# CITY OF LANDER


*Photo courtesy of Ken Colovich*

# 2021 MUNICIPAL ENERGY & ENVIRONMENT REPORT

CREATED BY KARA COLOVICH AT CLIMATE MITIGATION STRATEGIES LLC

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# EXECUTIVE SUMMARY

*Photo courtesy of Ken Colovich*

The 2021 Municipal Energy and Environment Report is a snapshot in time of the City of Lander's energy and fuel use, greenhouse gas(GHG) emissions, and environmental impacts. The impetus for this report stems from the **2020 mayoral and city council proclamation supporting the intent to reduce GHG emissions** (see appendix). The city's Energy and Environment (E&E) Task Force was formed shortly afterward to aid in efforts to reduce GHG emissions while also increasing energy efficiency and lowering operational costs for the city. During 2021 and 2022, the E&E Task Force and an independent contractor from Climate Mitigation Strategies LLC analyzed data from city records, toured all city-operated facilities, and met with city staff to gain an in-depth understanding of the city's operations. Research of best practices and methods from other similar cities played a heavy role in the team's recommended guidance.

**The goal of this report** is to:

- Educate readers on the City of Lander's GHG emissions footprint and energy- and fuel-usage trends.
- Identify areas where the City of Lander could save money, energy, and fuel while also reducing emissions.
- Suggest new methods or technologies that could be implemented by the city to achieve these savings.
- Set the stage for the next phase of action planning with the City of Lander.

Each section of the report corresponds with one of the city's GHG emissions sectors– buildings & facilities, wastewater treatment, solid waste, transportation, and street lights. Below are the big takeaways from these topics:

## EMISSIONS

The total amount of metric tons of carbon dioxide equivalent (MT CO2e), the standard comparable unit for all greenhouse gases, emitted in 2021 for all **municipal operations and city-leased properties equaled 3,203 MT CO2e**.

### GHG EMISSIONS BY SECTOR & SOURCE

(MT CO2E)

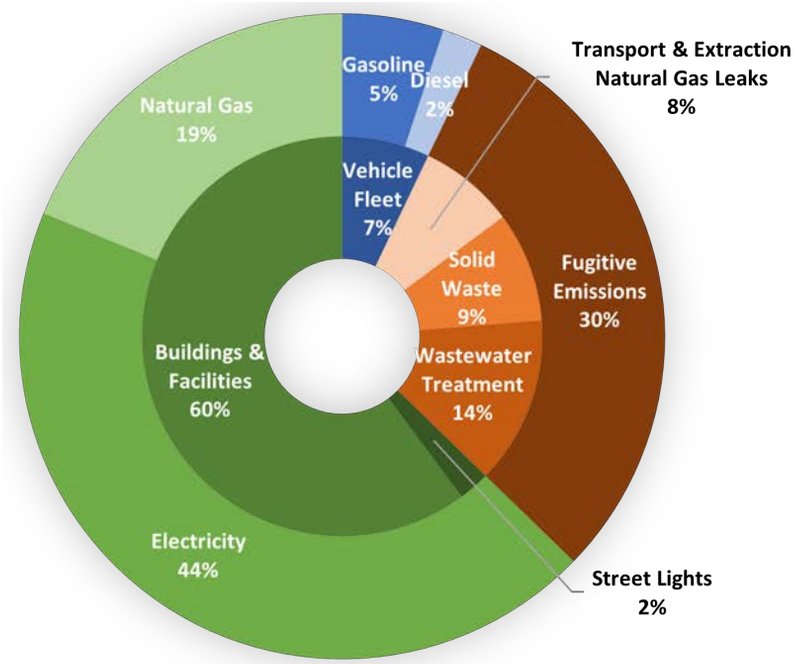



*Figure 1 shows the emissions sector on the interior ring surrounded by the source of emissions that make up the sector around the outside.*

Many cities track GHG emissions to set climate change mitigation goals, prioritize action items within an implementation plan, and monitor their progress overtime. Having these priorities in place also opens more federal **grant opportunities**, especially when it comes to energy use and transportation. Whitefish, MT; Red Lodge, MT; and Laramie, WY are comparable cities in our region that Lander can look to for models of how to perform this work.

## BUILDINGS & FACILITIES

Buildings and facilities are the city's largest GHG emitter at 1,928 MT CO2e. **Total energy costs** for this sector in 2021 equaled **$247,396** (76 percent for electricity and 24 percent for natural gas).

The largest single energy consuming meters are the Wastewater Treatment Plant for electricity (21 percent of the city's electricity cost) and the Water Treatment Plant for natural gas (35 percent of the city's natural gas cost). These two facilities represent different opportunities. At the Wastewater Treatment Plant, the meter aerates the first sewage pond using giant air compressors. The air compressors already run at their max efficiency by using variable frequency drive motors so there is little opportunity for cost savings. On the other hand, the Water Treatment Plant meter that heats the main building could save thousands of dollars by turning down the heat in unoccupied areas and spot insulating.


*Photo showing chemical lines at the Water Treatment Plant that could be spot insulated (HEAL, 2022)*

## BUILDINGS & FACILITIES CONT.

The E&E Task Force recommends the city **continue conducting energy audits** of all of its properties, including leased facilities, to identify more energy and cost savings. Additionally, the city should aim to better understand each building's energy usage trends and strategically schedule high electricity loads to **reduce demand charges**. Strategic use of distributed energy, such as solar and storage, can greatly reduce demand charges while also providing emergency back-up power. The 25 kilowatt net metering rule in Wyoming may limit the size of distributed energy installations; however, negotiations with Rocky Mountain Power (RMP) may lead to special exemptions for grid resilience projects.

**Electrifying buildings** should be done whenever possible to take advantage of decreasing electricity costs, greater energy efficiency, and decreasing GHG emissions from the electrical grid or from distributed renewable energy. In comparison, natural gas provides relatively small GHG reduction opportunities. Natural gas has no zero GHG emission option and the methane leakage, which largely occurs outside city boundaries, is beyond the city's control. The E&E Task Force recommends that all old furnaces, air conditioning units, and water heaters be replaced with Energy Star-rated electric air-source heat pumps. New buildings should incorporate this technology from the start and save on natural gas service fees to undeveloped land.

To amplify the effect of energy conservation throughout the community, the city should **adopt building codes that establish a minimum baseline for energy efficiency**. Jackson and Laramie have already done so. The city could also incentivize and educate the public on high-performance buildings.

## STREET & BALLFIELD LIGHTS

Street and ballfield lighting made up about 17 percent of the city's electricity costs in 2021 at $41,967. Flat rate schedules (RMP-owned lights) are substantially more expensive than metered schedules (city-owned lights) costing an annual total of $33,318 for 57,624 kWh compared to $8,649 for 85,407 kWh. **The cost to energy ratio is more than six times higher**. All city-owned street lights, not including the ballfield lights, have been replaced with energy efficient LED lamps. Rocky Mountain Power-owned street lights can only be replaced with LED lamps when they burn out and RMP is notified – creating little opportunity for energy savings. The city should consider switching all street lighting to metered schedules to take advantage of lower rates and the opportunity to switch all lamps to LED.

*Photo courtesy of Ken Colovich*

## WASTEWATER TREATMENT

Open sewage lagoons release high amounts of methane as microorganisms in the lagoons decompose biosolids. The technology of methane capture traps those gases and puts them to use as biogas in vehicles or to run the facility. **Federal grant funding exists to implement low GHG emission wastewater treatment technologies,** which could be used at our current facility or at a hypothetical regional facility. Anaerobic digesters and hydrothermal carbonization are two technologies that should be strongly considered with a regional wastewater facility given their low GHG emissions and commercially viable byproducts. Other environmental concerns at the wastewater lagoons that are being addressed by the city include cracked sewage pipes in town, over dumping from septic haulers, and trash build up.

*Photo courtesy of Brian Linton*

## SOLID WASTE

In 2021, the city spent **$20,954 on waste disposal**. Waste reduction is the primary way the city can reduce this cost while also reducing GHG emissions. Less waste means the city could either consolidate dumpsters or reduce dumpster size. **A waste audit should be performed to see the types and the quantity of waste that could be diverted from the landfill** through methods of reuse, recycling, and composting. The city already takes advantage of internal city and county communications networks to both post and receive reused items. Staff also report to reuse and repair large equipment, such as bike racks; cabinetry; and playground components, until they are no longer safe to use. On the other hand, there is no coordinated recycling program within the city leaving it up to departments whether they want to recycle. Composting is currently not available; however, if the wastewater treatment plant is transferred to an anaerobic digester or hydrothermal carbonization plant, then organic waste could be included in the treatment process.

The city does not have operational control over the county's landfill and therefore cannot implement GHG emissions reducing technology, such as methane capture. However, since the city is a major client for the landfill, they could recommend the use of methane capture and put financial support behind it.

## TRANSPORTATION

The city's fleet consists of **121 vehicles** (85 on-road vehicles, 36 off-road vehicles) with **total fuel costs of $65,795** in 2021. Two main strategies were identified for reducing cost and GHG emissions – right-sizing the fleet and replacing old vehicles with new hybrid or electric models.

**Right-sizing the fleet** is accomplished by assessing the transportation needs of departments and matching needs with the type of vehicles best equipped for the job. If pick-up trucks can be swapped for more fuel efficient SUVs or passenger vehicles, this would be the first step in reducing fuel costs. Non-motorized vehicles, such as bicycles or e-bikes, should also be considered for the fleet.

**Replacing older vehicles in the fleet**, especially pick-up trucks that date pre-2000, **with new hybrid or electric models** reduces fuel and operating costs while saving thousands of pounds of $CO_2e$ from entering the atmosphere each year. Many hybrid models are already less expensive than their gas equivalents and electric vehicles (EVs) can beat hybrid prices when the 30 percent tax incentive is used. Considering the volatility of gas prices, the relatively stable and forecasted decrease in electricity prices, the tax credits available for EVs, and the expanding charging infrastructure, EVs are a serious option to consider.

## NEXT STEPS

Using this baseline of knowledge, the E&E Task Force now recommends:

**For city council and mayor**:

1. Continue to understand the local climate risks to Lander,
2. Set science-based GHG emissions reduction targets, and
3. Integrate climate mitigation and adaptation strategies into both the city's strategic plan and master plan.

**For city staff**:

- Integrate the list of facility improvements into departmental calendars.
- Test drive electric vehicles as they appear at our local car dealerships to become more familiar with them. Ask questions of both the dealers and the E&E Task Force.
- Take note of building and vehicle asset replacement schedules and share with the E&E Task Force.
- Identify departmental transportation needs and determine a vehicle make-up that would best serve the fleet.
- Engage in conversations with RMP to understand where grid vulnerabilities lay and how distributed renewable energy can help provide essential services.
- Inquire with RMP about high costs of flat rate street lighting and consider switching to metered lighting.
- Work with community partners to perform a waste audit of city buildings and the city's public spaces.

Biennial GHG monitoring is recommended to track how projects and policies influence the city's energy and fuel use and their costs. Additional grant funding is needed to fully support the city in this next planning phase. As the city increases its focus in this area, it should assess whether a city-supported position is necessary to manage progress monitoring and project implementation.

# INTRODUCTION

## BACKGROUND

**WINTER 2020**

Around 300 Lander citizens gather for at the Lander Community Center for a climate change educational series.

**SPRING 2020**

Lander Climate Action Network (LCAN) is formed.

**OCTOBER 2020**

City officials issue a proclamation acknowledging the threat of climate change and supporting the intent to reduce the city's greenhouse gas emissions.

**APRIL 2021**

City of Lander Energy & Environment Task Force is established

**APRIL 2022**

LCAN hires an independent contractor to compile this comprehensive report for the City of Lander with the funding assistance from the LOR Foundation.

## THE WHY

### ENERGY TRENDS

As of writing this report in 2022, several major energy events have occurred. One is Russia's war in Ukraine. This war's ripple effects throughout the world is causing disruptions in food, feedstock, and energy supply chains. During the spring and summer of 2022, U.S. consumers saw skyrocketing gasoline prices at the pump and European countries that rely on Russia's natural gas continue to deal with volatility in energy sourcing and prices.

*Photo credit: Penn Today*

Other energy events of 2022 include the passing of the $369 billion Inflation Reduction Act (IRA) and the $550 billion Bipartisan Infrastructure Act (BIA), both of which earmark funding for electrification, clean energy and climate priorities. Even without these incentives to electrify, the U.S. Energy Information Administration's Annual Energy Outlook forecasts electricity consumption to rise and rates to fall over the next few decades. With consumer incentives and the falling price of electricity compared to natural gas, electrified building heating and cooling and EVs will become more commonplace in our society.

The E&E Task Force is aware of these trends and wants the City of Lander to both prepare itself for future energy volatility while also taking advantage of cost savings and funding opportunities.

## U.S. COMMERCIAL BUILDINGS ENERGY CONSUMPTION

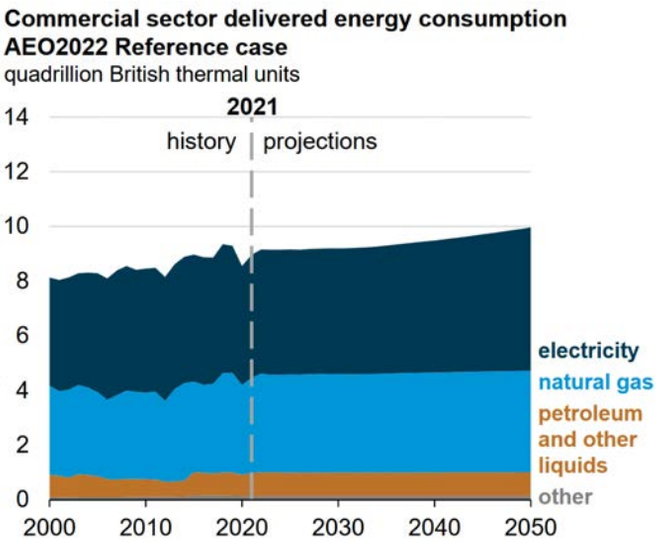



*Figure 2: Historical and projected energy consumption trends in the U.S. (the U.S. Energy Information Administration's 2022 Annual Energy Outlook Report, 2021)*

## U.S. ENERGY PRICES

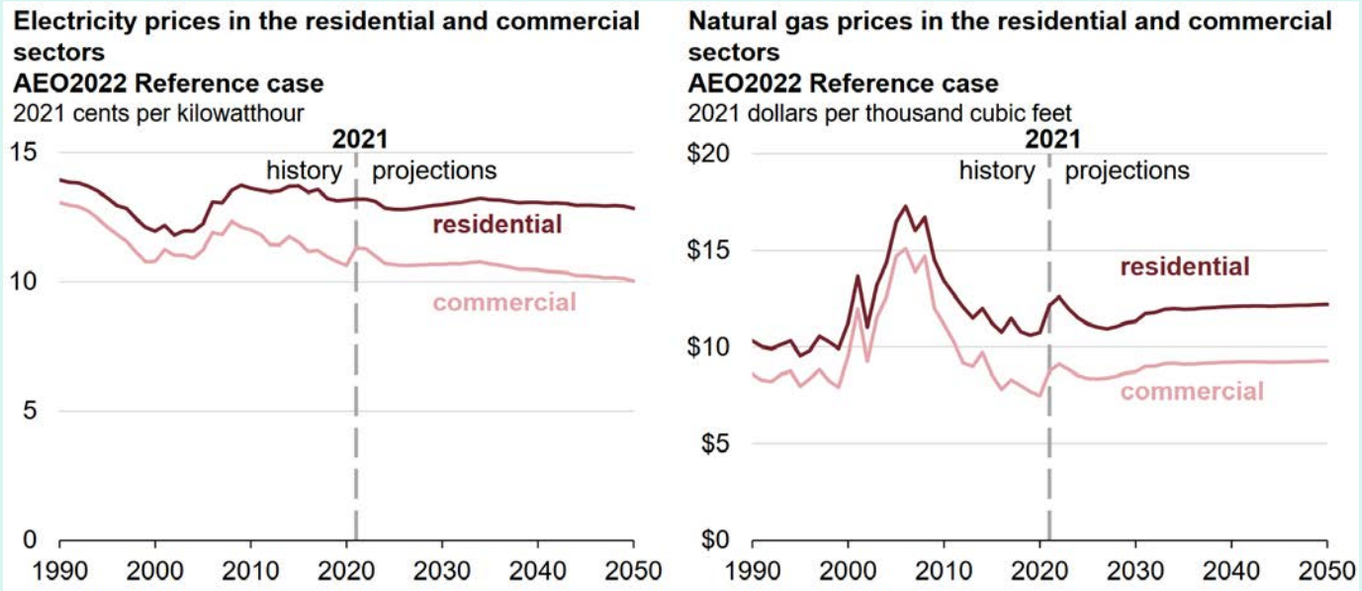



*Figure 3: Historical and projected energy price trends in the U.S. (the U.S. Energy Information Administration's 2022 Annual Energy Outlook Report, 2021)*

*Hyperlinks:*
*https://www.eia.gov/outlooks/aeo/pdf/AEO2022_ChartLibrary_Buildings.pdf*

## CLIMATE TRENDS

This report is timely is because climate change impacts are being felt across the world and here at home. According to climate research performed by regional scientists for the Greater Yellowstone Coalition, the Greater Yellowstone ecosystem (outlined in the map below) is already experiencing climatic shifts. From 1950 to 2020, the region saw a rise in the average annual temperature of over two degrees Fahrenheit. This warmth meant less precipitation fell as snow and caused earlier peak run-off.

## GREATER YELLOWSTONE ECOSYSTEM BOUNDARY

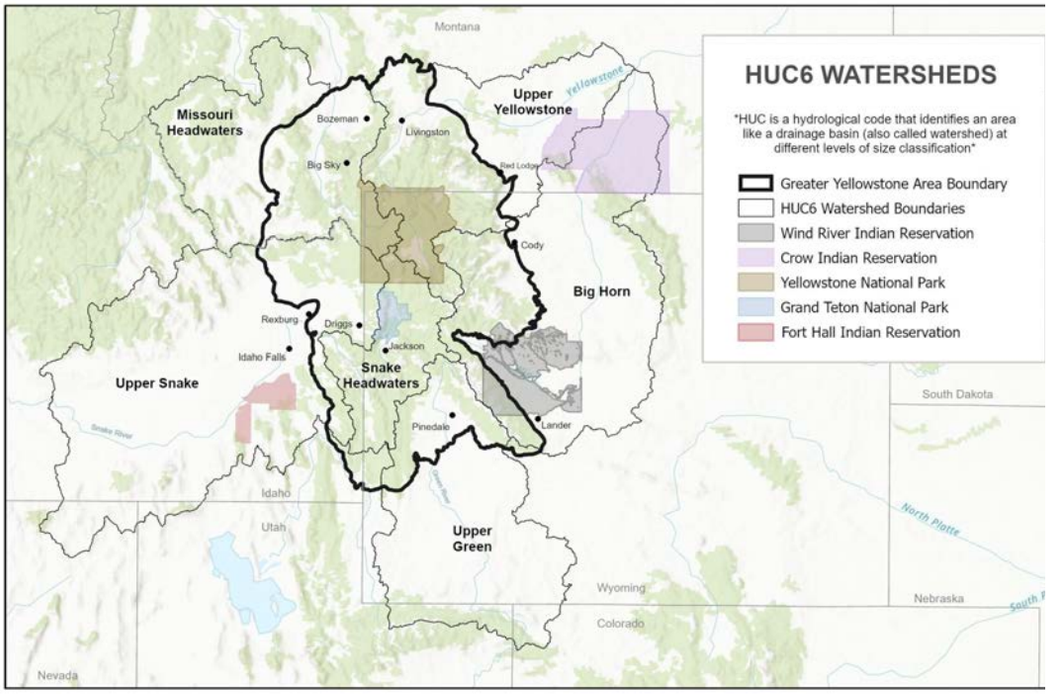



*Figure 4: Greater Yellowstone research boundary (Greater Yellowstone Climate Assessment, 2021)*

## CLIMATE TRENDS IN THE GREATER YELLOWSTONE ECOSYSTEM

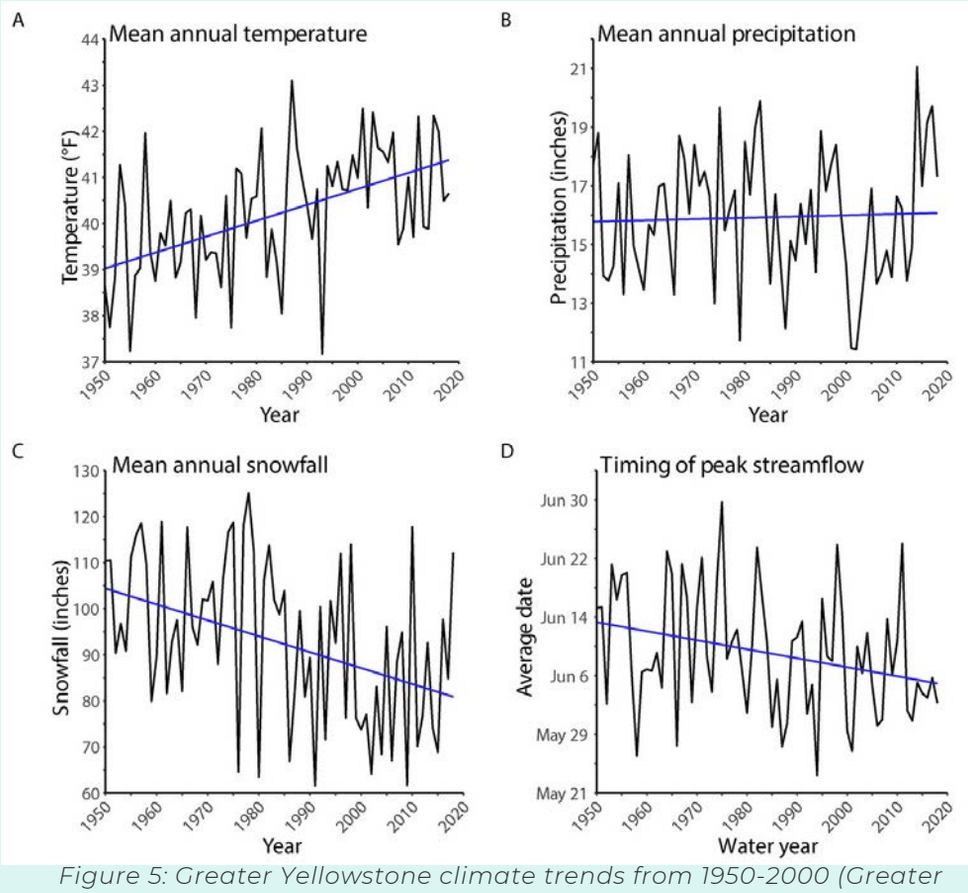



*Figure 5: Greater Yellowstone climate trends from 1950-2000 (Greater Yellowstone Climate Assessment, 2021)*

*Hyperlinks:*
*http://www.gyclimate.org/*

# DAYS ↓32°F CUT IN HALF

To get a sense of what is to come, we can look to the U.S. Global Change Research Program's Climate Mapping For Resilience and Adaptation tool. This tool's county-specific focus paints a clear picture of what our city will face in the decades to come depending on a low or high GHG emissions scenario. If we continue on a high emissions trajectory, by the time someone born in 2021 turns 56 years old (year 2077), they are likely to experience about 45 more days above 90 degrees in Lander when compared to historical averages. The amount of days below 32 degrees would be about cut in half from 65 to 34 days. That is a drastically different Lander. There would be no ice skating or skiing in the winter, incidents of heat stress would increase (especially for those without air conditioning), and water scarcity from lack of snowpack would increase tensions amongst the county's water users.

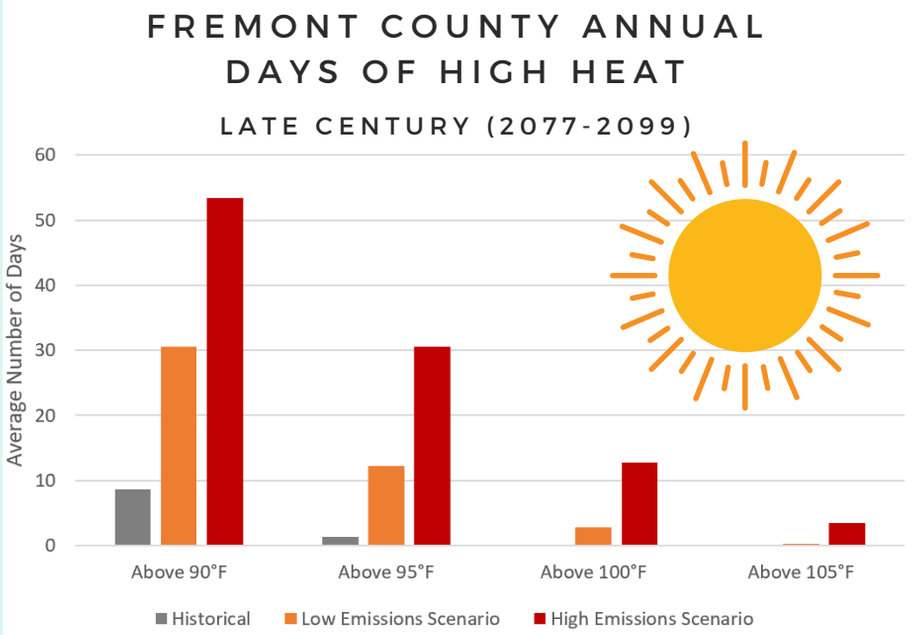



*Figure 6: Number of high heat days in Fremont County given historical, low emissions, and high emissions scenarios. (U.S. Global Change Research Program's Climate Mapping For Resilience and Adaptation tool)*

*Hyperlinks:*
*https://livingatlas.arcgis.com/assessment-tool/search*

### COST SAVING & FUNDING OPPORTUNTIES

Over the past year and a half, the E&E Task Force observed the city's energy and fuel use trends and identified several opportunities for cost savings. Upgrading equipment and using current resources more efficiently are among the task force's primary recommendations – details of which are contained in this report. Current national trends, such as the decrease in electricity price and the build-out of EV charging stations, also play into the task force's recommendations.

