

# EV Power - Lab 4 Project Report

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## Example Solution 1

### Part 0: libraries

```
library(tidyverse)
```

```
— Attaching core tidyverse packages ————— tidyverse 2.0.0
—
✓ dplyr      1.1.4      ✓ readr      2.1.5
✓ forcats    1.0.1      ✓ stringr    1.5.2
✓ ggplot2    4.0.0      ✓ tibble     3.3.0
✓ lubridate  1.9.4      ✓ tidyr      1.3.1
✓ purrr      1.1.0
— 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(stringr)
library(leaflet)
library(sf)
```

```
Linking to GEOS 3.13.1, GDAL 3.11.0, PROJ 9.6.0; sf_use_s2() is TRUE
```

```
library(maps)
```

```
Attaching package: 'maps'
```

```
The following object is masked from 'package:purrr':
```

```
map
```

```
library(rnaturalearth)
```

## Part 1: Defining Research Question

Chosen Question: Do states with higher shares of electricity that comes from clean sources have lower average electricity prices?

## Part 2: Data Preparation and Cleaning

```
#Load datasets relevant to Renewable energy usage, energy prices, and total  
energy usage  
avg_energy_prices = read_csv("data/av-energy-price-2021-2023.csv")
```

```
Rows: 54 Columns: 1  
— Column specification
```

---

```
Delimiter: ","  
chr (1): Total energy average price, dollars per million Btu,,,
```

```
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.
```

```
renewable_energy_usage_2021 = read_csv("data/renew-use-2021.csv")
```

```
Rows: 260 Columns: 3  
— Column specification
```

---

```
Delimiter: ","  
chr (3): State, Energy_Source, Renewable_Use_2021
```

```
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.
```

```
renewable_energy_usage_2022 = read_csv("data/renew-use-2022.csv")
```

```
Rows: 260 Columns: 3  
— Column specification
```

---

```
Delimiter: ","  
chr (3): State, Energy_Source, Renewable_Use_2022
```

```
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.

```
renewable_energy_usage_2023 = read_csv("data/renew-use-2023.csv")
```

Rows: 260 Columns: 3  
— Column specification

---

Delimiter: ","

chr (3): State, Energy\_Source, Renewable\_Use\_2023

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.

```
total_energy_usage_2021 = read_csv("data/total-use-2021.csv")
```

Rows: 5 Columns: 53  
— Column specification

---

Delimiter: ","

chr (1): Energy\_Source

dbl (52): AK, AL, AR, AZ, CA, CO, CT, DC, DE, FL, GA, HI, IA, ID, IL, IN, KS...

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.

```
total_energy_usage_2022 = read_csv("data/total-use-2022.csv")
```

Rows: 5 Columns: 53  
— Column specification

---

Delimiter: ","

chr (1): Energy\_Source

dbl (52): AK, AL, AR, AZ, CA, CO, CT, DC, DE, FL, GA, HI, IA, ID, IL, IN, KS...

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.

```
total_energy_usage_2023 = read_csv("data/total-use-2023.csv")
```

Rows: 5 Columns: 53

— Column specification

Delimiter: ","

chr (1): Energy\_Source

dbl (52): AK, AL, AR, AZ, CA, CO, CT, DC, DE, FL, GA, HI, IA, ID, IL, IN, KS...

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.

```
#Standardize Columns.
```

```
total_energy_usage_2021 <- total_energy_usage_2021 |>  
  rename()
```

```
#Renewable_Energy_Usage data is very messy. Standardized Units? ($, KWH, etc)  
#Create a tidy dataframe with col:  
#Cols: State, Coal, Natural Gas, Petroleum (BTU), nuclear,  
total_renewable_energy  
#Currently each state has a col, with rows for each energy source. I want to  
flip this.
```

```
#Transform dataset
```

```
# state (abbrev)
```

```
#make a pivot_longer for total_energy_usage for each year
```

```
#I want each column of 53 locations (50 states and 1 cumulative USA) to be a  
separate data entry for each usage.
```

