Emissions Reduction Potential for Planned Climate Action

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INTRODUCTION

The City of Milwaukie convened a series of six workshops with implementation partner organizations and other local experts to discuss and prioritize best mitigation and adaptation practices for community climate action. Three of the workshops focused on greenhouse gas (GHG) mitigation strategies and actions, while two of the workshops focused on climate adaptation strategies and one focused on both. The following sections provide additional information on the actions prioritized in the mitigation workshops, which included the following topic areas:

- Building Energy Sourcing and Efficiency
- Fleets and Fuels
- Land Use and Transportation Planning
- Material Purchasing, Use, and Recovery

Each workshop consisted of the following components:

Review of Best Management Practices

Good Company reviewed peer community climate action plans and related documents to summarize the best management practices (BMPs) being used around the U.S. to reduce climate pollution. The intent of this research was to identify potential actions with: (1) significant mitigation potential, (2) commercial availability; (3) successful implementation, and (4) offers community co-benefits (e.g., air quality, local jobs).

BMP Review and Discussion

Local experts and community implementation partners reviewed and discussed the BMPs actions for opportunities and risks and applicability based on local context. The groups prioritized actions for further assessment. The prioritized actions were then analyzed for mitigation potential and cost effectiveness.

Assessment and Comparison of Potential Actions

The City's 2016 Community Greenhouse Gas Inventory and BMP research were used as primary data to model GHG and fossil fuel reductions. These were processed to estimate marginal capital and operational costs and energy reductions for specific actions. The primary unit of analysis is $ per metric tonne of carbon dioxide equivalent reduced (all GHGs normalized to CO2 as the base unit of one). Calculation values and assumptions are summarized in the Appendices.

SUMMARY OF RESULTS

The prioritized actions, if implemented, would get the community of Milwaukie to approximately 33% of its existing carbon footprint. While this likely will fall well short of the goal to go beyond carbon neutral to carbon negative – it does represent a substantial set of first steps. If the City revisits its planning efforts in a few years, a "second wave" of actions could be initiated to take the community much further. In Figure 1 – the first orange block of emissions reductions results from the implementation of existing policies such as the Renewable Portfolio Standard for electricity sold in Oregon, the Clean Fuels Program for liquid fuels and the Montreal protocol for the reduction of climate intense refrigerants. The second orange block shows the scale of the prioritized actions. Figure 2 shows more detail for the same actions.

Figure 1: Milwaukie's 2016 emissions and the reduction potential of existing and planned actions. Business as Usual (BAU) refers to the reductions that will come from existing state and federal policy implementation. *Note this does not include scaling the reduction of household emissions.*

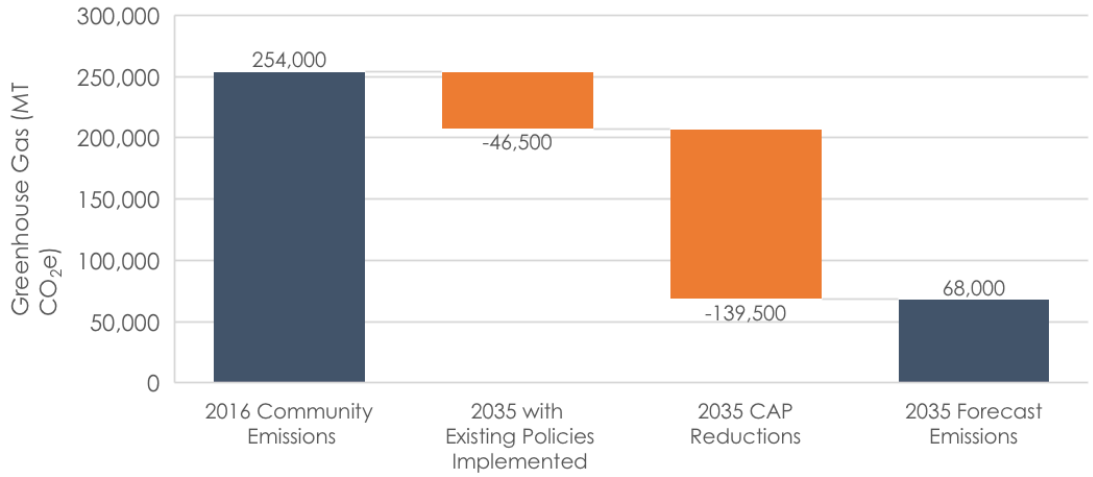
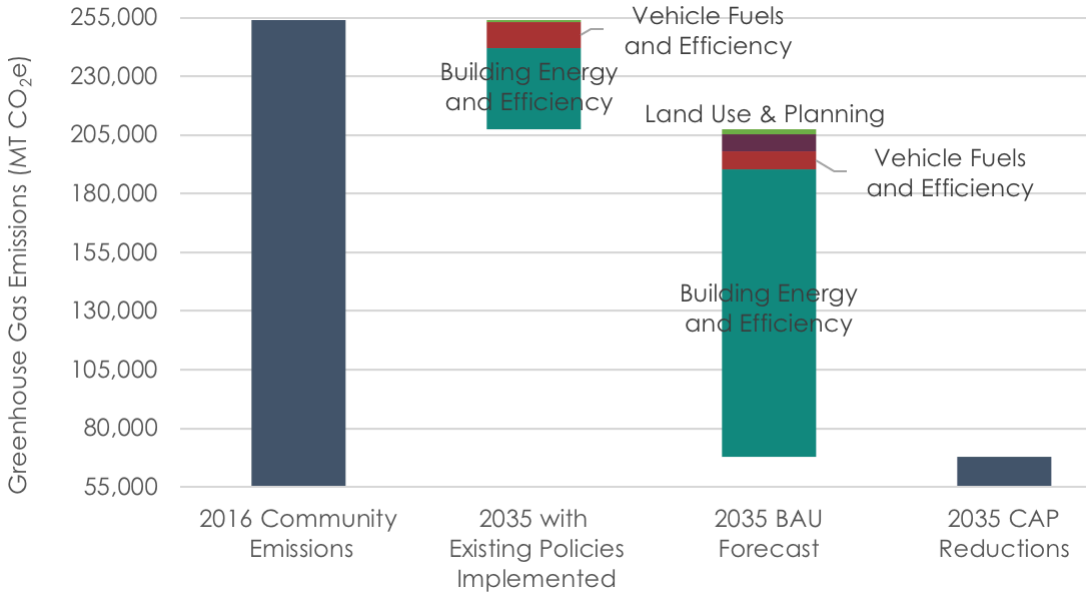


Figure 2: Details of Business-as-Usual (BAU) and Climate Action Plan emissions reductions.



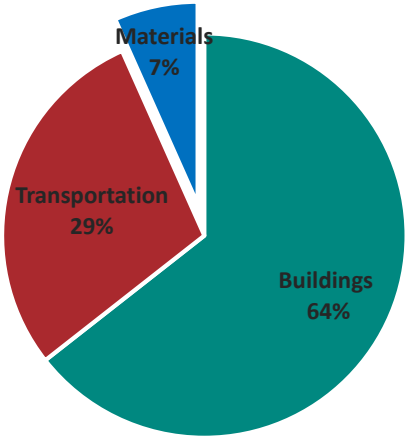
Note this does not include scaling the reduction of household emissions. Also note that Materials mitigations are included below as a turquoise bar but are too slim to label.