As mentioned previously, there is an unprecedented amount funding available for climate change mitigation and adaptation through the Inflation Reduction Act and the Bipartisan Infrastructure Act. The E&E Task Force will parse through these pieces of legislation as funding becomes available and identify grants that will advance the city's energy and climate goals.

# PURPOSE

The purpose of the Municipal Energy and Environment Report is to:

- Educate readers on the City of Lander's GHG emissions footprint and energy- and fuel-usage trends.
- Identify areas where the City of Lander could save money, energy, and fuel while also reducing emissions.
- Suggest new methods or technologies that could be implemented by the city to achieve these savings.
- Set the stage for the next phase of action planning with the City of Lander.

This report is not an implementation document or action plan but rather a report of insights and recommendations. The City of Lander's municipal operations and its properties are the reporting boundaries. In other words, it does not include residential or commercial sectors. Properties owned by the city are currently leased to the following organizations: the Lander Senior Citizens Center, the Lander Golf Course, the Chamber of Commerce, Wind River Aviation, and Guardian Flight. Water use was not an environmental factor included within the scope of this report. For more information on next steps, please refer to the concluding paragraphs.

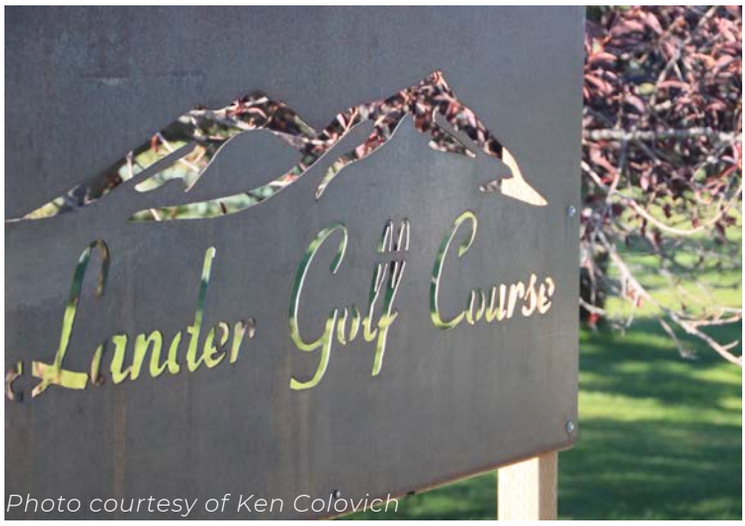


*Photo courtesy of Ken Colovich*

# AUDIENCE

The audience for this report is wide ranging, from city officials to civically-engaged Lander residents who may take an interest and wish to provide their input. A condensed version of this report will be available for public distribution and public presentations will be given to the city council and through the LCAN. For any readers who would like to follow-up with comments or questions, please reach out to the E&E Task Force by emailing landereetaskforce@gmail.com.

# METHODS

Data for this report was collected from city records including utility bills, invoices, and internal record keeping documents for the year 2021. Facility tours were conducted with the facility managers of each city-operated property. Historical context, operational functions, and future developments were provided by RaJean Strube-Fossen, the assistant mayor, and Lance Hopkin, the public works director and city engineer. Where possible, local expertise was sought from practitioners and professionals in the Lander community or the Mountain West region for technical insight.

# GLOSSARY

- Carbon dioxide equivalent (CO2e) - a comparable unit of measurement across greenhouse gases.
- Electric Vehicle (EV) - a vehicle with no internal combustion engine that runs entirely off of an electricity-charged battery.
- Fugitive emissions - unintentional emissions that result from decomposition of organic materials or leaks in natural gas infrastructure.
- Fremont County Solid Waste (FCSW) - the landfill and recycling center for Fremont County. The location outside of Lander is both a landfill and baling station.
- Greenhouse gases (GHG) - primarily water vapor, carbon dioxide, methane, nitrous oxide, and ozone. These gases trap heat within the atmosphere causing a greenhouse effect.
- kW - kilowatt; a measurement of power
- kWh - kilowatt-hour; a measurement of energy (power output over a period of time). The quantity of kilowatts used or produced in an hour.
- Municipal solid waste (MSW) - everyday waste, more commonly referred to as trash or garbage.
- Rocky Mountain Power (RMP) - power utility serving the Lander area.
- U.S. Environmental Protection Agency (U.S. EPA)
- U.S. Department of Energy (U.S. DOE)
- Wyoming Department of Transportation (WYDOT)
- Wyoming Energy Authority (WEA)
- Wyoming Waste Systems (WWS) - solid waste hauler serving Fremont County.

# GREENHOUSE GAS EMISSIONS

Greenhouse gas emissions are the common thread throughout this report since every city function emits GHG. Some activities contribute directly to emissions, such as driving, while other causes are more indirect, such as decomposition of waste in the landfill. In other scenarios, our emissions are outsourced to other communities. Power plants that generate electricity to power Lander's homes and businesses are located far away; however, communities closer to those power plants feel the impacts from the pollution. Every section of this report opens with context about the emission source and highlight current trends or opportunities.

## GHG EMISSIONS INSIGHTS

The most potent greenhouse gases consist of methane, carbon dioxide, and nitrous oxide. In order to compare the scale of these emissions, we convert the potency of the gases into one common denominator. This report uses metric tons of carbon dioxide, or MT CO2e. Below is a representation of the city's emissions (including city leased properties) by sector and by source. The total amount of CO2e emitted in 2021 was 3,203 MT CO2e.

### FUGITIVE EMISSIONS

Fugitive emissions are unintentional emissions that result from decomposition of organic materials or leaks in natural gas infrastructure. These emissions (mostly consisting of methane) could be captured and used to power facilities or vehicles but escape into the atmosphere instead.

### GHG EMISSIONS BY SECTOR & SOURCE

(MT CO2E)

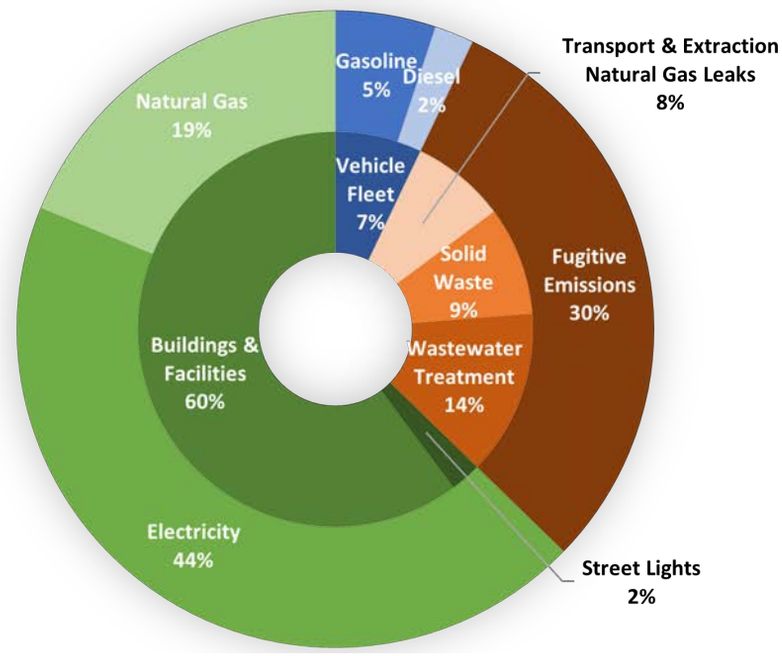



*Figure 1 shows the emissions sector on the interior ring surrounded by the source of emissions that make up the sector around the outside.*

| Sector | MT CO2e |
|---|---|
| Street Lights | 81 |
| Buildings & Facilities | 1928 |
| Wastewater Treatment | 434 |
| Solid Waste | 285 |
| Transport & Extraction Natural Gas Leaks | 248 |
| Vehicle Fleet | 227 |
| Total | 3203 |

| Source | MT CO2e |
|---|---|
| Electricity | 1408 |
| Natural Gas | 601 |
| Fugitive Emissions | 967 |
| Gasoline | 163 |
| Diesel | 64 |
| Total | 3203 |

*Figure 7: Metric tons of carbon dioxide equivalent for each city sector and emission source.*

*Hyperlinks:*
*https://www.epa.gov/ghgemissions/overview-greenhouse-gases*

# GHG EMISSIONS OPPORTUNITIES

Many cities track GHG emissions in order to set climate mitigation goals and identify pathways for emissions reduction. Lander city officials support this intent in the 2020 proclamation to, "reduce greenhouse gas emissions to enhance community resilience, quality of life, and economic viability for current and future generations." With the new IRA and BIA federal grants, funders are increasingly looking for climate mitigation and climate adaptation plans when funding infrastructure projects. For example, the following is language from a U.S. DOE grant, "Eligible applications must demonstrate that switching to a geothermal district heating and cooling system would result in greenhouse gas emission reductions for the community where the system is installed." For this reason, among others, the city should keep an updated inventory of emissions in order to demonstrate change after adoption of new policies and technologies.

COMMUNITY SPOTLIGHTS

## LANDER, WY

Population: 7,550
Elevation: 5,358 ft.
Municipal GHG Footprint: 3,203 MT CO2e
Municipal GHG per capita: 0.424 MT CO2e/resident

## RED LODGE, MT

Population: 2,134
Elevation: 5,568 ft.
Municipal GHG Footprint: 1,910 MT CO2e
Municipal GHG per capita: 0.895 MT CO2e/resident

- 2017 An Energy Use, Cost & Greenhouse Gas Emissions Inventory of City Government Operations
- 2018 City of Red Lodge Energy Conservation Plan
- 2020 An Energy Use and Emissions Inventory of the Red Lodge Community

## WHITEFISH, MT

Population: 8,032
Elevation: 3,028 ft.
Municipal GHG Footprint: 1,760 MT CO2e
Municipal GHG per capita: 0.219 MT CO2e/resident

- Whitefish 2016 Greenhouse Gas Inventory
- Whitefish 2018 Climate Action Plan

## LARAMIE, WY

Population: 32,515
Elevation: 7,165 ft.
Municipal GHG Footprint: 18,334 MT CO2e
Municipal GHG per capita: 0.564 MT CO2e/resident

- City of Laramie's Carbon Neutrality Resolution
- Laramie 2019 Municipal Greenhouse Gas Emissions Inventory
- Laramie 2019 Community-Wide Greenhouse Gas Inventory
- Laramie Emission Reduction Management Plan
- EAC Subcommittee Recommendations for Emissions Reduction & Carbon Neutrality

# BUILDINGS & FACILITIES

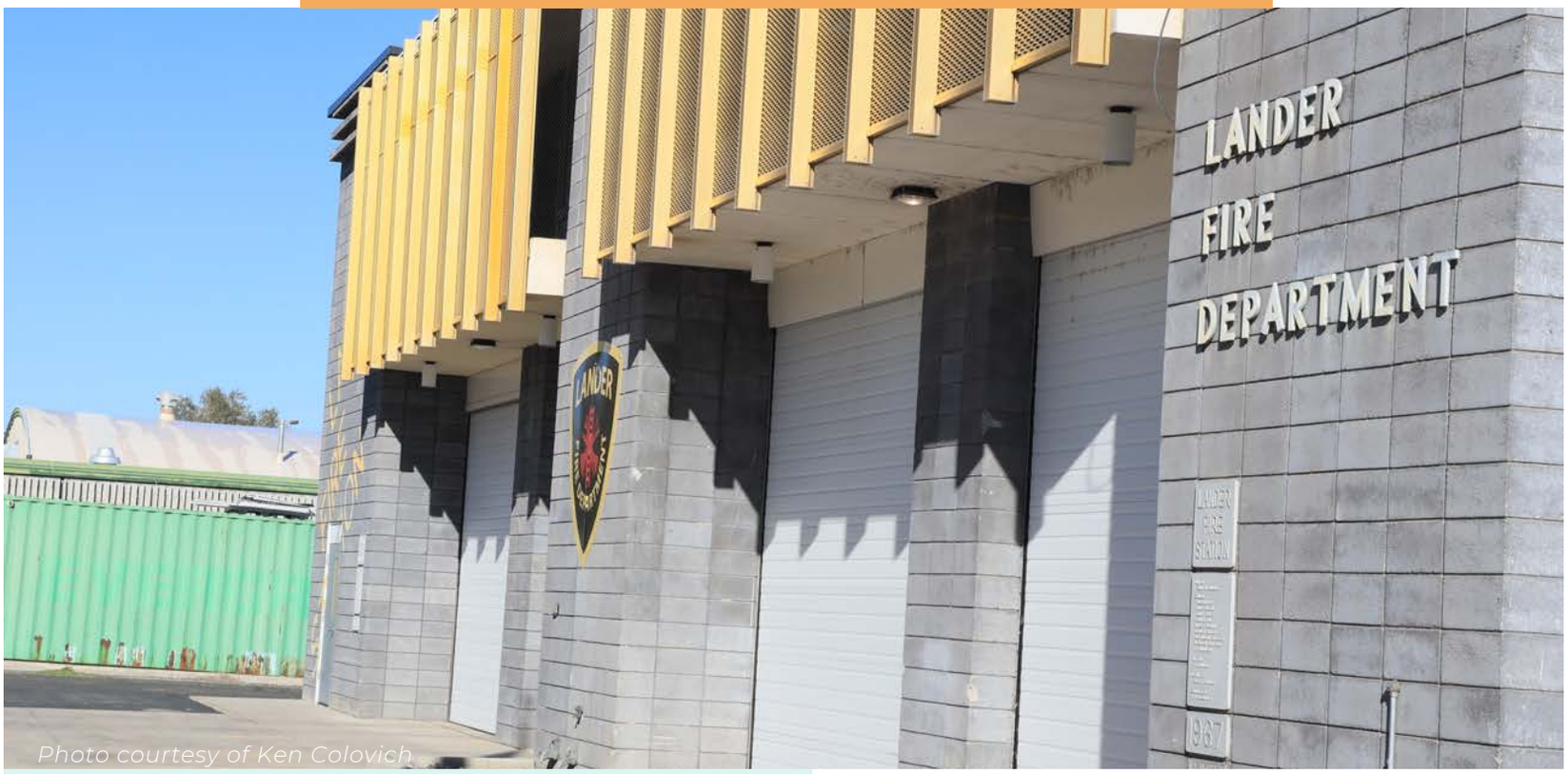



*Photo courtesy of Ken Colovich*

## BUILDING & FACILITY EMISSIONS

### GHG EMISSIONS BY SECTOR

(MT CO2E)

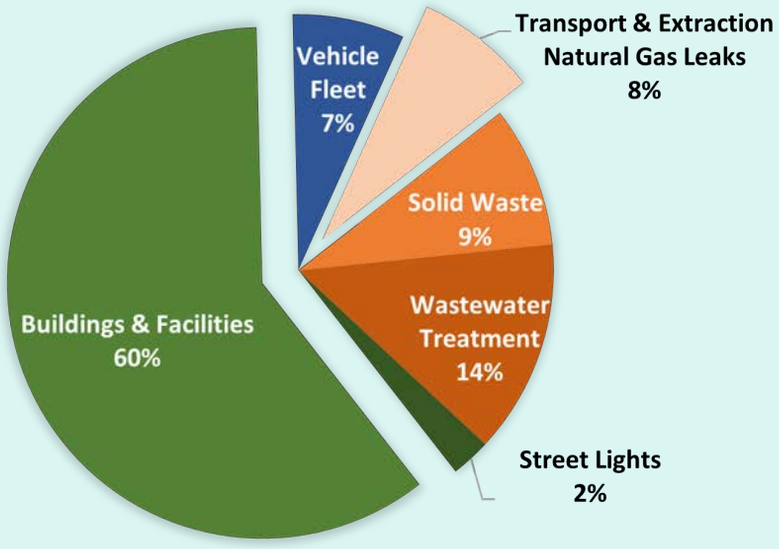



*Figure 8: "Buildings & Facilities" and "Transport & Extraction Natural Gas Leaks" greenhouse gas sectors.*

Buildings and facilities are commonly the largest source of CO2e emissions within an organization's operations. The main services that equip our city buildings are electricity and natural gas. When assessing the emissions of these two services, we look at the amount of emissions from their respective energy sources.

Natural gas (mostly consisting of methane) emits 50 percent less GHG emissions than coal, but it is still more polluting than most renewable energy technologies. Emissions occur during combustion of the fuel within buildings and during the transport and extraction of the fuel. An estimated 0.3 percent of natural gas transported within city gas pipes is lost due to leakage and an additional 4 percent is leaked during extraction of the fuel and transportation to Lander, which we account for as part of our upstream emissions. (note: Methane does not last as long as carbon dioxide in the atmosphere but it is 80 times more potent than carbon dioxide in the first 20 years.)

## UPSTREAM EMISSIONS

It is important to include upstream emissions in a GHG inventory when they have a substantial impact on the overall GHG footprint of an organization or if it influences an organization's decision making. At eight percent of the city's GHG footprint, fugitive emissions from upstream natural gas drilling and transport are material enough to include in the inventory. The four percent estimated leakage rate from the Denver-Julesburg Basin (see image) was used for this emissions calculation and is a conservative estimate when compared to other natural gas basins in our region, This wasted fuel is out of the city's control and can only be reduced by using less fuel or switching to another energy source.

## FUGITIVE METHANE FROM NATURAL GAS PRODUCTION ZONES

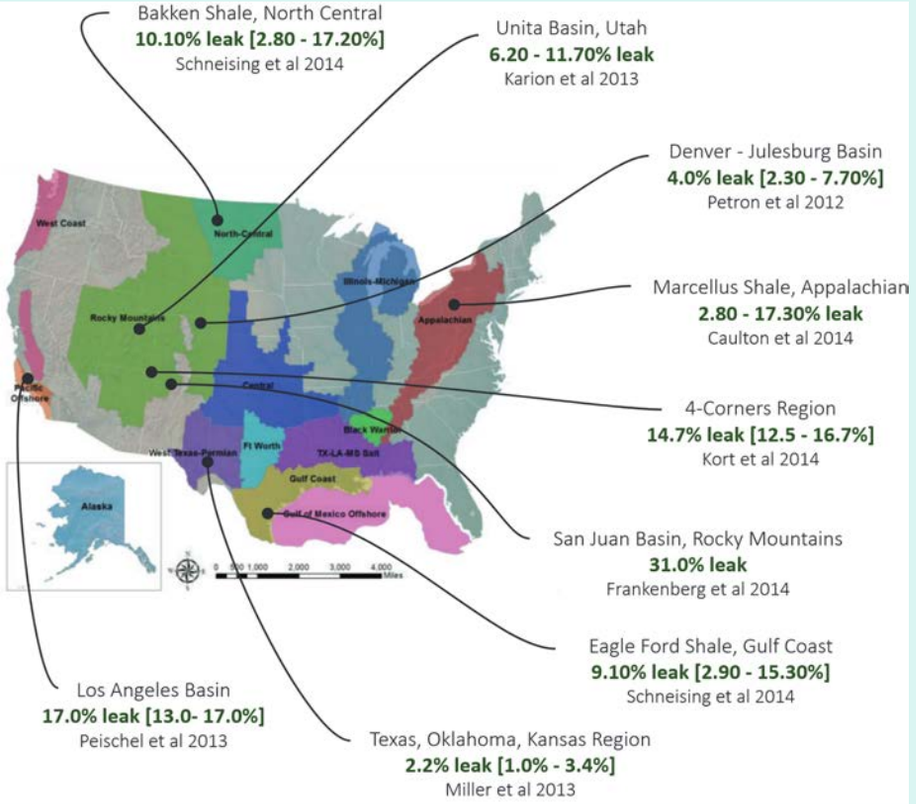
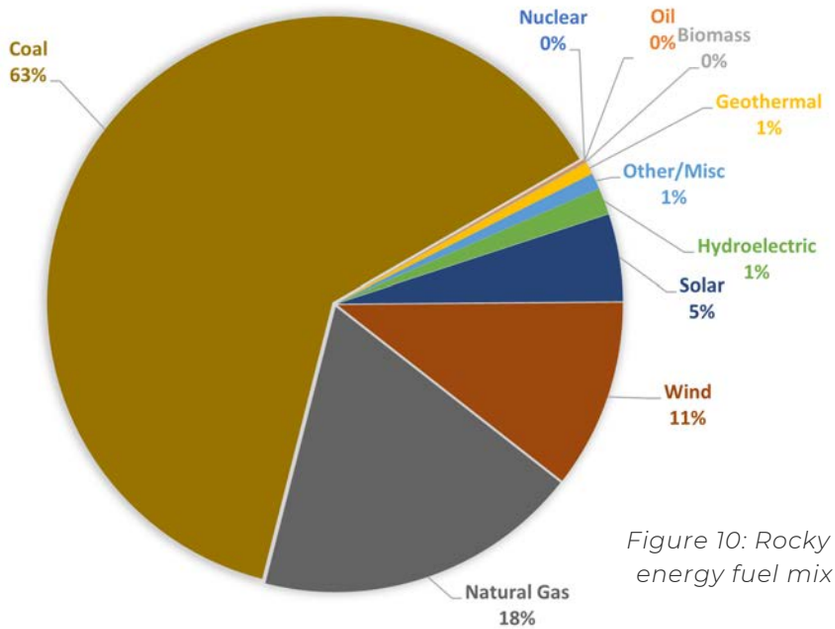



*Figure 9: Studies of methane leakage for U.S. natural gas production zones (Methane Math: How Cities Can Rethink Emissions from Natural Gas by San Francisco Department of the Environment, 2017)*

## ROCKY MOUNTAIN POWER'S 2020 FUEL MIX




Rocky Mountain Power (RMP), our electricity service provider, sources their energy from the fuel mix displayed here. About 81 percent of the electricity fuel mix comes from GHG emitting fuels which makes the climate impacts of electricity usage from our grid relatively high.

*Figure 10: Rocky Mountain Power's 2020 energy fuel mix (U.S. EPA eGRID, 2020)*

*Hyperlinks:*
*https://www.usdn.org/uploads/cms/documents/methane-math_natural-gas-report_final.pdf*

PacifiCorp, RMP's parent company that covers parts of Washington; Oregon; California; Idaho; Utah; and Wyoming, spells out in their Integrated Resource Plan the investments they intent to make over the next twenty years, PacifiCorp's resource portfolio, (see graph below) shows increases in installed energy from solar and storage, wind, energy efficiency, and demand response technologies (the positive numbers) while also removing coal and natural gas from the grid (negative numbers). With PacifiCorp and RMP adopting a cleaner energy mix, the city's emissions from electricity usage will decrease in the decades to come.

