2018 Community Greenhouse Gas Inventory

Petaluma Climate Action and Adaptation Plan

October 2021

CITY OF PETALUMA
GENERAL PLAN UPDATE

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Greenhouse Gas Emissions Inventory

Petaluma's Climate Emergency Framework articulates a vision to make Petaluma a leader in climate mitigation and sequestration to ensure a stable climate for current and future generations. The City endeavors to reach carbon neutrality no later than 2030. These commitments demonstrate local, regional, and national leadership to creating innovative and strategic pathways to carbon neutrality, a resilient community, and a just transition.

This Community-Wide Greenhouse Gas (GHG) Inventory provides an update on emissions occurring in Petaluma in 2018.[1] It includes emissions by sector (energy, on-road and off-road transportation, solid waste, and water and wastewater) that were emitted in 2010 and 2018. This report presents a summary of the 2010 GHG emissions and details the 2018 data year community GHG inventory completed in 2020 by the Sonoma County Regional Climate Protection Authority (RCPA). It also provides an emissions forecast to 2050.

Key Findings

- **Overall greenhouse gas emissions are rising but emissions per service population are declining.** Community-wide, Petaluma emitted 472,422 metric tons of carbon dioxide equivalent ($MTCO_2e$) in 2018, up 3% from the 2010 greenhouse gas emissions estimate of 460,355 $MTCO_2e$. Despite a 3% increase in overall emissions, annual per service population emissions decreased from 2010 to 2018 by 3% from 5.3 $MTCO_2e$ in 2010 to 5.2 $MTCO_2e$ in 2018.
- **Transportation continues to be the largest sector of emissions**. Greenhouse gas emissions from on-road transportation were the largest sector, accounting for 67% of all community emissions in 2018. Emissions grew by over 52,000 $MTCO_2e$ between 2010-2018, however the increase was largely caused by the change in employment-related land use data from the 2010 transportation model.
- **Emissions from energy use in buildings declined**. Nonresidential and residential energy use made up the second largest sector, accounting for 24% of all community emissions in 2018. Between 2010 and 2018, emissions fell by almost 51,000 $MTCO_2e$, largely due to establishment of Sonoma Clean Power.
- **Solid waste emissions increased**. Landfill emissions increased between 2010 and 2018 by almost 11,000 $MTCO_2e$ accounting for 7% of all community emissions in 2018. Landfill waste emissions increased significantly due in part to the Redwood Landfill processing methane less efficiently.

[1] Emissions from the City of Petaluma's municipal operations are included in the community-wide inventory. A separate Municipal Operations Inventory will be prepared for 2019 emissions by sector, including building energy use, employee commute, and fleet vehicles.

- **Projected emissions are expected to fall but not enough to meet local targets without additional measures**. Total GHG emissions, adjusted for State policy, are projected to decrease 8% from 2018 to 2050 and per service population emissions are projected to decrease 28%.
- **Consumption-based emissions totaled approximately 1.2 million $MTCO_2e$ in 2015, about 146%** higher emissions than the traditional activity-based approach for Petaluma in the same year. This is largely due to higher emissions from air travel and the inclusion of emissions from food, goods, and services.

Petaluma's Greenhouse Gas Emissions Target

Petaluma calculates its greenhouse gas emissions because addressing the impacts of climate change is a core value of the City and community. This emissions inventory provides an overview of Petaluma's current emissions and helps guide greenhouse gas reduction and carbon sequestration policy. Using a coordinated approach, Petaluma and the community can help make residents, businesses, and properties more resilient to the impacts of climate change.

In January 2021, the Petaluma City Council adopted the Climate Emergency Framework. Using a science-based approach, this Framework recommended achieving a target of **carbon neutrality by 2030**. To meet the greenhouse gas emission target, the Framework laid out the following actions:

- Substantially reduce direct emissions from all sectors of the economy;
- Reduce emissions resulting from the purchase of goods and services; and
- Sequester, or draw down, emissions through land and vegetation management practices.

Community-Wide Greenhouse Gas Inventory

This community-wide GHG emissions inventory for Petaluma captures the primary sources of emissions that can be reduced through local and regional government actions. This includes energy use in homes, businesses, vehicles, off-road equipment; emissions from treating and delivering water; and emissions from materials that are thrown away. The activity data is collected from service providers, local utilities, and regional and state agencies.[2] Petaluma uses the inventory to better understand emission sources and trends and track progress towards meeting the carbon neutrality target. Reporting this progress is an important action for Petaluma to ensure accountability.

2010 Community GHG Inventory

The City of Petaluma total 2010 GHG emissions were estimated to be 460,355 $MTCO_2e$. The inventory included building energy use, transportation (on-road and off-road[3]), solid waste, and water. Of the five sectors, on-road transportation accounted for the largest amount of GHG emissions with an estimated emissions of 261,790 $MTCO_2e$, or 57% of total emissions. The second largest was energy with estimated emissions of 165,349 $MTCO_2e$, or 36% of total emissions. The remaining 7% of emissions were made up by solid waste, off-road transportation, and water and wastewater.

