CASCADIA
PARTNERS

COMMUNITY-SCALE GHG EMISSIONS INVENTORY

METHODOLOGY REPORT

City of Salem and Salem UGB

Prepared by Cascadia Partners
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Introduction

The Intergovernmental Panel on Climate Change (IPCC), the United Nations body that regularly convenes climate scientists, has identified human activity as the primary driver of global climate change. Salem is not immune to the impacts of climate change. Everything from the Willamette Valley produce on our table to the Santiam River water flowing from our taps is susceptible to climate change. Recognizing this, the 2017 Salem Strategic Plan identified a GHG inventory as a way to measure the community's impact on the environment.

This Community Greenhouse Gas (GHG) Inventory report was prepared using the "Global Protocol for Community Scale Greenhouse Gas Emission Inventories" (GPC). The GPC is an internationally accepted method for community-scale GHG accounting that covers a range of emissions sources including transportation, waste production, and energy use. The purpose of this technical report is to document the inventory methodology and provide a replicable snapshot of emissions from human activity within and originating from Salem's UGB and city limits.

EPA Local Greenhouse Gas Inventory Tool

This GHG emissions inventory was conducted with the assistance of the Local Greenhouse Gas Inventory Tool: Community Module, developed for the United States Environmental Protection Agency (US EPA) by the consulting firm ICF. This module was chosen from amongst a small set of software GHG inventory tool options, including ICLEI's ClearPath tool. In general, a software tool is recommended to provide a framework to follow for conducting GHG inventories. Following the framework ensures compliance with the relevant GHG inventory protocol. Following protocols means that the results are comparable between communities, so that one city's community GHG inventory emissions per capita results are generally comparable to those from another city.

The EPA Local GHG Inventory Tool: Community Module was chosen for this project over ICLEI's ClearPath tool, largely to ensure replicability. As of this writing, the City of Salem is not yet a signatory city or member of ICLEI. If it were, ICLEI's tool would be available to it free of charge. However, there is a fee to use the ClearPath tool for non-member jurisdictions, which could become a barrier to conducting future GHG inventory updates in Salem due to budget constraints. As the EPA tool is free to download and use, there should be very few barriers to replicating this inventory in the future for inventory years beyond 2016 using this tool.

The EPA tool and ICLEI's ClearPath tool were developed in compliance with the same protocol: the Global Protocol for Community-Scale Greenhouse Gas Emissions (GPC). Moreover, while the ICLEI ClearPath tool was developed to meet the specific needs of U.S. local governments, the EPA tool is more comprehensive in its adherence to the GPC. This is acknowledged in ICLEI's documentation:

> *"[Users] should refer to the GPC as they establish the scope of their inventory to ensure GPC reporting requirements will be met; at the time of this writing, the GPC requires inclusion of sources and activities that are not required by this protocol. (ICLEI U.S. Community Protocol, p.50)*

GHG Inventory Summary

The results of this GHG inventory are shown in Table 1, for both the area currently within the City of Salem, as well as for the area within Salem's Urban Growth Boundary (UGB), including the City of Salem but excluding areas within any other jurisdictions within the UGB.

Table 1: GHG Inventory Results for Salem

Salem GHG Inventory Results (2016)	**Salem UGB**	**Salem City**
Population	209,072	162,060
Residential (Market-Based, MT CO2e/year)	**317,817**	**271,051**
Electricity (Market-based)	215,967	171,525
Natural Gas	96,815	96,815
Other Fuels	5,035	2,712
Commercial & Industrial (Market-Based, MT CO2e/year)	**380,988**	**380,987**
Electricity (Market-based)	226,497	226,496
Natural Gas	108,434	108,434
Other Fuels	46,057	46,057
Transportation (MT CO2e/year)	**960,732**	**837,185**
Gasoline (E10)	470,527	568,460
Diesel (B5)	461,126	232,468
Jet Fuel	1,567	1,567
Aviation Gasoline	259	259
Non-CO2/Other Transport Emissions, All Sectors	27,253	34,431
Waste (MT CO2e/year)	**104,422**	**84,856**
Landfilled Solid Waste	35,710	18,120
Wastewater Treatment Process	68,712	66,736
Other (MT CO2e/year)	**(20,891)**	**(20,506)**
Agriculture & Land Management (Emissions from Fertilizer)	139	11
Urban Forestry / City Operations	(21,031)	(20,518)
Total Emissions (Market-Based)	**1,743,068**	**1,553,574**
Per Capita Emissions (Market-Based)	**8.34**	**9.59**
Per-Capita Residential Emissions (Market-Based)	1.5	1.7
Per-Capita Energy Emissions	3.3	4.0
Per-Capita Transportation Emissions	4.6	5.2
Per-Capita Waste Emissions	0.5	0.5

