December 2017

# Trends in Operational Energy Use and Greenhouse Gas Emissions, 2007 – 2016

## Executive Summary

The City of Hillsboro has collected operational energy data and completed greenhouse gas (GHG) inventories for data years 2007 through 2016 to support tracking progress towards Hillsboro's 2030 organizational goals for energy and air emissions. During that time period the City has implemented significant energy efficiency retrofits to reduce electricity and natural gas consumption and purchased renewable electricity via Renewable Energy Certificates (RECs). These actions have Hillsboro on track to meet the 2030 organizational goals related to energy use, renewable energy purchases, and GHG emissions reductions.

Efforts related to goals for production of renewable energy and fossil-free staff vehicles are off track. These goals correspond with capital intensive investments with longer payback periods than actions related to the other goals. The City may be able to make more rapid progress on these goals in the 2020 – 2030 period based on projected cost reductions for electric vehicles and solar photovoltaic systems. In the near term, there are common practices in fleet management that could be considered to increase equipment and operational efficiency. These potential opportunities include implementation of a vehicle and equipment purchasing policy that prioritizes efficiency and low-carbon fuels and use of telematics to collect data that would allow the City to identify additional opportunities. See *Additional Opportunities* below for more details.

**Table 1:** Summary of Energy and Air Quality Goals and 2016 Status.

| Hillsboro Organizational Goals - Energy and Air Quality | 2016 Goal Status |
|---|---|
| 20% reduced energy intensity by 2020<br>(for facilities in the Better Building Challenge only) | *ACHIEVED*: Decreased by 25% |
| 60% reduced energy intensity by 2030<br>(for total Hillsboro electricity and NG use) | *ON TRACK*: Decreased by 41% |
| 100% of electricity and natural gas sourced from renewable sources for City facilities by 2030 | *ON TRACK*: Increased by 23% |
| 80% reduction in greenhouse gas emissions; 100% of remaining emissions offset by 2030 | *ON TRACK*: Decreased by 30% (see Fig. 2) |
| 80% production of energy for City facilities from renewable energy sources by 2030 | *NOT ON TRACK*: Increased by 1% |
| 100% fossil fuel-free staff vehicles; 40% reduction for other exempt vehicles by 2030 | *NOT ON TRACK*: Staff vehicles increased by 10%<br>*NOT ON TRACK*: Exempt Vehicles increased by 5% |

Figure 1 below provides a more detailed view of the City's operational GHG goal (80% reduction by 2030). The lines on the graph represent two groups of emissions sources that are primarily distinguished by ownership and operational level of control.

### *Scope 1 & Scope 2 Emissions*

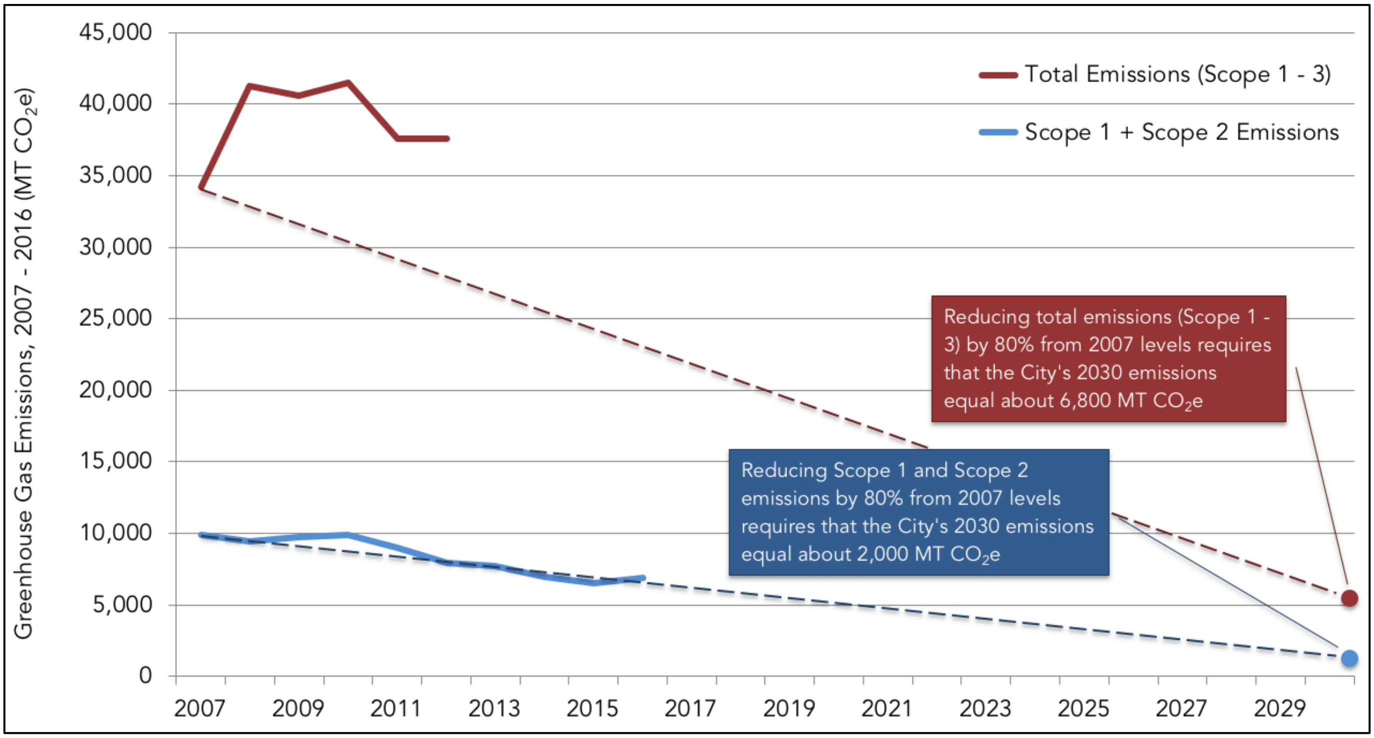
These emissions include those from City-owned vehicles and other mobile equipment, natural gas use by facilities, and purchased electricity. This group of emissions sources is a common boundary for GHG-related goals, include

Oregon state goals. As can be seen, the City is currently on track to meet the 2030 goal. This progress is largely the result of electric and natural gas efficiency projects and the purchase of renewable electricity.

### *Scope 3 Emissions*

These indirect emissions include those shared with City Vendors and employees. These include purchased goods and services, business travel, solid waste disposal, and employee commute. These emissions are shared because City operations create demand for goods and services, but the City will typically not have any, or very limited, control over the carbon intensity of production. Therefore Scope 3 emissions are more difficult to accurately track and control than Scope 1 and Scope 2 emissions, but are included in the reporting because of the scale relative to Scope 1 and Scope 2. As of 2013, these emissions were not on track to meet the City's 2030 GHG-related Goal.

**Figure 1:** Status of Hillsboro's 2030 GHG Goal (80% reduction by 2030), by Scope category.




Note on Figure 1: Scope 2 emissions are calculated using the market-based methodology.

## Introduction

This analysis focuses on Scope 1 and Scope 2 emissions and related energy use. These emissions sources are under the City's direct control and were the emphasis of recent data collection and inventory accounting. Scope 3 emissions sources, as previously mentioned, are significant, particularly supply chain purchases and employee commute, but are not as easily tracked and managed.

This analysis is intended to help assess progress to date and to identify focus areas for future efforts related to GHG emissions under the City's direct control. The analysis concludes with a brief list of additional opportunities that may help the City progress toward the established goals.