[2] For information on the specific data sources used for each sector, see Appendix A: Detailed 2018 Community-Wide Sector Inventory.
[3] The off-road transportation sector includes lawn and garden, recreational, construction, and industrial equipment.

Table 1: Total Annual Community GHG Emissions (2010)

Community Sector	Subsector	Subsector $MTCO_2e$	Sector $MTCO_2e$	Percent of Total
Transportation	On-Road Transportation	261,790	261,790	57%
Energy	N/A	165,349	165,349	36%
Solid Waste	Residential	9,430	22,262	5%
	Commercial	12,832		
Transportation	Off-Road Transportation	9,960	9,960	2%
Water and Wastewater	Water Use	471	994	0.2%
	Wastewater Treatment	523		
Total		**460,355**		**100%**

Source: RCPA 2018 Sonoma County Greenhouse Gas Inventory and Raimi + Associates 2021.[4]

2018 Community GHG Inventory

The City of Petaluma total 2018 GHG emissions were estimated to be 472,422 $MTCO_2e$, an increase of 12,067 $MTCO_2e$ from the 2010 inventory as shown in Table 2. Of the five sectors, on-road transportation accounted for the largest amount of GHG emissions with estimated emissions of 314,493 $MTCO_2e$, or 67% of total emissions. The second largest sector was residential energy use with estimated emissions of 60,409 $MTCO_2e$, or 13% of total emissions. The remaining 20% of emissions were made up by nonresidential energy, solid waste, off-road transportation, and water and wastewater.

[4] The 2010 emissions presented in Table 1 differ from those presented by the County in the 2015 and 2018 Sonoma County Greenhouse Gas Inventory reports. This is the result of new data and updated accounting best practices for solid waste and off-road transportation emissions. First, solid waste emissions were attributed to the City of Petaluma and the data was updated to reflect the 100-year global warming potential (GWP) value for methane. Second, based on newly obtained data for off-road transportation, emissions from this sector also increased because it includes emissions from additional subsectors consistent with the most recent 2018 Petaluma inventory. As a result of these adjustments, the 2010 community base year GHG inventory increased by 6%.

Table 2: Total Annual Community GHG Emissions (2018)

Community Sector	Subsector	Subsector $MTCO_2e$	Sector $MTCO_2e$	Percent of Total
Transportation	On-Road Transportation	314,493	314,493	67%
Energy	Residential	60,409	114,475	24%
	Nonresidential	54,065		
Solid Waste	Residential	12,669	33,137	7%
	Commercial	20,468		
Transportation	Off-Road Transportation	9,727	9,727	2%
Water and Wastewater	Water Use	73	590	0.1%
	Wastewater Treatment	517		
Total		**472,422**		**100%**

Source: RCPA 2018 Sonoma County Greenhouse Gas Inventory and Raimi + Associates.

Emissions Trends 2010 to 2018

Between 2010 to 2018, Petaluma's emissions increased by 3%, but emissions per service population decreased during the same period. Overall emissions grew by over 12,000 $MTCO_2e$. The service population, which is the sum of population and jobs in the City, also grew from 86,184 in 2010 to 91,577 in 2018. With this, the emissions per service population saw a decrease of 3% from 5.3 $MTCO_2e$ to 5.2 $MTCO_2e$ per service population.

Table 3: Petaluma Total Annual Community GHG Emissions in 2010 and 2018 (in $MTCO_2e$)

Community Sector	2010	2018	2010 Per Service Population	2018 Per Service Population	Service Population Percent Change
On-Road Transportation	261,790	314,493	3.0	3.4	13%
Energy	165,349	114,475	1.9	1.6	-35%
Solid Waste	22,262	33,137	0.3	0.4	40%
Off-Road Transportation	9,960	9,727	0.1	0.1	-8%
Water and Wastewater	994	590	0.01	0.01	-44%
Total	**460,355**	**472,422**	**5.3**	**5.2**	**-3%**

Source: RCPA 2018 Sonoma County Greenhouse Gas Inventory and Raimi + Associates 2021.

Emissions growth was largely propelled by on-road transportation (+13%) and solid waste (+40%).

- **On-road transportation**: The large increase in vehicle miles traveled (VMT) can be attributed to a recalibration of employment-related land use data used to model transportation. This illustrates how impactful land use is on VMT and greenhouse gas emissions.
- **Solid waste**: The City experienced an increase in waste being sent to the landfill. Landfill waste emissions increased significantly due in part to the Redwood Landfill processing methane less efficiently.[5]