The two largest sources of emissions per capita are for energy and transportation. Energy is used mostly for heating, cooling, and electricity use within buildings, suggesting future policy work to bring down building energy use through retrofits and energy fuel shift efforts. Transportation emissions mostly come from private automobile travel; efforts to reduce Vehicle Miles Traveled (VMT) and to shift the fleet from fossil fuels to renewable energy use will be the policy areas to focus on to bring down GHG emissions from transportation sources.

General Assumptions

Year

All data sources for this inventory were from the year 2016. The choice of 2016 was made to line up with the most recently available data from the American Community Survey (ACS). At the time of project scoping, 2012-2016 5-Year ACS data was the most current available. Census data is needed in for some emissions sources in order to back up data that is not locally available

Geographic Scope

The inventory was developed to span two geographic scopes. First, it was calculated for Salem's portion of the Salem-Keizer Urban Growth Boundary (UGB). The purpose of this geographic extent was to create a policy relationship with the City's Comprehensive Plan which is currently being updated. The second geographic scope is the City of Salem's municipal boundary.

An inventory was developed for the City's boundaries in order to facilitate future annual updates. Certain data sources needed to create a community GHG inventory provide reporting only for standard geographies such as city, county, and metropolitan statistical area (MSA) boundaries. This lack of UGB-scale data makes meaningful updates to UGB-scale GHG inventories difficult. Examples of data sources that are not regularly updated or unavailable for the UGB geography are population, electricity use, and urban tree canopy.

Tracking emissions changes over time is one of the primary benefits of performing a community GHG inventory. Not surprisingly, reliable and readily available data sources are essential to accomplishing a multi-year analysis of emissions. The consultant team worked with the City of Salem to arrive at a hybrid approach that provides a single year of UGB-scale inventory data, but also provides a city-scale baseline that can be more meaningfully and readily updated as time goes on.

Population

Population is an important component of any GHG inventory. It is the means by which we can meaningfully compare emissions at the community scale. For Salem, UGB population was estimated using Portland State University Population Research Center estimates for the Salem-Keizer UGB. These estimates were adjusted to reflect the assumed population of Salem's portion of the UGB by subtracting the City of Keizer's municipal population. City population estimates from PSU, which are updated annually, were the source used for the City of Salem's population assumptions. These assumptions are summarized in table 1.

Table 1: Population Controls	Total	Source
Marion County	333,950	PSU PRC (2016)
Polk County	79,730	PSU PRC (2016)
Salem-Keizer UGB (Marion)	218,689	PSU PRC (2017)
Salem-Keizer UGB (Polk)	27,888	PSU PRC (2017)
Salem-Keizer UGB (Total)	246,577	PSU PRC (2017)
City of Keizer	37,505	PSU PRC (2016)
Salem UGB (estimated total)	209,072	Cascadia Partners Estimate
City of Salem	162,060	PSU PRC (2016)

Scope 1

Scope 1 includes all direct GHG emission sources from activities taking place within a community's geopolitical boundary.

Stationary Combustion

Stationary combustion includes residential, commercial, and industrial activities that consume combustible fuel such as natural gas, propane, and fuel oil.

Natural Gas

Natural gas is the most commonly used fuel in stationary combustion activities in most communities. Natural gas service is provided to the City of Salem and surrounding areas by Northwest Natural. While the consumption data received from NW Natural was for the City of Salem only, it was assumed that few users exist outside Salem city limits. The table below shows the city-scale data received from NW Natural for 2016. For the UGB-scale analysis there were assumed to be no additional natural gas users in the unincorporated portion of Salem's UGB.

