# Introduction to System76's Sustainability Reporting

At **System76**, our commitment to open, accessible, and sustainable technology continues to guide us. From premium Linux laptops, desktops, and servers to our community-favored operating system, **Pop!_OS**, we remain dedicated to empowering creators, innovators, and builders to shape a better future.

In this report, we reaffirm our core principles of **Reduce, Reuse, Recycle**. Our products are designed for longevity and repairability, and we continue to integrate recycled materials, offer lifetime support, and facilitate cost-free recycling programs. This ongoing approach underpins our efforts to minimize waste and extend product life cycles.

This report is prepared in accordance with the **Global Reporting Initiative** (GRI) Standards, focusing on disclosures related to **energy consumption** (GRI 302), **water and effluents** (GRI 303), and **emissions** (GRI 305). While we are in the process of finalizing our environmental management system, this report reflects our continuous commitment to transparency and sustainability as we lay the groundwork for future improvements.

Below, you will find the GRI Content Index, outlining the specific disclosures covered in this report, the pages where they can be found, and any relevant explanations.

# GRI Index

| GRI Standard | Disclosure Number | Disclosure Title | Page Number | Omissions |
|---|---|---|---|---|
| GRI 2: General Disclosures | | Organization and Reporting Practices | | |
| GRI 2 | 2-1 | Organizational details | Page 2 | None |
| GRI 2 | 2-2 | Entities included in sustainability reporting | Page 3 | None |
| GRI 2 | 2-3 | Reporting period, frequency, and contact point | Page 4 | None |
| GRI 2 | 2-4 | Restatements of information | Page 4 | None |
| GRI 2 | 2-5 | External assurance | Page 5 | None |

| | | | | |
|---|---|---|---|---|
| GRI 302: Energy | | Energy | | |
| GRI 302 | 302-1 | Energy consumption within the organization | Page 5 | None |
| GRI 303: Water and Effluents | | Water Management | | |
| GRI 303 | 303-3 | Water withdrawal | Page 10 | Water data includes the entire building's use, and it was not possible to separate System76's water use from another business or irrigation. No immediate plans for sub-metering. Located in an area of extreme water stress. |
| GRI 303 | 303-5 | Water consumption | Page 13 | |
| GRI 305: Emissions | | Emissions | | |
| GRI 305 | 305-1 | Direct (Scope 1) GHG emissions | Page 17 | None |
| GRI 305 | 305-2 | Energy indirect (Scope 2) GHG emissions | Page 20 | None |
| GRI 305 | 305-7 | Nitrogen oxides ($NO_x$), sulfur oxides ($SO_x$), and other significant air emissions | Page 23 | None |

## GRI 2-1: Organizational Details

**Legal Name:**
System76, Inc.[1]

**Primary Activities, Products, and Services**
System76, Inc. is a leading manufacturer of open-source hardware, including Linux-based laptops, desktops, servers, and accessories. The company also develops and maintains Pop!_OS, a Linux operating system that empowers creators, innovators, and builders to achieve their potential by providing a highly customizable and secure platform. System76 advocates for user freedom, including the right to repair and modify the technology they purchase.

**Headquarters Location**
System76, Inc. is headquartered in Denver, Colorado, USA.

**Ownership and Legal Form**
System76, Inc. is a privately held corporation.

**Countries of Operation**
System76 operates primarily within the United States, with global product distribution through its online sales platform. Additionally, some of the remote software developers the company employs, who contribute to the development of Pop!_OS, are based in Europe.

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## GRI 2-2: Entities Included in Sustainability Reporting

This sustainability report covers **System76, Inc.**, including its headquarters in **Denver, Colorado**, where the company designs, manufactures, and distributes its Linux-based laptops, desktops, servers, and accessories.

The reporting boundaries for this sustainability report are consistent with those used for financial reporting. There are no significant differences between the entities considered in financial reporting and those included in this sustainability report.

System76 does not control or have ownership in any other operational entities beyond those included in this report. Sustainability impacts associated with our **remote employees**, including remote developers located in Europe, are considered immaterial due to their small number and the nature of their work, which is entirely digital and remote. As such, their environmental impact (such as energy use and emissions) is excluded from this report.

This report covers the sustainability impacts of the following:

- The **Denver manufacturing facility**, where the primary environmental impacts include **energy consumption**, **water use**, and **emissions** from production processes.
- The remote activities of employees contributing to **Pop!_OS** from various locations, with sustainability reporting focused on operational practices within our Denver headquarters.

No other entities are included in this report as System76, Inc. does not have operational control or significant sustainability impacts in other regions.

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## GRI 2-3: Reporting Period, Frequency, and Contact Point

**Reporting Period**
This sustainability report covers the period from **January 1, 2024, to December 31, 2024**. This period aligns with our financial reporting cycle and reflects System76's sustainability performance during the calendar year 2024.

**Reporting Frequency**
System76, Inc. intends to issue its sustainability reports on an **annual** basis. This report is the first in a series of annual sustainability reports that will document the progress of our environmental and social initiatives, focusing on our energy consumption, water use, and emissions.

**Contact Point for Questions Regarding the Report**
For any questions or inquiries regarding this sustainability report or our sustainability initiatives, please contact:

**Jacob Kaulike**
**Sustainability Lead**
System76, Inc.
Email: **sustainability@system76.com**
Phone: **+1 (720) 226-9269**
Address: **4240 Carson St Suite 101, Denver, Colorado, 80239, USA**

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## GRI 2-4: Restatements of Information

This report covers the period from January 1, 2024, to December 31, 2024, and builds on the foundation established in our inaugural report for the period from January 1, 2023, to December 31, 2023. There are no material changes to the data or methodology previously disclosed. As we continue to use the same methodology, no corrections or revisions to previously reported information are necessary.

In future reports, any significant changes—including revisions to methodologies, data corrections, or adjustments in reporting boundaries—will be transparently disclosed in this section.

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# GRI 2-5: External Assurance

System76, Inc. has obtained third-party assurance to verify the accuracy and reliability of the data presented in this sustainability report. The assurance engagement was conducted by ISOS Group, Inc., an independent assurance provider, in accordance with the AccountAbility 1000 Assurance Standard v3 (“AA1000AS”).

The assurance process included an evaluation of the following key disclosures:

- **Energy consumption** (GRI 302-1)
- **Greenhouse gas emissions** (GRI 305-1, GRI 305-2, & 305-7)
- **Water withdrawal** (GRI 303-3)

ISOS Group, Inc. assessed the completeness, accuracy, and consistency of the reported data, applying recognized assurance standards to ensure the credibility and transparency of System76's sustainability reporting practices. The final assurance statement, which outlines the methodology, findings, and recommendations, is available here.

System76’s commitment to third-party assurance underscores our dedication to transparency, accuracy, and accountability in our sustainability practices.

**Change in assurance scope**

On May 28, 2025, the scope of the third-party assurance was expanded to include our water withdrawal disclosure (GRI 303-3). This update supersedes the original engagement, which covered only energy consumption and greenhouse gas emissions.

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# GRI 302-1: Energy Consumption within the Organization

For the 2024 reporting period, System76’s energy consumption continues to be measured by the electricity and natural gas used at our headquarters and manufacturing facility in Denver, Colorado. All energy figures are converted into gigajoules (GJ) for consistency. For context, we also present the 2023 figures for comparison.

**2023 Energy Consumption from Non-Renewable Sources**

- **Natural Gas:** In **2023**, we consumed **6,838 therms** of natural gas, primarily for heating purposes. Using the conversion factor (**1 therm = 0.1054804 GJ**[2]), this equals **721.275 GJ** of energy.
- **Electricity:** In **2023**, System76 purchased **246,960 kWh** of electricity from the local grid in the **Colorado** eGRID subregion[3]. With a conversion factor of **1 kWh = 0.0036 GJ**[4], this amounts to **889.056 GJ** of energy.

- **Total Energy Consumption (2023):** The combined total energy consumption for **2023** was **1,610.331 GJ**.

