Greenhouse Gas Emissions Inventory

Carson City School District – Baseline (FY15) and Update (FY18)

Overview

Through McKinstry's powerED program, Carson City School District has elected to track greenhouse gas (GHG) emissions through a GHG emissions inventory baseline and recent update. GHGs are gases that trap heat in the atmosphere, leading to a rise in average global temperature and substantially increased risks to the future health, wellbeing, and prosperity of our communities. Carson City School District recognizes this and is taking action to monitor and reduce their GHG emissions and impact on the environment.

Greenhouse gases vary in the strength of induced warming and how long they can remain in the atmosphere, continuing to contribute to warming. This inventory covers three out of six GHGs covered in the Kyoto Protocol crafted at the UN Framework Convention on Climate Change:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous Oxide (N_2O)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs)
- And hexafluoride (SF_6)

At the level of operations of a school district, the primary GHG emission is CO_2, followed by CH_4 and N_2O. Each of these gases are converted into a unit of carbon dioxide equivalence (CO2e) based on their global warming potential (GWP)—each gas' contribution to global warming over a designated time scale. For example, methane's 100-yr GWP is 21. This means that every metric ton of methane emitted has the same warming impact as 21 metric tons of carbon dioxide. In alignment with standard GHG protocol, all GWPs are on a 100-year time horizon. GWPs for each gas are listed below[1].

Table 1. Greenhouse Gases and their Global Warming Potential

Greenhouse Gas	Chemical Formula	Global Warming Potential
Carbon Dioxide	CO_2	1
Methane	CH_4	21
Nitrous Oxide	N_2O	310
Hydrofluorocarbons	Various	43-11,700
Perfluorocarbons	Various	6,500-9,000
Sulfur Hexafluoride	SF_6	23,900

GHGs are categorized as direct or indirect emissions – Scope 1, Scope 2, or Scope 3. The prevention of double counting for major categories, such as electricity use and waste disposal, is one of the most important reasons for using the scopes framework for reporting greenhouse gas emissions at the local level.

[1] GWPs from IPCC Second Assessment Report: https://unfccc.int/process/transparency-and-reporting/greenhouse-gas-data/greenhouse-gas-data-unfccc/global-warming-potentials

- **Scope 1:** Direct Emissions – emissions physically produced onsite and are "owned or directly controlled" by your institution (e.g. on-site generators, gas from vehicle fleets, refrigerant leaks).
- **Scope 2:** Indirect Emissions – emissions resulting from activities taking place onsite or within the boundary of the organization but are controlled by other entities (e.g. purchased utilities).
- **Scope 3:** Induced Emissions – emissions from sources not owned or controlled by your institution but are central to site operations (e.g. solid waste, non-fleet transportation, employee/student commuting, materials).[2]

Our methodology focuses on Scope 1 and 2 emissions and Scope 3 solid waste, only quantifying emissions for components well within the District's control, such as building energy usage or solid waste produced; it excludes components such as employee/student transportation and wastewater treatment, where the District has little control over improvements. Future inventories could be expanded to include additional Scope 3 items.

All emissions are described in units of metric tons of carbon dioxide equivalent (MT-CO_2e). This is a calculation-based methodology represented by the basic equation: *Mass of GHG (CO_2e) = Source x Emission Factor* (see Appendix for more details on methodology).

The following section details Carson City School District's GHG inventory using the 2015 academic fiscal year[3] (FY15) as the baseline inventory year and the 2018 academic fiscal year[4] (FY18) as the comparison update inventory year.

Data Limitations

Transportation data was only available for FY18. For purposes of this inventory, McKinstry assumed the same emissions for FY15. Furthermore, solid waste data was not available prior to February 2019. While not able to quantify solid waste emissions for the base or comparison year, using FY19 data provided a ballpark emissions quantity allocated to solid waste and a rough estimation of the source/sector breakdown. The EPA WARM model[5], used to quantify emissions from waste, treats recycling as landfill emissions avoided. To reflect the District's progress by adopting recycling, the solid waste base year is FY19 solid waste emissions plus FY19 avoided emissions from recycling. Although missing transportation and waste data means the FY15/FY18 inventory is incomplete, it will serve as a data point to benchmark against in future inventories and decision making. Furthermore, the District can now identify key data to track for future reports.