Table 2: Natural Gas Use (2016)[1]	Therms Delivered	Meters
Residential - City of Salem	18,253,947	33,374
Commercial / Industrial - City of Salem	20,444,652	3,824
Residential - Salem UGB	18,253,947	33,374
Commercial / Industrial - Salem UGB	20,444,652	3,824

Other Stationary Fuels

Aside from natural gas, two other combustive fuels comprise this emissions category – propane (liquid petroleum gas or LPG) and diesel fuel oil. The only reliable Salem-specific source of this data comes from the US Census American Community Survey: House Heating Fuel (table B25040) summarized below. This data source tells us the number of households using this fuel, but not their annual consumption. For that, we use the 2015 Energy Information Administration (EIA) Residential Energy Consumption Survey (RECS). The RECS provides average annual household consumption of these fuels by Census Division.

[1] Source: Northwest Natural

Table 3: Other Stationary Fuels (2016)	City of Salem	Salem UGB	Source
Households Using LPG	320	544	ACS 2012 - 2016 5-Year Est.
Annual HH LPG Consumption (MM BTUs)	24	24	EIA RECS 2015 (Pacific Division)
Area-Wide LPG Consumption (MM BTUs)	7,680	13,056	
Households Using Fuel Oil	515	973	ACS 2012 - 2016 5-Year Est.
Annual HH Fuel Oil Consumption (MM BTUs)	59	59	EIA RECS 2015 (Pacific Division)
Area-Wide Fuel Oil Consumption (MM BTUs)	30,488	57,627	

Stationary Combustion Contacts:

- Natural Gas
    - Bruce Anderson, Community Affairs Manager, NW Natural / Bruce.Anderson@NWNatural.com
    - Rick Hodges, Energy Efficiency Programs Manager, NW Natural / Rick.Hodges@nwnatural.com

Mobile Combustion

Mobile combustion is the use of fuel, primarily gasoline, diesel, and aviation gasoline, from mobile sources within a community's geopolitical boundaries. This includes tailpipe emissions from personal and commercial vehicles on Salem's roads and local air travel originating from Salem's municipal airport.

On-Road Vehicle Travel

By far the largest contributor to Salem's mobile combustion is on-road passenger and commercial vehicle travel. In order to calculate emissions from on-road vehicle travel, three sources of data are required: vehicle miles traveled (VMT), composition of the vehicle fleet, and fuel economy.

Vehicle Miles Traveled (VMT)

The primary source of data for on-road VMT is Mid-Willamette Valley Council of Governments (MWVCOG) and the Salem-Keizer Area Transportation Study (SKATS). SKATS is the Metropolitan Planning Organization (MPO) for the Salem-Keizer area and is run by MWVCOG staff.

SKATS manages the Salem-Keizer Metropolitan Area Travel Demand Model which estimates trips by purpose (work, shop, etc), trip lengths, and the origins and destinations of trips undertaken within the MPO boundary. The model reports VMT summarized to traffic analysis zones (TAZs) and has a base year of 2010 and a forecast year of 2035.

In order to estimate 2016 vehicle miles traveled within Salem's UGB and city boundary, a straight-line projection was performed between the model's 2010 base year and 2035 horizon year. Then, trips occurring within the two inventory geographic areas were isolated by removing trips without at least one trip end within the area of interest. For example, trips starting in Salem, but ending elsewhere were included, but those starting and ending outside the study area were not. For those trips with only one trip end in the study area, only the vehicle miles traveled to the edge of the SKATS boundary were included. That means trips originating in Eugene and ending in Downtown Salem only include vehicle

miles traveled from the southern edge of the SKATS boundary to their end point in Salem. Estimates from the Salem-Keizer Travel Demand model are summarized below:

Table 4: SKATS Travel Model VMT Estimates[2]	2010	2016	2035
Annual VMT - City of Salem	1,379,076,991	1,495,890,182	1,865,798,619
Annual VMT - Salem UGB	1,549,907,401	1,688,043,391	2,125,474,025

Vehicle Fleet Composition

Fleet composition is the share of cars, trucks, motorcycles, and other vehicle types that use Salem's roadways. The best available source for this data is the Federal Highway Administration (FHWA) 2016 Vehicle Survey. This data source provides annual VMT by vehicle type which was applied in a pro-rata share to the annual VMT totals received from the SKATS Travel Demand Model.