```
tidy_2021_energy_usage <- total_energy_usage_2021 |>  
  pivot_longer(cols = 2:length(total_energy_usage_2021), names_to = "state",  
values_to = "values") |>  
  pivot_wider(names_from = "Energy_Source", values_from = "values") |>  
  mutate(year = 2021)  
# ---- replicate for 2022 ----  
tidy_2022_energy_usage <- total_energy_usage_2022 |>  
  pivot_longer(cols = 2:length(total_energy_usage_2022), names_to = "state",  
values_to = "values") |>  
  pivot_wider(names_from = "Energy_Source", values_from = "values") |>  
  mutate(year = 2022)
```

```

# ---- replicate for 2023 -----
tidy_2023_energy_usage <- total_energy_usage_2023 |>
  pivot_longer(cols = 2:length(total_energy_usage_2023), names_to = "state",
values_to = "values") |>
  pivot_wider(names_from = "Energy_Source", values_from = "values") |>
  mutate(year = 2023)

# STANDARDIZE Column Names OR add another column with Year. Then merge all
data frames together to create panel data

STANDARDIZED_COLUMN_NAMES <- c("State", "Coal Consumption", "Natural Gas",
"Petroleum (BTU)", "Nuclear Energy", "Total Renewable Energy", "Year")

colnames(tidy_2023_energy_usage) = STANDARDIZED_COLUMN_NAMES
colnames(tidy_2022_energy_usage) = STANDARDIZED_COLUMN_NAMES
colnames(tidy_2021_energy_usage) = STANDARDIZED_COLUMN_NAMES

### CLEAN avg_energy_prices -> turn each row of STATE(abbrev), AMOUNT
(unstructured),
#STATE, YEAR (2021-2023)
## ie., CA, 2021 amount per million BTU, 2022 amount per million BTU, 2023
amount per million BTU

#STATE ABBREVIATION: "[A-Z]{2}"
# Amount per million BTU: /d*//./d*
#\d*\.\d*
tidy_avg_energy_prices <- avg_energy_prices |>
  separate_wider_delim(
    "Total energy average price, dollars per million Btu,,,",
    delim = ",",
    names = c("State", "2021", "2022", "2023")
  ) |>
  #Filters empty/header row
  filter(!State %in% c("", "State", NA)) |>
  #extract numeric values
  mutate(
    across('2021':'2023', ~parse_number(.x))
  ) |>
  pivot_longer(cols = c("2021", "2022", "2023"), names_to = "Year",
values_to = "Avg_Energy_Price") |>
  mutate(Year = as.double(Year), Avg_Energy_Price =
Avg_Energy_Price/1000000)
#Price PER MILLION IS NOW PRICE PER BTU

```

## Part 3: Joining / Pivoting Datasets for Analysis

```

#combine yearly files into single tables as needed

```

```

#Document whcih method you chose and why. Create new variables such as % of
renewable ernergy out of total energy, ratio of EV registrations, etc

#combine 2021, 2022, 2023 data to have panel data.
joined_energy_usage <- bind_rows(tidy_2021_energy_usage,
tidy_2022_energy_usage, tidy_2023_energy_usage)