DETAILED RESULTS

Materials Purchasing, Use, and Recovery

Description of Prioritized Actions

The following sections provide a description of the action prioritized during the Materials workshop. It's important to note that material mitigation actions with implementation partner technical experts.



Promote the repair of equipment and materials and buy used and durable before purchasing new

City staff will work with County partners to host repair fair events, promote local repair and used goods vendors, and provide educational outreach on the connections between consumption of materials goods and climate pollution. Oregon Department of Environmental Quality (ODEQ) has developed systems to measure a household and community consumption-based emissions and guidance on the most effective strategies to reduce these emissions. Clackamas County has existing educational materials that could be utilized by City staff and can support the City to host repair events. This action should be implemented in City operations as well as in the community-at-large.

City to provide education and outreach to avoid edible food waste

One of the most cost-effective strategies to reduce GHG emissions, is to avoid wasting of edible food from households, restaurants, grocery stores, farms, food processors, etc. Reducing food waste saves money, reduces the overall demand for food (and related consumption-based emissions), and reduces local landfill emissions by diverting materials from the waste stream. According to ReFED's[1] report *The Roadmap to Reduce U.S. Food Waste*, one of the most effective strategies to reduce emissions is consumer education campaigns. ODEQ also supports this action and has developed its *Strategy for Preventing the Wasting of Food* and is in the process of conducting in-depth research to better understand the causes of waste, collect reliable data on wasted edible food, and assess shifts in waste prevention behaviors or levels of awareness. City staff will work with County partners to utilize existing consumer education resources to be targeted toward fairs and festivals, farmers markets, schools and other events.

City to showcase materials management practices with a demonstration project

The City will host a demonstration of best materials management practices in construction and operations with the renovation of the Ledding Library. These practices could include implementing a deconstruction plan; utilizing environmental product disclosures in material selections; identifying opportunities to reuse and incorporate reclaimed materials; selection of durable roofing material; purchase of used or highly durable furniture; and limit the use of carpet.

[1] ReFED is a collaboration of business, nonprofit, foundation, and government leaders committed to reducing food waste in the United States. ReFED seeks to unlock new philanthropic and investment capital, along with technology, business, and policy innovation, which is projected to catalyze tens of thousands of new jobs, recover billions of meals annually for the hungry, and reduce national water use and greenhouse gas emissions.

City Public Works to use less impactful pavement alternatives

City Public Works will request environmental product disclosures (EPD) from project bidders for cement and concrete products to be used in projects to allow for comparison of climate impacts of various products and mixes. The City will evaluate the potential to increase the use of lower-carbon substitutes for Portland cement for appropriate applications.

City to use mulch and compost in landscaping

The State of Oregon is focused on diverting food waste from landfill disposal into higher-and-better uses including anaerobic digestion and composting. The City will do its part to close the loop and utilize the soil amendment products from these treatment options. Treating food waste via AD or composting reduces landfill emissions, but more importantly reduces the need for conventional fertilizers and increases solid carbon storage.

City staff and partners to promote existing food waste composting services

The State of Oregon is focused on diverting food waste from landfill disposal into higher-and-better uses. The existing haulers in Milwaukie operate a curbside food waste collection system. The City should promote and educate residents of the importance of using this program.

Emissions Reduction Potential and Cost Effectiveness of Actions

The actions found to be most cost effective are those that reduce waste at the source and displace the need to purchase additional goods. See Table 1. Education programs to reduce edible food waste are the most effective. These education programs would require Milwaukie staff time, but staff cost is far outweighed by the financial and GHG value of the food. Likewise, actions that encourage the repair and reuse of consumer goods will require staff time for coordination of repair fairs and marketing local repair and thrift and consignment shops is far outweighed by the value ($ and emissions) of extending the lifespan of good and avoiding the need for new replacements.

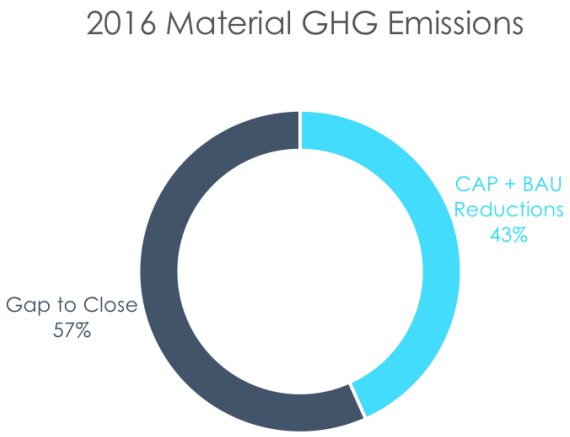


Figure 3: Fraction of Milwaukie's 2016 community GHG emissions that will be reduced Milwaukie action and existing State and Federal Policy

Milwaukie residents and businesses are already able to compost food waste. These programs have not been promoted to reach maximum potential, but the cost to dispose of compostable materials at Metro transfer stations is much less than landfill disposal of those same materials. Composting also avoids fugitive methane emissions from landfills; reduces emissions from material transportation; and produces a product (compost) that when applied to the soil, stores carbon.

The largest potential for emissions reductions is for building deconstruction, but unfortunately this action is also the least cost effective. Deconstruction is more labor and time intensive than mechanical deconstruction and is roughly twice the cost, but material reuse avoids the need for new materials.

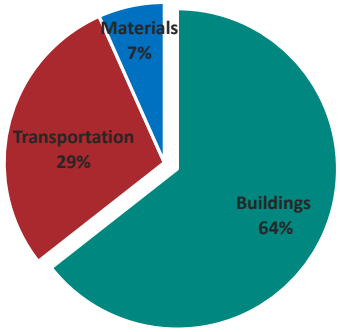
Table 1: Emission reduction potential and cost-effectiveness for materials-related actions. *Note that a negative number in "Marginal Cost Effectiveness" implies savings over time.*

Strategy	Action	Emissions Reduction versus 2016 Emissions (MT CO_2e)	Marginal Cost Effectiveness ($ / -1 MT CO2e)
Strategy 1: Food Waste Avoidance and Recovery			
	City staff to provide community education around food waste and prevention	500	-$1,000
	City staff and to promote existing residential commercial food waste composting opportunities and use mulch and compost in operations	300	-$300
Strategy 2: Building Material Recovery and Reuse			
	Showcase best practices through a City demonstration project at Ledding Library	Not scalable without design plans	
	City to require deconstruction and / or delay property demolition	1,400	$225
	City Public Works to use less impactful pavement alternatives, as appropriate	100	$35
Strategy 3: Consumer Goods Repair, Reuse, and Lifespan Extention			
	City to work with county partners to host neighborhood repair events and promote local repair businesses	600	-$150
	Material-related Subtotal (does not include BAU actions):	**2,900**	
	BAU Existing Policy Reductions:	**1,000**	
	CAP + BAU Reductions as a % of 2016 Baseline Material Emissions:	**43%**	

Buildings Energy Sourcing and Efficiency

Description of Prioritized Actions

The following sections describe the Building-related actions prioritized from the workshop with implementation partner technical experts.



Net Zero Electricity by 2035

By 2035, Milwaukie's buildings will have no net emissions from electricity. We'll achieve this by partnering with PGE, our electricity provider, to become more energy efficient and use renewable electricity sources.

