# City of Eau Claire Municipal Operations Carbon Footprint Report Year 2011

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# Executive Summary

## Findings

The carbon footprint for the City of Eau Claire's municipal operations for year 2011 was **28,514 metric tons of carbon dioxide equivalent**, excluding sequestration (see Glossary for definitions). Eighty percent (80%) of these emissions were distributed among four sectors: Wastewater Treatment Facilities, Buildings and Facilities, Water Delivery Facilities, and Streetlights and Traffic Lights. This carbon footprint report is to assist in meeting the following objectives:

- ✓ Developing a potential strategy to reduce greenhouse gas emissions per the *Sustainability Chapter* of the *City of Eau Claire's Comprehensive Plan* (p. 15-11)
- ✓ Shifting towards accomplishing 25% of the energy from renewable sources by year 2025, per the City's *25x25 Plan for Energy Independence*
- ✓ Fulfilling Wisconsin Green Tier Legacy Communities' sustainability strategies options
- ✓ Meeting The Natural Step© four eco-municipality system conditions:
    1. Decreasing the concentrations of substances extracted from the Earth's crust
    2. Decreasing the concentrations of harmful substances produced by society
    3. Stopping the degradation of nature by physical means
    4. Not subjecting people to conditions that systematically undermine their capacity to meet their needs
- ✓ Helping to meet the goals of the *City of Eau Claire's Natural Hazard Mitigation Plan, 2012-2017*

## Next Steps

This 2011 emission baseline serves as the City's first examination of its contribution to what greenhouse gasses it emits into the earth's atmosphere. In light of possible future Federal carbon pollution legislation and growing climate impacts attributed to a warming world, it is prudent for the City to be prepared while monitoring its emission levels and working to reduce them. The following recommendation options are advised if the City of Eau Claire decides to pursue next steps.

1. Continue implementing the goals of the *Sustainability Chapter* of the *Eau Claire Comprehensive Plan* and strategies options under the Green Tier Wisconsin Legacy Communities program that help reduce emissions. Implementation progress should be tracked in Green Tier annual reports.

2. Adopt a formal resolution stating the City will reduce its contribution to Climate Change and pledge to join others in working towards this goal.

3. Continue conducting the City's carbon footprint study at least on a biennial basis. (As part of their curriculum, the University of Wisconsin – Eau Claire University trains a group of students to conduct a similar study for the campus every other year. For this report, the City's Planning Division, in partnership with the University, hired a student to complete the majority of the work.)

4. Consider an emission reduction target goal. While scientific guidance in this area ranges, and no hard national policy has been set; the G8 nations (the US, UK, France, etc.) have pledged to reduce their country's 1990 greenhouse gas emissions levels 80% by 2050. In Wisconsin, the Task Force on Global Warming agreed upon a group of interim targets to reduce emissions to 2005 levels by 2014 and 22% of 2005 levels by 2022. The long-term target includes a goal to reach 75% reduction from 2005 levels by 2050.

5. Consider implementing mitigation measures outlined in the "Recommendations" section of this report. These could also be described in a future Climate Change Action Plan along with adaptation techniques in preparing for potential impacts of Climate Change (e.g. flash flood property prevention).

# Purpose & Background

## Purpose

The *Eau Claire Comprehensive Plan, Sustainability Chapter*, adopted in 2009 by the Eau Claire City Council recommended developing a strategy to reduce greenhouse gas emissions. Towards that end, a greenhouse gas emissions inventory was conducted for the calendar year of 2011. It was decided to first look at the City's own municipal operations footprint since the means to collect data was more readily available and to lead the community by example. At a later date, it may be useful to conduct a comprehensive community greenhouse gas emissions profile. However, this will take more time and resources. This City emissions inventory serves multiple purposes by establishing a baseline emission level for municipal operations, collecting total energy usage (needed in reaching the 25% renewable energy goal), improving data sharing, and suggesting policy approaches on reduction goals and mitigation measures.

## Methodology

In conducting the City's baseline inventory, an established accounting methodology or "protocol" was used. Since most U.S. cities committed to reporting totals use ICLEI – Local Governments for Sustainability's protocol guidance and tracking software, it was decided to use these services. ICLEI recommends a "five-milestone" method in reducing emissions. This report represents completing Milestone 1: Conduct a Carbon Footprint Assessment (see right-hand Figure 1).

Figure 1. ICLEI's 5 Milestones

According to the *Local Government Operations Protocol* (LGOP), the greenhouse gas inventory protocol developed by ICLEI, the benefits of developing a greenhouse gas (GHG) inventory include[1]:

- Risk Management: voluntarily reporting GHG emissions may help local governments manage climate risk by documenting early actions to reduce GHG emissions. Such information may be accepted by future state, federal or international regulatory GHG programs.
- Addressing inefficiencies: accounting for emissions has helped many organizations gain better insights into the relationship between improving efficiency (reducing factor inputs and waste) and reducing emissions. As a result, organizations have redesigned business operations and processes, implemented technological innovations, improved products and services, and ultimately saved money and resources.
- Readiness for a carbon constrained future: identifying emission sources to develop a GHG profile and management strategies may help local government prepare for and to respond to the potential impact of new regulations/carbon markets.
- Recognition as an environmental leader: voluntarily reporting GHG emissions provide local governments with a pathway to recognize, publicize, and promote their environmental stewardship.
- Stakeholder education: assembling an annual GHG emissions inventory can help inform management, constituents, employees and the general public about a local government's GHG emissions profile.

[1] LGOP ver.1 Page 4

Thus, greenhouse gas inventory reports provide an educational framework for leaders, citizens, and businesses to learn about their community's impact on the environment. This carbon footprint report adheres to the *Local Government Operation Protocol* GHG Accounting and Reporting principles. The five reporting principles outlined in LGOP 2010 are Relevance, Completeness, Consistency, Transparency and Accuracy.[2]

**Tracking Software**

Dues to ICLEI – Local Governments for Sustainability obtained their proprietary Clean Air Climate Protection software, known as CACP 2009. This software allows for conversions of activity data such as kilowatt hours and mass of natural gas consumed by the City of Eau Claire's operations into equivalents of $CO_2$ produced. CACP 2009 is based on the Local Government Operations Protocol.

In accordance with LGOP, three scopes were used to classify and report the activity data. The use of scopes to classify emissions is done to avoid potential double counting of emissions. It is worthy to note that reporting of Scope 3 emissions under LGOP is voluntary. Select Scope 3 emissions were included in this report to identify inefficiencies that can be resolved with minimal investment.

- **Scope 1**: All direct emissions from sources within the geopolitical boundary of the City of Eau Claire, including stationary combustion of fuels to produce heat, mobile combustion of fuels in fleet vehicles, and fugitive emissions, such as refrigerant leaks and methane escapes from landfills.
- **Scope 2**: A special category of indirect emissions which refers only to indirect emissions associated with the consumption of purchased or acquired electricity, steam, heating, or cooling. Scope 2 emissions physically occur at the facility where electricity is generated (i.e. power plant). The City's Scope 2 emissions are often the utility company's Scope 1 emissions.
- **Scope 3**: Indirect emissions that are not physically or operationally controlled by the City of Eau Claire. These include any emissions that are not covered in Scope 2. For the purpose of this report the main Scope 3 emissions examined will consist of emissions from employee commute, employee air and ground travel, and emissions resulting from solid waste disposal at a facility not operated or owned by the City.

CACP 2009 allows municipalities to track not only emissions due to government operations, but also the community as a whole. As mentioned, this report will only present the emissions from municipal City operations, but in the future a comprehensive community-scaled analysis should be completed.

**Activity Data**

Emissions were calculated using the 2011 calendar year. Most of the data was gathered from direct documentations such as energy bills and travel statements. Proxies were used for emission sources where no direct data was available. Proxies were acquired from previous years, or estimated by using LGOP and ICLEI guidelines. Data for employee commutes was estimated using a survey (see Appendix VI for the full survey), which was sent out to City employees.

**Greenhouse Gases & Air Pollutants**

The six internationally recognized greenhouse gases regulated under Kyoto Protocol include $CO_2$ (carbon dioxide), $CH_4$ (methane), $N_2O$ (nitrous oxide), HFCs (hydroflurocarbons), PFCs (perflurocarbons), and $SF_6$ (sulfur hexafluoride). All these compounds have variable Global Warming Potentials (GWPs). GWP describes the potency to trap infrared radiation coming from the Earth surface in the atmosphere. The potency is measured in relation to the potency of carbon dioxide (the least potent but most commonly produced gas, whose GWP is 1).

[2] LGOP ver. 1 Page 10

The GWP of methane for example is 25. In other words, methane is 25 times more potent at trapping infrared radiation than carbon dioxide). Sulfur hexafluoride is the most potent greenhouse gas, with a GWP of 22,800. The use of GWP allows for reporting all emissions in equivalents of carbon dioxide ($CO_2e$). This enables for easier and more direct comparisons across emission sectors which tend to emit different mixtures of GHGs (e.g. transportation vs. electricity use), and it also allows for direct comparisons between similar sized cities.

**Sectors**

Under the protocol, emissions are categorized in sectors. The sectors outlined in LGOP are: buildings and other facilities, streetlights and traffic signals, water delivery facilities, port facilities, airport facilities, vehicle fleet, transit fleet, power generation facilities, solid waste facilities, wastewater facilities, and other process and fugitive emissions. Some of these such as port and airport facilities are not in the City of Eau Claire's ownership control, and are therefore not counted in the carbon footprint inventory. Sources of City emissions were grouped into sectors as follows:

Table 1. City Emission Sectors

| | | |
|---|---|---|
| **Buildings & Facilities**<br>Backup Generators<br>Fire Stations<br>Propane use<br>Parks - Ballfields<br>Parks - Cemeteries<br>Parks - Community<br>Parks - Neighborhood<br>Fairfax Pool<br>Hobbs Ice Arena<br>Police<br>Public Works Facilities<br>City Hall<br>L.E. Philips Memorial Library<br>Transit Center | **Streetlights & Traffic Lights**<br>Metered Lights and Traffic<br>Unmetered Whiteway Lights<br>Unmetered Neighborhood Lights<br>Unmetered Traffic Lights | **Vehicle Fleet**<br>Heavy Duty Vehicles<br>Light Trucks<br>Passenger Cars<br>Off-Road Equipment |
| | **Wastewater Facilities**<br>Stormwater Stations<br>Lift Stations<br>Wastewater Treatment Plant | **Employee Transportation**<br>Employee Commute<br>In-town Travel<br>Out-of-town travel<br>Business air travel |
| | **Water Delivery Facilities**<br>Water Reservoirs and Towers<br>Booster Stations<br>Water Wells and Treatment | **Mobile Refrigerant Leaks**<br>Mobile A/C leaks |
| **Process Fugitive**<br>City Hall R22 leak<br>Library R-410a leak | **Solid Waste Facilities**<br>Blue Valley Landfill<br>Sky Park Landfill | **Transit Fleet**<br>Diesel |

# Sector Analysis

## Summary

This section presents emission sources grouped by sectors, along with the methods used to convert activity data into emissions. Included are the references on who provided the activity data. This will help identify the responsible entity to collect source information for the next carbon footprint. The City of Eau Claire's municipal operations in 2011 resulted in **28,514 metric tons of carbon dioxide equivalents** ($CO_2e$), excluding sequestration. There was specifically 28,224 metric tons of carbon dioxide ($CO_2$), 482 kilograms of nitrous oxide ($N_2O$), and 625 kilograms of methane ($CH_4$). The following figure and table note the emission breakdown per City sector.

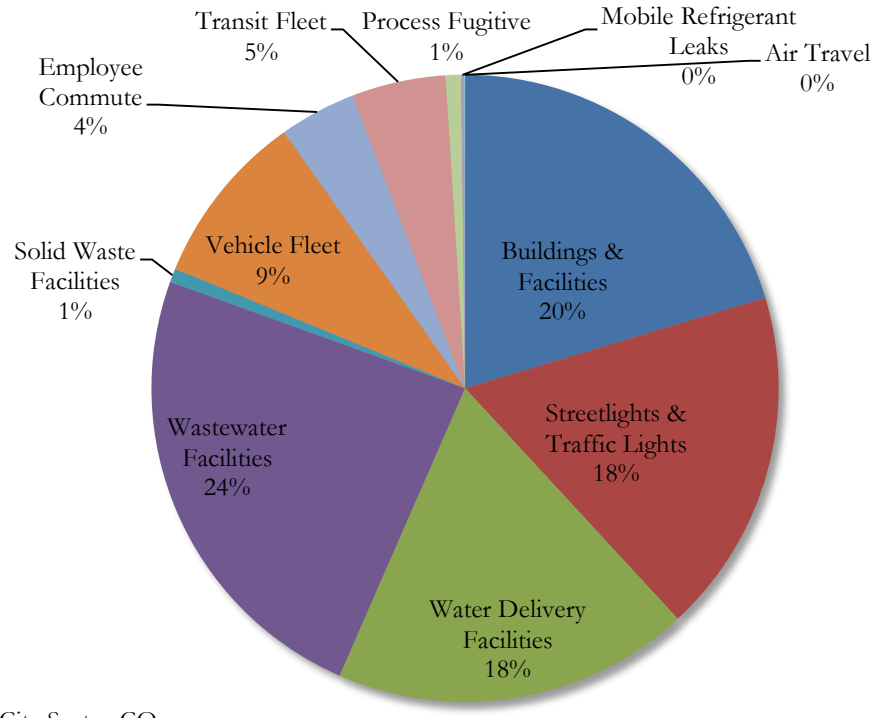


Figure 2. City Sector $CO_2e$

Table 2. City Sector $CO_2e$

| Sector | $CO_2e$ produced, metric tons | Energy consumed, MMBtus |
|---|---|---|
| Buildings & Facilities | 5,800 | 48,559 |
| Streetlights & Traffic Lights | 5,075 | 23,320 |
| Water Delivery Facilities | 5,252 | 25,407 |
| Wastewater Facilities | 6,832 | 22,567 |
| Solid Waste Facilities | 200 | 920 |
| Vehicle Fleet | 2,564 | 35,301 |
| Employee Commute | 1,125 | 16,085 |
| Transit Fleet | 1,383 | 18,691 |
| Process Fugitive | 226 | 0 |
| Mobile Refrigerant Leaks | 44 | 0 |
| Air Travel | 13 | 188 |
| **Totals** | **28,514** | **191,044** |
| Public Trees (partial inventory) | -3,037 | 0 |

## Buildings & Facilities

This sector's emissions mainly consisted of Scope 1 emissions due to combustion of natural gas, propane and other fuels on site, and Scope 2 electricity purchased from utility providers such as Xcel Energy and Eau Claire Energy Cooperative.

