EV Power - Lab 4 Project Report

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Example Solution 1

Part 0: libraries

```
── 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   3.5.2     ✔ 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
Linking to GEOS 3.13.0, GDAL 3.8.5, PROJ 9.5.1; sf_use_s2() is TRUE
```

Part 1: Defining Research Question

Chosen Question: Do states with cheaper electricity have faster EV adoption rates?

Part 2: Data Preparation and Cleaning

```
# DATA
ev_reg <- read_csv("data/ev-registrations-by-state-2023.csv")
```

```
New names:
Rows: 54 Columns: 2
── Column specification
──────────────────────────────────────────────────────── Delimiter: "," chr
(2): electric vehicle registrations_by_state (2023), ...2
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.
• `` -> `...2`
```

```
ev_reg
```

```
# A tibble: 54 × 2
   `electric vehicle registrations_by_state (2023)` ...2
   <chr>                                            <chr>
 1 <NA>                                             <NA>
 2 STATE                                            Count-EVs
 3 Alabama                                          #13047
 4 Alaska                                           ~2697
 5 Arizona                                          89798
 6 Arkansas                                         7108 EVs
 7 California                                       1256646
 8 Colorado                                         90083
 9 Connecticut                                      EVs 31557
10 Delaware                                         8435
# ℹ 44 more rows
```

```
avg_price <- 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.
```

```
avg_price
```

```
# A tibble: 54 × 1
   `Total energy average price, dollars per million Btu,,,`
   <chr>
 1 ,,,
 2 State,2021,2022,2023
 3 AK,$20.03 per MMBtu,$27.33,$23.84 est.
 4 AL,about 17.85 USD,23.37 USD,≈21.11
 5 AR,$18.42,$23.84 per MMBtu,$21.76
 6 AZ,≈25.07,31.72 USD,about 30.28
 7 CA,$28.44,$37.35,$35.72 per MMBtu
 8 CO,20.64 USD,≈25.85,23.85
 9 CT,about $25.85,$33.15,$32.32 est.
```

```
10 DC,≈25.67,$30.84,about 32.28 USD
# ℹ 44 more rows
```

```
states_list <- tibble(
    Name = state.name,
    Code = state.abb
)
states_list
```

```
# A tibble: 50 × 2
   Name        Code
   <chr>       <chr>
 1 Alabama     AL
 2 Alaska      AK
 3 Arizona     AZ
 4 Arkansas    AR
 5 California  CA
 6 Colorado    CO
 7 Connecticut CT
 8 Delaware    DE
 9 Florida     FL
10 Georgia     GA
# ℹ 40 more rows
```

```
# CLEANING
colnames(ev_reg) <- ev_reg[2,]
ev_reg_2 <- ev_reg |>
    filter(STATE %in% states_list$Name) |>
    mutate(Count = as.numeric(str_extract(`Count-EVs`, pattern = "[0-9]+"))) |
>
    select(STATE, Count)

ev_reg_3 <- ev_reg_2 |>
    left_join(states_list, by = c("STATE" = "Name"))

ev_reg_3
```

```
# A tibble: 50 × 3
   STATE         Count Code
   <chr>         <dbl> <chr>
 1 Alabama       13047 AL
 2 Alaska         2697 AK
 3 Arizona       89798 AZ
 4 Arkansas       7108 AR
```

```
 5 California  1256646 CA
 6 Colorado      90083 CO
 7 Connecticut   31557 CT
 8 Delaware       8435 DE
 9 Florida      254878 FL
10 Georgia       92368 GA
# ℹ 40 more rows
```

```
colnames(avg_price) <- c("states")
avg_price_2 <- avg_price |>