Greenhouse Gas Emissions by Sector

In this section, the focus is on the breakdown of GHG emissions across four main sectors—buildings, water, fleet transport, and solid waste[6]. In FY15, the baseline year, Carson City School District emitted 5,452 MT-CO_2e across all sectors or 0.71 MT-CO_2e /capita[7]. Emissions from buildings leads the way, responsible for 52% of those emissions, followed by solid waste at 36% and fleet transportation at 12% (Figure 2a). Domestic and irrigation water is negligible.

[2] GWP Scope Descriptions from Second Nature: https://secondnature.org/signatory-handbook/measuring-progress/
[3] July 1, 2015 to June 30, 2016
[4] July 1, 2018 to June 30, 2019
[5] See Appendix for further explanation.
[6] Includes landfill waste and recycling.
[7] Based on 2017 Carson City School District occupant count of 7,623

Greenhouse Gas Emissions Inventory

Carson City School District – Baseline (FY15) and Update (FY18)

In FY18, Carson City School District decreased its emissions to 4,163 MT-CO_2e across all sectors or a reduction of 24%. This reduced emissions to 0.54 MT-CO_2e/capita[7]. The sector breakdown shifts to buildings leading the way at 59% (with a reduction of 13%) followed by solid waste at 25% (with a reduction of 47%), and fleet transport at 16% (Figure 2b). See Table 2 for full breakdown.