**Methods:** The data for natural gas and electricity was acquired from Xcel Energy. For each building, the volume of natural gas (therms) and kilowatt hours used were calculated for the entire year of 2011. The numbers were then plugged into the CACP 2009 software, which converted the activity data into GHG emissions.
**Data:** The operations of the buildings and facilities consumed an equivalent of 48,559 MMBtus of energy, which resulted in the emissions of 5,771 metric tons $CO_2$, 79 kilograms $N_2O$, and 220 kilograms $CH_4$, totaling in 5,800 metric tons of $CO_2e$.
**References:** Judy Ring, Commercial Account representative of Xcel Energy; Dave Graves, Sr. Member Services Associate of Eau Claire Energy Cooperative; Vicki Franson, Accountant and Rod Bonesteel, Buildings Supervisor, City of Eau Claire.

Table 3. Buildings & Facilities Emissions

| **Emission Source** | **Emissions (metric tons $CO_2e$)** |
|---|---|
| Fire Stations | 314 |
| Parks Propane | 25 |
| Ballfields (Parks) | 168 |
| Cemeteries (Parks) | 39 |
| Community Parks | 116 |
| Neighborhood Parks | 38 |
| Fairfax Pool | 205 |
| Hobbs Ice Arena | 2,244 |
| Police Facilities | 34 |
| Public Works Facilities | 1,016 |
| City Hall | 895 |
| L.E. Phillips Memorial Library | 677 |
| Transit Center | 28 |
| **Total:** | **5,799** |

## Streetlights & Traffic Lights

This sector consisted mainly of Scope 2 emissions due to electricity purchased from Xcel Energy.

**Methods:** The data for metered Lights and Traffic Lights was acquired directly from Xcel bills. For unmetered lights, the quantities and power rating of the bulbs used (wattage) were known. The lights were assumed to be operating 4,083 hours a year (approximately 11 hours a day). The number of kilowatt-hours used by unmetered lighting in 2011 was calculated using the following formula provided by Xcel Energy:

**Power rating of bulbs used (watts) * # of bulbs * 4,083 (hours)/1,000**

Sample calculation: 100 watts * 328 bulbs * 4,083 hours/1000 = 133,922.4 kWh
**Data:** Street light and traffic light operation paid for by the City of Eau Claire consumed an equivalent of 23,320 MMBtus, emitting 5,046 metric tons of $CO_2$, 90 kilograms of $N_2O$, and 87 kilograms of $CH_4$, totaling in 5,075 metric tons of $CO_2$.
**References:** Judy Ring of Xcel Energy; Ross Spitz, Traffic Engineer and Jodi Nuenke, Engineering Tech., City of Eau Claire.

Table 4. Streetlight & Traffic Light Emissions

| Emissions Source | Emissions (metric tons $CO_2e$) |
|---|---|
| Metered Lights | 1,122 |
| Unmetered Whiteway Lights | 2,634 |
| Unmetered Xcel Owned Lights | 1,045 |
| Other Unmetered Lights | 217 |
| Unmetered Traffic Lights | 57 |
| **Total:** | **5,075** |

## Water Delivery Facilities

This sector contained emissions associated with Scope 1 natural gas combustion and Scope 2 electricity.

**Methods:** The data for Water Delivery Facilities were acquired directly from Xcel bills.
**Data:** Operating Water Delivery Facilities consumed an equivalent of 25,407 MMBtus, resulting in emissions of 5,221 metric tons of $CO_2$, 92 kilograms of $N_2O$ and 97 kilograms of $CH_4$, totaling in 5,252 metric tons of $CO_2e$.
**References:** Jeff Pippenger, Utilities Administrator and Tim Greene, Water Plant Supervisor, City of Eau Claire.

Table 5. Water Delivery Facilities Emissions

| Emissions Source | Emissions (metric tons $CO_2e$) |
|---|---|
| Water Reservoirs and Towers | 23 |
| Booster Stations | 593 |
| Water Wells and Treatment Plant | 4,636 |
| **Total:** | **5,252** |

## Wastewater Facilities

This sector contains Scope 1 emissions from combustion of purchased natural gas, combustion of biogas produced on site and used in electricity generation; as well as process and fugitive emissions of $CH_4$ due to incomplete combustion of digester gas. Also included are Scope 1 $N_2O$ emissions associated with effluent discharge and Scope 2 emissions associated with purchased electricity.

**Methods:** Emissions resulting from purchased electricity and natural gas were calculated using CACP 2009 and activity data acquired directly from Xcel billing. Fugitive and process emissions were calculated using the formulas presented in LGOP 2010. Some formulas use the population served by the wastewater treatment plant (estimated at 74,122) as the proxy. Other use effluent nitrogen discharge per day (estimated at 735 kg/day). See Appendix IV for complete formulas and emission factors.
**Data:** The operation of the wastewater facilities consumed an equivalent of 22,567 MMBtus and resulted in the emissions of 70 metric tons of methane, 2.4 metric tons of nitrous oxide, and 4,202 metric tons of carbon dioxide, which summed up to 6,436 metric tons of $CO_2e$.
**References:** Jeff Pippenger, Utilities Administrator, Steve Hayden, Sewage Plant Supervisor, Craig Capper, Chemist, City of Eau Claire.

Table 6. Wastewater Facilities Emissions

| Emissions Source | Emissions (metric tons $CO_2e$) |
|---|---|
| Stormwater Pumps | 8 |
| Lift Stations | 582 |
| Wastewater Treatment Plant | 6,242 |
| **Total:** | **6,832** |

## Solid Waste Facilities

The emissions in this sector consisted of Scope 1 fugitive emissions from the City's closed Blue Valley Landfill (also known as Town of Union Landfill) and the Sky Park Landfill, as well as Scope 2 emissions due to purchased electricity to operate the water purification system at the Blue Valley Landfill site.

**Methods:** The Scope 2 emissions were calculated using CACP 2009 and activity data acquired from Eau Claire Energy Cooperative (ECEC). Wisconsin DNR studies indicate that landfill gas production and release still occur at the Blue Valley and Sky Park landfill sites. Because the City did not practice keeping track of the types and quantities of substances received (see Appendix VII) and because the landfills have been closed for over 40 years, it is difficult to estimate the fugitive emissions due to methane escapes. Because of this lack of direct data and methodologies available to us, a good estimate cannot be ascertained. Thus, fugitive emissions will be excluded from the analysis.
**Data:** The emissions due to purchased electricity resulted in 199 metric tons of $CO_2$, 4 kilograms of $N_2O$ and 3 kilograms of $CH_4$, which sums to 200 metric tons of $CO_2e$.
**References:** Dave Graves, Sr. Member Services Associate of Eau Claire Energy Cooperative; Colleen Schian, Risk Manager and Kathy White, Chemist, City of Eau Claire.

Table 7. Solid Waste Facilities Emissions

| Emissions Source | Emissions (metric tons $CO_2e$) |
|---|---|
| Blue Valley Landfill | 200 |

## Vehicle Fleet

The emissions in this sector consisted of Scope 1 mobile emissions due to mobile combustion of fossil fuels (unleaded gasoline and diesel). The fleet consists of a multitude of fuel combusting equipment such as heavy duty vehicles, trucks, cars, off-road vehicles, fire trucks, lawn mower equipment, etc.

**Methods:** The activity data were acquired from Fleet Manager, Bob Boecher and consisted of total miles driven as well as volume (gallons) and type of fuel used by each type of vehicle. The data was then processed in CACP 2009 using default settings to find greenhouse gas emissions.
**Data:** The operations of the vehicle fleet emitted 2,548 metric tons $CO_2$, 48 kilograms $N_2O$, and 42 kilograms $CH_4$, totaling 2,564 metric tons $CO_2e$.
**References:** Bob Boecher, Buildings, Grounds, & Fleet Manager, Kelly Kuba, Accountant Analyst, and Vicki Franson, Accountant, City of Eau Claire.

Table 8. Vehicle Fleet Emissions

| Emissions Source | Emissions (metric tons $CO_2e$) |
|---|---|
| Heavy Duty Vehicles | 1,169 |
| Lawn and Small Equipment | 139 |
| Light Trucks | 561 |
| Passenger Cars | 696 |
| **Total:** | **2,565** |

## Employee Commute

The emissions in this sector consisted of Scope 3 emissions resulting from mobile combustion of fossil and biogenic fuels due to employees' commute between their residence and workplace, as wells as in-town ground travel and out-of-town ground travel.

**Methods:** The activity data for the daily commute was estimated using a survey (see Appendix VI for the full survey). The survey was sent out to all employees via email. The response rate was around 35%. The responses were extrapolated for the whole employee population (Full time equivalent – 566). The activity data for the employee in and out-of-town travel was acquired from Accounting Supervisor, Kathy Ludack, and the Accounting Division. The data provided were the number of miles reimbursed by the City of Eau Claire. The total mileage was divided by the 22 miles/gallon fuel economy (estimate the City of Eau Claire used then for reimbursements) to calculate the volume of fuel consumed. The activity data were converted into emissions using CACP 2009.
**Data:** The employee commute and work related travel resulted in emissions of 1,094 metric tons $CO_2$, 95 kilograms of $N_2O$, and 83 kilograms of $CH_4$, totaling 1,125 metric tons $CO_2e$.
**References:** Employee Commuter Survey Results, Kathy Ludack, Accounting Supervisor, City of Eau Claire.

Table 9. Employee Commute Emissions

| **Emissions Source** | **Emissions (metric tons $CO_2e$)** |
|---|---|
| Commuting | 8 |
| Single Occupancy Vehicles | 1,026 |
| In-Town Travel | 61 |
| Out-Of-Town Travel | 28 |
| Moped and Motorcycle Commuting | 1 |
| **Total:** | **1,124** |

## Air Travel

The emissions in this sector consisted of Scope 3 emissions due to work-related employee air travel.

**Methods:** The number of miles reimbursed by the City was acquired from the Accounting Division and then converted to greenhouse gas emissions using the formula from *Climate Leaders GHG Inventory Protocol* published by EPA (see appendix V)
**Data:** The number of miles reimbursed by the City in 2011 equaled 49,170. This resulted in 13.4 metric tons of $CO_2e$.
**References:** Kathy Ludack, Accounting Supervisor and Vicki Franson, Accountant, City of Eau Claire.

Table 10. Air Travel Emissions

| **Emissions Source** | **Emissions (metric tons $CO_2e$)** |
|---|---|
| Airplane Diesel Combustion | 1,383 |

## Transit Fleet

The emissions in this sector consisted of Scope 1 emissions resulting from mobile combustion of diesel in the transit fleet buses.

**Methods:** Activity data was acquired from the Transit Division and consisted of distance travelled (miles) and volume of diesel consumed (gallons). The data was then converted into emissions using CACP 2009.
**Data:** The operations of the transit buses led to emissions of 1,382 metric tons $CO_2$, 3 kilograms $N_2O$, and 4 kilograms $CH_4$, totaling 1,383 metric tons of $CO_2e$.
**References:** Bob Boecher, Buildings, Grounds, & Fleet Manager and Mike Branco, Transit Manager, City of Eau Claire.

Table 11. Transit Fleet Emissions

| **Emissions Source** | **Emissions (metric tons $CO_2e$)** |
|---|---|
| Transit Diesel Combustion | 1,383 |

## Process Fugitive Emissions

This sector consists of Scope 1 fugitive emissions of refrigerants, due to leaks in the air conditioning and chiller systems. Refrigerants are often very potent greenhouse gases (See Appendix III for reference).

**Methods:** There are two leaks that occurred in 2011: one at the L.E. Phillips Memorial Library and the other at the City Hall. The amount and type of refrigerants that leaked were acquired from servicing companies and then converted to $CO_2e$ using the respective GWP's for the gases.
**Data:** The leak at the City Hall discharged 190 lbs. of R22 refrigerator gas (chlorodifluoromethane). The GWP of the gas is 1,810, so the leak amounted to 156 metric tons of $CO_2e$. The leak at the Library resulted in a 90 lbs. discharge of R-410A refrigerator blend, amounting to 70 metric tons of $CO_2e$. Combined, the two leaks totaled 226 metric tons of $CO_2e$.
**References:** Rod Bonesteel, Buildings Supervisor, City of Eau Claire; Roger Plombun of Hovland's Inc. (City Hall leak); Mark Franson of Bartingale Mechanical Inc. (Library leak).

Table 12. Process Fugitive Emissions

| **Emissions Sources** | **Emissions (metric tons $CO_2e$)** |
|---|---|
| City Hall R22 Leak | 156 |
| Phillips Library R410a leak | 70 |
| **Total:** | **226** |

## Mobile Source Refrigerants

This sector consists of Scope 1 emissions resulting from refrigerant leaks from mobile sources – the fleet vehicles.

**Methods:** Activity data was converted into $CO_2e$ using the CACP 2009.
**Data:** This sector resulted in emissions of 44 metric tons of $CO_2e$.
**References:** Bob Boecher, Buildings, Grounds, & Fleet Manager, City of Eau Claire.