    separate(states, into = c("State", "2021", "2022", "2023"), sep = ",") |>
    filter(State %in% states_list$Code) |>
    select(State, `2023`) |>
    mutate(`Avg Energy Price` = as.numeric(str_extract(`2023`, pattern =
"[0-9]{2}\\.[0-9]{2}"))) |>
    select(State, `Avg Energy Price`)

print(avg_price_2, n = 50)
```

```
# A tibble: 50 × 2
   State `Avg Energy Price`
   <chr>              <dbl>
 1 AK                  23.8
 2 AL                  21.1
 3 AR                  21.8
 4 AZ                  30.3
 5 CA                  35.7
 6 CO                  23.8
 7 CT                  32.3
 8 DE                  26.7
 9 FL                  28.1
10 GA                  23.0
11 HI                  40.3
12 IA                  18.1
13 ID                  22.8
14 IL                  21.6
15 IN                  19.9
16 KS                  22.2
17 KY                  22.2
18 LA                  12.4
19 MA                  31.7
20 MD                  28.8
21 ME                  28.8
22 MI                  22.4
23 MN                  22.2
24 MO                  24.7
```

```
25 MS                 22.4
26 MT                 24.0
27 NC                 25.0
28 ND                 18.2
29 NE                 20.5
30 NH                 32.3
31 NJ                 25.2
32 NM                 24.7
33 NV                 28.6
34 NY                 27.0
35 OH                 21.6
36 OK                 20.3
37 OR                 26.6
38 PA                 23.7
39 RI                 31.5
40 SC                 23.1
41 SD                 21.3
42 TN                 23.3
43 TX                 17.4
44 UT                 23.8
45 VA                 23.8
46 VT                 29.8
47 WA                 26.4
48 WI                 22.7
49 WV                 24.3
50 WY                 19.7
```

Part 3: Joining / Pivoting Datasets for Analysis

```
full_data <- left_join(ev_reg_3, avg_price_2, by = c("Code" = "State"))
full_data
```

```
# A tibble: 50 × 4
   STATE         Count Code  `Avg Energy Price`
   <chr>         <dbl> <chr>              <dbl>
 1 Alabama       13047 AL                  21.1
 2 Alaska         2697 AK                  23.8
 3 Arizona       89798 AZ                  30.3
 4 Arkansas       7108 AR                  21.8
 5 California  1256646 CA                  35.7
 6 Colorado      90083 CO                  23.8
 7 Connecticut   31557 CT                  32.3
 8 Delaware       8435 DE                  26.7
 9 Florida      254878 FL                  28.1
10 Georgia       92368 GA                  23.0
# ℹ 40 more rows
```

```r
states_sf <- ne_states(country = 'United States of America', returnclass =
"sf")
full_data_states <- left_join(states_sf, full_data, by = c("postal" = "Code"))
full_data_states
```

```
Simple feature collection with 51 features and 124 fields
Geometry type: MULTIPOLYGON
Dimension:     XY
Bounding box:  xmin: -179.1435 ymin: 18.90612 xmax: 179.7809 ymax: 71.4125
Geodetic CRS:  WGS 84
First 10 features:
                      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
7  Admin-1 states provinces lakes         2  USA-3550    3550      US-OH
8  Admin-1 states provinces lakes         2  USA-3560    3560      US-PA
9  Admin-1 states provinces lakes         2  USA-3559    3559      US-NY
10 Admin-1 states provinces lakes         2  USA-3540    3540      US-VT