single_table <- left_join(joined_energy_usage, tidy_avg_energy_prices, by =
c("State", "Year")) |>
  # mutate(Total_Coal_Price = Avg_Energy_Price * `Coal Consumption`,
Total_Natural_Gas_Price = Avg_Energy_Price * `Natural Gas`,
Total_Petroleum_Price = Avg_Energy_Price * `Petroleum (BTU)`,
Total_Nuclear_Energy_Price = Avg_Energy_Price * `Nuclear Energy`,
Total_Renewable_Energy_Price = Avg_Energy_Price * `Total Renewable Energy`) |>
#Total Price of Fuel for Components
  mutate(Total_Non_Renewable_Energy_Usage = `Coal Consumption` + `Natural
Gas` + `Petroleum (BTU)` + `Nuclear Energy`) |> #Total Non Renewable Energy
Usage
  mutate(Total_Energy_Usage = Total_Non_Renewable_Energy_Usage + `Total
Renewable Energy`) |> #Total Energy Usage
  mutate(Proportion_of_Renewable_Energy = `Total Renewable Energy` /
Total_Energy_Usage, Percentage_Energy_Per_Unit_Of_Price =
Proportion_of_Renewable_Energy/Avg_Energy_Price) |>
  select(State, `Total Renewable Energy`, Year, Avg_Energy_Price,
Proportion_of_Renewable_Energy, Percentage_Energy_Per_Unit_Of_Price)

```

## Part 4: Mapping Visualization

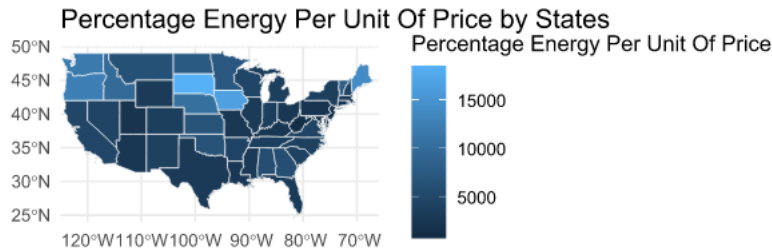
```

#df <- single_table |>
#   mutate(Year = as.integer(Year))
#us_states <- st_as_sf(map("state", plot = FALSE, fill = TRUE))

test_2021_table <- single_table |>
  filter(Year == 2021)

us_states <- ne_states(country = "united states of america", returnclass =
"sf")
us_joined <- us_states |>
  right_join(test_2021_table, by = join_by("postal"=="State"))
#Plot and Color by Proportion
ggplot(us_joined) +
  geom_sf(aes(fill=Percentage_Energy_Per_Unit_Of_Price), color = "white") +
  scale_fill_continuous(name = "Percentage Energy Per Unit Of Price", na.value
= "grey90") +
  labs(title = "Percentage Energy Per Unit Of Price by States") +
  coord_sf(xlim = c(-125, -66), ylim = c(24, 50), expand = FALSE) +
  theme_minimal()

```



### Title: Higher Number

#### Overview:

Do states with higher shares of electricity that comes from clean sources have lower average electricity prices?

#### Data and Methods:

Show keys tables or data summaries (head()) of joined dataset)