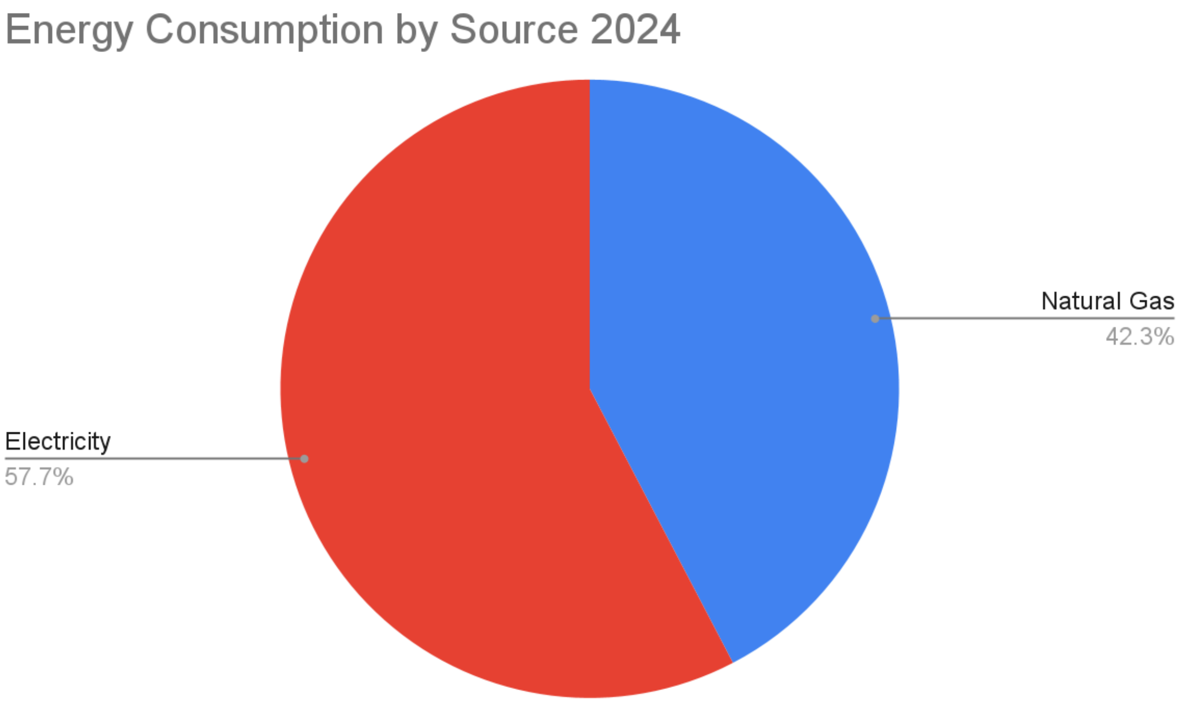
**2024 Comparative Energy Consumption**

For 2024, using the same conversion factors and methodology, our consumption at the same facilities was:

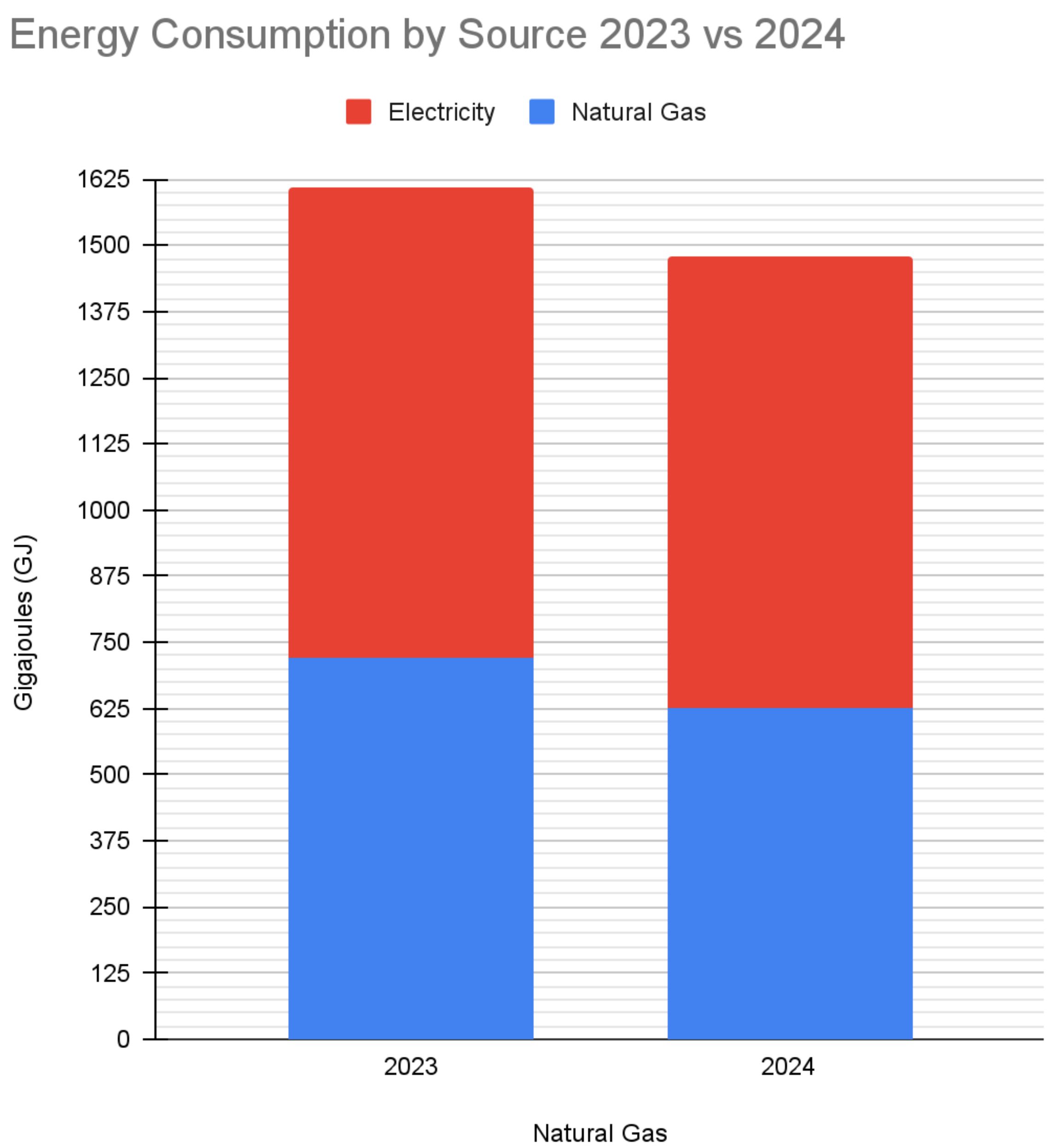
- **Natural Gas:** We consumed **5,931 therms** of natural gas, which converts to approximately **625 GJ** of energy.
- **Electricity:** System76 purchased **236,680 kWh** of electricity from the local grid in the **Colorado** eGRID subregion[5], translating to approximately **852.048 GJ** of energy.
- **Total Energy Consumption (2024):** The combined total for 2024 is approximately **1,477.05 GJ**, reflecting a reduction in energy use compared to 2023 and highlighting our ongoing efforts to optimize energy consumption.

*Notes:*

- The conversion factors used are: **1 therm = 0.1054804 GJ**[6] and **1 kWh = 0.0036 GJ**[7].
- No renewable energy was purchased or self-generated in either reporting period.
- System76 did not generate or sell electricity, heating, cooling, or steam in either reporting period..
- The methodology used to report these figures has remained consistent between 2023 and 2024, ensuring the comparability of our data and supporting our commitment to transparent reporting.



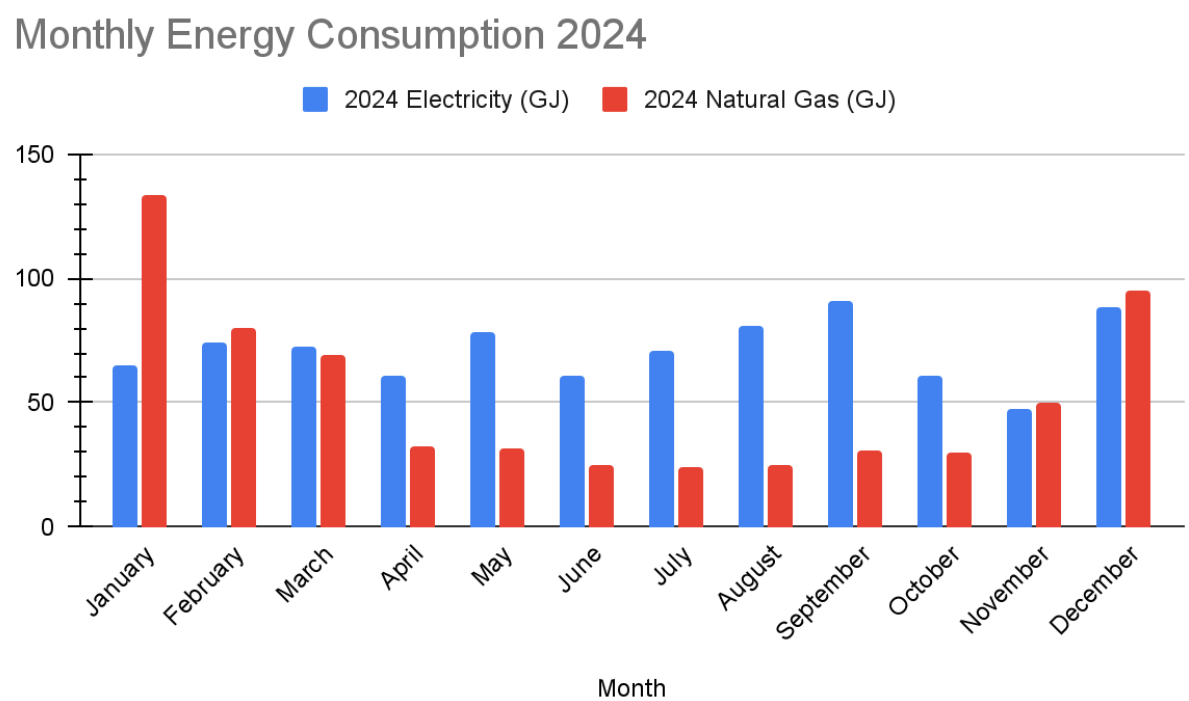

| Energy Source | Unit | Amount | Gigajoules (GJ) |
|---|---|---|---|
| Natural Gas | Therms | 5,931 | 625 GJ |
| Electricity | kWh | 236,680 | 852.048 GJ |
| **Total Energy** | - | - | **1,477.048 GJ** |