## Energy and GHG Results

*Emissions Trends for City Operations*

- **Total Scope 1 and 2 emissions have decreased by 30% between 2007 and 2016**
    - Scope 1 emissions have decreased by 15.7% between 2007 and 2016. Gasoline and diesel emissions have decreased by 14% and natural gas emissions are down just under 20%.
    - Scope 2 emission have decreased 38% between 2007 and 2016
- **Scope 1 and 2 emissions intensities have significantly decreased.**
    - Emissions per square foot of City-owned building space have decreased by 30%
    - Emissions per full-time City employee (FTE) have decreased by 20%
    - Emissions per Hillsboro resident have decreased by 38% (see Figure 5)

Figure 2 and Figure 3 show identical emissions for Scope 1 (fleet and natural gas). The two graphs differ in their accounting approach for Scope 2 (purchased electricity). There are two accounting approaches for electricity – market-based and location-based accounting. Figure 2 shows the market-based results, which is based on an organization's contracts for purchasing electricity, including a utility-specific emissions factor for the local electric utility as well as other contractual mechanisms, such as the purchase of Renewable Electricity Certificates (RECs).

Figure 3 shows the location-based results which represent the average emissions generated in a regional electricity grid. Electricity is constantly being traded between utilities and each utility's contracts represent their contribution to the larger grid. Location-based emissions are a representation of the average emissions associated with using or not using a kilowatt hour of electricity.

Ultimately, the highest-level goal related to electricity is to drive down regional electricity-related emissions by purchasing low carbon electricity and driving development of new, additional renewable electricity generation. For the purpose of tracking Hillsboro's progress toward its goals, market-based accounting should be used.

**Figure 2:** Scope 1 and 2 energy emissions by source.

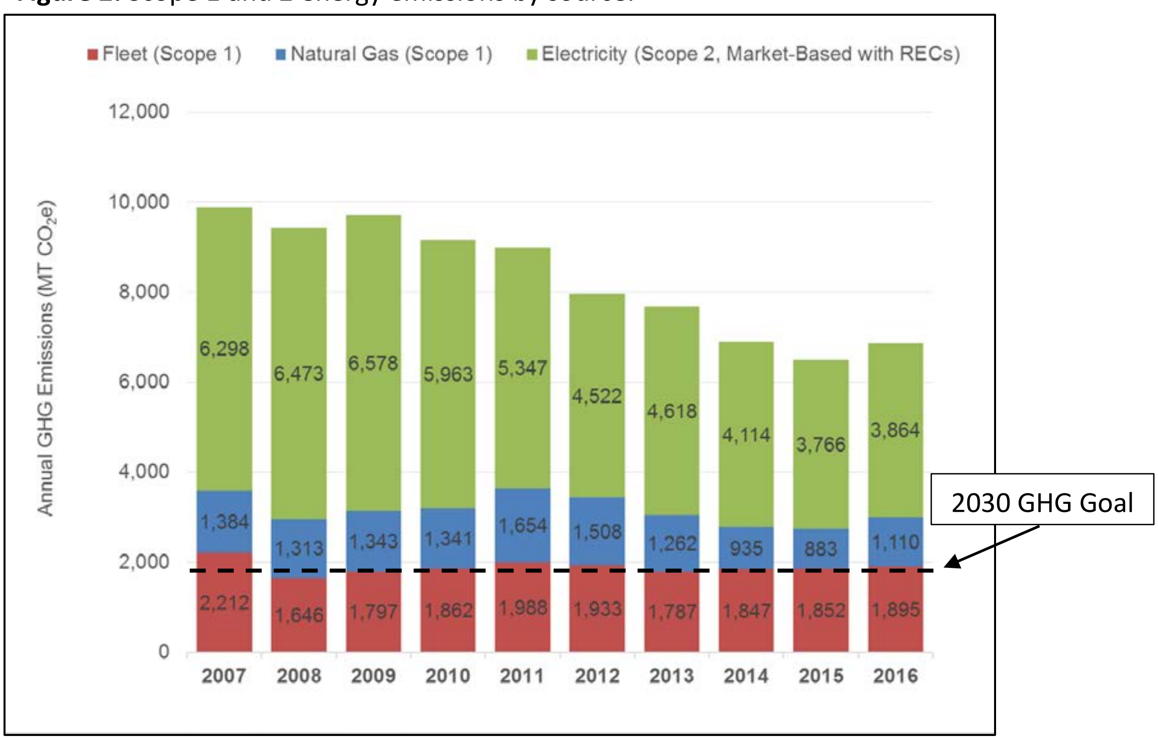
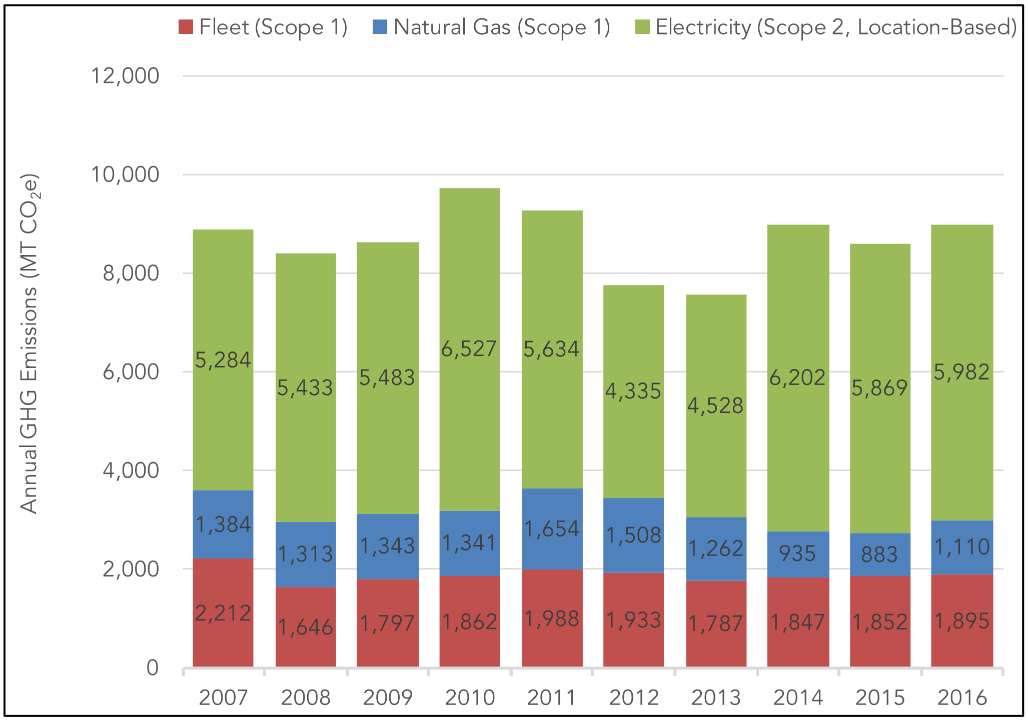
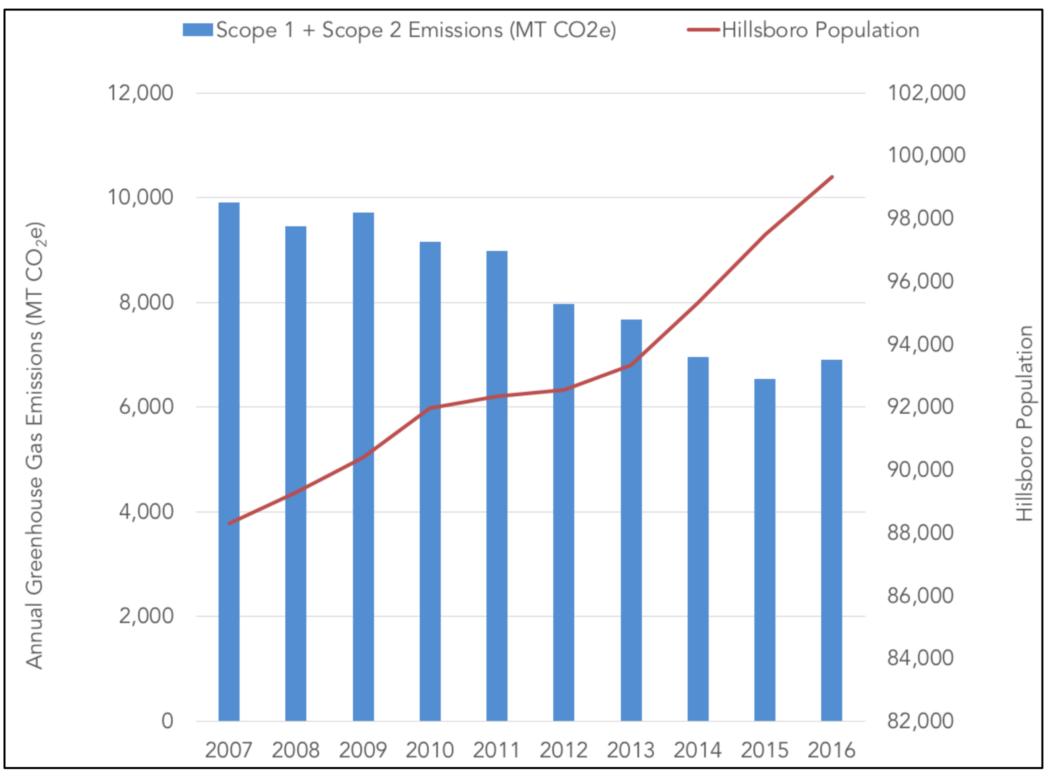


**Figure 3:** Scope 1 and 2 energy emissions by source.




Note: Electricity emissions in Figure 3 are calculated using market-based electricity accounting.

