoption of soil health practices, with maintained resource lands, with riparian reforestation, and with urban forest canopy expansion to help the state evaluate progress.

End box

Low Carbon Co-benefits in Clackamas County

Community co-benefits associated with the County's low-carbon scenario and carbon sequestration activities include improved health outcomes, economic prosperity, opportunities for equity enhancement, and climate resilience.

[30] (2021). *Natural & Working Lands Proposal*. Oregon Global Warming Commission. https://static1.squarespace.com/static/59c554e0f09ca40655ea6eb0/t/6148a9d36431174181e05c7c/1632152029009/2021+OGWC+Natural+and+Working+Lands+Proposal.pdf

[31] (2021). *Natural & Working Lands Proposal*. Oregon Global Warming Commission. https://static1.squarespace.com/static/59c554e0f09ca40655ea6eb0/t/6148a9d36431174181e05c7c/1632152029009/2021+OGWC+Natural+and+Working+Lands+Proposal.pdf

Air Quality and Health Benefits

Combusting fossil fuels for energy use releases air pollutants, such as sulfur dioxide, nitrogen oxides, particulate matter, carbon monoxide, volatile organic compounds, and others, and can create ground-level ozone. These pollutants impact human health as they are breathed in during regular daily activities. For example, air pollution from traffic is linked to cardiovascular disorders, bronchitis, asthma, and other respiratory illnesses. Often, low-income residents experience the impacts of air pollution to a greater extent compared to other residents, due to proximity to pollution sites, lack of indoor air filtration, and other inequities affecting health outcomes. A quantitative assessment of impact was conducted for Clackamas County using the U.S. Environmental Protection Agency (EPA) CO-Benefits Risk Assessment Health Impacts Screening and Mapping Tool (COBRA) tool. The total health benefits of reducing particulate matter by implementing the low-carbon scenario amounted to between $3.5 and $7.9 billion dollars by 2028 and resulting in an overall decrease in total mortalities[32]. A U.S.-based study quantified the health benefit of reducing tailpipe pollution at between $0.02 and $0.12 per mile[33].

Begin Box

COBRA Model Summary: What accounts for the benefits?

COBRA's estimates reflect the current scientific thinking on the relationship between particulate matter and human health, as well as the economic valuation of these health effects. Additionally, EPA's methodology for characterizing health impacts has been reviewed by two National Academy of Sciences panels and multiple EPA Science Advisory Boards. Because the health impacts of air pollution and approaches to assign a value to these impacts are areas of active research, the selection of studies used in COBRA may evolve over time as new evidence and studies emerge.

End Box

Indoors, natural gas stoves[34] and fireplaces are being identified as contributors to negative health impacts, especially for children[35]. This means their replacement with electric units over time can further decrease negative health outcomes and the associated human and financial costs of those outcomes.

Retrofits in existing buildings can also reduce indoor air pollutants (i.e., NOx, CO, and VOCs), reduce mold and dampness, and improve the thermal comfort of buildings. Health benefits associated with these

[32] US Environmental Protection Agency. CO-Benefits Risk Assessment Health Impacts Screening and Mapping Tool (COBRA). https://www.epa.gov/cobra

[33] Choma, E. F., Evans, J. S., Hammitt, J. K., Gómez-Ibáñez, J. A., & Spengler, J. D. (2020). Assessing the health impacts of electric vehicles through air pollution in the United States. Environment International, 144, 106015.

[34] Multnomah County. 10 November 2022. "The Board of Commissioners briefed on the Public Health review of health risks posed by gas stoves," https://www.multco.us/multnomah-county/news/board-commissioners-briefed-public-health-review-health-risks-posed-gas-stoves

[35] Seals, B. and Karasner, A. (2020). Health effects from gas stove pollution. Retrieved from: https://rmi.org/insight/gas-stoves-pollution-health

changes can include reduced risks of cardiovascular, respiratory and cardiopulmonary illnesses, and cancer[36,37]. Evidence also suggests that these improvements contribute to better mental health outcomes[38].

Active Transportation and Health Benefits

Increasing walking and biking is one of the most significant ways to improve the physical health of those in the community. Health benefits from routine physical exercise include reductions in rates of diabetes, cancer, and heart-related illnesses[39], as well as improvements in mental health[40].

Equity

Increased equity is possible but not guaranteed by the outcomes considered in the low carbon scenario. Equity is a broad term that encompasses fairness for many different demographics across many different situations. The low-carbon scenario can only contribute to, not create, equity by addressing intergenerational equity, income inequality, housing affordability, and global equity.

Intergenerational Equity

As the impacts of climate change increase in frequency, duration, and severity, younger generations and generations yet to be born are and will be increasingly affected by the impacts and the responsibility of reducing emissions contributed to systems created by older and past generations. Addressing emissions in the short-term decreases that burden.

Income Inequality

We often hear that it is "expensive to be poor" and that is true in the low-carbon transition unless an effort is made to decrease the financial burden for individuals and families living on low incomes. For example, if a person cannot afford energy efficiency upgrades in their home due to the upfront cost, it could mean an increase in their ongoing costs or missing out on utilities savings that others in higher income brackets can take advantage of. In addition to this, most utility fees are determined based on the fixed cost of operating and usage fees. This means that if a greater number of higher-income earning homes are using less energy, the fixed costs could increase per unit of energy used, disproportionately impacting lower

[36] Wu, F., Jacobs, D., Mitchell, C., Miller, D., & Karol, M. H. (2007). Improving Indoor Environmental Quality for Public Health: Impediments and Policy Recommendations. Environmental Health Perspectives, 115(6), 953–957. https://doi.org/10.1289/ehp.8986.

[37] Barton, A., Basham M., Foy C., Buckingham, K., and Somerville, M., on behalf of the Torbay Healthy Housing Group. 2007. The Watcombe Housing Study: the short term effect of improving housing conditions on the health of residents. Journal of Epidemiol Community Health, 61(9):771e7.

[38] Bonnefoy, X. 2007. Inadequate housing and health: An overview. International Journal of Environment and Pollution, 30(3/4), 411. doi: 10.1504/IJEP.2007.014819

[39] CSEP (2019). Canadian 24-Hour Movement Guidelines. Canadian Society for Exercise Physiology. Retrieved from: https://csepguidelines.ca/

[40] Sampasa-Kanyinga, H., Colman, I., Hamilton, H. A., & Chaput, J. P. (2020). Outdoor physical activity, compliance with the physical activity, screen time, and sleep duration recommendations, and excess weight among adolescents. Obesity science & practice, 6(2), 196-206.

income households by costing them more money per unit of energy used. However, if individuals and families living on a low income are supported to make their homes and vehicles more efficient, they could see utility savings. It is vital for the County and other levels of government to play a role in this in order for it to be successful, including ensuring that the support is accessible for low-income earners. For example, instant rebates and other time-of-purchase financial supports may be more realistic than post-purchase rebates.

Access to transit and active transportation can also increase equity. For individuals who do not own a vehicle, especially for those that cannot own a vehicle due to cost, access to transit and active transportation increases the ability to get to services, appointments, activities, and employment. This is only possible if robust transit and active transportation networks are extended to areas within the community where lower-income earners reside and are connected to areas with employment opportunities and services.

Individuals living on low and fixed incomes are also more susceptible to climate risks. A lack of money to prepare for climate-related events, limited access to transportation to flee during climate-related events, lack of money for alternative accommodations, lack of money to repair or restore their dwellings after an event, lack of air conditioning during heat-related events, lack of access to affordable healthcare, and higher rates of comorbidities[41] make this demographic more vulnerable to climate risks than wealthier individuals.

Global Equity

Climate change is currently having a disproportionate impact on poorer nations, globally, with more climate-related events[42] and resulting in higher mortality rates. Many of the countries impacted by climate have also had a lesser impact on the increased use of fossil fuels that has led to the current climate crisis. Led by C40[43] , many communities have set GHG reduction targets that acknowledge that those in wealthier countries must act more rapidly to reduce emissions than communities that have been struggling with widespread poverty. While action by wealthier countries is imperative from an equity standpoint, global climate mitigation can also help reduce the risk of climate-driven instabilities, refugee crises, conflicts, and threats to international security.

Climate Resilience

[41] Comorbidities refer to the presence of multiple chronic conditions in a single individual. These conditions can be related or unrelated, and they can have a significant impact on a person's overall health and well-being. Examples of comorbidities include diabetes and heart disease, or depression and anxiety.

[42] Climate-related events, such as extreme weather events and sea level rise, can happen more frequently and with greater severity in poorer nations due to a combination of factors. These nations often lack the resources and infrastructure to prepare for and recover from severe weather events and other climate-related impacts. They also tend to be located in areas that are particularly vulnerable to the impacts of climate change, such as coastal regions or areas prone to drought. Additionally, poorer nations are less likely to have the economic means to adapt to the changing climate, making them more susceptible to the negative effects of climate change.