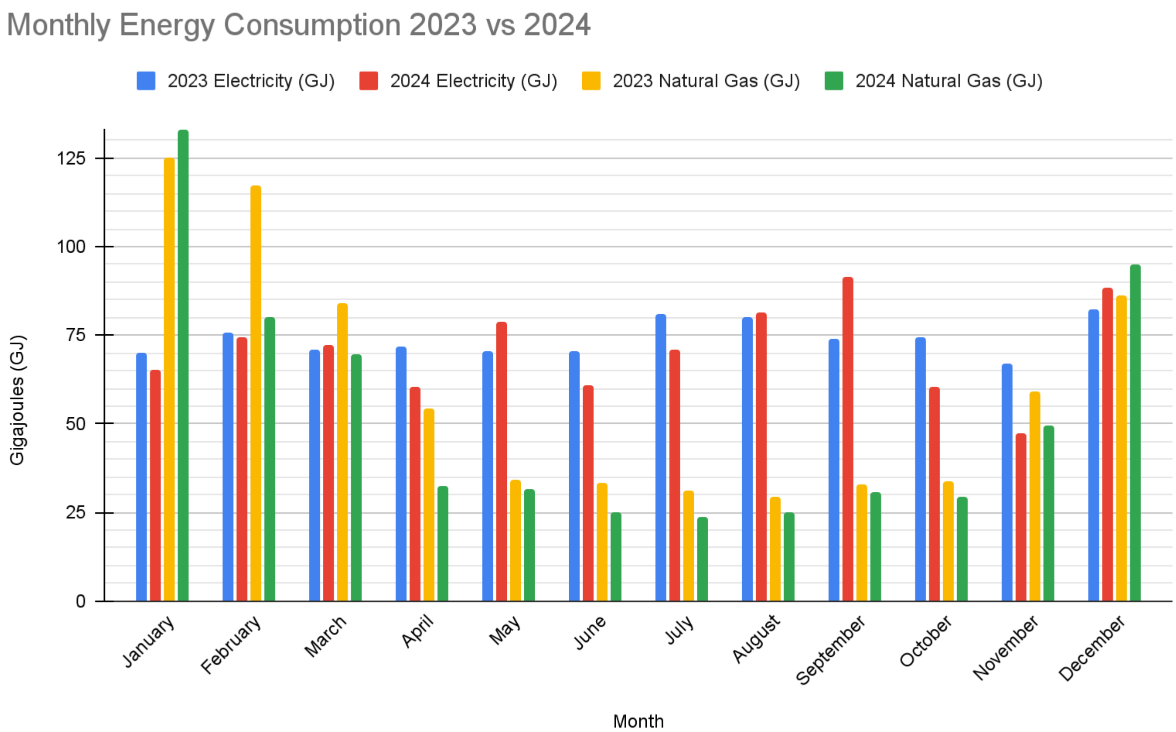

| Energy Source | Unit | 2023 Consumption | 2023 (GJ) | 2024 Consumption | 2024 (GJ) |
|---|---|---|---|---|---|
| Natural Gas | Therms | 6,838 | 721.275 | 5,931 | 625.0 |
| Electricity | kWh | 246,960 | 889.056 | 236,680 | 852.048 |
| **Total Energy** | - | - | **1,610.331** | - | **1,477.048** |

## Monthly Energy Consumption

We tracked energy consumption on a monthly basis to observe any seasonal trends and ensure continuous monitoring of energy use.




| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Electricity | 65.09 | 74.59 | 72.29 | 60.48 | 78.62 | 60.77 | 71.14 | 81.22 | 91.3 | 60.62 | 47.52 | 88.42 |
| Natural Gas | 133.11 | 79.93 | 69.45 | 32.56 | 31.80 | 25.22 | 23.89 | 24.87 | 30.52 | 29.54 | 49.66 | 95.11 |




| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2023 Electricity | 69.98 | 75.74 | 71.14 | 72.0 | 70.56 | 70.56 | 80.93 | 80.06 | 74.02 | 74.59 | 67.1 | 82.37 |
| 2024 Electricity | 65.09 | 74.59 | 72.29 | 60.48 | 78.62 | 60.77 | 71.14 | 81.22 | 91.3 | 60.62 | 47.52 | 88.42 |
| 2023 Natural Gas | 124.95 | 117.29 | 84.19 | 54.32 | 34.34 | 33.2 | 31.15 | 29.47 | 33.10 | 33.63 | 59.25 | 86.41 |
| 2024 Natural Gas | 133.11 | 79.93 | 69.45 | 32.56 | 31.80 | 25.22 | 23.89 | 24.87 | 30.52 | 29.54 | 49.66 | 95.11 |

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## GRI 303-3: Water Withdrawal

System76's water withdrawal is sourced entirely from the **municipal water supply** at our headquarters in **Denver, Colorado**. Due to the absence of **sub-metering**, it remains **impossible to separate System76's specific water use** from that of another business operating in the same building or from water used for irrigation. **This limitation persists in 2024 and is expected to continue for the foreseeable future.**

**Water Withdrawal Overview**

| Year | Water Withdrawal (gallons) | Water Withdrawal (ML) |
|---|---|---|
| **2023** | 187,000 | 0.71 |
| **2024** | 195,000 | 0.74 |

**Conversion Details**

- **NIST Conversion Factors:**
  1 US gallon = 3.785412 liters[8]
  1 Megaliter (ML) = 1,000,000 liters[9]
- **2023 Conversion Calculation:**
  **2023 Water Withdrawal**: 187,000 gallons
  $187,000\ gallons \times 3.785412 \frac{liter}{gallon} = 707,872\ liters$
  $707,872\ liters \times (\frac{1}{1,000,000} (\frac{ML}{liter})) = 0.707872\ ML$
  (Rounded, this is approximately **0.71 ML**)
- **2024 Conversion Calculation:**
  **2024 Water Withdrawal:**
  $195,000\ gallons \times 3.785412 \frac{liter}{gallon} = 738,155\ liters$
  $738,155\ liters \times (\frac{1}{1,000,000} (\frac{ML}{liter})) = 0.738155\ ML$
  (Rounded, this is approximately **0.74 ML**)

**Water Withdrawal by Source**

| Source | Unit | 2023 | 2024 |
|---|---|---|---|
| Municipal Water Supply | ML | 0.71 ML | 0.74 ML |
| Total Water Withdrawal | ML | 0.71 ML | 0.74 ML |

**Allocation Methodology for Water Withdrawal (2024)**

Beginning with the 2024 reporting period, System76 has adopted an **allocation methodology** to better estimate our specific share of building-wide water withdrawal. This change was implemented to improve the accuracy and transparency of our sustainability reporting.

Since no sub-metering exists, we have allocated our portion of the water use based on **floor area occupied**:

- **System76 occupancy:** 22,316 $ft^2$
- **Total building area:** 36,089 $ft^2$

- **System76's share:** $\frac{22,316}{36,089} \approx 0.6184$ or 61.84%

Using this factor, System76's **estimated water withdrawal for 2024** is:

$$195,000\ gallons \times 0.6184 = 120,588\ gallons$$
$$120,588\ gallons \times 3.785412 \frac{liter}{gallon} = 456,475\ liters$$
$$456,475\ liters \times (\frac{1}{1,000,000} (\frac{ML}{liter})) = 0.456475\ ML$$

**Allocated 2024 Water Withdrawal: 0.46 ML**

| **Metric** | **Unit** | **2024 (Allocated)** |
|---|---|---|
| System76 Estimated Withdrawal | ML | 0.46 |

**Water Source**
All water withdrawn is sourced from the municipal water supply. No water is withdrawn from surface water, groundwater, seawater, or other third-party sources.

**Water Stress Context**
System76 operates in Denver, Colorado, an area classified as having high water stress (with water stress levels between 40% and 80%)[10]. This classification underscores the importance of responsible water management in System76's operations to reduce unnecessary water consumption.

**Limitations and Future Reporting**
System76 currently receives water usage data for the entire building, which includes consumption by another business and irrigation over which we have no control. Due to the absence of sub-metering, it remains impossible to directly measure System76's specific water use.

Beginning in 2024, we have implemented a square footage–based allocation methodology to more accurately estimate our portion of water withdrawal. While this approach improves reporting accuracy, it remains an approximation based on building occupancy rather than direct measurement.

There are no current plans to install sub-metering or water monitoring systems. As a result, allocated estimates will continue to be used in future reporting periods, unless more precise data becomes available.