                                          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
7               http://en.wikipedia.org/wiki/Ohio     US       1         Ohio
8       http://en.wikipedia.org/wiki/Pennsylvania     US       1 Pennsylvania
9           http://en.wikipedia.org/wiki/New_York     US       3     New York
10           http://en.wikipedia.org/wiki/Vermont     US       1      Vermont
                        name_alt name_local  type type_en code_local
1                       WA|Wash.       <NA> State   State       US53
2                       ID|Idaho       <NA> State   State       US16
3                       MT|Mont.       <NA> State   State       US30
4                        ND|N.D.       <NA> State   State       US38
5                       MN|Minn.       <NA> State   State       US27
6                       MI|Mich.       <NA> State   State       US26
7                        OH|Ohio       <NA> State   State       US39
8  Commonwealth of Pennsylvania|PA       <NA> State   State       US42
9                        NY|N.Y.       <NA> State   State       US36
10                            VT       <NA> State   State       US50
   code_hasc note hasc_maybe    region region_cod provnum_ne gadm_level
1      US.WA <NA>       <NA>      West       <NA>          0          1
2      US.ID <NA>       <NA>      West       <NA>          0          1
```

```
3      US.MT <NA>       <NA>      West       <NA>          0          1
4      US.ND <NA>       <NA>   Midwest       <NA>          0          1
5      US.MN <NA>       <NA>   Midwest       <NA>          0          1
6      US.MI <NA>       <NA>   Midwest       <NA>          0          1
7      US.OH <NA>       <NA>   Midwest       <NA>          0          1
8      US.PA <NA>       <NA> Northeast       <NA>          0          1
9      US.NY <NA>       <NA> Northeast       <NA>          0          1
10     US.VT <NA>       <NA> Northeast       <NA>          0          1
   check_me datarank abbrev postal area_sqkm sameascity labelrank name_len
1        20        1  Wash.     WA         0        -99         0       10
2        20        1  Idaho     ID         0        -99         0        5
3        20        1  Mont.     MT         0        -99         0        7
4        20        1   N.D.     ND         0        -99         0       12
5        20        1  Minn.     MN         0        -99         0        9
6        20        1  Mich.     MI         0        -99         0        8
7        20        1   Ohio     OH         0        -99         0        4
8        20        1    Pa.     PA         0        -99         0       12
9        20        1   N.Y.     NY         0        -99         0        8
10       20        1    Vt.     VT         0        -99         0        7
   mapcolor9 mapcolor13 fips fips_alt  woe_id                      woe_label
1          1          1 US53     <NA> 2347606   Washington, US, United States
2          1          1 US16     <NA> 2347571        Idaho, US, United States
3          1          1 US30     <NA> 2347585      Montana, US, United States
4          1          1 US38     <NA> 2347593 North Dakota, US, United States
5          1          1 US27     <NA> 2347582    Minnesota, US, United States