**Figure 4:** Historic Scope 1 and 2 emissions and emissions intensity per community member.



*Electricity – Detailed Energy Use Trends*

In 2016, the City of Hillsboro used approximately 13,400,000 kilowatt hours (kWh) of electricity in its facilities and 800,000 kWh to power the City's operational share of the water treatment system for a total of roughly 14,200,000 kWh. The largest electricity-consuming facilities and equipment include streetlights, Civic Center, SHARC, and the Brookwood Library. The City purchased RECs from wind-generated electricity in a quantity equal to 37% of the City facilities electricity use.

Table 2 summarizes 2016 electricity use by City facilities and equipment in kWh and % of total City facility use. It also shows the change in electricity use between 2011 and 2016. The impact of numerous energy efficiency projects are evident in the emissions reductions. The largest increases between 2011 and 2016 were at the Brookwood Library, Hillsboro Stadium, Ron Tonkin Field, and the Parks Administration building. There are many reasons for increases, such as year-over-year weather variability or facility expansion or increased use, and as part of the City's energy management program, staff are consistently working to address facility energy efficiency. The Brookwood Library is the focus of a current in-depth energy efficiency assessment through the Energy Trust of Oregon.

**Table 2:** Comparison of operational electricity use in 2011 and 2016.

| Facility | 2011 Electricity Use (kWh) | 2016 Electricity Use (kWh) | % of 2016 Electricity Use | % Change, 2016 vs. 2011 | kWh Change, 2016 vs. 2011 |
|---|---|---|---|---|---|
| Street Lights - Total | 4,577,895 | 3,703,149 | 26% | -19% | -874,746 |
| Civic Center | 1,856,700 | 1,734,000 | 12% | -7% | -122,700 |
| Brookwood Library | 949,386 | 1,283,501 | 9% | 35% | 334,115 |
| SHARC | 1,546,320 | 1,130,480 | 8% | -27% | -415,840 |
| Hillsboro Stadium | 791,300 | 909,040 | 6% | 15% | 117,740 |
| Police West Precinct | 687,600 | 676,160 | 5% | -2% | -11,440 |
| Ron Tonkin Field* | Not applicable | 478,800 | 3% | 18% | 74,600 |
| Intermodal Transit Facility* | 79,733 | 324,219 | 2% | -14% | -52,096 |
| Shute Park Library | 279,760 | 300,600 | 2% | 7% | 20,840 |
| Traffic Signals | 268,208 | 267,145 | 2% | 0% | -1,063 |
| SHARC - Bath House | 220,320 | 231,840 | 2% | 5% | 11,520 |
| Police East Precinct | 184,314 | 184,254 | 1% | 0% | -60 |
| Parks Maintenance | 178,200 | 183,000 | 1% | 3% | 4,800 |
| Cherry Lane Fire | 149,440 | 171,520 | 1% | 15% | 22,080 |
| Parks Administration | 99,760 | 170,240 | 1% | 71% | 70,480 |
| Senior Center | 177,360 | 162,300 | 1% | -8% | -15,060 |
| Avenue Park | 140,400 | 149,520 | 1% | 6% | 9,120 |
| Water Distribution | 959,184 | 850,827 | 6% | -11% | -108,357 |
| Rest of Facilities | 1,940,423 | 1,298,777 | 9% | -33% | -641,646 |
| TOTAL: | 15,086,303 | 14,209,372 | 100% | -6% | -876,931 |

Figure 5 shows facility electricity use and the electricity use intensity per $100^2$ feet of building space. Hillsboro's electricity use is nearly identical in 2016 as it was in 2008 although City-owned facilities increased by 300,000 square feet during that period, due in large part to dramatically improving facility energy efficiency.

Figure 6 compares the City's electricity emissions with and without the purchase of Renewable Energy Certificates (RECs). Between 2010 and 2016, the City has cumulatively reduced emissions from its electricity use by 3,000 MT $CO_2$e. This is a 40% reduction compared to 2007 emissions from electricity.