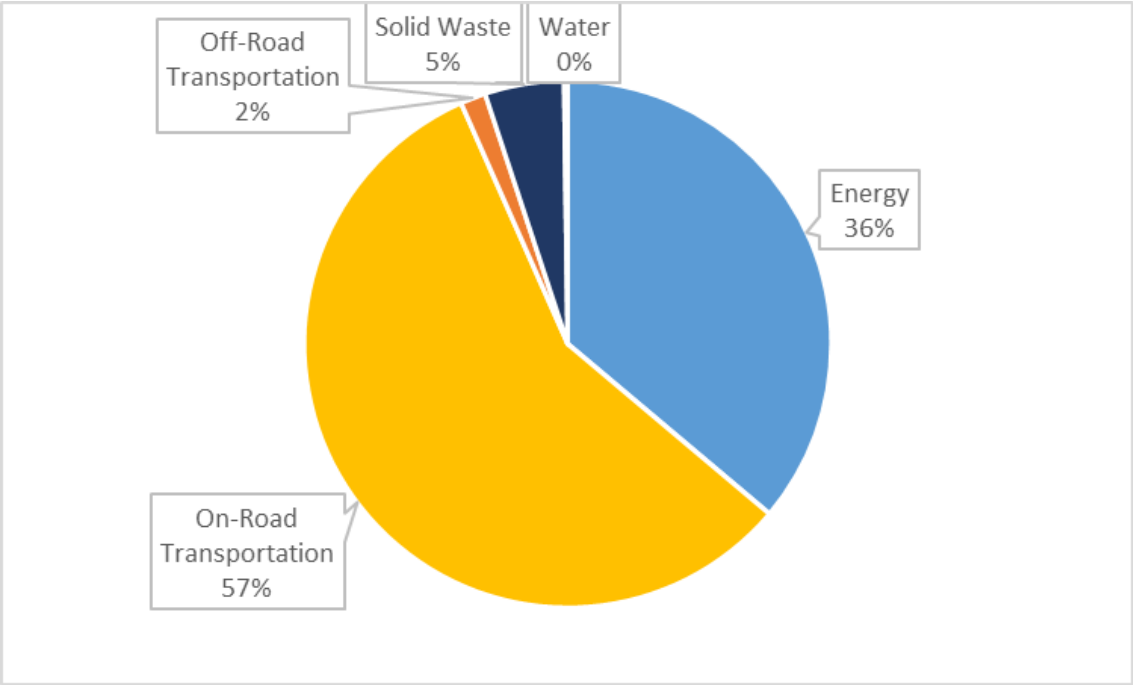
Emissions reductions were largely in the energy (-35%) and water (-44%) sectors.

[5] Regional Climate Protection Authority. 2018. Greenhouse Gas Inventory Report: Sonoma County Update 2015. Retrieved from https://rcpa.ca.gov/wp-content/uploads/2018/08/Sonoma-County-GHG-Inventory-Update-2015-070618.pdf

- **Energy**: While population and jobs grew, building emissions decreased significantly through establishment of Sonoma Clean Power and increased renewable energy for electricity generation. As a member agency of Sonoma Clean Power, Petaluma has helped to provide residential and commercial customers options for clean power through Clean Start and Evergreen programs.
- **Water and wastewater**: Between 2010 and 2018, water sector emissions declined by 44%, reflecting cleaner energy used to convey water. [6]

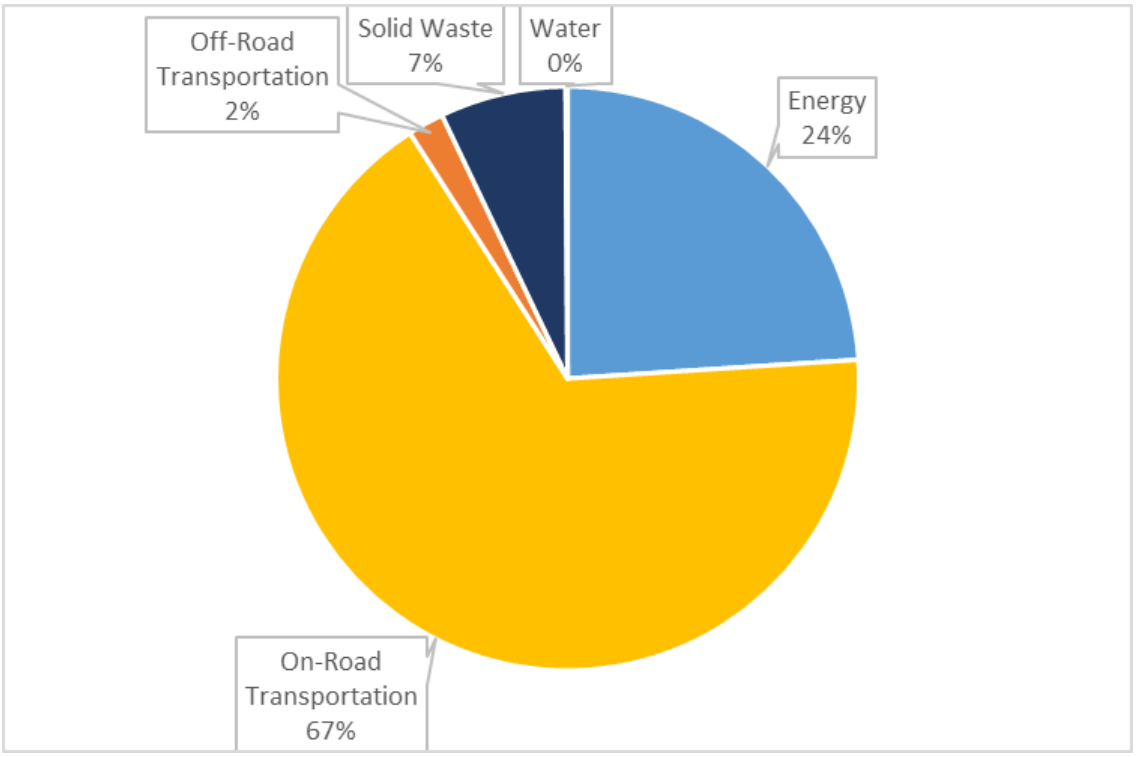
These drivers of change are reflected in Figures 1 and 2, the proportion of emissions by sector. Between 2010 and 2018, the proportion of the City's community-wide emissions for on-road transportation grew from 57% to 67% and for solid waste grew from 5% to 7%. Whereas, the proportion of emissions from building energy declined from 36% to 24%.

