Climate resilience requires equitable access to quality green energy jobs. St. Paul is at the forefront.

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Abstract

Minnesota, particularly the City of Saint Paul, has seen a surge in climate resilience funding aimed at expanding green energy job opportunities. However, BIPOC communities remain underrepresented in these jobs and disproportionately suffer from the adverse effects of human-driven climate change.

## Background

This analysis looks at access to green energy jobs (like energy efficiency, renewable energy, and green construction) by race/ethnicity, gender, education, and income in St. Paul, Minnesota, USA.

## Research Questions

Here are some of the questions I will explore using different datasets:

* How much climate resilience funding has St. Paul received?
* What specific green jobs are being created in St. Paul (e.g., energy efficiency, renewable energy, green construction)?
* What is the quality of these jobs? How much do they pay? What qualifications are needed (education and experience)?
* Who is getting these jobs, based on education, race/ethnicity, gender, and income levels?

## Data Sources

The data for this project comes from:

* The National Center for O\*NET Development
* 2023 Occupational Employment and Wage Survey
* Urban Institute 11 elements of job quality: Clean Energy Job Quality and Education Data
* National and local demographic data from the 2022 American Community Survey Public Use Microdata Sample (ACS PUMS)
* US Census Bureau’s 2023 QuickFacts tool
* Invest.gov
* Geocorr from the Missouri Census Data Center

I will reduce each large dataset to focus only on questions related to green jobs and job quality. Please note that some datasets have already been pre-processed in Python with specific filters applied. You can find the original raw datasets in the data folder for reference.

## Analysis

I will look at each question one by one and clean the data as I go. Some datasets might need to be combined, so I will organize the data during the analysis before exploring the results.

### Load packages and libraries

## For folder structure  
library(here)

here() starts at /Users/elhamali/Documents/Data Projects/climate-equity-workforce

library(ezknitr)  
  
## For data import/cleaning  
library(tidyverse)

── Attaching core tidyverse packages ──────────────────────── tidyverse 2.0.0 ──  
✔ dplyr 1.1.4 ✔ readr 2.1.5  
✔ forcats 1.0.0 ✔ stringr 1.5.1  
✔ ggplot2 3.5.1 ✔ tibble 3.2.1  
✔ lubridate 1.9.3 ✔ tidyr 1.3.1  
✔ purrr 1.0.2

── Conflicts ────────────────────────────────────────── tidyverse\_conflicts() ──  
✖ dplyr::filter() masks stats::filter()  
✖ dplyr::lag() masks stats::lag()  
ℹ Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to become errors

library(purrr)  
library(rlang)

Attaching package: 'rlang'  
  
The following objects are masked from 'package:purrr':  
  
 %@%, flatten, flatten\_chr, flatten\_dbl, flatten\_int, flatten\_lgl,  
 flatten\_raw, invoke, splice

library(forcats)  
library(readxl)  
  
## For graphing  
library(highcharter)

Registered S3 method overwritten by 'quantmod':  
 method from  
 as.zoo.data.frame zoo   
Highcharts (www.highcharts.com) is a Highsoft software product which is  
not free for commercial and Governmental use

library(igraph)

Attaching package: 'igraph'  
  
The following object is masked from 'package:rlang':  
  
 is\_named  
  
The following objects are masked from 'package:lubridate':  
  
 %--%, union  
  
The following objects are masked from 'package:dplyr':  
  
 as\_data\_frame, groups, union  
  
The following objects are masked from 'package:purrr':  
  
 compose, simplify  
  
The following object is masked from 'package:tidyr':  
  
 crossing  
  
The following object is masked from 'package:tibble':  
  
 as\_data\_frame  
  
The following objects are masked from 'package:stats':  
  
 decompose, spectrum  
  
The following object is masked from 'package:base':  
  
 union

library(RColorBrewer)  
library(htmlwidgets)  
# library(viridis)

Source: [Article Notebook](https://beeckcenter.github.io/climate-equity-workforce/index-preview.html)

### 1. Climate Resilience Funding for St. Paul

|  |
| --- |
| RQ 1: How much climate resilience funding has St. Paul received? |
| The total amount of funding **Minnesota** received for climate resilience as of June 2024 is **$7,101,423,527**  The total amount of funding **St. Paul** received for climate resilience as of June 2024 is **$446,286,762**  St. Paul’s funding is **6.28 %** of Minnesota’s total funding.  Almost **95%** of St. Paul’s funding goes to transportation efforts. Clean energy, buildings and manufacturing received less than **2%** of funding. |