Figure 1. GHG Emissions by Sector

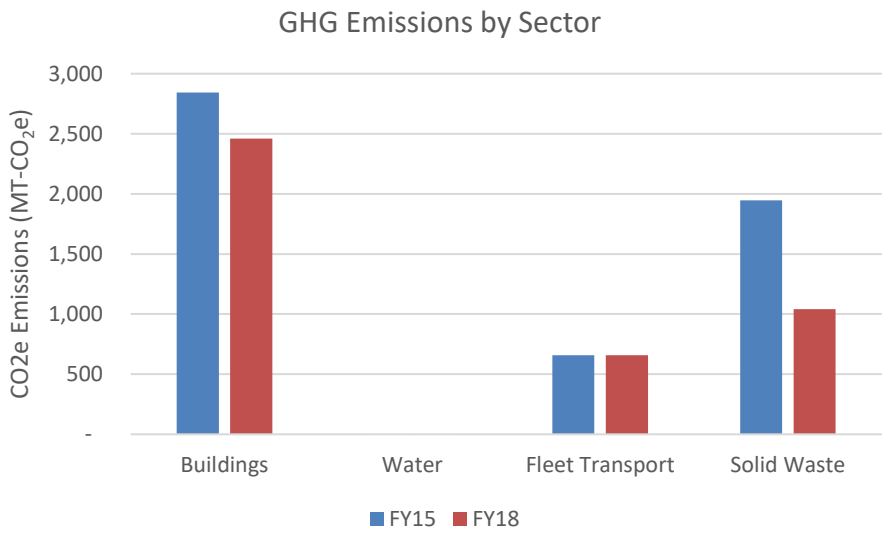


Figure 2a. Base Year Percentage of Emissions by Sector

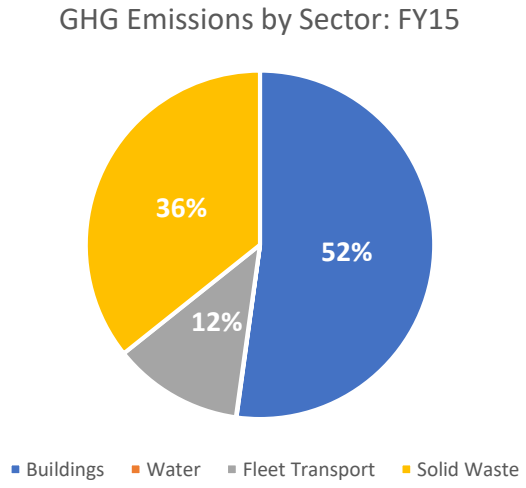


Figure 2b. Comparison Year Percentage of Emissions by Sector

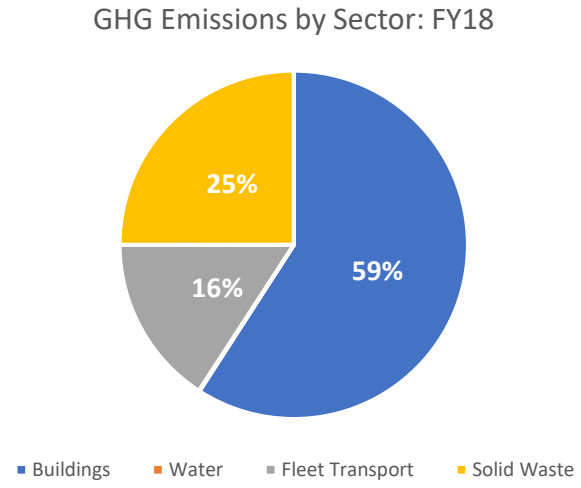


Table 2. Base and Comparison Year Emissions by Sector

	FY15	FY18	% Change
	[MT-CO_2e]	[MT-CO_2e]	
Buildings	**2,844**	**2,461**	**-13%**
Water Treatment	**3**	**3**	**0%**
Fleet Transport	**658**	**658**	**0%**
Solid Waste	**1,947**	**1,041**	**-47%**
Total Emissions	**5,452**	**4,163**	**-24%**

Greenhouse Gas Emissions by Source

In this section, the focus is on the breakdown of GHG emissions by source—electricity, natural gas, water, diesel, gasoline, and solid waste. In FY15, solid waste and electricity are the lead emitters at 36% and 33%, respectively. These are followed by natural gas at 19%, diesel fuel at 10%, and gasoline at 2% (Figure 4a). Domestic and irrigation water are negligible.

In FY18, the sector breakdown changes to electricity leading at 31% of total emissions followed by natural gas at 28%, solid waste at 25%, diesel fuel at 13%, and gasoline at 3% (Figure 4a). See Table 3 for the full breakdown.