**Clarification Regarding 2023 Methodology and Earlier Versions of This Report**

The 2023 water withdrawal disclosure did not use an allocation methodology. Instead, the entire building-wide water usage total (187,000 gallons) was reported as System76's water withdrawal, even though it included irrigation and water used by another tenant. While this approach was transparent about its limitations, it did not isolate System76's specific operational usage.

An earlier published version of this 2024 report also presented water withdrawal data without applying an allocation methodology. In alignment with a recommendation included in the public assurance statement for this report, the updated version now applies an area-based allocation approach to more accurately reflect System76's share of water withdrawal.

This correction was made to improve the accuracy and transparency of our water-related disclosures and to provide a clearer reflection of System76's actual operational water use.

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## GRI 303-5: Water Consumption

System76's operations at **4240 Carson St, Denver, Colorado** involve **water consumption for both operational and employee use**. While total **water withdrawal** includes irrigation and water used by another business in the same building, only a **portion of this water is actually consumed**, meaning it **is not returned to the municipal system**.

Based on **operational processes**, System76 estimates the following **annual water consumption** for 2023 and 2024:

**Water Consumption Overview**

| Year | Water Consumed (gallons) | Water Consumed (ML) |
|---|---|---|
| **2023** | 27,480.56 | 0.104 ML |
| **2024** | 29,514.34 | 0.112 ML |

### Water for Powder Coating (Etch & Rinse Tanks)

System76's **powder coating process** requires **two 300-gallon tanks**:

- **Etch tank** – used for surface preparation.
- **Rinse tank** – used to remove excess chemicals.

## Annual Water Usage Breakdown

- **Complete refills:** Each tank is fully refilled **3 times per year**, using **600 gallons per refill (300 per tank)**.
- **Top-offs:** Between refills, each tank is **topped off 3 times**, with **1.5 gallons per tank per top-off**.
- **Disposal: All water from these tanks is collected and sent for safe disposal**, meaning it **is not returned to the municipal system**.

**Total powder coating water consumption (unchanged from 2023)**

1. **Complete refills**
   - Each tank is completely refilled 3 times per year.
   - Total per refill: $300 \frac{gallons}{refill} \times 2\ tanks = 600 \frac{gallons}{refill}$
   - Total refills per year: $600 \frac{gallons}{refill} \times 3 \frac{refills}{year} = 1,800 \frac{gallons}{year}$
2. **Top-offs between refills**
   - Each tank is topped off 3 times per complete refill cycle.
   - Each top-off uses 1.5 gallons per tank.
   - Total per top-off cycle: $1.5 \frac{gallons}{top\ off} \times 2\ tanks = 3 \frac{gallons}{top\ off}$
   - Total top-offs per year: $3 \frac{gallons}{top\ off} \times 3 \frac{top\ offs}{refill} \times 3 \frac{refills}{year} = 27 \frac{gallons}{year}$

**Total annual powder coating water consumption (2023 & 2024)**

$$1,800\ gallons + 27\ gallons = 1,827\ gallons$$

## Employee drinking water consumption

Drinking water estimates are based on daily per-worker consumption of 0.34375 gallons[11]

### Calculation

$$Estimated\ Annual\ Drinking\ Water\ Consumption = Workers \times Days \times 0.34375 \frac{gallons}{day}$$

### 2023 Calculation

- Workers in factory: 34[12]
- Working Days in 2023: 251[13]
- **Calculation**:

  $$34\ workers \times 251\ days \times 0.34375 \frac{gallons}{day} = 2,933.56\ gallons$$

### 2024 Calculation

- Workers in factory: 31[14]
- Working Days in 2024: 254[15]

- **Calculation**:
  $31\ workers \times 254\ days \times 0.34375 \frac{gallons}{day} = 2,706.69\ gallons$

## Swamp coolers (weekdays, July–October)

Swamp coolers consume water only when operating. Due to higher temperatures in 2024, estimated operating hours increased between 2023 and 2024. Each swamp cooler consumes an estimated 20 gallons of water per hour[16]. System76 uses 2 swamp coolers to cool its factory.

### Calculation

$Estimated\ Annual\ Swamp\ Cooler\ Water\ Consumption = Average\ Daily\ hours \times 20 \frac{gallons}{hour} \times Weekdays$

### 2023 Calculation

- Average daily hours operating: 6.5287[17]
- Week days in operating months: 87[18]
- **Calculation**:
  $6.5287 \frac{hours}{weekday} \times 20 \frac{gallons}{hour} \times 87\ weekdays = 11,360\ gallons$
  $11,360\ gallons \times 2\ swamp\ coolers = 22,720\ gallons$

### 2024 Calculation

- Average daily hours operating: 7.1798[19]
- Week days in operating months: 89[20]
- **Calculation**:
  $7.1798 \frac{hours}{weekday} \times 20 \frac{gallons}{hour} \times 89\ weekdays = 12,780\ gallons$
  $12,780\ gallons \times 2\ swamp\ coolers = 25,560\ gallons$

### Conversion Details

- **NIST Conversion Factors:**
  1 US gallon = 3.785412 liters[21]
  1 ML = 1,000,000 liters[22]
- **Calculation**:
  To convert gallons to megaliters:
  $ML = (gallons \times 3.785412 \frac{liter}{gallon}) \times (\frac{1}{1{,}000{,}000} (\frac{ML}{liter}))$

### Using this conversion

- **Powder Coating**
  - **2023 & 2024:**
    $1,827\ gallons \times 3.785412 \frac{liter}{gallon} \times (\frac{1}{1{,}000{,}000} (\frac{ML}{liter})) \approx 0.00692\ ML$
- **Employee Consumption**

- **2023**:
  $2,933.56\ gallons \times 3.785412\frac{liter}{gallon} \times (\frac{1}{1{,}000{,}000}(\frac{ML}{liter})) \approx 0.011105\ ML$
- **2024**:
  $2,706.69\ gallons \times 3.785412\frac{liter}{gallon} \times (\frac{1}{1{,}000{,}000}(\frac{ML}{liter})) \approx 0.010246\ ML$

- **Swamp Coolers**
  - **2023**:
    $22,720\ gallons \times 3.785412\frac{liter}{gallon} \times (\frac{1}{1{,}000{,}000}(\frac{ML}{liter})) \approx 0.086005\ ML$
  - **2024**:
    $25,560\ gallons \times 3.785412\frac{liter}{gallon} \times (\frac{1}{1{,}000{,}000}(\frac{ML}{liter})) \approx 0.096755\ ML$
- **Total Water Consumed**
  - **2023**:
    $(1,827\ +\ 2,933.56\ +\ 22,720)\ gallons\ =\ 27,480.56\ gallons$
    $27,480.56\ gallons \times 3.785412\frac{liter}{gallon} \times (\frac{1}{1{,}000{,}000}(\frac{ML}{liter})) \approx 0.104025\ ML$
    (rounded to approximately **0.104 ML**)
  - **2024**:
    $(1,827\ +\ 2,706.69\ +\ 25,560)\ gallons\ =\ 30,093.69\ gallons$
    $30,093.69\ gallons \times 3.785412\frac{liter}{gallon} \times (\frac{1}{1{,}000{,}000}(\frac{ML}{liter})) \approx 0.113917\ ML$
    (rounded to approximately **0.114 ML**)

**Water Consumption by Source**

| Water Use | Unit | 2023 Amount | 2024 Amount |
|---|---|---|---|
| Water for powder coating (etch and rinse tanks) | ML | 0.007 | 0.007 |
| Employee drinking water consumption | ML | 0.011 | 0.01 |
| Swamp coolers (weekdays July–October) | ML | 0.086 | 0.097 |
| **Total Water Consumed** | ML | 0.104 | 0.114 |

**Water Stress Context**
System76 operates in Denver, Colorado, an area classified as having high water stress (with water stress levels between 40% and 80%)[23]. This underscores the importance of responsible water management in our operations.

**Limitations**
Since System76 operates in a shared building without sub-metering, it is not possible to fully separate our water consumption from the building's total water withdrawal. The data provided here is based on estimates for known operational usage, including the etch and rinse tanks, swamp coolers, and general employee consumption.

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# GRI 305-1: Direct (Scope 1) GHG Emissions

System76's operations generate **direct (Scope 1)** greenhouse gas (GHG) emissions primarily from the combustion of **natural gas** used for heating at our **Denver** facility. This natural gas not only fuels the building's heating systems but is also used in our powder coating oven and for water heating. The following sections detail our emissions calculation methodology and provide a comparative overview of 2023 and 2024 emissions.