```
head(us_joined)
```

Simple feature collection with 6 features and 126 fields

Geometry type: MULTIPOLYGON

Dimension: XY

Bounding box: xmin: -124.7346 ymin: 41.69681 xmax: -82.4146 ymax: 49.36949

Geodetic CRS: WGS 84

	featurecla	scalerank	adm1_code	diss_me	iso_3166_2		
1	Admin-1 states	provinces	lakes	2	USA-3519	3519	US-WA
2	Admin-1 states	provinces	lakes	2	USA-3518	3518	US-ID
3	Admin-1 states	provinces	lakes	2	USA-3515	3515	US-MT
4	Admin-1 states	provinces	lakes	2	USA-3516	3516	US-ND
5	Admin-1 states	provinces	lakes	2	USA-3514	3514	US-MN
6	Admin-1 states	provinces	lakes	2	USA-3562	3562	US-MI

	wikipedia	iso_a2	adm0_sr	name
1	http://en.wikipedia.org/wiki/Washington_(state)	US	6	Washington
2	http://en.wikipedia.org/wiki/Idaho	US	1	Idaho
3	http://en.wikipedia.org/wiki/Montana	US	1	Montana
4	http://en.wikipedia.org/wiki/North_Dakota	US	1	North Dakota
5	http://en.wikipedia.org/wiki/Minnesota	US	1	Minnesota
6	http://en.wikipedia.org/wiki/Michigan	US	1	Michigan

name_alt	name_local	type	type_en	code_local	code_hasc	note	hasc_maybe
----------	------------	------	---------	------------	-----------	------	------------

1	WA Wash.	<NA>	State	State	US53	US.WA	<NA>	<NA>
2	ID Idaho	<NA>	State	State	US16	US.ID	<NA>	<NA>
3	MT Mont.	<NA>	State	State	US30	US.MT	<NA>	<NA>
4	ND N.D.	<NA>	State	State	US38	US.ND	<NA>	<NA>
5	MN Minn.	<NA>	State	State	US27	US.MN	<NA>	<NA>
6	MI Mich.	<NA>	State	State	US26	US.MI	<NA>	<NA>

	region	region_cod	provnum_ne	gadm_level	check_me	datarank	abbrev	postal
1	West	<NA>	0	1	20	1	Wash.	WA
2	West	<NA>	0	1	20	1	Idaho	ID
3	West	<NA>	0	1	20	1	Mont.	MT
4	Midwest	<NA>	0	1	20	1	N.D.	ND
5	Midwest	<NA>	0	1	20	1	Minn.	MN
6	Midwest	<NA>	0	1	20	1	Mich.	MI

	area_sqkm	sameascity	labelrank	name_len	mapcolor9	mapcolor13	fips	fips_alt
1	0	-99	0	10	1	1	US53	<NA>
2	0	-99	0	5	1	1	US16	<NA>
3	0	-99	0	7	1	1	US30	<NA>
4	0	-99	0	12	1	1	US38	<NA>
5	0	-99	0	9	1	1	US27	<NA>
6	0	-99	0	8	1	1	US26	<NA>

	woe_id		woe_label	woe_name	latitude	longitude
1	2347606	Washington, US, United States	Washington	47.4865	-120.3610	
2	2347571	Idaho, US, United States	Idaho	43.7825	-114.1330	
3	2347585	Montana, US, United States	Montana	46.9965	-110.0440	
4	2347593	North Dakota, US, United States	North Dakota	47.4675	-100.3020	
5	2347582	Minnesota, US, United States	Minnesota	46.0592	-93.3640	
6	2347581	Michigan, US, United States	Michigan	43.4343	-84.9479	

	sov_a3	adm0_a3	adm0_label	admin	geonunit
1	US1	USA	2	United States of America	United States of America
2	US1	USA	2	United States of America	United States of America
3	US1	USA	2	United States of America	United States of America
4	US1	USA	2	United States of America	United States of America
5	US1	USA	2	United States of America	United States of America
6	US1	USA	2	United States of America	United States of America

	gu_a3	gn_id	gn_name	gns_id	gns_name	gn_level	gn_region	gn_al_code
1	USA	5815135	Washington	-1	<NA>	1	<NA>	US.WA
2	USA	5596512	Idaho	-1	<NA>	1	<NA>	US.ID
3	USA	5667009	Montana	-1	<NA>	1	<NA>	US.MT
4	USA	5690763	North Dakota	-1	<NA>	1	<NA>	US.ND
5	USA	5037779	Minnesota	-1	<NA>	1	<NA>	US.MN
6	USA	5001836	Michigan	-1	<NA>	1	<NA>	US.MI

	region_sub	sub_code	gns_level	gns_lang	gns_adm1	gns_region	min_label
1	Pacific	<NA>	-1	<NA>	<NA>	<NA>	3.5
2	Mountain	<NA>	-1	<NA>	<NA>	<NA>	3.5
3	Mountain	<NA>	-1	<NA>	<NA>	<NA>	3.5
4	West North Central	<NA>	-1	<NA>	<NA>	<NA>	3.5
5	West North Central	<NA>	-1	<NA>	<NA>	<NA>	3.5
6	East North Central	<NA>	-1	<NA>	<NA>	<NA>	3.5



	max_label	min_zoom	wikidataid	name_ar	name_bn	name_de	
1	7.5	2	Q1223	واشنطن	ওয়াশিংটন	Washington	
2	7.5	2	Q1221	أيداهو	আইডাহো	Idaho	
3	7.5	2	Q1212	مونتانا	মন্টানা	Montana	
4	7.5	2	Q1207	داكوتا الشمالية	নর্থ ডাকোটা	North Dakota	
5	7.5	2	Q1527	مينيسوتا	মিনেসোটা	Minnesota	
6	7.5	2	Q1166	ميشيغان	মিশিগান	Michigan	
	name_en		name_es	name_fr	name_el	name_hi	
1	Washington		Washington	Washington	Ουάσινγκτον	वॉशिंगटन राज्य	
2	Idaho		Idaho	Idaho	Αϊνταχο	आयडाहो	
3	Montana		Montana	Montana	Μοντάνα	मोन्टाना	