# Import data  
funding <- read\_csv(here("processed\_data", "FundingSummary.csv"))

Warning: One or more parsing issues, call `problems()` on your data frame for details,  
e.g.:  
 dat <- vroom(...)  
 problems(dat)

Rows: 49535 Columns: 15  
── Column specification ────────────────────────────────────────────────────────  
Delimiter: ","  
chr (14): Agency Name, Bureau Name, Program Name, Category, Subcategory, Pro...  
dbl (1): Unique ID  
  
ℹ Use `spec()` to retrieve the full column specification for this data.  
ℹ Specify the column types or set `show\_col\_types = FALSE` to quiet this message.

saveRDS(funding, here("processed\_data", "funding.rds"))  
  
funding <- readRDS(here("processed\_data", "funding.rds"))

Source: [Article Notebook](https://beeckcenter.github.io/climate-equity-workforce/index-preview.html)

### Convert the `Funding Amount` to numeric and handling commas in the values  
  
funding <- funding %>%  
 mutate(`Funding Amount` = as.numeric(gsub(",", "", `Funding Amount`)))

Warning: There was 1 warning in `mutate()`.  
ℹ In argument: `Funding Amount = as.numeric(gsub(",", "", `Funding Amount`))`.  
Caused by warning:  
! NAs introduced by coercion

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#### Filter for MN State and City of St. Paul

First, I will filter the dataset by State: **Minnesota**, and then narrow it down further to focus on the **City of St. Paul** and the surrounding region. Please note that St. Paul is part of the **Minneapolis-St. Paul-Bloomington, MN-WI** region, so I’ll ensure it’s included within that larger metropolitan area.

# Filter for Minnesota funding  
minnesota\_funding <- funding %>%  
 filter(State == "Minnesota")  
  
saveRDS(minnesota\_funding, here("processed\_data", "minnesota\_funding.rds"))

Source: [Article Notebook](https://beeckcenter.github.io/climate-equity-workforce/index-preview.html)

# Further filter for St. Paul, considering variations in city names  
st\_paul\_funding <- minnesota\_funding %>%  
 filter(str\_detect(City, regex("Saint Paul|St. Paul|South St. Paul|Minneapolis--St. Paul|Minneapolis-St. Paul", ignore\_case = TRUE)))  
  
saveRDS(st\_paul\_funding, here("processed\_data", "st\_paul\_funding.rds"))  
  
# glimpse(st\_paul\_funding)

Source: [Article Notebook](https://beeckcenter.github.io/climate-equity-workforce/index-preview.html)

#### Calculate funding for MN State and City of St. Paul

minnesota\_funding <- readRDS(here("processed\_data", "minnesota\_funding.rds"))  
st\_paul\_funding <- readRDS(here("processed\_data", "st\_paul\_funding.rds"))  
  
# Calculate total funding for Minnesota  
total\_minnesota\_funding <- minnesota\_funding %>%  
 summarise(total\_funding = sum(`Funding Amount`, na.rm = TRUE))  
  
cat("The total amount of funding Minnesota received for climate as of June 2024 is $",   
 format(total\_minnesota\_funding$total\_funding, big.mark = ","), "\n")

The total amount of funding Minnesota received for climate as of June 2024 is $ 7,101,423,527

# Calculate total funding for St. Paul  
total\_st\_paul\_funding <- st\_paul\_funding %>%  
 summarise(total\_funding = sum(`Funding Amount`, na.rm = TRUE))  
  
cat("The total amount of funding St. Paul received for climate as of June 2024 is $",   
 format(total\_st\_paul\_funding$total\_funding, big.mark = ","), "\n")

The total amount of funding St. Paul received for climate as of June 2024 is $ 446,286,762

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#### Calculate fraction of St. Paul’s funding from MN’s

minnesota\_funding <- readRDS(here("processed\_data", "minnesota\_funding.rds"))  
st\_paul\_funding <- readRDS(here("processed\_data", "st\_paul\_funding.rds"))  
  
# Calculate total funding for Minnesota  
total\_minnesota\_funding <- minnesota\_funding %>%  
 summarise(total\_funding = sum(`Funding Amount`, na.rm = TRUE)) %>%  
 pull(total\_funding)  
  