Table 13. Mobile Source Refrigerant Emissions

| **Emissions Source** | **Emissions (metric tons $CO_2e$)** |
|---|---|
| Mobile Air Conditioning | 44 |

## Carbon Sequestering

Trees absorb carbon dioxide to grow, and therefore play an important role in reducing this greenhouse gas. Mature trees like the silver maple, sugar maple, and hackberry can contribute to the most environmental benefit. The *City of Eau Claire's Urban Forest Management Plan* public tree inventory includes 28,815 street trees and trees in cultivated areas of parks and open spaces. The estimated canopy cover of these inventoried trees (in maintained areas) is roughly the size of a 314 acre forest, or approximately 1.45% of the city's total urban tree canopy. Eau Claire's public tree resource sequesters a net of 3,037 metric tons of $CO_2e$ per year, which represents nearly an 11% reduction from the 28,514 metric ton total. This percentage includes 6,694,955 lbs. of $CO_2$ used in photosynthesis and carbon stored in trees, but does not count the 5,775,364 lbs. avoided from the environmental benefit of trees (i.e. homeowners save electric cooling costs due to tree shading). The percentage of $CO_2e$ sequestrated is in fact higher if the City inventoried the full number and specie of all publically-owned trees. Forested areas such as Northwest Community Park, the Well Fields, and riverbank shorelands greatly increase the amount the City can take credit for. Since this number is not yet defined, sequestration was excluded from the grand total. However, an update to the *Urban Forest Management Plan* and future carbon footprints should factor in all public tree carbon sequestration since it will significantly reduce the City's total amount of $CO_2$ emissions.

# Peer City Comparison

The City of Oshkosh provided their municipal carbon footprint analyses completed for the years 2006, 2007, and 2008. Eau Claire and Oshkosh have very similar populations (~66,000) and weather conditions, so one would expect the footprints of the two cities to be close. Indeed, the average footprint of Oshkosh (28,808 MT $CO_2e$) and the 2011 footprint for Eau Claire (28,514 MT $CO_2e$) are almost the same.

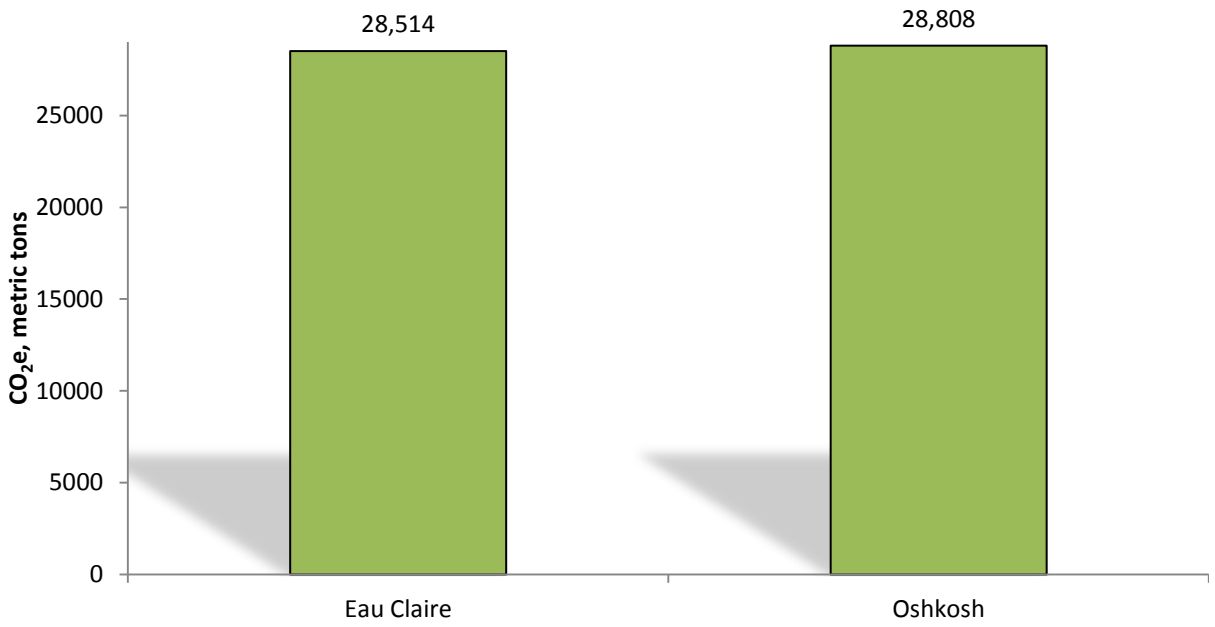


Figure 3. Peer City Carbon Footprint Comparison

In a local comparison, the University of Wisconsin – Eau Claire's 2010 carbon footprint for the fiscal year 2009-2010 was 38,870 metric tons of carbon dioxide equivalents. Interestingly enough, outside of electricity and heating use, a good portion of their footprint was attributed to student study-abroad air travel.

# Climate Change Impacts in Wisconsin

## Commerce

A warming atmosphere, surface, and water temperature will all affect Wisconsin and Eau Claire's area commerce in a variety of ways. Here are some examples to consider.

- Changes in temperature and precipitation patterns can affect growing seasons, crop yields, weed and pest infestation and dairy productivity.[3]
- Elevated $CO_2$ levels are likely to exacerbate pest problems, because $CO_2$ changes the quality of crop tissues, making plants themselves more susceptible to pest damage.[4]
- The length of the growing season continues to increase so that by the end of century it may be four to nine weeks longer than over the period of 1961-1990.[4]
- Communities and industries along Wisconsin's Great Lakes coastlines may be particularly sensitive to Climate Change due to coastal flooding, coastal erosion caused by storm surge and waves, lake water evaporation which could affect shipping traffic volume, coastal community planning, development pressures and associated coastal natural hazards.[3]
- Cities will need to plan for and cope with extreme weather from heat waves, droughts, and floods. These may cause damage to property, restrict the ability to conduct business, and limit some quality of life measures. Some Wisconsin cities are now planning for increased runoff by enhancing stormwater accommodations and erosion protection.

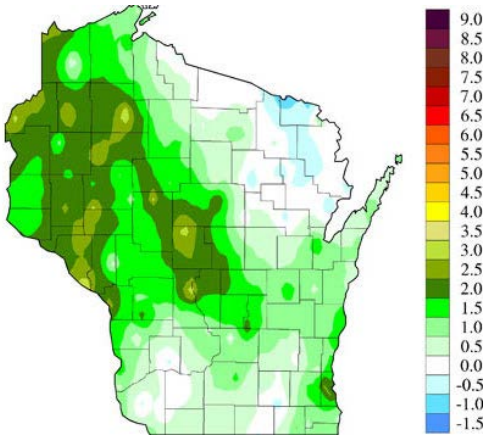


Figure 4. Change in WI Annual Average Temperature (°F) from 1950 to 2006

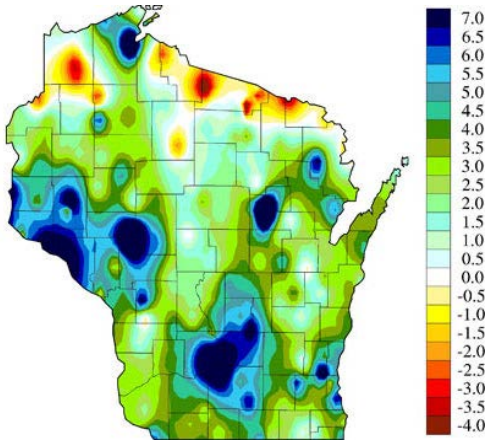


Figure 5. Change in WI Annual Average Precipitation (inches) from 1950 to 2006

## Human Health

Changing weather patterns can affect human health both directly and indirectly.

- Direct ways include more frequent and intense storms and heat waves. Indirect ways include changes in air and water quality and changes in biological patterns of disease vectors, such as deer ticks carrying Lyme disease.[3] Higher temperatures and moister air boost tick populations.[5]

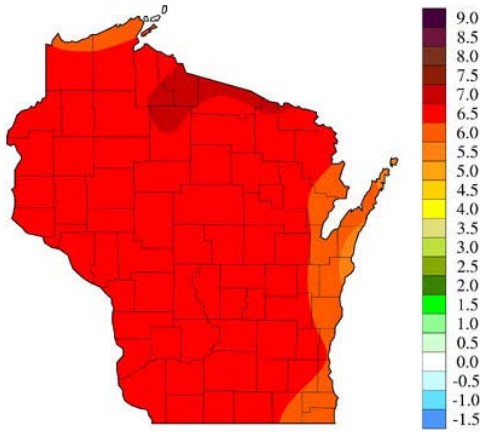


Figure 6. Projected Change in WI Annual Average Temperature (°F) from 1980 to 2055

[3] "Wisconsin Initiative on Climate Change Impacts - WICCI : Impacts." Wisconsin Initiative on Climate Change. Board of Regents of the University of Wisconsin System. http://www.wicci.wisc.edu/impacts.php. Figures from from: http://www.wicci.wisc.edu/climate-change.php

[4] Kling, George, and Donald Wuebbles. Confronting Climate Change in the Great Lakes Region. Rep. Cambridge, MA: Union of Concerned Scientists, 2005. Print.

[5] Chura, Lindsay. "An Atlas of Climate Change." *US News*. U.S.News & World Report, 25 July 2008. Web. 21 May 2012. http://www.usnews.com/science/articles/2008/07/25/an-atlas-of-climate-change.

- Heavy concentration of impermeable surfaces such as streets and parking lots make cities especially vulnerable to precipitation events. Heat waves are amplified in urban environments, which tend to have higher concentrations of vulnerable populations.[3] Higher temperatures and increased frequency of heat waves could increase the number of heat-related deaths and incidence of heat-related illnesses.[6]
- Some Wisconsin cities are responding with setting up "cooling centers" where people with no air conditioning or vulnerable populations can go to seek relief from the extreme heat.
- A 4 degree Fahrenheit warming in the Midwest (with no other change in weather or emissions) could increase concentrations of ozone, a major component of smog, by as much as 8%. Ground level ozone aggravates existing respiratory illnesses such as asthma, reduces lung function and induces a respiratory inflammation. Also, ambient ozone reduces crop yields and impairs ecosystem health.[6]
- Most storm water management systems have been designed based on certain precipitation patterns. Many of these systems will not be adequate for more intense and frequent storms.[3,5] As the atmosphere warms, it will carry more moisture, intensifying precipitation events and heightening flood risks.[5]
- Based on projections given by Intergovernmental Panel on Climate Change and results from the United Kingdom Hadley Centre's climate model (which accounts for both GHG emissions and aerosols) by year 2100 temperatures in Wisconsin could increase by about 4 degrees Fahrenheit (with a range of 2-7 degrees). Precipitation is projected to increase by 15-20% in winter, summer, and fall, with little change projected for spring.[6]

**Wildlife**

Wildlife changes due to warmer temperatures will affect Wisconsin's biodiversity and ecological landscape for decades to come.

- Coldwater fish species such as the brook trout and rainbow trout require specific temperatures and other conditions to survive. Changes in temperature or flow rates in trout streams could put these wildlife resources at risk.[3]
- Populations of plants and animals of the forests maintain themselves based on specific climatic conditions, and many may become vulnerable as average temperatures and seasons change. Tree species growing at the edge of their ranges, such as White Birch and Jack Pine, could be pushed out of the state as southern hardwood species move in.[3]
- A hotter and drier climate will create ideal conditions for the start and spread of wildfires. Fire disturbance can bring about changes in the distribution of tree species and can reduce their genetic diversity.
- An increased number of wildfires can exacerbate drought episodes by reducing rainfall. Smoke particles absorb solar heat, robbing convective currents of the energy they need to transport water vapor upward where it can precipitate, thus interfering with water cycle in the region.[4]
- Increased frequency and intensity of rain storms could increase erosion rates of certain soil types on vulnerable landscapes.[3]
- Warmer temperatures and precipitation changes will likely affect the habitats and migratory patterns of many types of wildlife. The range and distribution of many species will change.[3] Some species might become extinct.

[6] *Climate Change and Wisconsin*. Rep. Washington DC: United States Environmental Protection Agency, 1999. Print.

# Recommendations

This section of the report discusses possible greenhouse gas reduction targets, mitigation measures in reducing emissions, and adaptation strategies some communities are implementing.

**Reduction Targets**

One of the lingering problems is that the United States has not taken a firm policy position on reducing the percent of greenhouse gases. Thus cities are left to fend for their own targets and not able to follow any national standard useful for benchmarking. This may or may not change during President Obama's second term. The U.S. EPA has already moved forward though on various regulatory initiatives and made a Clean Air Act Finding that six key greenhouse gases constitute a public threat to the health and welfare of this nation. Thus, even in the absence of any national target, below are possible strategies the City might consider when selecting reduction targets.