[43] C40 is a network of mayors of nearly 100 world-leading cities collaborating to deliver the urgent action needed right now to confront the climate crisis. Learn more: https://www.c40.org

Some actions that support reducing emissions can also increase the capacity to adapt to climate change impacts. Some of the key resilience co-benefits associated with climate mitigation and sequestration include:

- ensuring safer buildings during extreme weather events (flooding, extreme heat/cold) because older buildings having been retrofitted;
- decreased impacts of power outages to homes having been fitted with renewable energy and storage systems;
- decreased impacts of power outages for homes that are connected to district energy systems[44];
- decreased stress on water and wastewater systems from retrofits and more stringent efficiency standards for new buildings;
- developing and implementing water conservation and management plans to ensure a reliable and resilient water supply during times of drought or water shortages;
- implementing green infrastructure and low-impact development techniques, such as rain gardens, green roofs, and permeable pavement, to improve water quality, reduce heat island effects, and cool surface temperatures in urban areas;
- protecting and restoring wetlands, riparian areas, and other natural water systems to act as buffers against floods and heat waves, and to improve water quality and quantity;
- developing and implementing heat warning and response systems to protect vulnerable populations from extreme heat events, including through the use of cool roofs and other shading strategies, as well as public education and outreach;
- building and retrofitting homes and other buildings to be more energy-efficient and resilient to extreme weather events, including through the use of resilient materials, improved ventilation, and shading strategies;
- encouraging the use of electric vehicles and installing charging infrastructure to support increased back-up power during power outages;
- encouraging the use of sustainable transportation methods such as cycling, walking and public transport to reduce urban heat island effect and decrease the stress on water and wastewater systems;
- developing and implementing policies and regulations to ensure the protection and restoration of urban and suburban green spaces, including parks and community gardens, which can provide cooling, improve air quality, and support biodiversity;
- promoting sustainable land-use planning and urban design to reduce heat island effects and support the conservation of natural areas and green spaces;

[44] A district energy system is a network of interconnected heating and cooling systems that serves multiple buildings or structures within a defined geographic area, like a neighborhood. These systems are designed to provide centralized heating and cooling to buildings, using a combination of energy sources such as natural gas, electricity, or renewable energy. The goal of a district energy system is to improve energy efficiency, reduce greenhouse gas emissions, and provide a reliable source of heating and cooling for buildings within the neighborhood.

- enhancing the resilience of ecosystems and communities by promoting the growth of vegetation that can act as carbon sinks (natural sequestration) and help stabilize the local climate; and
- increasing back-up power from electric vehicles.

Economic Prosperity

Clackamas County's economy will benefit from implementing the low-carbon scenario. Building retrofits and the expanded construction of active transportation networks contribute to jobs that can be held locally. Decreased utility and fuel costs can also decrease household and business costs, which offsets capital investments in low-carbon assets over time. All of these factors can be built into an economic strategy to encourage residents to think and buy locally to ensure more money stays within the community.

Capturing an Economic Opportunity

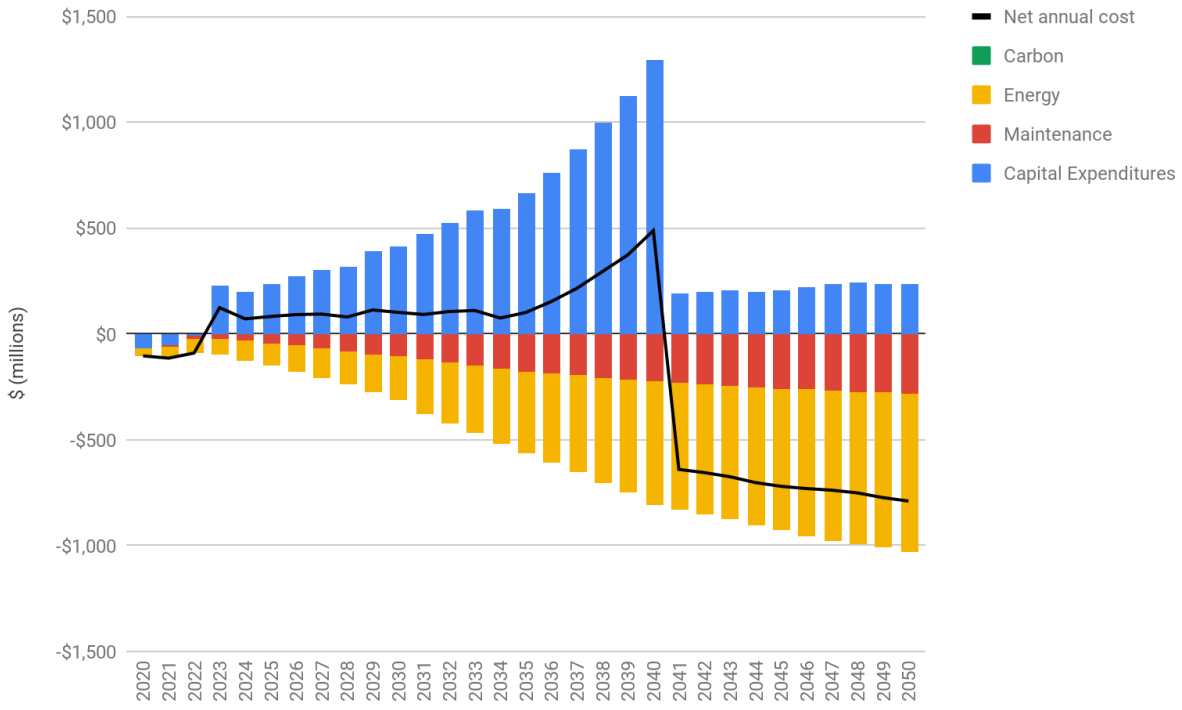
Up-front large investments lead to bigger returns on investment in jobs and long-term low-carbon savings.

Transitioning to a low-carbon economy will require investments in all sectors of the community - from residents, businesses, institutions, the County, and other levels of government. The investments need to begin now and continue out to 2050. While the need for capital is high, the paybacks of the investments are higher, especially if they happen in the short term.

Overall, implementing the low-carbon scenario to address sector-based emissions is projected to generate a net return of $5.6 billion across the county above the business-as-planned scenario.

Further, research on the cost of implementing Natural Climate Solutions in the U.S. estimates that 25 percent of the maximum potential of 1.2 billion MT CO2e can be achieved at less than $10 per ton, and an additional 51 percent can be achieved at between $10 and $50 per ton (Fargione et al 2018).[45]

The net return from the low-carbon scenario is based on savings in operations and maintenance, savings in energy costs, and revenue generation. The overall investment across the county amounts to $11.7 billion while savings amount to $17.3 billion.



[45] (2021). *Natural & Working Lands Proposal*. Oregon Global Warming Commission. https://static1.squarespace.com/static/59c554e0f09ca40655ea6eb0/t/6148a9d36431174181e05c7c/1632152029009/2021+OGWC+Natural+and+Working+Lands+Proposal.pdf

Figure x. Net investments and returns resulting from the low-carbon scenario.

Implementing the low-carbon scenario will also generate job growth in Clackamas County. More than 36,000 person-years of employment between 2023 and 2050 are estimated to be created through implementation of the scenario. This is equal to 1,300 full-time equivalent jobs above the jobs that would be created in the business-as-planned scenario.

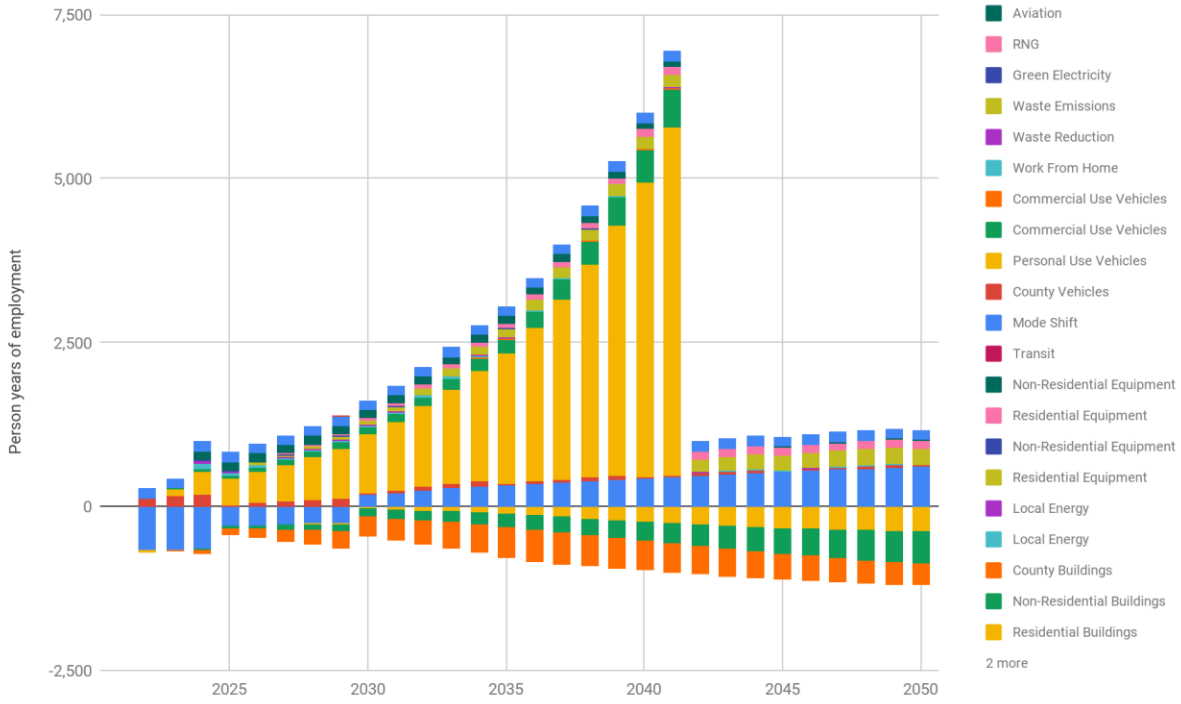


Figure x. Person years of employment resulting from the low-carbon scenario.