**Figure 5:** Historic facility electricity use and intensity per 100 square feet of building space.

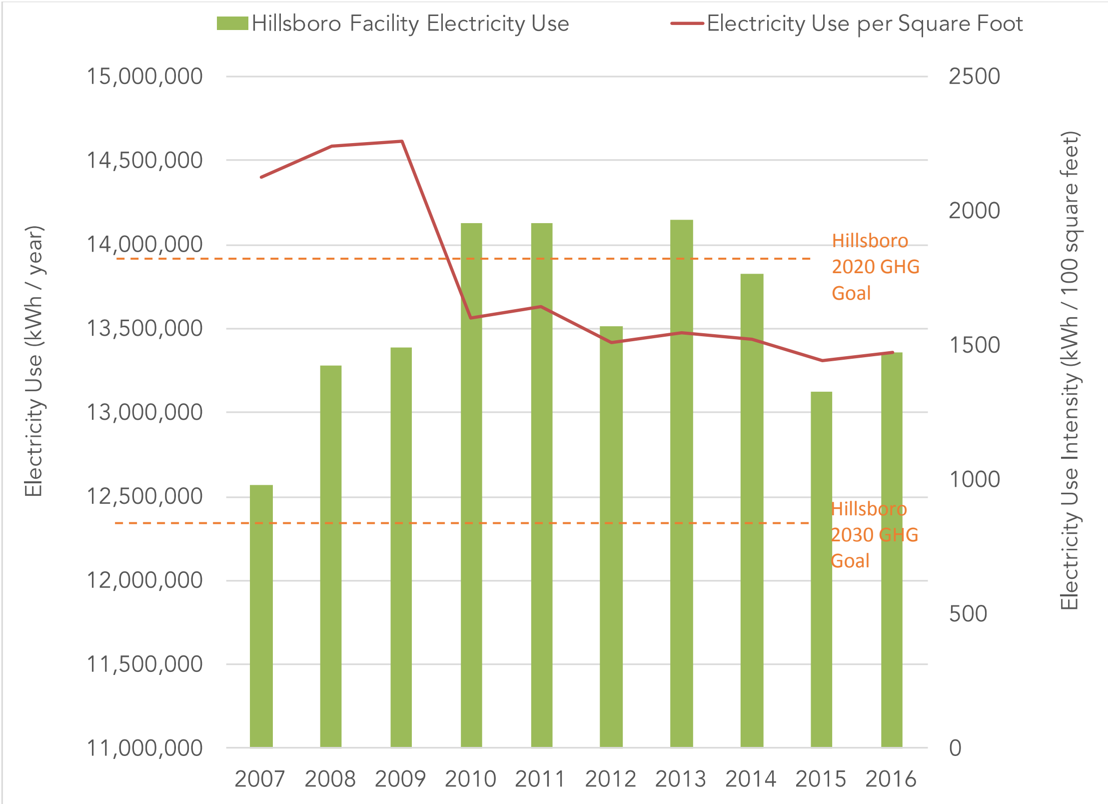
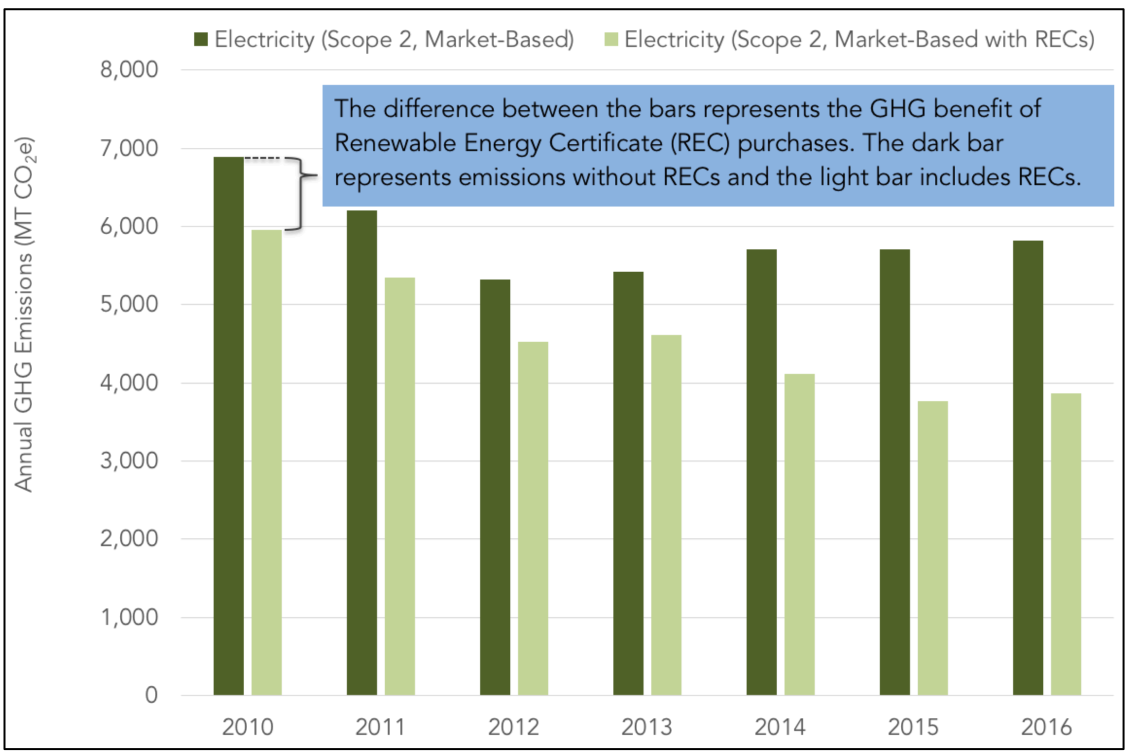



**Figure 6:** Greenhouse gas benefit for the City's purchase of Renewable Energy Certificates.



*Natural Gas – Detailed Energy Use Trends*

In 2016, the City of Hillsboro used about 212,000 therms of natural gas in its facilities. For comparison, an average Oregon home uses about 650 therms per year. The largest consumer of natural gas is the SHARC. Table 3 summarizes 2011 and 2016 natural gas use by City facility (the most significant users) and the percentage of total 2016 natural gas use by facility.

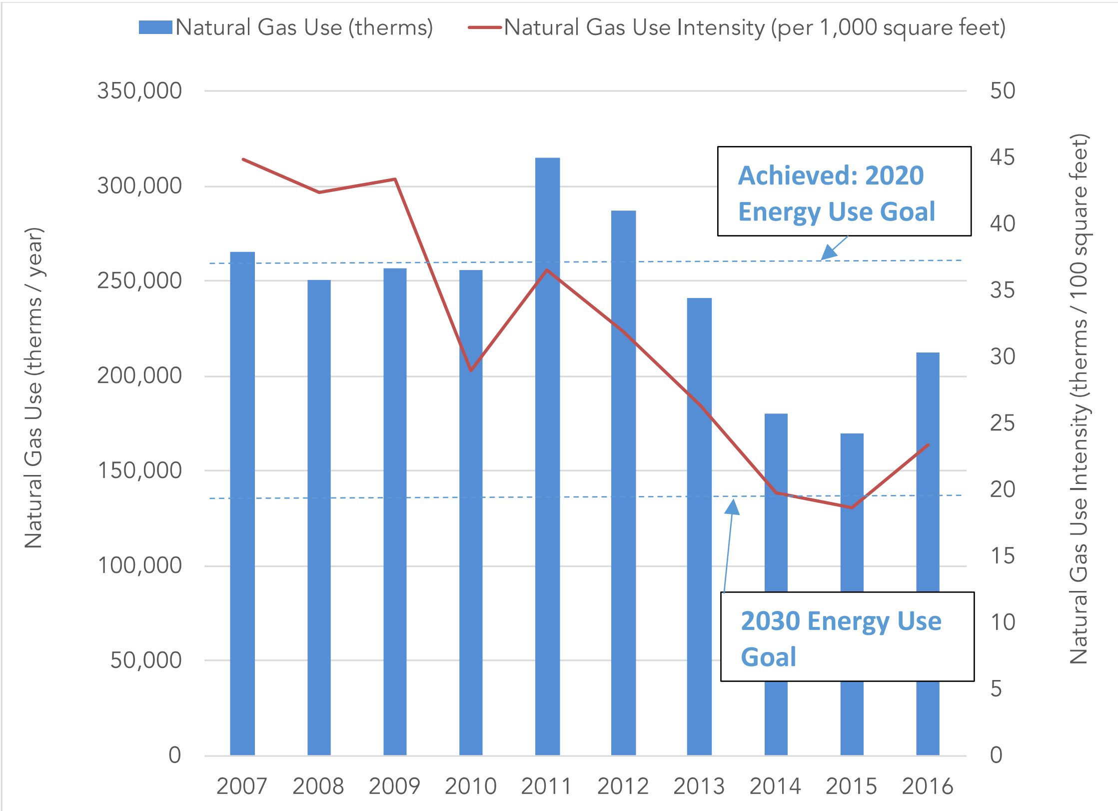
Table 3 also shows the percentage change in natural gas use between 2011 and 2016 and the change in therms over this period. This table shows the impact of the many energy efficiency projects at the SHARC and other facilities. The largest increases between 2011 and 2016 were at facilities brought online during this time period, such as Ron Tonkin Field.

**Table 3:** Summary of natural gas consumption and change, by facility, between 2011 and 2016.

| Facility | 2011 Natural Gas Use (therms) | 2016 Natural Gas Use (therms) | % of 2016 Natural Gas Use | % Change 2016 vs. 2011 | Therms Change 2016 vs. 2011 |
|---|---|---|---|---|---|
| SHARC | 152,706 | 125,413 | 59% | -18% | -27,294 |
| Parks Maintenance | 10,850 | 8,406 | 4% | -23% | -2,444 |
| Senior Center | 8,959 | 7,787 | 4% | -13% | -1,172 |
| Cherry Lane Fire | 10,124 | 6,676 | 3% | -34% | -3,448 |
| Jones Farm Fire | Not applicable | 5,497 | 3% | 66% | 2,184 |
| Ronler Acres Fire | 8,621 | 5,302 | 3% | -38% | -3,319 |
| Main Fire | 9,772 | 5,103 | 2% | -48% | -4,669 |
| Hillsboro Stadium | Not applicable | 4,854 | 2% | 0% | 14 |
| Public Works (old Maple St Bldg) | 4,791 | 3,861 | 2% | -19% | -930 |
| Civic Center | 4,741 | 3,766 | 2% | -21% | -975 |
| Ron Tonkin Field | Not applicable | 3,147 | 1% | 250% | 2,247 |
| Police East Precinct | 2,887 | 3,000 | 1% | 4% | 113 |
| Walters Cultural Arts Center | 4,180 | 2,933 | 1% | -30% | -1,247 |
| Water Ops. Building | 3,615 | 2,796 | 1% | -23% | -819 |
| Brookwood Library | 1,536 | 2,761 | 1% | 80% | 1,225 |
| Parks Administration | 3,134 | 2,414 | 1% | -23% | -720 |
| Rest of Facilities | 42,747 | 18,060 | 9% | -58% | -24,688 |
| **TOTAL:** | **268,663** | **211,777** | **100%** | **-21%** | **-65,940** |

Figure 7 shows Hillsboro's facility natural gas use and the use intensity per $100^2$ feet of building space. Hillsboro's 2016 natural gas use is less than 2007 even though City-owned facilities increased by 300,000 square feet during that time. This was accomplished by dramatically improving energy efficiency at many facilities, and relatively warmer winters during 2014 and 2015.