- **Carbon Neutral:** The ultimate goal of reducing emissions is to become "carbon neutral", or having a net zero carbon footprint. This can be achieved through offsets (i.e. buying carbon credits), or ideally by changing individual practices. Generating renewable energy to perform work, constructing/inhabiting green buildings, using bicycles or transit for transportation, gardening for food, recycling and composting waste, and planting trees to sequester carbon are all individual actions that can add up. Often times it takes a combination of both offsetting and individual practices. Carbon neutrality is far simpler for homeowners to achieve and becomes more difficult and complex for businesses, institutions, cities, and nations. The countries of Norway, Iceland, New Zealand, and Costa Rica have pledged to become carbon neutral. Locally, the University of Wisconsin – Eau Claire has signed onto the American College & University Presidents' Climate Commitment. Over 300 institutions have pledged to make their campuses carbon neutral. If the City of Eau Claire were to strive for carbon neutrality, 28,514 metric tons of carbon dioxide equivalents would need to be mitigated and/or offset by purchased carbon credits.
- **The G8 Nation Pledge:** The U.S., Canada, Germany, U.K., Italy, France, Russia, and Japan have pledged to reduce their country's 1990 greenhouse gas emissions levels 80% by 2050. This is a non-binding commitment however and the G8 is trying to expand the agreement to include China, Brazil, Mexico, India, and South Africa. (Eighty percent by 2050 has been the consensus of the climate science community.)
- **Wisconsin Task Force on Global Warming:** During former Governor Doyle's Administration, a Task Force agreed upon a group of interim targets to reduce emissions to 2005 levels by 2014, and reduce the 2005 level by 22% by 2022 (approximately equaling the 1990 level). The long-term target includes a goal to reach 75% reduction from 2005 levels by 2050. The Task Force's report found Wisconsin's state emissions had increased at an annual average rate of 1.2 percent from 105.9 million metric tons of $CO_2e$ in 1990 to 123.1 in 2003 (excludes forest sequestration). Compared to other states, Wisconsin ranked 21st in emissions and would rank as the 42nd largest emitter worldwide if it were a country, just behind Romania.[7] This 75% State goal or the above G8 goal of 80% by 2050 are two further options to consider.
- **Kyoto Protocol:** This is a protocol developed in 1997 during the United Nations Framework Convention on Climate Change (UNFCCC). Ratified in 2005, it requires developed nations to meet reduction targets of GHG emissions relative to their 1990 levels during the period of 2008–12. The U.S. never ratified it however. The U.S. Conference of Mayors Climate Protection Agreement was developed so that cities could meet or beat the protocol reducing their global warming levels to 7 percent below 1990 levels by 2012. The protocol was extended late last year with the hopes that by 2015 a new protocol will be in place. In Wisconsin, most large cities have signed onto this Mayor's Agreement and could present an option for the City of Eau Claire to do similar.

[7] Wisconsin's Strategy for Reducing Global Warming. Governor's Task Force on Global Warming. July 2008. Pages 11-12.

**Mitigation Measures**

Whether or not a reduction target policy is set, alleviating the amount of greenhouse gases for the City of Eau Claire will take significant focus. Several current plans, initiatives, and projects already work towards this end.

Key Documents (not limited to):

- *City of Eau Claire, Capital Improvement Plan 2013 - 2017*
- *Chippewa Valley Partnership, 25 x 25 Plan for Energy Independence*
- *City of Eau Claire, Green Tier Legacy Community Annual Report - 2012*
- *City of Eau Claire, Comprehensive Plan 2005 – 2025 (includes a sustainability chapter)*
- *City of Eau Claire, Natural Hazard Mitigation Plan, 2012 – 2017*
- *City of Eau Claire, Park & Open Space Plan 2008 - 2012*
- *City of Eau Claire, Waterways Plan*
- *City of Eau Claire, Urban Forest Management Plan*
- *City of Eau Claire, Transit Development Plan*
- *City of Eau Claire, Bicycle & Pedestrian Plan*

Some cities have created and adopted a specific Climate Change Action Plan. Not only do these plans specifically note what mitigation measure might equal in reducing overall emissions, and include a reduction target, but they can also bring all other relevant planning documents together. This could be something the City might consider in the future.

The focus of this report was not to create an exhaustive mitigation strategy but to calculate the City's carbon footprint and then frame that within a discussion of possible next steps. The mitigation measures below were not entered into Clean Air Climate Protection software (CACP 2009) but could be when more refined. Many of the energy efficiency and renewable energy measures have been quantified using an Energy Independent Communities Tool created by the Energy Center of Wisconsin. The City also has a detailed *Energy Efficiency and Renewable Energy Solutions Report* created by Sustainable Engineering Group, LLC that can be used to enter data into CACP 2009. These documents, along with the City's *Capital Improvement Plan* should be referred to for more specific project information. Mitigation measures listed herein are more general in description and not all-inclusive.

<u>Energy</u>

- Focus on energy conservation as much as possible (i.e. turn off computers and monitors, reduce other plug loads, turn off lights, use day-lighting, reduce fleet vehicle idling, geographically route fleet vehicles to use less fuel using GPS, etc.)
- Enhance energy efficiencies in buildings such as envelope improvements, high performance commissioned heating, ventilation, and cooling systems, retrofit lighting, install variable frequency drives on pumps, etc. Purchase more Energy Star labeled appliances and consumer products when needed.
- Continue LED signalization of intersections and convert City owned streetlights over to LED or other energy efficient lighting (UW- Eau Claire has decided to convert their outdoor campus lighting over to all LEDs).
- Meet the goal of 25% renewable energy by 2025, or before that year. The City stands at 18%.
- Install more renewable energy systems (e.g. solar hot water and electric, geothermal, biomass, methane digesters, and wind turbines). Geothermal is a possible project at Central Maintenance Facility. Sky Park Landfill was recently studied by the Department of Energy's National Renewable Energy Laboratory as a site deployable for a large-scale 3.5 to 4.0 MW solar electric array. Blue Valley Landfill may also be a solar electric or wind site to offset energy used by the stripping tower. Consider adding solar panels on parking canopies, on top of municipal parking ramps, on appropriate right-of-ways, and for trail lighting.
- Consider purchasing renewable forms of energy from local utility providers.
- Consider Energy Performance Contracting to improve energy efficiency and renewables.

- Continue to advocate for state policy change on a more aggressive renewable energy portfolio standard (RPS) and mechanisms/partnerships to lower the costs of renewable energy projects.

Sustainable Development

- Build green buildings and remodel existing structures per green building standards such as Leadership in Energy and Environmental Design (LEED). Consider adopting a City policy on constructing green buildings.
- Continue to promote Smart Growth land development principles which promote compact urban form, mixed-uses, open space, transportation choice, and preserving rural lands. These techniques can create efficiencies in delivering City services (police and fire service, snow plowing, utilities piping, transit use, etc.).

Material Use

- Continue to exceed 50% or more green office supply purchases, with a goal of reaching 75%.
- Salvage office and desk supplies; recycle construction debris like roadway asphalt millings, concrete, steel, and old buildings materials for new purposes. Auction or donate old materials to reuse centers to reduce landfill emissions.
- Continue operating the waste water treatment's plant anaerobic digester as well as look for possible ways to use the City's leaf and yard waste organics in dry-digesters. This could be done in a possible partnership with others (e.g. CVTC, waste companies, etc.)
- Continue to increase recycling amounts at City parks, concessions stands, and in government buildings by providing more containers and education (e.g. a new battery collection program will start in early 2013).

Transportation

- Phase out via attrition inefficient fleet vehicles in favor of more fuel efficient models (e.g. hybrids, electric vehicles, etc.).
- Transition the fleet to alternative fuels with lower carbon emissions outputs. Investigate using compressed natural gas (CNG) as a substitute for gasoline or diesel powered vehicles. Continue to explore a possible partnership with Chippewa Valley Technical College on using bio-diesel blends in the City fleet.
- Increase use of alternative forms of transportation and methods for employee travel and commutes (e.g. bike patrol, bike-to-work campaigns, bike-sharing program, carpooling, transit use, flex-hours, video conferencing, etc.). Possibly reuse and repair unclaimed bicycles for employee use to-and-from the Courthouse, City Hall and other core-city locations for day-use travel.
- Consider allowing free or reduced bus tokens for city staff to use to get around the city for their jobs. Incentives could be created for employees who carpool, commute using the city bus system, or bicycle.
- Consider revising the employee policy to direct employees to carpool and use the most fuel efficient rental vehicle available when travelling out of the city.
- Develop electric chargers at strategic municipal sites for possible electric vehicle fleet and public use. Consider adding solar electric on stations to power chargers.

Natural Resources

- Grow and buy more local food to reduce food transportation miles for City employees, (e.g. pilot the farm-to-work program in 2013).
- Follow the *City of Eau Claire, Urban Forest Management Plan* to maintain and increase the urban tree canopy cover by 2.5% per year.
- Currently, the City has a goal of planting 400 trees per year. Last year 856 street and park trees were planted. Planting levels were higher due to a violent wind storm uprooting many trees and in planning for the loss of Ash trees when the Emerald Ash Borer arrives.

- During planting cycles continue to plant Hackberry and Sugar Maple trees. When these trees mature they have the potential to reach some of the greatest $CO_2$ absorption rates. Plant Sugar Maples in wider boulevard space due to the tree's susceptibility of deicing salts. There are other species that absorb greenhouse gases well but select trees right for the City's warming projections/future ecosystem conditions.
- Sequester carbon emissions by increasing the number of the current 'carbon-sinks'. For example plant and maintain small/large urban forests on City-owned land parcels that are marginally used. Consider tree planting in right-of-ways where appropriate and in other open spaces outside or in City parks.
- On municipal building grounds consider landscape beautification that would also fulfill carbon sink requirements (grassy & herbaceous plants).
- Plant drought tolerant, low maintenance trees and landscaping.
- If timber harvests are ordered, consideration should be given to sustainable forestry/selectively thinning tree populations so as to preserve carbon sinks.

<u>Water</u>

- Conserve water use in City buildings, parks, and streets. Consider installing more bio-swales, rain gardens, rain barrels, irrigation climate sensors, grey-water recycling systems, low-flow or waterless urinals, etc.
- Continue to detect for unaccounted water lost in the City's water delivery system. A 5% to 10% lost in water translates to wasted energy and treatment chemicals.

<u>General</u>

- Continue to support the work of the City's sustainability initiatives and work promoted by the City's inter-departmental Green Team.
- Improve data accessibility and cross coordination between departments to obtain the relevant information to compile the City's carbon footprint and other sustainability reports. Devise a common format and electronic location of data storage for retrieval.
- Possibly collaborate with stakeholders who are also focused on reducing carbon emissions. UW-EC, Sierra Club – Chippewa Valley Chapter, Citizens Climate Lobby (CCL), Eau Claire Climate Action Now, etc.
- The City of Eau Claire should complete the footprint analysis at least biennially (as UW-EC does). Consider using student talent again to help perform the municipal and/or city-wide carbon footprint.
- Perform a 3rd party verification of the carbon footprint analysis.
- Consider creating a Climate Change Action Plan for the City.

**Adaptation Strategies**

Adaptation strategies are in response to Climate Change's effects, what is occurring now and what is projected to come, in weather and natural landscape changes. A fundamental mission of cities is to protect citizen health and welfare as best as possible from real or perceived threats. A warming climate presents community challenges such as flash floods, intense storms, droughts, and extreme cold and heat conditions. The *City of Eau Claire, Natural Hazard Mitigation Plan, 2012 – 2017* is one approach to help protect citizens. Some Wisconsin communities have begun to adapt by bolstering stormwater runoff conveyance systems, installing more robust flood prevention/erosion measures, adding bio-retention facilities, and using FEMA funds to remove flood-prone homes. "Cooling centers" are also being designated in public or community-type buildings for vulnerable populations to seek respite during heat waves. Other strategies are possible. If a Climate Change Action Plan is created, it would make sense then to comprehensively investigate what adaption measures for the municipality and city-at-large should be implemented. Adaptation strategies can also be implemented before such a plan.

# Appendices

## I. City of Eau Claire – CACP Output

12/7/2012 Page 1

# Government Greenhouse Gas Emissions in 2011
# Detailed Report

### *Scope 1 + Scope 2 + Scope 3*

| | $CO_2$ (tonnes) | $N_2O$ (kg) | $CH_4$ (kg) | Equiv $CO_2$ (tonnes) | Bio $CO_2$ (tonnes) | Energy (MMBtu) | Cost ($) |
|---|---|---|---|---|---|---|---|
| **Buildings and Facilities** | | | | | | | |
| **Eau Claire, Wisconsin** | | | | | | | |
| *Backup Generators* | | | | | | | |
| Carbon Dioxide | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| *Subtotal Backup Generators* | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| *FIRE - Fire Stations Electricity* | | | | | | | |
| Electricity | 185 | 3 | 3 | 186 | 0 | 856 | 0 |
| *Subtotal FIRE - Fire Stations Electricity* | 185 | 3 | 3 | 186 | 0 | 856 | 0 |
| *FIRE - Fire Stations Gas* | | | | | | | |
| Natural Gas | 127 | 0 | 12 | 128 | 0 | 2,403 | 0 |
| *Subtotal FIRE - Fire Stations Gas* | 127 | 0 | 12 | 128 | 0 | 2,403 | 0 |
| *Parks - Propane Use* | | | | | | | |
| Propane | 25 | 0 | 4 | 25 | 0 | 403 | 0 |
| *Subtotal Parks - Propane Use* | 25 | 0 | 4 | 25 | 0 | 403 | 0 |
| *PKBL - Ballfields* | | | | | | | |
| Electricity | 167 | 3 | 3 | 168 | 0 | 773 | 0 |
| *Subtotal PKBL - Ballfields* | 167 | 3 | 3 | 168 | 0 | 773 | 0 |
| *PKCM - Cemeteries Electricity* | | | | | | | |
| Electricity | 32 | 1 | 1 | 32 | 0 | 147 | 0 |
| *Subtotal PKCM - Cemeteries Electricity* | 32 | 1 | 1 | 32 | 0 | 147 | 0 |
| *PKCM - Cemeteries Gas* | | | | | | | |
| Natural Gas | 7 | 0 | 1 | 7 | 0 | 129 | 0 |
| *Subtotal PKCM - Cemeteries Gas* | 7 | 0 | 1 | 7 | 0 | 129 | 0 |

This report has been generated for Eau Claire, Wisconsin using ICLEI's Clean Air and Climate Protection 2009 Software.