The financial analysis is developed at the low-carbon pathway (high-level). What this means is: it represents total costs across the community and does not allocate costs or savings specifically to the County or other sectors or investors, although it does assign costs to current asset owners[46].

Actual costs to the County are dependent on third-party funding available for direct County actions (e.g. in its own buildings and fleet) and the degree to which the County chooses to invest in certain actions and incentivize other sectors. Investigating all financial tools available to the County and other community stakeholders -- including individuals, businesses, and other levels of government -- will be critical to the implementation of the low-carbon actions.

Incentives and rebates currently available to residents and businesses through local, state, and federal programs are not included in the analysis above—this means that the actual costs of mitigation to

[46] For example: while the cost of a retrofit would be assigned to a homeowner, in this projection, it does not necessarily mean the homeowner will pay that cost entirely. This number allows for the financial analysis across the county, to help understand where individual costs come from, to assist in incentivizing potential programs to help invest in the low-carbon economy.

Clackamas County residents and businesses would in many cases be lower than the conservative assumptions made in this analysis.

A cursory analysis of funding available at the federal level was completed to determine the approximate value of incentives currently available to residents in Clackamas County.

Inflation Reduction Act (IRA) and Infrastructure Investment and Jobs Act (IIJA) Funding Opportunities

Table X ODOE and DEQ IRA and IIJA opportunities

Program	Description	Timing
Energy Efficiency and Electrification	$113 million in rebates for energy efficiency retrofits and upgrades and electric and energy efficient appliances like heat pumps	Oregon Department of Energy (ODOE) expects to receive funding in late 2023 or early 2024
Energy Auditor Training	Up to $2 million to train energy auditors to help home business owners identify opportunities to save energy and money	ODOE applying for a competitive grant around the first quarter 2023
Investing In Communities	$3.2 million for the Energy Efficiency and Conservation Block Grant (EECBG) Program, which provides grants to states, local governments, and Tribes to help them implement strategies to reduce fossil fuel emissions, reduce total energy use, and improve energy efficiency.	State and local governments slated to receive a direct allocation will be able to apply in spring 2023
Weatherization	34.7 million for Oregon Housing and Community Services to support weatherization and energy conservation services for low-income households	Unknown

Marginal Abatement Costs (MACs)

The Marginal Abatement Cost (MAC) is the incremental cost of one ton of GHG reductions. The lower the cost, the more affordable the outcome and, in some cases, the outcome can actually be profitable. It is calculated by adding the net present value of capital costs and operating costs over the lifetime of the investments divided by the tons of GHGs reduced.

Begin Box

Figure X illustrates an abatement curve of actions. Actions on the left save money and are therefore financially interesting to investors. Actions in the middle have a net present value (NPV) that is either slightly negative or slightly positive and may require credit enhancements to be compelling. Finally, on the right are actions that are NPV negative, which will require subsidies. A capital-constrained public sector must concentrate on the less expensive projects and difficult to otherwise fund (but important for reducing emissions) while relying on the private sector for the rest. A capital-rich public sector can invest in projects that are more expensive and those which may generate more interesting financial returns.

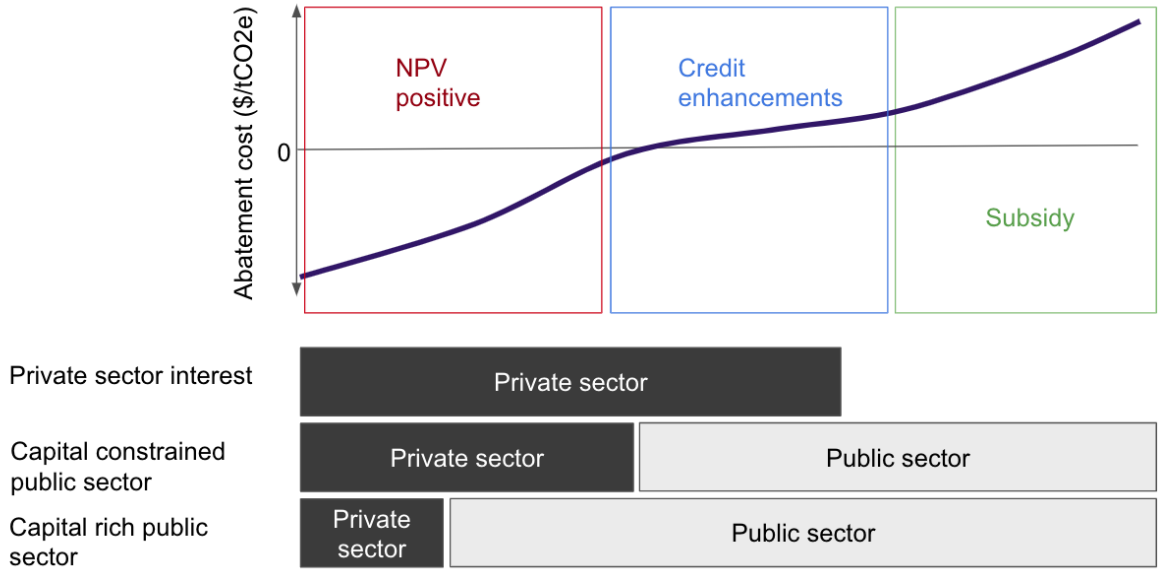


Figure X. Aligning the abatement costs with investor interest.

End box

By providing individual costs for actions, MACs can imply that the actions are a menu from which individual actions can be selected. In fact, many of the actions are dependent on each other for example, energy costs increase without retrofits. Another important message is that in order to achieve Clackamas County's target, all the actions need to be undertaken as soon as possible.

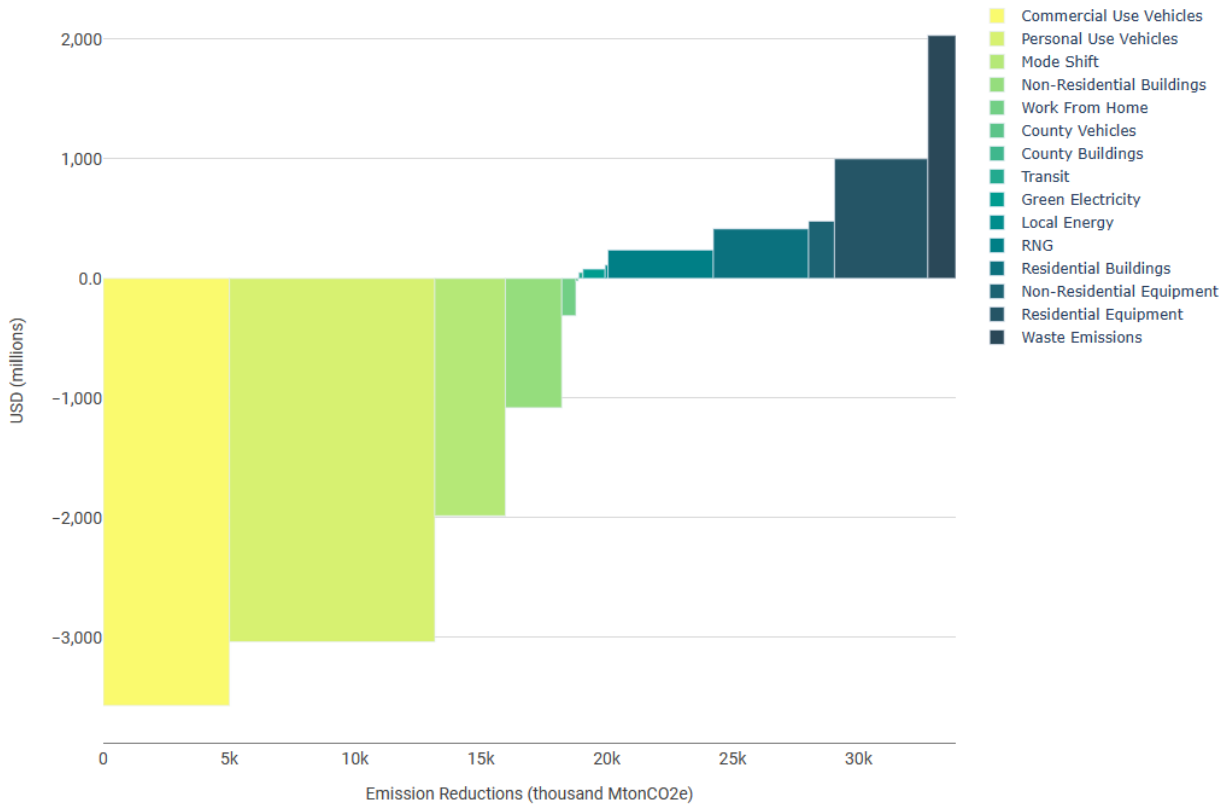


Figure X. Marginal Abatement Cost Curve (MACC)

Table X below, the MACC Table, summarizes the marginal abatement costs for the modeled actions (outcomes) in Clackamas County's low-carbon future.