Figure 1: Petaluma Total Annual Community GHG Emissions in 2010



[6] City of Petaluma. 2021. 2020 Urban Water Management Plan. Retrieved from: https://docs.google.com/viewerng/viewer?url=https://storage.googleapis.com/proudcity/petalumaca/uploads/2021/06/R-702-City-of-Petaluma-Final-2020-UWMP-2.pdf

Figure 2: Petaluma Total Annual Community GHG Emissions in 2018



Community GHG Forecast

A forecast of the City's emissions was developed using demographic and socio-economic forecasts to understand how emissions would change over time. This includes two forecasts:

- A **"Business as Usual" (BAU)** GHG emissions forecast considers how Petaluma's emissions would change over time if no action were taken to reduce emissions by the State or at the local level.
- An **Adjusted Business as Usual (ABAU)** forecast shows how Petaluma's emissions are anticipated to change accounting for the impacts of adopted State policies without local action.

Both forecasts use a consistent set of demographic and economic projections derived from the Association of Bay Area Governments (ABAG) and the Metropolitan Transportation Commission (MTC).[7] These projections assume that population, housing, employment, and transportation activity will continue to grow through 2040. ABAG/MTC projections have been extrapolated to 2050 to align with the State's GHG reduction targets. Table 4 shows the assumed demographic changes.[8]

Table 4: Petaluma Demographic Projections (2010-2050)

	2010	2018	2020	2025	2030	2040	2045	2050
Population	56,689	60,635	60,830	63,455	64,795	65,970	67,390	68,810
Jobs	29,495	30,942	33,440	34,330	35,460	36,795	39,840	42,885
Housing Units	22,382	23,172	23,745	24,315	24,385	24,760	25,110	25,460
Service Population	86,184	91,577	94,270	97,785	100,255	102,765	107,230	111,695

Source: ABAG/MTC Projections 2040; extrapolated to 2050 by Raimi + Associates.

[7] Association of Bay Area Governments and the Metropolitan Transportation Commission. Plan Bay Area 2040 Growth Projections. Retrieved from: http://projections.planbayarea.org/

[8] The ABAG/MTC projections are used for the purposes of preparing the BAU and ABAU forecasts. The General Plan Update process may refine these growth projections for Petaluma based on the Alternatives and Plan Development phases of work. If so, these demographic and socio-economic projections will be updated for consistency later in the process, along with the BAU and ABAU GHG forecasts.

Business as Usual GHG Forecast

BAU forecast emissions are expected to rise from 472,442 $MTCO_2e$ in 2018 to 613,288 $MTCO_2e$ in 2050, a 30% increase. Table 5 shows the forecasted BAU emission levels for each sector in future years and the forecasted annual emissions per capita and per service population.

Table 5: Forecasted Business as Usual Total Annual Community GHG Emissions in 2020-2050 (in $MTCO_2e$)

Sector	2010	2018	2020	2025	2030	2035	2040	2045	2050
On-Road Transportation	261,790	314,493	323,742	335,813	344,295	352,915	368,249	383,582	398,916
Energy	165,349	114,475	126,980	130,189	132,469	135,965	142,552	149,139	155,726
Solid Waste	22,262	33,137	34,112	35,383	36,277	37,185	38,801	40,417	42,032
Off-Road Transportation	7,112	9,727	10,370	10,756	11,028	11,304	11,795	12,286	12,778
Water	994	590	588	608	622	636	661	687	712
Total	**457,507**	**472,422**	**496,533**	**513,353**	**525,433**	**538,975**	**563,746**	**588,517**	**613,288**
Per capita	*8.1*	*7.8*	*8.2*	*8.1*	*8.1*	*8.2*	*8.4*	*8.6*	*8.7*
Per Service Population	*5.3*	*5.2*	*5.3*	*5.2*	*5.2*	*5.2*	*5.3*	*5.3*	*5.3*

Source: RCPA 2018 Sonoma County Greenhouse Gas Inventory and Raimi + Associates 2021.