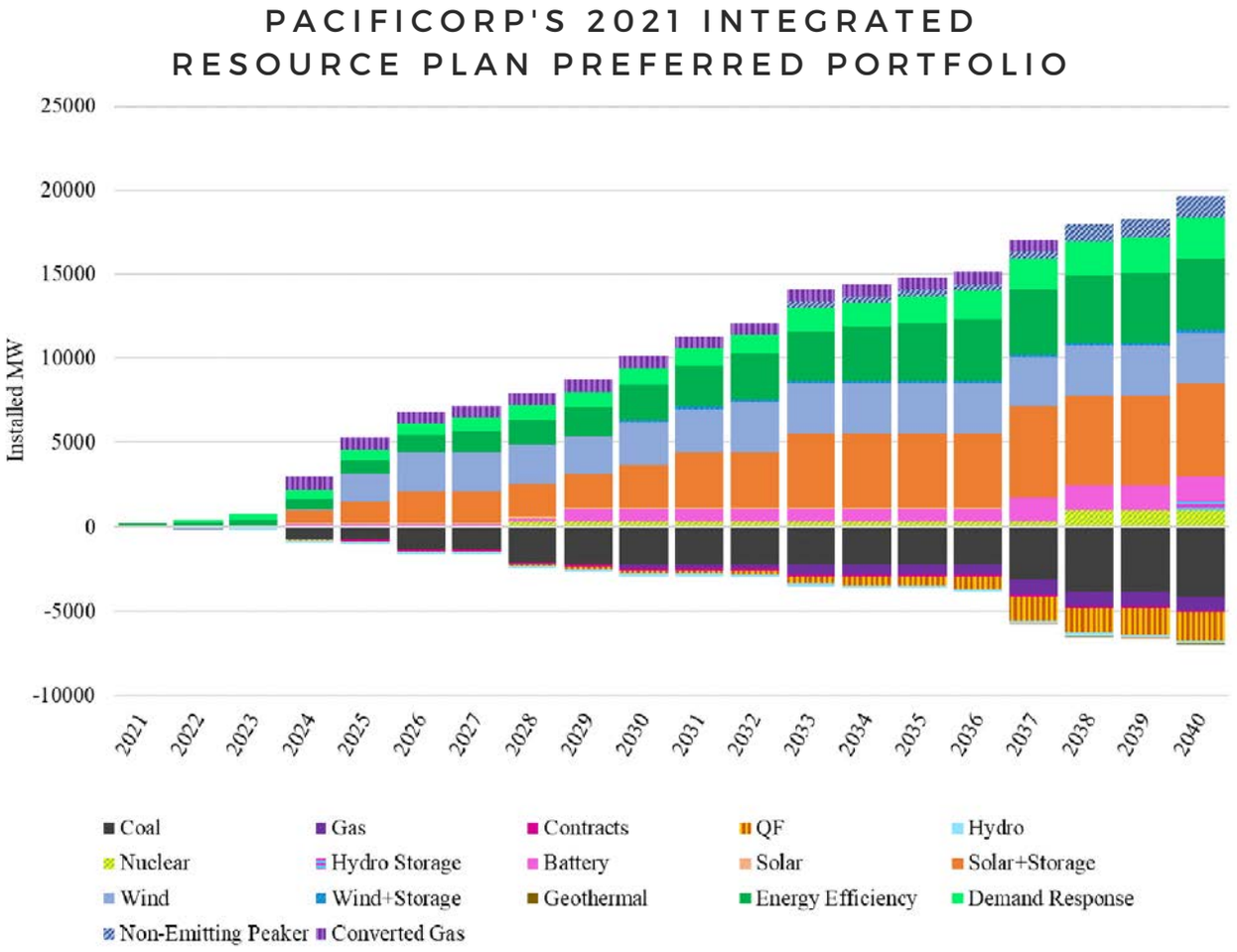



*Figure 11: PacifiCorp's preferred energy resource mix from 2021-2040 with positive numbers as investments and negative numbers as divestments (Pacificorp 2021 Integrated Resource Plan, 2021)*

## RECOMMENDATIONS

- As our grid transitions to lower GHG-emitting energy, consider transitioning appliances from natural gas to electricity. For the city's buildings, that means switching to heat pumps for space heating/cooling and hot water.
- Look to other city's policies and programs that speed the adoption of electrification.
- Renewable energy certificates and power purchase agreements are market-based alternatives for organizations to pursue low GHG energy – the latter also happens to supply electricity at a fixed rate.

*Hyperlinks:*
*https://www.pacificorp.com/content/dam/pcorp/documents/en/pacificorp/energy/integrated-resource-plan/2021-irp/Volume%201%20-%209.15.2021%20Final.pdf*
*https://rmi.org/a-landmark-year-for-building-electrification/*
*https://www.epa.gov/green-power-markets/renewable-energy-certificates-recs*
*https://www.powermag.com/types-of-power-purchase-agreements-and-why-each-ppa-might-be-used/*

# ENERGY USE INSIGHTS

BY THE NUMBERS
2021

**$247,396** Total energy costs for city-operated facilities (76% electricity, 24% natural gas)

**1,708,368 KWH** Total electricity consumed by city-operated facilities

**97,792 THERMS** Total natural gas consumed by city-operated facilities

## ELECTRICITY USE BY DEPARTMENT

(KWH)

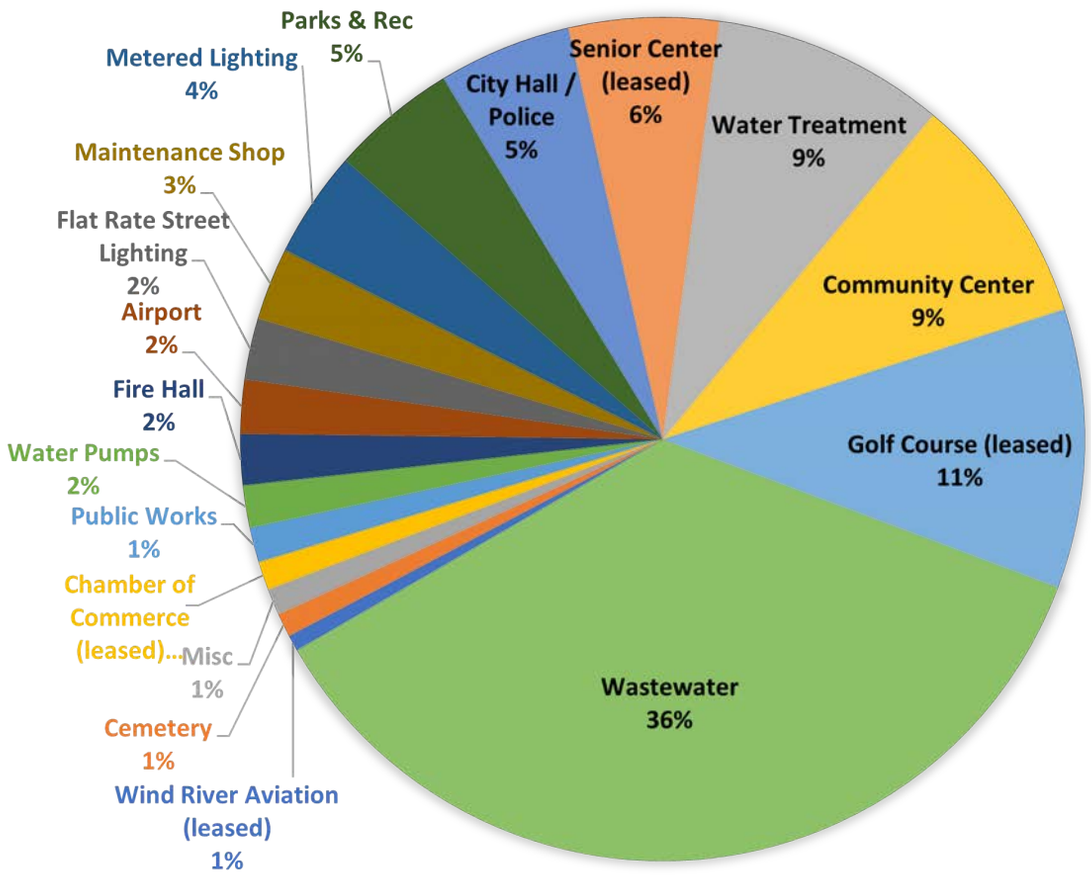



*Figure 12: The City of Lander's electricity use by department and its leased properties*

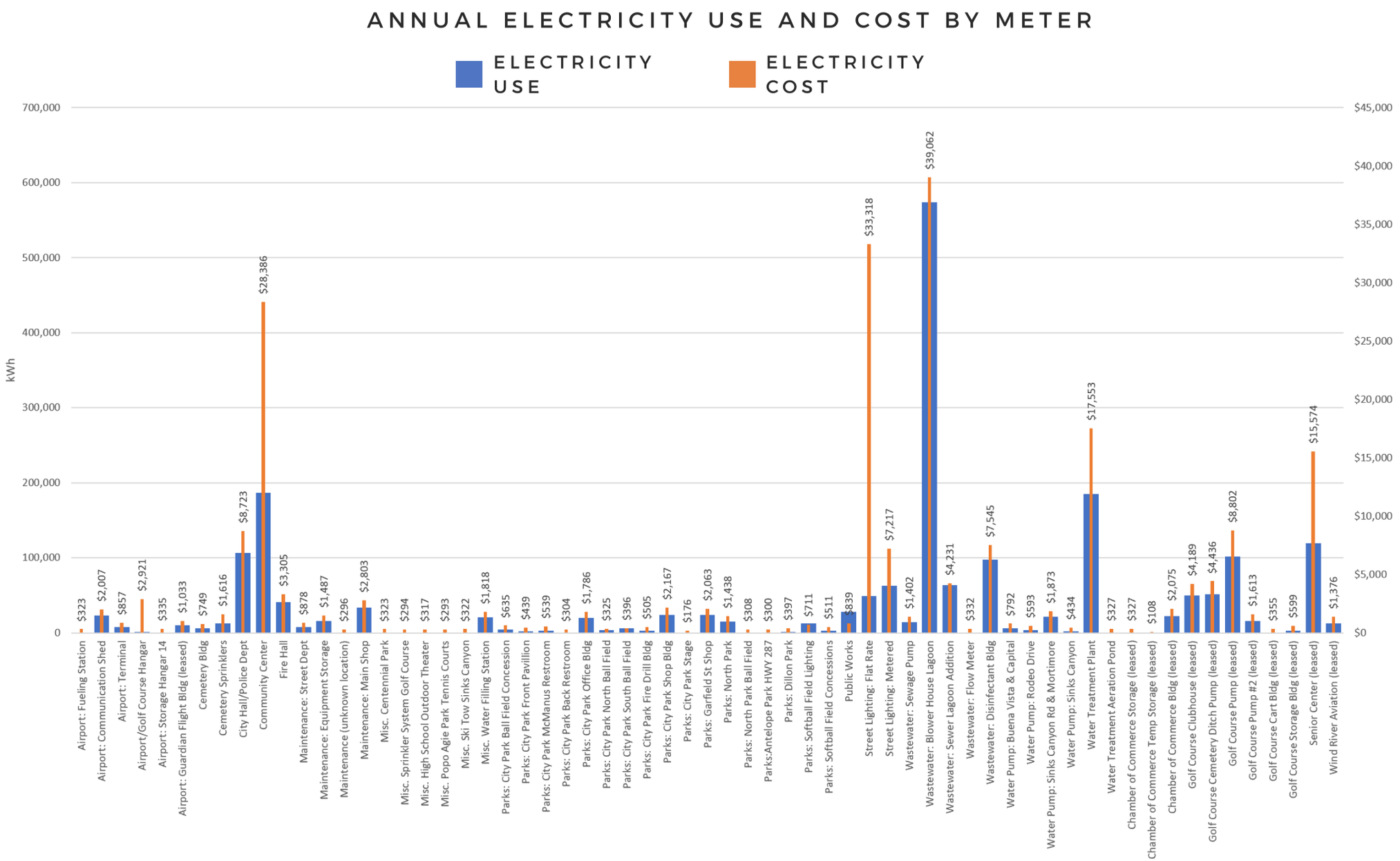



*Figure 13: The City of Lander's electricity use by meter – including its leased properties. Meters with large disparities between electricity use and cost are billed demand charges, except for flat rate street lighting which has its own billing structure.*

- The Wastewater Treatment Plant's blower house meter, which contains the air compressors that power the aerators for the sewage lagoons, is the largest consumer of electricity for the city. **This one meter cost $39,062 in 2021** – that's 21 percent of the city's total annual electricity costs. Variable frequency drive pumps that maximize efficiency have already been installed.

- Flat rate street lighting (RMP-owned) is charged at a substantially higher rate than metered lighting (city-owned). The ratio of cost to electricity use is over **six times higher**.

## CITY-PAID ELECTRICITY BILLS

(NO LEASED PROPERTIES)

| Department | Cost | % of total | Electricity Use (kWh) | % of total | Cost/kWh |
|---|---|---|---|---|---|
| Wastewater | $ 52,572 | 28% | 750,413 | 44% | $ 0.07 |
| Flat Rate Street Lighting | $ 33,318 | 18% | 49,273 | 3% | $ 0.68 |
| Community Center | $ 28,386 | 15% | 186,640 | 11% | $ 0.15 |
| Water Treatment | $ 17,880 | 10% | 186,054 | 11% | $ 0.10 |
| Parks & Rec | $ 11,569 | 6% | 100,866 | 6% | $ 0.11 |
| City Hall/Police | $ 8,723 | 5% | 106,240 | 6% | $ 0.08 |
| Metered Lighting | $ 8,649 | 5% | 85,407 | 5% | $ 0.10 |
| Airport | $ 7,476 | 4% | 43,065 | 3% | $ 0.17 |
| Maintenance Shop | $ 5,464 | 3% | 57,781 | 3% | $ 0.09 |
| Water Pumps | $ 3,692 | 2% | 33,764 | 2% | $ 0.11 |
| Misc | $ 3,367 | 2% | 21,215 | 1% | $ 0.16 |
| Fire Hall | $ 3,305 | 2% | 40,713 | 2% | $ 0.08 |
| Cemetery | $ 2,365 | 1% | 18,927 | 1% | $ 0.12 |
| Public Works | $ 839 | 0% | 28,010 | 2% | $ 0.03 |
| Totals | $187,605 | 100% | 1,708,368 | 100% | |

*Figure 14: The City of Lander's electricity cost and use by department – shown as totals, percentage and cost/kWh.*

- The Water Treatment Plant and the City Hall /Police Department building are some of the next largest city-operated electricity users. An energy audit was conducted for these two facilities in the summer of 2022. See RaJean Strube-Fossen at the City for a copy of the audit report.

- The Community Center, another large electricity consumer, was determined by the E&E Task Force to use energy relatively efficiently but correctly sizing the commercial kitchen appliance needs would reduce energy use.

- The Airport/Golf Course Hangar's cost is substantially higher than its use because the location is charged at a residential rate. The hangar is currently equipped with a small living quarters.

- The Golf Course (a leased facility) uses variable frequency drive pumps; however, efficient use of these pumps and sealing leaking water pipes would greatly reduce the electricity use.

- The **Senior Center's solar array came online in 2022** and therefore will not reflect on this 2021 data. The system was sized at 24.7kW and will supply about 31% of the Senior Center's power needs.

- **The city has been paying for Guardian Flight's electricity**, which is not part of their lease agreement. This topic should be discussed with the tenants. Their electricity usage in 2021 equaled **9,985 kWh and cost $1,033**.

- **Two meters have consumed no electricity for the past two years but are still charged connection fees**. These meters were "873 Sweetwater" (the tennis courts behind the swimming pool) and "250 Tiger Drive" (the outdoor theater at the high school). **Each meter costs about $300/year in fees**. City officials are now aware of this and are researching whether the city is bound by contracts with the school district for operating these meters.

- **One meter was not able to be located**, "1390 Buena Vista Dr BBQ Hut". All other meters with this address are located by the Maintenance Shops; however, no city staff knows where the meter is located or what it services. Rocky Mountain Power's GPS coordinates are not exact but show the meter in the general Maintenance Shop and airport area. This meter's 2021 power **consumption was 39 kWh, which cost $296**.

- Six city-operated facilities and one leased property are **billed demand charges**. RMP defines a demand charge as, "The average kilowatts (kW) supplied during the 15-minute period of maximum use during the month as determined by a Demand meter" (Rocky Mountain Power WY Price Information, 2020). Using the example image below from the Community Center bill, we can determine that during some 15-minute time period that month, the Community Center demanded 103 kW of power. The utility charges $16.92 per kW in order to meet this extra demand on the grid. **That one-time peak of 103 kW cost the city an extra $1,743 for the month.**
    - Meters with demand charges: Community Center, Water Treatment, City Hall / Police Department, Wastewater Disinfectant Building, Wastewater Blower House, Wastewater Sewage Lagoon Addition, Senior Center (leased)

## EXAMPLE OF DEMAND BILLING

**Detailed Account Activity**

***ITEM 101 - ELECTRIC SERVICE*** 950 Buena Vista Dr Lander WY
Community Center Building Permanent General Service Schedule 28

| METER NUMBER | SERVICE PERIOD From | To | ELAPSED DAYS | METER READINGS Previous | Current | METER MULTIPLIER | AMOUNT USED THIS MONTH |
|---|---|---|---|---|---|---|---|
| 59815053 | Sep 3, 2021 | Oct 5, 2021 | 32 | 16172 | 16421 | 80.0 | 19,920 kwh |
| 59815053 | Demand | Oct 5, 2021 | | | 1.288 | 80.0 | 103 kw |
| 59815053 | Reactive | Oct 5, 2021 | | | 0.472 | 80.0 | 38 kvar |

Next scheduled read date: 11-03. Date may vary due to scheduling or weather.

| ***NEW CHARGES - 10/21*** | UNITS | COST PER UNIT | CHARGE |
|---|---|---|---|
| Basic Charge, 3P, Sec Delivery | | | 32.30 |
| Demand Use Details | 103 kw | | |
| Demand Charge - Secondary | | 16.9200000 | 1,742.76 |
| Net Power Cost Demand - Sec | | 1.8000000 | 185.40 |
| Energy Charge - Secondary | 19,920 kwh | 0.0152100 | 302.98 |
| Net Power Cost Energy - Sec | 19,920 kwh | 0.0164400 | 327.48 |
| Renewable Rev Adj Demand - Sec | 103 kw | -0.0500000 | -5.15 |
| Renewable Rev Adj Energy - Sec | 19,920 kwh | -0.0000500 | -1.00 |
| Customer Efficiency Services | | 0.0167000 | 43.17 |
| Tax And Jobs Act Adjustment | 19,920 kwh | -0.0040700 | -81.07 |
| **Total New Charges** | | | **2,546.87** |

*Figure 15: Screenshot from the City of Lander's electric bill highlighting the Community Center's demand charges.*

*Hyperlinks:*
*https://www.youtube.com/watch?v=4eQ5UiMxiCk&t=115s*

- The Water Treatment Plant's main meter is the largest natural gas consumer. **This one meter cost $20,620 in 2021** – that's almost 35 percent of the city's total natural gas bill.

- Many city facilities, such as the Water Treatment Plant; the Community Center; the Maintenance Shop; and the Fire Hall, are large open concept buildings. These require a lot of energy to heat the space and partly why they are within the top five largest natural gas consumers.

- **The city has been paying for Guardian Flight's natural gas**, which is not part of their lease agreement. This topic should be discussed with the tenants. Their natural gas usage in 2021 equaled **544 therms and cost $661.59**.

## NATURAL GAS USE BY DEPARTMENT

(THERMS)

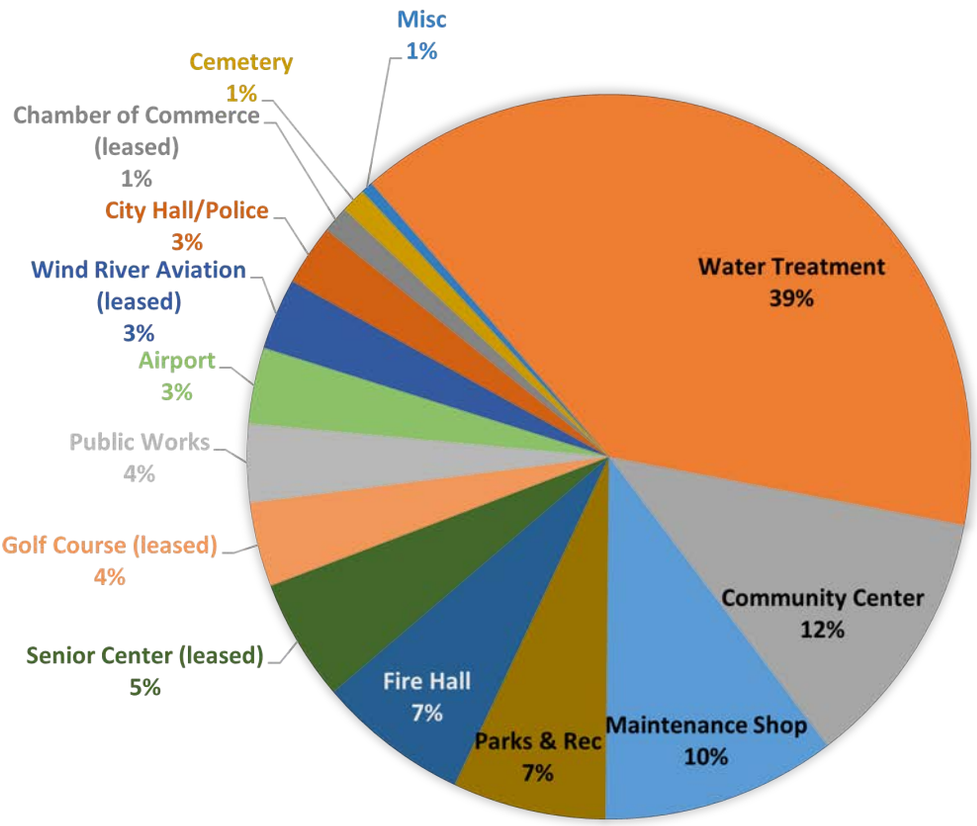



*Figure 16: The City of Lander's natural gas use by department and its leased properties*

## CITY-PAID NATURAL GAS BILLS

(NO LEASED PROPERTIES)

| Department | Cost | % of total | Natural Gas Use (therms) | % of total | Cost/therm |
|---|---|---|---|---|---|
| Water Treatment | $23,162 | 39% | 44,611 | 46% | $0.52 |
| Community Center | $7,797 | 13% | 13,187 | 13% | $0.59 |
| Maintenance Shop | $7,652 | 13% | 11,844 | 12% | $0.65 |
| Parks & Rec | $6,197 | 10% | 7,753 | 8% | $0.80 |
| Fire Hall | $4,894 | 8% | 7,651 | 8% | $0.64 |
| Airport | $3,243 | 5% | 3,838 | 4% | $0.84 |
| Public Works | $2,630 | 4% | 3,964 | 4% | $0.66 |
| City Hall/Police Dept. | $2,098 | 4% | 3,077 | 3% | $0.68 |
| Cemetery | $1,072 | 2% | 1,265 | 1% | $0.85 |
| Misc | $1,048 | 2% | 602 | 1% | $1.74 |
| Totals | $59,791 | 100% | 97,792 | 100% | |

*Figure 17: The City of Lander's natural gas cost and use by department – shown as totals, percentage and cost/therm.*

# ENERGY EFFICIENCY OPPORTUNITIES

## ENERGY AUDITS

The Wyoming Energy Authority (WEA) provides municipalities with up to three energy audits per year free of charge to identify energy efficiency opportunities. First time applicants are prioritized for this program; however, so far, all of the city's audit requests have been funded. There is also a $25,000 WEA grant available for facilities that undergo a WEA audit. Even if the city is not chosen for the WEA program, grants for energy audits are abundant and should be strongly considered. The city's strategy should prioritize auditing facilities with shorter payback periods – often buildings that are highly used, older, and have not undergone recent renovations.

During 2022, the city received funding from the WEA to energy audit the Water Treatment Plant and City Hall/Police Department. Below is an image taken from the energy audit of the Water Treatment Plant performed by Home Energy Assessment of Lander LLC (HEAL). Either recommended energy efficiency measure would save an estimated $11,980 per year with relatively small renovations required — mostly caustic freeze protection and turning down the heat. Even the scenario with the longer payback period, would save the city about $61,815 in the first ten years.

TOOL

After tours of all city facilities between March and June of 2022, the E&E Task Force created a prioritized list of actionable items that the city can take to achieve further cost savings. Some actions, such as installing weatherstripping and turning down the heat, require little to no funding — only staff time and coordination. For the larger items, such as installing variable frequency drive motors or insulating large spaces, there are federal, state, and private funding sources that can subsidize the costs.

| Energy Efficiency Measure | Capital Cost [$] | Estimated Annual Savings [$] | Estimated Payback [years] | Estimated Annual Gas Savings [therms] |
|---|---|---|---|---|
| Install separation wall, heat trace and insulate caustic lines, lower unoccupied zone temperatures to 50 degrees Fahrenheit | $58,000 | $11,980 | 4.84 | 22,315 |
| Install separation wall, switch to a 30/70 caustic mix, insulate pipes, lower unoccupied zone temperatures to 50 degrees Fahrenheit | $35,000 | $11,980 | 2.92 | 22,315 |

*Figure 18: Screenshot of recommendations from the Water Treatment Plant's energy audit (HEAL, 2022)*

RECOMMENDATIONS

Continue with facility energy audits in this order based on the observed potential for energy efficiency gains and the amount of energy currently used. If using WEA funds, all buildings located on the same campus can collectively count towards one of the three available audits.