Net Zero Natural Gas by 2040

By 2040, Milwaukie's buildings will have no net emissions from all fuels, including gas, oil and propane. We'll achieve this by buying offsets from source reducing projects first, such as those capping leaking gas wells, sealing distribution system leaks, using bio-methane from wastewater treatment plants and dairy operations, and producing renewable hydrogen as substitutes for traditional methane.

"No net emissions" means overall, Milwaukie's buildings will either offset or reduce their greenhouse gas emissions completely. In other words, our community's homes, businesses and structures will emit no more greenhouse gases than they consume, either through energy efficiency, using renewable sources or by purchasing emission offsets. Like a bank account, the "net balance" of greenhouse gas emissions at the end of the year will be zero across all of Milwaukie's buildings.

City to advocate for ever more efficient state building energy codes

City staff and elected officials work with partner agencies to implement a net-zero energy code by 2025. Beginning in 2018, Oregon updated its *residential* building code. A *commercial* code update will be implemented in 2019. According to Oregon Department of Energy staff – the recent residential update and next year's commercial update are expected to reduce energy use from new buildings by 8% relative to previous code. ODOE staff also indicated that net-zero energy codes could be implemented in Oregon as early as the mid-2020s. These codes will reduce energy use by buildings built in 2018 and beyond versus previous building codes.

City to adopt a commercial and residential building energy score program

City staff and elected officials works with partners to develop and implement a residential and commercial disclosure program within the next 5-years. This program would require that the owner assess their building's energy efficiency and identify areas for improvement prior to listing the property for sale. This information will provide additional information to buyers to compare energy use between properties. An example of this is the City of Portland's Home Energy Score and the European Union's 2010 Energy Performance of Buildings Directive. Milwaukie staff time would be required to develop and implement such a program, but the process could leverage Portland's development process and programmatic resources.

City to implement a Property Assessment for Clean Energy Program (PACE)

City staff and elected officials works with partners to develop and implement a PACE financing program within the next 5-years. PACE financing may be used to install clean energy, renewable energy, water conservation and seismic resiliency improvements for commercial, industrial and multifamily buildings. The purpose of PACE financing is to reduce the financial barriers for building resiliency projects by eliminating an up-front cash investment and provides loans up to 100% of the cost of upgrades. The loan follows the building, not the owner and automatically transfers upon sale. A collaboration between Multnomah County, Prosper Portland, and Energy Trust of Oregon resulted in the PropertyFit program – Oregon's first PACE program in 2018. Milwaukie staff time would be required to develop and implement such a program, but the process could leverage PropertyFit development process and programmatic resources.

Revise City regulations to encourage multifamily energy efficiency upgrades

The City of Milwaukie passes an ordinance to address the issue of "split incentives" in rental housing within the next 5-years. Rental properties are notoriously difficult when it comes to energy efficiency because the owners of these properties do not typically pay the energy bills, while those who pay the bills do not want to invest in upgraded equipment in spaces where they live for a limited duration. The City of Boulder recently addressed this issue in a policy called SmartRegs that requires that all long-term licensed rental properties to meet minimum efficiency standards.

City to support development of a Clackamas County Sustainability Plan

Clackamas County developed its first sustainability plan in 2008. The City will support the County in updating this plan and working to align the goals and actions with Milwaukie's climate action plan.

City to develop Community Solar Project Hosted at a City Facility

The City could install a 300-kW solar photovoltaic system at one of its facilities on SE Johnson Creek Boulevard. The output of this system could be purchased by Milwaukie residents that are not able to install an owned system at their home or business.

Community-at-large to develop distributed energy systems

Distributed energy systems can take a variety of forms, but this action focuses on community-at-large installation of rooftop solar PV. Other distributed systems could include a biomass or natural gas combined heat and power system or integrating energy storage (such as batteries) with local solar PV generation. This action focuses on net-metered solar PV for a number of reasons. First, no development plans for other types of distributed energy systems were identified during the CAP process. Second, the City of Milwaukie City Council set a 5-year goal in 2016 to triple the solar PV generation capacity to 2.2 MW (about 300 new rooftop units) by 2021. The City of Milwaukie also ran a pilot Solarize Milwaukie, which utilized the power of bulk purchasing to lower upfront system costs. Third, Portland General Electric conducted a comprehensive Market Study to quantify the number of cost-effective solar PV installations in its service territory which provides data to estimate the number of systems and generation for the Milwaukie Community.

PGE to implement demand response program

PGE will work with the Milwaukie community to identify the implement a variety of demand response technologies. Demand response technologies allow an electric utility to control load during times of peak demand. Power generation during peak events is often fossil fuel intensive; therefore reducing the peak demand also reduces the need for fossil fuels. There are a variety of technologies that support demand response including water heaters, electric vehicle charging, residential battery storage, etc.

Emissions Reduction Potential and Cost Effectiveness of Actions

Table 2 presents the emissions reduction potential and marginal cost effectiveness for the building-related actions. Installation of solar PV systems was found to be the most cost-effective strategy – resulting in a negative cost, or a financial savings over the system lifespan. While it is true that solar PV systems can have a long payback period – as long as 20 years – these systems operate for up to 30 years or more – meaning 10 years or more of free electricity once the system has been paid for. Solar is a great option for some homes and businesses, but not all locations are the same and therefore this strategy is limited to an estimate of achievable potential for the Milwaukie community.

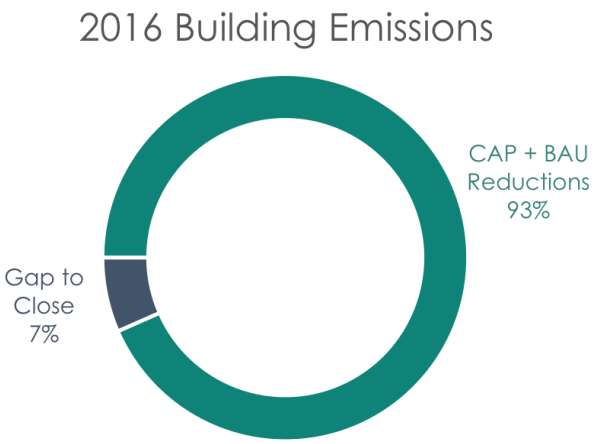


Figure 4: Fraction of Milwaukie's GHG emissions that will be reduced Milwaukie's action and existing State and Federal Policy

Energy efficiency provides significant additional mitigation potential. "Cost-effective" energy efficiency potential is included in the business-as-usual

forecast and is not included in the table below. Energy Trust of Oregon is in charge of implementing the lowest cost energy efficiency upgrades up to the current price of power. The actions prioritized for Milwaukie's climate action plan seek to go beyond only the lowest cost or "cost-effective" options. "Cost effective" is defined as less than the cost of adding power generation at the current retail rate for power. If a cost of carbon were added to power, the definition of "Cost effective" would change. Currently, the most cost-effective way to do this is by implementing more stringent State of Oregon Building Codes. These code changes won't require significant City staff resources and will result in significant energy savings on homes built after 2018.

To address energy efficiency in existing buildings, workshop participants selected three actions to drive efficiency improvements – energy scores for residential and commercial buildings, PACE financing program, and addressing issues in multi-family rental properties. Emissions savings from these actions are significant, but the emissions reductions will be more expensive. These actions will require City staff time to develop and administer the programs and energy efficiency measures will also be more expensive.