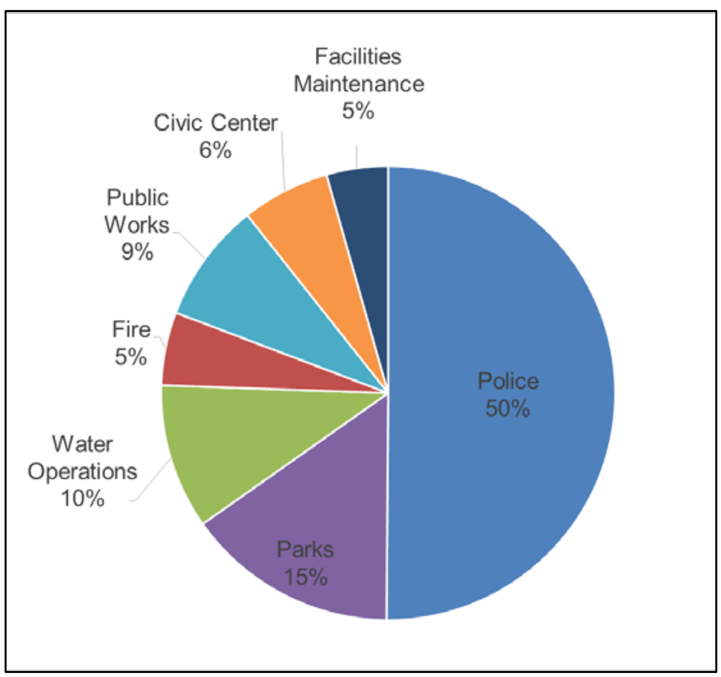
**Figure 7:** Historic natural gas use and intensity per $100^2$ feet of building space.




*Gasoline – Detailed Energy Use Trends*

Gasoline use in 2016 was dominated by Police (50% of total) followed by Parks (15%), Water Operations (10%), and Public Works (9%). Figure 8 shows that these four groups make up 84% of 2016 gasoline use.

**Figure 8:** 2016 gasoline use, by department.




The total fuel use and the mix of gasoline to ethanol has remained consistent between 2010 and 2016 at around 160,000 gallons per year. The significant decrease in 2008 is attributed to the recession. The increased use of ethanol in 2009-10 can be attributed to the implementation of Oregon's Renewable Fuel Standard, which requires that most gasoline sold in Oregon will contain at least 10% ethanol (i.e., E10 blend). Between 2007 and 2016 total gasoline fuel volume has increased by about 2%. It is difficult to consider trends for Hillsboro gasoline use over the 2007 to 2016 period due to changes in data collection and accounting systems. There are significant changes in department-level fuel use over the time period for which data is available, but the total fuel use has remained consistent. This indicates that year-over-year department or functional area changes are likely related to shifting organizational accounting as opposed to operational changes.

Figure 9 shows that the volume of E10 required to provide City services has decreased between 2007 and 2016 by over 15%, from 1.75 gallons to 1.45 gallons per community member. It is suggested that in the future, additional data is collected on average fleet fuel economy, vehicle miles traveled, and hours of operation in order to improve and refine intensity metrics. This additional data would be particularly helpful for departments that consume the largest volumes of gasoline blends. Table 4 summarizes fuel use by department.