4	North Dakota	Dakota del Norte		Dakota du Nord	Βόρεια Ντακότα	उत्तर डेकोटा	
5	Minnesota		Minnesota	Minnesota	Μινεσότα	मिनेसोटा	
6	Michigan		Míchigan	Michigan	Μίσιγκαν	मिशिगन	
	name_hu	name_id		name_it	name_ja	name_ko	
1	Washington	Washington		Washington	ワシントン州	워싱턴	
2	Idaho	Idaho		Idaho	アイダホ州	아이다호	
3	Montana	Montana		Montana	モンタナ州	몬태나	
4	Észak-Dakota	Dakota Utara	Dakota del Nord		ノースダコタ州	노스다코타	
5	Minnesota		Minnesota		ミネソタ州	미네소타	
6	Michigan		Michigan		ミシガン州	미시간	
	name_nl	name_pl		name_pt	name_ru	name_sv	
1	Washington	Waszyngton		Washington	Вашингтон	Washington	
2	Idaho	Idaho		Idaho	Айдахо	Idaho	
3	Montana	Montana		Montana	Монтана	Montana	
4	Noord-Dakota	Dakota Północna	Dakota do Norte		Северная Дакота	North Dakota	
5	Minnesota		Minnesota		Миннесота	Minnesota	
6	Michigan		Michigan		Мичиган	Michigan	
	name_tr	name_vi	name_zh	ne_id	name_he	name_uk	
1	Vaşington	Washington	华盛顿州	1159309547	וואשינגטון	Вашингтон	
2	Idaho	Idaho	爱达荷州	1159315339	איידהו	Айдахо	
3	Montana	Montana	蒙大拿州	1159315333	מונטנה	Монтана	
4	Kuzey Dakota	Băc Dakota	北达科他州	1159315337	דקוטה הצפונית	Північна Дакота	
5	Minnesota		明尼苏达州	1159315297	מינסוטה	Міннесота	
6	Michigan		密歇根州	1159314665	מישיגן	Мічиган	
	name_ur	name_fa	name_zht	FCLASS_ISO	FCLASS_US	FCLASS_FR	
1	واشینگتن ایالت	ریاست واشنگتن	華盛頓州	<NA>	<NA>	<NA>	
2	آیداهو	ایڈاہو	愛達荷州	<NA>	<NA>	<NA>	
3	مونتانا ایالت	مونٹانا	蒙大拿州	<NA>	<NA>	<NA>	
4	داکوتای شمالی	شمالی ڈکوتا	北達科他州	<NA>	<NA>	<NA>	
5	مینیسوتا	مینیسوٹا	明尼蘇達州	<NA>	<NA>	<NA>	
6	میشیگان	مشی گن	密歇根州	<NA>	<NA>	<NA>	
	FCLASS_RU	FCLASS_ES	FCLASS_CN	FCLASS_TW	FCLASS_IN	FCLASS_NP	FCLASS_PK
1	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>
2	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>
3	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>
4	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>
5	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>

6	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>
	FCLASS_DE	FCLASS_GB	FCLASS_BR	FCLASS_IL	FCLASS_PS	FCLASS_SA	FCLASS_EG
1	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>
2	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>
3	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>
4	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>
5	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>
6	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>
	FCLASS_MA	FCLASS_PT	FCLASS_AR	FCLASS_JP	FCLASS_KO	FCLASS_VN	FCLASS_TR
1	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>
2	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>
3	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>
4	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>
5	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>
6	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>
	FCLASS_ID	FCLASS_PL	FCLASS_GR	FCLASS_IT	FCLASS_NL	FCLASS_SE	FCLASS_BD
1	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>
2	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>
3	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>
4	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>
5	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>
6	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>	<NA>
	FCLASS_UA	FCLASS_TLC	Total Renewable	Energy Year	Avg_Energy_Price		
1	<NA>	<NA>		394052 2021	2.095e-05		
2	<NA>	<NA>		74428 2021	1.934e-05		
3	<NA>	<NA>		56334 2021	2.062e-05		
4	<NA>	<NA>		92653 2021	1.559e-05		
5	<NA>	<NA>		216113 2021	1.875e-05		
6	<NA>	<NA>		194075 2021	1.938e-05		
	Proportion_of_Renewable_Energy		Percentage_Energy_Per_Unit_Of_Price				
1	0.2438154		11637.966				
2	0.1856439		9598.963				
3	0.1271964		6168.592				
4	0.1137804		7298.296				
5	0.1327478		7079.882				
6	0.0705000		3637.771				
	geometry						
1	MULTIPOLYGON (((-122.753 48...						
2	MULTIPOLYGON (((-117.0382 4...						
3	MULTIPOLYGON (((-116.0482 4...						
4	MULTIPOLYGON (((-104.0476 4...						
5	MULTIPOLYGON (((-97.22609 4...						
6	MULTIPOLYGON (((-84.4913 46...						