1. Public Works building
2. Fire Hall
3. Maintenance shops
4. Lander Community & Convention Center
5. Senior Citizens Center (leased)
6. Parks & Recreation/Weed & Pest shop
7. Wind River Aviation (leased)
8. City Park office, shop, and fire drill building
9. Airport terminal, Guardian Flight building (leased), Hangar 14, Airport/Golf Course Hangar
10. Golf Course (leased)
11. Wastewater Treatment building

*Hyperlinks:*
*https://docs.google.com/spreadsheets/d/17MfS-nZsZRRUkE98uGf-eQfOpiA-YOoJ_jteMgYl1FM/edit#gid=0*

## DEMAND FLEXIBILITY

Demand flexibility is the concept that certain activities can be scheduled so that they fall within a period of high renewable energy production or low cost. The strategy differs depending on whether solar and battery systems are implemented and if demand charges are billed.

**No solar. No demand billing.** These facilities tend to not catch the utility's attention with their low electricity use and fairly stable electricity demand. Currently, no city meters are charged time-of-use billing so the time of day that electrical loads happen does not have financial implications.

**No solar. Yes, demand billing.** In this scenario, it is best to spread out high electricity loads. When high amounts of electricity are demanded from the grid all at once, it costs the utility money to fire up more power generating capacity to meet that surge – a cost they pass along to the customer.

**Yes solar. Yes or No demand billing.** Whether or not demand billing is used, solar can help reduce electric bills if the electrical loads are concentrated under the bell curve of solar production. The savings can be more pronounced if the facility is under demand billing.

**Yes solar & storage. Yes or No demand billing.** The second graph below shows solar electricity production, battery storage, and activity timing working together. During the daylight hours, activities such as operating the dishwasher, drying laundry, and charging an electric vehicle can all be done while solar capacity is at its fullest. The battery would also be charging throughout the day during periods that power was not actively being used to run appliances. This stored energy can be used later to power some of the evening activities. By morning, the battery might be spent so the operator should only loads that cannot wait until the solar starts producing power. The electric bill under this well managed demand load system would be very small.

DEMAND FLEXIBILITY

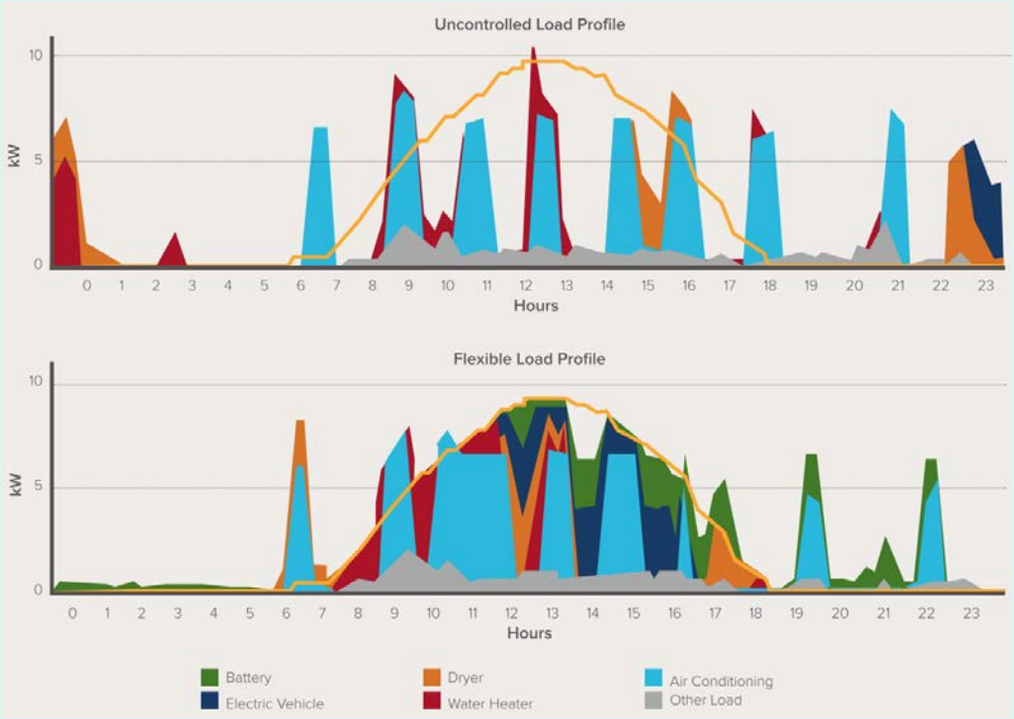



*Figure 19: The first graph shows solar working under uncoordinated electricity usage and without battery storage. The second graph coordinates electrical loads to take advantage of solar production and battery storage. (RMI's Economics of Electrifying Buildings Report, 2018)*

RECOMMENDATIONS

- Understand the energy usage of all appliances and either stagger their time use if solar is not used or take advantage of solar power and run appliances when power production is high.
- Use energy efficient appliances to reduce the amount of energy consumed during operation.
- Know when electricity usage is highest – this might require additional energy monitoring for the building.

## BUILDING ELECTRIFICATION

Right now in our country, there is an effort to electrify both vehicles and buildings. One rationale for this change is that, if we are going to address climate change with the urgency it requires, we need to transition away from GHG-emitting fuels like natural gas and towards electricity where it is easier to source low to no GHG-emitting energy. In this transition to building electrification, technologies like air-source heat pumps (see appendix) are planned to take the place of natural gas furnaces, heat pump water heaters (see appendix) in place of natural gas water heaters, and induction cooktops in place of natural gas ranges. A side benefit to using these technologies is that indoor air quality improves since no fuels combust inside the building.

Electrified buildings should also save money on energy bills. Given how electricity costs are predicted to decrease over the next few decades (reference Introduction) and with electric technologies, like those mentioned above, being more energy efficient than combustion-fueled technology, we would expect to see cost savings from electrified buildings.

### TOOL

This calculator can be used to compare natural gas furnaces and air-source heat pumps based on a building's footprint, the model of heat pump, local climate, and energy costs. In an example calculation by the E&E Task Force, the operational costs of a natural gas furnace and an air-source heat pump for a 2,000 square foot space in Lander are almost identical.

### COMMUNITY SPOTLIGHT

Some towns, such as Crested Butte, Colorado (population 1,639; elevation 8,909 ft), have mandated that all new constructions or major retrofits within the town be completely electric, with only a few exceptions. City council voted unanimously in support of this measure and cited the cleaner energy sources available through using electricity (especially if on-site renewables are used), the affordability for the bill payers, and the well-equipped technology to make it happen.

### RECOMMENDATIONS

The E&E Task Force recommends that all old furnaces, air conditioning units, and water heaters be replaced with Energy Star rated heat pump technology. New buildings should incorporate these units from the start to save on natural gas service fees to undeveloped land.

*Hyperlinks:*
*https://www.pickhvac.com/calculator/heating-annual-cost/*
*https://crestedbuttenews.com/2022/08/cb-council-all-in-on-electrification-starting-in-january-2023/*

*Photo courtesy of Ken Colovich*

# RENEWABLE ENERGY OPPORTUNITIES

## NET METERING 25 KW LIMIT

There are scenarios where having a renewable energy system sized over 25 kW might interest both the city and RMP. For example, the city might want to install back-up power for essential services in the event of a grid outage. A large solar array paired with battery back-up or a micro-grid could be a good fit for essential service facilities such as the Water Treatment Plant or the Community Center (a designated emergency shelter). Depending on RMP's grid resilience plans for our region, they might be willing to waive the 25 kW system limitation and, if they can use some of the stored energy, might even contribute financially to the project.

The E&E Task Force identified one potential micro-grid location which includes the Community Center, Sage West Hospital, and Hunt Field Airport. Since this theoretical micro-grid encompasses three separate entities in a small area that each provide essential services during a disaster, the task force feels this idea should be pursued further.

### COMMUNITY SPOTLIGHT

The Town of Jackson (TOJ), WY recently negotiated with their electric coop a 583 kW solar array that would power their city hall, wastewater plant, and water treatment plant as well as the Teton County Courthouse. In exchange for a larger system size, TOJ agreed to a reduced net metering compensation on their bills for any extra electricity put onto the grid. Since TOJ had outside funding for the capital investment of the solar array, the lower compensation from the co-op did not impair the overall return on investment.

### ADDITIONAL RESOURCES

Snohomish PUD micro-grid

## MICRO-HYDRO

Micro-hydro systems operate by running flowing water through a turbine, either in a waterway or water pipe, to produce electricity. A few factors influence the viability of this technology including how much water flows through a location, the pressure of the water, the consistency of water flow throughout a day or year, and the amount of sediment and other debris in the water source. Many micro-hydro companies help secure funding for their projects.

**Community Center – 8 kW**

An estimated 8 kW in-pipe micro-hydro could be installed at the Dillon pressure reducing valve (PRV) on Flat Ditch between the Community Center and the SageWest Hospital. Micro-hydro at this location would need to be assessed alongside other energy options to see what is most cost effective and best serves the needs of the Community Center.

**Water Treatment Plant – 48 kW**

An estimated 48 kW in-pipe micro-hydro could be considered at the Water Treatment Plant. However, there is currently too much sediment in the water for a turbine. Installing a sediment filter would reduce the pressure too drastically and the city does not have the land area to create a settling pond. If the intake were before Sawmill Creek, this issue might be alleviated and a turbine could be installed. The city should determine if switching the intake back up to before Sawmill Creek would be worth the cost savings from the micro-hydro power production.

*Hyperlinks:*
*https://www.youtube.com/watch?v=5uSOp9tvVrA*
*https://www.snopud.com/community-environment/our-energy-future/projects/arlington-microgrid-project/*

## SOLAR ELECTRIC

Solar electric, more commonly referred to simply as solar, is often a cost-effective technology that has been on the market for decades (see appendix for optimization and maintenance of solar systems). One major benefit to solar is that it can be installed just about anywhere using either a rooftop or a ground mount.

The addition of battery storage can help avoid demand charges and extend the use of solar-generated power into the nighttime hours. Batteries can also serve a vital role in providing emergency back-up power to keep essential tasks running while the electric grid is down. Communities are becoming increasingly aware of the latter use due to natural disaster risks posed by climate change. When the power goes out due to a flood, fire, heat wave, or extreme cold, having battery back-ups or micro-grids paired with renewable energy can keep drinking water clean, emergency shelters powered, and critical operations running.

Based on a recent quote from a local solar installer using 2021 electricity use data, a 24 kW solar array on the Community Center, which would cover about 20 percent of the total electricity needs, comes out to about $64,150. Without any financial incentives, the payback period for this system would take 24 years. If the city took advantage of the 30 percent federal investment tax credit, this would lower the payback to 17 years. If the city received funding from Rocky Mountain Power's BlueSky program, which typically covers 80 percent of the project cost, the payback period would be as little as 5 years. These systems can be paired with EV chargers for either public or private use and/or battery storage.

*Photo courtesy of Creative Energies LLC*

### COMMUNITY SPOTLIGHT

The City of Lander invested $96,381 in a 24.7 kW system at their Lander Senior Center building in 2022 which will supply about 31% of the Senior Center's power needs. Two EV chargers were also installed on-site – one for public use and the other for Lander Senior Center shuttles. A Rocky Mountain Power BlueSky grant paid $73,451 for 80 percent of the system cost which left $22,930 to be shared by the LOR Foundation, the Lander Senior Center Foundation, and the Lander Senior Center Endowment. If the Senior Center operates most of its electrical loads during peak solar power production, the demand charges will be substantially less for the center.

### RECOMMENDATIONS

During the E&E Task Force's city tour, several facilities appeared ideal for solar installations due to the characteristics of the facility and whether they were billed using demand charges. The appendix provides further detail on these locations. Official estimates from a solar installation provider should be acquired to determine the capital expenditure, energy production, and cost savings.

*Hyperlinks:*
*https://www.energy.gov/eere/solar/solar-photovoltaic-technology-basics*

## GROUND-SOURCE HEAT PUMPS

Ground-source heat pumps (also called geothermal heat pumps) are a technology that can be used for both space and water heating (see appendix for technical detail). They are extremely efficient with a well-insulated system providing 3-4.5 times the electrical energy it consumes compared to the 1-to-1 ratio of the best combustion-fueled furnaces. While installation prices can range from $10,000-$30,000, the U.S. DOE estimates that these costs can be recouped in as little as 5-10 years, depending on the local cost of energy. The interior components have a lifespan of about 24 years while the ground loop components should last 50+ years.

### COMMUNITY SPOTLIGHT

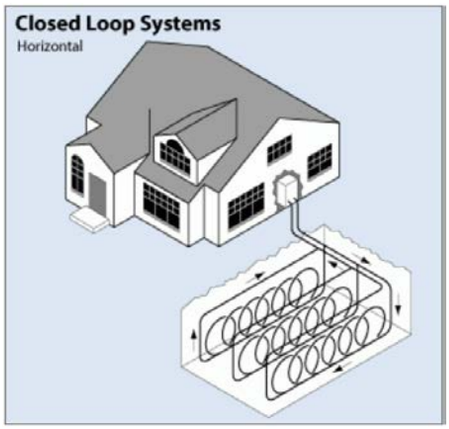
There are at least three commercial-sized geothermal heat pumps already installed in the Lander area —the Fremont County Library, NOLS Rocky Mountain, and the NOLS Wyss Wilderness Medicine campus in Red Canyon. Both NOLS campuses opted for a vertical closed loop system (as shown to the right) with well depths reaching down to 250–260 feet. Some of the pros and cons of these systems include:

**PROS**

- Minimal energy is consumed to heat or cool the building since the refrigerant solution enters the facility at around 52 degrees.
- Results in lower energy bills.
- Local HVAC providers can provide maintenance on the system.
- Operates day and night, rain or shine.

**CONS**

- A high water table at NOLS Rocky Mountain causes freezing around the ground entry pipes during sub-zero temperatures.
- The system at the NOLS Wyss campus requires specialty parts that are only made by one manufacturer.
- Contractors need to be knowledgeable about the building's substrate since this will influence drilling costs.



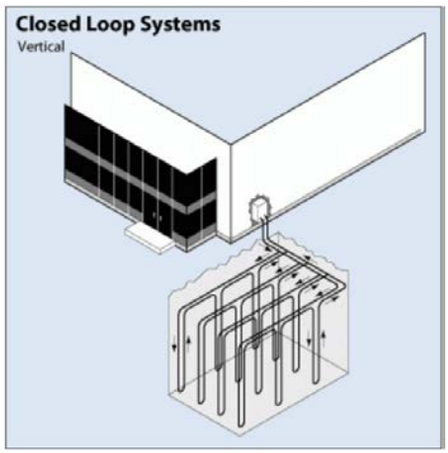




*Figure 20: Diagrams of the two types of ground-source heat pumps – vertical and horizontal. (U.S. DOE)*

### RECOMMENDATIONS

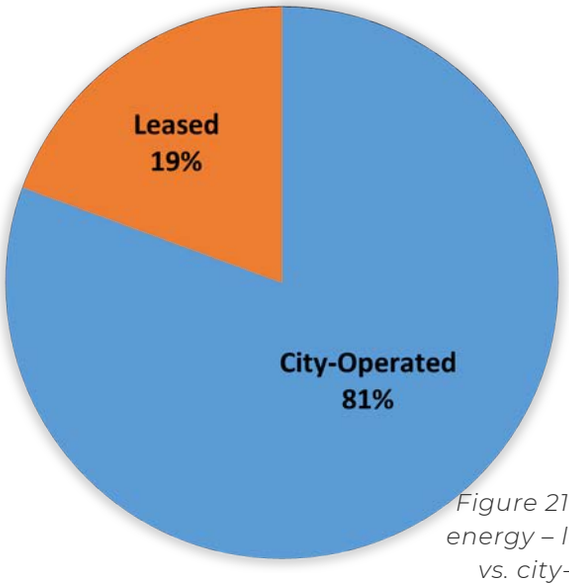
Consider a ground-source heat pump at the Community Center due to the ample land availability to dig trenches, the long-term cost savings, and the capacity of the system to heat large buildings.

*Hyperlinks:*
*https://www.energy.gov/energysaver/geothermal-heat-pumps*
*https://www.energysage.com/clean-heating-cooling/geothermal-heat-pumps/costs-benefits-geothermal-heat-pumps/*

# LEASED FACILITIES OPPORTUNITIES

There are currently five city-owned facilities that are being leased to the following entities: the Golf Course, the Senior Center, the Chamber of Commerce, Wind River Aviation, and Guardian Flight. The graphs below demonstrate that the energy consumed by these leased facilities is not insignificant; however, the tenants have no incentive to make improvements.

ELECTRICITY USE
LEASED VS. CITY-OPERATED FACILITIES




NATURAL GAS USE
LEASED VS. CITY-OPERATED FACILITIES

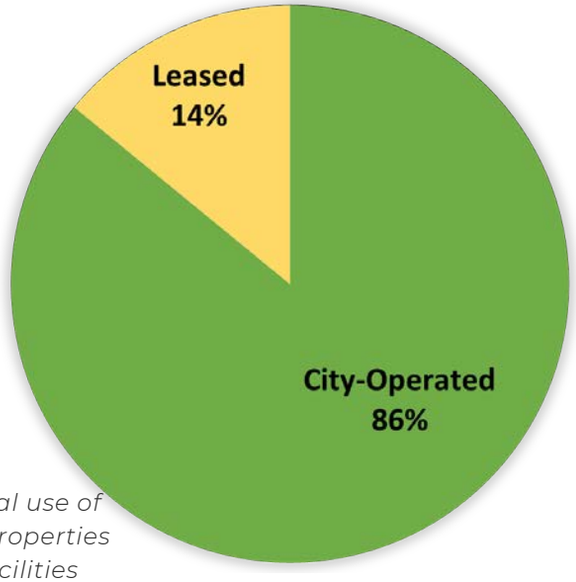



*Figure 21: Proportional use of energy – leased city properties vs. city-operated facilities*

## COMMUNITY SPOTLIGHT

In 2020 and 2021, the city upgraded the furnace and AC units to more energy efficient models at the city-owned Lander Senior Center building. The 98 percent efficient furnace (compared to 85 percent) saved about $1,400/year in natural gas costs. Two separate Wyoming Energy Authority Grants helped pay for the AC units. The combined $50,000 grant covered all but $12,750 of the costs. These AC units come with a Seasonal Energy Efficiency Ratio (SEER) ranking of 15 on a scale of 10 to 23. Within the last nine months, these more efficient AC units have already saved the Senior Center $1.100 and the tenants report increased comfort within the building. This is a great example of how the city can make valuable upgrades to its facilities, reduce operating costs for tenants, and reducing GHG emissions. All payments came out of the senior center endowment.

## RECOMMENDATIONS

As the landlord of these facilities, the city holds a unique opportunity to incentivize change. The city could start by offering energy audits for these buildings and acquiring grants and/or establishing payment terms with the tenants for energy efficiency improvements. The tenants would benefit from lower utility bills while the city increases the value of their assets. Other terms that could be negotiated in a lease include: renewable distributed energy, water conservation measures, recycling, non-toxic cleaning, and electrification of appliances.

# BUILDING CONSTRUCTION OPPORTUNITIES

## BUILDING CODES

Wyoming is a "home rule" state which means that it is up to municipalities to adopt their own building codes. The City of Lander has adopted two sets of codes from the International Code Council (ICC) — the 2018 International Residential Code (IRC) and the 2021 International Building Code (IBC). The ICC is a very common source of codes for municipalities and they provide several additional codes beyond base IRC and IBC.

COMMUNITY SPOTLIGHT

Laramie and Jackson both adopted the ICC's International Energy Conservation Code which ensures that all buildings are constructed to a minimum level of energy efficiency.

ADDITIONAL RESOURCES

The New Buildings Institute provides building code adaptations to achieve zero emissions and decarbonization

RECOMMENDATIONS

The city should ask the cities of Laramie and Jackson for their feedback on the energy conservation codes.

## NEW CONSTRUCTION

There are many programs in the U.S. that focus on creating high-performance and energy-efficient building designs including: the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED), the U.S. EPA and U.S. DOE's Energy Star Program, and the Passive House Institute. If the city did not wish to go through the certification process for some of these programs, the concepts are well known and can be applied to any facility. A few examples include: incorporating natural light, tightly sealing and insulating interiors, installing energy- and water-efficient appliances, and minimizing water- and fertilizer-heavy landscaping in favor or native plants and shade trees.

COMMUNITY SPOTLIGHT

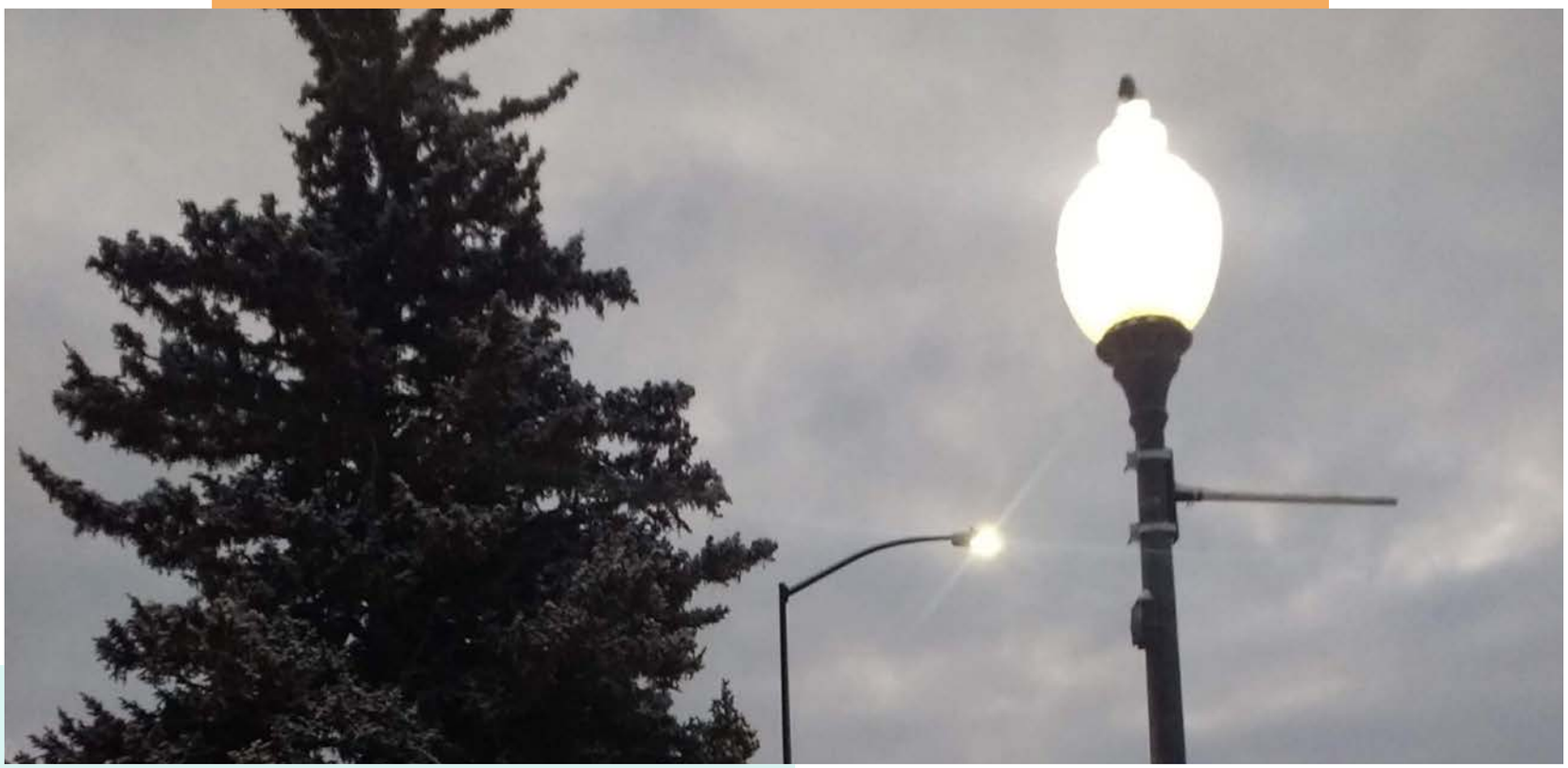
To learn more about these concepts, the city could turn to the University of Wyoming College of Engineering and Applied Science's Solar Decathlon team. This year's team is competing on the national stage with its zero-energy building design and construction located in Red Canyon just outside of Lander. The NOLS Wyss Wilderness Medicine campus is another good resource as they achieved LEED platinum for their facility in 2013. Ron McCall, the head of facilities, would be able to point to the pros and cons of certain systems.

## INCENTIVES & EDUCATION

The city can propel these concepts into action through incentives and education. Some of the more recognized incentives include: expedited permitting, density and height bonuses, fee waivers, and additional marketing for contractors. To educate the local workforce on high-performance building practices and any adopted incentive programs, the city should work in collaboration with non-profit and private leaders to provide technical training. Making high-performance building a positive and rewarding field for contractors, architects, HVAC technicians, and building owners could become a vital role in the city's building department.