# Government Greenhouse Gas Emissions in 2011
# Detailed Report

## *Scope 1 + Scope 2 + Scope 3*

| | $CO_2$ (tonnes) | $N_2O$ (kg) | $CH_4$ (kg) | Equiv $CO_2$ (tonnes) | Bio $CO_2$ (tonnes) | Energy (MMBtu) | Cost ($) |
|---|---|---|---|---|---|---|---|
| *PKCP - Community Parks Electricity* | | | | | | | |
| Electricity | 111 | 2 | 2 | 112 | 0 | 513 | 0 |
| *Subtotal PKCP - Community Parks Electricity* | 111 | 2 | 2 | 112 | 0 | 513 | 0 |
| *PKCP - Community Parks Gas* | | | | | | | |
| Natural Gas | 4 | 0 | 0 | 4 | 0 | 67 | 0 |
| *Subtotal PKCP - Community Parks Gas* | 4 | 0 | 0 | 4 | 0 | 67 | 0 |
| *PKFP - Fairfax Pool Electricity* | | | | | | | |
| Electricity | 121 | 2 | 2 | 121 | 0 | 558 | 0 |
| *Subtotal PKFP - Fairfax Pool Electricity* | 121 | 2 | 2 | 121 | 0 | 558 | 0 |
| *PKFP - Fairfax Pool Gas* | | | | | | | |
| Natural Gas | 84 | 0 | 8 | 84 | 0 | 1,588 | 0 |
| *Subtotal PKFP - Fairfax Pool Gas* | 84 | 0 | 8 | 84 | 0 | 1,588 | 0 |
| *PKHI - Hobbs Ice Arena Electricity* | | | | | | | |
| Electricity | 1,804 | 32 | 31 | 1,815 | 0 | 8,338 | 0 |
| *Subtotal PKHI - Hobbs Ice Arena Electricity* | 1,804 | 32 | 31 | 1,815 | 0 | 8,338 | 0 |
| *PKHI - Hobbs Ice Arena Gas* | | | | | | | |
| Natural Gas | 428 | 1 | 40 | 429 | 0 | 8,077 | 0 |
| *Subtotal PKHI - Hobbs Ice Arena Gas* | 428 | 1 | 40 | 429 | 0 | 8,077 | 0 |
| *PKNP - Neighborhood Parks Electricity* | | | | | | | |
| Electricity | 29 | 1 | 0 | 29 | 0 | 132 | 0 |
| *Subtotal PKNP - Neighborhood Parks Electricity* | 29 | 1 | 0 | 29 | 0 | 132 | 0 |
| *PKNP - Neighborhood Parks Gas* | | | | | | | |
| Natural Gas | 9 | 0 | 1 | 9 | 0 | 163 | 0 |
| *Subtotal PKNP - Neighborhood Parks Gas* | 9 | 0 | 1 | 9 | 0 | 163 | 0 |

This report has been generated for Eau Claire, Wisconsin using ICLEI's Clean Air and Climate Protection 2009 Software.

# Government Greenhouse Gas Emissions in 2011
# Detailed Report

## *Scope 1 + Scope 2 + Scope 3*

| | $CO_2$ (tonnes) | $N_2O$ (kg) | $CH_4$ (kg) | Equiv $CO_2$ (tonnes) | Bio $CO_2$ (tonnes) | Energy (MMBtu) | Cost ($) |
|---|---|---|---|---|---|---|---|
| *PO - Police Electricity* | | | | | | | |
| Electricity | 26 | 0 | 0 | 26 | 0 | 120 | 0 |
| *Subtotal PO - Police Electricity* | 26 | 0 | 0 | 26 | 0 | 120 | 0 |
| *PO - Police Gas* | | | | | | | |
| Natural Gas | 8 | 0 | 1 | 8 | 0 | 149 | 0 |
| *Subtotal PO - Police Gas* | 8 | 0 | 1 | 8 | 0 | 149 | 0 |
| *PW - Public Works Facilities Electricity* | | | | | | | |
| Electricity | 441 | 8 | 8 | 444 | 0 | 2,040 | 0 |
| *Subtotal PW - Public Works Facilities Electricity* | 441 | 8 | 8 | 444 | 0 | 2,040 | 0 |
| *PW - Public Works Facilities Gas* | | | | | | | |
| Natural Gas | 571 | 1 | 54 | 572 | 0 | 10,763 | 0 |
| *Subtotal PW - Public Works Facilities Gas* | 571 | 1 | 54 | 572 | 0 | 10,763 | 0 |
| *PWCB - City Hall Electricity* | | | | | | | |
| Electricity | 737 | 13 | 13 | 741 | 0 | 3,406 | 0 |
| *Subtotal PWCB - City Hall Electricity* | 737 | 13 | 13 | 741 | 0 | 3,406 | 0 |
| *PWCB - City Hall Gas* | | | | | | | |
| Natural Gas | 153 | 0 | 14 | 154 | 0 | 2,892 | 0 |
| *Subtotal PWCB - City Hall Gas* | 153 | 0 | 14 | 154 | 0 | 2,892 | 0 |
| *PWCBM - Philips Library Electricity* | | | | | | | |
| Electricity | 547 | 10 | 9 | 550 | 0 | 2,529 | 0 |
| *Subtotal PWCBM - Philips Library Electricity* | 547 | 10 | 9 | 550 | 0 | 2,529 | 0 |
| *PWCBM - Philips Library Gas* | | | | | | | |
| Natural Gas | 126 | 0 | 12 | 127 | 0 | 2,381 | 0 |
| *Subtotal PWCBM - Philips Library Gas* | 126 | 0 | 12 | 127 | 0 | 2,381 | 0 |

This report has been generated for Eau Claire, Wisconsin using ICLEI's Clean Air and Climate Protection 2009 Software.

# Government Greenhouse Gas Emissions in 2011
# Detailed Report

## *Scope 1 + Scope 2 + Scope 3*

| | $CO_2$ (tonnes) | $N_2O$ (kg) | $CH_4$ (kg) | Equiv $CO_2$ (tonnes) | Bio $CO_2$ (tonnes) | Energy (MMBtu) | Cost ($) |
|---|---|---|---|---|---|---|---|
| *TRA - Transit Center* | | | | | | | |
| Electricity | 28 | 1 | 0 | 28 | 0 | 130 | 0 |
| *Subtotal TRA - Transit Center* | 28 | 1 | 0 | 28 | 0 | 130 | 0 |
| **Subtotal Buildings and Facilities** | 5,771 | 79 | 220 | 5,800 | 0 | 48,559 | 0 |
| **Streetlights & Traffic Signals** | | | | | | | |
| **Eau Claire, Wisconsin** | | | | | | | |
| *Metered Lights and Traffic* | | | | | | | |
| Electricity | 1,115 | 20 | 19 | 1,122 | 0 | 5,155 | 0 |
| *Subtotal Metered Lights and Traffic* | 1,115 | 20 | 19 | 1,122 | 0 | 5,155 | 0 |
| *Unmetered - Whiteway* | | | | | | | |
| Electricity | 2,618 | 47 | 45 | 2,634 | 0 | 12,101 | 0 |
| *Subtotal Unmetered - Whiteway* | 2,618 | 47 | 45 | 2,634 | 0 | 12,101 | 0 |
| *Unmetered - XCel Owned* | | | | | | | |
| Electricity | 1,039 | 19 | 18 | 1,045 | 0 | 4,803 | 0 |
| *Subtotal Unmetered - XCel Owned* | 1,039 | 19 | 18 | 1,045 | 0 | 4,803 | 0 |
| *Unmetered Lights* | | | | | | | |
| Electricity | 216 | 4 | 4 | 217 | 0 | 999 | 0 |
| *Subtotal Unmetered Lights* | 216 | 4 | 4 | 217 | 0 | 999 | 0 |
| *Unmetered Traffic Lights* | | | | | | | |
| Electricity | 56 | 1 | 1 | 57 | 0 | 261 | 0 |
| *Subtotal Unmetered Traffic Lights* | 56 | 1 | 1 | 57 | 0 | 261 | 0 |
| **Subtotal Streetlights & Traffic Signals** | 5,046 | 90 | 87 | 5,075 | 0 | 23,320 | 0 |

This report has been generated for Eau Claire, Wisconsin using ICLEI's Clean Air and Climate Protection 2009 Software.

# Government Greenhouse Gas Emissions in 2011
# Detailed Report

## *Scope 1 + Scope 2 + Scope 3*

| | $CO_2$ (tonnes) | $N_2O$ (kg) | $CH_4$ (kg) | Equiv $CO_2$ (tonnes) | Bio $CO_2$ (tonnes) | Energy (MMBtu) | Cost ($) |
|---|---|---|---|---|---|---|---|
| **Water Delivery Facilities** | | | | | | | |
| **Eau Claire, Wisconsin** | | | | | | | |
| *UWRT - Water Reservoirs and Towers* | | | | | | | |
| Electricity | 22 | 0 | 0 | 23 | 0 | 104 | 0 |
| *Subtotal UWRT - Water Reservoirs and Towers* | 22 | 0 | 0 | 23 | 0 | 104 | 0 |
| *UWWB - Booster Stations* | | | | | | | |
| Electricity | 590 | 11 | 10 | 593 | 0 | 2,726 | 0 |
| Natural Gas | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Subtotal UWWB - Booster Stations* | 590 | 11 | 10 | 593 | 0 | 2,727 | 0 |
| *UWWB - Water Wells and Treatment Plant Electricity* | | | | | | | |
| Electricity | 4,519 | 81 | 78 | 4,546 | 0 | 20,887 | 0 |
| *Subtotal UWWB - Water Wells and Treatment Plant Electricity* | 4,519 | 81 | 78 | 4,546 | 0 | 20,887 | |
| *UWWB - Water Wells and Treatment Plant Gas* | | | | | | | |
| Natural Gas | 90 | 0 | 8 | 90 | 0 | 1,689 | 0 |
| *Subtotal UWWB - Water Wells and Treatment Plant Gas* | 90 | 0 | 8 | 90 | 0 | 0 | 1,689 |
| **Subtotal Water Delivery Facilities** | 5,221 | 92 | 97 | 5,252 | 0 | 25,407 | 0 |
| **Wastewater Facilities** | | | | | | | |
| **Eau Claire, Wisconsin** | | | | | | | |
| *USTW - Stormwater* | | | | | | | |
| Electricity | 8 | 0 | 0 | 8 | 0 | 36 | 0 |
| *Subtotal USTW - Stormwater* | 8 | 0 | 0 | 8 | 0 | 36 | 0 |
| *UWWI - Lift Stations XCel Electricity* | | | | | | | |
| Electricity | 562 | 10 | 10 | 565 | 0 | 2,596 | 0 |
| *Subtotal UWWI - Lift Stations XCel Electricity* | 562 | 10 | 10 | 565 | 0 | 2,596 | 0 |

This report has been generated for Eau Claire, Wisconsin using ICLEI's Clean Air and Climate Protection 2009 Software.

# Government Greenhouse Gas Emissions in 2011
# Detailed Report

## *Scope 1 + Scope 2 + Scope 3*

| | CO2 (tonnes) | N2O (kg) | CH4 (kg) | Equiv CO2 (tonnes) | Bio CO2 (tonnes) | Energy (MMBtu) | Cost ($) |
|---|---|---|---|---|---|---|---|
| *UWWI - Lift Stations XCel Natural Gas* | | | | | | | |
| Natural Gas | 17 | 0 | 2 | 17 | 0 | 317 | 0 |
| *Subtotal UWWI - Lift Stations XCel Natural Gas* | 17 | 0 | 2 | 17 | 0 | 317 | 0 |
| *WWTP - CH4 emissions* | | | | | | | |
| Carbon Dioxide | 1,465 | 0 | 0 | 1,465 | 0 | 0 | 0 |
| *Subtotal WWTP - CH4 emissions* | 1,465 | 0 | 0 | 1,465 | 0 | 0 | 0 |
| *WWTP - Generator CO2 emissions* | | | | | | | |
| Carbon Dioxide | 396 | 0 | 0 | 396 | 0 | 0 | 0 |
| *Subtotal WWTP - Generator CO2 emissions* | 396 | 0 | 0 | 396 | 0 | 0 | 0 |
| *WWTP - N2O emissions* | | | | | | | |
| Carbon Dioxide | 745 | 0 | 0 | 745 | 0 | 0 | 0 |
| *Subtotal WWTP - N2O emissions* | 745 | 0 | 0 | 745 | 0 | 0 | 0 |
| *WWTP - XCel Electricity* | | | | | | | |
| Electricity | 3,411 | 61 | 59 | 3,431 | 0 | 15,767 | 0 |
| *Subtotal WWTP - XCel Electricity* | 3,411 | 61 | 59 | 3,431 | 0 | 15,767 | 0 |
| *WWTP - Xcel Natural Gas* | | | | | | | |
| Natural Gas | 204 | 0 | 19 | 205 | 0 | 3,851 | 0 |
| *Subtotal WWTP - Xcel Natural Gas* | 204 | 0 | 19 | 205 | 0 | 3,851 | 0 |
| **Subtotal Wastewater Facilities** | 6,808 | 71 | 89 | 6,832 | 0 | 22,567 | 0 |
| **Solid Waste Facilities** | | | | | | | |
| **Eau Claire, Wisconsin** | | | | | | | |
| *EC Old Town of Union Landfill* | | | | | | | |
| Electricity | 199 | 4 | 3 | 200 | 0 | 920 | 0 |
| *Subtotal EC Old Town of Union Landfill* | 199 | 4 | 3 | 200 | 0 | 920 | 0 |
| **Subtotal Solid Waste Facilities** | 199 | 4 | 3 | 200 | 0 | 920 | 0 |

This report has been generated for Eau Claire, Wisconsin using ICLEI's Clean Air and Climate Protection 2009 Software.