Adjusted Business as Usual GHG Forecast

The Adjusted Business as Usual (ABAU) forecast shows how Petaluma's emissions are anticipated to change accounting for the impacts of adopted State policies if no action is taken at the local level. There are four major policies that the State has adopted to reduce GHG emissions at the local level:

1. **Renewables Portfolio Standard (RPS):** This law requires that electrical utilities provide an increased amount of electricity from eligible renewable sources. SB 100 requires that 33% of electricity sold by utilities in 2020 be renewable, 60% be renewable in 2030, and 100% be carbon-free in 2045. While Sonoma Clean Power provides a significant amount of the community's electricity, the forecast assumes the same portion of electricity will provided by PG&E as in 2018 (12.5% for residential, 7.1% for nonresidential).
2. **Title 24:** Title 24 is the set of regulations that specifies how new buildings must be constructed, including specifying minimum energy efficiency standards. These standards are updated triennially to be more stringent. California has set a goal for zero-net energy for new construction by 2030.
3. **Pavley Clean Car Standards:** These standards require that vehicles sold in California meet minimum fuel efficiency requirements, and that fuel sold in the state emits less GHGs during production and use.
4. **SB 1383 Regulations:** This law requires organic waste disposal to be reduced by 50% by 2020 and 75% by 2025 in California. To achieve these targets, starting in 2022 jurisdictions must

provide organic waste collection services to all residents and businesses and recycle the materials.[9]

Under the ABAU forecast, emissions are expected to fall from 472,422 $MTCO_2e$ in 2018 to 432,379 $MTCO_2e$ in 2050, a decrease of 8%. Table 6 shows the forecasted ABAU emission levels for each sector in future years and the forecasted annual emissions per capita and per service population. The ABAU forecast illustrates the importance of supporting the State's climate targets to reduce emissions statewide and the need to kickstart local actions.

Table 6: Forecasted Adjusted Business as Usual Total Annual Community GHG Emissions in 2020-2050 (in $MTCO_2e$)

Sector	2010	2018	2020	2025	2030	2035	2040	2045	2050
On-Road Transportation	261,790	314,493	330,638	292,040	264,133	252,916	256,843	265,534	255,454
Energy	165,349	114,475	125,855	127,866	126,709	124,811	124,977	108,824	113,197
Solid Waste	22,262	33,137	34,112	24,154	24,846	25,607	27,170	28,732	30,294
Off-Road Transportation [10]	7,112	9,727	10,370	10,756	11,028	11,304	11,795	12,286	12,778
Water	994	590	588	608	622	636	661	631	656
Total	**457,507**	**472,422**	**501,563**	**455,425**	**427,339**	**415,275**	**421,446**	**416,007**	**432,379**
Per capita	*8.1*	*7.8*	*8.2*	*7.2*	*6.6*	*6.3*	*6.3*	*6.0*	*6.2*
Per Service Population	*5.3*	*5.2*	*5.3*	*4.7*	*4.3*	*4.0*	*3.9*	*3.7*	*3.7*

Source: RCPA 2018 Sonoma County Greenhouse Gas Inventory and Raimi + Associates 2021.

Local GHG Reduction Measures

Though local measures are not included in the BAU and ABAU forecasts, the City of Petaluma has goals and programs in some of the sectors that go beyond the State's. The impact of these local measures will be further analyzed in the Climate Action and Adaptation Plan.

1. Carbon Neutral by 2030 Target: A target adopting 2030 as the City's target date for carbon neutrality was adopted by the City Council as an action of the Climate Emergency Framework.
2. All-Electric Construction Code: In May 2021 City Council adopted an "All-Electric Construction in New Constructed Buildings" ordinance. The ordinance requires all new residential and commercial buildings use electricity-based systems rather than natural gas.
3. Zero Waste Resolution: In July 2019, the City passed a Zero Waste Resolution that set the goal to reduce waste generation per person by 90% compared to 2003 levels by 2030.

[9] CalRecycle. California's Short-Lived Climate Pollutant Reduction Strategy. Retrieved from: https://www.calrecycle.ca.gov/organics/slcp

[10] This forecast applies the 2018 Off-Road Transportation $MTCO_2e$ per service population as a constant multiplied by the service population estimates for 2020-2050.

2015 Consumption-Based Greenhouse Emissions

Petaluma's Climate Emergency Framework calls for the reduction of indirect emissions in addition to elimination of direct emissions to meet State, County, and City climate goals. A consumption-based GHG inventory captures the community's indirect emissions in addition to the direct emissions discussed in the previous sections of this report. This method of GHG accounting measures the consumption of goods and services by city residents instead of the activities that create emissions within the city. Emissions are reported by consumption category rather than emission source category.

Measuring consumption captures both the direct and lifestyle emissions of the goods and services Petaluma residents use (transportation, housing, food, goods, services, and composting). Emissions are created at all lifecycle stages of those categories: from their raw materials, manufacturing, distribution, retail, and disposal. The consumption-based GHG inventory allocates those emissions to the final consumers instead of the sources that produced them. It excludes emissions from visitor activities and the goods and services produced in Petaluma but exported for consumption outside the city.