*Hyperlinks:*
*https://energyefficientcodes.org/iecc/;*
*https://newbuildings.org/hubs/codes-policy/#tools-guides;*
*https://www.usgbc.org/credits;*
*https://www.energystar.gov/buildings/building_recognition/building_certification;*
*https://passivehouse.com/02_informations/01_whatisapassivehouse/01_whatisapassivehouse.htm;*
*https://county10.com/uw-students-compete-in-solar-decathlon-for-next-generation-clean-energy-buildings-near-lander/;*
*https://www.outsidebusinessjournal.com/press-releases/nols-wyss-wilderness-medicine-campus-earns-leed-platinum-certification/;*
*https://www.usgbc.org/articles/good-know-green-building-incentive-strategies-0*

# STREET & BALLFIELD LIGHTS



## STREET & BALLFIELD LIGHTS EMISSIONS

GHG EMISSIONS BY SECTOR

(MT CO2E)

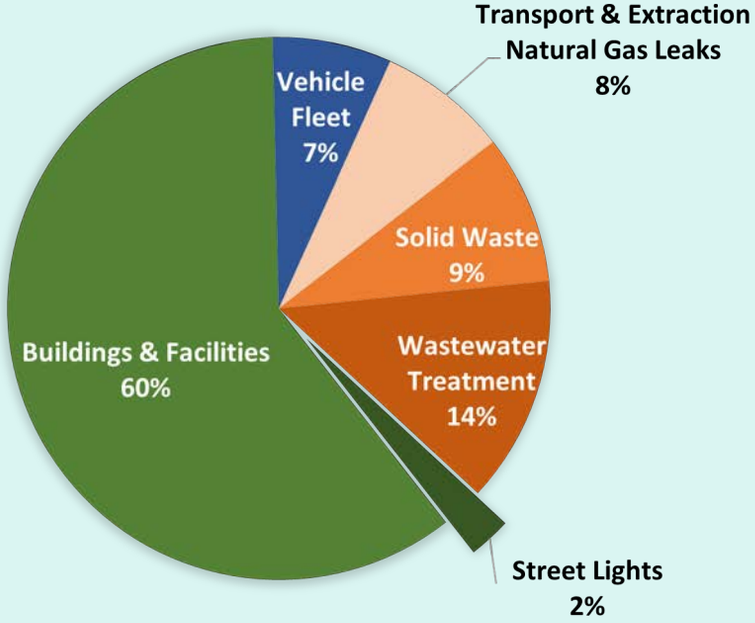



*Figure 22: "Street Lights" greenhouse gas sector.*

Street and ballfield lighting is a smaller portion of the city's emissions at 81 MT CO2e. Rocky Mountain Power's electrical grid powers these lights and therefore they have the same energy fuel mix. Outdoor lighting is unique from buildings and facilities in that there is really only one way to reduce emissions – by swapping the lamp out for a more efficient model, preferably LED.

## STREET & BALLFIELD LIGHTS INSIGHTS

Street lights comprise six percent of the city's overall electricity use. Four out of that six percent are metered lights, which are under the city's purview, while the other two percent are under a flat rate schedule and the responsibility of RMP. Flat rate scheduled lighting is over six times more expensive, costing a total of $33,318 in 2021 for 49,273 kWh compared to $8,649 for 85,407 kWh for metered lighting.

This price difference is possibly due to the maintenance service performed by RMP on their lights. The determination of whether a street light is metered or flat rate appears random and was likely established when new sections of lighting were needed. If the city wanted to take ownership of all the lighting, that would need to be a conversation between RMP and city staff. Below is a list of the various RMP light billing schedules that the city is assigned.

*Flat rate scheduled lighting is over six times more expensive than metered lighting.*

Metered light billing schedules

- Schedule 25 Small General Service - The city can request changes to these lights.
- Schedule 54 Metered Outdoor Lighting - Same as above.
- Schedule 58 Street Lighting Service Customer-Owned System - The city can have new lights installed by qualified personnel and will thereafter become responsible for their maintenance. When lights become inoperable, the city may request RMP to change them. The city will be billed for the new lights and labor.

Flat rate light billing schedules

- Schedule 15 Outdoor Area Lighting Service - When lights become inoperable, the city may request RMP to change them. RMP will install lighting from their approved list. This comes at cost to the customer.
- Schedule 51 Street Lighting Service Company-Owned System - same as above.

## STREET & BALLFIELD LIGHTS OPPORTUNITIES

### COMMUNITY SPOTLIGHT

The City of Lander switched city-owned street lights on Main Street under the Schedule 58 to LED in 2017. This cost the city $28,000 of which a Wyoming Energy Authority Grant paid $25,000 (~90%}. Cost savings from energy reduction in the first full year of operation after the LED bulbs were installed was $2,582.

During the fall of 2021, LCAN hosted a streetlight audit event where citizens walked the streets of Lander to record non-functioning lights. The group identified 43 lights with issues around town: 24 bulbs that were completely out and another 19 that were dim. These lamps were reported to RMP with the request that they be replaced with LEDs. Most of these lights were under Schedule 51 so RMP sent a bill of $6,800 to the city for replacing the lights. Now Lander's streets will be safer for pedestrians and using energy efficient technology.


### RECOMMENDATIONS

- Inquire with RMP why the flat rate lighting schedules are so much more expensive than metered lighting.
- Consider switching all street lighting to metered schedules to take advantage of lower rates and the opportunity to switch all lamps to LED, or a comparable lamp.
- Continue periodic street light audits and request inoperable lights be replaced with LED technology.

*Hyperlinks:*
*https://www.rockymountainpower.net/about/rates-regulation/wyoming-rates-tariffs.html*

# WASTEWATER

*Photo courtesy of Brian Linton*

## WASTEWATER EMISSIONS

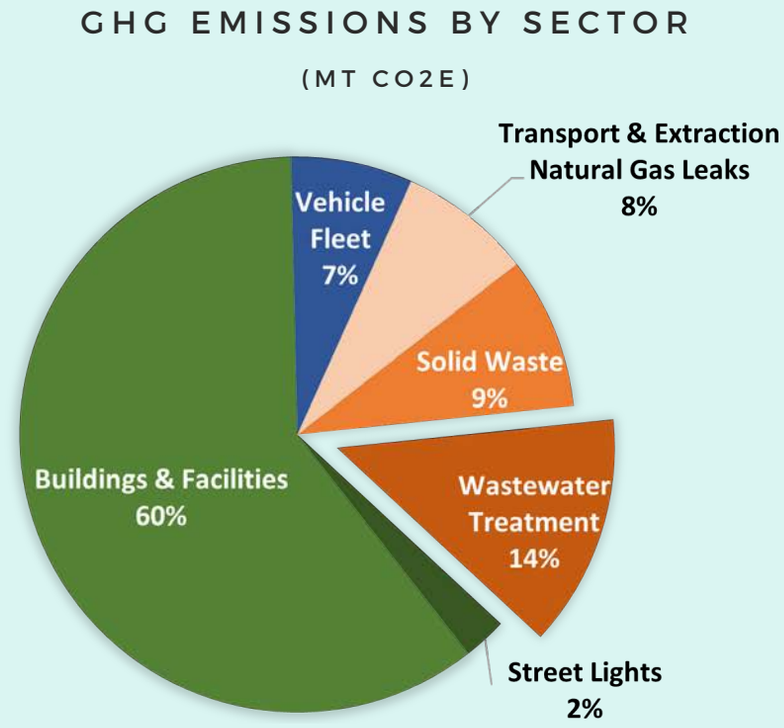



*Figure 23: "Wastewater Treatment" greenhouse gas sector.*

Wastewater Treatment is the second largest slice of the emissions pie at 434 MT CO2e. Here we are accounting for the emissions that are emitted from the sewage lagoons during the decomposition of biosolids and not the electricity used to run the facility – this would be in the Buildings & Facilities section. Methane emissions are calculated by the difference in biochemically dissolved oxygen (BOD) from the influent source at the input lagoon to the effluent source at the discharge. That difference in BOD signals the activity of the microorganisms that decompose the solids. For each kilogram (kg) of BOD removed, the microorganisms release 0.6 kg of methane as a waste byproduct. Low discharge BOD levels are important for stream health so methane reduction should not be achieved by keeping BOD levels high. The incorporation of aerators has helped reduce BOD levels and reduce the odor of the lagoons.

*Hyperlinks:*
*https://deq.mt.gov/files/Water/TFAB/Documents/SOPs/20201023Basic%20Lagoon%20Manual_Edited.pdf*

# WASTEWATER INSIGHTS

The city's current wastewater treatment method is an aerated lagoon system. This system operates by letting biosolids settle in one input lagoon, after which it is filtered through a series of open water lagoons. These lagoons are filled with imported specialized insects and bacteria that digest the organic matter and over 100 aerator machines that pump air into the anaerobic, meaning oxygen devoid, environment . After the water reaches the fifth lagoon in the series, it is tested for nutrient levels and released back into the Popo Agie River. If too much biosolid accumulates in the input lagoon, the city dredges the lagoon and local farmers can spread it on their hay fields. When applying biosolids on fields, extra treatment must occur so that pathogens are destroyed and vector attraction potential is reduced.

# WASTEWATER OPPORTUNITIES

## CRACKED PIPES

Under the streets of Lander is a network of sewage pipes carrying our biosolid waste to the lagoons. These sewage pipes are old and cracked. During highwater events, the water table rises and groundwater seeps into the cracks of the pipe. All of the extra water volume flows into the lagoons which can create the risk of breaching the dam and letting untreated water discharge into Little Dickinson Creek. Luckily, the lagoon system was overbuilt for the population size of Lander and can absorb some of this extra volume. The city is addressing this issue by relaying segments of sewage pipe each year.

## TRASH IN THE LAGOONS

Trash is also a big problem at the input lagoon. Everything from needles to clothing to prescription drugs to plastic wrappers are irresponsibly flushed down the drain and appear in the input lagoon. The city is aware of this problem and solutions are being approached through public education and the use of a trash screen. The trash screen is an expensive piece of equipment so, until that is installed, more can be done by Lander residents to ensure that their trash is disposed of properly.

## SEPTIC HAULER DUMPING

Lander's sewage lagoons service more than just the city boundary. Septic haulers that service the surrounding rural areas also dump their sewage into the lagoons. Depending on the day, sometimes multiple haulers from the same or different entities dump their biosolid waste into the input lagoon. If not properly managed, this situation creates the risk of tipping the scale of this usually ecologically balanced system. When there are too many biosolids in the system, there is less wastewater to allow the solids to settle. This reduces the retention time and could affect the nutrient levels of the water that exits the facility into the Popo Agie. The biosolid digesting insects cannot keep up with the increased volume, which results in more build-up over time. To alleviate this problem, the city is currently looking to upgrade their reporting system for sewage dumping making septic haulers more accountable to their dumping limits.

*Photo courtesy of Brian Linton*

*Hyperlinks:*
*https://www3.epa.gov/npdes/pubs/land_application.pdf*
*https://www.epa.gov/system/files/documents/2022-03/lagoon-complianceadvisory.pdf*

## THE FUTURE OF LANDER'S WASTEWATER MANAGEMENT

The city has started talking with surrounding communities, including Riverton; Hudson; and Arapahoe, to see about transitioning to a regional wastewater treatment facility. The facility would pipe in sewage from participating communities upstream to one central location in Riverton for treatment. Many small towns in the area struggle to financially support their own sewage treatment. This centralized approach would allow parties to pool resources and better comply with environmental regulations. The type of treatment facility has not been decided yet but the technologies recommended below should be considered.

### RECOMMENDATIONS

- If the city's plan is to keep the sewage lagoons for the foreseeable future, the city should look into methane capture and use (see table in the appendix). The captured methane becomes a valuable commodity that can be used to power facilities and vehicles or sold to natural gas companies.
- If the city is to invest in a new regional facility, anaerobic digesters or co-anaerobic digesters and hydrothermal carbonization should be strongly considered. These technologies capture and use methane while also creating valuable commodities byproducts (see appendix). They can also incorporate a broader diversity of inputs, such as organic waste and manure. The U.S. EPA is funding projects like these through FY2026 (see funding).

### COMMUNITY SPOTLIGHT

Phoenixville, Pennsylvania (population 16,961) broke ground on the nation's first hydrothermal carbonization (HTC) facility during the first quarter of 2022. The city chose to transition from an anaerobic digester to HTC as part of its commitment to 100 percent clean energy by 2035 in addition to the technology being faster, safer, and more efficient than anaerobic digestion. With HTC producing 153 percent of the wastewater treatment plant's energy demand, the facility becomes a 24/7 clean energy producer. HTC will also produce valuable commodities such as biocoal, construction sand, synthetic gas and improved fertilizers.

Learn more at:

- http://phoenixville.org/2538/PXVNEO---New-Energy-Optimization
- https://patch.com/pennsylvania/phoenixville/phoenixville-names-wastewater-treatment-project-pxvneo
- https://www.youtube.com/watch?v=p6CF-umWLZg


*Image from the Phoenixville, PA New Energy Optimization project.*

*Hyperlinks:*
*https://www.epa.gov/agstar/how-does-anaerobic-digestion-work*
*https://www.youtube.com/watch?v=p6CF-umWLZg*

# SOLID WASTE


*Photo courtesy of Ken Colovich*

## SOLID WASTE EMISSIONS

### GHG EMISSIONS BY SECTOR

(MT CO2E)

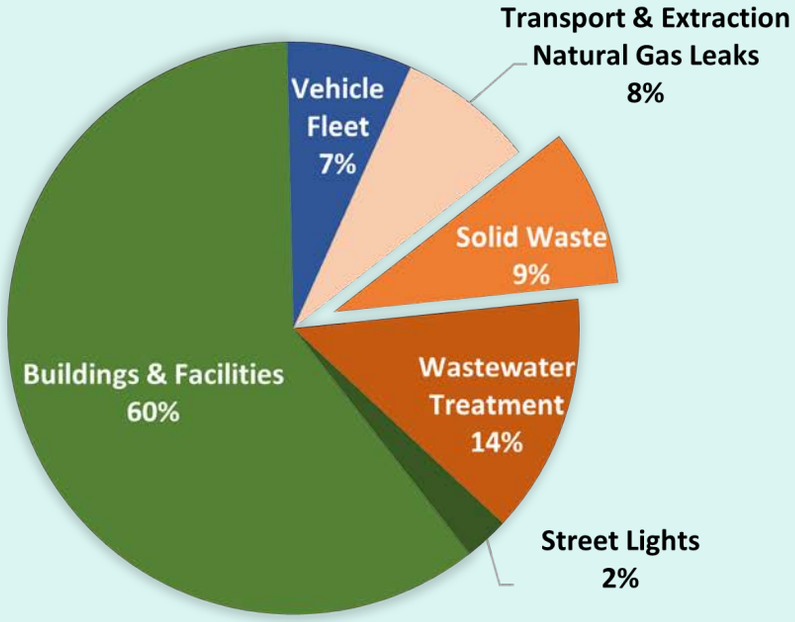



*Figure 24: "Solid Waste" greenhouse gas sector.*

Solid waste is the city's third largest source of GHG emissions at 285 MT CO2e. About half of emissions from municipal solid waste (MSW) landfills are methane and the other half are carbon dioxide. Technology exists to capture these landfill gases and use them as biogas or to generate electricity. While the city does not have ownership or operational control of the county's landfill, as a major client it could recommend the use of methane capture and put financial support behind it.

What the city does have full control over is the amount of waste it sends to the landfill. Through efforts in reuse, recycling, purchasing quality products that last longer, and potentially composting in the future, the amount of waste that ends up in the landfill can be reduced.

# SOLID WASTE INSIGHTS

*Wyoming Waste Systems (WWS)*
*Fremont County Solid Waste (FCSW)*

BY THE NUMBERS
2021

**$20,954** Total cost for waste disposal ($20,251 WWS; $703 FCSW)

**336,150 LBS.** Total weight of MSW – the weight of 30 full-grown elephants (95%* WWS; 5% FCSW)

## ESTIMATED* WASTE GENERATED BY DEPARTMENT

(ONLY WY WASTE SYSTEMS DATA)

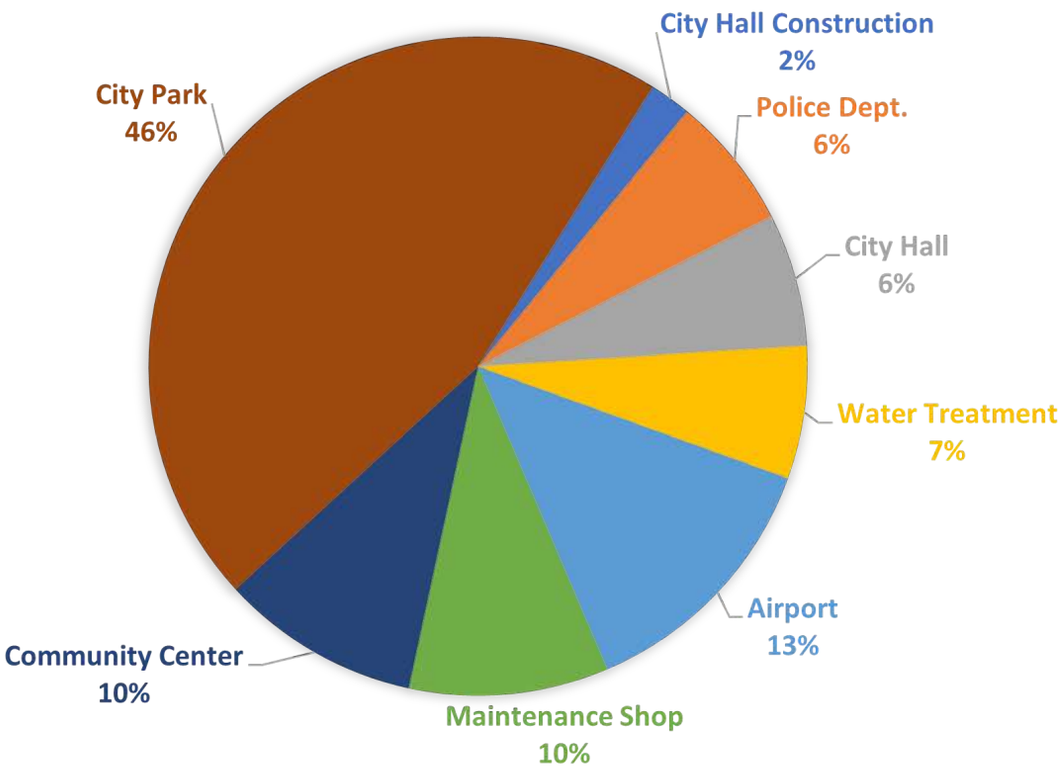



*Figure 25: Proportional waste from city departments based on dumpster volume size.*

*WWS only provides data on the size of the dumpster and the frequency of pick-up. The New Hampshire Dept. of Environmental Services estimates that every cubic foot of uncompacted municipal solid waste weighs between 150–350 pounds. If we assume that the WWS dumpsters are not full on every pick-up, an average weight of 225 pounds for each cubic yard can be used as a reasonable estimate.

*Hyperlinks:*
*https://www.themeasureofthings.com/results.php?comp=weight&unit=tnsm&amt=170&sort=pr&p=1*
*https://www.des.nh.gov/sites/g/files/ehbemt341/files/documents/vol-to-weight-conversion.pdf*

# SOLID WASTE OPPORTUNITIES

## RECYCLING

Unfortunately, the financial incentive to recycle is limited since WWS charges by dumpster size and not by weight. If the city were able to consolidate dumpsters across facilities or reduce the dumpster volume size by diverting recyclable waste, then there could be an opportunity for cost savings. Self-service recycling at FCSW is free or the company Lander Recycles performs curbside pick-up at cost.

## COMPOSTING

Currently, there is no privately- or publicly-run composting service in Lander. According to city staff, the city council researched offering both solid waste and composting services in the 2000's. However, the two private companies in town at the time felt that the city providing these services, would impede on their business. In the end, the council decided that the investment in equipment and labor would not be a cost effective enterprise, although it is unclear if they performed a full cost-benefit analysis. Council also hesitated to provide services that would compete with the solid waste private businesses. Neither solid waste company resulted in servicing compost. Since a waste audit was not performed at city facilities, it is unclear how much of the city's waste stream could be composted at an industrial facility.

### COMMUNITY SPOTLIGHT

The following are waste diversion practices of the City of Lander:

- The Parks & Recreation Department keeps grass clippings on the lawn to decompose and mulches Fall leaves from the various parks at the cemetery instead of sending them to the landfill.
- Larger equipment, such as bike racks; cabinetry; and playground components, are repurposed or repaired until they are no longer safe to use.
- City employees use internal emails to list items that can be reused by other city departments. Fremont County entities use similar communication to post surplus items internally. In fact, the city made use of several used desks and chairs for the City Hall remodel that came from Central Wyoming College (CWC).

### RECOMMENDATIONS

- Keep using the city's and county's internal communications to take advantage of reusable items.
- Perform a waste audit of the city's WWS dumpsters and public trash cans to understand how much waste could be diverted to recycling and composting. Consider reaching out to partners like LCAN and students at the high school or CWC to help conduct this audit.
- Post waste audit, consider the savings from waste diversion and compare it to the expense of staff labor and resources.
- Technologies such as anaerobic digesters and hydrothermal carbonization (see Wastewater section) can process most forms of organic waste. As the city researches whether these technologies should replace the current wastewater treatment system, expanding the inputs from biosolids to food waste and other organic waste could become part of the equation.

# TRANSPORTATION


*Photo courtesy of Ken Colovich*

## TRANSPORTATION EMISSIONS

### GHG EMISSIONS BY SECTOR

(MT CO2E)

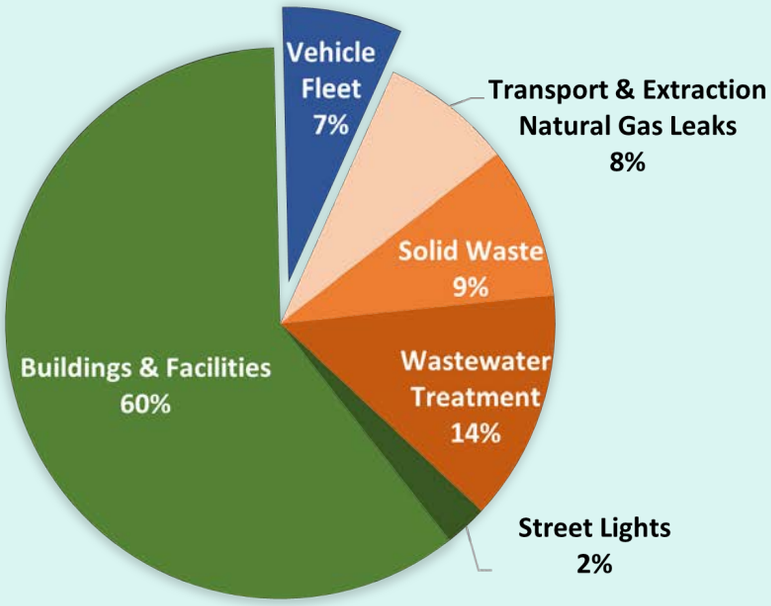



*Figure 26: "Vehicle Fleet" greenhouse gas sector.*

City vehicles have a sizable impact on GHG emissions at 227 MT CO2e as well as on local air quality. Some of the most concerning emissions from combustion engines are: nitrogen oxides, particulate matter, volatile organic compounds (VOCs), methane, and carbon dioxide. Studies have linked particulate matter and VOCs to numerous pulmonary illnesses such as asthma, chronic bronchitis, and lung cancer. Due to Lander's winter valley inversions, it is important to think about the impact this polluted air has on the people who breathe it. Nitrogen oxides, methane and carbon dioxide are all heat-trapping gases which contribute to the climatic changes we are seeing in our region and worldwide. EVs do not contribute to local smog and, if charged using low carbon energy, there are no emissions from charging the vehicle.