```
summarize(us_joined)
```

```

Simple feature collection with 1 feature and 0 fields
Geometry type: MULTIPOLYGON
Dimension:      XY
Bounding box:   xmin: -179.1435 ymin: 18.90612 xmax: 179.7809 ymax: 71.4125
Geodetic CRS:  WGS 84
              geometry
1 MULTIPOLYGON (((-90.92863 4...

```

```
summary(us_joined)
```

featurecla	scalerank	adm1_code	diss_me
Length:52	Min. :2	Length:52	Min. :3513
Class :character	1st Qu.:2	Class :character	1st Qu.:3526
Mode :character	Median :2	Mode :character	Median :3538
	Mean :2		Mean :3538
	3rd Qu.:2		3rd Qu.:3550
	Max. :2		Max. :3563
	NA's :1		NA's :1
iso_3166_2	wikipedia	iso_a2	adm0_sr
Length:52	Length:52	Length:52	Min. :1.000
Class :character	Class :character	Class :character	1st Qu.:1.000
Mode :character	Mode :character	Mode :character	Median :1.000
			Mean :2.627
			3rd Qu.:5.000
			Max. :8.000
			NA's :1
name	name_alt	name_local	type
Length:52	Length:52	Length:52	Length:52
Class :character	Class :character	Class :character	Class :character
Mode :character	Mode :character	Mode :character	Mode :character
type_en	code_local	code_hasc	note
Length:52	Length:52	Length:52	Length:52
Class :character	Class :character	Class :character	Class :character
Mode :character	Mode :character	Mode :character	Mode :character
hasc_maybe	region	region_cod	provnum_ne
Length:52	Length:52	Length:52	Min. :0
Class :character	Class :character	Class :character	1st Qu.:0
Mode :character	Mode :character	Mode :character	Median :0

```

Mean      :0
3rd Qu.   :0
Max.      :0
NA's      :1

gadm_level  check_me  datarank  abbrev
Min.   :1   Min.   :20   Min.   :1.000   Length:52
1st Qu.:1   1st Qu.:20   1st Qu.:1.000   Class :character
Median :1   Median :20   Median :1.000   Mode  :character
Mean   :1   Mean   :20   Mean   :1.137
3rd Qu.:1   3rd Qu.:20   3rd Qu.:1.000
Max.   :1   Max.   :20   Max.   :8.000
NA's   :1   NA's   :1   NA's   :1

postal      area_sqkm  sameascity  labelrank
Length:52   Min.     :0   Min.     :-99.00   Min.     :0.0000
Class :character  1st Qu.:0   1st Qu.: -99.00   1st Qu.:0.0000
Mode  :character  Median :0   Median : -99.00   Median :0.0000
Mean   :0   Mean   :-96.88   Mean   :0.1765
3rd Qu.:0   3rd Qu.: -99.00   3rd Qu.:0.0000
Max.   :0   Max.   : 9.00   Max.   :9.0000
NA's   :1   NA's   :1   NA's   :1