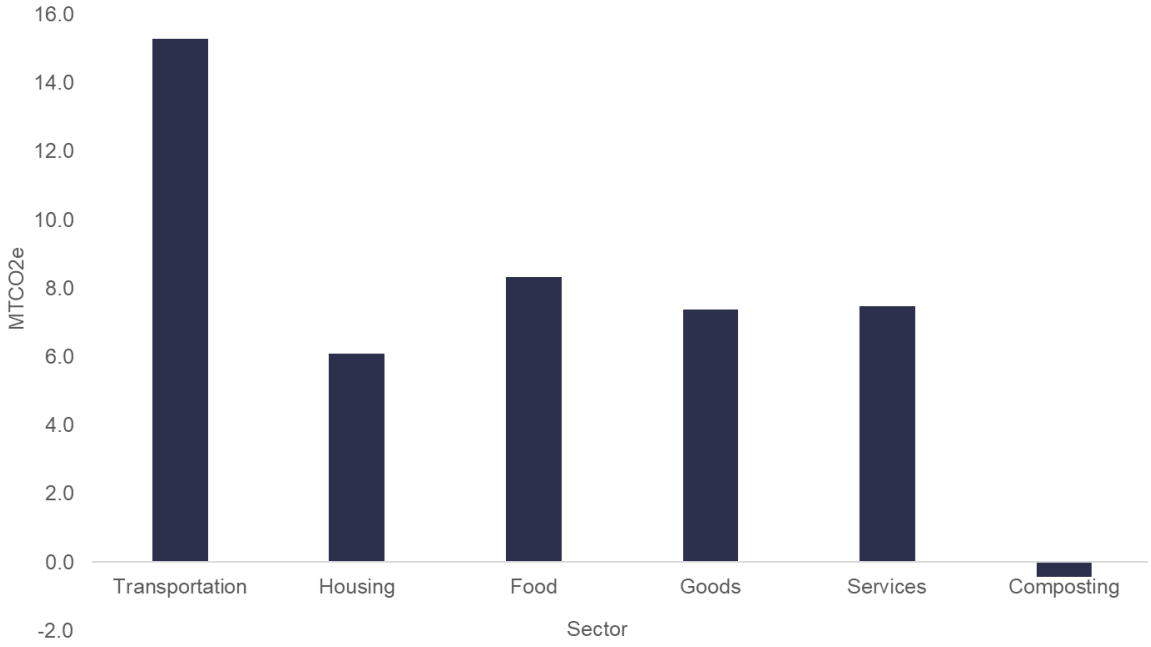
The methodology incorporates local consumption and emissions data wherever possible. In other cases, consumption is approximated using econometric analysis of national and statewide transportation and household consumption survey from a study conducted by UC Berkeley and the Bay Area Air Quality Management District in 2015. Due to the many assumptions made in the methodology, the results are only able to provide an indicative approximation of the emissions associated with Petaluma's consumption activities.

This method results in a total of 1.2 million $MTCO_2e$, about 146% higher emissions than the traditional activity-based approach for Petaluma in 2015 and 150% higher than the activity-based emissions in 2018. This is largely due to higher emissions from transportation and the inclusion of emissions from food, goods, and services. Transportation remains the largest source of emissions (35%), followed by food (19%), services (17%), goods (17%), and housing (which includes electricity consumption) (14%). Composting reduces 1% of total GHG emissions. Figure 3 illustrates the average amount of consumption-based, or indirect, emissions by sector for an average Petaluma household in 2015. In total, the average Petaluma household's consumption-based emissions were 44.1 $MTCO_2e$ in 2015.[11]

Petaluma's average household consumption-based emissions were higher than Sonoma County's but consistent with the San Francisco Bay Area as a whole. Sonoma County's average household emissions were 40.4 $MTCO_2e$, 8% less than Petaluma's. The San Francisco Bay Area's emissions were an average of 44.3 $MTCO_2e$ per household, only 0.4% greater than Petaluma's. Despite the differences in GHG emissions per household, the composition of Petaluma, Sonoma County, and the San Francisco Bay Area's consumption-based emissions by sector are nearly identical.[12]

[11] UC Berkeley and the Bay Area Air Quality Management District. Consumption-Based Greenhouse Gas Inventories. Retrieved from: https://coolclimate.org/inventory
[12] UC Berkeley and the Bay Area Air Quality Management District. Consumption-Based Greenhouse Gas Inventories. Retrieved from: https://coolclimate.org/inventory

Figure 3: 2015 Consumption Based GHG Emissions per Petaluma Household



Source: 2015. UC Berkeley and the Bay Area Air Quality Management District. Consumption-Based Greenhouse Gas Inventories.[13]

This graphic shows that while reduction of direct emissions on a jurisdiction level is important, personal choices at a household level are also a key component in achieving carbon neutrality. There are emissions embedded into the services and products received. The path to carbon neutrality must travel through the impacts of business decisions and household choices, and consumers must become educated on those impacts.

[13] UC Berkeley and the Bay Area Air Quality Management District. Consumption-Based Greenhouse Gas Inventories. Retrieved from: https://coolclimate.org/inventory

Appendix A: Detailed 2018 Community-Wide Sector Inventory

Appendix A provides a detailed inventory of emissions and activity data by sector.