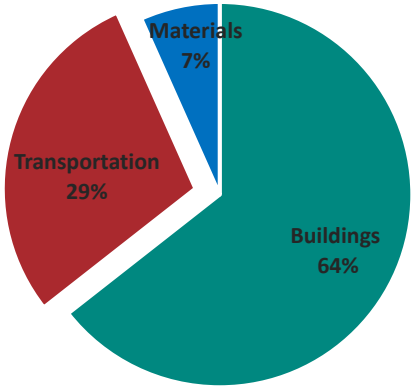
Table 2: Emission reduction potential and cost-effectiveness for building-related actions. *Note that a negative number in "Marginal Cost Effectiveness" implies savings over time.*

Strategy	Action	Emissions Reduction versus 2016 Emissions (MT CO_2e)	Marginal Cost Effectiveness ($ / -1 MT CO_2e)
Strategy 1: Energy Efficiency			
	Utilize existing ETO programs to install cost-effective energy efficiency (*represents existing BAU policy, but presented here for scale)	22,300	-$150 to $0
	City staff to advocate for updated building energy codes at the state level	3,300	$3
	PGE to implement demand response programs in Milwaukie	4,300	To be determined
	City to adopt a commercial and residential building energy score program	5,800	$1 - $200
	Revise City regulations to encourage multifamily energy efficiency upgrade	1,800	$1 - $200
Strategy 2: Energy Sourcing			
	Net zero electricity by 2035	54,000	To be determined
	Net zero natural gas by 2040	48,000	$15
	Community solar project at City facility (Commercial - 300 kW system)	100	-$100
	City to support community installation of solar PV systems		
	Residential Sytems (4 kW)	1,800	-$60
	Commercial Systems (100 kW)	4,300	-$75
Strategy 3: Regional Planning Coordination			
	Develop a comprehensive sustainability plan for Clackamas County	Emissions are not scalable prior to plan development	
	Building-related Subtotal (does not include BAU actions):	**123,400**	
	BAU Existing Policy Reductions:	**34,500**	
	CAP + BAU Reductions as a % of 2016 Baseline Material Emissions:	**93%**	

Vehicle Fleets and Fuels

Description of Prioritized Actions

The following sections provide a description of the action prioritized during the Vehicle Fleet and Fuels workshop with implementation partner technical experts.



For City of Milwaukie's light fleet, identify and replace least efficient vehicles with most efficient vehicles

City staff have already begun to identify and replace vehicles that are underutilized. Milwaukie's fleet department has saved 450 gallons of fuel by replacing vehicles with more efficient versions. Further efforts to electrify the light vehicle fleet and adopt practices that will increase overall fleet efficiency. Electric vehicles and charging infrastructure, combined with electricity from renewable and other low-carbon generation sources, is the City's largest opportunity to significantly increase vehicle and equipment energy efficiency and substitute a low-carbon fuel for gasoline. The opportunities for the city's fleet, given changes that have already been adopted, transitioning police cruisers to EVs as those models become widely available (earlier to mid-2020s) and hybrid vehicles to EVs when replacement timelines are conducive. EV technology is market-ready and cost competitive for mid-sized sedans and similar circumstances for different model classes are predicted to arrive by 2025. EVs should then be substituted for gasoline vehicles as soon as technologically and financially viable. The timeline and prioritization for vehicle replacement will depend on the replacing vehicles in an order that most appropriately maximizes GHG reductions and reduces the capital cost constraints for Milwaukie. The 2017 City of Portland Electric Vehicle Strategy, outlines effective strategies to displace internal combustion engine (ICE) vehicles for electric vehicles including charging infrastructure, fleets, personal vehicles and shared mobility, innovation and information, and economic development.

For City of Milwaukie's light fleet, align and justify fleet use with true needs

This action will reduce the overall size of the fleet to the most suitable number of vehicles to meet the needs of the City. Recently, Milwaukie's fleet has reduced the fleet number and size of vehicles by increased sharing of vehicles in the department and ensuring the right vehicle for the task. In 2017, Milwaukie's fleet department sold eight pieces of surplus equipment for a total value of $16,000 and in 2018 the department anticipates selling 20 vehicles and equipment for a total of $90,000. Part of these effort will be to right-size the fleet to ensure that the types of vehicles owned and operated meet the uses needed but also reduce emissions overall. For instance, most vehicles could be electric for in-City and regional daily travel, but a certain percentage may be needed for longer distance, less frequent work travel – indicating a hybrid vehicle. One potential strategy that could be useful in right-sizing the fleet and identifying additional potential for use cases is deploying telematics. Telematics refers to equipment that allows collection of vehicle operational data such as fuel use, maintenance, utilization, idling, location, routing or mapping of trips, emissions, braking patterns and speed. These telematic units on the vehicles and equipment show the greatest potential opportunities to reduce fleet size, fuel use, unnecessary maintenance and implement opportunities to right-size vehicles and conduct driver training to reduce fleet costs.

For City of Milwaukie's heavy-duty fleet, target diesel fleet for conversion to low carbon fuels

Rather than replacing the heavy-duty vehicle fleet, as the prior action identifies, this action will transition the heavy-duty fleet to lower carbon fuels to decrease the intensity of these vehicles. Renewable and biodiesel offers the potential to almost fully replace conventional diesel fossil fuel with a fuel made from low-carbon, plant-based feedstocks that are certified in Oregon's Clean Fuels Program. Specifying ODEQ certified, lower-carbon fuels is essential to avoid purchasing fuels with lifecycle emissions greater than conventional B5 diesel fuel. The City will work with local and regional partners to identify and secure additional supply of low carbon 99% blend of renewable diesel (R99) or use cooking oil biodiesel (B99) as soon as possible to substitute for 100% of the City's current diesel use. The R99 or B99 will be certified as a low-carbon fuel in Oregon's Clean Fuels Program.

Partner with the school district, waste haulers, and waste water agency on fleet transition

The City can leverage partnerships with local partners particularly North Clackamas School District, Waste Management, and Water Environment Service (WES) to develop Renewable Natural Gas for operating fleets. Waste Management has already transitioned its fleet of trucks to compressed natural gas (CNG) that serve City of Milwaukie. While the fleets could still pursue the Renewable Natural Gas from other sources, WES has already committed the surplus gas to a combined heat and power system onsite.

Bulk purchasing of EVs

This action would seek to leverage bulk purchasing to reduce the upfront cost of EVs. Oregon's Department of Administration Services (DAS) is a good resource. Brian King, Fleet and Parking Services Manager, and Kelly Mann, State Procurement Analyst, both with DAS can be a helpful conduit for information related to bulk purchasing and identifying current changes to programs and incentive structures. Price agreements allow for purchases by state agencies including the Oregon Cooperative Procurement Program (ORCPP). Currently, there are no formal incentives for public agencies for EV purchases, however, DAS has had experiences working with dealers that share the federal tax credit based on their level of tax burden. Also the details of the state of Oregon's zero emission vehicle rebate program are forthcoming and will identify the rebate amount and the low and moderate income thresholds for households interested in purchasing a vehicle.

Incentivize multi-family complexes to install EV charging infrastructure

This action seeks to incentivize EV parking and charging infrastructure for new multi-family construction projects to more effectively offer on-site charging options. The City of Portland has mandated that all new parking lots have 5% of spaces that are charger ready. Given the predicted timing and adoption of EVs it is worthwhile to install charging conduit into all parking spots because it is a relatively low cost during *new* construction. However, this cost is substantially more when it comes as a retrofit, costing at a minimum $500 per space in addition to the Level 2 charger. PGE's team, particularly Aaron Milano, are a valuable resource that are interested in assisting the City to install more EV charging stations.