- The actions with green, or negative abatement costs generate financial returns over their lifetimes.
- A red, or positive abatement cost, costs money over the span of the project.

This comparison provides one way to view the costs and benefits of implementing emissions-reducing actions, but should not be the only metric used to measure an action.

	Cumulative Emissions Reduction (kt CO2eq)	Net Present Value (discounted at 3%)	Marginal Abatement Cost ($ / t CO2 eq)
Residential Buildings	2,261	-$2,320,000,000	-$1,026
Non-Residential Buildings	1,149	-$890,000,000	-$775
Residential Buildings	1,523	$2,740,000,000	$1,799
Non-Residential Buildings	1,092	-$190,000,000	-$174
County Buildings	16	$10,000,000	$639

Local Energy	77	$40,000,000	$516
Local Energy	37	$70,000,000	$1,895
Residential Equipment	1,230	$690,000,000	$561
Non-Residential Equipment	947	-$50,000,000	-$53
Residential Equipment	2,481	$310,000,000	$125
Non-Residential Equipment	79	$530,000,000	$6,750
Transit	169	$50,000,000	$295
Mode Shift	2,801	-$1,990,000,000	-$710
County Vehicles	96	-$20,000,000	-$208
Personal Use Vehicles	8,158	-$3,040,000,000	-$373
Commercial Use Vehicles	4,295	-$460,000,000	-$107
Commercial Use Vehicles	718	-$3,110,000,000	-$4,334
Work From Home	562	-$310,000,000	-$551
Waste Emissions	1,108	$2,030,000,000	$1,833
Green Electricity	878	$80,000,000	$91
RNG	4,187	$240,000,000	$57

Begin Box

Reading the MACC table

This MACC table provides information on the cost-effectiveness of various carbon emissions reduction outcomes for different sectors. The table shows the cumulative emissions reduction (in kt CO2eq), the net present value (NPV) of the reduction strategy discounted at 3%, and the marginal abatement cost (MAC) of the outcome measured in dollars per ton of CO2eq. The MAC column also shows the marginal cost of reducing one additional ton of CO2eq emissions.

From the MACC table above, the most cost-effective carbon reduction outcomes are:

- Reducing emissions from renewable natural gas (RNG), with a marginal abatement cost (MAC) of $57/tCO2eq and a net present value (NPV) of $240,000,000
- Reducing emissions from green electricity, with a MAC of $91/tCO2eq and a NPV of $80,000,000
- Reducing emissions from residential equipment, with a MAC of $125/tCO2eq and a NPV of $310,000,000
- Reducing emissions from waste, with a MAC of $1,833/tCO2eq and a NPV of $2,030,000,000

It is worth noting that cost-effectiveness is subjective. Some people might consider other criteria more important than cost when choosing an outcome, for example, looking at how much emissions are reduced or how fast the reduction is reached.

It is also important to note that this table only shows the cost of reducing one additional ton of CO2eq emissions. If the outcome is to achieve a certain target, the total cost of achieving the target will be different.

Some outcomes in the table, such as reducing emissions from residential buildings, non-residential buildings, and county buildings, have negative NPV, indicating that the cost of implementing the outcome is greater than the benefits. Other outcomes, such as reducing emissions from residential and non-residential equipment and green electricity, have positive NPV, indicating that the benefits of implementing the outcome outweigh the costs.

This table can be used to inform decisions about which emissions reduction strategies to pursue, as it shows the cost-effectiveness of different options. It can also be used to identify the least-cost options for achieving a given emissions reduction target.

End Box

Begin Box

Financial Scenario Limitations

The financial scenario is a current best-guess estimate of implementing the low carbon actions, but it is very sensitive to change. For example, the introduction of new technology that causes individuals to make currently unexpected changes to reduce emissions can change the financial scenario.

The financial scenario is also sensitive to changes in energy prices. As we have seen in recent years, energy prices can fluctuate widely based on global events such as pandemics and wars. Higher fossil energy prices will mean a low-carbon future for the County will create even more value. These global events cannot be reliably predicted, but if some energy prices were to increase while others remained stable or vice versa, the price of the scenario would change drastically and could push individuals and governments to make different choices about energy sources.

End box

All the actions outlined in the low-carbon scenario need to be implemented to achieve the emissions reductions target. Therefore, for actions that do not have an attractive payback to individual residents or businesses, it is logical for the County to provide financial support when it is financially able to do so, especially when funding opportunities from other levels of government have already been considered or applied.

When there is a clear and timely financial payback for community members, the County's role is to educate and support using non-financial mechanisms. The Climate Action Plan Implementation Guide

ancillary report provides initial recommendations on how the County can support residents and sectors in the community to take action using financial and non-financial mechanisms.

For a more detailed financial analysis, please review the *Climate Action Plan Sector-based Emissions Financial Analysis ancillary report.*

Moving Toward Implementation

The low-carbon scenario sets an ambitious course for sector-based emissions reductions and sequestration actions. These actions must all be implemented to reach the carbon neutral target, but they cannot all be completed at once. They must also be balanced with achieving other Climate Action Plan outcomes.

Outcome Two: Reduce Consumption-based Emissions

Consumption-based Emissions

The County is also interested in quantifying consumption-based emissions. Consumption-based emissions -- GHG emissions associated with the production and delivery of the goods and services we consume, regardless of where they were manufactured -- account for emissions through a product or service's entire lifecycle.

When consumption-based emissions are included in the Clackamas BAP, emissions increase by 11% between 2018 and 2050, from 7.2 MtCO2e to nearly 8 MtC02e. Throughout the BAP scenario, consumption-based emissions increase in line with population growth and make up the largest share of community emissions throughout the scenario.

To reduce consumption-based emissions, shifts are typically needed in individual choices, such as reducing overall consumption, eating more local and sustainable foods, and purchasing less carbon-intensive products. Other shifts include using less carbon-intensive building and construction materials across the community. Preliminary actions to reduce consumption-based emissions will be explored later in the plan and emissions reduction activities that also reduce consumption-based emissions will be identified.

Outcome Three: Adapt to Climate Change and Reduce Climate-related Risk

Adapting to climate change requires that a community explore the climate hazards it is facing due to a changing climate, and addresses those hazards by addressing risk.

Climate Hazards and Risks in Clackamas County

The Fifth Oregon Climate Assessment published by the Oregon Climate Change Research Institute at Oregon State University in January 2021 outlines the climate hazards and related risks across the state.

Climate and Natural Hazards

As evidenced by increasing average annual temperatures and instances of wildfire, climate change impacts are starting to be prominent across Oregon and in Clackamas County. Historical climate data analysis and climate change modeling projections provide estimates for the types and scales of climate impacts expected in the region in the coming years. Of central interest are:

- Temperature;
- Precipitation;
- Snowpack and runoff; and
- Natural hazards, such as: extreme heat, drought, wildfire, and floods.

Much of the information in this section represents studies and modeled projections for the whole state of Oregon and is presented as average values. Precise projected values will vary by geographic region throughout the state and throughout Clackamas County.

Temperature

Oregon's annual average temperature is increasing at the average national rate (Figure 2). Annual average temperatures in Clackamas County have increased by about 2.2 degrees since 1901.

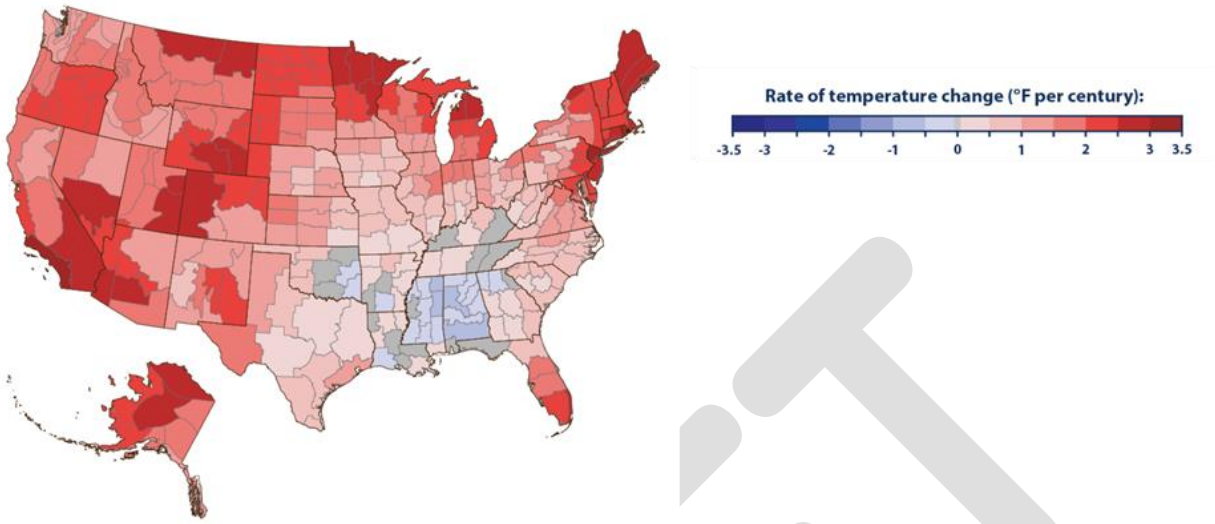
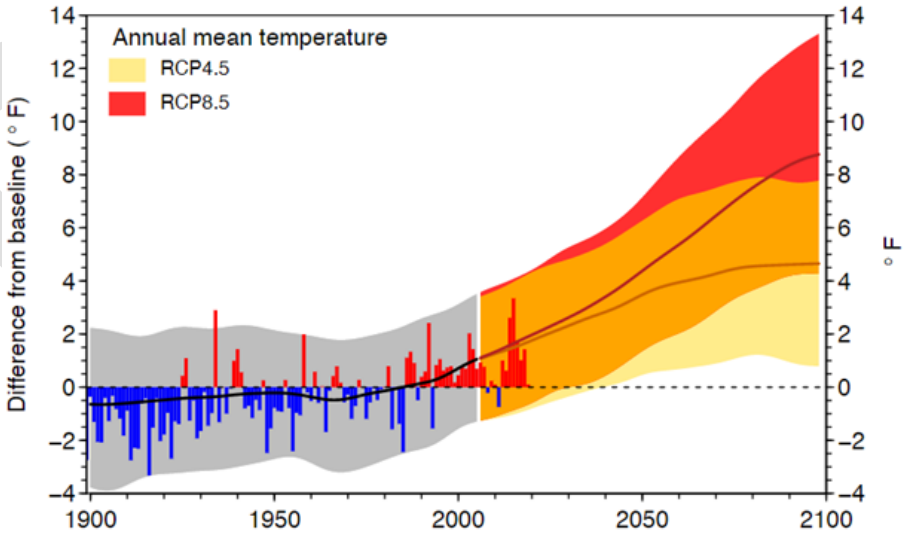