6          1          1 US26     <NA> 2347581     Michigan, US, United States
7          1          1 US39     <NA> 2347594         Ohio, US, United States
8          1          1 US42     <NA> 2347597 Pennsylvania, US, United States
9          1          1 US36     <NA> 2347591     New York, US, United States
10         1          1 US50     <NA> 2347604      Vermont, US, United States
       woe_name latitude longitude sov_a3 adm0_a3 adm0_label
1    Washington  47.4865 -120.3610    US1     USA          2
2         Idaho  43.7825 -114.1330    US1     USA          2
3       Montana  46.9965 -110.0440    US1     USA          2
4  North Dakota  47.4675 -100.3020    US1     USA          2
5     Minnesota  46.0592  -93.3640    US1     USA          2
6      Michigan  43.4343  -84.9479    US1     USA          2
7          Ohio  40.0924  -82.6719    US1     USA          2
8  Pennsylvania  40.8601  -77.6094    US1     USA          2
9      New York  43.1988  -75.3242    US1     USA          2
10      Vermont  44.0886  -72.7317    US1     USA          2
                     admin                geonunit gu_a3   gn_id
gn_name
1  United States of America United States of America   USA 5815135
Washington
2  United States of America United States of America   USA 5596512
Idaho
3  United States of America United States of America   USA 5667009
```

```
Montana
4  United States of America United States of America   USA 5690763 North
Dakota
5  United States of America United States of America   USA 5037779
Minnesota
6  United States of America United States of America   USA 5001836
Michigan
7  United States of America United States of America   USA 5165418
Ohio
8  United States of America United States of America   USA 6254927
Pennsylvania
9  United States of America United States of America   USA 5128638     New
York
10 United States of America United States of America   USA 5242283
Vermont
   gns_id gns_name gn_level gn_region gn_a1_code         region_sub sub_code
1      -1     <NA>        1      <NA>      US.WA            Pacific     <NA>
2      -1     <NA>        1      <NA>      US.ID           Mountain     <NA>
3      -1     <NA>        1      <NA>      US.MT           Mountain     <NA>
4      -1     <NA>        1      <NA>      US.ND West North Central     <NA>
5      -1     <NA>        1      <NA>      US.MN West North Central     <NA>
6      -1     <NA>        1      <NA>      US.MI East North Central     <NA>
7      -1     <NA>        1      <NA>      US.OH East North Central     <NA>
8      -1     <NA>        1      <NA>      US.PA    Middle Atlantic     <NA>
9      -1     <NA>        1      <NA>      US.NY    Middle Atlantic     <NA>
10     -1     <NA>        1      <NA>      US.VT        New England     <NA>
   gns_level gns_lang gns_adm1 gns_region min_label max_label min_zoom
1         -1     <NA>     <NA>       <NA>       3.5       7.5        2
2         -1     <NA>     <NA>       <NA>       3.5       7.5        2
3         -1     <NA>     <NA>       <NA>       3.5       7.5        2
4         -1     <NA>     <NA>       <NA>       3.5       7.5        2
5         -1     <NA>     <NA>       <NA>       3.5       7.5        2
6         -1     <NA>     <NA>       <NA>       3.5       7.5        2