Fuel Economy

Fuel economy, measured in miles per gallon, was estimated for light duty, short wheelbase vehicles using the 2017 Oregon Department of Transportation (ODOT) Passenger Vehicle Fuel Economy Survey. This survey provides census block-level fuel economy data for passenger vehicles by type. For all other vehicles, average fuel economy from the FHWA Vehicle Survey was used. Those vehicle fleet composition splits and fuel economy estimates are summarized below:

Table 5: Fleet Composition and Fuel Economy (FHWA - 2016, unless otherwise noted)	Annual VMT	National VMT Share	Fuel Economy (MPG)
Light Duty Short Wheelbase	2,191,764	69%	21.8*
Light Duty Long Wheelbase	657,954	21%	17.4
Motorcycles	20,445	1%	43.9
Buses	16,350	1%	7.3
Single Unit Trucks	113,338	4%	7.4
Combination Trucks	174,557	5%	5.9

** Estimated using 2017 ODOT Passenger Vehicle Survey*

Air Travel

Air travel for the City of Salem includes both local and itinerant aircraft originating from the Salem Municipal Airport. Data on the number of flights and amount of fuel sold in 2016 were provided by airport management. It was assumed that roughly 66% of the fuel sold in 2016 was attributable to Salem's GHG inventory. This was calculated by applying a percent share of attributable trips (all local and 50% of itinerant trips) to the airport's total annual fuel sales.

Table 6: Annual Aircraft Trips (McNary Field, 2016)[3]	Local	Itinerant	Percent Attributable
Annual Aircraft Trips	11,085	23,571	66%

[2] MWVCOG SKATS Travel Model (2015)

[3] Data provided by John Paskell, Manager, City of Salem Municipal Airport

Like on-road emissions, fuel economy was also required to compute GHG emissions for the inventory. This was accomplished using a 2012 Federal Aviation Administration (FAA) database of average fuel economy by aircraft and fuel type summarized in table 7.

Table 7: Aircraft Fuel Economy Estimates (2016)[4]	Attributable Fuel Sold (2016)	Average Aircraft Fuel Economy (MPG)[5]	Attributable VMT (2016)
AV Gas	31,113	12.3	382,641
JetA	163,748	5.0	825,737

Mobile Combustion Contacts

- VMT
  - Kim Sapunar, MWVCOG / KSapunar@mwvcog.org
  - Kindra Martineko, MWVCOG / KMartinenko@mwvcog.org
  - Mike Jaffe, MWVCOG / mjaffe@mwvcog.org
- Fuel Economy/VMT
  - Rebecca Knudson / Rebecca.A.KNUDSON@odot.state.or.us
- Air Travel
  - John Paskell, Manager, Salem Municipal Airport / JPaskell@cityofsalem.net

Solid Waste

Solid waste emissions include those GHGs originating directly from the storage and decomposition of waste within a community's geopolitical boundaries. Salem does have a landfill within its UGB and city limits – Brown's Island Demolition Landfill. This landfill, operated by Marion County, accepts only construction debris and emits little to no measurable CO2e so it was not included in the inventory. As Salem sends the rest of its solid waste outside of city and UGB boundaries, this emissions source was not included in the community-scale GHG inventory. For indirect emissions for solid waste sent outside Salem's geopolitical boundaries, see *Scope 3: Waste Production*.

Wastewater

Wastewater emissions result from the treatment of sewage, runoff, and other contaminated waters originating from households and businesses within the city of Salem and/or its UGB. The EPA Local Greenhouse Gas Inventory Tool requires users to enter the following characteristics related to the local wastewater treatment system. All information in this section was provided by the City of Salem Department of Public Works unless otherwise noted.

Anaerobic or Aerobic Digestion?

The City of Salem serves several communities in the region with wastewater treatment services processing about 200 million gallons of wastewater per day at their Willow Lake Wastewater Pollution Control Facility (WPCF). This facility uses Anerobic Digestion (AD) whereby microorganisms break down organic matter in the absence of oxygen.

[4] Data provided by John Paskell, Manager, City of Salem Municipal Airport
[5] GA Survey: General Aviation and Air Taxi Total Fuel Consumed and Average Fuel Consumption Rate (FAA, 2012)

Biogas Production

Another key element of determining wastewater emissions is the amount of biogas produced during the treatment process and the methane (CH4) content of that biogas. Those figures, provided to the consultant team by members of the City of Salem's public works department, are included below.