Figure 2: Rate of temperature change in the United States, 1901-2015.

Oregon's temperatures are projected to increase in all seasons, with summer temperatures increasing the most (Figure 3). In Figure 3, blue and red bars are observed temperatures (1900–2019) from the National Centers for Environmental Information. Solid lines are the mean values of 35 climate model simulations for the 1900–2005 period, which were based on observed climate forcings[47] (black line), and the 2006–2099 period for the two future scenarios RCP 4.5 and red RCP 8.5 (orange and red lines). Shading indicates the range in annual temperatures.



[47] A climate forcing is a factor that can alter the Earth's climate, such as changes in the amount of greenhouse gasses in the atmosphere (creating an energy imbalance in the Earth's energy budget) or changes in solar radiation. These changes can cause the Earth's climate to warm or cool, leading to changes in precipitation patterns, sea level, and other aspects of the climate system.

Figure 3: Observed, simulated, and projected changes in Oregon's mean annual temperature relative to 1970-1999 (baseline) under RCP 4.5 and RCP 8.5 future scenarios.

AA representative concentration pathway (RCP) is a greenhouse gas concentration trajectory used in climate modeling to describe different climate futures that are considered possible depending on the volume of greenhouse gas emissions in the future. RCP 4.5 is an intermediate scenario representing global temperature rise between 2 and 3°C (3.6 and 5.4° F). RCP 8.5 is the worst-case scenario, under which temperatures rise between 3 and 5°C (5.4 and 9°F).

Begin Box

RCP 4.5 and RCP 8.5 Explained

Representative Concentration Pathway (RCP) 4.5 is the scenario developed by the United Nations Intergovernmental Panel on Climate Change (IPCC) that describes a future where greenhouse gas emissions increase at a slower rate than in the higher-emissions RCP 8.5 scenario, ***but still exceed the levels needed to stabilize the climate.*** This scenario assumes that there will be a rapid deployment of renewable energy technologies, as well as some reduction in energy demand through energy efficiency measures. As a result, CO_2 emissions peak around 2040, and then decline until they stabilize at approximately 4.5 times preindustrial levels by the end of the century. This scenario projects a warming of about 2.6 to 3.9 degrees C (4.7 to 7.0°F) by 2100, compared to preindustrial levels.

Representative Concentration Pathway (RCP) 8.5 is the scenario developed by the IPCC that describes a future where greenhouse gas emissions continue to increase at a high rate, resulting in high levels of warming by the end of the century. This scenario assumes that there will be limited efforts to reduce emissions and that fossil fuels will continue to be the primary source of energy. As a result, CO_2 emissions continue to rise throughout the century and stabilize at approximately 8.5 times preindustrial levels. This scenario projects a warming of about 4.8 to 7.4 degrees C (8.6 to 13.5°F) by 2100, compared to preindustrial levels. ***This scenario is often considered the "worst-case" scenario and is used as a benchmark to evaluate the potential impacts of high emissions.***

End box

Elevated and sustained temperatures will result in longer, hotter summers likely to induce droughts and heat waves, which are major threats to human survival, especially in vulnerable populations. Extended heat can have many negative impacts, including on water supply and water quality, agricultural yields, livestock survival, ecosystem health, and soil erosion rates. In addition, increased energy demand for air conditioning can put strain on electricity generation and transmission infrastructure.

Precipitation

The historical annual variability of Oregon's precipitation is expected to continue in future years, with a slight increasing trend (Figure 4). Precipitation is expected to increase during the spring and winter and decrease in summer months. It is likely that the intensity of heavy precipitation events will increase in coming years.

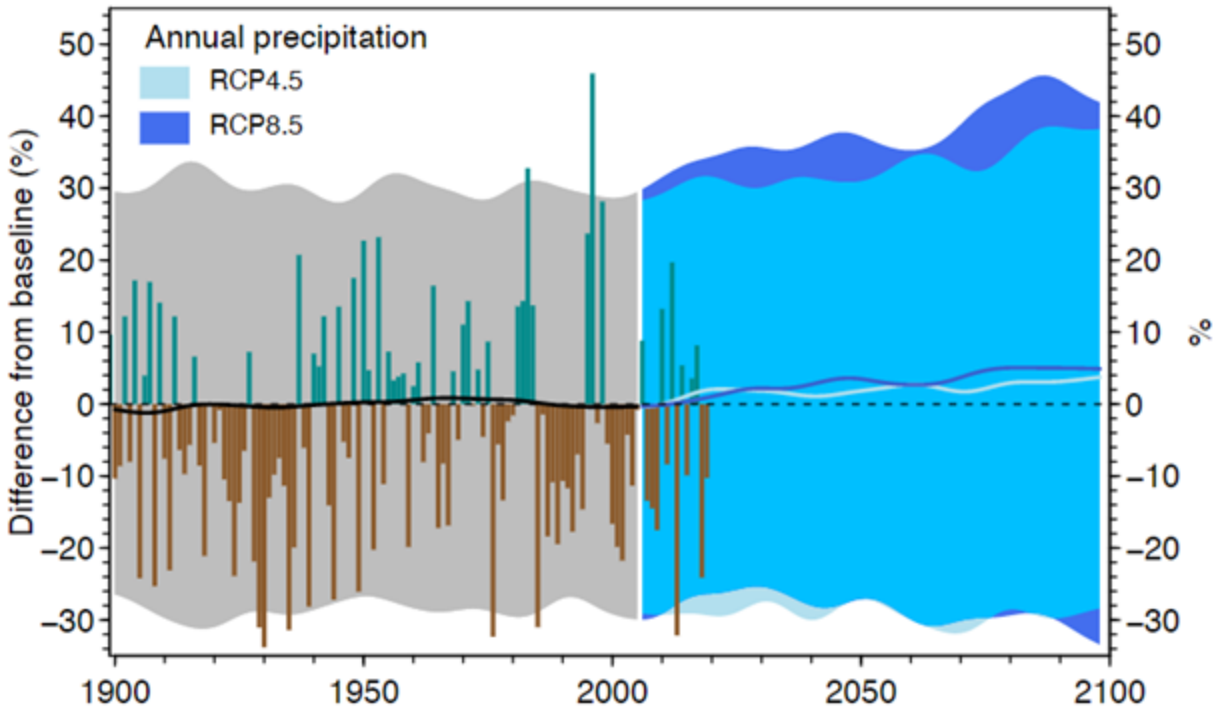


Figure 4: Observed, simulated, and projected changes in Oregon's mean annual precipitation relative to 1970–1999 (baseline) under RCP 4.5 and RCP 8.5 future scenarios. Green and brown bars are observed precipitation amounts (1900–2019) from the National Centers for Environmental Information. Solid lines are the mean values of simulations from 35 climate models for the 1900–2005 period, which were based on observed climate forcings (black line), and the 2006–2099 period for the two future scenarios, RCP 4.5 and RCP 8.5 (light and dark blue lines). Shading indicates the annual precipitation range from all models.

Increased precipitation and more intense storm events risk overwhelming stormwater management systems resulting in flooding and wastewater overflow issues in urban areas. Flooding and landslide risks are also increased, posing threats to housing, urban infrastructure, transportation, and energy generation and distribution networks.

Snowpack and Runoff

Many Clackamas County rivers and streams rely on the melting of winter snowpack in the Oregon Cascade Mountain Range. Annual snowpack in these mountains has been in decline in recent decades and is likely to continue to decrease as the climate warms. Warmer air temperatures will mean more moisture in the air, which will fall more often as rain than snow. In the Oregon Cascades, fewer than 25% of wet days are projected to be days with snow by the mid-21st century, compared to about 50% of wet days during the late 20th to early 21st centuries. Continued warming is projected to result in earlier streamflow, declining summer flows, and increasing winter flows.