# Government Greenhouse Gas Emissions in 2011
# Detailed Report

## *Scope 1 + Scope 2 + Scope 3*

| | $CO_2$ (tonnes) | $N_2O$ (kg) | $CH_4$ (kg) | Equiv $CO_2$ (tonnes) | Bio $CO_2$ (tonnes) | Energy (MMBtu) | Cost ($) |
|---|---|---|---|---|---|---|---|
| **Vehicle Fleet** | | | | | | | |
| **Eau Claire, Wisconsin** | | | | | | | |
| *Heavy Duty Vehicles* | | | | | | | |
| Diesel | 1,152 | 3 | 4 | 1,153 | 0 | 15,581 | 0 |
| Gasoline | 15 | 1 | 1 | 15 | 0 | 214 | 0 |
| *Subtotal Heavy Duty Vehicles* | 1,167 | 4 | 5 | 1,169 | 0 | 15,795 | 0 |
| *Lawn and Misc. Small Equipment* | | | | | | | |
| OFF ROAD Diesel | 106 | 0 | 0 | 106 | 0 | 1,429 | 0 |
| OFF ROAD Gasoline | 33 | 0 | 0 | 33 | 0 | 476 | 0 |
| *Subtotal Lawn and Misc. Small Equipment* | 139 | 0 | 0 | 139 | 0 | 1,905 | 0 |
| *Light trucks - CO2 only* | | | | | | | |
| Diesel | 109 | 0 | 0 | 109 | 0 | 1,474 | 0 |
| Gasoline | 445 | 0 | 0 | 445 | 0 | 6,332 | 0 |
| *Subtotal Light trucks - CO2 only* | 554 | 0 | 0 | 554 | 0 | 7,806 | 0 |
| *Light trucks - NO2 and CH4 only* | | | | | | | |
| Diesel | 0 | 0 | 0 | 0 | 0 | 443 | 3 |
| Gasoline | 0 | 20 | 15 | 7 | 0 | 4,210 | 0 |
| *Subtotal Light trucks - NO2 and CH4 only* | 0 | 21 | 15 | 7 | 0 | 4,653 | 3 |
| *Passenger Cars - CO2 only* | | | | | | | |
| Gasoline | 688 | 0 | 0 | 688 | 0 | 9,795 | 0 |
| *Subtotal Passenger Cars - CO2 only* | 688 | 0 | 0 | 688 | 0 | 9,795 | 0 |
| *Passenger cars - NO2 and CH4 only* | | | | | | | |
| Gasoline | 0 | 24 | 22 | 8 | 0 | 5,083 | 0 |
| *Subtotal Passenger cars - NO2 and CH4 only* | 0 | 24 | 22 | 8 | 0 | 5,083 | 0 |
| **Subtotal Vehicle Fleet** | 2,548 | 48 | 42 | 2,564 | 0 | 45,037 | 3 |

This report has been generated for Eau Claire, Wisconsin using ICLEI's Clean Air and Climate Protection 2009 Software.

# Government Greenhouse Gas Emissions in 2011
# Detailed Report

## *Scope 1 + Scope 2 + Scope 3*

| | $CO_2$ (tonnes) | $N_2O$ (kg) | $CH_4$ (kg) | Equiv $CO_2$ (tonnes) | Bio $CO_2$ (tonnes) | Energy (MMBtu) | Cost ($) |
|---|---|---|---|---|---|---|---|
| **Employee Commute** | | | | | | | |
| **Eau Claire, Wisconsin** | | | | | | | |
| *Commuting - Carpooling CH4 and N2O* | | | | | | | |
| Ethanol (E100) | 0 | 0 | 0 | 0 | 0 | 17 | 0 |
| Gasoline | 0 | 1 | 1 | 0 | 0 | 168 | 0 |
| *Subtotal Commuting - Carpooling CH4 and N2O* | 0 | 1 | 1 | 0 | 0 | 185 | 0 |
| *Commuting - Carpooling CO2* | | | | | | | |
| Ethanol (E100) | 0 | 0 | 0 | 0 | 1 | 18 | 0 |
| Gasoline | 8 | 0 | 0 | 8 | 0 | 116 | 0 |
| *Subtotal Commuting - Carpooling CO2* | 8 | 0 | 0 | 8 | 1 | 135 | 0 |
| *Commuting SOV - CH4 and N2O only* | | | | | | | |
| Diesel | 0 | 0 | 0 | 0 | 0 | 1,778 | 0 |
| Ethanol (E100) | 0 | 2 | 2 | 1 | 0 | 189 | 0 |
| Gasoline | 0 | 85 | 74 | 28 | 0 | 18,099 | 0 |
| *Subtotal Commuting SOV - CH4 and N2O only* | 0 | 88 | 76 | 29 | 0 | 20,066 | 0 |
| *Commuting SOV - CO2 only* | | | | | | | |
| Diesel | 66 | 0 | 0 | 66 | 0 | 890 | 0 |
| Ethanol (E100) | 0 | 0 | 0 | 0 | 8 | 117 | 0 |
| Gasoline | 932 | 0 | 0 | 932 | 0 | 13,263 | 0 |
| *Subtotal Commuting SOV - CO2 only* | 997 | 0 | 0 | 997 | 8 | 14,270 | 0 |
| *Employee In Town Travel - CH4 and N2O* | | | | | | | |
| Gasoline | 0 | 4 | 4 | 1 | 0 | 955 | 0 |
| *Subtotal Employee In Town Travel - CH4 and N2O* | 0 | 4 | 4 | 1 | 0 | 955 | 0 |
| *Employee In Town Travel - CO2* | | | | | | | |
| Gasoline | 60 | 0 | 0 | 60 | 0 | 854 | 0 |
| *Subtotal Employee In Town Travel - CO2* | 60 | 0 | 0 | 60 | 0 | 854 | 0 |

This report has been generated for Eau Claire, Wisconsin using ICLEI's Clean Air and Climate Protection 2009 Software.

# Government Greenhouse Gas Emissions in 2011
# Detailed Report

## *Scope 1 + Scope 2 + Scope 3*

| | CO2 (tonnes) | N2O (kg) | CH4 (kg) | Equiv CO2 (tonnes) | Bio CO2 (tonnes) | Energy (MMBtu) | Cost ($) |
|---|---|---|---|---|---|---|---|
| *Employee Out-of-town Travel - CH4 and N2O* | | | | | | | |
| Gasoline | 0 | 2 | 2 | 1 | 0 | 430 | 0 |
| *Subtotal Employee Out-of-town Travel - CH4 and N2O* | | 0 | 2 | 2 | 1 | 0 | 430 |
| *Employee Out-of-town Travel - CO2* | | | | | | | |
| Gasoline | 27 | 0 | 0 | 27 | 0 | 384 | 0 |
| *Subtotal Employee Out-of-town Travel - CO2* | 27 | 0 | 0 | 27 | 0 | 384 | 0 |
| *Moped and Motorcycle* | | | | | | | |
| OFF ROAD Gasoline | 1 | 0 | 0 | 1 | 0 | 13 | 0 |
| *Subtotal Moped and Motorcycle* | 1 | 0 | 0 | 1 | 0 | 13 | 0 |
| **Subtotal Employee Commute** | 1,094 | 95 | 83 | 1,125 | 9 | 37,291 | 0 |
| **Transit Fleet** | | | | | | | |
| **Eau Claire, Wisconsin** | | | | | | | |
| *Transit CO2 only* | | | | | | | |
| Diesel | 1,382 | 0 | 0 | 1,382 | 0 | 18,691 | 0 |
| *Subtotal Transit CO2 only* | 1,382 | 0 | 0 | 1,382 | 0 | 18,691 | 0 |
| *Transit N2O & CH4 only* | | | | | | | |
| Diesel | 0 | 3 | 4 | 1 | 0 | 15,294 | 0 |
| *Subtotal Transit N2O & CH4 only* | 0 | 3 | 4 | 1 | 0 | 15,294 | 0 |
| **Subtotal Transit Fleet** | 1,382 | 3 | 4 | 1,383 | 0 | 33,985 | 0 |
| **Other Process Fugitive** | | | | | | | |
| **Eau Claire, Wisconsin** | | | | | | | |
| *PWCB - City Hall R22 Leak* | | | | | | | |
| Carbon Dioxide | 156 | 0 | 0 | 156 | 0 | | |
| *Subtotal PWCB - City Hall R22 Leak* | 156 | 0 | 0 | 156 | 0 | | |

This report has been generated for Eau Claire, Wisconsin using ICLEI's Clean Air and Climate Protection 2009 Software.

# Government Greenhouse Gas Emissions in 2011
# Detailed Report

## *Scope 1 + Scope 2 + Scope 3*

| | $CO_2$ (tonnes) | $N_2O$ (kg) | $CH_4$ (kg) | Equiv $CO_2$ (tonnes) | Bio $CO_2$ (tonnes) | Energy (MMBtu) | Cost ($) |
|---|---|---|---|---|---|---|---|
| *PWCBM - Philips Library Leak* | | | | | | | |
| R-410A Blend | 0 | 0 | 0 | 70 | 0 | | |
| *Subtotal PWCBM - Philips Library Leak* | 0 | 0 | 0 | 70 | 0 | | |
| **Subtotal Other Process Fugitive** | 156 | 0 | 0 | 226 | 0 | | |
| **Mobile Source Refrigerants** | | | | | | | |
| **Eau Claire, Wisconsin** | | | | | | | |
| *Mobile A/C Fugitive Emission* | | | | | | | |
| HFC-134a 236cb 43-10mee | 0 | 0 | 0 | 44 | 0 | | |
| *Subtotal Mobile A/C Fugitive Emission* | 0 | 0 | 0 | 44 | 0 | | |
| **Subtotal Mobile Source Refrigerants** | 0 | 0 | 0 | 44 | 0 | | |
| **Total** | 28,224 | 482 | 625 | 28,501 | 9 | 237,086 | 3 |

This report has been generated for Eau Claire, Wisconsin using ICLEI's Clean Air and Climate Protection 2009 Software.

# II. Standard Conversion Factors

| | | | |
|---|---|---|---|
| **Mass** | | | |
| 1 pound (lb) = | 453.6 grams (g) | 0.4536 kilograms (kg) | 0.0004536 metric tons (tonnes) |
| 1 kilogram (kg) = | 1,000 grams (g) | 2.2046 pounds (lb) | 0.001 metric tons (tonnes) |
| 1 short ton (ton) = | 2,000 pounds (lb) | 907.18 kilograms (kg) | 0.9072 metric tons (tonnes) |
| 1 metric ton (tonne) = | 2,204.62 pounds (lb) | 1,000 kilograms (kg) | 1.1023 short tons (tons) |
| **Volume** | | | |
| 1 cubic foot ($ft^3$) = | 7.4805 US gallons (gal) | 0.1781 barrels (bbl) | |
| 1 cubic foot ($ft^3$) = | 28.32 liters (L) | 0.02832 cubic meters ($m^3$) | |
| 1 US gallon (gal) = | 0.0238 barrels (bbl) | 3.785 liters (L) | 0.003785 cubic meters ($m^3$) |
| 1 barrel (bbl) = | 42 US gallons (gal) | 158.99 liters (L) | 0.1589 cubic meters ($m^3$) |
| 1 liter (L) = | 0.001 cubic meters ($m^3$) | 0.2642 US gallons (gal) | 0.0063 barrels (bbl) |
| 1 cubic meter ($m^3$) = | 6.2897 barrels (bbl) | 264.17 US gallons (gal) | 1,000 liters (L) |
| **Energy** | | | |
| 1 kilowatt hour (kWh) = | 3,412 Btu (Btu) | 3,600 kilojoules (KJ) | |
| 1 megajoule (MJ) = | 0.001 gigajoules (GJ) | | |
| 1 gigajoule (GJ) = | 0.9478 million Btu (MMBtu) | 277.8 kilowatt hours (kWh) | |
| 1 British thermal unit (Btu) = | 1,055 joules (J) | 1.055 kilojoules (KJ) | |
| 1 million Btu (MMBtu) = | 1.055 gigajoules (GJ) | 293 kilowatt hours (kWh) | |
| 1 therm = | 100,000 Btu | 0.1055 gigajoules (GJ) | 29.3 kilowatt hours (kWh) |
| **Other** | | | |
| kilo = | 1,000 | | |
| mega = | 1,000,000 | | |
| giga = | 1,000,000,000 | | |
| tera = | 1,000,000,000,000 | | |
| peta = | 1,000,000,000,000,000 | | |
| 1 mile = | 1.609 kilometers | | |
| 1 metric ton carbon (C) = | $^{44}/_{12}$ metric tons $CO_2$ | | |

# III. GWP Factors for Greenhouse Gases

| Common Name | Formula | Chemical Name | GWP |
|---|---|---|---|
| Carbon dioxide | $CO_2$ | | 1 |
| Methane | $CH_4$ | | 21 |
| Nitrous oxide | $N_2O$ | | 310 |
| Sulfur hexafluoride | $SF_6$ | | 23,900 |
| **Hydrofluorocarbons (HFCs)** | | | |
| HFC-23 | $CHF_3$ | trifluoromethane | 11,700 |
| HFC-32 | $CH_2F_2$ | difluoromethane | 650 |
| HFC-41 | $CH_3F$ | fluoromethane | 150 |
| HFC-43-10mee | $C_5H_2F_{10}$ | 1,1,1,2,3,4,4,5,5,5-decafluoropentane | 1,300 |
| HFC-125 | $C_2HF_5$ | pentafluoroethane | 2,800 |
| HFC-134 | $C_2H_2F_4$ | 1,1,2,2-tetrafluoroethane | 1,000 |
| HFC-134a | $C_2H_2F_4$ | 1,1,1,2-tetrafluoroethane | 1,300 |
| HFC-143 | $C_2H_3F_3$ | 1,1,2-trifluoroethane | 300 |
| HFC-143a | $C_2H_3F_3$ | 1,1,1-trifluoroethane | 3,800 |
| HFC-152 | $C_2H_4F_2$ | 1,2-difluoroethane | 43* |
| HFC-152a | $C_2H_4F_2$ | 1,1-difluoroethane | 140 |
| HFC-161 | $C_2H_5F$ | fluoroethane | 12* |
| HFC-227ea | $C_3HF_7$ | 1,1,1,2,3,3,3-heptafluoropropane | 2,900 |
| HFC-236cb | $C_3H_2F_6$ | 1,1,1,2,2,3-hexafluoropropane | 1,300* |
| HFC-236ea | $C_3H_2F_6$ | 1,1,1,2,3,3-hexafluoropropane | 1,200* |
| HFC-236fa | $C_3H_2F_6$ | 1,1,1,3,3,3-hexafluoropropane | 6,300 |
| HFC-245ca | $C_3H_3F_5$ | 1,1,2,2,3-pentafluoropropane | 560 |
| HFC-245fa | $C_3H_3F_5$ | 1,1,1,3,3-pentafluoropropane | 950* |
| HFC-365mfc | $C_4H_5F_5$ | 1,1,1,3,3-pentafluorobutane | 890* |
| **Perfluorocarbons (PFCs)** | | | |
| Perfluoromethane | $CF_4$ | tetrafluoromethane | 6,500 |
| Perfluoroethane | $C_2F_6$ | hexafluoroethane | 9,200 |
| Perfluoropropane | $C_3F_8$ | octafluoropropane | 7,000 |
| Perfluorobutane | $C_4F_{10}$ | decafluorobutane | 7,000 |
| Perfluorocyclobutane | $c\text{-}C_4F_8$ | octafluorocyclobutane | 8,700 |
| Perfluoropentane | $C_5F_{12}$ | dodecafluoropentane | 7,500 |
| Perfluorohexane | $C_6F_{14}$ | tetradecafluorohexane | 7,400 |

Source: Intergovernmental Panel on Climate Change (IPCC) Second Assessment Report published in 1995, unless no value was assigned in the document. In that case, the GWP values are from the IPCC Third Assessment Report published in 2001 (those marked with *). GWP values are from the Second Assessment Report (unless otherwise noted) to be consistent with international practices. Values are 100-year GWP values.