**Figure 9:** Historic gasoline use (gallons) and the intensity of use per Hillsboro resident.

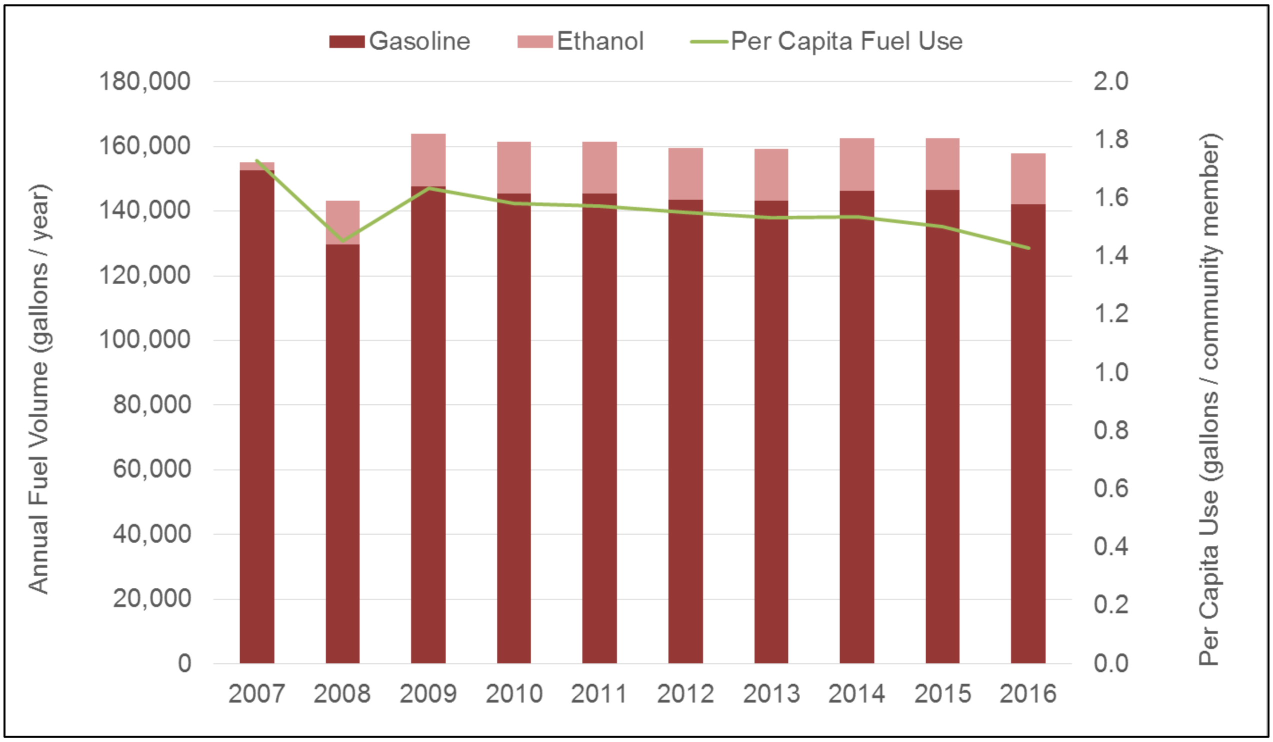


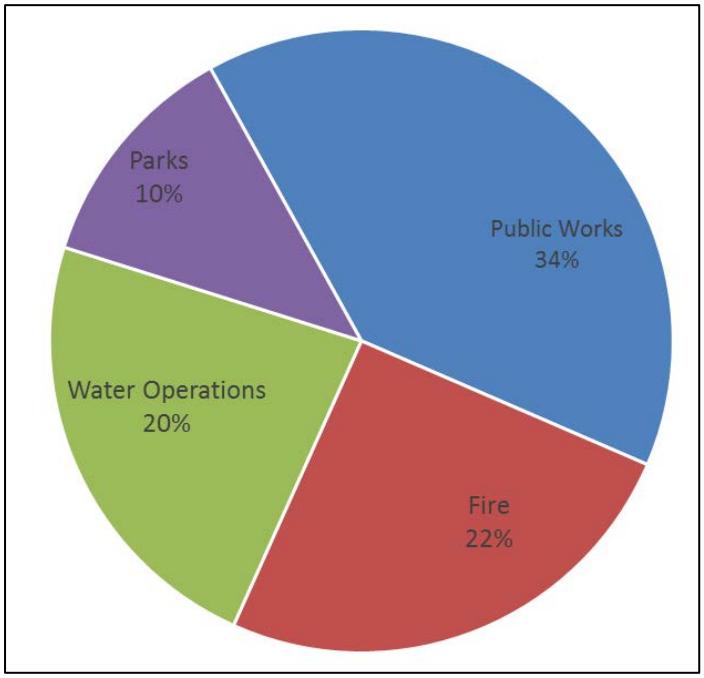

**Table 4:** Gasoline/ethanol consumption and change, by department, 2011 vs. 2016.

| Department | 2011 Gasoline/Ethanol Gallons | 2016 Gasoline/Ethanol Gallons | % of 2016 Total Fuel Volume | % Change 2016 vs. 2011 | Gallons Change 2016 vs. 2011 |
|---|---|---|---|---|---|
| Police | 82,684 | 79,085 | 50% | -4% | -3,599 |
| Parks | 25,859 | 23,826 | 15% | -8% | -2,033 |
| Water Operations | 13,527 | 16,308 | 10% | 21% | 2,782 |
| Fire | 14,864 | 8,217 | 5% | -45% | -6,647 |
| Public Works | 11,854 | 13,537 | 9% | 14% | 1,683 |
| Civic Center | 8,252 | 9,903 | 6% | 20% | 1,651 |
| Facilities Maintenance | 4,347 | 6,918 | 4% | 59% | 2,571 |
| Gasoline Total (gallons) | 145,364 | 142,015 | 90% | -2% | -3,349 |
| Ethanol (gallons) | 16,022 | 15,779 | 10% | -2% | -243 |
| Total (gallons) | 161,387 | 157,795 | 100% | -2% | -3,592 |

*Diesel – Detailed Energy Use Trends*

Diesel use in 2016 was dominated by Public Works (34% of total) followed by Fire (22%) and Water (20%). Figure 10 shows that these three groups comprise the majority of 2016 diesel use.

**Figure 10:** 2016 diesel use, by department.




Total fuel use and the mix of diesel to biodiesel has fluctuated considerably between 2010 and 2016 with an average of about 60,000 gallons per year. The significant increase in 2009 (see Figure 11) is attributed to data issues, specifically the exclusion of Public Works fuel use. The increase in 2011-12 is the result of increased use by Fire. The reason for the increase is not clear based on available data. Fire's diesel use increased from roughly 9,300 gallons in 2010 to 27,000 gallons in 2011. In 2012, consumption dropped to 20,000 gallons and down to 13,000 gallons in 2013 where it has remained relatively constant through 2012. Between 2009[1] and 2011 total diesel fuel use has increased by about 47%. Diesel use peaked in 2011 and has since *decreased* by 5%.

The increased use of biodiesel around 2011-12 is attributed to the implementation of Oregon's Renewable Fuel Standard, which required that most diesel sold in Oregon contain at least 5% biodiesel (i.e., B5 blend).

Figure 11 also shows that the volume of B5 required to provide City services has increased per resident served between 2009 and 2016 by about 20%, from 0.5 to 0.6 gallons per community member. The increase in diesel use is similar to the decrease in gasoline use, which implies that City services that were once provided using gasoline have been substituted with diesel fuel. It is suggested that in the future, additional data is collected on average fleet fuel economy, vehicle miles traveled, and hours of operation in order to improve and refine intensity metrics. This additional data would be particularly helpful for departments that consume the largest volumes of diesel.

[1] 2009 was selected for comparison because 2007 and 2008 data does not include public works fuel use. The data between 2009 and 2016 appears to be consistently accounted and reported.

**Figure 11:** Historic diesel use (gallons) and use per Hillsboro community member.

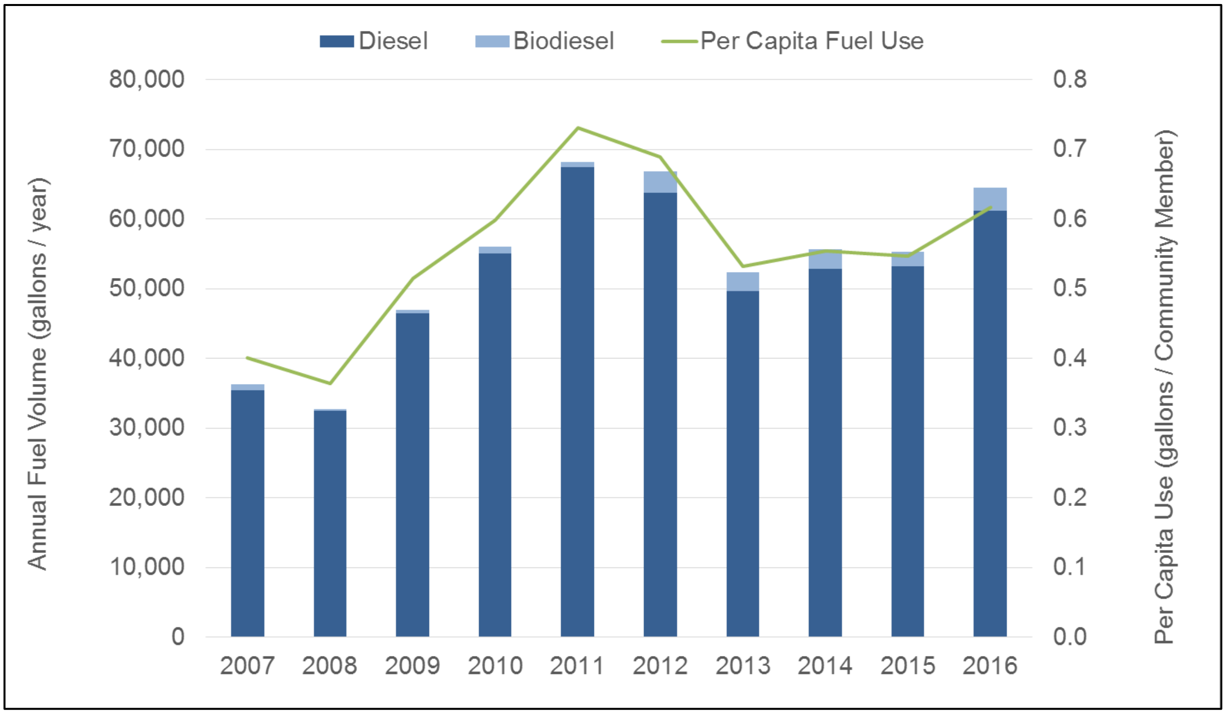



**Table 5**: Summary of diesel / biodiesel consumption and change, by department, 2011 vs. 2016.

| Department | 2011 Diesel/Biodiesel Gallons | 2016 Diesel/Biodiesel Gallons | % of 2016 Total Fuel Volume | % Change, 2016 vs. 2011 | Gallons Change, 2016 vs. 2011 |
|---|---|---|---|---|---|
| Public Works | 23,810 | 21,959 | 34% | -8% | -1,851 |
| Fire | 27,422 | 14,008 | 22% | -49% | -13,414 |
| Water Operations | 11,318 | 12,839 | 20% | 13% | 1,521 |
| Parks | 4,065 | 6,715 | 10% | 65% | 2,650 |
| Diesel Totals | 67,490 | 61,249 | 95% | -9% | -6,241 |
| Biodiesel Totals | 689 | 3,224 | 5% | 368% | 2,535 |
| Total | 68,179 | 64,473 | 100% | -5% | -3,706 |

## Progress Toward Organizational Goals

Hillsboro has made significant progress towards its operational energy-related sustainability goals. The first four goals listed on Table 6 have either been achieved or are on track to being achieved. The last two goals listed are not on track. These include 80% onsite production of renewable energy and reducing the use of fossil fuels in transportation in fleet vehicles.