Median summer runoff in the Clackamas River watershed is projected to decline 50% under an RCP 8.5 scenario. Extreme high flows are projected to increase up to 19%, and extreme low flows are projected to decrease by as much as 20 m3/s by the middle and late 21st century. The center timing of flow is projected to shift two to three weeks earlier by the 2080s (2070–2099).

Decreased snowpack and runoff will result in lessened stream flows and increased stream temperatures that may pose risks to stream and riparian wildlife. Hydroelectric utilities rely on steady stream flows and temperatures for consistent generation operation and thus are at risk from these climate change impacts.

Extreme Heat

Warming temperatures are increasing the frequency and severity of extreme heat days, seasons, and waves. Since 1940, the number of days exceeding 90°F increased by over eight days per year in Portland and Pendleton, and 21 days per year in Medford (Figure 5). The number of 90°F days in Portland in 2015 (29) and 2018 (31) broke records.

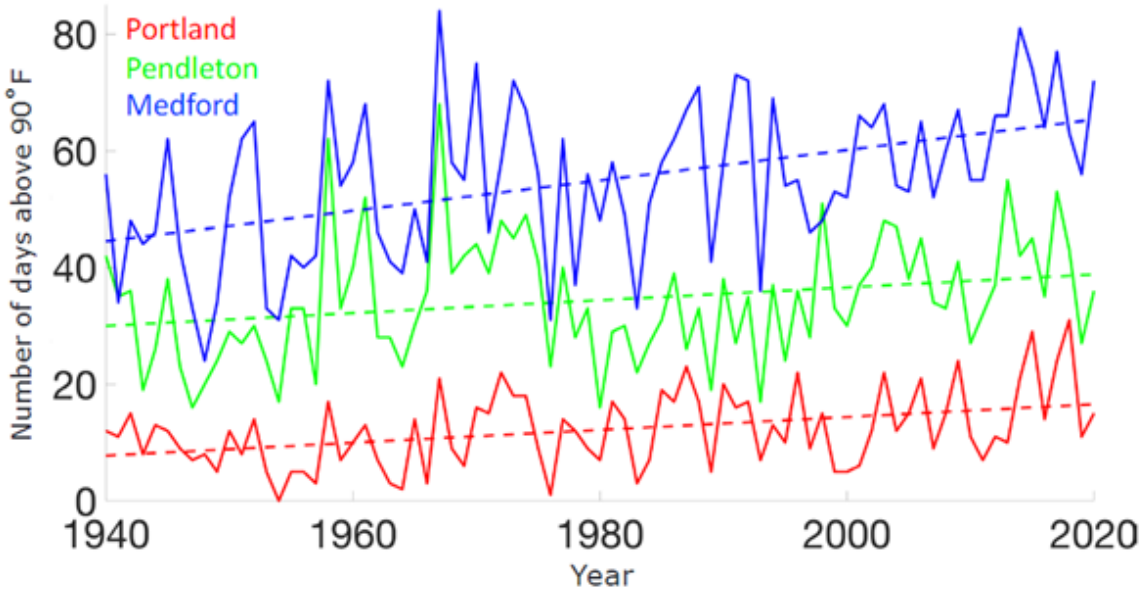


Figure 5: Number of days per year on which the daily high temperature exceeded 90°F at Medford, Pendleton, and Portland.

Projections indicate that most areas in Oregon can expect annual extreme heat day (above 86°F) totals to increase by 30 days by the end of the century (Figure 6). The increase in extreme heat days will likely be smaller in Clackamas County's mountainous regions.

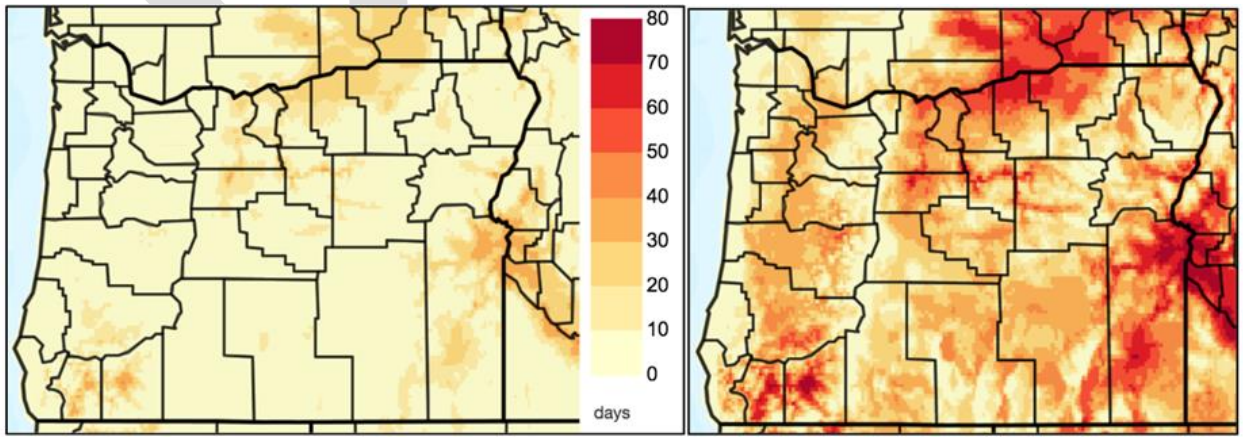


Figure 6: Number of days from April through October with a heat index ≥90°F in historic (1971–2000, left) and future (2040–2069, right) periods under RCP 8.5.

The rising frequency of extreme heat events will increase heat-related illness and death frequency, particularly among vulnerable populations (elderly; children; people with chronic illnesses; people with low incomes; Black, Indigenous, and People of Color; and outdoor workers). Projections indicate a 422% increase in heat-related deaths under RCP 8.5 during the 2031-2080 period across the country. Cooling systems in buildings can reduce extreme heat mortality risk. However, these systems contribute to climate change through their use of high greenhouse gas-intensive refrigerants and create increased electrical demand, posing challenges for the electricity grid. Sustained high temperatures and aridity can also contribute to the transmission of infectious diseases present in the state, including Lyme disease, and West Nile virus.[48]

Drought

Persistent drought is common in the Pacific Northwest. Over the last 20 years, the incidence, extent, and severity of drought has increased in the Northwest compared with the 20th century. These droughts have had numerous adverse impacts on agriculture, water availability, drinking water quality[49], recreation, ecosystems, and wildfire risk. Anticipated warmer, drier summers and decreased snowpack due to warmer winter temperatures are expected to result in more frequent droughts. As climate change reduces mountain snowpack, seasonal drought will become less predictable in Clackamas County and winter snow droughts will increase the likelihood of hydrological or agricultural drought during the following spring and summer.

Increased summer drought conditions may warrant new infrastructure for water storage for potable and agricultural uses. Elevated water efficiency measures may be required for users and utilities as well. Drought also effects the availability of water for hydroelectric generation, risking decreased generation output.

Wildfire

Wildfire is a naturally occurring phenomenon whose frequency and severity is increased by climate change. The Oregon 2020 fire season was one of the worst on record, with five wildfires of over 100,000 acres each. These fires resulted in thousands of displaced people, destroyed structures and infrastructure, while also contributing to hazardous air quality in many parts of Oregon and the Northwest US.

Various wildfire modeling efforts predict that under a mean temperature increase of 3.6°F the median annual area burned by wildfires in Oregon will increase 200%. The incidence of very large fires (burning

[48] National Environmental Health Association, (2019). Regional Climate and Health Monitoring Report. Blueprint for a Healthy Clackamas County: https://www.blueprintclackamas.com/tiles/index/display?alias=ClimateChange

[49] According to the Oregon Water Resources Department, droughts can lead to reduced stream flows and groundwater levels, which can make it more difficult to access and treat water for drinking. During droughts, water demand increases, and water sources may become over-allocated, leading to competition between different users and potentially reducing the availability of water for drinking. Additionally, droughts can cause wells to go dry, making it difficult to access groundwater. State of Oregon, Water Resources Department. Drought Impacts on Water Quality: https://www.oregon.gov/owrd/programs/drought/Pages/impacts.aspx

more than 5000 acres) is likely to increase 200-400% under RCP 8.5. Increased wildfire frequency and severity are likely to increase risk of drought, insect outbreaks, and pathogens that can lead to substantial ecological changes and further risk to human health and survivability.

Clackamas County has many communities in wildland-urban interfaces, which are high-risk areas for wildfire damage to infrastructure and threat to human life. Wildfire depletion of vegetation increases erosion, flood and landslide risk. These, in turn, pose additional risks to water supply infrastructure (e.g. treatment plants, reservoirs) via overflow, turbidity, and contamination.

Transportation is also at risk from wildfires, primarily due to on-road wildfire debris. Human and animal health is at risk during wildfire events as well; extremely elevated levels of airborne particulate matter pose threats to breathing, resulting in increased hospitalization for asthma and Chronic Obstructive Pulmonary Disease (COPD) exacerbations, heart attacks and strokes, as well as increased susceptibility to respiratory viruses. Vulnerable groups, including the children and elderly, face higher risks.