## IV. Wastewater Treatment Plant – Specific Emission Equations

Stationary annual $CH_4$ emissions from Incomplete Combustion of Digester Gas (metric tons $CO_2e$) =
**(P x Digester Gas x F $CH_4$ x ϱ(CH4) x (1-DE) x 0.0283 x 365.25 x $10^{-6}$) x GWP**
Where:

| Term | Description | Value |
|---|---|---|
| P | population served by the WWtp with anaerobic digesters | user input |
| Digester Gas | cubic feet of digester gas produced per person per day | 1 |
| F $CH_4$ | fraction of $CH_4$ in biogas | 0.65 |
| ϱ ($CH_4$) | density of methane [g/$m^3$] | 662 |
| DE | methane destruction efficiency | 0.99 |
| 0.0283 | conversion from $ft^3$ to $m^3$ [$m^3$/$ft^3$] | 0.0283 |
| 365.25 | conversion factor [day/year] | 365.25 |
| $10^{-6}$ | conversion from g to metric ton [metric ton/g] | $10^{-6}$ |
| GWP | Global Warming Potential | 21 |
| Source: EPA *Inventory of US Greenhouse Gas Emissions and Sinks: 1990-2007,* Chapter 8, 8-7 (2009). | | |

Annual Process $CH_4$ emissions from Wastewater Treatment Lagoons (metric tons CO2e) =
**((P x Find-com) x BOD5 load x (1-FP) x Bo x MCF anaerobic x 365.25 x 10-3) x GWP**
Where:

| Term | Description | Value |
|---|---|---|
| P | population served by lagoons adjusted for industrial discharge | user input* |
| Find-com | factor for industrial and commercial co-discharge waste into the sewer system | 1.25 |
| Bod5 load | amount of BOD5 produced per person | 0.09 |
| FP | fraction of BOD5 removed in primary treatment | 0.325 |
| Bod5 load | maximum $CH_4$ producing capacity for domestic wastewater [kg $CH_4$/kg BOD5 removed] | 0.6 |
| MCF anaerobic | $CH_4$ correction factor for anaerobic systems | 0.8 |
| 365.25 | conversion factor [day/year] | 365.25 |
| 0.001 | conversion from kg to metric ton [metric ton/kg] | 0.001 |
| GWP | Global Warming Potential | 21 |
| Source: EPA *Inventory of US Greenhouse Gas emissions and Sinks: 1990-2007,* Chapter 8, 8-9 (2009) | | |

Annual Fugitive $CH_4$ emissions from Septic Systems (default $BOD_5$ load) =
**(P x BOD5 load x Bo x MCFseptic x 365.25 x 0.001) x GWP**
Where:

| Term | Description | Value |
|---|---|---|
| P | population served by septic systems [persons] | user input |
| BOD 5 load | amount of BOD5 produced per person per day [kg BOD5/person/day] | 0.09 |
| Bo | maximum $CH_4$ producing capacity for domestic wastewater [kg $CH_4$/kg BOD5 removed] | 0.6 |
| MCF septic | $CH_4$ correction factor for septic systems | 0.5 |
| 635.25 | conversion factor [day/year] | 365.25 |
| 0.001 | conversion from kg to metric ton [metric ton/kg] | 0.001 |
| GWP | global warming potential | 21 |
| Source: EPA *Inventory of US Greenhouse Gas Emissions and Sinks: 1990-2006*, Chapter 8, 8-9 (2008) | | |

Annual Process $N_2O$ Emissions from Effluent Discharge (metric tons CO2e) =
**(N Load x EF effluent x 365.25 x $10^{-3}$ x 44/28) x GWP**
Where:

| Term | Description | Value |
|---|---|---|
| N load | measured average total nitrogen discharged [kg N/day] | user input** |
| EF effluent | emission factor [kg $N_2O$-N/kg sewage-N produced] | 0.005 |
| 365.25 | conversion factor [day/year] | 365.25 |
| $10^{-3}$ | conversion from kg to metric ton [metric ton/kg] | $10^{-3}$ |
| 44/28 | stoichiometric ration of $N_2O$ to $N_2$ | 1.57 |
| GWP | $N_2O$ global warming potential | 310 |
| Source: EPA *Inventory of US Greenhouse Gas Emissions and Sinks: 1990-2007, CH.8, 8-13 (2009)* | | |

Process $CO_2$ emissions due to $CO_2$ combustion (metric tons $CO_2$) =
**$P_{total}$ x $ft^3$/person/day x 0.65 * 662 g/$m^3$ x 0.0283 $m^3/ft^3$ x 365.25 x $10^{-6}$ x 24/20**
Where:

| Term | Description | Value |
|---|---|---|
| $P_{total}$ | population served (persons) | user input* |
| 0.65 | fraction of $CH_4$ in biogas | 0.65 |
| 662 g/$m^3$ | density of methane | 662 |
| 0.0283 $m^3/ft^3$ | conversion factor [$ft^3$ to $m^3$] | 0.0283 |
| 365.25 | conversion factor [day/year] | 365.25 |
| $10^{-6}$ | conversion factor [g/ton] | $10^{-6}$ |
| 24/20 | stoichiometric ratio [g $CO_2$/g $CH_4$] | 1.2 |

*Population served by the Wastewater treatment plant: 74,122. This includes the whole populations of Eau Claire, Altoona. and a fraction of the population of the Town of Washington.
**Effluent discharge is estimated at 735 kg N/day

## V. Air Travel Emission Factors & Equation

### Table 4: Emission Factors for Airline Business Travel (passenger-mile)

| Airline Travel Distance | $CO_2$ Emission Factor (kg $CO_2$/passenger-mile) | $CH_4$ Emission Factor (g $CH_4$/passenger-mile) | $N_2O$ Emission Factor (g $N_2O$/passenger-mile) |
|---|---|---|---|
| Long Haul (≥ 700 miles) | 0.185 | 0.0104 | 0.0085 |
| Medium Haul (≥ 300 and < 700 miles) | 0.229 | 0.0104 | 0.0085 |
| Short Haul (< 300 miles) | 0.277 | 0.0104 | 0.0085 |
| Distance Not Known | 0.271 | 0.0104 | 0.0085 |

### Equation 4: Airline Business Travel Emissions (passenger-mile)

$$E = PMT * (EF_{CO2} + EF_{CH4} * 0.021 + EF_{N2O} * 0.310)$$

where:

$E$ = Total $CO_2$-equivalent Emissions

$PMT$ = Passenger Miles Traveled

$EF_{CO2}$ = $CO_2$ Emission Factor

$EF_{CH4}$ = $CH_4$ Emission Factor

$EF_{N2O}$ = $N_2O$ Emission Factor

0.021 = Conversion Factor

0.310 = Conversion Factor

# VI. Employee Commute Survey

Q1 This survey will estimate your commuting habits and provide us with data to compile the Carbon Footprint Inventory of the City of Eau Claire. All your responses are anonymous.

Q2 How far away is your residence from your work? If you think your estimate is inaccurate, please use Google Maps.
#miles:

Q3 Which modes of transportation do you regularly use to get to work? Check all that apply:
- ❑ Car
- ❑ Carpool
- ❑ Bus
- ❑ Moped/Motorcycle/Scooter
- ❑ Riding a bicycle
- ❑ Walking
- ❑ Other _____

Q4 In a typical week, how many round trips do you complete by driving to work by yourself? If you go home for lunch, count it as a separate round trip.
- ❍ 1
- ❍ 2
- ❍ 3
- ❍ 4
- ❍ 5
- ❍ 6
- ❍ 7
- ❍ 8
- ❍ 9
- ❍ 10
- ❍ 11+

Q5 Which of these classifies your primary vehicle best?
- ❍ Passenger car
- ❍ Light truck
- ❍ Heavy Duty vehicle

Q6 Which best classifies the fuel/powertrain technology used in the vehicle you drive to work?
- ❍ Gasoline
- ❍ Diesel
- ❍ E85 ethanol
- ❍ Hybrid
- ❍ Plug-in hybrid
- ❍ Electric
- ❍ Other _____

Q7 What is the fuel economy of the vehicle you drive to work? If you cannot estimate it, use this tool (http://www.fueleconomy.gov/feg/findacar.shtml) .
miles per gallon:

Q10 Is your moped/scooter/motorcycle electric?
- ❍ Yes
- ❍ No

Q11 Please estimate the fuel economy of your moped/motorcycle. If you think your estimate is inaccurate, use the following averages. Moped/scooter: 75mpg, motorcycle: 50 mpg.
- ❍ 50 miles per gallon
- ❍ 75 miles per gallon
- ❍ Other _____

Q12 What is the total number of people in your carpool?
- ❍ 2
- ❍ 3
- ❍ 4
- ❍ 5

Q13 How many times do you carpool a week?
- ❍ 1
- ❍ 2
- ❍ 3
- ❍ 4
- ❍ 5
- ❍ 6+

Q14 Which classifies the vehicle used for carpool best ?
- ❍ Passenger car
- ❍ Light truck
- ❍ Heavy duty vehicle

Q15 Which best classifies the type of fuel/drivetrain used in the carpool vehicle?
- ❍ Gasoline
- ❍ Diesel
- ❍ E85 ethanol
- ❍ Hybrid
- ❍ Plug-in hybrid
- ❍ Electric
- ❍ Other _____

Q16 What is the gas mileage of the vehicle used for carpool? If you do not think your estimate is accurate, use this tool.
miles per gallon

Q19 Would you be more likely to carpool to work if an on-line sharing board were available to you and other city employees?
- ❍ Yes
- ❍ No
- ❍ I would like more information

Q20 Which would make you more likely to take the bus to work? Check all that apply:
- ❑ I am not likely to take the bus to work
- ❑ Wireless Internet access on the buses and at the transit center
- ❑ Bus passes discounted for city employees
- ❑ Bus passes available as a payroll deduction
- ❑ Credit cards accepted on the bus

Q21 How can the City of Eau Claire encourage you to bicycle to work?

Q22 How can the City of Eau Claire encourage you to commute to work in a sustainable way?

# VII. Blue Valley Landfill Information

From city of Eau Claire

Ms. Diane Tesinsky
Environmental Claim Technician [illegible] Insurance
November 9, 1988
Page 2.

Letters dated August 21 and August 28, 1987 referenced improving the Bauer well. The decision to improve the well came as a result of a preliminary evaluation of the well contamination conducted by Ayres Associates, Inc. (See attached letter dated July 13, 1987)

There are six residences within 2,000 feet of the Bauer home. Two are approximately 500 feet away and the other four are located at approximately 1,000 feet, 1,800 feet, 1,900 feet, and 2,000 feet respectively.

No other residences have been offered bottled water, new wells, or well reconstruction.

It was not a practice of the City to record the type of substances, the quantity, or the dates on which each was delivered or deposited at the Blue Valley landfill.

Waste was transported to the landfill by licensed and private haulers, industries, contractors, and by residents of the City of Eau Claire and the Town of Union. Waste materials were separated at the site and deposited in certain areas of the landfill. Generally, waste materials were not transported to the landfill in specific containers as standards for same had not been mandated. Liquid industrial forging compound from National Presto Industries was transported to the site in a tanker and released into a lagoon. This practice was used for approximately one year in 1970. Waste Research and Reclamation Company, Inc. transported approximately 8,980 55-gallon steel barrels of toxic and hazardous waste to the landfill between March and December, 1974. The barrels were placed into excavated trenches and covered with soil. Other wastes were placed into large natural ravines or excavated trenches and covered with soil. On a portion of the site, wastes were placed over the filled trenches and covered with soil and papermill sludge. This practice was known as the "area fill" method.

The City of Eau Claire purchased the landfill site and operated it from when it opened on September 7, 1965 to its closing date of December 2, 1978. The site was properly abandoned on November 2, 1982, and was approved by the Wisconsin Department of Natural Resources. The site is presently owned by the City of Eau Claire.

The City did not keep a perpetual record of all the transporters of waste materials to this site, nor the materials and dates any of these substances were delivered to, or deposited at, the site.