name_len    mapcolor9  mapcolor13  fips
Min.   : 4.000   Min.   :1   Min.   :1   Length:52
1st Qu.: 7.000   1st Qu.:1   1st Qu.:1   Class :character
Median : 8.000   Median :1   Median :1   Mode  :character
Mean   : 8.667   Mean   :1   Mean   :1
3rd Qu.:10.000   3rd Qu.:1   3rd Qu.:1
Max.   :20.000   Max.   :1   Max.   :1
NA's   :1   NA's   :1   NA's   :1

fips_alt    woe_id    woe_label    woe_name
Length:52   Min.     :2347559   Length:52   Length:52
Class :character  1st Qu.:2347572   Class :character  Class :character
Mode  :character  Median :2347584   Mode  :character  Mode  :character
Mean   :2347584
3rd Qu.:2347597
Max.   :2347609
NA's   :1

latitude    longitude    sov_a3    adm0_a3
Min.   :21.49   Min.   :-158.00   Length:52   Length:52
1st Qu.:35.68   1st Qu.: -102.92   Class :character  Class :character
Median :39.50   Median : -89.58   Mode  :character  Mode  :character
Mean   :39.59   Mean   : -93.38
3rd Qu.:43.32   3rd Qu.: -78.55
Max.   :65.36   Max.   : -69.20
NA's   :1   NA's   :1

adm0_label  admin    geonunit    gu_a3
Min.   :2   Length:52   Length:52   Length:52
1st Qu.:2   Class :character  Class :character  Class :character
Median :2   Mode  :character  Mode  :character  Mode  :character

```

```

Mean      :2
3rd Qu.   :2
Max.      :2
NA's      :1

  gn_id      gn_name      gns_id      gns_name
Min.   :4099753 Length:52   Min.    :-1 Length:52
1st Qu.:4629604 Class :character 1st Qu.:-1 Class :character
Median :5090174 Mode  :character Median :-1 Mode  :character
Mean    :5113064          Mean    :-1
3rd Qu.:5574132          3rd Qu.:-1
Max.     :6254928          Max.    :-1
NA's     :1              NA's     :1

  gn_level  gn_region      gn_al_code      region_sub
Min.    :1 Length:52      Length:52      Length:52
1st Qu.:1 Class :character Class :character Class :character
Median :1 Mode  :character Mode  :character Mode  :character
Mean    :1
3rd Qu.:1
Max.    :1
NA's    :1

  sub_code      gns_level  gns_lang      gns_adm1
Length:52      Min.    :-1 Length:52      Length:52
Class :character 1st Qu.:-1 Class :character Class :character
Mode  :character Median :-1 Mode  :character Mode  :character
Mean    :-1
3rd Qu.:-1
Max.    :-1
NA's    :1

  gns_region      min_label      max_label      min_zoom  wikidataid
Length:52      Min.    :3.5   Min.    :7.5   Min.    :2   Length:52
Class :character 1st Qu.:3.5   1st Qu.:7.5   1st Qu.:2   Class :character
Mode  :character Median :3.5   Median :7.5   Median :2   Mode  :character
Mean    :3.5   Mean    :7.5   Mean    :2
3rd Qu.:3.5   3rd Qu.:7.5   3rd Qu.:2
Max.    :3.5   Max.    :7.5   Max.    :2
NA's    :1     NA's    :1     NA's    :1

  name_ar      name_bn      name_de      name_en
Length:52      Length:52      Length:52      Length:52
Class :character Class :character Class :character Class :character
Mode  :character Mode  :character Mode  :character Mode  :character