Floods

Floods across Oregon are likely to be more severe in years to come because of three key climate impacts: large precipitation events are expected to be more intense, precipitation will fall more as rain than snow, and total wet-season precipitation volumes will increase. As the air warms it holds more moisture, causing more frequent and more severe precipitation. As less precipitation falls as snow, rain events have more volume. More frequent rain events means wetter soil and reduced depth to groundwater—conditions that enable flood events. Flood modeling predicts that by the 2030s and 2070s, major flood events on the nearby lower Columbia River (below the confluence with the Willamette River) will be 44% and 151% larger, respectively, under an RCP 8.5 scenario. Wetter soils and increased flood conditions present greater risk of landslides in hilly and mountainous areas. As of 2020, less than 6% of Oregon's levees were certified by FEMA.

Flooding poses risks to water supply, wastewater, and hydroelectric infrastructure, with the potential to overwhelm each. As many dams and reservoirs across the state are aging, their susceptibility to increased flood frequency and severity is elevated.

Climate Change Effects on Species of Note

The many animal and plant species across Clackamas County will each respond differently to local changes in climate. Some will adapt, some will migrate, and some may suffer in place. Most species will have to respond to habitat changes resulting from warmer temperatures, water availability, floods, warmer streams and lakes, landslides, less snow, food availability, etc. It would be overly speculative to estimate the effects of climate change on each species in this report. However there are two species known to be reacting to changes in climate already that have great potential to negatively effect tree populations, and thus animal habitats and the rate and severity of local climate change impacts. Those two species are mountain pine beetle and Swiss needle cast fungus.

Warmer winters are likely to increase the presence of mountain pine beetles in the Cascade Mountain Range. Mountain pine beetle larvae burrow into conifers like Ponderosa pine, lodgepole pine, limber pine, and whitebark pine (a candidate for listing under the U.S. Endangered Species Act), inhibiting nutrient

and water flow in the trees, often to the point of tree death. Freezing temperatures kill the pine beetles, but fewer freezing days will result in more frequent and greater manifestations.

Swiss needle cast fungus inhibits Douglas fir growth. Warmer winters and autumns and springs with more moisture are likely to increase its presence, threatening the well-being of Douglas firs in the region.

Climate Change Impacts on Human Health

A variety of studies have attempted to qualitatively and quantitatively estimate the effects of climate change to human health. Table 3 summarizes six categories of climate effects, the major health risks associated with them, and the populations vulnerable to these effects.

Table 2: Climate effects, health risks, priority populations, and example actions by the Oregon Health Authority.

Climate Effects	**Health Risks**[50]	**Priority Populations**	**Example Actions**
Storms, floods, landslides and sea-level rise	Injuries	People dependent on medical equipment that requires electricity	The Oregon Health Authority (OHA) partnered with the Oregon Department of Transportation (ODOT) to conduct a case study on creation of climate resilience on Oregon's North Coast (https://www.oregon.gov/odot/Programs/TDD%20Documents/Case-Study-Tillamook.pdf). The project interviewed state and local transportation and health leaders and documented lessons learned.
	Toxic Exposures	Socially isolated people	
	Displacement	Older adults	
	Disruptions in medical care	Coastal communities	
	Mental health effects	Children	
		Pregnant individuals	
Wildfire	Respiratory diseases	People with pre-existing conditions	The 2019 OHA report *More days with haze: how Oregon is adapting to the public health risks of increasing wildfires* (https://www.oregon.gov/oha/PH/HEALTHYENVIRONMENTS/CLIMATECHANGE/Documents/2020/oha2688_0.2.pdf) identified ways in which the public health system is adapting to increasingly severe wildfires and opportunities for climate adaptation.
	Cardiovascular diseases	Outdoor workers	
	Cancer	Children	
	Injuries	Pregnant individuals	
	Displacement	Older adults	
	Toxic exposures	Rural communities	
	Mental health effects	Tribal communities	

[50] Note: the categories in the Health Risks and Priority Populations are not a direct comparison. Each column is its own independent list.

Infectious disease	Lyme disease	Outdoor workers	In 2016, OHA developed a guidance document for use of weather and environmental data with syndromic surveillance data (www.youtube.com/watch?v=BvTVSNZ2LuI&list=PLd4xfJU3qzMWQlcfWZDGEj1rMncXTUeWV&index=6) for rapid assessment of the correlation.
	West Nile disease	Outdoor recreationalists	
	Fungal diseases	People experiencing homelessness	
	Shigellosis	Tribal communities	
		Rural communities	
Drought and water quality hazards	Mental health effects	Low-income communities	In 2017, OHA partnered with members of the Confederated Tribes of Warm Springs on a digital storytelling project (https://www.oregon.gov/oha/ph/healthyenvironments/climatechange/pages/perspectives.aspx) that documented climate-driven change in water quality in rivers and water shortages on the reservation. OHA also has assessed water insecurity in Oregon (Schimpf and Cude 2020).
	Dehydration	Tribal communities	
	Toxic exposures	Rural communities	
	Diminished living conditions	Farming and farmworker communities	
		Coastal communities	
Extreme heat	Heat-related illness & death	People with pre-existing conditions	OHA contributed to the State of Oregon's 2020 Natural Hazard Mitigation Plan (www.oregon.gov/lcd/NH/Pages/Mitigation-Planning.aspx). For the first time, the plan includes a chapter on extreme heat. Inclusion makes the state eligible for Federal Emergency Management Agency funding for mitigation actions that reduce identified risks.
	Violence	Outdoor workers	
		Outdoor athletes	
		People without air conditioning or housing	
		Residents of urban heat islands	
		Children	
		Pregnant individuals	
		Low-income communities	
		Communities of color	
Air quality and allergens	Ozone and smog	Low-income communities	In 2018, at the request of the governor's Carbon Policy Office, OHA prepared a policy paper on climate change and public health
	Airborne pollen	Communities of color	

	Airborne molds	Communities near highways and industrial facilities	(www.oregon.gov/oha/ph/healthenvironments/climatechange/documents/2018/2018-OHA-Climate-and-Health-Policy-Paper.pdf) that identifies communities most affected by health risks of climate hazards and pollutants from greenhouse gas emissions.
		Outdoor workers	
		People with pre-existing conditions	
		Farmworker communities	

The Cost of Inaction

Studies point to climate change being a threat multiplier. The frequency and severity of natural events are increased under a climate that is warming and fostering unstable and fluctuating conditions. This is accompanied by increased costs incurred in response to climate change events. Limiting climate change impacts through GHG emissions mitigation has costs, but these are dwarfed by the costs of inaction, which increase with each year action is not taken.

Various studies have modeled estimated economic damages of climate change impacts. The World Resources Institute summarizes several studies in its 10 Charts Show the Economic Benefits of US Climate Action (2020). Figure 7 from this summary demonstrates how the damages from climate change and associated recovery costs will increase the longer action is delayed.

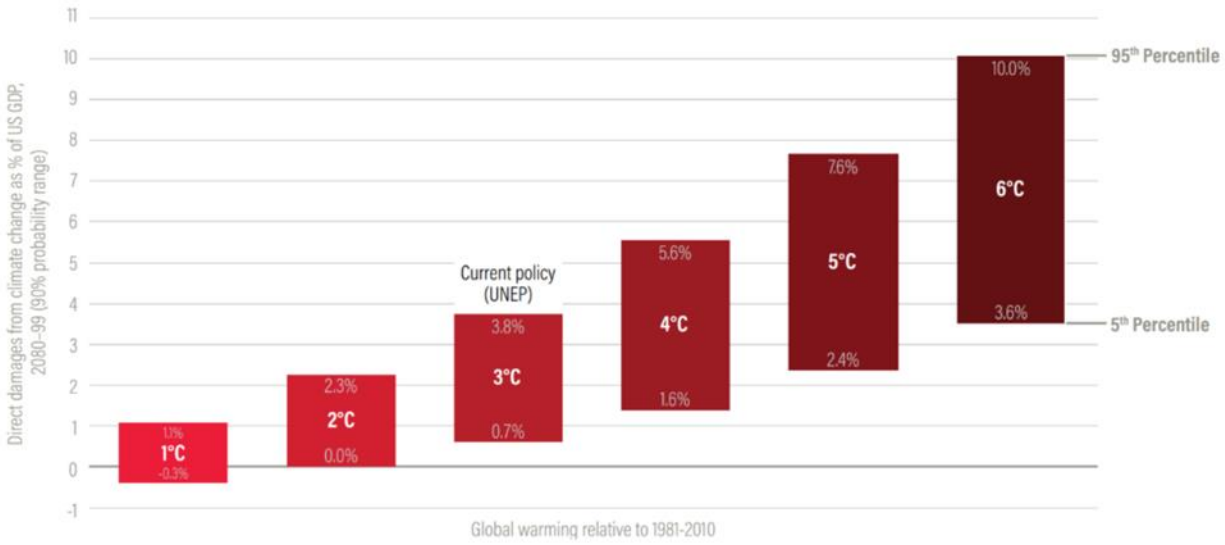


Figure 7: US economic damages at different levels of global warming.

From 1980 to 2020, Oregon experienced 32 natural disaster and storm events whose recovery exceeded $1 billion in costs (Table 3). Twenty-five of these events have occurred in the past 20 years during which time the Earth has experienced its 19 hottest years on record.