**Table 6:** City goals progress data, 2007 – 2016.

| Energy-related 2030 Goals | Indicator | 2007 Baseline | 2016 Results | Current Goal Status |
|---|---|---|---|---|
| 20% reduced energy intensity by 2020 (for Better Buildings Challenge facilities only, 2009 Baseline) | Natural gas + electricity consumption (MMBTU) per square foot | 0.27 | 0.20 | ACHIEVED: Decreased by 25% |
| 60% reduced energy intensity by 2030 (for total Hillsboro electricity and natural gas use) | Natural gas + electricity consumption (MMBTU) per square foot | 0.12 | 0.07 | ON TRACK: Decreased by 41% |
| 100% of electricity and natural gas sourced from renewable sources for City facilities and exterior lighting infrastructure | Percentage of total energy offset by renewable purchases | 0% | 23% | ON TRACK: Increased by 23% |
| 80% reduction in greenhouse gas emissions; 100% of remaining emissions offset (2007 baseline) | Total Scope 1 + Scope 2 emissions. Market-Based accounting for electricity. | 9,915 | 6,911 | ON TRACK: Decreased by 30% |
| 80% production of energy for City facilities from renewable energy sources | Percentage of total energy use by City-owned generation | 0 kWh | 140,609 kWh | OFF TRACK: Increased by 1% |
| 100% fossil fuel-free staff vehicles and 40% reduction for other exempt vehicles | Percent reduction in vehicle fossil fuel use | Staff Vehicles: 0%<br>Exempt Vehicles: 0% | Staff Vehicles: 10% ethanol use<br>Exempt Vehicles: 5% biodiesel fuel use | OFF TRACK: Staff vehicles increased by 10%<br>OFF TRACK: Exempt Vehicles increased by 5% |

## Additional Opportunities

The City is on track to meet many of the 2030 goals for energy and air emissions, as is shown on Table 6, with two goals as exceptions, which include:

- 80% production of energy for City facilities from renewable energy sources
- 100% fossil fuel-free staff vehicles and 40% reduction for other exempt vehicles

The following sections offer information on the practices other communities have used to make progress on similar goals. They also offer suggestions to revise these two goals to be inclusive of the most cost-effective means of achieving the goals.

*Production of Renewable Energy for City Facilities*

City facilities use two primary types of energy – electricity and natural gas. Currently, the City purchases electricity from PGE and natural gas from Northwest Natural Gas. To meet the 2030 80% renewable energy production goal, the City will need to install significant electricity generation capacity (such as photovoltaic (PV) solar) as well as energy storage systems. These systems are likely to become more viable, common and affordable over the coming years. Renewable options for natural gas are to purchase a low carbon alternative, such as wastewater treatment or landfill biogas, or to replace natural gas-powered equipment with electric equivalents. Currently, opportunities to purchase biogas are limited due to distribution challenges. There aren't simple, cost-effective ways to transport it from the source to an end buyer. Therefore, the only current commercially available option to meet the 2030 renewable production goal for thermal energy is to substitute natural gas with electric equipment. For example, replacing natural gas furnaces with heat pumps. Another option is to further develop renewable electricity generation capacity.

PV solar systems offer carbon-free electricity generation for 30 years and in many cases, will pay for themselves over the life of the system. The City currently has a significant amount of solar on facilities, totaling more than 250 kW of capacity, and additional installations will be considered in the coming years. These technologies are expected to become less expensive, while adding new, powerful features such as battery storage. The Solar Energy Industries Association (SEIA) reports that prices have fallen from about $6 per installed watt in 2010 to $1.50 per installed watt in 2016. The National Renewable Energy Laboratories (NREL) released a report this year that provides detailed information on costs and barriers for a variety of PV solar systems with battery storage.[2]

In order to make progress on this goal, there are some initial questions that should be considered:

- What would be required and what are the limitations of electrifying the City's thermal load?
- What roof and open space is viable to install renewable generation capacity?
- How much energy storage would be required to meet nighttime demand?
- What technologies are on the horizon (e.g., solar roofing tiles, solar window films)?
- What are the current costs? How are costs expected to change between now and 2030?

Depending on the answers to the above questions, the City might also consider revising the goal to be inclusive of using renewable power purchase contracts to meet the goal. Larger systems offer economies of scale that will reduce costs while accomplishing the intent of the goal.

*Fossil Fuel-free Staff Vehicles*

The City's contractor Good Company recently conducted research benchmarking best practices for municipal governments related to reducing GHG emissions from fleets. The following actions were found to be the most often implemented and have the greatest potential to reduce fleet-related emissions.

- Green Vehicle Purchasing Standards

Like the City's goals related to facilities, the goal related to fossil fuel vehicles could be revised and split into two separate goals – one goal related to the efficiency of City-owned vehicles and equipment and the second goal related to decreasing the quantity of fossil fuels used by the City. As currently written, the fleet-related goal focuses correctly on significantly reducing the use of fossil fuels, but it should also include an efficiency component.

Many cities in the U.S. use a vehicle lifecycle assessment methodology for new vehicle selection and purchase that ensures maximum efficiency by vehicle class and operational needs. A policy could also consider opportunities to reduce emissions and total cost of ownership by extending vehicle service life when appropriate. Based on the research, this action represents the most implemented tool by other cities. Many of these programs are based in City Code, Ordinance, or Administrative Policy that requires purchasing for maximum efficiency for

**Case Study New York City**

NYC's Fleet, through Local Law 38 of 2005, has been required to purchase the most fuel-efficient vehicles for light- and medium-duty non-emergency units and to report on the manufacturer-listed fuel economy for these units. The law report provides a fleet equivalent of Corporate Average Fuel Economy (CAFE) standards at the federal level. These standards are under review nationally and currently call for new light- and medium-duty units to achieve 54.5 average mpg by 2025. The NYC fleet exceeded the 2025 CAFE goal in FY-16, ten years early. The approximate fuel and maintenance savings to NYC fleet, the largest fleet in the U.S., is approximately $100 million a year for FY-12-16, with annual new vehicle purchases of $120 million per year.

[2] For details see the report title Installed Cost Benchmarks and Deployment Barriers for Residential Solar Photovoltaics with Energy Storage: Q1 2016. Accessed 8/2017 at https://www.nrel.gov/docs/fy17osti/67474.pdf.

light- and medium-duty vehicles. Emergency vehicles are commonly exempt as are other vehicles on a case-by-case basis.

- Use of Telematics

Utilizing telematics to collect operational data for individual vehicles — such as fuel use, maintenance, utilization, idling, location, routing or mapping of trips, emissions, or speed — can help fleet managers identify opportunities to reduce fleet size, fuel use, unnecessary maintenance, and ultimately, reduce costs. The City has realized solid savings, both cost and fuel consumption, at Parks Maintenance, which has used the system for several years. Recently, Utility Billing also added the system. One efficiency opportunity that has been discussed is the use of on-board power supplies, which can help to reduce the need for idling in the field. This, combined with a no-idle policy (with necessary exceptions) can be a great area of opportunity for fuel use reduction.

- Biodiesel

*Estimated B20 Mitigation Potential (for 20% of diesel use):* **95 MT $CO_2$e**

The most obvious opportunity for the City to reduce its fleet-related Scope 1 emissions is to increase the use of biodiesel. Biodiesel is a readily available fleet fuel that is commonly used, primarily B20 blends, which is 15% greater than the City's current use of B5. This change alone would result in reducing Hillsboro's emissions by roughly 100 MT $CO_2$e per year, or about 5% of Hillsboro's total 2016 fleet emissions. For certain applications, other cities in Oregon are using biodiesel in blends as high as B50. The use of biodiesel can be unappealing to fleet managers due to warranty concerns (for use of blends greater than B20) as well as the need for increased maintenance. The City should also consider the lifecycle carbon score in selection and purchase of biodiesel. Figure 12 below shows that the carbon score for biodiesel can range from 18 (for waste grease biodiesel) to 58 (for soybean biodiesel).