Figure 3. GHG Emissions by Source

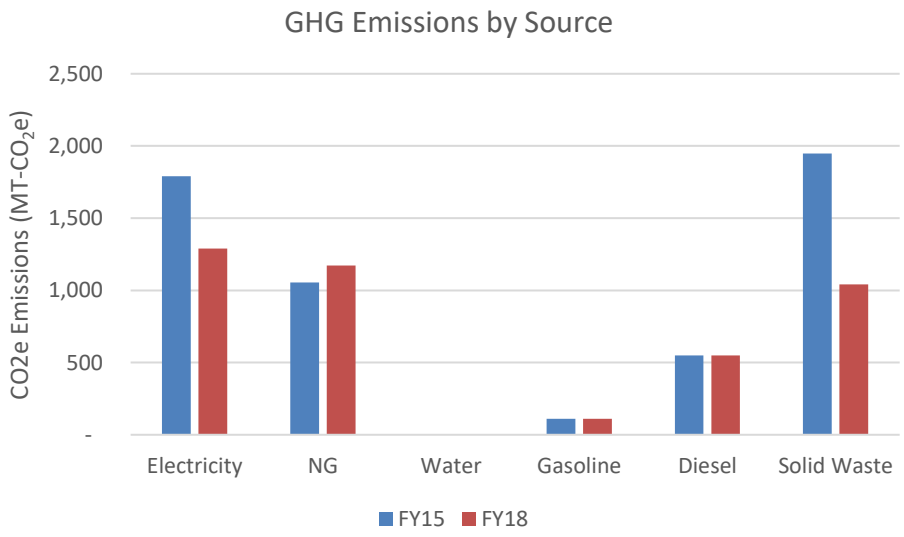


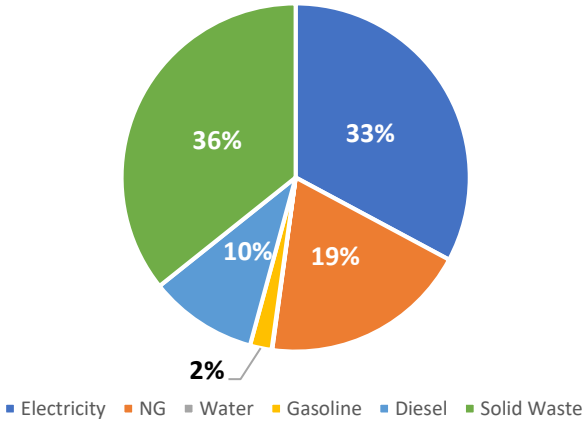
Figure 4a. Base Year Percentage of Emissions by Source

Figure 4b. Comparison Year Percentage of Emissions by Source

Greenhouse Gas Emissions Inventory

Carson City School District – Baseline (FY15) and Update (FY18)

GHG Emissions by Source: FY15



GHG Emissions by Source: FY18

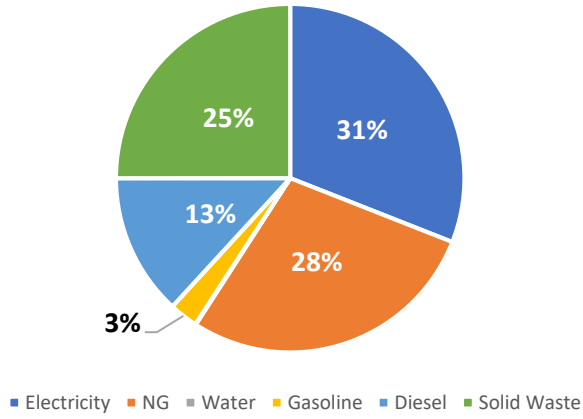


Table 3. Base and Comparison Year Emissions by Source

	FY15	FY18	% Change
	[MT-CO_2e]	[MT-CO_2e]	
Electricity	**1,790**	**1,289**	**-28%**
NG	**1,054**	**1,172**	**11%**
Water	**3**	**3**	**0%**
Gasoline	**110**	**110**	**0%**
Diesel	**548**	**548**	**0%**
Solid Waste	**1,947**	**1,041**	**-47%**
Total Emissions	**5,452**	**4,163**	**-24%**

Conclusion

Carson City School District GHG emissions have declined by approximately 1,290 MT-CO_2e or 24% from FY18 compared to the FY15 baseline. Adopting recycling is responsible for roughly 70% of this emissions reduction and building improvements make up the remaining 30%. Although there are still data gaps in fleet transportation and solid waste, this exercise now provides the framework for future inventories and data collection.

Appendix

INVENTORY CALCULATIONS

Inventories were evaluated using District-provided utility data and fleet transportation data translated into metric tons of carbon dioxide equivalent (MT-CO_2e) based on the emission factors listed in the following section. This is a calculation-based methodology represented by the basic equation:

Mass of GHG (CO_2e) = Source x Emission Factor

Sources considered in this inventory are electricity, natural gas, diesel fuel, gasoline, and domestic + irrigation water. Electricity and natural gas source data were provided via building utility invoices. Annual gallons of diesel fuel and gasoline represent fuel used by District fleet vehicles and were provided via Carson Valley Oil invoices. Water data represents only water used for domestic and irrigation purposes at District buildings and was provided via utility invoices. Emissions factors are typically expressed in terms of emissions per unit of source data (e.g. lbs CO_2/kWh of electricity). The following section details the emission factors used in this inventory.

EMISSION FACTORS

Table A1 shows the emission factors used for the FY15 and FY18 GHG inventories. Only electricity and water factors change value by year. All other sources are held constant.