Table 8: Willow Lake WPCF Biogas Characteristics

Amount of Digester Biogas Produced Daily (ft3/day)	360,000
Percentage of CH4 in Biogas	61%

BOD_5 Input and Removal

The final component of wastewater GHG emissions is Biochemical Oxygen Demand or BOD_5 input and removal. Based on data received from the City of Salem's Public Works Department, the daily BOD_5 input to the Willow Lake WPCF is 25,288.7 kg per day. Of that, 45% is removed in primary treatment.

Wastewater Contacts

- Public Works
  - Keith Garlinghouse, Utilities Engineer, Public Works / KGARLINGHOUSE@cityofsalem.net
- Wastewater Treatment
  - Jue Zhao, Wastewater Treatment Division Manager / JZhao@cityofsalem.net

Scope 2

Scope 2 emissions are indirect emissions resulting from the purchase of electricity within a community.

Electricity Use

Salem is served by two electric utilities: Salem Electric and Portland General Electric (PGE). While Salem Electric serves customers in Downtown and West Salem, PGE serves the balance of Salem-area customers. The source of the electricity provided by both utilities is different. Salem Electric purchases its power from the Bonneville Power Administration (BPA) as hydro power. PGE, on the other hand, generates and purchases from a mix of sources including hydro and other renewables as well as natural gas and coal. As a result, the amount of CO2e released into the atmosphere for each kilowatt-hour (kWh) each utility provides is different. Table 9 below shows the difference expressed as pounds of CO2e per megawatt-hour (MWh), as reported by the Oregon Department of Environmental Quality.

Table 9: Emissions Factors (2016)[6]	**lb CO2e / MWh**
Portland General Electric (PGE)	824.24
Salem Electric (SE)	26.76

Data on electricity usage from 2016 was received from Salem Electric and PGE. This data included kWh used by sector as well as the number of meters by sector. Table 10 summarizes this information.

[6] List of Potentially Regulated Entities Under Senate Bill 1070 (Oregon DEQ, 2017)

Table 10: Electricity Consumption	Residential		Commercial / Industrial		Street & Highway
Electricity Consumption (2016) - City of Salem	kWh	Meters	kWh	Meters	kWh
PGE (City of Salem Only)	454,956,585	49,949	602,445,916	12,218	7,413,401
Salem Electric (City of Salem Only)	117,861,699	11,617	103,870,276	1,281	1,804,031
Electricity Consumption (2016) - Salem UGB	kWh	Meters	kWh	Meters	kWh
PGE (Estimated Salem UGB)	573,591,296	62,974	602,445,916	12,218	7,413,401
Salem Electric (Salem UGB)	125,170,387	12,119	103,945,314	1,229	1,804,031

Limitations for UGB Areas

One limitation of the UGB analysis is that electricity consumption data was not universally available for areas outside Salem City limits. For Salem Electric, data on the number of meters and consumption were available for both City of Salem and Salem UGB, but the same was not true for PGE. To extrapolate from city-level data provided by PGE, to electricity consumption within the Salem-Keizer UGB, a simple calculation was used:

> *(Total kWh Delivered to Salem PGE Customers / Total number of PGE meters in Salem) * Total estimated number of PGE meters within the Salem-Keizer UGB, excluding those within Keizer and its UGB*

This calculation essentially establishes an average electrical consumption rate per PGE meter in Salem, then applies this rate to the estimated number of meters outside of Salem but within its portion of the UGB. This method is not ideal, as it does not rely on actual electrical meter readings for UGB meters outside of city boundaries. Those meters may in fact use more power than meters within city limits; if so, then this methodology could under-estimate electrical consumption within the UGB.

Electricity Contacts

- Salem Electric
  - Brittani Davidson, Member Services Manager / davidson@salemelectric.com
- Portland General Electric
  - Wendy Veliz, Local Government Affairs Manager / Wendy.Veliz@pgn.com
  - Brendan J McCarthy, State Environmental Policy Manager / Brendan.Mccarthy@pgn.com

Scope 3

Scope 3 includes GHG emissions from: agriculture and land management; urban forestry; waste generation; and water use. Please note that this inventory follows both the GPC and the ICLEI protocols,

and as such includes data on emissions from agriculture, land management, and urban forestry, though these emissions sources are not included in the ICLEI protocol.