7         -1     <NA>     <NA>       <NA>       3.5       7.5        2
8         -1     <NA>     <NA>       <NA>       3.5       7.5        2
9         -1     <NA>     <NA>       <NA>       3.5       7.5        2
10        -1     <NA>     <NA>       <NA>       3.5       7.5        2
   wikidataid         name_ar      name_bn      name_de      name_en
1       Q1223          واشنطن     ওয়াশিংটন   Washington   Washington
2       Q1221          أيداهو       আইডাহো        Idaho        Idaho
3       Q1212          مونتانا       মন্টানা      Montana      Montana
4       Q1207 داكوتا الشمالية   নর্থ ডাকোটা North Dakota North Dakota
5       Q1527        مينيسوتا     মিনেসোটা    Minnesota    Minnesota
6       Q1166         ميشيغان      মিশিগান     Michigan     Michigan
7       Q1397          أوهايو        ওহাইও         Ohio         Ohio
8       Q1400      بنسيلفانيا পেনসিলভেনিয়া Pennsylvania Pennsylvania
9       Q1384          نيويورك     নিউ ইয়র্ক     New York     New York
10     Q16551         فيرمونت       ভার্মন্ট      Vermont      Vermont
```

```
           name_es          name_fr        name_el      name_hi      name_hu
1       Washington       Washington    Ουάσινγκτον वॉशिंगटन राज्य   Washington
2            Idaho            Idaho        Άινταχο       आयडाहो        Idaho
3          Montana          Montana        Μοντάνα       मोन्टाना      Montana
4  Dakota del Norte   Dakota du Nord Βόρεια Ντακότα   उत्तर डेकोटा Észak-Dakota
5        Minnesota        Minnesota       Μινεσότα      मिनेसोटा     Minnesota
6         Míchigan         Michigan       Μίσιγκαν       मिशिगन     Michigan
7             Ohio             Ohio         Οχάιο        ओहायो         Ohio
8       Pensilvania     Pennsylvanie    Πενσιλβάνια   पेन्सिलवेनिया Pennsylvania
9        Nueva York État de New York      Νέα Υόρκη       न्यूयॉर्क      New York
10         Vermont          Vermont        Βερμόντ        वर्माट       Vermont
       name_id         name_it          name_ja      name_ko      name_nl
1   Washington      Washington     ワシントン州       워싱턴    Washington
2        Idaho           Idaho       アイダホ州     아이다호         Idaho
3      Montana         Montana       モンタナ州       몬태나       Montana
4  Dakota Utara Dakota del Nord   ノースダコタ州   노스다코타 Noord-Dakota
5    Minnesota       Minnesota       ミネソタ州     미네소타     Minnesota
6     Michigan        Michigan       ミシガン州       미시간      Michigan
7         Ohio            Ohio       オハイオ州     오하이오          Ohio
8  Pennsylvania    Pennsylvania ペンシルベニア州 펜실베이니아 Pennsylvania
9     New York        New York   ニューヨーク州         뉴욕      New York
10     Vermont         Vermont     バーモント州       버몬트       Vermont
          name_pl         name_pt         name_ru      name_sv      name_tr
1       Waszyngton      Washington       Вашингтон   Washington    Vaşington
2            Idaho           Idaho          Айдахо        Idaho        Idaho
3          Montana         Montana         Монтана      Montana      Montana
4  Dakota Północna Dakota do Norte Северная Дакота North Dakota Kuzey Dakota
5        Minnesota       Minnesota       Миннесота    Minnesota    Minnesota
6         Michigan        Michigan         Мичиган     Michigan     Michigan
7             Ohio            Ohio           Огайо         Ohio         Ohio
8      Pensylwania     Pensilvânia    Пенсильвания Pennsylvania  Pensilvanya