Table 3: Billion-dollar events to affect Oregon from 1980 to 2020 (CPI-Adjusted).

Disaster Type	Events	Events/year	Percent Frequency	Total Costs	Percent Of Total Costs
Drought	*13*	*0.3*	*40.6%*	*$2.0B-$5.0B*	*34.6%*
Flooding	*3*	*0.1*	*9.4%*	*$1.0B-$2.0B*	*15.9%*
Freeze	*1*	*0.0*	*3.1%*	*$100M-$250M*	*1.3%*
Severe Storm	*2*	*0.0*	*6.3%*	*$5M-$100M*	*1.0%*
Wildfire	*13*	*0.3*	*40.6%*	*$2.0B-$5.0B*	*47.1%*
All Disasters	*32*	*0.8*	*100.0*	*$5.0B-$10.0B*	*100.0%*

The Oregon Global Warming Commission's 2020 Biennial Report includes this summary of recent climate change-exacerbated events and their costs:

In Oregon in 2020, an extreme runoff event caused damage to and closed I-84 and flooded homes in the Pendleton area; Governor Brown issued drought declarations for 14 counties from the coast to northeastern Oregon; and in the fall we experienced devastating fires across the state—in which at least nine Oregonians lost their lives and more than 40,000 had to evacuate; more than 4,000 structures and nearly 1.1 million acres were burned with an estimated $354 million in fire-fighting costs. A 2018 Headwaters Economics study found that wildfire suppression costs may account for only 9 percent of the total direct and indirect costs of major wildfires. By all measures the costs to Oregonians are incalculable.

This is one example from one state agency. Climate change impacts will elicit such responses from many departments at all levels of government, as well as from businesses, organizations, and institutions. The incalculable costs will be all the more so. The cheapest option is emissions mitigation, even given the investments that must be made in sectors like renewable energy, buildings energy efficiency retrofits, EV infrastructure, etc. These investments are proactive, controllable, and predictable, unlike climate change impact responses.

Clackamas County Multi-Jurisdictional Hazard Mitigation Plan

Clackamas County developed a Multi-Jurisdictional Natural Hazards Mitigation Plan (NHMP) in 2019. The plan was developed to help the county plan for actions that can lessen the impact of disasters, which allows the county to identify risks associated with natural disasters and work on long-term strategies for protecting people and property.

The goals of the NHMP are to:

- protect life and property;
- enhance natural systems;
- augment emergency services;
- encourage partnerships for implementation;
- and promote public awareness.

The plan ranks hazards and vulnerabilities (Figure 8), which also helps us to determine the key topics to address when identifying impacts, exposure, risks, and vulnerabilities.

Hazard	History	Vulnerability	Maximum Threat	Probability	Total Threat Score	Hazard Rank	Hazard Tiers
Earthquake - Cascadia	4	45	100	49	198	#1	Top Tier
Earthquake - Crustal	6	50	100	21	177	#2	
Wildfire	12	25	70	56	163	#3	
Winter Storm	10	30	70	49	159	#4	
Drought	10	15	50	56	131	#5	Middle Tier
Flood	16	20	30	56	122	#6	
Windstorm	14	15	50	42	121	#7	
Landslide	14	15	20	63	112	#8	Bottom Tier
Volcanic Event	2	35	50	14	101	#9	
Extreme Heat	2	20	40	14	76	#10	

Source: Clackamas County NHMP Hazard Mitigation Advisory Committee, 2018

Figure 8: Hazard and vulnerability assessment summary

Climate Adaptation Assessment and Methodology

SSG (the consultants responsible for assembling and advising on this plan) have accepted the climate change projections and hazards assessed in the Fifth Oregon Climate Assessment, published by the Oregon Climate Change Research Institute at Oregon State University, and support the recommendations made in the NHMP.

We have not conducted further quantitative analysis of the climate change projections and hazards. We have investigated the relationship between the hazards and vulnerabilities such as demographic factors (e.g. poverty) and asset management and any asset deficits.

We will focus further analysis on engagement and best practices to identify risks, vulnerabilities, exposure, impacts, and stressors.

Short-term Implementation

The CAP is an ambitious plan that spans every sector of the community. While climate action is essential, all the changes required cannot happen at once. Over the next year, Clackamas County can take five key steps to set the foundation that will ensure climate action remains a priority within the County and the broader community.

1. Hire dedicated staff to manage the implementation of the CAP.
2. Confirm and apply for funding from federal and state programs aligned with action implementation.
3. Establish an ongoing advisory committee with members from the public to provide ongoing feedback and support of implementation initiatives.
4. Identify and evaluate readiness of key potential partners to assist with implementation of actions not fully within Clackamas County's jurisdictional control.
5. Establish a set of key performance indicators to report on progress and challenges related to implementation.

As these foundational pieces are put into place, the County can be planning how to operationalize the implementation actions outlined in the Implementation Guide ancillary report over the next five years.

The challenges that climate change poses on Clackamas County, as well as globally, can seem daunting. This plan has described how climate change poses a significant threat to human well-being, including impacts on health, food and water security, and economic growth. Failure to take action on climate change could lead to more frequent and severe heat waves, droughts, floods, and storms, which could cause widespread damage to infrastructure and communities, as well as loss of life.

The cost of inaction on climate change is likely to be much greater than the cost of taking action. The longer we wait to take action, the more difficult and expensive it will be to reduce emissions and adapt to the impacts of climate change.

Notably, taking action on climate change also brings economic benefits, such as job creation in clean energy and energy efficiency sectors, and reduced reliance on fossil fuels which can lead to energy independence and security.

Tackling climate change is a global responsibility and taking action can help to ensure that future generations inherit a planet that is hospitable to human life and that can support continued sustainable development now, and for generations to come.

Appendix A: Glossary of Terms

Adaptation: the process by which human systems adjust to actual or expected climate change and its effects. Adaptation seeks to moderate or avoid harm or even to exploit potential beneficial opportunities with the changing climate.

Climate hazards: the potential occurrence of climate-related physical events, such as extreme weather (heatwaves or floods), or climate change trends, such as increasing temperatures, that result in an impact on natural, built, or human systems.

Comorbidities: the presence of multiple chronic conditions in a single individual. These conditions can be related or unrelated, and they can have a significant impact on a person's overall health and well-being. Examples of comorbidities include diabetes and heart disease, or depression and anxiety.

Exposure: the presence of people, livelihoods, species or ecosystems, environmental functions, services and resources, infrastructure, or economic, social, or cultural assets in places and settings that could be adversely affected by climate-related events. Examples include assets located in a floodplain or people living in poor-quality housing.

Greenhouse gasses: gasses in the Earth's atmosphere that trap heat, causing the planet's surface to warm up. The most well-known greenhouse gas is carbon dioxide, but other examples include methane, nitrous oxide, and water vapor. These gasses are produced naturally, but human activities such as burning fossil fuels, deforestation, and industrial processes have significantly increased their levels in the atmosphere. This has led to global warming and climate change, which have been linked to rising sea levels, more severe weather events, and other environmental problems.

Impacts, also referred to as consequences or outcomes: primarily the effects of climate hazards on natural, built, and human systems. This includes the effects on lives, livelihoods, health, ecosystems, economies, societies, cultures, services, and infrastructure. Impacts generally manifest in some form of damage, disruption, or complete (irretrievable) loss and can be generally categorized as physical, social, or economic. Impacts result due to the interaction of climate events or trends (occurring within a specific time period) and vulnerability of an exposed society or system.

Additionally, impacts can be considered direct (damage to a building) or indirect (loss of a job or income as a result of damage to a building).

Resilience: the capacity of a system, either social, economic, or environmental, to cope with hazardous events or disturbances. This can involve responding to hazards or reorganizing systems in ways that allow them to maintain their essential function, identity, and structure.

Risk: results from the interaction of vulnerability, exposure, and hazard, and in this context, the term primarily refers to the risks of climate change impacts (see Figure 6). Risk is also referred to as the potential for consequences where something of value is at stake and where the outcome is uncertain. It is often represented as the probability of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur. However, this mathematical approach requires the consideration of vulnerability and exposure intrinsically for it to be valuable.

Stressors: events and trends, which are often not climate-related, that have an important effect on the system exposed and can increase vulnerability to climate-related risk. For example, growing income inequality is a stressor that is pushing already low-income families to their financial limits, further increasing these families' vulnerability because they have fewer resources (and therefore decreased capacity) to respond to the impacts of a major climate event. This framing underscores that the development of a society has significant implications for exposure, vulnerability, and risk. Climate change is not a risk per se, rather climate changes and related hazards interact with the evolving vulnerability and exposure of systems and determine the changing level of risk. Identifying key vulnerabilities facilitates the estimation of key risks when coupled with information about evolving hazards and exposure associated with climate change.

Vulnerability: the likelihood of being adversely affected and primarily refers to characteristics of human or social-ecological systems that are exposed to hazardous climatic events or trends. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt (adaptive capacity).

Ecosystems, geographic areas, assets, humans, etc. can be classified as vulnerable, and this is of particular concern if vulnerability in one area (e.g. humans) increases as a result of potential impairment or increased vulnerability in other areas (e.g. assets).