## Emission Calculation Methodology (2023 & 2024)

System76 calculated its Scope 1 GHG emissions from natural gas combustion using a volume-based approach, leveraging emission factors for **$CO_2$**, **$CH_4$**, and **$N_2O$** expressed in tonnes per cubic meter (m³). This method aligns with regulatory and industry-standard methodologies, such as the **GHG Protocol Stationary Combustion Guide**[24]. Below is a detailed breakdown of the methodology and calculation steps:

1. **Conversion of Natural Gas Volume to Cubic Meters**
    - The initial volume of natural gas was recorded in **ccf** (hundred cubic feet)[25]. To convert this to cubic meters (m³)[26] for consistent unit usage in the calculation:
        - Convert ccf to cubic feet: $ccf \times 100$
        - Convert cubic feet to cubic meters: $1\,ft^3 \;=\; 0.02831685\,m^3$
2. **Calculation of Emission Factor per m³**
    - Initial $CO_2$ energy basis: 53.06 kg/mmBTU[27][28]
    - Conversion factor from mmBTU to TJ: 0.001055056[29]
    - $CO_2$ energy basis converted to kg/TJ with this formula:

$$Emission\ basis\ (\frac{kg}{TJ}) \;=\; Emission\ basis\ (\frac{kg}{mmBTU}) \times (\frac{1}{0.001055056}\ (\frac{TJ}{mmBTU}))$$
$$=\; 53.06\frac{kg}{mmBTU} \times (\frac{1}{0.001055056}\ (\frac{TJ}{mmBTU})) \;=\; 50291.16938\ \frac{kg}{TJ}$$

    - The emission factor was calculated by considering the **Energy basis value (50291.16938 kg/TJ)**, **Net Calorific Value (NCV) of 48.0 TJ/Gg**[30], and **density of natural gas (0.7 kg/m³)**[31].
    - The formula[32] applied was:

$$Emission\ factor\ (\frac{Tonnes}{m^3}) \;=\; Energy\ basis\ (\frac{kg}{TJ}) \times (\frac{NCV\ (\frac{TJ}{Gg})}{1{,}000{,}000\,\frac{kg}{Gg}}) \times Density\ (\frac{kg}{m^3}) \times 0.001\frac{tonne}{kg}$$

      where the 0.001 factor at the end is to convert the units from kg to tonnes[33].
    - This calculation yielded an emission factor of **0.00169 tonnes $CO_2$ per m³**. (This factor remains unchanged between 2023 and 2024.)
3. **$CH_4$ and $N_2O$ Emissions Calculations**
    - $CH_4$ and $N_2O$ emissions were calculated using similar volume-based emission factors, derived from industry standards. For both years, the mass-based emission factors remain the same.
    - **$CH_4$ Emissions**
        - Initial energy basis: 0.001 kg/mmBTU[34][35]
        - Energy basis in kg/TJ: 0.9478 kg/TJ

- Emission Factor: 0.000000032 tonnes $CH_4$ per $m^3$

- **$N_2O$ Emissions**
  - Initial energy basis: 0.0001 kg/mmBTU[36][37]
  - Energy basis in kg/TJ: 0.09478 kg/TJ
  - Emission Factor: 0.0000000032 tonnes $N_2O$ per $m^3$
- Differences lie in the Global Warming Potentials (GWP-100) applied
  - **2023:** $CH_4$ GWP = 25[38], $N_2O$ GWP = 298[39]
  - **2024:** $CH_4$ GWP = 29[40], $N_2O$ GWP = 265[41]

## 2023 Emissions Data

**Natural Gas Consumption:** 6,941 ccf

- **Converted Volume**

  $6,941\ ccf \times 100 \frac{ft^3}{ccf} = 694,100\ ft^3$

  $694,100\ ft^3 \times 0.02831685 \frac{m^3}{ft^3} \approx 19,654.73\ m^3$
- **$CO_2$ Emissions**

  $19,654.73\ m^3 \times 0.00169 \frac{tonne}{m^3} CO_2 \approx 33.22\ tonnes\ CO_2$
- **$CH_4$ Emissions**

  Mass: $19,654.73\ m^3 \times 0.000000032 \frac{tonne}{m^3} CH_4 \approx 0.000629\ tonnes\ CH_4$

  $CO_2$e: $0.000629\ tonnes\ CH_4 \times 25 \approx 0.016\ tonnes\ CO_2e$
- **$N_2O$ Emissions**

  Mass: $19,654.73\ m^3 \times 0.0000000032 \frac{tonne}{m^3} N_2O \approx 0.0000629\ tonnes\ N_2O$

  $CO_2$e: $0.0000629\ tonnes\ N_2O \times 298 \approx 0.0187\ tonnes\ CO_2e$
- **Total Scope 1 Emissions (2023)**

  $33.22 + 0.016 + 0.0187 \approx 33.25\ metric\ tonnes\ CO_2e$

## 2024 Emissions Data

**Natural Gas Consumption:** 5,995 ccf

- **Converted Volume**

  $5,995\ ccf \times 100 \frac{ft^3}{ccf} = 599,500\ ft^3$

  $599,500\ ft^3 \times 0.02831685 \frac{m^3}{ft^3} \approx 16,976\ m^3$
- **$CO_2$ Emissions**

  $16,976\ m^3 \times 0.00169 \frac{tonne}{m^3} CO_2 \approx 28.70\ tonnes\ CO_2$
- **$CH_4$ Emissions**

  Mass: $16,976\ m^3 \times 0.000000032 \frac{tonne}{m^3} CH_4 \approx 0.0005432\ tonnes\ CH_4$

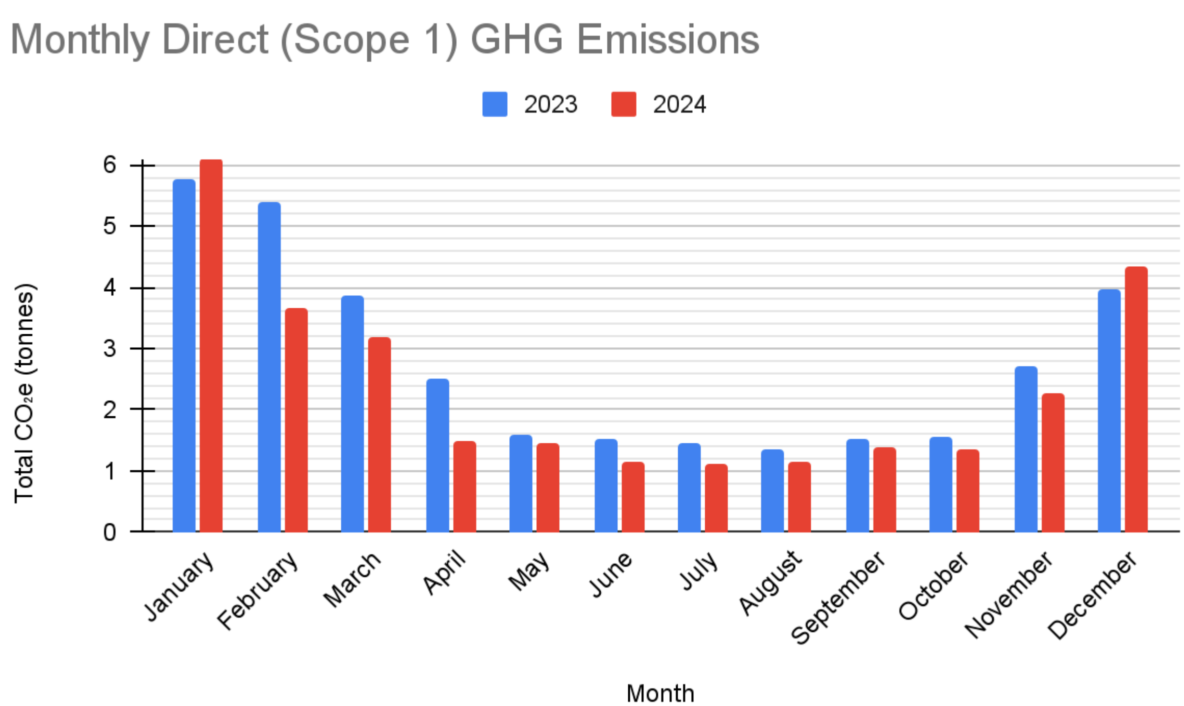
  $CO_2$e: $0.0005432\ tonnes\ CH_4 \times 29 \approx 0.0157\ tonnes\ CO_2e$

- **$N_2O$ Emissions**
  Mass: $16,976\ m^3 \times 0.0000000032\ \frac{tonne}{m^3} N_2O \approx 0.00005432\ tonnes\ N_2O$
  $CO_2e$: $0.00005432\ tonnes\ N_2O \times 265 \approx 0.0144\ tonnes\ CO_2e$
- **Total Scope 1 Emissions (2024)**
  $28.70 + 0.0157 + 0.0144 \approx 28.73\ metric\ tonnes\ CO_2e$

**$CO_2e$ Explanation**

- **$CO_2e$**, or **carbon dioxide equivalent**, is a metric used to express the impact of different greenhouse gasses (GHGs) in a common unit. Since gasses like **$CH_4$** and **$N_2O$** have different warming impacts, **$CO_2e$** allows emissions to be reported in terms of the equivalent amount of **$CO_2$** that would produce the same warming effect, facilitating clearer comparisons and reporting.