Incentivize workplace charging in parking lots

While most EV owners are going to charge at home due to convenience and cheaper electricity prices at night, some EV owners that do not have access to off-street parking and the functionality of charging at their residence. Parking lot charging, whether workplace or public parking charging will become a more important as the transition to EVs continues. Many workplaces are installing EV charging stations as a low-cost benefit to their employees and as a recruitment tool. Milwaukie has the benefit of partnering with PGE and learning from its experience with Electric Avenue.

Outreach efforts to encourage shift to EV

The City has a few strong partners and outlets to encourage the community to make an EV their next vehicle purchase. Forth, based in Portland, offers ride and drive events and is also actively engaging underserved communities. PGE is supportive of this effort and is installing quick charging infrastructure, Electric Avenue an "electric gas station" in Milwaukie. In Portland, a similar station allows the community to observe and talk to drivers about their experience. Milwaukie, can further assist in education and outreach efforts by providing information through farmers' markets and business organizations. Milwaukie can also partner to co-host education and outreach events.

Micro-transit from park-and-ride or light rail station to local destinations

This action is meant to provide an additional layer to transportation options and solve the challenge of last-mile connections, by transporting people from major transit stations to their final destination. In recent years, electric vehicles coupled with autonomous technology have advanced. Companies such as EasyMile (and others emerging) are manufacturing micro-transit EV buses that can transport up to 15 passengers that can be used for regular route patterns (similar to bus route) or on demand routes (similar to Uber, Lyft, or taxi) to reduce the use of SOVs.

Emissions Reduction Potential and Cost Effectiveness of Actions

Table 3 presents the emissions reduction potential and marginal cost effectiveness for the Fleet and Fuels-related actions.

The shift to individual ownership and fleet use of EVs demonstrates the most cost-effective strategy for reducing community GHGs. At a high level, the transition to EVs is anticipated to be 10% by 2035 based on Metro's Climate Smart modeling. For the purposes of comparison, 50% and 100% transition to EVs was modeled for the CAP. The shift in the individual ownership and use of EVs for transportation will require several CAP actions to support the transition from internal combustion engine vehicles (ICE) to EVs. EVs are on par or save money compared to ICE vehicles and will only become more cost competitive as more models start to enter the market in the next few years.

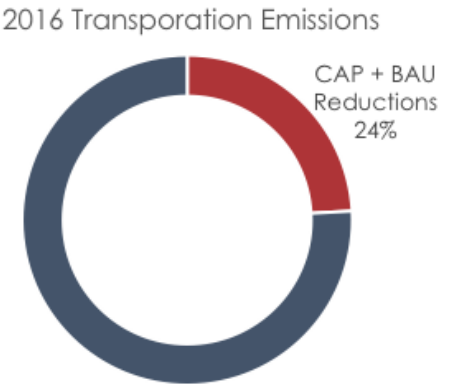


Figure 5: Fraction of Milwaukie's GHG emissions that will be reduced Milwaukie's action and existing State and Federal Policy

For Milwaukie's own fleet, the greatest opportunity for GHG reductions are in transitioning the police fleet to EVs when those models become available and continuing the efforts of Milwaukie's fleet department to right size vehicles and transition to EVs as models for specific uses (e.g., class 3-

4 truck) become available. In the near term, using R99 renewable diesel or used cooking oil biodiesel B99 from low-carbon sources is a good strategy for offsetting current diesel fuel usage in vehicles that have low to moderate use, and EV replacement is not possible or cost effective.

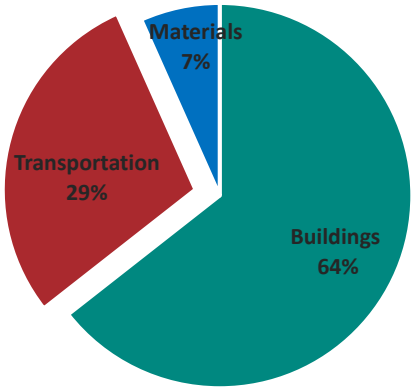
Table 3: Emission reduction potential and cost-effectiveness for vehicle and fuel-related actions. *Note that a negative number in "Marginal Cost Effectiveness" implies savings over time.*

Strategy	Action	Emissions Reduction versus 2016 Emissions (MT CO_2e)	Marginal Cost Effectiveness ($ / -1 MT CO2e)
Strategy 1: Vehicle Efficiency			
	Identify and replace City's least efficient light-duty vehicles with most efficient vehicles	200	-$40
	Align and justify light-duty fleet use with actual service needs	10	-$325
Strategy 2: EV Transition and Vehicle Fuels			
	Incentivize workplace and multi-family EV charging	500	$25
	Implement "EV ready" building codes or zoning regulations. Opportunities could include: 1) Providing incentives through zoning, 2) Implementing public area requirements	2,500	$3
	Public outreach to encourage shift to EV	4,000	-$175
	Partner with waste haulers, school districts and wastewater on fleet transition	Data unavailable	
	Target City's heavy-duty diesel fleet for conversion to low carbon fuels	100	$58
	Material-related CAP Subtotal (does not include BAU actions):	**7,310**	
	BAU Existing Policy Reduction Subtotal:	**11,000**	
	CAP + BAU as % of 2016 Baseline Transportation Emissions:	**24%**	

Land Use and Transportation Planning

Description of Prioritized Actions

The following sections describe the Land Use and Transportation Planning actions prioritized during the workshop with implementation partner technical experts.



Implement a Transportation Management Agency (TMA) with area partners to create a better vision for transit serving Milwaukie and Clackamas County communities

This action is directed as a coalition and partnership effort that will serve as the foundation to implement future climate action. Milwaukie will coordinate with Clackamas County, Metro, TriMet, as well as neighboring communities. PGE will also serve as a partner as it relates to net zero plan components (e.g., electric vehicles, last mile connection via EV micro-transit). The following plans and partner staff will contribute to the formation and integration with partners. Metro's Climate Smart Strategy has a number of the needed strategies and actions to address decarbonization of the transportation sector. This document served as an important reference in scaling the types of actions that Milwaukie is interested in adopting.

Implement "EV ready" building codes or zoning regulations

This action provides the building code or zoning regulations that can more easily integrate EVs into new buildings in Milwaukie. Some of the opportunities include providing incentives through zoning and implementing public area requirements for EV charging stations that can accommodate

residents and businesses. The City of Portland has also adopted this action as a method for facilitating greater adoption of EVs. Note that many new vehicles have a standard 3 prong outlet for charging the vehicles over night.

Lower parking ratios near high capacity corridors

City staff and elected officials will continue to develop and implement the mechanisms to reduce parking ratios in high capacity corridors to increase housing density with lower parking requirements. Currently, staff is conducting a study via Rick Williams Consulting and the lessons learned in this study will indicate the potential locations and timing of designated current parking areas as new multi-family construction. This action will most likely take a number of years to implement effectively.