Community Energy

This section presents GHG emissions for the energy sector, specifically emissions generated from residential and nonresidential energy use that occurred within City limits. This section provides electricity and natural gas activity data and emissions estimates in both residential and nonresidential settings for the year 2018.

Electricity

Pacific Gas and Electric (PG&E) and Sonoma Clean Power (SCP) provide electric service to the community and offer community electricity data to local agencies. SCP is a community choice energy provider that offers 93% carbon-free electricity (CleanStart) and 100% renewably-sourced electricity (EverGreen). There are also some Petaluma residents with direct access accounts, meaning they buy power directly from suppliers.

To calculate GHG emissions, an emissions factor is applied to the activity data. Electricity suppliers provided carbon dioxide (CO_2) emissions factors. The electricity generation process also releases small amounts of methane (CH_4) and nitrous oxide (N_2O). Their emissions factors are provided by the EPA's Emissions & Generation Resource Integrated Database (eGRID) and Comprehensive Air Quality Model CAMX. CO_2 is the most commonly referenced GHG, however, numerous gasses have greenhouse characteristics. CH_4 and N_2O are commonly accounted for in GHG inventories. These gasses have a greater global warming potential; CH_4 traps approximately 28 times as much heat as CO_2 over a 100-year period and N_2O traps approximately 265 times as much heat. To account for these differences, a factor is applied to the gasses emissions to calculate a CO_2 equivalence (CO_2e). The emissions factors differ by electricity provider due to their energy portfolio. Table A-1 provides the GHG emissions from electricity use in the city by residential and nonresidential subsectors in 2018. Table A-2 provides the electricity emissions factors from the suppliers that serve Petaluma.

Table A-1: Total Annual Community Electricity Usage and GHG Emissions (2018)

Subsector	Usage (kWh)	Emissions ($MTCO_2e$)
Residential	115,635,936	6,232
Nonresidential	225,115,544	17,945
Total	**340,751,480**	**24,177**

Source: Usage data from PG&E and SCP. Emissions from RCPA 2018 Sonoma County Greenhouse Gas Inventory.

Table A-2. Electricity Emissions Factor by Supplier (2018)

Electricity Supplier	Emissions Factor ($MTCO_2e$/kWh)
PG&E	0.00033348
Direct Access	0.0002404
Sonoma Clean Power Clean Start	0.00004573
Sonoma Clean Power Ever Green	0.00002178

Source: PG&E and SCP

Natural Gas

PG&E provides natural gas utility services to Petaluma. Table A-3 provides the natural gas activity data in therms and the emissions estimates for 2018 separated by residential and nonresidential uses. Nonresidential use combines commercial and industrial use. As with electricity, GHG emissions are estimated from activity data by applying an emission factor. However, unlike electricity, the carbon intensity of the combustion of natural gas does not vary annually and it does not vary between residential and nonresidential. These estimates are using the most current emissions coefficient for natural gas from the provider.

Table A-3: Total Annual Community Natural Gas Usage and GHG Emissions (2018)

Subsector	Usage (therms)	Emissions ($MTCO_2e$)
Residential	10,074,751	54,177
Nonresidential	6,716,871	36,120
Total	**16,791,622**	**90,297**

Source: Usage data from PG&E. Emissions from RCPA 2018 Sonoma County Greenhouse Gas Inventory.

Total Energy GHG Emissions

Table A-4 shows the total energy related GHG emissions decreased by 31% from 2010 to 2018. In particular, this overall reduction in energy GHG emissions reflects the transition to the SCP.

Table A-4: Total Annual Community GHG Emissions from Energy Use in 2010 and 2018

	2010	2018	% Change
GHG Emissions ($MTCO_2e$)	165,259	114,475	-31%

On-Road Transportation

This section presents the GHG emissions for the transportation sector, specifically from all on-road trips (including cars, trucks, buses, etc.) that have occurred within City limits. This section provides activity data and emissions estimates for baseline year 2010 and 2018. Transportation emissions were calculated using the origin-destination methodology and the data sources were the 2010 and 2015 Sonoma County Transportation Authority Travel Models and EMFAC 2017. Vehicle miles traveled estimates for both years were converted to GHG emissions using the 2017 Emissions Factor (EMFAC) model. EMFAC represents the state's current understanding of motor vehicle travel activities and associated emission levels from on-road vehicles including cars, trucks, and buses in California. Though the Sonoma-Marin Area Rail Transit (SMART) began service in August 2017, its emissions are not captured in the city's inventory due to the use of the SCTA's 2015 model.

Table A-5 shows that VMT has increased in Petaluma by 42% from 2010 to 2018 and associated GHG emissions increased by only 20%. The large jump in VMT is due to the recalibration of employment-related land use data over time used in the transportation models.

Though the VMT increase can be attributed to the modelling, the trend of smaller gains in emissions compared to VMT is a factor of State and Federal regulations including improved fuel efficiency standards and low carbon fuel standards. Emissions have also increased slower than VMT due to an increasingly efficient overall fleet of vehicles within the city (including an increased uptake of electric, hybrid, and high efficiency vehicles). In 2018, there were more electric vehicle sales in Sonoma County than any previous year.