## Monthly Direct (Scope 1) GHG Emissions 2023 vs 2024




| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tonnes $CO_2e$ 2023 | 5.76 | 5.41 | 3.88 | 2.50 | 1.58 | 1.52 | 1.44 | 1.37 | 1.53 | 1.55 | 2.72 | 3.97 |
| Tonnes $CO_2e$ 2024 | 6.1 | 3.67 | 3.18 | 1.49 | 1.47 | 1.16 | 1.1 | 1.14 | 1.4 | 1.36 | 2.26 | 4.34 |

### Scope 1 GHG Emissions by Source (2023 & 2024)

| Emission Source | Unit | Amount Consumed | $CO_2$ Emissions (mt) | $CH_4$ Emissions (mt $CO_2e$) | $N_2O$ Emissions (mt $CO_2e$) | Total Scope 1 Emissions (mt $CO_2e$) |
|---|---|---|---|---|---|---|
| **2023 Natural Gas** | ccf | 6,941 | 33.216 | 0.016 | 0.019 | 33.25 |
| **2024 Natural Gas** | ccf | 5,995 | 28.70 | 0.0157 | 0.0144 | 28.73 |

### Justification of Calculation Method

This approach is based on volume-based emission factors and aligns with industry-standard methodologies outlined in the GHG Protocol for stationary combustion. The methodology—including conversion factors and the emissions basis for $CO_2$, $CH_4$, and $N_2O$—remains unchanged between 2023 and 2024, ensuring comparability. The only updates in 2024 are the reduced natural gas consumption and the revised GWP factors ($CH_4$: 29; $N_2O$: 265), which have been applied to the corresponding mass-based emissions.

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## GRI 305-2: Indirect (Scope 2) GHG Emissions

System76's Scope 2 emissions result from the use of purchased electricity at our **Denver facility**.

**Purchased Electricity Consumption**

- **Electricity consumed**
  - **2023:** 246,960 kWh
  - **2024:** 236,680 kWh

### Emission Calculation Methodology

System76 calculated its Scope 2 GHG emissions from electricity consumption using **regional emission factors** provided by the **EPA's eGRID power profiler**[42]. Below is a detailed breakdown of the methodology and calculation steps:

1. **Application of eGRID Emission Factors**
   - **2023 eGRID Emission Factors**
     - **$CO_2$**: 1,166.201 lb $CO_2$/MWh[43]
     - **$CH_4$**: 0.103 lb $CH_4$/MWh[44]
     - **$N_2O$**: 0.015 lb $N_2O$/MWh[45]
     - **$CH_4$ GWP**: 25; **$N_2O$ GWP**: 298
   - **2024 eGRID Emission Factors**

- $CO_2$: 1,084.314 lb/MWh[46]
- $CH_4$: 0.092 lb/MWh[47]
- $N_2O$: 0.013 lb/MWh[48]
- **$CH_4$ GWP**: 29; **$N_2O$ GWP**: 265

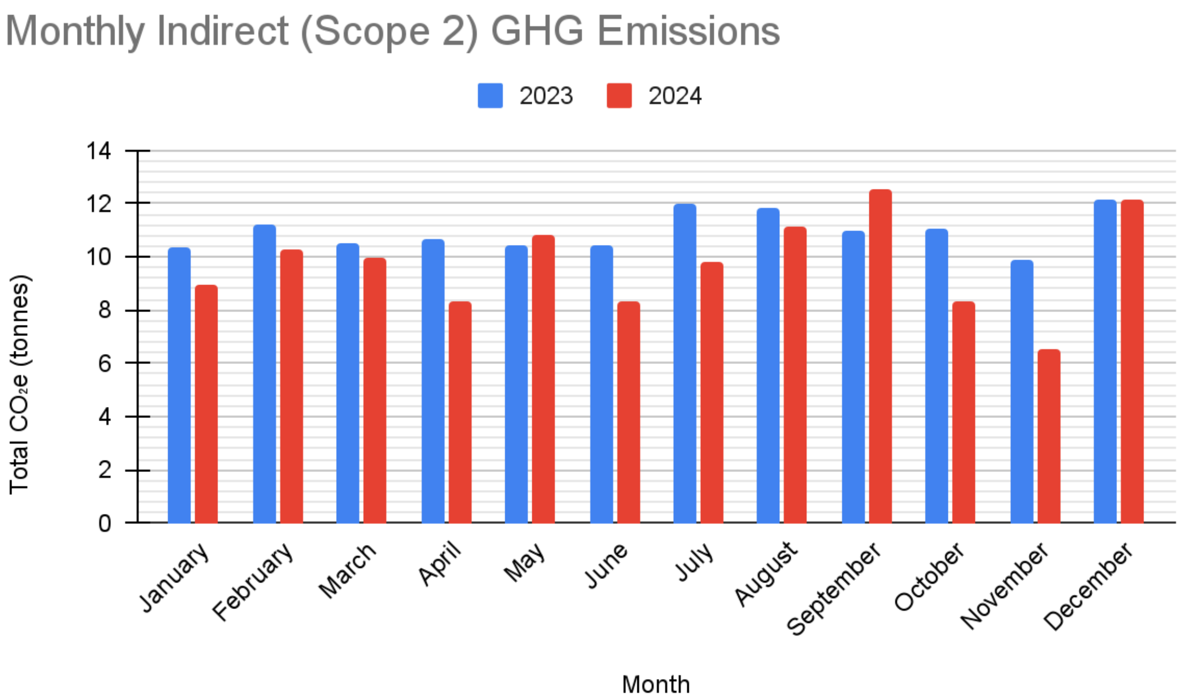
2. **Calculation of $CO_2e$ Emissions**
   - Conversion factor from lbs to kg: 0.45359237[49]
   - Conversion factor from kWh to MWh: 0.001[50]
   - Conversion factor from kilograms to metric tonnes: 0.001[51]

**Each greenhouse gas was calculated using this formula**

$$(Electricity\ Consumption\ (kWh) \times 0.001\frac{MWh}{kWh}) \times eGRID\ Factor\frac{lb}{MWh} \times 0.45359237\frac{kg}{lb} = Emissions\ (kg)$$

- **2023 Calculations**
  - **$CO_2$ Emissions**
    $(246,960 \times 0.001) \times 1,166.201 \times 0.45359237 = 130,636.87\ kg$
    $130,636.87kg \times 0.001\frac{tonne}{kg} = 130.64\ tonnes\ CO_2$
  - **$CH_4$ Emissions** $(246,960 \times 0.001) \times 0.103 \times 0.45359237 = 11.54\ kg$
    $11.54kg \times 0.001\frac{tonne}{kg} = 0.01154\ tonnes\ CH_4$
    $0.01154\ metric\ tonnes \times 25\frac{tonnes\ CO_2e}{tonnes\ CH_4} = 0.29\ tonnes\ CO_2e$
  - **$N_2O$ Emissions**
    $(246,960 \times 0.001) \times 0.015 \times 0.45359237 = 1.68\ kg$
    $1.68kg \times 0.001\frac{tonne}{kg} = 0.00168\ tonnes\ N_2O$
    $0.00168\ metric\ tonnes \times 298\frac{tonnes\ CO_2e}{tonnes\ N_2O} = 0.50\ tonnes\ CO_2e$
  - **Total Scope 2 Emissions**
    $130.64 + 0.29 + 0.50 = 131.34\ tonnes\ CO_2e$
- **2024 Calculations**
  - **$CO_2$ Emissions**
    $(236,680 \times 0.001) \times 1,084.314 \times 0.45359237 = 116,407.88\ kg$
    $116,407.88kg \times 0.001\frac{tonne}{kg} = 116.41\ tonnes\ CO_2$
  - **$CH_4$ Emissions**
    $(236,680 \times 0.001) \times 0.092 \times 0.45359237 = 9.88\ kg$
    $9.88kg \times 0.001\frac{tonne}{kg} = 0.00988\ tonnes\ CH_4$
    $0.00988\ metric\ tonnes \times 29\ \frac{tonnes\ CO_2e}{tonnes\ CH_4} = 0.29\ tonnes\ CO_2e$
  - **$N_2O$ Emissions**
    $(236,680 \times 0.001) \times 0.013 \times 0.45359237 = 1.4\ kg$
    $1.4kg \times 0.001\frac{tonne}{kg} = 0.0014\ tonnes\ N_2O$
    $0.0014\ metric\ tonnes \times 265\frac{tonnes\ CO_2e}{tonnes\ N_2O} = 0.37\ tonnes\ CO_2e$
  - **Total Scope 2 Emissions**
    $116.41 + 0.29 + 0.37 = 117.07\ tonnes\ CO_2e$

## Monthly Indirect (Scope 2) GHG Emissions




| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tonnes $CO_2e$ 2023 | 10.35 | 11.2 | 10.52 | 10.64 | 10.43 | 10.43 | 11.96 | 11.84 | 10.94 | 11.03 | 9.92 | 12.18 |
| Tonnes $CO_2e$ 2024 | 8.94 | 10.25 | 9.93 | 8.31 | 10.80 | 8.35 | 9.77 | 11.16 | 12.54 | 8.33 | 6.53 | 12.15 |

## Scope 2 GHG Emissions Summary

| Emission Source | Unit | Amount Consumed | $CO_2$ Emissions (mt) | $CH_4$ Emissions (mt $CO_2$e) | $N_2O$ Emissions (mt $CO_2$e) | Total Scope 2 Emissions (mt $CO_2$e) |
|---|---|---|---|---|---|---|
| **2023 Purchased Electricity** | kWh | 246,960 | 130.64 | 0.29 | 0.50 | 131.43 |
| **2024 Purchased Electricity** | kWh | 236,680 | 116.41 | 0.29 | 0.37 | 117.07 |

### Justification of Calculation Method

This approach is based on the GHG Protocol's Scope 2 Accounting and Reporting Standard and utilizes EPA's eGRID power profiler data for Colorado. The methodology—including the conversion of electricity consumption from kWh to MWh, and the conversion of emission factors from lbs to kg and to metric tonnes—remains consistent between 2023 and 2024, ensuring comparability. The only updates in 2024 are the reduced electricity consumption and the revised eGRID emission factors, along with updated GWP values ($CH_4$: 29; $N_2O$: 265), which have been applied to the corresponding emissions.