*GHG inventories typically take into account employee commuting practices under transportation; however, these were not assessed for this inventory due to the short commutes of a small town and the relatively minute impact change would have.*

*Hyperlinks:*
*https://www.epa.gov/transportation-air-pollution-and-climate-change/smog-soot-and-other-air-pollution-transportation;*
*https://www.epa.gov/system/files/documents/2022-04/ghg_emission_factors_hub.pdf;*
*https://www.transportation.gov/mission/health/cleaner-air*

# TRANSPORTATION INSIGHTS

*Data for fuel costs, gallons of fuel, and miles driven came from WYDOT statements. For purchases not captured at WYDOT stations, best estimates given for fuel prices and miles driven.*

## BY THE NUMBERS 2021

**$65,795** Total fuel costs

**121** Total fleet vehicles (85 on-road; 36 off-road)

**24,830** Total gallons of fuel purchased (74% gasoline; 26% diesel)

**182,013** Miles recorded from April-December 2021.*

## ON-ROAD VEHICLE FLEET

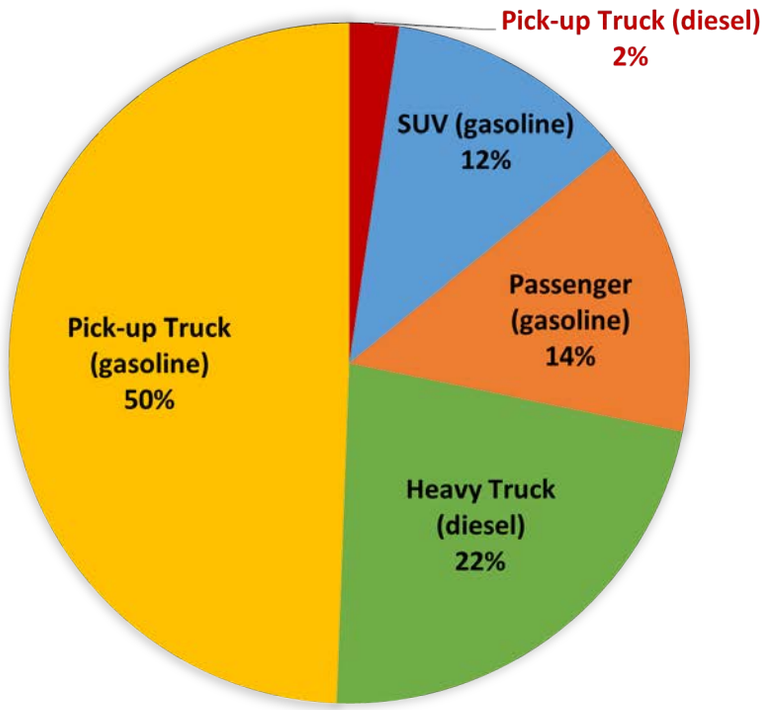



*Figure 27: Proportional make-up of the city vehicle fleet.*

## DEFINITIONS

- On-road - vehicles that are intended for road driving
- Off-road - machinery or utility vehicles that are not intended for road driving (i.e. mowers, construction vehicles, etc.)
- Passenger Vehicle - a low-profile vehicle used primarily for transportation of people
- SUV - a vehicle used for hauling people or loads
- Heavy Truck - large engine vehicles used to perform work or haul heavy loads (i.e. fire trucks, snow blowers, dump trucks, street sweepers, etc.)
- Utility Vehicle - small to medium sized vehicle or equipment used for a specialized task
- Construction - equipment used to perform heavy tasks

**The city transitioned to a new record keeping system, Stacker, in April 2021. Taking into account time for training and compliance with the new system, reliable data is not expected from this data set for the first few months.*

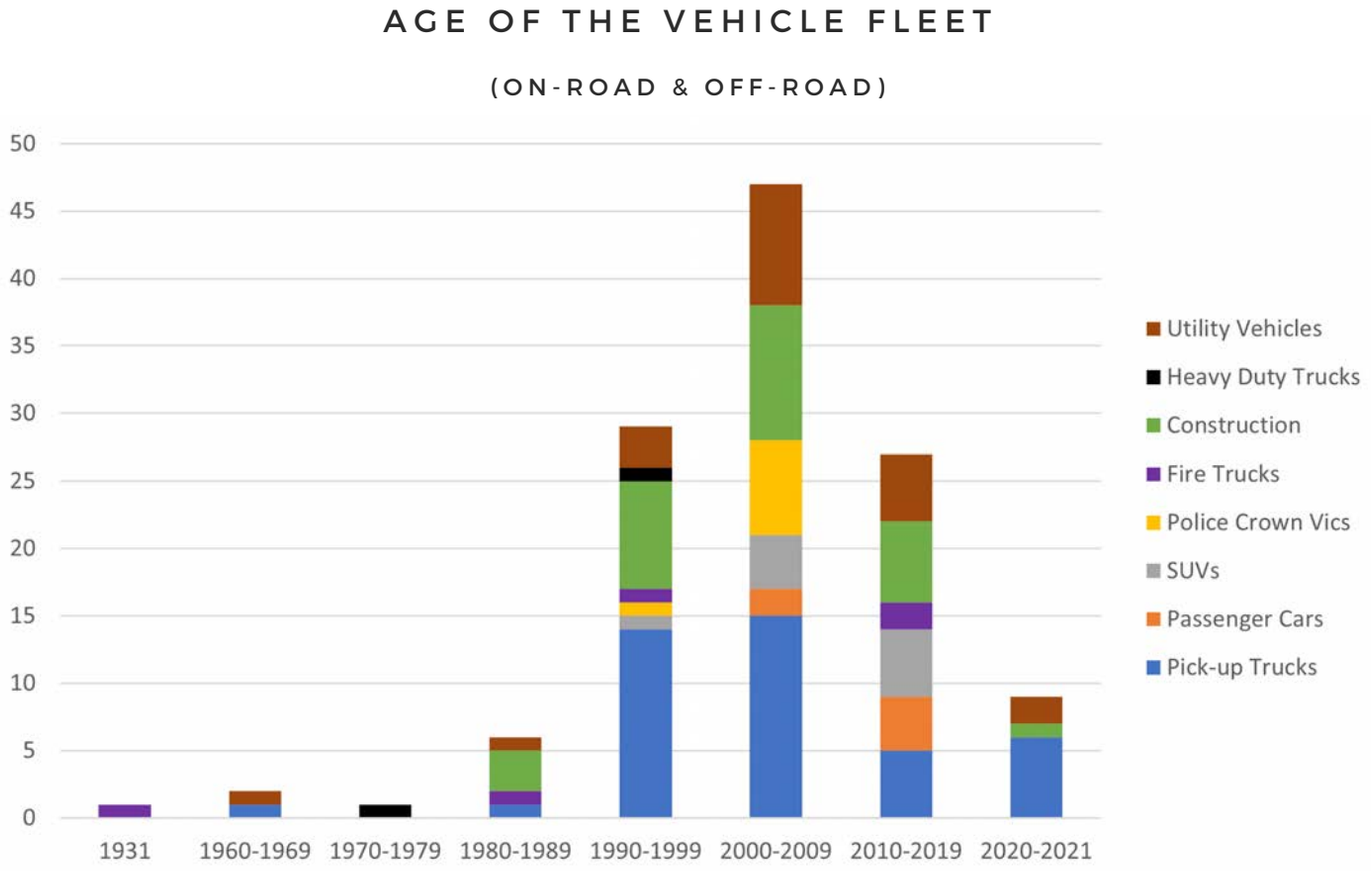



*Figure 27: Age of vehicles the city fleet.*

## CITY STAFF OUT-OF-TOWN TRAVEL

City employee travel request forms for the year 2021 showed that the majority of travel outside of city limits for training or conferences was done in city vehicles – there being only one recorded flight. When asked about the nature of city employee travel, administrators commented that many of the conferences have moved online and that driving is the preferred method of travel.

# TRANSPORTATION OPPORTUNITIES

## RIGHT-SIZING THE FLEET

When looking at the make-up of a fleet, we should determine what type of vehicle is most suited for the tasks required and how a diverse fleet can serve the various needs of a department. For example, suppose the Public Works Department has a five vehicle fleet. Staff need to tow trailers on average twice per month, haul items in the bed of the truck once per week, and the rest of the time is spent driving around the city performing tasks that do not require a truck's utility. Perhaps two pick-up trucks would accomplish this amount of work and the other three vehicles could be more fuel efficient and less expensive passenger cars or SUVs.

City staff could also consider including bicycles or e-bikes into the fleet. Whether it's city hall employees running errands or police officers on their patrol, bikes can get people out of their cars and interacting with their community. Not to mention, bikes are infinitely less expensive to own and operate, saving those taxpayer dollars.

RECOMMENDATIONS

Conduct a study of each department's vehicle needs and make a plan to swap vehicles with other departments or replace them with the appropriate vehicle.

## ELECTRIFYING THE FLEET

There is no doubt that as of 2022, the vehicle market is expanding from the binary option of gas or diesel. A combination of volatile gas prices, decreasing electricity prices, improvements in performance, and increased affordability has made electric vehicles a more viable option for the average consumer. Plus, with a nation-wide build-out of electrical charging infrastructure underway, travelers will soon be able to charge in towns throughout Wyoming.

TOOL

As the city looks to acquire new vehicles, elements of purchase price, operating expenses, and fuel costs/usage should be considered when making a vehicle purchase. The U.S. DOE's vehicle cost calculator allows users to assess these elements between multiple vehicles by comparing vehicle makes and models, current gas prices, and vehicle usage trends (see appendix for examples).

RECOMMENDATIONS

- When buying a new vehicle, the city should consider the cumulative cost of ownership of the vehicle. Hybrids should be the new standard purchase due to their cost effectiveness (reference the comparison study). EVs qualify for tax incentives that would substantially lower the upfront cost and would make great vehicles for in-town driving.
- Landscaping equipment, such as mowers; trimmers; and leaf blowers, are readily available in electric models. While there may be a price difference for the larger equipment, like riding mowers, total operational costs and outside funding should be considered when acquiring new EV equipment. Pilot programs can also allow staff to test run products.

*Hyperlinks:*
*https://afdc.energy.gov/calc/#result_a*

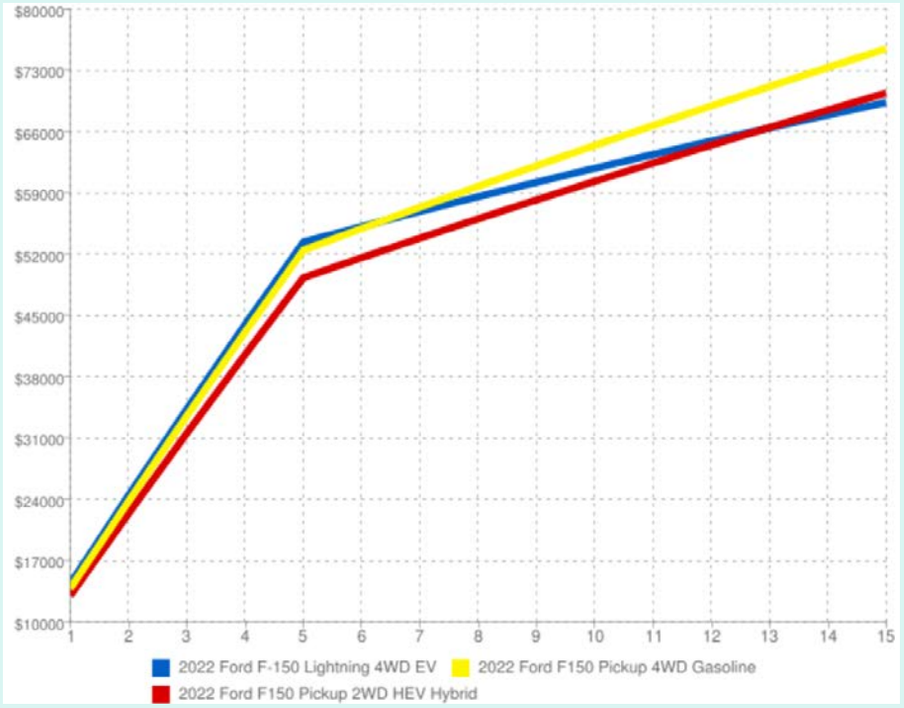
## COMPARISON STUDY

Using the U.S. DOE vehicle cost calculator, consider the two graphs comparing the cumulative cost of ownership between 2022 models of the gas, hybrid, and EV Ford F150. One graph depicts a low gas price scenario at $2.50/gallon and the other a high gas price scenario of $4.13/gallon. The hybrid wins over the gas in both scenarios and the EV supersedes the gas in year 12 with low gas prices and year 6.5 with high gas prices. The low purchase price of the hybrid sets it apart from the other models; however, the EV could become the overall winner if the city took advantage of the 30 percent EV tax incentive available to municipalities (see funding section). With this tax break, the price of the EV would drop below that of the hybrid and maintain its cost competitiveness with lower fuel and operating costs. The same exercise is demonstrated with SUV and passenger cars in the appendix.

*Assumptions: This graph shows the cumulative cost of ownership by year for each vehicle, including fuel, tires, maintenance, registration, license, insurance, and loan payment. The tool assumes a five-year loan with a 10% down payment. Year one on the graph represents the 10% down payment plus the first year's total operating costs.*

### CUMULATIVE COST OF OWNERSHIP FORD F150 MODELS

HIGH FUEL PRICE SCENARIO ($4.13/GALLON)




### CUMULATIVE COST OF OWNERSHIP FORD F150 MODELS

LOW FUEL PRICE SCENARIO ($2.50/GALLON)

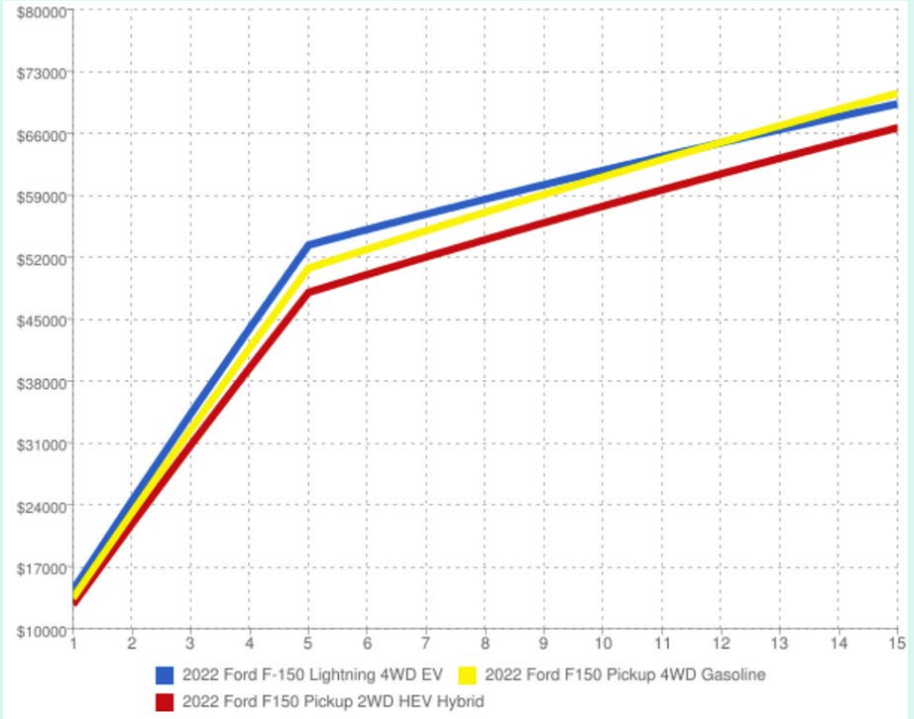



*Figure 28: Cost comparisons of a gas, a hybrid, and an all electric F150 under different fuel price scenarios using the U.S. DOE's vehicle cost calculator.*

## COMPARISON STUDY CONT.

### CUMULATIVE COST OF OWNERSHIP FORD F150 MODELS

#### HIGH FUEL PRICE SCENARIO ($4.13/GALLON)

| Vehicle | Annual Fuel Use | Annual Electricity Use | Annual Fuel/Elec Cost | Annual Operating Cost | Cost Per Mile | Annual Emissions (lbs CO2) |
|---|---|---|---|---|---|---|
| 2022 Ford F-150 Lightning 4WD EV | 0 gal | 1,792 kWh | $201 | $1,981 | $0.50 | 3,524 |
| 2022 Ford F150 Pickup 2WD HEV Hybrid | 160 gal | 0 kWh | $661 | $2,492 | $0.62 | 3,840 |
| 2022 Ford F150 Pickup 4WD Gasoline | 209 gal | 0 kWh | $861 | $2,693 | $0.67 | 5,006 |

### CUMULATIVE COST OF OWNERSHIP FORD F150 MODELS

#### LOW FUEL PRICE SCENARIO ($2.50/GALLON)

| Vehicle | Annual Fuel Use | Annual Electricity Use | Annual Fuel/Elec Cost | Annual Operating Cost | Cost Per Mile | Annual Emissions (lbs CO2) |
|---|---|---|---|---|---|---|
| 2022 Ford F-150 Lightning 4WD EV | 0 gal | 1,792 kWh | $201 | $1,981 | $0.50 | 3,524 |
| 2022 Ford F150 Pickup 2WD HEV Hybrid | 160 gal | 0 kWh | $400 | $2,231 | $0.56 | 3,840 |
| 2022 Ford F150 Pickup 4WD Gasoline | 209 gal | 0 kWh | $521 | $2,353 | $0.59 | 5,006 |

*Figure 29: Cost comparisons of a gas, a hybrid, and an all electric F150 under different fuel price scenarios using the U.S. DOE's vehicle cost calculator.*

The cost savings and GHG emissions reduction are very pronounced if EVs replace the oldest vehicles in the fleet. Compare the two tables with the first one comparing 2022 gas models to 2022 EV models and the second one comparing pre-2000 gas models with 2022 EVs. By replacing the oldest vehicles in the fleet with EVs, there are hundreds of dollars more in savings and thousands of pounds of CO2e reduction. Therefore, if the city is going to replace vehicles, the oldest should be the first to go.

*Figure 30: Cost savings and pounds of carbon dioxide equivalent reduction comparisons using estimates from the U.S. DOE's vehicle cost calculator and the assumptions below.*

### ANNUAL FUEL & OPERATIONAL SAVINGS

#### CHOOSING EV OVER GASOLINE (2022 MODELS)

| | Cost savings ($4.13/gallon) | Cost savings ($2.50/gallon) | lbs CO2e reduction |
|---|---|---|---|
| Passenger vehicle | $ 903 | $ 481 | 1,267 |
| SUV | $ 809 | $ 419 | 937 |
| Pick-up | $ 1,372 | $ 692 | 1,482 |

### ANNUAL FUEL & OPERATIONAL SAVINGS

#### REPLACING PRE-2000 VEHICLE* WITH 2022 EV

| | Cost savings ($4.13/gallon) | Cost savings ($2.50/gallon) | lbs CO2e reduction |
|---|---|---|---|
| Passenger vehicle | $ 1,934 | $ 1,030 | 4,157 |
| SUV | $ 1,676 | $ 868 | 3,354 |
| Pick-up | $ 2,236 | $ 1,128 | 3,868 |

**Assumptions: For this exercise, pre-2000 vehicles came from the City of Lander's fleet records. The figures listed represent the average difference in savings from those vehicles. Miles per gallon data came from fueleconomy.gov or fuelly.com. All pre-2000 vehicles assumed the purchase price of $10,000. Estimated driving habits for passenger vehicles and SUVs differed from that of pick-up trucks by 660 miles.*

## ELECTRIC VEHICLE INFRASTRUCTURE

There are currently two levels of EV chargers the city should be aware of – Level 2 and Level 3.

**Level 2 chargers** charge an empty vehicle battery to 80 percent in about 8-12 hours – ideal for plugging vehicles in overnight. They can be used with existing 240 volt receptacles; however, these receptacles are often not accessible near vehicle parking. An electrician will be needed to install a dedicated 240 volt outlet and, depending on the electrical load being drawn at a given location, the electrician may also need to upgrade the electrical panel. Basic installation for a Level 2 is about $250-$400. Mounting a station and running 50-amp dedicated wiring will run between $400 and $1,700. In total, mounting a new station, installing a new service panel, wiring, and equipping it with a 240-volt outlet will cost between $1,500 and $4,500. Extra expenses could be incurred for extensive wiring or trenching.

### RECOMMENDATIONS

- Once the city identifies which departments will use EVs, Level 2 chargers should be installed at that facility.
- All wiring for Level 2 chargers should be laid during new city building constructions. This way, the electrical hook ups will be ready for EV chargers once EVs become a larger part of the fleet. It is much less expensive to dig the trenches and lay the conduit while the site is still under construction.

**Level 3 chargers**, also known as DC Fast Chargers, utilize 480 volt power and can charge a battery from empty to 80 percent full in 30 minutes. These high power chargers are installed and managed by charging networks, such as ElectrifyAmerica or ChargePoint. Since they are operated by a commercial entity, all Level 3 chargers are for public use. Businesses that keep customers occupied for 30 minutes, such as grocery stores or coffee shops, are perfectly situated for charging stations. Some companies will pay for the design, installation, and maintenance costs associated with the chargers.

### RECOMMENDATIONS

- The city could influence tourists to stop at the Chamber of Commerce's Visitor's Center by working with a charging network to install a Level 3 charger there.

### ADDITIONAL RESOURCES

- Yellowstone-Teton Clean Cities and their Green Fleet consulting
- Guide On How To Charge Your Electric Car With Charging Stations

*Hyperlinks:*
*https://www.getneocharge.com/blog-post/three-levels-of-electric-car-charging*
*https://blog.carvana.com/2021/07/how-much-does-it-cost-to-install-an-ev-charger/*
*https://www.electrifyamerica.com/realestate/*
*https://ytcleancities.org/projects/services/*
*https://chargehub.com/en/electric-car-charging-guide.html*

# CONCLUSION

The City of Lander is taking the first step in accountability with this report by becoming aware of its energy and fuel consumption, the costs associated with that consumption, and the GHG emissions from its operations. Several tactics are outlined in this report for how to reduce operational costs while simultaneously enhancing the city's resilience and lessening environmental impact. Various forecasts, including the price of energy and the electrical grid fuel mix, were included to inform decision makers on trends to be aware of while investing in long-term infrastructure needs. Due to the accelerated pace of climate change, the next few years will be critical to transition the city's buildings and vehicles to low GHG-emitting technology. Funding is available and plentiful to help communities that are committed to GHG reduction make this transition, our task is to set a course and act.

# NEXT STEPS

This report serves as the city's baseline. Continued annual or biennial reporting of building and transportation usage trends, which tend to be more dynamic, is recommended to track efficiency gains and cost savings. Tools such as enhanced billing or building data management for facilities and telematics for the fleet can help monitor energy use, driving and fuel efficiency. Any major projects or policy changes that impact the city's energy use, fuel use, or GHG emissions requires a comprehensive inventory update.

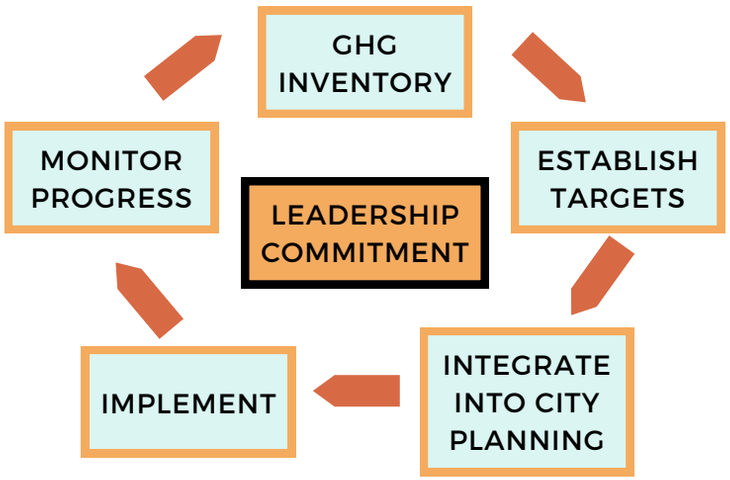



*Figure 31: Progression of municipal climate change planning. (Adapted from ICLEI)*

Grant funding from the LOR Foundation and LCAN helped support the creation of this report. To assist the city in this next phase of planning, additional grant funding will be needed. As the city increases its focus in this area, it should assess whether a city-supported position is necessary to manage progress monitoring and project implementation.

## ...FOR CITY COUNCIL & MAYOR

- Attend the city council public work session concerning the contents of this report on November 22, 2022.
- Understand the localized risks of climate change and how they will impact city infrastructure, emergency services, and the citizens of Lander.
- Establish science-based GHG emission reduction targets for city operations.
- Integrate climate mitigation and adaptation strategies into the city's short-term strategic plan and its long-term master plan in order to reach these targets.

## ...FOR CITY STAFF

- Integrate the list of facility improvements into departmental calendars.
- Test drive electric vehicles as they appear at our local car dealerships to become more familiar with them. Ask questions of both the dealers and the E&E Task Force.
- Take note of building and vehicle asset replacement schedules and share with the E&E Task Force.
- Identify departmental transportation needs and determine a vehicle make-up would best serve the fleet.
- Engage in conversations with RMP to understand where grid vulnerabilities lay and how distributed renewable energy can help provide essential services.
- Inquire with RMP about high costs of flat rate street lighting and consider switching to metered lighting.
- Work with community partners to perform a waste audit of city buildings and the city's public spaces.

## ...FOR E&E TASK FORCE

- Present this report to the city council on November 22, 2022.
- Educate city officials on local climate risks.
- Advise city council on science-based GHG emission reduction targets.
- Identify specific projects for the strategic and master plans that direct the city towards achieving its targets.
- Initiate and participate in conversations between the city and RMP concerning grid vulnerabilities.
- Organize a waste audit for the city with community partners.
- Continue identifying grants to aid the city in pursuit of its energy and environment goals.

# ACKNOWLEDGEMENTS

City Of Lander Wyoming

Staff time touring city facilities. Teaching the E&E Task Force key city operations. Reviewing this report.

ICLEI Local Governments for Sustainability

Technical guidance and use of their greenhouse gas inventory calculator.

LOR FOUNDATION

Major funding for this report.