Table A-5: Total Annual Community GHG Emissions from On-Road Transportation (2018)

Transit Type	2010			2018		
	Total VMT	$MTCO_2e$/ VMT	Total Emissions	Total VMT	$MTCO_2e$/ VMT	Total Emissions
Vehicles	513,485,773	0.000692	261,790	729,365,214	0.000431	314,439

Off-Road Transportation

This section presents the GHG emissions for off-road transportation activity, specifically emissions from construction, lawn and garden, recreational, and industrial equipment use within the city.

Off-road emissions data for Sonoma County was gathered from the CARB OFFROAD2007, OFFROAD2017, RV2018, and PC2014 modelling tools. Since the CARB tool models emissions for the entire county, city specific emissions data was proportioned using demographic and housing data. Data from the tool was compiled and summed according to emissions type. Emissions were then converted into carbon dioxide equivalents. From 2010 to 2018, the city experienced the largest increases in emissions from the Airport Ground Support Equipment and Construction and Mining Equipment subsectors. The largest decreases were from the Recreational Equipment and Oil Drilling subsectors.

Table A-6: Total Annual Off-Road GHG Emissions by Subsector for 2010 and 2018

Subsector	GHG Emissions ($MTCO_2e$)		
	2010	2018	% Change
Recreational Equipment	1,036.65	766.93	-26%
Construction and Mining Equipment	2,920.63	3,517.75	20%
Industrial Equipment	2,307.39	2,157.34	-7%
Lawn and Garden Equipment	271.20	297.32	10%
Light Commercial Equipment	1,637.86	1,393.30	-15%
Agricultural Equipment	337.76	292.31	-13%
Airport Ground Support Equipment	13.44	17.10	27%
Transport Refrigeration Units	5.29	4.26	-19%
Oil Drilling	4.98	3.94	-21%
Entertainment Equipment	5.50	5.41	-2%
Pleasure Craft	1,419.74	1,271.45	-10%
Total	**9,960.43**	**9,727.10**	**-2%**

Source: CARB EMFAC Off-Road model

Solid Waste

Solid waste emissions include emissions associated with the decomposition of waste in landfills and compost facilities. The 2018 data for residential and commercial waste in landfills was provided by Zero Waste Sonoma (formerly Sonoma County Waste Management Agency).

Solid waste emissions are mostly methane (CH_4) from the decomposition of the materials in the landfill. Emissions are estimated from activity data (tons of waste sent to landfill) by applying an emissions factor, which is different for residential and commercial waste because their composition varies. The waste composition comes from the CalRecycle 2015 Waste Characterization Study and the emissions factors are from the WARM model.

Table A-7 indicates that total solid waste emissions increased by 49% from 2010 to 2018. Landfill waste emissions increased significantly due in part to the Redwood Landfill processing methane less efficiently.[14]

Table A-7: Total Annual Community Solid Waste Tons and GHG Emissions (2010 and 2018)

Solid Waste	2010		2018			% Change
	Tons	Emissions ($MTCO_2e$)	Tons	Emissions Factor	Emissions ($MTCO_2e$)	
Residential	-	9,430	21,485	0.5896548	12,669	34%
Commercial	-	12,832	36,105	0.5669055	20,468	60%
Total Sector		**22,262**	**57,590**	**-**	**33,137**	**49%**

Water Use and Wastewater

The water sector uses energy to collect, convey, treat, and deliver water to users, and then it uses additional energy to collect, treat, and dispose of the resulting wastewater. This energy use yields both direct and indirect greenhouse gas emissions. The City of Petaluma uses municipal water sources from Sonoma Water and recycled water from the Petaluma Wastewater Treatment Plant, which serves the City of Petaluma as well as a small portion of Unincorporated Sonoma County.

For water use, the city witnessed a significant reduction in GHG emissions from potable water use between 2010 and 2018. While the City's gross water use declined (5-year average 10,289 acre feet

[14] Regional Climate Protection Authority. 2018. Greenhouse Gas Inventory Report: Sonoma County Update 2015. Retrieved from https://rcpa.ca.gov/wp-content/uploads/2018/08/Sonoma-County-GHG-Inventory-Update-2015-070618.pdf

[2003-2007][15] to 9,816 acre feet in 2018), the GHG intensity of the energy used to convey water declined significantly with the use of renewable energy by the Sonoma County Water Agency. As a result, emissions from water use declined by 85%.

Table A-8: Total Annual Community Water Usage and Wastewater GHG Emissions

Water	2010		2018		% Change
	Gallons (mil)	Emissions ($MTCO_2e$)	Gallons (mil)	Emissions ($MTCO_2e$)	
Water Use	Not available	471	30,124	73	- 85%
Wastewater	1,852	523	1,708	517	-1%
Total Sector		**994**	**31,832**	**590**	**-41%**

[15] City of Petaluma. 2021. 2020 Urban Water Management Plan. Retrieved from: https://docs.google.com/viewerng/viewer?url=https://storage.googleapis.com/proudcity/petalumaca/uploads/2021/06/R-702-City-of-Petaluma-Final-2020-UWMP-2.pdf.