# Calculate total funding for St. Paul  
total\_st\_paul\_funding <- st\_paul\_funding %>%  
 summarise(total\_funding = sum(`Funding Amount`, na.rm = TRUE)) %>%  
 pull(total\_funding)  
  
# Calculate the fraction of St. Paul's funding from Minnesota's total funding  
fraction\_st\_paul <- total\_st\_paul\_funding / total\_minnesota\_funding  
  
# Output the results  
cat("The fraction of St. Paul's funding from Minnesota's total funding is: ",   
 round(fraction\_st\_paul, 4), "\n")

The fraction of St. Paul's funding from Minnesota's total funding is: 0.0628

cat("This means St. Paul's funding is", round(fraction\_st\_paul \* 100, 2), "% of Minnesota's total funding.\n")

This means St. Paul's funding is 6.28 % of Minnesota's total funding.

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#### Visualize categories of funding for St. Paul

# Group the St. Paul data by Category and calculate the total funding for each category  
st\_paul\_category\_funding <- st\_paul\_funding %>%  
 group\_by(Category) %>%  
 summarise(total\_funding = sum(`Funding Amount`, na.rm = TRUE)) %>%  
 arrange(desc(total\_funding))  
  
colors <- brewer.pal(n = length(unique(st\_paul\_category\_funding$Category)), "Set3")  
  
# Create an interactive bar chart using highcharter  
hchart\_bar <- highchart() %>%  
 hc\_chart(type = "bar") %>%  
 hc\_xAxis(categories = st\_paul\_category\_funding$Category, title = list(text = "Category")) %>%  
 hc\_yAxis(title = list(text = "Total Funding ($)"), labels = list(format = "{value:,.0f}")) %>%  
 hc\_add\_series(name = "Total Funding",   
 data = st\_paul\_category\_funding$total\_funding,   
 colorByPoint = TRUE,   
 colors = colors) %>%  
 hc\_title(text = "Total Funding by Category in St. Paul") %>%  
 hc\_tooltip(pointFormat = "Total Funding: ${point.y:,.0f}") %>%  
 hc\_exporting(  
 enabled = TRUE,  
 buttons = list(contextButton = list(menuItems = c("downloadPNG", "downloadJPEG", "downloadSVG", "downloadPDF")))  
 )  
  
# Saving the chart as an HTML file  
saveWidget(hchart\_bar, file = here("graphs", "st\_paul\_funding\_bar.html"))

Source: [Article Notebook](https://beeckcenter.github.io/climate-equity-workforce/index-preview.html)

A quick glance tells us that almost **95%** of St. Paul’s funding goes to transportation efforts. Clean energy, buildings and manufacturing received less than **2%** of funding.

# Create an interactive pie chart using highcharter  
hchart\_pie <- highchart() %>%  
 hc\_chart(type = "pie") %>%  
 hc\_add\_series(name = "Total Funding",   
 data = list\_parse2(st\_paul\_category\_funding %>%   
 mutate(name = Category, y = total\_funding)),   
 colors = colors) %>%  
 hc\_title(text = "Total Funding by Category in St. Paul") %>%  
 hc\_tooltip(pointFormat = "Total Funding: ${point.y:,.0f}") %>%  
 hc\_plotOptions(pie = list(innerSize = '50%', dataLabels = list(enabled = TRUE))) %>%  
 hc\_exporting(  
 enabled = TRUE,  
 buttons = list(contextButton = list(menuItems = c("downloadPNG", "downloadJPEG", "downloadSVG", "downloadPDF")))  
 )  
  
saveWidget(hchart\_pie, file = here("graphs", "st\_paul\_funding\_pie.html"))

Source: [Article Notebook](https://beeckcenter.github.io/climate-equity-workforce/index-preview.html)

## Export the funding data to CSV for graphing  
write.csv(minnesota\_funding, here("processed\_data", "minnesota\_funding.csv"), row.names = FALSE)  
write.csv(st\_paul\_funding, here("processed\_data", "st\_paul\_funding.csv"), row.names = FALSE)

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### 2. Types of Green Jobs in St. Paul

### 3. Quality, Pay, and Qualifications of Green Jobs

### 4. Demographics of Green Job Recipients