- Renewable Diesel

*Estimated R99 Annual Mitigation Potential (for 100% of diesel use):* **619 MT $CO_2$e**

Another low-carbon fuel substitute for diesel is renewable diesel. Renewable diesel is made from similar feedstocks as biodiesel but uses a different production and refinement process. The experience of fleet managers in Oregon who have tested renewable diesel at an R99 blend has been overwhelmingly positive, with limited warranty and maintenance concerns. While renewable diesel appears to be a silver bullet to address GHG emissions from fossil diesel fuel there is a significant downside – currently and looking out 5 years the supply to meet demand will not be available. Supply constraints, which are the result of available refining capacity, will likely improve on a longer time frame, but it is unclear at present the precise timing of this supply. Carbon scores for renewable diesel range similarly to biodiesel depending on the feedstock used for production.

- Electricity (EV)

*Estimated EV Annual Mitigation Potential (for 75% of City gasoline use):* ***830 MT CO2e***

The most common fleet-related emissions action by Cities for passenger vehicles is investment in charging infrastructure and battery electric vehicles. The City has led Oregon over the past ten years in build-out of both publicly-available and fleet EV charging infrastructure. A few battery-powered or plug-in hybrids electric (PHEV) have also been added to the City fleet. However, a greater portion of the City's fleet could be all-electric or PHEV. In many cases, this option has been found to be cost-effective and in most cases will provide a very short payback period with significant fuel and maintenance savings. The remaining issue with cost competitive, commercially available EV technologies is limited travel range, particularly in colder parts of the year. That said – battery technologies are rapidly evolving to increase storage capacity and range, while at the same time reducing per-unit costs.

Bloomberg New Energy Finance predicts 2025 to 2029 as the point at which EV's are fully cost competitive in the light-duty class and that the greatest barrier at present is development of the charging infrastructure.[3] There are also currently commercially available fully electric and hybrid electric options in the medium to heavy duty classes – transit buses being the most notable.

- Use of On-Board Power Supplies

On-board power supplies can be used to avoid main engine idling. Generally, vehicles such as bucket trucks, sewer-line maintenance trucks, wood chippers, and various emergency vehicles require power take-off (PTO) equipment, a system that diverts power from the main vehicle engine to power another device, such as a hydraulic lift or lights. Examples of on-board power supplies include Auxiliary Power Units (APUs), generator sets, and battery power that provides identical service more efficiently than vehicle engine idling.

The benefit of on-board power supplies depends on current equipment efficiencies and how often the equipment is used. Tables 7 and 8 show that payback periods for bucket trucks and emergency vehicles range from less than 1 year to 10 years. Because paybacks have a wide range, telematics can be used to identify vehicles with the shortest payback periods.

**Table 7:** U.S. Department of Energy payback estimates for Class 7 and Class 6 bucket trucks.

**Table 1. New Class 7 Hybrid Bucket Truck Projected Payback**

| Parameter | Base Case Value (12.7-y payback) | Changed to | New Payback (y) |
|---|---|---|---|
| Idling Fuel Use (gal/h) | 1.0 | 1.5 | 8.1 |
| Idling Hours (h/d) | 4 | 6 | 6.9 |
| Vehicle Marginal Cost ($) | 60,000 | 50,000 | 10.6 |

**Table 2. New Class 5 Hybrid Bucket Truck Projected Payback**

| Parameter | Base Case Value (5.7-y payback) | Changed to | New Payback (y) |
|---|---|---|---|
| Idling Fuel Use (gal/h) | 0.8 | 1.0 | 4.7 |
| Idling Hours (h/d) | 4 | 6 | 4.6 |
| Vehicle Marginal Cost ($) | 24,000 | 14,000 | 3.3 |

References: All About Trucks—Fleet Electrification, Joe Dalum, Odyne Plug-in 2013 (September 2013); Transportation Electrification: Utility Fleets Lead the Charge, http://www.eei.org/issuesandpolicy/electrictransportation/FleetVehicles/Documents/EEI_UtilityFleetsLeadingTheCharge.pdf (Edison Electric Institute, June 2014)

**Source: USDOE, 2017. https://cleancities.energy.gov/files/pdfs/idlebox_work_truck_idling_reduction.pdf**

[3] For details see: https://about.bnef.com/blog/electric-vehicles-accelerate-54-new-car-sales-2040/

**Table 8:** U.S. Department of Energy payback estimates for emergency vehicle onboard power units.

| Vehicle | Power Source | Services | Fuel Use* gal/h | Typical Equipment Cost ($) | Added Maintenance ($/yr) | Payback (yr) |
|---|---|---|---|---|---|---|
| Police Car | Idling[1] | All | 0.5–1.0 | 0 | 350 | |
| | **Power Management System[1]** | **Restarts engine if battery low** | **0.02–0.38** | **1,200** | **0** | **0.2** |
| | **Heat Recovery System[2]** | **Heat** | **0** | **700** | **0** | **0.1** |
| | **Battery APU[3]** | **Power** | **0.6** | **3,300–4,300** | **0** | **0.6** |
| Fire Truck/ Engine | Idling[4,5] | All | 1.25–1.5 | 0 | 600 | |
| | **Diesel APU[4,5]** | **All but pumping** | **0.25** | **14,000** | **200** | **2.9** |
| Ambulance | Idling[6] | All | 1.5 | 0 | 1,000+ | |
| | **Battery Power Pack[7]** | **All** | **0.9** | **16,000** | **0** | **2–8** |
| | **Electrified Parking Space[8]**** | **All** | **0** | **0** | **30** | **2.5** |
| Armored Car | Idling[9] | All | 0.5–1.5 | 0 | 200 | |
| | **Battery APU[9]** | **All** | **0.4** | **15,000** | **0** | **3.8** |

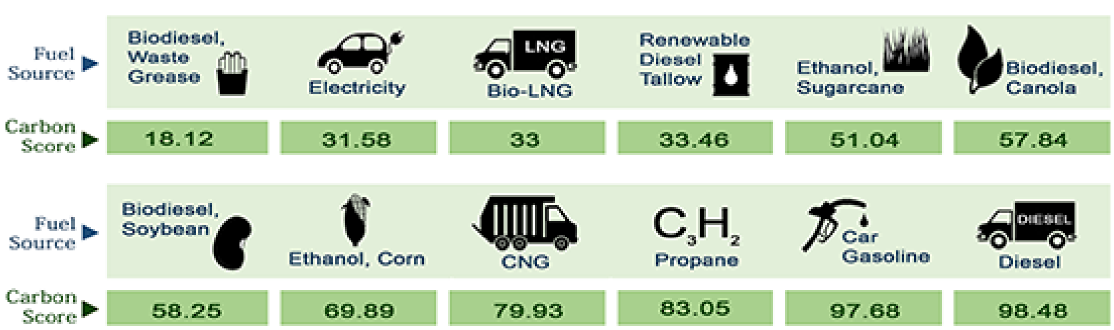
**Source: USDOE, 2015.** http://www.afdc.energy.gov/uploads/publication/idling_emergency-service_vehicles.pdf

- Use of Low-Carbon Fuels and Development of Related Infrastructure

There are several low-carbon fuel choices, with each type offering a unique set of benefits and challenges. The City already uses ethanol and biodiesel blended with gasoline and diesel. Expanding use of these fuels and exploring the potential for other fuel types should be assessed based on Hillsboro's operational needs, capital costs, O&M costs or savings, and fuel availability in the marketplace.

Low-carbon fuel choices and their respective carbon scores are compared in the following graphic from Oregon Department of Environmental Quality's Clean Fuels Program. Ethanol has a carbon benefit of about 30% compared to gasoline, electricity has a 70% benefit compared to gasoline, and soybean biodiesel has a benefit of about 40% compared to diesel.

**Figure 12:** Comparison of lifecycle GHG emissions (carbon score) by fuel type.




**Source: ODEQ, 2016.** **https://www.oregon.gov/deq/aq/programs/Pages/Clean-Fuels.aspx**