Water Use

The City of Salem receives its water supply from a 490,000-acre watershed draining into the North Santiam River. The City of Salem Public Works operates and maintains the Geren Island water treatment facility on the North Santiam River; water flows by gravity from here to the City of Salem for distribution to customers. Though a backup water supply has been developed in the form of an Aquifer Storage and Recovery System (ASR) in the South Salem Hills, this water source is used only during peak water demand periods in the summer, or during emergencies. It was not used during 2016. Therefore, during 2016 there were no significant GHG emissions associated with pumping water for distribution to customers served by Salem Public Works[7].

Water Use Contacts

- Public Works
    - Keith Garlinghouse, Utilities Engineer, Public Works / KGARLINGHOUSE@cityofsalem.net

Waste Generation

Though direct emissions from solid waste disposal were not included in this inventory, Salem's residents, businesses, and visitors do produce solid waste. The vast majority of Salem's solid waste is sent to three locations: Brown's Island Demolition Landfill, Coffin Butte Landfill, and the Covanta Marion Waste-to-Energy Facility (WtEF)[8]. Emissions from the processing and storage of that solid waste is accounted for under scope 3 as an indirect source of emissions. Data and assumptions for how attributable emissions were calculated for each source are summarized below.

Brown's Island Demolition Landfill

Though Brown's Island is currently operational and does accept waste from the City of Salem and its UGB, it was established through interviews with Marion County that the landfill produces an unknown but negligible amount of CO2e. Thus, its emissions were not included in this inventory.

Coffin Butte Landfill

The Coffin Butte Landfill, located in Benton County, is owned and operated by Republic Services. The landfill accepts waste from numerous communities in the Willamette Valley. According to data received from the Mid-Valley Garbage Recycling Association, the City of Salem sent 46,469[9] metric tons of solid waste to Coffin Butte in 2016. In order to calculate Salem's share of solid waste emissions occurring at Coffin Butte, its share of the total waste received by Coffin Butte in 2016 was used to determine the share of attributable emissions. Total emissions were determined using the Oregon Department of Environmental Quality's annual GHG Facility Emissions Inventory which reports anthropogenic and biogenic emissions for facilities holding EPA pollution permits. The estimates are summarized in the table 11.

[7] Interview with Keith Garlinghouse, City of Salem Public Works
[8] Interview with Brian May, Environmental Services Division Manager, Marion County Public Works
[9] Mid-Valley Garbage and Recycling Association

Table 11: Coffin Butte Solid Waste Estimates (2016)	MT Solid Waste Received	Attributable CO2e
Coffin Butte (Total)	552,979[10]	28,366[11]
From City of Salem	46,250[12]	2,372
From Salem UGB*	59,666	3,061

** Estimated as using city of Salem per capita rate*

The above table summarizes anthropogenic emissions from the decomposition of solid waste in the Coffin Butte landfill. This is, however, not the only source of emissions from solid waste sent to Coffin Butte. Some of the landfill gas produced by Coffin Butte is burned to create electricity by a co-generation facility owned by PNGC Power. Like Coffin Butte, the co-generation facility reports anthropogenic and biogenic emissions to DEQ. Attributable emissions for the city of Salem and its UGB are calculated in the same fashion as was done for Coffin Butte.

Table 12: PNGC Co-Generation Facility Attributable CO2e (2016)	Attributable CO2e
PNGC Facility (Total)	46.98[13]
From City of Salem	3.93
From Salem UGB*	5.07

* Estimated as using city of Salem per capita rate

Covanta Marion Waste-to-Energy Facility

Marion County is unique in how it manages solid waste. Instead of decomposing in landfills, waste is used to generate electricity. Waste sent to the Covanta WtEF emits little to no landfill gas, but as a result of incineration, still results in GHG emissions. Though the GPC does not require communities to account for emissions from energy generation outside their municipal boundary, a portion of the emissions generated by the Covanta WtEF were included in this inventory. That portion is the difference between the emissions Covanta Marion produced and the emissions that a reasonable source of alternative power, such as natural gas, would emit to generate the same amount of electricity

This portion was calculated as follows. The Covanta Marion WtEF generated 93,506 MW of electricity in 2016[14]. Of that, 44% (41,250 MW / 70,813 MT CO2e) was generated from anthropogenic sources[15]. If the anthropogenic portion of had been produced by an alternative anthropogenic energy generation source such as natural gas, it would have emitted an estimated 13,578 MT CO2e[16]. Thus, the net annual emissions of the WTEF attributable to solid waste incineration is 57,235 MT CO2e[17]. Portion of Covanta's net emissions attributable to the city of Salem and its UGB were assumed proportional to their share of solid waste sent to Covanta for incineration. These estimates are summarized in table 13.