  name_es      name_fr      name_el      name_hi
Length:52      Length:52      Length:52      Length:52
Class :character Class :character Class :character Class :character
Mode  :character Mode  :character Mode  :character Mode  :character

```

name_hu	name_id	name_it	name_ja
Length:52	Length:52	Length:52	Length:52
Class :character	Class :character	Class :character	Class :character
Mode :character	Mode :character	Mode :character	Mode :character

name_ko	name_nl	name_pl	name_pt
Length:52	Length:52	Length:52	Length:52
Class :character	Class :character	Class :character	Class :character
Mode :character	Mode :character	Mode :character	Mode :character

name_ru	name_sv	name_tr	name_vi
Length:52	Length:52	Length:52	Length:52
Class :character	Class :character	Class :character	Class :character
Mode :character	Mode :character	Mode :character	Mode :character

name_zh	ne_id	name_he	name_uk
Length:52	Min. :1.159e+09	Length:52	Length:52
Class :character	1st Qu.:1.159e+09	Class :character	Class :character
Mode :character	Median :1.159e+09	Mode :character	Mode :character
	Mean :1.159e+09		
	3rd Qu.:1.159e+09		
	Max. :1.159e+09		
	NA's :1		

name_ur	name_fa	name_zht	FCLASS_ISO
Length:52	Length:52	Length:52	Length:52
Class :character	Class :character	Class :character	Class :character
Mode :character	Mode :character	Mode :character	Mode :character

FCLASS_US	FCLASS_FR	FCLASS_RU	FCLASS_ES
Length:52	Length:52	Length:52	Length:52
Class :character	Class :character	Class :character	Class :character
Mode :character	Mode :character	Mode :character	Mode :character

FCLASS_CN	FCLASS_TW	FCLASS_IN	FCLASS_NP
Length:52	Length:52	Length:52	Length:52
Class :character	Class :character	Class :character	Class :character
Mode :character	Mode :character	Mode :character	Mode :character

FCLASS_PK	FCLASS_DE	FCLASS_GB	FCLASS_BR
Length:52	Length:52	Length:52	Length:52
Class :character	Class :character	Class :character	Class :character
Mode :character	Mode :character	Mode :character	Mode :character

FCLASS_IL	FCLASS_PS	FCLASS_SA	FCLASS_EG
Length:52	Length:52	Length:52	Length:52
Class :character	Class :character	Class :character	Class :character
Mode :character	Mode :character	Mode :character	Mode :character

FCLASS_MA	FCLASS_PT	FCLASS_AR	FCLASS_JP
Length:52	Length:52	Length:52	Length:52
Class :character	Class :character	Class :character	Class :character
Mode :character	Mode :character	Mode :character	Mode :character

FCLASS_K0	FCLASS_VN	FCLASS_TR	FCLASS_ID
Length:52	Length:52	Length:52	Length:52
Class :character	Class :character	Class :character	Class :character
Mode :character	Mode :character	Mode :character	Mode :character

FCLASS_PL	FCLASS_GR	FCLASS_IT	FCLASS_NL
Length:52	Length:52	Length:52	Length:52
Class :character	Class :character	Class :character	Class :character
Mode :character	Mode :character	Mode :character	Mode :character

FCLASS_SE	FCLASS_BD	FCLASS_UA	FCLASS_TLC
Length:52	Length:52	Length:52	Length:52
Class :character	Class :character	Class :character	Class :character
Mode :character	Mode :character	Mode :character	Mode :character

Total Renewable Energy	Year	Avg_Energy_Price
Min. : 2487	Min. :2021	Min. :1.248e-05
1st Qu.: 60741	1st Qu.:2021	1st Qu.:1.883e-05
Median : 115669	Median :2021	Median :1.987e-05
Mean : 293889	Mean :2021	Mean :2.069e-05
3rd Qu.: 194800	3rd Qu.:2021	3rd Qu.:2.180e-05
Max. :7646167	Max. :2021	Max. :3.269e-05

Proportion_of_Renewable_Energy	Percentage_Energy_Per_Unit_Of_Price
Min. :0.01401	Min. : 699.5
1st Qu.:0.05343	1st Qu.: 2448.3
Median :0.07883	Median : 3715.1
Mean :0.09995	Mean : 4963.2
3rd Qu.:0.11370	3rd Qu.: 5854.3
Max. :0.34874	Max. :18500.8

```

      geometry
MULTIPOLYGON :52
epsg:4326      : 0
+proj=long... : 0

```

### Analysis:

So a higher number means the state gets more renewable energy for every dollar spent.

### What patterns do you notice?

How does your map help answer the main research question? - it gives a new metric - “How much renewable energy (%) you get per dollar spent on energy.” - Proportion of Renewable Energy Divided by Average Energy Price -