Implement variable system development charges (consider square footage, etc.) to encourage ADU development

City staff will consider altering the permitting cost structure and system development charges (SDCs) for accessible dwelling units (ADUs) in order to incentivize greater adoption. In 2010, the City of Portland implemented favorable ADU changes by waiving the SDCs for ADUs for three years (which was extended an additional three years) and increased the maximum allowance for square footage of ADUs from 33% to 75% (but capped at 800 ft^2). Portland also offers a zero-interest loan program for ADUs up to $80,000. These changes resulted in 30 ADUs being constructed annually to 200 ADUs annually. As Oregon DEQ has identified via its life-cycle materials and energy use research, ADUs are an effective approach to GHG reduction as they consume less energy and require fewer building materials to construct. Additionally, ADUs more fully utilize existing land that might not otherwise be accessible to development, displacing the need for greenfield development. ADU occupants tend to use multi-modal transportation rather than driving single occupancy vehicles and also have less room for buying or keeping objects.

Partner with Metro and TriMet to increase bus service, particularly to underserved employment areas

City planning staff will continue to coordinate with Metro and TriMet partners to provide additional service. Greater options for bus travel to Milwaukie residents, particularly areas of the community that are not well served by bus service currently can lead to the reduction of individual SOV trips. TriMet is currently conducting a community survey to direct future changes to bus operations including increasing bus service, expanding service areas, additional service hours, reliability, safety, capital improvements, and fares. Milwaukie will continue to participate in TriMet's HB 2017 transit committee.

Incentivize employers to encourage active transportation

This action will direct efforts to engaging local employers to encourage more active transportation options, particularly bicycling and walking. By shifting to more active transportation options, vehicle miles traveled (VMT) in single occupancy vehicles decreases but this transition also has public health benefits due to increased levels of exercise and decreased stress. For Milwaukie, this action will target projects that can also implement infrastructure to ensure safe routes to industrial areas. Portland's Bureau of Transportation developed a brief transportation toolkit geared to employers to learn about the benefits of active transportation and multi-modal options for employees.

Implement parking pricing in downtown

This action focuses on implementing a price for parking in the downtown area in Milwaukie in order to encourage the adoption of alternative transportation modes. Milwaukie is currently conducting a parking study with a consultant to better understand the thresholds for current parking space usage by area Implement parking pricing in downtown. This study is anticipated to be completed at the end of summer 2018 but parking pricing will largely depend on the occupancy rates and changes to use patterns that can lead to effective use of this strategy.

Continue to promote a "fee in lieu of" for areas outside of pedestrian corridors that do not need infrastructure improvements and redirect funds to corridors that do

One of the action ideas that emerged from the workshop was to promote further to homeowners and developers their ability to pay a fee in lieu of developing sidewalks on a street that does not have them. Rather, the moneys go to programs to fill critical gaps in high use pedestrian and bike paths.

Promote "neighborhood hubs" through Comprehensive Plan policies

One of the initiatives Milwaukie is embracing is the development of neighborhood hubs that can serve as centers the reduce the distance for communities to reach work and everyday services like grocery stores, restaurants, and community active spaces. These hubs can serve the function of reducing trip times and modes of transportation, making a neighborhood more walkable or bikeable, but also serve a social function, allowing for greater community engagement and cohesion. The Comprehensive Plan and vision process led to the community's interest in this action area and will serve as one of the areas that also assists the CAP process and implementation.

Emissions Reduction Potential and Cost Effectiveness of Actions

Table 4 presents the emissions reduction potential and marginal cost effectiveness for the Land Use and Transportation Planning-related actions.

Development of smaller axillary dwelling units and other smaller housing was found to be the most cost-effective strategy – resulting in a savings per GHG reduction - as well as the strategy with the greatest emissions reduction potential. The financial and emissions reductions are a combination of reduced construction costs, reduced material use and shorter construction times compared to average single-family homes in addition to the lifecycle energy cost and emissions savings.

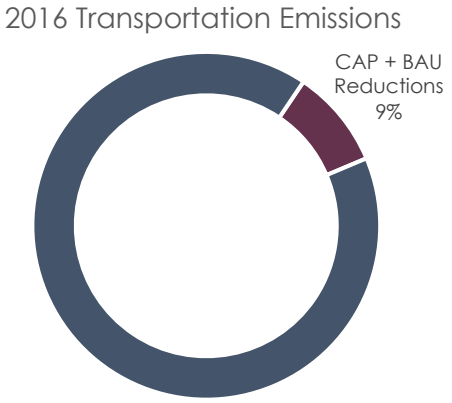


Figure 6: Fraction of Milwaukie's GHG emissions that will be reduced Milwaukie's action and existing State and Federal Policy

The cost effectiveness of the other actions on Table 4 is based on cost and savings estimates associated with implementation of the Climate Smart Strategy which is based on the 2014 Regional Transportation Plan. Cost data is not available for each strategy included in the plan therefore total costs and savings are applied to each action. Mitigation potential is greatest for expansion of transit services followed by

parking pricing; development of bike and pedestrian infrastructure; and development of neighborhood hubs – all of which have very similar reduction potentials.

Table 4: Emission reduction potential and cost-effectiveness for land use and transportation planning-related actions. *Note that a negative number in "Marginal Cost Effectiveness" implies savings over time.*

Strategy	Action	Emissions Reduction versus 2016 Emissions (MT CO_2e)	Marginal Cost Effectiveness ($ / -1 MT CO2e)
Strategy 1: Support Transit and Multi-Modal Transportation			
	Implement a Regional Transportation Agency with Clackamas County	Supports reductions in other Actions	
	Partner with Metro and Trimet to increaes bus service, particularly to underserved employement areas (e.g. micro-transit from major stations)	3,900	$190 [1]
	Work with partner organizations to complete bicycle and pedestrian gaps and to promote new connections options to residents.	700	$190 [1]
	Implement a "fee in lieu of" for areas outside of pedestrian corridors that do not need infrastructure improvements and redirect funds to corridors that do		
	Implement parking pricing in downtown	800	Not scalable
Strategy 2: Increase Urban Density			
	Implement variable system development charges (consider square footage, etc.) to encourage ADUs.	1,000	-$1,000
	Promote "neighborhood hubs" through Comprehensive Plan policies	600	$190 [1]
Land Use & Planning -related CAP Subtotal (does not include BAU actions):		**7,000**	
BAU Existing Policy Reduction Subtotal:		**0**	
CAP + BAU as % of 2016 Baseline Transportation Emissions:		**9%**	