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## GRI 305-7: Nitrogen Oxides ($NO_x$), Sulfur Oxides ($SO_x$), and Other Significant Air Emissions

In 2023 and 2024, System76's operations generated air emissions primarily from:

- **Purchased Electricity (Scope 2)** – Indirect emissions due to electricity generation in the Colorado grid region.
- **Natural Gas Combustion (Scope 1)** – Direct emissions from burning natural gas for building heat, powder coating ovens, and water heating.

Emissions were calculated using **regional emission factors** provided by **EPA's eGRID**[52] for purchased electricity and **emissions factors for natural gas combustion**[53] in our stationary equipment. Below are the calculations and results for both years.

### Emission Calculation Methodology

1. **Purchased Electricity (Scope 2)**
    - **Pollutants**
        - **Nitrogen Oxides ($NO_x$)**
        - **Sulfur Oxides ($SO_x$)**
    - **Activity Data**
        - **2023**: 246,960 kWh

        - **2024**: 236,680 kWh
    - **Emissions Factors (eGRID)**
        - **2023 $NO_x$ Factor:** 0.636 lb/MWh[54]
        - **2023 $SO_2$ Factor:** 0.36 lb/MWh[55]
        - **2024 $NO_x$ Factor:** 0.543 lb/MWh[56]
        - **2024 $SO_2$ Factor:** 0.35 lb/MWh[57]
    - **Conversions**
        - Conversion factor lb to kg: 0.453592[58]
        - Conversion factor kWh to MWh: 0.001[59]

**Formula for Each Pollutant**

$$Emissions\ (kg)\ =\ (Electricity\ (kWh) \times 0.001 \frac{MWh}{kWh}) \times (eGRID\ Factor \frac{lb}{MWh}) \times 0.453592 \frac{kg}{lb}$$

2. **Combustion of Natural Gas (Scope 1)**
    - **Activity Data (in ccf)**:
        - **2023**: 6,941 ccf
        - **2024**: 5,995 ccf
    - **Steps to convert from ccf to m³**
        - $ft^3\ =\ ccf\ \times\ 100 \frac{ft^3}{ccf}$ [60]
        - $m^3\ =\ ft^3\ \times\ 0.02831685 \frac{m^3}{ft^3}$ [61]
    - **Emissions Factors (2023 & 2024)**
        - **$NO_x$:** 100 lb/$10^6$ scf[62]
        - **$SO_2$:** 0.6 lb/$10^6$ scf[63]
        - Conversion factor lb to kg: 0.453592[64]
        - Conversion factor $10^6$ scf to m³: 28316.85[65]

**Formula from lb/$10^6$ scf to kg/m³**

$$Emission\ factor\ (\frac{kg}{m^3})\ =\ (Emission\ factor\ (\frac{lb}{10^6\ scf})\ \times\ 0.453592 \frac{kg}{lb})\ \times\ (\frac{1}{28316.85}\ (\frac{m^3}{10^6\ scf}))$$

Once the factor is in kg/m³, multiply by the total cubic meters of natural gas consumed to get the total in kg of each pollutant.

- **$NO_x$ Factor (kg/m³)**

  $$(100 \frac{lb}{10^6\ scf}\ \times\ 0.453592 \frac{kg}{lb})\ \times\ (\frac{1}{28316.85}\ (\frac{m^3}{10^6\ scf}))\ =\ 0.001602 \frac{kg}{m^3}$$
- **$SO_2$ Factor (kg/m³)**

  $$(0.6 \frac{lb}{10^6\ scf}\ \times\ 0.453592 \frac{kg}{lb})\ \times\ (\frac{1}{28316.85}\ (\frac{m^3}{10^6\ scf}))\ =\ 0.00000961 \frac{kg}{m^3}$$

## 2023 Air Emissions Calculations

### Purchased Electricity (Scope 2)

- **$NO_x$ (2023)**
  $(246,960\,kWh \times 0.001\frac{MWh}{kWh}) \times 0.636\frac{lb}{MWh} \times 0.453592\frac{kg}{lb} \approx 71.24kg$
- **$SO_2$ (2023)**
  $(246,960\,kWh \times 0.001\frac{MWh}{kWh}) \times 0.36\frac{lb}{MWh} \times 0.453592\frac{kg}{lb} \approx 40.33\,kg$

### Natural Gas (Scope 1)

- **Consumption to $m^3$ (2023)**
  $(6,941\,ccf \times 100\frac{ft^3}{ccf}) \times 0.02831685\frac{m^3}{ft^3} \approx 19,654.73\,m^3$
- **$NO_x$ (2023)**
  $19,654.73\,m^3 \times 0.001602\frac{kg}{m^3} \approx 31.49\,kg$
- **$SO_2$ (2023)**
  $19,654.73\,m^3 \times 0.00000961\frac{kg}{m^3} \approx 0.1889\,kg$

## 2024 Air Emissions Calculations

### Purchased Electricity (Scope 2)

- **$NO_x$ (2024)**
  $(236,680\,kWh \times 0.001\frac{MWh}{kWh}) \times 0.543\frac{lb}{MWh} \times 0.453592\frac{kg}{lb} \approx 58.29kg$
- **$SO_2$ (2024)**
  $(236,680\,kWh \times 0.001\frac{MWh}{kWh}) \times 0.35\frac{lb}{MWh} \times 0.453592\frac{kg}{lb} \approx 37.57\,kg$

### Natural Gas (Scope 1)

- **Consumption to $m^3$ (2024)**
  $(5,995\,ccf \times 100\frac{ft^3}{ccf}) \times 0.02831685\frac{m^3}{ft^3} \approx 16,976\,m^3$
- **$NO_x$ (2024)**
  $16,976\,m^3 \times 0.001602\frac{kg}{m^3} \approx 27.20\,kg$
- **$SO_2$ (2024)**
  $16,976\,m^3 \times 0.00000961\frac{kg}{m^3} \approx 0.16\,kg$

## Air Emissions Summary Table

| Emission Source | Year | $NO_x$ Emissions (kg) | $SO_2$ Emissions (kg) |
|---|---|---|---|
| **Purchased Electricity (Scope 2)** | 2023 | 71.24 | 40.33 |
| | 2024 | 58.29 | 37.57 |
| **Natural Gas (Scope 1)** | 2023 | 31.49 | 0.1889 |
| | 2024 | 27.20 | 0.16 |

## Justification of Calculation Method

System76 used **EPA eGRID** emission factors for Scope 2 pollutants and national emission factors for natural gas combustion (Scope 1). These standardized factors allow for consistent and regionally relevant reporting of $NO_x$, $SO_x$, and other pollutants in alignment with GRI and regulatory requirements.

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## References


**[1] - https://www.system76.com**

**[2], [6] - https://nvlpubs.nist.gov/nistpubs/Legacy/SP/nistspecialpublication1038.pdf**

Page 12 has the conversion factor from therm to MJ as 105.4804. 1 MJ is 1/1000th of 1 GJ, so multiplying 105.4804 by 0.001 gets 0.1054804 for therm to GJ.

**[3] - https://www.epa.gov/system/files/documents/2024-01/egrid2022_data.xlsx**

Within the egrid2022_data.xslx workbook, worksheet ST22, row 8 for Colorado specific data.

**[4], [7] - https://nvlpubs.nist.gov/nistpubs/Legacy/SP/nistspecialpublication1038.pdf**

Page 12 has the conversion factor from kWh to MJ as 3.6. 1 MJ is 1/1000th of 1 GJ, so multiplying 3.6 by 0.001 gets 0.0036 for kWh to GJ.

**[5] - https://www.epa.gov/system/files/documents/2025-01/egrid2023_data_rev1.xlsx**

Within the egrid2023_data_rev1.xlsx workbook, worksheet ST23, row 8 for Colorado specific data.

**[8], [21] - https://nvlpubs.nist.gov/nistpubs/Legacy/SP/nistspecialpublication1038.pdf**

Page 9 has the conversion factor from Gallons to liters

**[9], [22] - https://nvlpubs.nist.gov/nistpubs/Legacy/SP/nistspecialpublication1038.pdf**

Table 2 on Page 3 shows common SI Prefixes.