FROM:KONICA FAX 10:CITY OF EAU CLAIRE JUN 4, 1991 1:51PM P.05

# Abbreviations, Glossary, & Chemical Formulas

**Activity data:** data on the magnitude of a human activity resulting in emissions taking place over a given period of time. Examples include data on energy use, fuel used, miles traveled.
**Anthropogenic:** human induced, resulting from human activities.
**Anthropogenic emissions:** GHG emissions that are a direct result of human activities or are the result of natural processes that have been affected by human activities.
**Barrel:** commonly used to measure quantities of various petroleum products, a volumetric measure of liquids equal to 42 U.S. gallons at 60 degrees Fahrenheit.
**Biofuel:** a fuel that is obtained from renewable resources, especially plant biomass, vegetable oils, and treated municipal and industrial wastes. Biofuels are considered neutral with respect to emission of carbon dioxide because the carbon dioxide given off by burning them is balanced by the carbon dioxide absorbed by the plants used to produce them. The use of biofuels as an additive to petroleum-based fuels can result in cleaner burning with fewer emissions of carbon monoxide and particulates.
**Biodiesel** is made by processing vegetable oils and other fats and is used in internal-combustion engines either in pure form or as an additive to petroleum based diesel fuel.
**Bioethanol** is ethanol produced by fermenting the sugars in biomass materials such as corn and agricultural residues. It is also used either in pure from or more often as a gasoline additive.
**Biogas (natural gas)** is a mixture of methane, carbon dioxide and other gases produced by the anaerobic decomposition of organic matter such as sewage and municipal wastes by bacteria. It is used especially in the generation of hot water and electricity.
**Biogenic emissions from combustion:** $CO_2$ emissions produced from combusting a variety of biofuels and biomass, such as biodiesel, ethanol, wood, wood waste and landfill gas.
**Biomass:** Non-fossilized organic material originating from plants, animals and microorganisms, including products, byproducts, residues and waste from agriculture, forestry and related industries as well as the non-fossilized and biodegradable organic fractions of industrial and municipal wastes, including gases and liquids recovered from the decomposition of non-fossilized and biodegradable organic material.
**Boundaries:** GHG accounting and reporting boundaries can have several dimensions, e.g. organizational, operational, and geographic. These boundaries determine which emissions are accounted for and reported by the entity.
**BTU (British thermal unit):** the amount of heat required to raise the temperature of 1 pound (0.4 kilogram) of water by 1 degree Fahrenheit. BTUs are used to describe the heat values of fuels and the power of both heating and cooling systems.
**CACP:** Clean Air Climate Protection software, a carbon footprint calculator, provided by ICLEI.
**Carbon Dioxide:** The most common of the six primary GHGs, consisting of a single carbon atom and two oxygen atoms, providing the reference point for the GWP of other gases (The GWP of $CO_2$ is thus equal to 1).
**Carbon Dioxide Equivalent:** A commonly used measure for carbon footprints, which accounts for the difference in GWP between carbon dioxide and other greenhouse gases. Concentration or mass of a greenhouse gas is converted into $CO_2e$ to show how much carbon dioxide would have been released to match the greenhouse warming potential of a given gas. $CO_2e$ is the universal unit for comparing emissions of different GHGs expressed in terms of the GWP of one unit of carbon dioxide.
**Carbon Footprint:** for a defined period of time, the total amount of greenhouse gases, usually expressed in $CO_2e$, produced by and directly or indirectly supporting human activities.
**Carbon Neutral:** having a net zero carbon footprint or zero carbon emissions. This can be ideally achieved through offsets (i.e. buying carbon credits), or by directly using renewable energy, bicycle transportation, gardening, and planting trees to sequester carbon. Often times it takes a combination of both offsetting and individual practices.
**Carbon sequestration:** the removal and storage of carbon from the atmosphere in carbon sinks (such as oceans, forests, or soil) through physical or biological processes, such as photosynthesis or by technological processes, preventing the volatile greenhouse gases from escaping into the atmosphere.

**Carbon sink:** a natural or artificial reservoir that accumulates and stores a carbon–containing chemical for an indefinite period. The main natural sinks are the ocean and photosynthetic algae and plants. Manmade carbon sinks include geologic repositories, the deep ocean, and pilot-scale or experimental carbon capture and storage projects.
**CFCs (Chlorofluorocarbons):** any of the several volatile, inert compounds consisting of fluorine, chlorine, carbon and hydrogen. Once commonly used as aerosol propellants and refrigerants, the CFCs are greenhouse gases with ozone depleting properties.
**Chiller systems**: Cooling system that removes heat from one element and deposits it into another. It is used for cooling and dehumidification.
**Commingled recyclables:** commingled recyclables consist of metal, specifically aluminum and tin, plastic, and glass.
**Commuting:** regularly traveling from a home or local residence to another location before returning.
**Composting:** converting decaying organic matter into soil.
**Direct Emissions:** Emissions from sources within the reporting entity's organizational boundaries that are owned or controlled by the reporting entity, including stationary combustion emissions, mobile combustion emissions, process emissions, and fugitive emissions. All direct emissions are Scope 1 emissions, with the exception of biogenic $CO_2$ emissions from biomass combustion.
**Emission factor:** A unique value for determining an amount of a GHG emitted on a per unit activity basis (for example, metric tons of $CO_2$ emitted per million BTUs of coal combusted, or metric tons of $CO_2$ emitted per kWh of electricity consumed).
**EPA (Environmental Protection Agency):** an independent federal agency, created in 1970, which sets and enforces rules and standards that protect the environment and control pollution.
**Facility:** Any property, plant, building, structure, stationary source, stationary equipment or grouping of stationary equipment or stationary sources located on one or more contiguous or adjacent properties, in actual physical contact or separated solely by a public roadway or other public right-of way, and under common operational or financial control, that emits or may emit any greenhouse gas.
**Fossil fuel:** A fuel, such as coal, oil, and natural gas, produced by the decomposition of ancient (fossilized) plants and animals.
**Fugitive Emissions:** Emissions that are not physically controlled but result from the intentional or unintentional release of GHGs. They commonly arise from the production, processing, transmission, storage and use of fuels or other substances, often through joints, seals, packing, gaskets, etc. Examples include HFCs from refrigeration leaks, SF6 from electrical power distributors, and $CH_4$ from solid waste landfills.
**Geothermal Energy:** in this geographical region, where there is a lack of high-temperature geological surface features, geothermal energy is usually generated using a geothermal heat pump (sometimes referred to as geo-exchange energy). In this case, a fluid is circulated through the subsurface pipes in the ground in the immediate vicinity of a building. The moderate temperatures below the surface act as an enormous heat sink, producing cooling in summer and heating in winter.
**GHGs (greenhouse gases):** any of the atmospheric gases in the atmosphere that contribute to the greenhouse effect by absorbing infrared radiation produced by solar warming of the Earth's surface. Most common GHGs are carbon dioxide, methane, nitrous oxide, ozone, chlorofluorocarbons and water vapor.
**Greenhouse effect:** the effect that ultimately results in heating of the Earth, as GHGs allow incoming sunlight to pass through the atmosphere, and absorb heat radiated back from the Earth's surface.
**Green Power:** A generic term for renewable energy sources and specific clean energy technologies that emit fewer GHG emissions relative to other sources of energy that supply the electric grid. Some green energy sources are solar photovoltaic panels, solar thermal energy, geothermal energy, landfill gas, low-impact hydropower, and wind turbines.
**GWP (Global Warming Potential):** The ratio of radiative forcing (degree of warming to the atmosphere) that would result from the emissions of one mass based unit of a given GHG compared to one equivalent unit of carbon dioxide ($CO_2$) over a given period of time.
**Heating Efficiency:** Heating Efficiency is the amount of heat obtained by the burning of a specified quantity and type of fuel.

**HFCs (hydroflurocarbons):** One of the six primary GHGs, a group of manmade chemicals with various commercial uses (e.g., refrigerants) composed of one or two carbon atoms and varying numbers of hydrogen and fluorine atoms. Most HFCs are highly potent GHGs with 100-year GWPs in the thousands.

**ICLEI (International Council for Local Environmental Initiatives):** founded in 1990, ICLEI is an international association of local governments and national and regional local governments that have made a commitment to sustainable development. More than 1,200 cities, towns, counties and their associations in 70 countries comprise ICLEI's membership. The name of the organization has changed to Local Governments for Sustainability but has retained its ICLEI acronym in front of this new name.

**Indirect Emissions:** Emissions that are a consequence of activities that take place within the organizational boundaries of the reporting entity, but that occur at sources owned or controlled by another entity. For example, emissions of electricity used by a manufacturing entity that occur at a power plant represent the manufacturer's indirect emissions.

**IPCC (Intergovernmental Panel on Climate Change):** International body of climate change scientists. The role of the IPCC is to assess the scientific, technical and socio-economic information relevant to the understanding of the risk of human-induced climate change (www.ipcc.ch).

**kWh (kilowatt hour):** The electrical energy unit of measure equal to one thousand watts of power supplied to, or taken from, an electric circuit steadily for one hour. (A Watt is the unit of electrical power equal to one ampere under a pressure of one volt, or 1/746 horsepower.)

**Kyoto Protocol:** A protocol to the United Nations Framework Convention on Climate Change (UNFCCC). Ratified in 2005, it requires countries listed in its Annex B (developed nations) to meet reduction targets of GHG emissions relative to their 1990 levels during the period of 2008–12.

**Life Cycle Analysis:** Assessment of the sum of a product's effects (e.g. GHG emissions) at each step in its life cycle, including resource extraction, production, use and waste disposal.

**Long Ton:** Unit of weight equal to 2,240 pounds which his most commonly used in the United Kingdom and other Commonwealth countries.

**LGOP:** Local Government Operations Protocol, a greenhouse inventory protocol for local governments, developed and published by ICLEI.

**MBTU (also known as MMBTU):** one million British thermal units. Used as a standard unit of measurement for natural gas and provides a convenient base for comparing the energy content of various grades of natural gas and other fuels. One thousand cubic feet of natural gas produce approximately 1 MMBtu.

**MCF:** One thousand cubic feet, a common measurement for natural gas.

**Methane ($CH_4$):** One of the six primary GHGs, consisting of a single carbon atom and four hydrogen atoms, possessing a GWP of 25, and produced through the anaerobic decomposition of waste in landfills, animal digestion, decomposition of animal wastes, production and distribution of natural gas and petroleum, coal production, and incomplete fossil fuel combustion.

**Mobile Combustion:** Emissions from the combustion of fuels in transportation sources (e.g., cars, trucks, buses, trains, airplanes, and marine vessels) and emissions from non-road equipment such as equipment used in construction, agriculture, and forestry. A piece of equipment that cannot move under its own power but that is transported from site to site (e.g., an emergency generator) is a stationary, not a mobile, combustion source.

**MT (Metric ton):** One metric ton is equivalent to 1,000 kilograms, 1.1 short tons or about 2,205 pounds. Metric tons are a common measurement for the quantity of greenhouse gas emissions.

**Nitrous oxide ($N_2O$):** One of the six primary GHGs, consisting of two nitrogen atoms and a single oxygen atom, possessing a GWP of 298, and typically generated as a result of soil cultivation practices, particularly the use of commercial and organic fertilizers, fossil fuel combustion, nitric acid production, and biomass burning.

**Offset:** a carbon offset is a reduction in emissions of carbon dioxide or greenhouse gases made in order to compensate for or to offset and emissions made elsewhere. Carbon offsets are measured in MT $eCO_2$. Offsets are typically achieved through financial support of projects that reduce the emission of greenhouse gases in the short or long term. The most common project type is renewable energy, such as wind farms, biomass energy or hydroelectric dams. Others include energy efficiency projects, the destruction of industrial pollutants or agricultural byproducts, destruction of landfill methane, and forestry projects. Some of the most popular carbon offset projects from a corporate perspective are energy efficiency and wind turbine projects.

**PFC:** perflurocarbons, a powerful greenhouse gas emitted during the production of aluminum.
**Scope:** defines the operational boundaries in relation to indirect and direct GHG emissions.
**Scope 1 emissions:** all direct GHG emissions, with the exception of direct $CO_2$ emissions from biogenic sources.
**Scope 2 emissions:** indirect GHG emissions associated with the consumption of purchased or acquired electricity, heating, cooling or steam.
**Scope 3 emissions:** All indirect emissions not covered in Scope 2. Examples include upstream and downstream emissions, emissions resulting from the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the reporting entity, use of sold products and services, outsourced activities, recycling of used products, waste disposal, etc.
**Short ton:** Unit of weight equal to 2,000 pounds.
**Stationary combustion:** Emissions from the combustion of fuels to produce electricity, steam, heat, or power using equipment (boilers, furnaces, etc.) in a fixed location.
**Sulfur Hexafluoride:** One of the six primary GHGs, consisting of a single sulfur atom and six fluoride atoms, possessing a very high GWP of 22,800, and primarily used in electrical transmission and distribution systems.
**Therm:** a measure of one hundred thousand ($10^5$) Btu.
**The Sierra Club:** is an organization of over 1.4 million patrons, founded in 1892 by John Muir. They are the largest and most influential grassroots environmental organization in the United States. The Sierra Club focuses on moving beyond coal, limiting greenhouse gas emissions, developing clean energy and transportation solutions, and safeguarding communities and natural habitats.
**UW-Eau Claire:** The University of Wisconsin-Eau Claire is located in northwestern Wisconsin. With over 11,000 undergraduate and graduate students, UWEC is considered to be one of the Midwest's top public universities.
**Wood Pellets:** A type of wood fuel of compacted sawdust, with high density and low water content. The pellets are compressed into pieces uniform in diameter to create the most effective heating potential.
**Verification:** An independent assessment of the reliability (considering completeness and accuracy) of a GHG inventory. For the purposes of this Protocol, the method used to ensure that a given participant's GHG emissions inventory has met a minimum quality standard and complied with an appropriate set of California Registry- or California Air Resource Board-approved procedures and protocols for submitting emissions inventory information.