9        Nowy Jork     Nova Iorque        Нью-Йорк     New York     New York
10         Vermont         Vermont         Вермонт      Vermont      Vermont
       name_vi      name_zh      ne_id       name_he         name_uk
1   Washington     华盛顿州 1159309547     וושינגטון       Вашингтон
2        Idaho     爱达荷州 1159315339        איידהו          Айдахо
3      Montana     蒙大拿州 1159315333        מונטנה         Монтана
4   Bắć 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
7         Ohio     俄亥俄州 1159315315         אוהיו           Огайо
8  Pennsylvania 宾夕法尼亚州 1159315331     פנסילבניה    Пенсильванія
9     New York       纽约州 1159312155      ניו יורק   штат Нью-Йорк
10     Vermont     佛蒙特州 1159315305        ורמונט         Вермонт
        name_ur        name_fa     name_zht FCLASS_ISO FCLASS_US FCLASS_FR
1  ریاست واشنگٹن ایالت واشینگتن     華盛頓州       <NA>      <NA>      <NA>
2        آیداهو         ایڈاہو     愛達荷州       <NA>      <NA>      <NA>
3       ایالت مونتانا  مونٹانا     蒙大拿州       <NA>      <NA>      <NA>
```

```
4    داکوتای شمالی  شمالی ڈکوٹا   北達科他州       <NA>      <NA>      <NA>
5        مینهسوتا       مینیسوٹا   明尼蘇達州       <NA>      <NA>      <NA>
6         میشیگان        مشی گن     密歇根州       <NA>      <NA>      <NA>
7          اوهایو         اوہائیو     俄亥俄州       <NA>      <NA>      <NA>
8      پنسیلوانیا      پنسلوانیا 賓夕法尼亞州       <NA>      <NA>      <NA>
9         نیویورک         نیویارک       紐約州       <NA>      <NA>      <NA>
10        ورمونت         ورمونٹ     佛蒙特州       <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>
7       <NA>      <NA>      <NA>      <NA>      <NA>      <NA>      <NA>
8       <NA>      <NA>      <NA>      <NA>      <NA>      <NA>      <NA>
9       <NA>      <NA>      <NA>      <NA>      <NA>      <NA>      <NA>
10      <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>
7       <NA>      <NA>      <NA>      <NA>      <NA>      <NA>      <NA>
8       <NA>      <NA>      <NA>      <NA>      <NA>      <NA>      <NA>
9       <NA>      <NA>      <NA>      <NA>      <NA>      <NA>      <NA>
10      <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>
7       <NA>      <NA>      <NA>      <NA>      <NA>      <NA>      <NA>
8       <NA>      <NA>      <NA>      <NA>      <NA>      <NA>      <NA>
9       <NA>      <NA>      <NA>      <NA>      <NA>      <NA>      <NA>
10      <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>
7       <NA>      <NA>      <NA>      <NA>      <NA>      <NA>      <NA>
```

```
8       <NA>      <NA>      <NA>      <NA>      <NA>      <NA>      <NA>
9       <NA>      <NA>      <NA>      <NA>      <NA>      <NA>      <NA>
10      <NA>      <NA>      <NA>      <NA>      <NA>      <NA>      <NA>
   FCLASS_UA FCLASS_TLC        STATE  Count Avg Energy Price
1       <NA>       <NA>   Washington 152101             26.35
2       <NA>       <NA>        Idaho   8501             22.77
3       <NA>       <NA>      Montana   4608             24.05
4       <NA>       <NA> North Dakota    959             18.15
5       <NA>       <NA>    Minnesota  37050             22.18
6       <NA>       <NA>     Michigan  50284             22.37
7       <NA>       <NA>         Ohio  50393             21.65