Appendix A – Material Data and Assumptions

Action Description	Data and Assumptions used in Calculations
City Public Works to use less impactful pavement alternatives, as appropriate	• *Baseline concrete mixes use 100% Portland cement* • *Action concrete mixes use 85% Portland cement and 15% blast furnace slag (BFS)* • *Baseline asphalt mixes are assumed to use 0% RAP* • *Action asphalt RAP mixes are assumed to use 30% RAP* • *Action asphalt RAP greenhouse gas values are based on values from Environmental Protection Agency's Waste Reduction Model (EPA WARM)* • *Action concrete SCM greenhouse gas values are based on National Ready Mix Concrete Association Environmental Product Disclosures* • *Action asphalt 30% RAP mix is assumed to not increase materials costs based on City of Eugene and Knife River reporting on recent material pricing. Note 1 - Material prices are subject to significant change over time.* • *Action concrete 15% BFS mix is assumed to not increase materials costs based on City of Eugene and Knife River reporting recent materials pricing. Note - Material prices are subject to significant change over time.*
City staff to provide community education around food waste and prevention	• *Action assumes a 10% reduction in food waste from 2016 baseline, or roughly 125 short tons per year* • *Action cost assumes 1 full time employee at fully loaded cost of $100,000 per year.* • *Action cost assumes the value of the avoided food waste a $2.50 per pound based on ReFed Road Map Report (pg. 5)* • *Baseline and Action greenhouse gas emissions calculated using EPA WARM set using Landfill and Source Reduction*
City staff and to promote existing residential commercial food waste composting opportunities and use mulch and compost in operations	• *Action assumes a 25% reduction in landfilled food waste to composting from a 2016 baseline.* • *Action assumes $0 additional marginal capital cost for residential disposal. System is already established. Additional marginal cost for commercial food waste data is not available and therefore not included.* • *Actions assumes a Metro transfer station fee of $96 per ton for landfilled materials and $64 per ton for composted materials*
City to require deconstruction and / or delay property demolition	• *It is assumed that recovered materials will be primarily dimensional lumber and metal goods based on City of Portland case studies.* • *Recoverable materials quantities were estimated using ODEQ's waste composition study (1,000 ton of wood and 100 tons of metal annually)* • *Baseline and Action emissions are based on values from Environmental Protection Agency's Waste Reduction Model (EPA WARM)* • *It is assumed that the Baseline cost of mechanical deconstruction is $7,500 and Action deconstruction is $15,000* • *Action includes a cost savings for avoided tip fees of $96 per ton*
City to require deconstruction and / or delay property demolition	• *It is assumed that recovered materials will be primarily dimensional lumber and metal goods based on City of Portland case studies.* • *Recoverable materials quantities were estimated using ODEQ's waste composition study (1,000 ton of wood and 100 tons of metal annually)* • *Baseline and Action emissions are based on values from Environmental Protection Agency's Waste Reduction Model (EPA WARM)* • *It is assumed that the Baseline cost of mechanical deconstruction is $7,500 and Action deconstruction is $15,000* • *Action includes a cost savings for avoided tip fees of $96 per ton*
City to work with county partners to host neighborhood repair events and promote local repair businesses	• *Action assumes 0.5 full time employee for program staffing* • *Cost effectiveness for waste prevention, which includes repair and reuse, presented in Oregon's Cost of Carbon Abatement Curves found the cost effectiveness of waste prevention at -$272 / MT CO2e. This value was adjusted with FTE cost.* • *ODEQ literature review found that programs of this type reduce BAU emissions by 0.7% annually. Action emissions reductions were calculated based on 0.7% of Milwaukie's 2016 emissions for clothing, furniture, and other goods.*
Showcase best practices through a City demonstration project at Ledding Library	• *Data was not available to scale this action*

Appendix B – Building Data and Assumptions

Action Description	Data and Assumptions used in Calculations
City staff to advocate for updated building energy codes at the state level	• *10% of 1 full time employee staff annual time for 1 year (~200 hours) to participate in meetings* • *1 FTE cost assumed to be equal to $100,000 per year* • *Marginal capital costs are assumed to be $0 as building codes are required* • *Marginal energy savings are assumed to be $0 as building codes are required* • *Baseline greenhouse gas emissions are based on 2016 residential and commercial energy use* • *Action greenhouse gas emissions are based on an estimate of 8% savings by Oregon Department of Energy staff for 2018 residential and 2019 commercial building code updates* • *Action greenhouse gas emissions are based on an assumption of a net zero residential energy code in 2025 and that a net-zero energy code is equivalent to net zero emissions*
City to adopt a commercial and residential building energy score	• *50% of 1 FTE for 2 years to develop and implement the programs* • *1 FTE cost assumed to be equal to $100,000 per year* • *Marginal energy costs are based on Energy Trust of Oregon's range of levelized costs for energy. For electricity achievable electric efficiency measures have a cost of between $87 and $115 per MWh. For natural gas achievable measures have a cost of between $1.06 and $2 per therm.* • *Baseline GHG emissions are based on Milwaukie's 2016 community GHG inventory.* • *Action GHG emissions are based on ETO's estimate of achievable efficiency potential to 2035 in their service area down-scaled by retail electricity deliveries.*
City to implement a Property Assessment for Clean Energy Program	• *50% of 1 FTE for 2 years to develop and implement the programs* • *1 FTE cost assumed to be equal to $100,000 per year* • *Marginal energy costs are based on Energy Trust of Oregon's range of levelized costs for energy. For electricity achievable electric efficiency measures have a cost of between $87 and $115 per MWh. For natural gas achievable measures have a cost of between $1.06 and $2 per therm.* • *Baseline GHG emissions are based on Milwaukie's 2016 community GHG inventory.* • *Action GHG emissions are based on ETO's estimate of achievable efficiency potential to 2035 in their service area down-scaled by retail electricity deliveries.*
Revise City regulations to encourage multifamily energy efficiency upgrades	• *10% of 1 FTE for 2 years to develop and implement the program* • *1 FTE cost assumed to be equal to $100,000 per year* • *Marginal energy costs are based on Energy Trust of Oregon's range of levelized costs for energy. For electricity achievable electric efficiency measures have a cost of between $87 and $115 per MWh. For natural gas achievable measures have a cost of between $1.06 and $2 per therm.* • *Baseline GHG emissions are based on Milwaukie's 2016 community GHG inventory.* • *Action GHG emissions are based on ETO's estimate of achievable efficiency potential for multi-family to 2035 in ETO's service area down-scaled by retail electricity deliveries.*
Community solar project at City facility (Commercial - 300 kW system)	• *Assumes site location as 6101 SE Johnson Creek Blvd and that PV solar would be installed at multiple buildings* • *Total system capacity is estimated at 280 kW using Mapdwell Solar System™ Portland* • *System lifespan is assumed to be 30 years* • *Total system first cost is estimated at $500,000* • *Annual revenue is estimated at $34,000*
City to support community installation of solar PV systems	• *PGE Market Assessment for achievable solar potential was downscaled by retail sales for Milwaukie* • *Emissions reductions are calculated using PGE's 2016 emissions factor* • *System lifespan is assumed to be 30 years* • *Annual panel degradation rate assumed to be 0.5%* • *Average residential system size assumed at 4 kW and commercial at 100 kW* • *Year 1 residential electric output is 4,500 kWh and commercial is 110,000 kWh. Calculated with PVwatts* • *Total system first cost is aligned with 2016 values from PGE's study $3.40 per watt for residential and $2.40 per watt for small commercial* • *Year 1 energy costs are assumed to be $0.10 for residential and $0.09 for commercial.* • *Energy costs are escalated at 3% annually*
Develop a comprehensive sustainability plan for Clackamas County	• *Data was not available to scale this action*