LANDER CAN

Support and funding of this work. Reviewing this report.

CITY OF LANDER
ENERGY & ENVIRONMENT
TASK FORCE

*Hyperlinks:*
*https://docs.google.com/spreadsheets/d/17MfS-nZsZRRUkE98uGf-eQfOpiA-YOoJ_jteMgYl1FM/edit#gid=0*

# FUNDING SOURCES

## GENERAL

- Inflation Reduction Act
- Bipartisan Infrastructure Law

## BUILDINGS & FACILITIES

### ENERGY AUDITS

- Many of the smaller fixes, such as installing weatherstripping, could be worked into current city employee schedules during down time.
- WEA grants project funding for up to $25,000 on facilities energy audited through their program.
- America Rescue Plan Act (ARPA) money that the city needs to spend by the end of 2023.
- The Wyoming Association of Municipalities/Wyoming County Commission Association (WAM-WCCA) Energy Lease Program offers zero-interest leases between $2,500 and $100,000 for energy efficiency upgrades.
- Rocky Mountain Wattsmart Programs
- U.S. DOE: Energy Efficiency & Conservation Block Grant

### SOLAR ELECTRIC & BATTERY STORAGE

- Municipalities can now take advantage of the 30 percent Investment Tax Credit in the form of a direct pay tax rebate.
- Rocky Mountain Power's Blue Sky Grant
- U.S. DOE:
  - Energy Efficiency and Conservation Block Grant
  - Program Upgrading Our Electric Grid and Ensuring Reliability and Resiliency

### GROUND-SOURCE HEAT PUMPS

- U.S. DOE: Community Geothermal Heating and Cooling Design and Deployment

### BUILDING CODES

- U.S. DOE: Building Codes Implementation for Efficiency and Resilience. Applicants must go through a state agency or state partner; however, the state agency does not need to be the prime applicant and a local government can go through a different state to pursue funding.

# WASTEWATER

- U.S. EPA: Water Efficiency Grant Pilot Program

# TRANSPORTATION

- Volkswagen settlement funds: EV charging infrastructure for all levels. 50/50 match. Grant managed by WYDOT's Zero Emission Vehicle working group. Locations off of WYDOT's National Electric Vehicle Infrastructure (NEVI) corridor are eligible.
- Infrastructure Investment and Jobs Act: Discretionary grants for EV charging infrastructure. Direct-to-user grant not managed by the federal or state government. Prioritizing highway corridors to facilitate long-distance travel with a focus on rural, disadvantaged, and hard-to-reach communities.
- Inflation Reduction Act: Direct pay tax credit up to 30 percent of cost for commercial clean vehicles (tax-exempt entities are eligible). Vehicles with a gross weight of less than 14,000 pounds receive a limit of $7,5000 and vehicles at or above that weight, such as fire trucks, have a limit of $40,000.

# APPENDIX

LANDER, WYOMING

## CITY OF LANDER, WYOMING

OFFICE OF THE MAYOR

**PROCLAMATION**

**A PROCLAMATION OF THE CITY COUNCIL SUPPORTING THE INTENT TO REDUCE GREENHOUSE GAS EMISSIONS TO ENHANCE COMMUNITY RESILIENCE, QUALITY OF LIFE, AND ECONOMIC VIABILITY FOR CURRENT AND FUTURE GENERATIONS.**

**WHEREAS,** the City of Lander's mission statement is to, "promote a safe, stable, and responsive environment that supports a traditional, yet progressive community with a high quality of life."

**WHEREAS,** there is broad scientific consensus that a changing climate can negatively impact human health, water availability, frequency and intensity of wildfires and floods, air quality, wildlife populations, and other environmental processes. These effects pose a threat to land uses, food supplies, natural amenities, recreational activities, and quality of life that have been and will continue to make Lander a desirable place to live for current and future generations.

**WHEREAS,** budget shortfalls due to Wyoming's shifting economic base and impacts from COVID-19 have increased the importance of cost-savings measures in the short, medium, and long-term.

**WHEREAS,** investment in renewable energy, energy efficiency, waste reduction, conservation techniques, etc., have a proven track record to realize cost savings, reduce utility and maintenance costs, and enhance community resilience (e.g. LED streetlight retrofit).

**WHEREAS,** the Governing Body of the City of Lander supports renewable energy, energy efficiency and other strategies that increases the efficiency and effectiveness of community services and promote partnerships with other governments and agencies to support community initiatives and economic development.

**NOW, THEREFORE,** I Monte Richardson, Mayor of Lander, acknowledge the adverse impacts of climate change and the risk it poses to the Lander Community and support the intent to reduce greenhouse gas emission to enhance community resilience, quality of life and economic viability for current and future generations.

SEAL

Mayor Monte Richardson
October 13, 2020

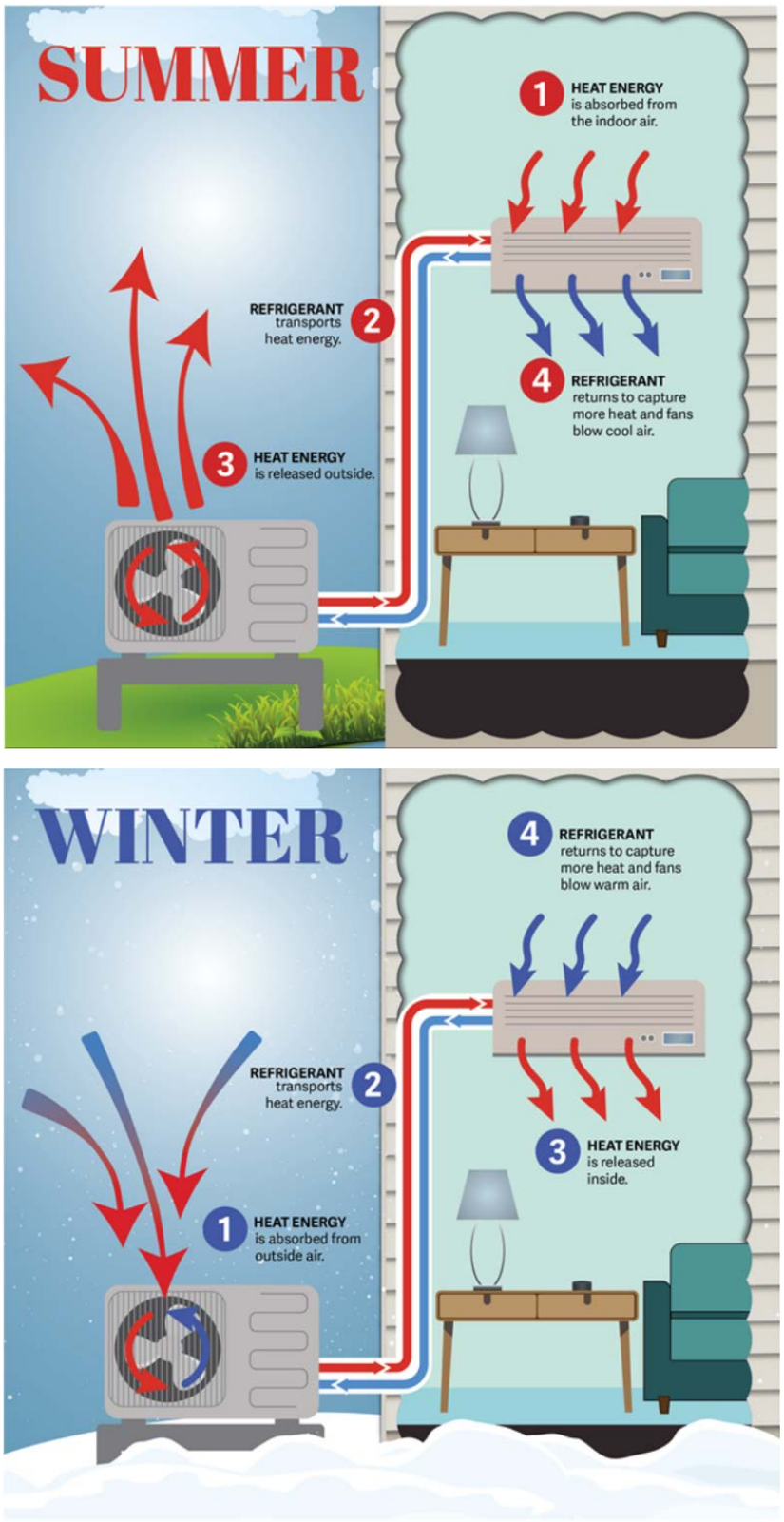
THE REAL WEST

# AIR-SOURCE HEAT PUMPS

Air-source heat pumps are an electric space heating and cooling appliance in one. The way they work is by transporting heat. In the summer, they cool indoor spaces by exporting heat from inside the building to the outdoors. In the winter, the unit functions like an air conditioner in reverse. The air-source heat pump's refrigerant extracts heat from the outside (even in temperatures as low as -5 to -14 degrees Fahrenheit), circulates the inside air over the heated refrigerant coils, and releases the warm air into the building. Cold climate heat pumps are often equipped with a variable speed compressor to help them cope with large temperature swings and flash (or vapor) injection, which short cuts the refrigerant loop and allows for quick warming of the incoming air. There are also gas/electric hybrid systems available where natural gas can serve as a back-up heat source during severely cold temperatures.

Since air-source heat pumps move heat instead of combusting fuel to heat or cool, they tend to be more energy efficient than natural gas. To demonstrate this efficiency, the best combustion-fueled furnaces have about a 1-to-1 ratio of energy consumed to heat provided whereas a well-insulated air-source heat pump can provide 1.5–3.5 times the electrical energy it consumes.

The upfront cost for air-source heat pumps ranges from $3,500 to $6,000 per installation, although tax incentives may be available.




*Images from Madison Gas & Electric (www.mge.com)*

*Hyperlinks:*
*https://www.consumerreports.org/heat-pumps/can-heat-pumps-actually-work-in-cold-climates-a4929629430/*
*https://www.energysage.com/clean-heating-cooling/air-source-heat-pumps/costs-and-benefits-air-source-heat-pumps/*

# HEAT PUMP WATER HEATERS

Heat pump water heaters function in much the same way as air-source heat pumps. Heat is extracted from the air in the room and warms the coils surrounding the water tank. Cool air is expelled from the heat pump as exhaust. These heat pumps are often hybrids with electric resistance heat available to kick on when large quantities of water are in demand.

The U.S. EPA and the U.S. DOE's Energy Star program estimates that a household of four saves about $425 per year and $3,700 over the life of the appliance by switching to an Energy Star-certified heat pump water heater. With these types of cost savings, the city should consider replacing any old and inefficient water heaters with heat pump water heaters and could even experiment with retrofitting a water heater. The only water heater not recommended for conversion is the commercial-sized water heater at the Community Center due to the volume of water it needs to supply and the small room it is located in.

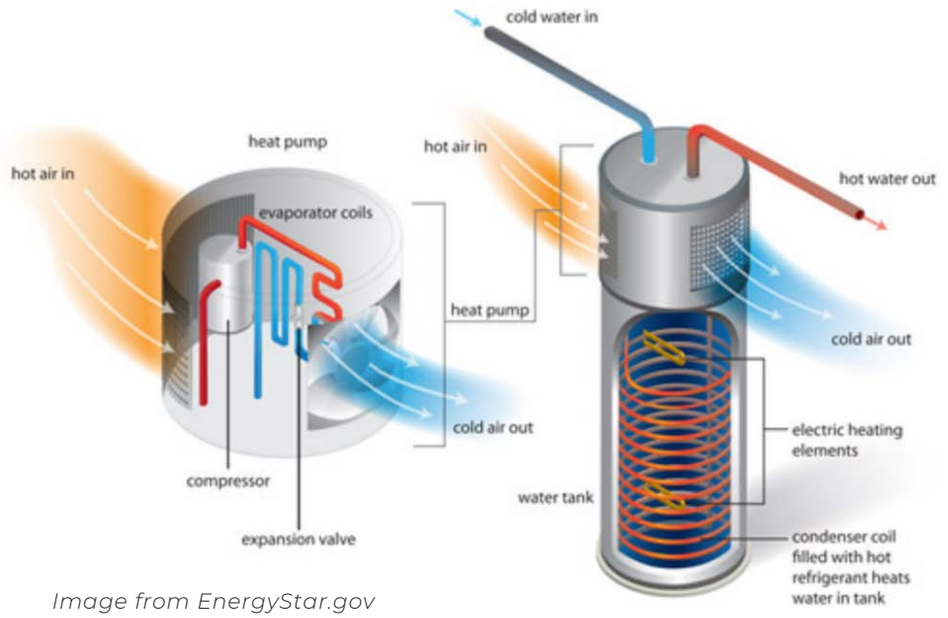



*Image from EnergyStar.gov*

Both air-source heat pumps and heat pump water heaters fit well into existing building infrastructure. There is no trenching to lay coils underground, the air-source heat pumps have both duct and ductless options and a conventional water heater can be retrofitted with a heat pump. Of course there are placement requirements for these systems to achieve optimal efficiency so seeking guidance from a professional installer is recommended.

# SOLAR OPTIMIZATION & MAINTENANCE

Ideally, the placement of the solar arrays would be near to the source of energy consumption to save on trenching and wiring costs. The optimal orientation for solar panels is south-facing with a 30-45 degree incline. West- or east-facing orientations aren't terrible with an associated 15 percent loss in power output. Tilting panels is another option to optimize the angle for energy generation. Ground mounts are ideal for situations when the roof is not compatible with solar, for ease of access to the panels (especially for clearing them free of snow in the winter months), or if the source of energy consumption is not near a structure. If year-round energy production is a priority, the solar panels would need to be brushed clear of snow during the winter months.

*Hyperlinks:*
*https://www.energystar.gov/products/water_heaters/high_efficiency_electric_storage_water_heaters/how_it_works;*
*https://www.energystar.gov/products/ask-the-experts/do-heat-pump-water-heaters-work-in-cold-climates;*
*https://www.energy.gov/energysaver/heat-pump-water-heaters;* *https://news.energysage.com/solar-panel-performance-orientation-angle/*

# SOLAR OPTIMIZATION & MAINTENANCE CONT.

Solar panel systems also benefit from low maintenance costs due to there being no moving parts. Maintenance costs might include:

- Replacing or repairing solar equipment: Solar part manufacturers typically have a warranty period on their equipment. Typically the customer will need to pay for labor to reinstall the part and perhaps a minimal cost for product replacement
- Reroofing after installation: Solar panels can be removed for reroofing but it is best to have the roof improved beforehand.
- Tree trimming: If shade starts encroaching on the solar panels, it will decrease the productivity of those panels.

Some commercial entities decide to purchase an operations and maintenance (O&M) package from the solar installer to ensure that the system is operating at full capacity. Some items in an O&M might include cleaning, electrical system checks, and/or pest control measures.

# STRATEGIC SOLAR LOCATIONS

The following four meters are billed demand charges and would benefit from solar electric generation, and perhaps battery storage, to curb demand charges. Red outlines being places for solar installation.

## WASTEWATER LAGOONS

- 2021 Blower House electrical usage = 573,960 kWh
- Size of solar array to provide 100% of power = 369 kW
- The six- acre area (highlighted in red below) would be an ideal site for connecting to the Blower House meter using a ground mount installation.
- While ground mounts tend to be more expensive due to necessary trench work and mounting equipment, the panels are more accessible to clean snow off during winter months.
- This land is currently being used to store gravel, manure from the rodeo grounds, and other construction material.
- If the lagoons are to retire before the payback period of the solar system is achieved (reference Wastewater section), then perhaps this site should not be prioritized for solar. However, this location is ideal for a potential city-owned solar array should a deal be struck with RMP to offset other city facilities outside of the net metering.


*Hyperlinks:*
*https://news.energysage.com/costs-of-solar-after-installation/*

## LANDER COMMUNITY & CONVENTION CENTER

- 2021 electricity use = 186,640 kWh
- Size of solar array to provide 100% of power = 120 kW
- Identified as one of the city's emergency shelters.
- Under the current net metering cap, a 25 kW roof-mounted solar power system paired with battery back-up could provide uninterrupted power to critical loads within the building.
- Paring a solar system with electric vehicle charging stations would be perfect for visitors attending a conference.
- This site would be ideal for a self contained micro-grid between the three essential services of the community center, hospital and airport.


*Image from Creative Energies LLC*

## WATER TREATMENT PLANT

- 2021 electricity usage = 185,600 kWh
- Size of solar array to provide 100% of power = 119 kW
- Provides another essential service for community health.
- Would be a candidate for battery back-up storage.

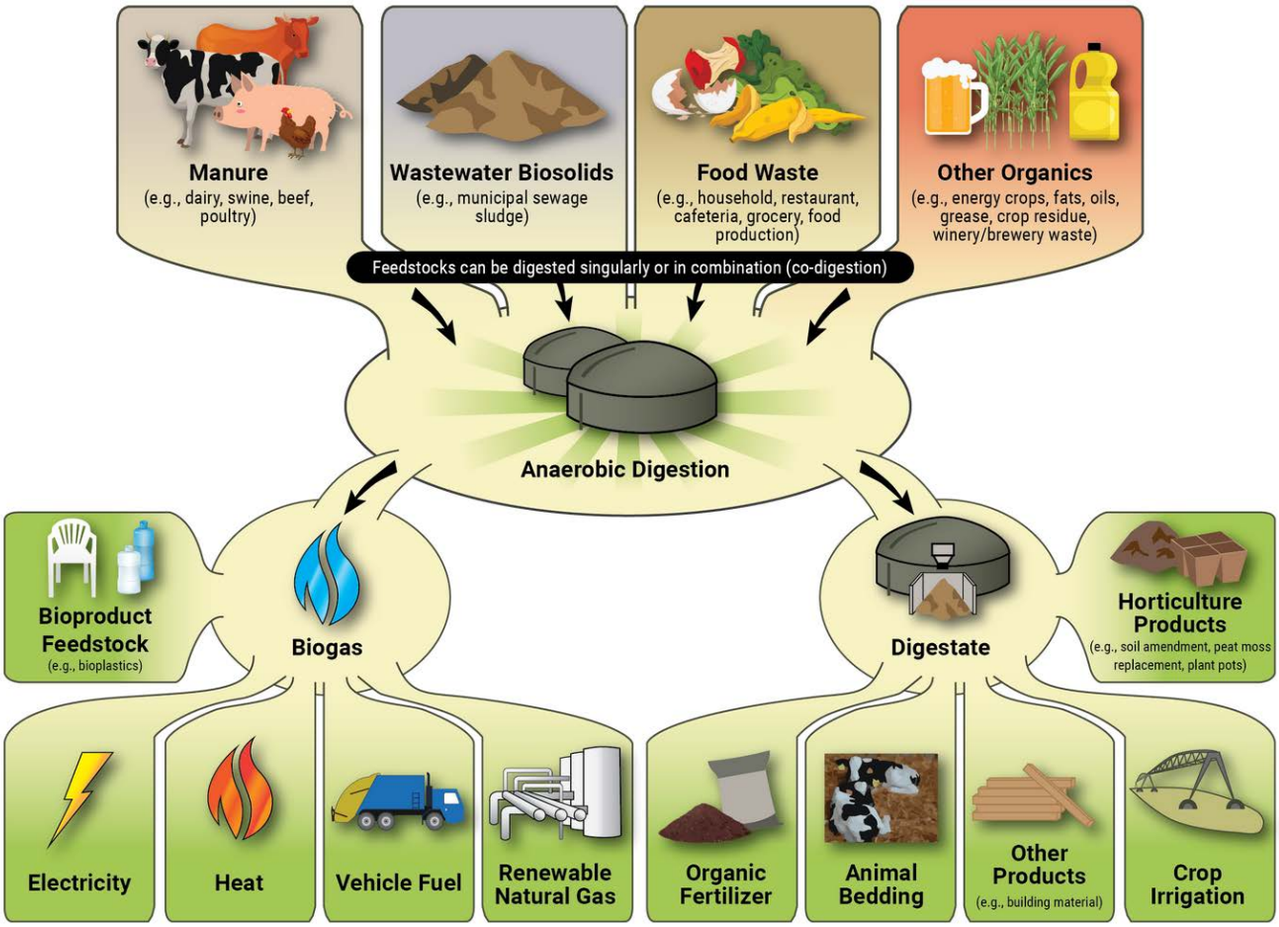
## CITY HALL / POLICE DEPARTMENT

- 2021 electricity usage = 106,240 kWh
- Size of solar array to provide 100% of power = 68 kW
- A highly visible location with good roof orientation.
- Could be equipped with electric vehicle charging stations for future electric city fleet vehicles.

# GROUND-SOURCE HEAT PUMPS – TECHNICAL

In the winter, the soil temperature a few feet underground is warmer than the air temperature above. Pipes filled with antifreeze solution are laid underground to absorb this warmth. The warmed solution is then piped to the building's heat exchanger where the heat is transferred from the solution to the exchanger and released throughout the building. The solution stays in a closed loop, not exposed to any machinery or the environment. The opposite is true in the summer when the soil temperature is cooler than the air temperature and the system can be used for cooling. To incorporate water heating to this geothermal system, a desuperheater would be added. This small auxiliary heat exchanger, which can be used with either a water storage tank or tankless system, takes warm air from either the heat pump's compressor or the ambient air in the summer and warms the water.

# ANAEROBIC DIGESTION




*Images from U.S. Environmental Protection Agency*

*Hyperlinks:*
*https://www.energy.gov/energysaver/heat-pump-water-heaters*

# METHANE CAPTURE

### Table 1: Wastewater Methane Mitigation and Recovery Approaches

| Recovery Approach | Description |
|---|---|
| Installing anaerobic sludge digestion (new construction or retrofit of existing aerobic treatment systems) | Anaerobic digesters are used to process wastewater biosolids and produce biogas, which can be used on site to offset the use of conventional fuel that would otherwise be used to produce electricity and thermal energy. |
| Installing biogas capture systems at existing open air anaerobic lagoons | Biogas capture systems for anaerobic lagoons are the simplest and easiest method of biogas implementation. Rather than investing in a new centralized aerobic treatment plant, covering an existing lagoon and capturing the biogas can be the most economically feasible means to reduce methane emissions. |
| Installing new centralized aerobic treatment facilities or covered lagoons | Installing new centralized aerobic treatment systems or new covered lagoons to treat wastewater in place of less-advanced decentralized treatment options (or no treatment at all) can greatly reduce current and future methane emissions associated with wastewater. This option is most viable in areas with expanding populations that have the infrastructure and energy available to support such systems. |
| Installing simple degassing devices at the effluent discharge of anaerobic municipal reactors | In several developing countries with warm climate (e.g., Brazil, India, Mexico) anaerobic reactors—which are fed directly with municipal wastewater—(e.g., UASBs, anaerobic filters, fluidized or expanded bed, baffled reactors) are being increasingly used for small and medium scale municipal wastewater treatment. In these systems, around 30 percent of produced methane is lost as dissolved gas in the treated effluent. A closed column with enough turbulence right after the reactor can capture a significant amount of methane, which may be used beneficially or directed to a flare. |
| Optimizing existing facilities/systems that are not being operated correctly and implementing proper operation and maintenance (O&M) | Optimizing existing facilities and wastewater systems that are not being operated correctly to mitigate methane emissions is a viable alternative to installing new facilities or wastewater treatment processes such as anaerobic digesters. Proper O&M also ensures that facilities continue to operate efficiently, with minimal methane emissions. |

### Table 2: Wastewater Methane Use Options

| Methane Use Option | Description |
|---|---|
| Digester gas for electric and heat generation with combined heat and power (CHP) | Facilities can use recovered methane as fuel to generate electricity and heat in a CHP system using a variety of prime movers, such as reciprocating engines, microturbines, and fuel cells. Power production on site can offset purchased electricity, and the thermal energy produced can be used to meet digester heat loads and for space heating. |
| Digester gas for electricity or heat only | Facilities can use recovered methane as fuel to generate electricity and heat in a CHP system using a variety of prime movers, such as reciprocating engines, microturbines, and fuel cells. Power production on site can offset purchased electricity, and the thermal energy produced can be used to meet digester heat loads and for space heating. |
| Digester gas purification to pipeline quality | Facilities can market and sell properly treated and pressurized biogas to the local natural gas utility. |
| Direct sale of digester gas to industrial user or electric power producer | Facilities can treat, deliver, and sell biogas to a local industrial user or power producer, where it can be converted to heat and/or power. |
| Digester gas to vehicle fuel | Facilities can treat and compress biogas on site to produce methane of a quality suitable for use as fleet vehicle fuel. |

*Tables from Global Methane Initiative: Municipal Wastewater Methane*

# ELECTRIC VEHICLE COMPARISONS

The following price and fuel economy figures for new vehicles were automatically generated by the U.S. DOE. Best estimates were used for older vehicles based on internet research. These vehicles were chosen for ease of comparison across similar models and accessibility to dealerships in the Lander area. Here is the link to the vehicle cost calculator: https://afdc.energy.gov/calc/

*Assumptions: These graphs shows the cumulative cost of ownership by year for each vehicle, including fuel, tires, maintenance, registration, license, insurance, and loan payment. The tool assumes a five-year loan with a 10% down payment. Year one on the graph represents the 10% down payment plus the first year's total operating costs.*

| | Vehicle | Price | Fuel Economy (City/Hwy) | Fuel Type |
|---|---|---|---|---|
|  | 2022 Ford F-150 Lightning 4WD Automatic (A1) EV | $ 39,974 Tax credit? | 44/56 kWh/100mi | Electric |
|  | 2022 Ford F150 Pickup 2WD HEV 6cyl 3.5L Automatic (S10) Hybrid | $ 33,935 Tax credit? | 25/25 mpg | Hybrid |
|  | 2022 Ford F150 Pickup 4WD 6cyl 2.7L Automatic (S10) Gasoline | $ 35,885 | 19/24 mpg | Gasoline |

**Normal Daily Use**

Average daily driving distance: 15 miles
Days per week: 5
Weeks per year: 52
Percent highway: 2

**Other Trips**

Annual mileage: 100 miles
Percent highway: 100

**Electricity Use**
Select a state so we can find the electricity price and calculate the emissions from generating electricity in your area.