8       <NA>       <NA> Pennsylvania  70154             23.67
9       <NA>       <NA>     New York 131250             27.05
10      <NA>       <NA>      Vermont   7816             29.76
                         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...
7  MULTIPOLYGON (((-80.52023 4...
8  MULTIPOLYGON (((-79.76301 4...
9  MULTIPOLYGON (((-79.06523 4...
10 MULTIPOLYGON (((-73.35134 4...
```

```
full_data |>
    arrange(desc(`Avg Energy Price`))
```

```
# A tibble: 50 × 4
   STATE          Count Code  `Avg Energy Price`
   <chr>          <dbl> <chr>              <dbl>
 1 Hawaii         25565 HI                  40.3
 2 California   1256646 CA                  35.7
 3 Connecticut    31557 CT                  32.3
 4 New Hampshire   9861 NH                  32.3
 5 Massachusetts  73768 MA                  31.7
 6 Rhode Island    6396 RI                  31.5
 7 Arizona        89798 AZ                  30.3
 8 Vermont         7816 VT                  29.8
 9 Maryland       72139 MD                  28.8
10 Maine           7377 ME                  28.8
# ℹ 40 more rows
```

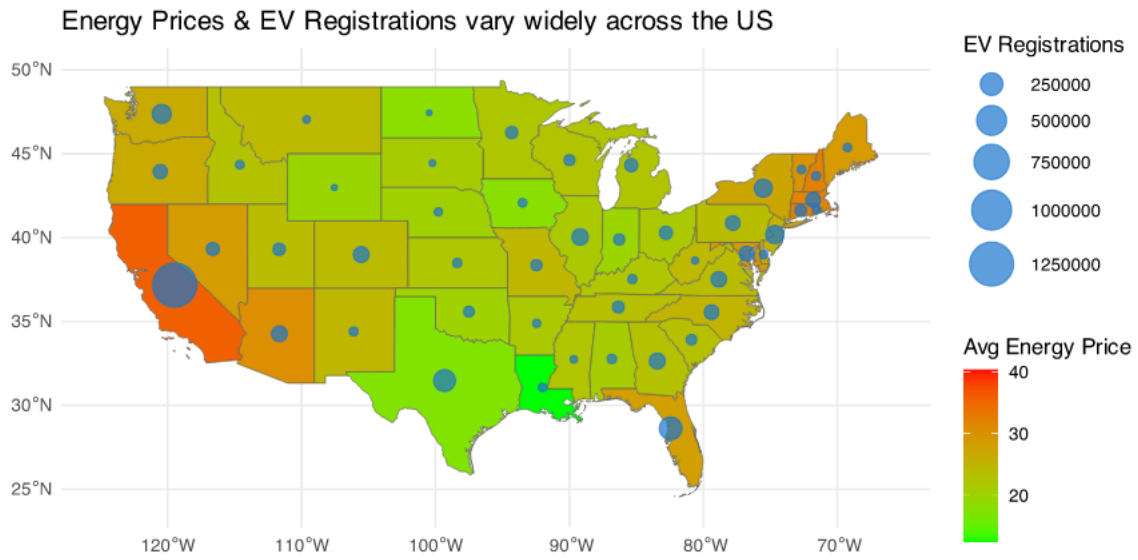
```
centroids <- st_centroid(full_data_states)
```

```
Warning: st_centroid assumes attributes are constant over geometries
```

Part 4: Mapping Visualization

```
full_data_states |>
    ggplot() +
    geom_sf(aes(fill = `Avg Energy Price`)) +
    geom_sf(data = centroids, aes(size = Count), color = "dodgerblue3", alpha
= 0.7) +
    scale_size(range = c(1, 10), name = "EV Registrations") +
    scale_fill_gradient(low = "green", high = "red", name = "Avg Energy
Price") +
    coord_sf(xlim = c(-125, -66), ylim = c(24, 50)) +
    theme_minimal() +
    labs(title = "Energy Prices & EV Registrations vary widely across the US")
```

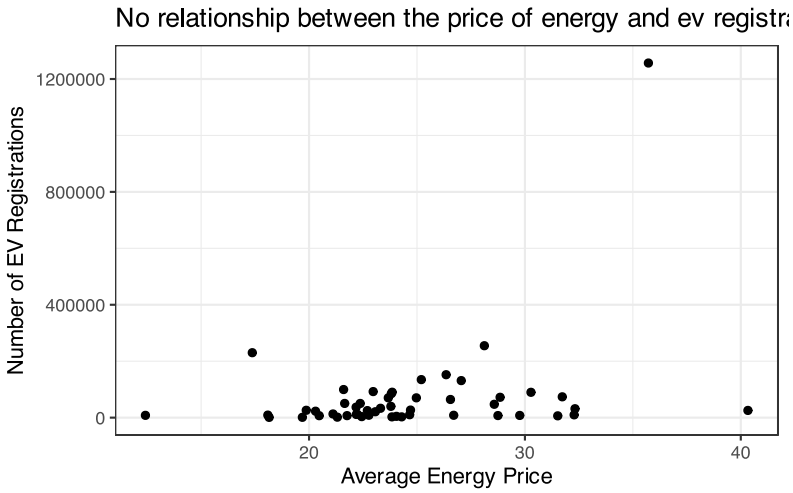
```
Warning: Removed 1 row containing missing values or values outside the scale
range
(`geom_sf()`).
```



From looking at our map visualization, we see no obvious relationship between the amount of EV Registrations (Blue Circle) and the Average Energy Price in the state. In fact, we see a huge discrepancy from what we would expect in California which has the most EV Registrations and the second highest Average Energy Cost. We also see states like Texas which still have a relatively

high amount of EV Registrations but a much lower cost of energy. States like Nevada, Arizona, and some in the New England area have high energy prices but not many EV Registrations.

```
full_data |>
    ggplot(aes(
        x = `Avg Energy Price`,
        y = Count
    )) +
    geom_point() +
    labs(x = "Average Energy Price",
        y = "Number of EV Registrations",
        title = "No relationship between the price of energy and ev
registrations") +
    theme_bw()
```



Taking a look at a scatter plot of Count vs. Average Energy Price, we see no obvious relationship between the two variables. If there is a relationship, it is extremely weak at best. If there were to be a relationship, it would be positive which goes against what we would expect to happen. We would expect that lower energy prices might drive more people to adopt electric vehicles. In conclusion, there is no observable relationship between Average Energy Price and the number of EV Registrations in a State.