Appendix C – Fleets and Fuels Data and Assumptions

Action Description	Data and Assumptions used in Calculations
For City of Milwaukie's light fleet, identify and replace least efficient vehicles with most efficient vehicles	• *Baseline conditions uses last 12 months (2017-2018) of vehicle fuel consumption ~26,000 gallons and ~250,000 miles.* • *Baseline fuel type is assumed to be 100% gasoline and alternative fuel type is assumed to be 100% PGE retail electricity* • *Action assumes EV uses 57 kWh per 100 miles (adjusted for idle time) and 32 kWh / 100 miles under normal operating conditions.* • *Action assumes BEV maintanance cost of $0.125 / mile and gasoline ICE maintanance cost of $0.137 / mile* • *Action assumes transition of 40 ICE vehicles in the lighter class of vehicles* • *Action assumes a $3.00 gasoline price and $0.09 electricity price* • *Action assumes GHG emissions for gasoline based on Argonne National Lab, AFLEET tool.* • *Action assumes GHG emissions for Scope 2 electricity emissions based on Oregon DEQ's emissions factor.*
For City of Milwaukie's light fleet, align and justify fleet use with true needs	• *Baseline conditions of Milwaukie's fleet data includes annual mileage and fuel use for last 12 months (2017-2018).* • *Action assumes Milwaukie's most efficient vehicle is substituted for 10% of annual vehicle mileage for all other passenger vehicles, light-duty trucks, medium-duty trucks.* • *Action assumes no right sizing changes are made for heavy duty vehicles as it is assumed these vehicles are only used when there is no other alternative.* • *Action assumes no additional capital costs for EVs.* • *Action assumes fuel savings are calculated based on a fuel cost of $3.30 per gallon.*
For City of Milwaukie's heavy duty fleet, target diesel fleet for conversion to low carbon fuels	• *Baseline conditions accounts for diesel fuel being used in current volumes of usage ~8,300 gallons per year based on past 12 months (2017-2018).* • *Action assumes a substitution of diesel fuel with 100% low-carbon sourced renewable diesel (R99).* • *Action assumes working with local and state partners to contract a supply of ODEQ certified renewable diesel (R99) for 100% of the City's current diesel use.* • *Action assumes renewable diesel prices have a $0.60 premium over conventional diesel.* • *Action assumes fuel heat contents and emissions factors from Argonne's AFLEET tool.*
Incentivize multi-family complexes to install EV charging infrastructure	• *Baseline conditions accounts for Milwaukie's 2016 Community GHG Emissions for on-road travel using gasoline.* • *Action assumes the installation of EV chargers at new multi-use parking structures in Milwaukie.* • *Action assumes that Milwaukie matches City of Portland's approach of requiring that 5% of parking spaces be equipped with EV chargers (all other parking spaces could be wired and charger ready). In addition to 5% of spaces, 50% of parking spaces was modeled as a point of reference for cost and GHG mitigation potential.* • *Action assumes costs are estimated based on a first cost of $2,000 / charger for Level 2 public chargers (equipment and installation).* • *Action calculates the difference between the carbon intensity of gasoline versus NWPP electricity.* • *Action assumes that 1,380 multi-family units will be built by 2035 based on the Milwaukie housing survey.*
Incentivize workplace charging in parking lots	• *Baseline conditions accounts for Milwaukie's 2016 Community GHG Emissions for on-road travel using gasoline.* • *Action assumes the installation of EV chargers at workplace parking lots at 15% and 50% penetration.* • *Action assumes that between 345 and 2,298 parking spaces are installed with Level 2 EV chargers , based on 15% and 50%.* • *Action assumes the average commute distance is assumed to be 15 miles.* • *Action assumes costs are estimated based on a first cost of $2,000 / charger for Level 2 public chargers (equipment and installation).*
Outreach efforts to encourage shift to EV	• *Data was not available to scale this action*
Micro-Transit and Last Mile Connection	• *Data was not available to scale this action*

Appendix D – Land Use / Planning Data and Assumptions

Note: These actions were downscaled using GHG and cost data from Metro's Climate Smart GreenSTEP modeling.[2]

Action Description	Data and Assumptions used in Calculations
Implement a Regional Transportation Agency with Clackamas County	• *Supports reductions on other CAP and future actions*
Partner with Metro and Trimet to increaes bus service, particularly to underserved employement areas (e.g. micro-transit from major stations)	• *Transit revenue miles per captica will increase from 0.8x to 1.4x* • *2016 baseline transportation emissions equal 2.4 MT CO2e / person. Based on 2016 Milwuakie GHG inventory* • *Percentage of workers participating in employer commuter programs increases by 10% between 2016 and 2035.* • *Metro estimates regional system improvement costs for transit through 2035 equal $7.2 billion. This cost is downscaled per captita for Milwaukie to about $4,000,000 annually.* • *Percentage of households participating in targeted marketing increases by 15% between 2016 and 2035.* • *Additional transit service redues per captia emissions 17% from baseline. Based on Metro Climate Smart Modeling - Phase 1 Sensitivity Analysis.*
Work with partner organizations to complete bicycle and pedestrian gaps and to promote new connections options to residents.	• *2016 baseline transportation emissions equal 2.4 MT CO2e / person. Based on 2016 Milwuakie GHG inventory* • *Percentage of workers participating in employer commuter programs increases by 10% between 2016 and 2035.* • *Metro estimates regional system improvement costs for transit through 2035 equal $900 million. This cost is downscaled per captita for Milwaukie to about $500,000 annually.* • *Percentage of households participating in targeted marketing increases by 15% between 2016 and 2035.* • *Percent of drive alone trips that shift to bikes increases by 8% from 2016 to 2035.* • *Emissions are reduced by 4% per capita. Based on Metro Climate Smart Modeling - Phase 1 Sensitivity Analysis.*
Implement a "fee in lieu of" for areas outside of pedestrian corridors that do not need infrastructure improvements and redirect funds to corridors that do	• *Scaling calculations for this action combined with Bike and Pedestrian action above.* • *Bike / ped reductions are increased by 15% to account for "fee in lieu of". This assumption is meant to account for the benefits of additional money available to make bike / ped upgrades*
Implement variable system development charges (consider square footage, etc.) to encourage ADUs.	• *Assumes Milwaukie needs an additional 1,068 houseing units by 2036. Based on City of Milwaukie's HOUSING AND RESIDENTIAL LAND NEEDS ASSESSMENT.* • *Assumes new housing is built with 30% less square footage than existing baseline housing. ODEQ found that decreasing a homes area by 30% (2,300 to 1,600 square feet) reduced lifecycle energy use by 15%.* • *Assumes a building cost of $150 per square foot* • *Residential electricity cost is $0.10 per kWh* • *Residential natural gas cost is $1.10 per therm*
Promote "neighborhood hubs" through Comprehensive Plan policies	• *Percent of households living in walkable, mixed-use areas increases by 11% between 2016 and 2035.* • *Percentage of workers participating in employer commuter programs increases by 20% between 2016 and 2035.* • *Percentage of households participating in targeted marketing increases by 40% between 2016 and 2035.* • *Percent of drive alone trips that shift to bikes increases by 11% from 2016 to 2035.* • *Data to support the cost effectiveness calculations are not available for each individual action. Cost effectiveness here is calculated based on Metro's projected costs and savings for implementation of the Climate Smart Strategy for the region.*
Implement parking pricing in downtown	• *Percentage of employees paying to park increased by 17% between 2016 and 2035* • *Percentage of non-work tripics paying to park increases by 22% between 2016 and 2035* • *Emissions are reduced by 5% per capita. Based on Metro Climate Smart Modeling - Phase 1 Sensitivity Analysis.* • *Data to support the cost effectiveness calculations are not available for each individual action. Cost effectiveness here is calculated based on Metro's projected costs and savings for implementation of the Climate Smart Strategy for the region.*

[2] See Summary of Key Scenario Analysis Inputs and Outputs and Phase 1 Sensitivity Analysis. Downloaded 3/2018 at https://www.oregonmetro.gov/sites/default/files/2015/05/29/Metro-GreenSTEP-inputoutput-201501130.pdf and https://www.oregonmetro.gov/sites/default/files/2015/05/29/phase_1_all_sensitivity_analysis_memo_062712.pdf