Table A1. Emission factors by source

Source	Units	2015 Emission Factor	2018 Emission Factor	Data Source
Electricity	[lb CO2e/MWh]	655.4	643.4	eGRID 2016[8] eGRID 2018[9] NWPP, WECC Northwest
Natural Gas	[lb CO2e/therm]	11.69	Same	EPA[10]
Diesel	[kg CO2e/gal]	10.18	Same	EPA[11]
Gasoline	[kg CO2e/gal]	8.887	Same	EPA[8]
Domestic + Irrigation Water	[lb CO2e/kgal]	0.115	0.112	Carson City Public Works Eddy Quaglieri *From July 2020 main well pump extrapolation
Solar	[lb CO2e/MWh]	0	0	

For the purposes of this inventory, any electricity generated by solar energy has an emission factor of zero. Additionally, we did not include the emissions offset in solar overproduction export to the grid. For reference, Carson City School District exported 1,524 MWh in FY15, which is equivalent to abating 453 MT-CO_2e, and 1,478 MWh in FY18, which is equivalent to abating 431 MT-CO_2e.

[8] https://www.epa.gov/sites/production/files/2018-02/egrid2016_summarytables.xlsx
[9] https://www.epa.gov/egrid/egrid-summary-tables
[10] https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references
[11] https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle

For solid waste, McKinstry utilized the EPA Waste Reduction Model (WARM) model[12]. This model was created specifically to help organizations track emission reductions from solid waste. It includes a range of options including aerobic or anaerobic digestion, combustion, composting, recycling, and landfilling. We modeled the Carson City Landfill with the following parameters:

Region	Mountain
State	Nevada
Recycling material	"Current Mix"
LFG Recovery?	No
MSW decay rate (k)	Dry (k=0.02) Less than 20in of precipitation per year
Digestion	Aerobic

To use the model, it was necessary to know how many tons of waste were recycled and landfilled. Waste Management invoices provide landfill and recycling data in yards and pickup frequency. Using a simple conversion, this was translated this into cubic yards; this conversion assumes trash and recycling receptacles are full at the time of pickup. Then, using EPA average volume-to-weight conversion factors for "Mixed MSW, uncompacted," "Mixed MSW, compacted," and "Commingled Campus Recyclables," these quantities were converted into tons, which could then be used in the WARM model. Both mixed MSW quantities were input as "Mixed MSW, Tons Landfilled" and the recyclables as "Mixed Recyclables, Tons Recycled."

$$\frac{\left(\frac{Yards}{pickup} * \frac{pickups}{week} * 52\ weeks\right)}{365\ days} * Bill\ days$$

[12] https://www.epa.gov/warm

Figure A1. WARM model inputs

1. Describe the baseline generation and management for the waste materials listed below. 2.
If the material is not generated in your community or you do not want to analyze it, leave it blank or enter 0. Make sure that the total quantity generated equals the total quantity managed.

Material Type	Material	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted	Tons Anaerobically Digested	Tons Generated
	Fiberglass Insulation	NA		NA	NA	NA	0.00
	Fly Ash			NA	NA	NA	0.00
	Medium-density Fiberboard				NA	NA	0.00
	Vinyl Flooring	NA			NA	NA	0.00
	Wood Flooring	NA			NA	NA	0.00
Tires	Tires				NA	NA	0.00
	Mixed Recyclables	318.23			NA	NA	318.23
Mixed Materials	Mixed Organics	NA					0.00
	Mixed MSW	NA	819.27		NA	NA	819.27

Please refer to the User's Guide if you need assistance completing this table.

Figure A. WARM model GHG output

GHG Emissions Analysis -- Summary Report

Version 15

GHG Emissions Waste Management Analysis for

Prepared by:

Project Period for this Analysis: 01/00/00 to 01/00/00

Note: If you wish to save these results, rename this file (e.g., WARM-MN1) and save it. Then the "Analysis Inputs" sheet of the "WARM" file will be blank when you are ready to make another model run.

GHG Emissions from Baseline Waste Management ($MTCO_2E$): 135.21 GH

Material	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted	Tons Anaerobically Digested	Total $MTCO_2E$
Mixed Recyclables	318.23	-	-	NA	NA	(905.81)
Mixed MSW	NA	819.27	-	NA	NA	1,041.02
						0
						0
						0
						0
						0
						0

As described in the main report overview, the WARM model treats recycling as emissions avoided. To estimate what Carson City School District's emissions may have been before adopting recycling, we added the avoided emissions to the Mixed MSW emissions for approximately 1,947 MT-CO_2e.