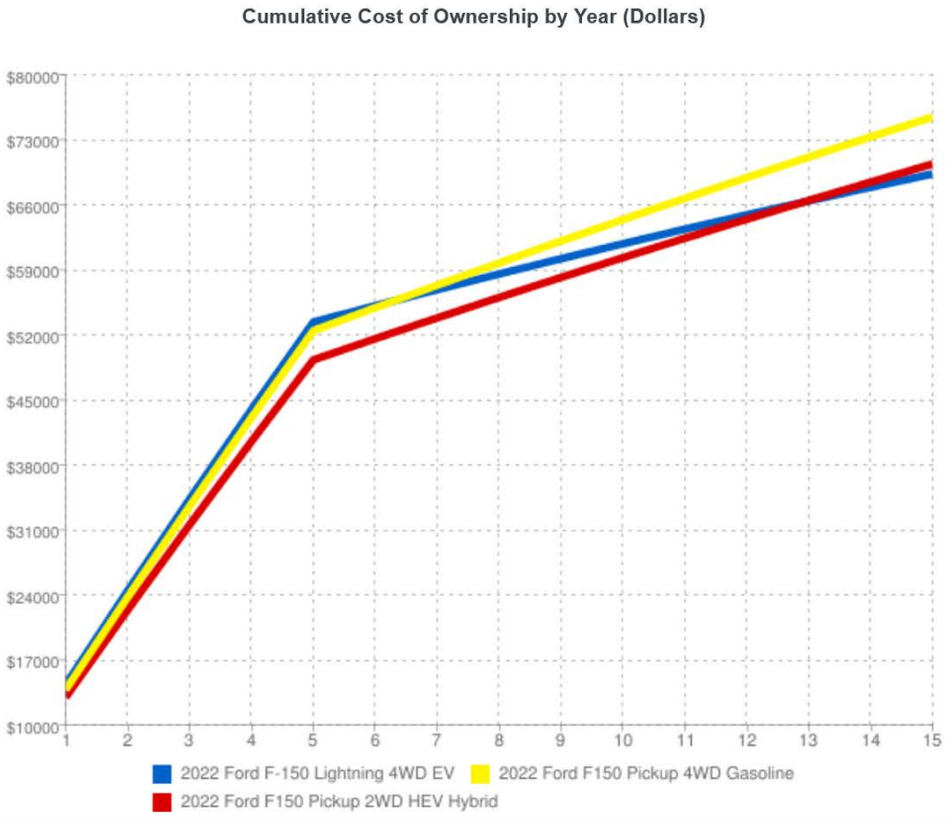
Wyoming

**Annual Driving Distance** 4000 miles
**City Distance** 3822 miles
**Highway Distance** 178 miles

## HIGH FUEL PRICE SCENARIO ($4.13/ GALLON)

| Vehicle | Annual Fuel Use | Annual Electricity Use | Annual Fuel/Elec Cost | Annual Operating Cost | Cost Per Mile | Annual Emissions (lbs CO2) |
|---|---|---|---|---|---|---|
| 2022 Ford F-150 Lightning 4WD EV | 0 gal | 1,792 kWh | $201 | $1,981 | $0.50 | 3,524 |
| 2022 Ford F150 Pickup 2WD HEV Hybrid | 160 gal | 0 kWh | $661 | $2,492 | $0.62 | 3,840 |
| 2022 Ford F150 Pickup 4WD Gasoline | 209 gal | 0 kWh | $861 | $2,693 | $0.67 | 5,006 |

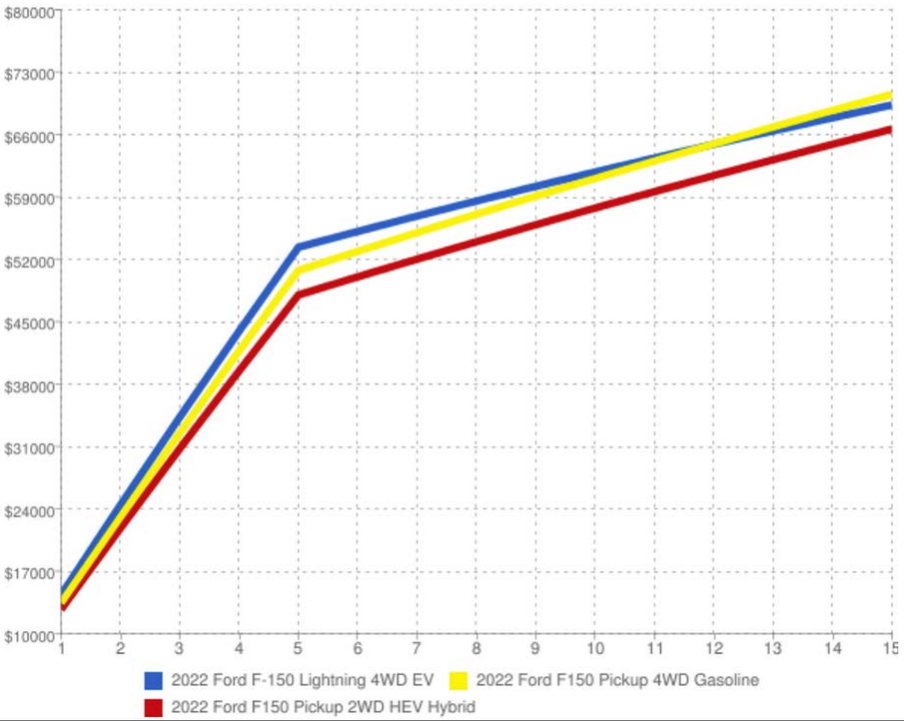
HIGH FUEL PRICE SCENARIO ($4.13/ GALLON)




## LOW FUEL PRICE SCENARIO ($2.50/ GALLON)

| Vehicle | Annual Fuel Use | Annual Electricity Use | Annual Fuel/Elec Cost | Annual Operating Cost | Cost Per Mile | Annual Emissions (lbs CO2) |
|---|---|---|---|---|---|---|
| 2022 Ford F-150 Lightning 4WD EV | 0 gal | 1,792 kWh | $201 | $1,981 | $0.50 | 3,524 |
| 2022 Ford F150 Pickup 2WD HEV Hybrid | 160 gal | 0 kWh | $400 | $2,231 | $0.56 | 3,840 |
| 2022 Ford F150 Pickup 4WD Gasoline | 209 gal | 0 kWh | $521 | $2,353 | $0.59 | 5,006 |

LOW FUEL PRICE SCENARIO ($2.50/ GALLON)



| | Vehicle | Price | Fuel Economy (City/Hwy) | Fuel Type |
|---|---|---|---|---|
|  | 2022 Chevrolet Bolt EUV Automatic (variable gear ratios) EV | $ 33,000 Tax credit? | 27/32 kWh/100mi | Electric |
|  | 2022 Toyota RAV4 Prime 4WD 4cyl 2.5L Automatic (AV-S6) Plug-in Hybrid | $ 39,800 Tax credit? | 40/36 mpg 32/40 kWh/100mi | Plug-in Hybrid |
|  | 2022 Toyota RAV4 Hybrid AWD 4cyl 2.5L Automatic (AV-S6) Hybrid | $ 29,575 Tax credit? | 41/38 mpg | Hybrid |
|  | 2022 Toyota RAV4 AWD 4cyl 2.5L Automatic (S8) Gasoline | $ 29,845 | 25/33 mpg | Gasoline |

**Normal Daily Use**

Average daily driving distance: 15 miles

Days per week: 3

Weeks per year: 52

Percent highway: 20

**Other Trips**

Annual mileage: 1000 miles

Percent highway: 100

**Annual Driving Distance** 3340 miles
**City Distance** 1872 miles
**Highway Distance** 1468 miles

**Electricity Use**

Select a state so we can find the electricity price and calculate the emissions from generating electricity in your area.

Wyoming

How often do you plug in your vehicle during normal daily use?

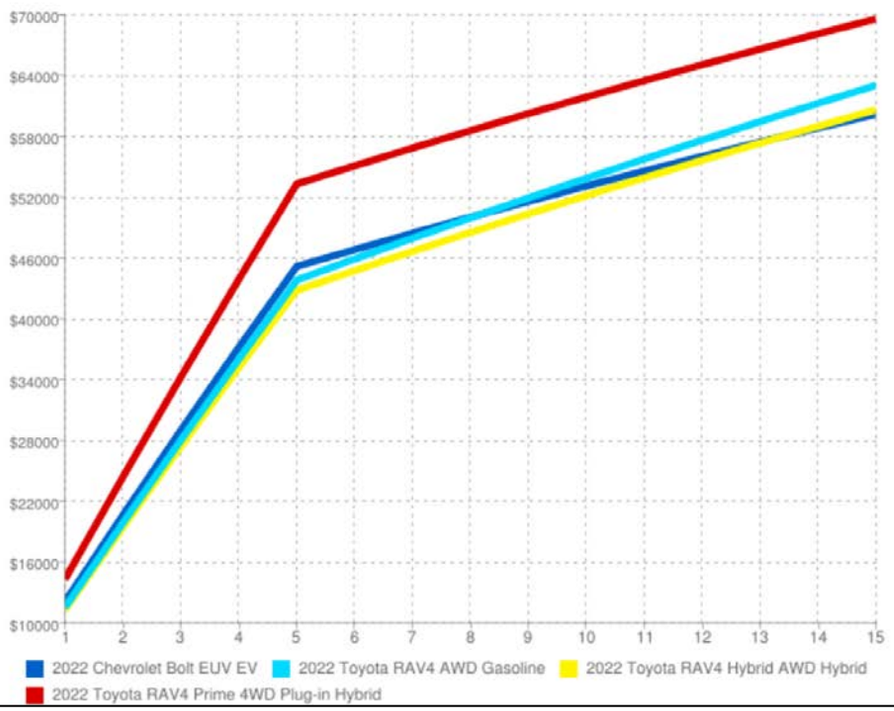
- ○ Twice a day
- ◉ Daily
- ○ Every other day

## HIGH FUEL PRICE SCENARIO ($4.13/ GALLON)

| Vehicle | Annual Fuel Use | Annual Electricity Use | Annual Fuel/Elec Cost | Annual Operating Cost | Cost Per Mile | Annual Emissions (lbs CO2) |
|---|---|---|---|---|---|---|
| 2022 Chevrolet Bolt EUV EV | 0 gal | 980 kWh | $110 | $1,863 | $0.56 | 1,928 |
| 2022 Toyota RAV4 Prime 4WD Plug-in Hybrid | 28 gal | 786 kWh | $203 | $1,998 | $0.60 | 2,213 |
| 2022 Toyota RAV4 Hybrid AWD Hybrid | 84 gal | 0 kWh | $348 | $2,144 | $0.64 | 2,023 |
| 2022 Toyota RAV4 AWD Gasoline | 119 gal | 0 kWh | $493 | $2,289 | $0.69 | 2,865 |

HIGH FUEL PRICE SCENARIO ($4.13/ GALLON)

Cumulative Cost of Ownership by Year (Dollars)

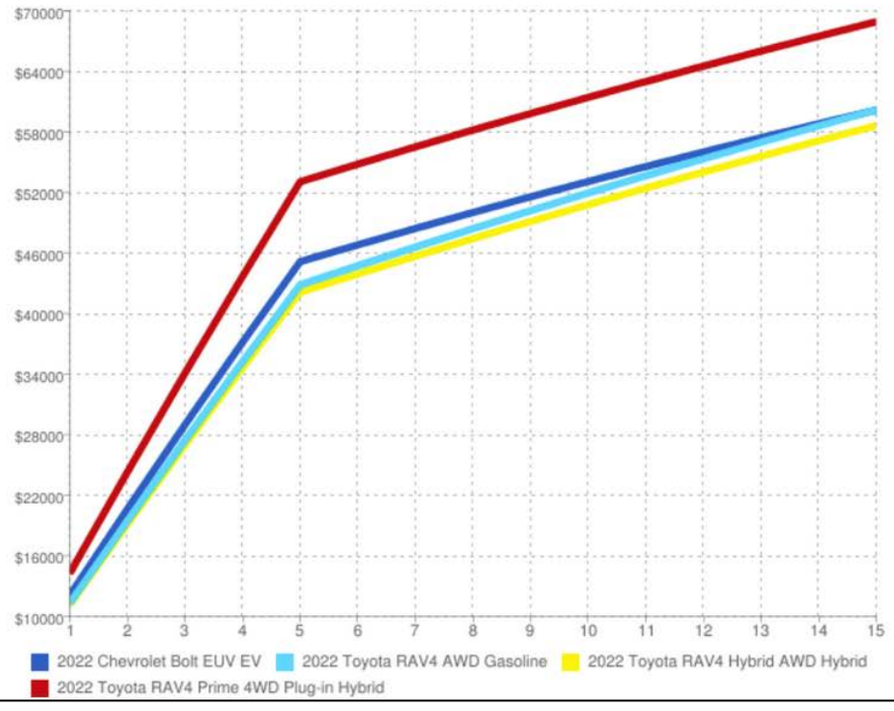



## LOW FUEL PRICE SCENARIO ($2.50/ GALLON)

| Vehicle | Annual Fuel Use | Annual Electricity Use | Annual Fuel/Elec Cost | Annual Operating Cost | Cost Per Mile | Annual Emissions (lbs CO2) |
|---|---|---|---|---|---|---|
| 2022 Chevrolet Bolt EUV EV | 0 gal | 980 kWh | $110 | $1,863 | $0.56 | 1,928 |
| 2022 Toyota RAV4 Prime 4WD Plug-in Hybrid | 28 gal | 786 kWh | $158 | $1,953 | $0.58 | 2,213 |
| 2022 Toyota RAV4 Hybrid AWD Hybrid | 84 gal | 0 kWh | $211 | $2,006 | $0.60 | 2,023 |
| 2022 Toyota RAV4 AWD Gasoline | 119 gal | 0 kWh | $298 | $2,094 | $0.63 | 2,865 |

LOW FUEL PRICE SCENARIO ($2.50/ GALLON)

Cumulative Cost of Ownership by Year (Dollars)



| | Vehicle | Price | Fuel Economy (City/Hwy) | Fuel Type |
|---|---|---|---|---|
|  | 2022 Chevrolet Bolt EV<br>Automatic (variable gear ratios) EV | $ 31,000<br>Tax credit? | 26/31 kWh/100mi | Electric |
|  | 2022 Chevrolet Malibu<br>4cyl 2.0L Automatic 9-spd Gasoline | $ 23,400 | 22/33 mpg | Gasoline |

**Normal Daily Use**

| | | |
|---|---|---|
| Average daily driving distance | 15 | miles |
| Days per week | 3 | |
| Weeks per year | 52 | |
| Percent highway | 20 | |

**Other Trips**

| | | |
|---|---|---|
| Annual mileage | 1000 | miles |
| Percent highway | 100 | |

**Annual Driving Distance** 3340 miles
**City Distance** 1872 miles
**Highway Distance** 1468 miles

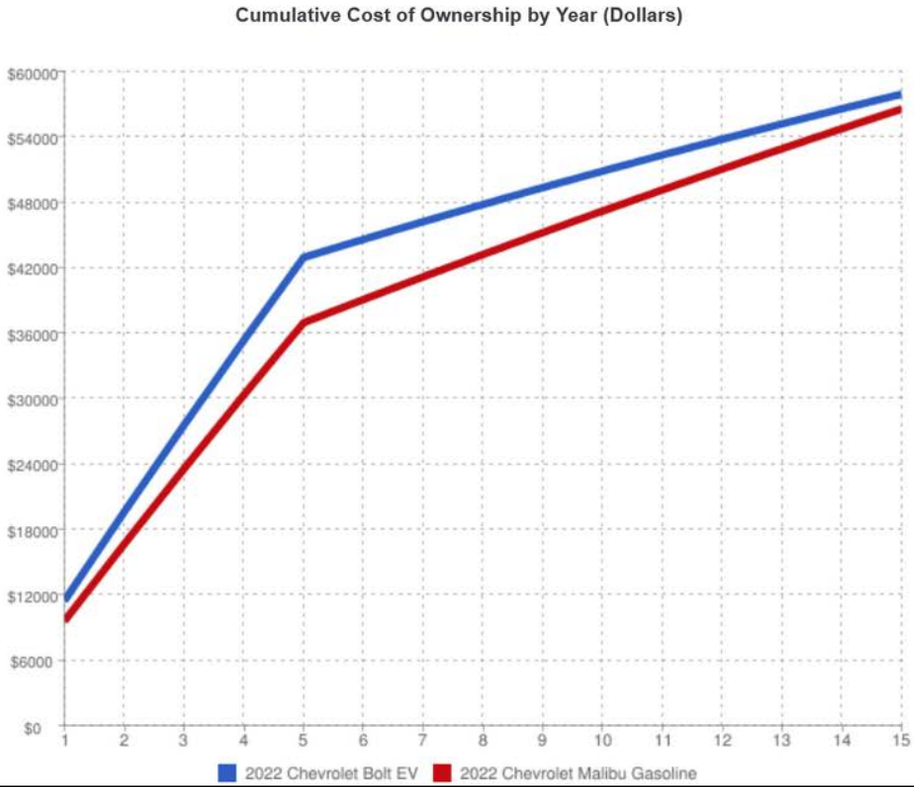
**Electricity Use**
Select a state so we can find the electricity price and calculate the emissions from generating electricity in your area.

Wyoming

## HIGH FUEL PRICE SCENARIO ($4.13/ GALLON)

| Vehicle | Annual Fuel Use | Annual Electricity Use | Annual Fuel/Elec Cost | Annual Operating Cost | Cost Per Mile | Annual Emissions (lbs CO2) |
|---|---|---|---|---|---|---|
| 2022 Chevrolet Bolt EV | 0 gal | 937 kWh | $105 | $1,858 | $0.56 | 1,843 |
| 2022 Chevrolet Malibu Gasoline | 130 gal | 0 kWh | $535 | $2,331 | $0.70 | 3,110 |

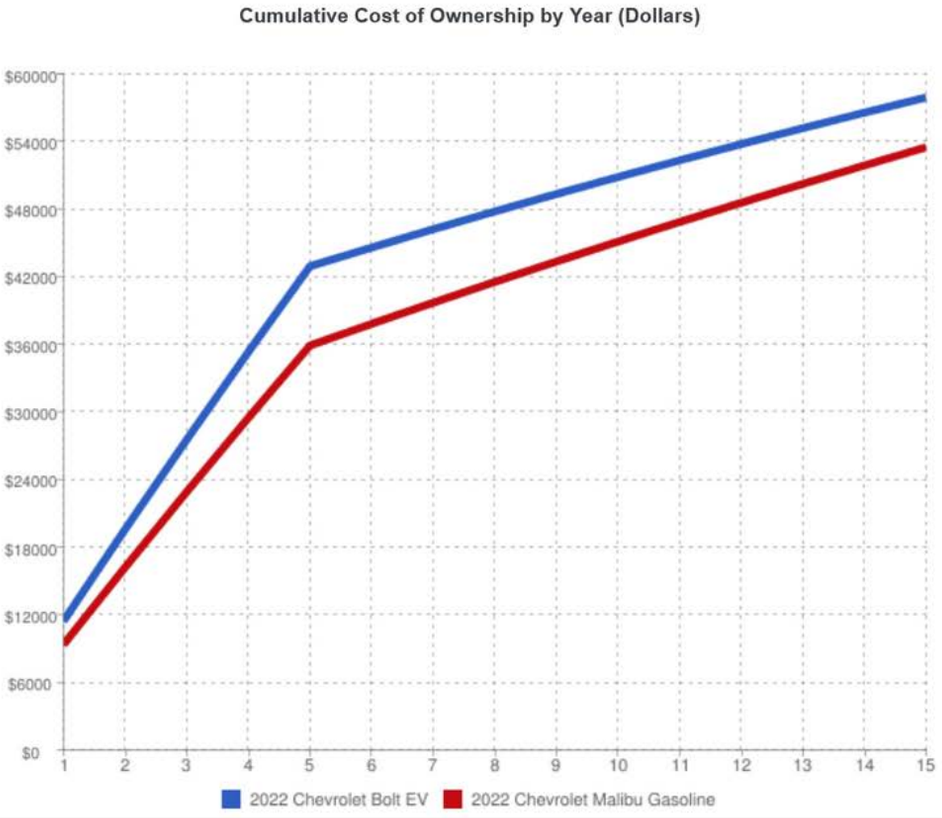
HIGH FUEL PRICE SCENARIO ($4.13/ GALLON)



## LOW FUEL PRICE SCENARIO ($2.50/ GALLON)

| Vehicle | Annual Fuel Use | Annual Electricity Use | Annual Fuel/Elec Cost | Annual Operating Cost | Cost Per Mile | Annual Emissions (lbs CO2) |
|---|---|---|---|---|---|---|
| 2022 Chevrolet Bolt EV | 0 gal | 937 kWh | $105 | $1,858 | $0.56 | 1,843 |
| 2022 Chevrolet Malibu Gasoline | 130 gal | 0 kWh | $324 | $2,120 | $0.63 | 3,110 |

LOW FUEL PRICE SCENARIO ($2.50/ GALLON)




PRE-2000 VEHICLES FROM THE CITY'S FLEET WITH ASSUMPTIONS OF $4.13/GALLON AND A $10,000 PURCHASE PRICE.

| Vehicle | Annual Fuel Use | Annual Electricity Use | Annual Fuel/Elec Cost | Annual Operating Cost | Cost Per Mile | Annual Emissions (lbs CO2) |
|---|---|---|---|---|---|---|
| 1966 Chevy Drill Truck Gasoline | 400 gal | 0 kWh | $1,652 | $3,483 | $0.87 | 9,600 |
| 1986 Ford Dump Truck Gasoline | 333 gal | 0 kWh | $1,377 | $3,208 | $0.80 | 8,000 |
| 1992 Ford F350 4WD Gasoline | 500 gal | 0 kWh | $2,065 | $3,896 | $0.97 | 12,000 |
| 1993 Ford F150 4WD Gasoline | 308 gal | 0 kWh | $1,271 | $3,102 | $0.78 | 7,385 |
| 1998 Ford LTD Crown Vic Gasoline | 250 gal | 0 kWh | $1,033 | $2,864 | $0.72 | 6,000 |
| 1999 Ford Explorer Gasoline | 220 gal | 0 kWh | $909 | $2,740 | $0.69 | 5,282 |
| 1992 Ford F250 4WD Gasoline | 308 gal | 0 kWh | $1,271 | $3,102 | $0.78 | 7,385 |
| 1992 Ford F150 4WD Gasoline | 308 gal | 0 kWh | $1,271 | $3,102 | $0.78 | 7,385 |
| 1992 Ford F150 4WD (1) Gasoline | 308 gal | 0 kWh | $1,271 | $3,102 | $0.78 | 7,385 |
| 1993 Ford F150 4WD Gasoline | 308 gal | 0 kWh | $1,271 | $3,102 | $0.78 | 7,385 |
| 1999 Ford R-1 (Ranger?) Diesel | 235 gal | 0 kWh | $1,191 | $3,022 | $0.76 | 5,191 |
| 1997 Ford F250 Gasoline | 308 gal | 0 kWh | $1,271 | $3,102 | $0.78 | 7,385 |
| 1999 Ford 1/2 ton 4WD Gasoline | 286 gal | 0 kWh | $1,180 | $3,011 | $0.75 | 6,857 |
| 1995 Ford Ranger Gasoline | 222 gal | 0 kWh | $918 | $2,749 | $0.69 | 5,333 |
| 1994 Ford (model?) Gasoline | 222 gal | 0 kWh | $918 | $2,749 | $0.69 | 5,333 |
| 1999 Ford 1/2 Ton 4WD (1) Gasoline | 286 gal | 0 kWh | $1,180 | $3,011 | $0.75 | 6,857 |