[10] Coffin Butte Landfill & Pacific Region Compost 2016 Annual Report (Republic Services, 2017)
[11] Oregon DEQ Greenhouse Gas Facility Emissions (2016)
[12] Mid-Valley Garbage Recycling Association
[13] Oregon DEQ Greenhouse Gas Facility Emissions (2016)
[14] Case Study: Marion County Waste to Energy Facility, Governmental Advisory Associates (2013)
[15] Oregon DEQ Greenhouse Gas Facility Emissions (2016)
[16] (41,250 MW * 725.8 lb CO2e)/2,205
[17] 70,813 MT CO2e – 13,578 MT CO2e

Table 13: Covanta Marion Net Emissions Estimates (2016)	MT Solid Waste Received	Attributable CO2e
Covanta Marion WtEF (Total)	168,933[18]	57,235
From City of Salem	46,469[19]	15,744
From Salem UGB*	51,953	17,602

** Estimated as using city of Salem per capita rate*

Waste Generation Contacts

- Marion County
  - Brian May, Environmental Services Division Manager, Marion County Public Works / BMay@co.marion.or.us

Agriculture and Land Management

Agriculture and land management can potentially contribute to GHG emissions at the community-scale when nitrogen-based fertilizers are used. For the city of Salem and its UGB, agricultural land area was estimated using assessor's data and land use codes. Of those agricultural lands identified, aerial imagery was used to determine the nature of the crops being grown. They were divided generally into three categories: fruits, vegetables, and nursery crops. Acreage of these crop types were then multiplied against average nitrogen use per acre from USDA crop-based surveys. These values are summarized in tables 14 and 15 below.

Table 14: Nitrogen Use (lb/acre)	lb/acre	Source
Fruit	84.3	USDA Agricultural Chemical Usage 2017 Field Crops Summary
Vegetable	67.1	USDA Agricultural Chemical Usage 2006 Vegetables Summary
Nursery	0.0	USDA Agricultural Chemical Usage 2006 Nursery and Floriculture Summary

Table 15: Estimated Nitrogen Use (2016)	Salem UGB	City of Salem
Nitrogen (Pounds)	34,557	2,834
Nitrogen (Short Tons)	17.3	1.4

Urban Forestry

Urban forestry accounts for trees and other vegetation within a community and their ability to remove and store carbon from the atmosphere. Salem has a robust tree canopy and has a relatively recent inventory of its tree canopy that facilitates tracking of this carbon emissions sink. The data for this emissions category came from a 2010 tree canopy report[20] commissioned by the city of Salem. This report tabulates tree canopy by land use type. The EPA Local GHG Inventory Tool: Community Module

[18] Marion County, OR Solid Waste and Energy Final Report Presentation, Gershman, Brickner, & Bratton (2017), s14
[19] Mid-Valley Garbage Recycling Association
[20] 2010 data used as more recent data not available

uses these coverages as an input to estimate metric tons of carbon removed on an annual basis. The inputs for that calculation are summarized in table 16. Note that for the UGB, an updated tabulation was developed using lidar and aerial imagery by Fregonese Associates. It is included as table 17.

Table 16: City of Salem Urban Tree Canopy (2010)[21]	Total Urban Area (Acres)	UTC Area (Acres)	Total Urban Area (km2)	% Urban Area with Tree Cover
Commercial	2,322	228	9.4	10%
Downtown	139	13	0.6	9%
Industrial	4,189	308	17.0	7%
Low Density Residential	6,698	1,649	27.1	25%
Medium Density Residential	10,591	2,609	42.9	25%
High Density Residential	2,362	413	9.6	17%
Other Public	3,664	374	14.8	10%
Public Right of Way	5,934	777	24.0	13%
Public Open Space	2,472	674	10.0	27%

Table 17: Salem UGB Urban Tree Canopy (2010)[22]	Total Urban Area (Acres)	UTC Area (Acres)	Total Urban Area (km2)	% Urban Area with Tree Cover
Residential	19,651	4,671	79.5	24%
Commercial/Industrial	6,650	549	26.9	8%
Institutional	12,070	1,825	48.8	15%

Additional Sources

Some additional emissions sources are not captured in the categories described above. These are large industrial or institutional facilities that are required to hold an EPA pollution permit. These data are contained within the Oregon DEQ Greenhouse Gas Facility Emissions database and are summarized in table 17. Note that though these are not captured in Scope 1, they are reported there as they involve stationary combustion within Salem's community boundaries.