**[10], [23] - https://www.wri.org/applications/aqueduct/water-risk-atlas/#/?advanced=false&basemap=hydro&geoStore=0c5fadaa7caaa473b38b30dff910a16e&indicator=w_awr_def_tot_cat&lat=39.77882630492905&lng=-104.81497764587404&mapMode=analysis&month=1&opacity=0.5&ponderation=DEF&predefined=false&projection=absolute&scenario=optimistic&scope=baseline&threshold&timeScale=annual&year=baseline&zoom=14**

**[11] - https://www.cdc.gov/nutrition/php/data-research/fast-facts-water-consumption.html**

Taken from Table 2, all adults, the CDC's mean daily water intake for adults is 44 ounces. Since there are 128 ounces in a gallon, 44/128 comes to 0.34375 gallons per day.

[12], [14] - Average estimated number of employees working in the factory per work day.

[13] - Working days in 2023, excluding weekends and company holidays. This figure was arrived at by a direct count of the days on a calendar.

[15] - Working days in 2024, excluding weekends and company holidays. This figure was arrived at by a direct count of the days on a calendar.

[16] - https://piec.com/how-much-water-does-an-evaporative-cooler-use/

[17] - https://weatherspark.com/h/y/3709/2023/Historical-Weather-during-2023-in-Denver-Colorado-United-States#Figures-ColorTemperature

The 6.5287 hour estimate comes from historical weather data from Weatherspark for the Denver area from 2023. Taking the average number of hours at temperatures at or above 75°F up to 7PM, when the swamp coolers are scheduled to shut off, during the months of July, August, September, and October.

[18], [20] - The number of weekdays in the months of July, August, September, October was arrived at by a direct count of the days on a calendar.

[19] - https://weatherspark.com/h/y/3709/2024/Historical-Weather-during-2024-in-Denver-Colorado-United-States#Figures-ColorTemperature

The 7.1798 hour estimate comes from historical weather data from Weatherspark for the Denver area from 2024. Taking the average number of hours at temperatures at or above 75°F up to 7PM, when the swamp coolers are scheduled to shut off, during the months of July, August, September, and October.

[24] - https://ghgprotocol.org/sites/default/files/2023-02/Stationary_Combustion_Guidance_final_1_0.pdf

[25], [60] - 1 ccf is equal to 100 cubic feet.

[26], [61] - https://nvlpubs.nist.gov/nistpubs/Legacy/SP/nistspecialpublication1038.pdf

Page 9 has the conversion factor from cubic feet to cubic meters as 0.02831685.

[27] -
https://www.epa.gov/system/files/documents/2023-03/ghg_emission_factors_hub.pdf

[28] -
https://www.epa.gov/system/files/documents/2024-02/ghg-emission-factors-hub-2024.pdf

[29] - https://nvlpubs.nist.gov/nistpubs/Legacy/SP/nistspecialpublication1038.pdf

Page 12 has the conversion factor from BTU to kJ as 1.055056. mmBTU is equal to 1,000,000 BTUs so 1 mmBTU is equal to 1,055,056 kJ. 1 kJ is equal to 0.000000001 TJ, so the conversion factor from mmBTU to TJ is 0.001055056.

[30] -
https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_1_Ch1_Introduction.pdf

Page 1.18, Table 1.2, we used the Net Calorific Value for Natural Gas, which is 48 TJ/Gg.

[31] -
https://ghgprotocol.org/sites/default/files/2024-10/Stationary_combustion_tool_Version4-2.xlsx

This workbook from the Greenhouse Gas Protocol uses a density value of 0.7 $kg/m^3$ in the “2. Settings” worksheet in cell C44. My use of this value was taken from here.

[32] -
https://ghgprotocol.org/sites/default/files/2024-10/Stationary_combustion_tool_Version4-2.xlsx

The formula used here was reverse engineered by analyzing the formula used in this workbook, within the ghostSpreadsheet_CO2 worksheet. Additionally, within the formula, the Net Calorific Value is divided by 1,000,000 in order to convert from TJ/Gg to TJ/kg.

[33], [51] - https://nvlpubs.nist.gov/nistpubs/Legacy/SP/nistspecialpublication1038.pdf

Footnote 24 at the bottom of page 10 states: “*The metric ton (referred to as "tonne" in many countries), equal to 1000 kg, is accepted for use with SI.*” If 1 tonne is equal to 1000 kg, then 1 kg is equal to 0.001 tonnes.

[34], [36], [38], [39] -
https://www.epa.gov/system/files/documents/2023-03/ghg_emission_factors_hub.pdf

In Table 1 for Stationary Combustion next to Natural Gas, the emission basis for $CH_4$ is in grams per mmBTU. Because 1 gram is equal to 0.001 kg it was fairly straightforward to convert this value from 1 g/mmBTU to 0.001 kg/mmBTU. Likewise the emission basis for $N_2O$ was 0.1 g/mmBTU which I converted to 0.0001 kg/mmBTU.

**[35], [37], [40], [41] -**
**https://www.epa.gov/system/files/documents/2024-02/ghg-emission-factors-hub-2024.pdf**

In Table 1 for Stationary Combustion next to Natural Gas, the emission basis for $CH_4$ is in grams per mmBTU. Because 1 gram is equal to 0.001 kg it was fairly straightforward to convert this value from 1 g/mmBTU to 0.001 kg/mmBTU. Likewise the emission basis for $N_2O$ was 0.1 g/mmBTU which I converted to 0.0001 kg/mmBTU.

**[42], [52] - https://www.epa.gov/egrid/power-profiler#/**

**[43] - https://www.epa.gov/system/files/documents/2024-01/egrid2022_data.xlsx**

From this workbook, within the worksheet for states (ST22), the annual $CO_2$ total output emission rate is in cell V8.

**[44] - https://www.epa.gov/system/files/documents/2024-01/egrid2022_data.xlsx**

From this workbook, within the worksheet for states (ST22), the annual $CH_4$ total output emission rate is in cell W8.

**[45] - https://www.epa.gov/system/files/documents/2024-01/egrid2022_data.xlsx**

From this workbook, within the worksheet for states (ST22), the annual $N_2O$ total output emission rate is in cell X8.

**[46] - https://www.epa.gov/system/files/documents/2025-01/egrid2023_data_rev1.xlsx**

From this workbook, within the worksheet for states (ST23), the annual $CO_2$ total output emission rate is in cell W8.

**[47] - https://www.epa.gov/system/files/documents/2025-01/egrid2023_data_rev1.xlsx**

From this workbook, within the worksheet for states (ST23), the annual $CH_4$ total output emission rate is in cell X8.

**[48] - https://www.epa.gov/system/files/documents/2025-01/egrid2023_data_rev1.xlsx**

From this workbook, within the worksheet for states (ST23), the annual $N_2O$ total output emission rate is in cell Y8.

**[49], [58], [64] -**
**https://nvlpubs.nist.gov/nistpubs/Legacy/SP/nistspecialpublication1038.pdf**

Page 11 has the conversion factor from pounds (lbs) to kilograms (kg) as 0.45359237.

**[50]**, **[59]** **-** 1 kilowatt hour is one one-thousandth of 1 megawatt hour, so the conversion factor from kWh to MWh is 0.001.

**[53]** **-** **https://gaftp.epa.gov/ap42/ch01/s04/final/c01s04_oct1996.pdf**

**[54]** **-** **https://www.epa.gov/system/files/documents/2024-01/egrid2022_data.xlsx**

From this workbook, within the worksheet for states (ST22), the annual $NO_x$ total output emission rate is in cell S8.

**[55]** **-** **https://www.epa.gov/system/files/documents/2024-01/egrid2022_data.xlsx**

From this workbook, within the worksheet for states (ST22), the annual $SO_2$ total output emission rate is in cell U8.

**[56]** **-** **https://www.epa.gov/system/files/documents/2025-01/egrid2023_data_rev1.xlsx**

From this workbook, within the worksheet for states (ST23), the annual $NO_x$ total output emission rate is in cell T8.

**[57]** **-** **https://www.epa.gov/system/files/documents/2025-01/egrid2023_data_rev1.xlsx**

From this workbook, within the worksheet for states (ST23), the annual $SO_2$ total output emission rate is in cell V8.

**[62]**, **[63]** **-** **https://gaftp.epa.gov/ap42/ch01/s04/final/c01s04_oct1996.pdf**

Page 1.4-5, Table 1.4-1, we're using the value for a commercial boiler (<10 mmBTU/hr) with no $CH_4$ controlled burners, so 100 lb/$10^6$ scf, and the value for $SO_2$ is 0.6 lb/$10^6$ scf.

**[65]** **-** **https://nvlpubs.nist.gov/nistpubs/Legacy/SP/nistspecialpublication1038.pdf**

Page 9 has the conversion factor from cubic feet to cubic meters at 0.02831685. $10^6$ scf is equal to 1,000,000 cubic feet (scf stands for standard cubic feet). This makes 1 $10^6$ scf equal to 28,316.85 cubic meters.