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

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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 --
v dplyr     1.1.4     v readr     2.1.5
v forcats   1.0.0     v stringr   1.5.1
v ggplot2   3.5.1     v tibble    3.2.1
v lubridate 1.9.3     v tidyr     1.3.1
v purrr     1.0.2
```

```
-- Conflicts --------------------------------------- tidyverse_conflicts() --
x dplyr::filter() masks stats::filter()
x dplyr::lag()    masks stats::lag()
i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to becor
```

```
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
```

```r
library(RColorBrewer)
library(htmlwidgets)
# library(viridis)
```

Source: Article Notebook

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

```
### 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
```

Source: Article Notebook

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

```
# 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|Mi

saveRDS(st_paul_funding, here("processed_data", "st_paul_funding.rds"))

# glimpse(st_paul_funding)
```

Source: Article Notebook

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
```

```r
# 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
```

Source: Article Notebook

Calculate fraction of St. Paul's funding from MN's

```r
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
```

```r
cat("This means St. Paul's funding is", round(fraction_st_paul * 100, 2), "% of Minnesota's t
```

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

Source: Article Notebook

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", "downloa
  )

# Saving the chart as an HTML file
saveWidget(hchart_bar, file = here("graphs", "st_paul_funding_bar.html"))
```

Source: Article Notebook

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", "downloa
  )

saveWidget(hchart_pie, file = here("graphs", "st_paul_funding_pie.html"))
```

Source: Article Notebook

```
## Export the funding data to CSV for graphing
write.csv(minnesota_funding, here("processed_data", "minnesota_funding.csv"), row.names = FA
write.csv(st_paul_funding, here("processed_data", "st_paul_funding.csv"), row.names = FALSE)
```

Source: Article Notebook

2. Types of Green Jobs in St. Paul

3. Quality, Pay, and Qualifications of Green Jobs

4. Demographics of Green Job Recipients