[21] GIS Analysis of Salem's Potential Urban Tree Canopy (AMEC, 2011)
[22] Fregonese Associates (2019)

Table 17: Additional Sources	Anthropogenic Emissions	Industry Type
Kettle Foods, Inc.	8,491	Other Snack Food Manufacturing
Salem Health	9,387	Healthcare Facility
Oregon State Penitentiary	7,079	Showcase, Partition, Shelving, and Locker Manufacturing
CPM Development Corporation	3,750	Asphalt Paving Mixture and Block Manufacturing
Willamette University	3,669	Colleges, Universities, and Professional Schools
Norpac Foods, Inc.	6,659	Frozen Specialty Food Manufacturing
Packaging Corporation of America	2,765	Corrugated and Solid Fiber Box Manufacturing
Truitt Bros., Inc.	4,257	Fruit and Vegetable Canning

Policy Considerations

Establish a Trend

With an initial GHG emissions inventory complete, Salem now has a basic understanding of where it stands today in terms of major emissions sources. However, it still lacks an understanding of where it is heading and what its goals should be. As a logical next step, it is recommended that Salem inventory additional years of emissions in order to establish GHG growth trends. This step is low-hanging fruit as the City has been provided with clear documentation and a framework for conducting additional inventories.

Develop a Climate Action Plan (CAP)

The subsequent step should be to establish a climate action plan (CAP). Most other large cities in Oregon (including Eugene, Corvallis, Portland, and Bend) already have climate action plans in place. The purpose of a CAP is twofold: first, it uses GHG inventory data to establish meaningful and achievable GHG reductions targets. Second, it provides practical recommendations for policies and programs that can start a community on the road to meaningful GHG reductions.

Sector-Specific Recommendations

Over 95 percent of Salem's emissions come from three emissions sources: mobile combustion, stationary combustion, and electricity use. In order to maximize the GHG reduction impact of policy decisions, they should be focused on these three emissions sources. Though sector-specific recommendations are typically covered as part of a CAP, general guidance is provided by sector below.

Mobile Combustion

Mobile combustion from transportation comprises over 53% of Salem's GHG emissions. Much of these emissions come from driving on Salem's roadways. Salem experiences above average vehicle miles traveled (VMT) for two reasons: first, it is a major job center that draws commuters from as far as

Portland. Second, Salem's residents tend to drive more than their counterparts in other Oregon cities. Thus, strategies to reduce emissions from mobile combustion should focus on reducing VMT. For long-haul commuters, such as those traveling from Portland or Eugene to work at the State Capitol, increased funding for shuttle service, vanpools, and Amtrak service could help reduce single occupancy vehicle trips. For those trips made by Salem's residents, improved transit and more compact land use patterns will help reduce VMT.

Electricity Use

Salem receives electricity from two utilities: Salem Electric and PGE. While PGE's power comes from more polluting sources than Salem Electric, those power sources are becoming cleaner. As PGE phases out coal and other non-renewables, scope 2 GHG emissions in Salem will decrease as well. While the City of Salem has little control over the source of PGE's power, it can work in tandem to reduce energy demand through home and business energy efficiency programs, and by making land use choices (such as encouraging more shared-wall construction rather than single-family homes and other lower-density, low-efficiency uses) that encourage inherently more energy-efficiency building types.

Stationary Combustion

Stationary combustion is the third-largest emissions category and is primarily driven by natural gas use. While Northwest Natural actively promotes energy efficiency in home heating and business processes, the City of Salem should seek partnership opportunities to accelerate the uptake of energy efficiency upgrades. In addition, the City should work with large facilities listed in DEQ's Facility Emissions Database on energy efficiency and emissions scrubbing technology as they contribute an outsized share of Salem's emissions within this category.

Salem GHG Inventory Contacts

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