Kritaporn Nitjaphanich

Data Visualization of Electricity Generation of 129 countries over time

Data set and questions

I decided to explore electricity generation data of 229 countries from 3 sources, including fossil fuels, renewable sources, and nuclear, during 1980 to 2021. The data can be downloaded from https://www.eia.gov/international/data/world

I have found that almost all graphics based on this data set on the internet would be based on visualizing the amount of electricity generated from each source in kilowatt-hour for each country.

However, I am personally interested in the proportion or percentage generated from each source of electricity because it could tell how the trend in the choice of electricity generation changes over time.

Based on the data set, I came up with the following questions.

1) How would a country allocate its electricity generation over 3 sources over time?
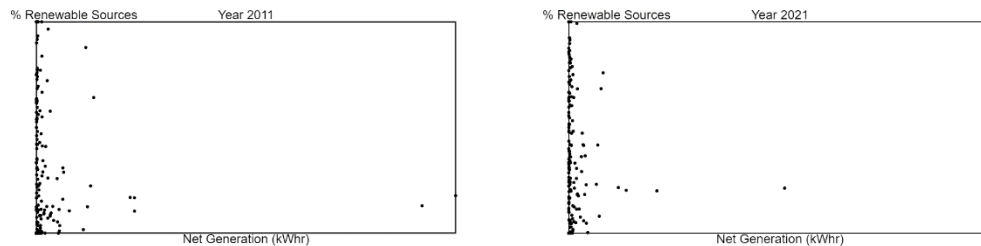2) Do large-size and small-size producers have different trends?

Data Exploration

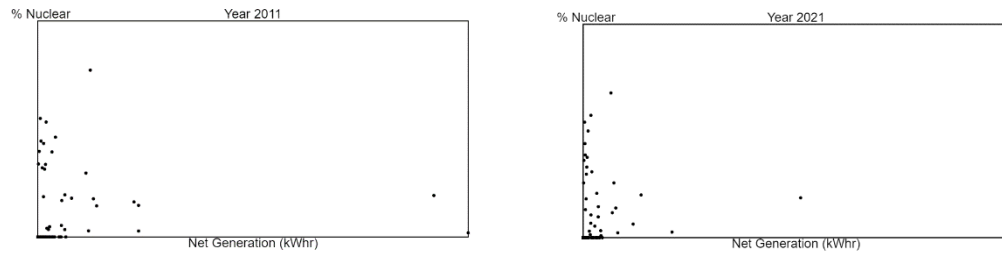**Step 1:** Plot the following 3 scatter plots. Try changing the year.

1) Percentage of electricity generated from fossil fuels (percent) vs total net generation (kWhr)
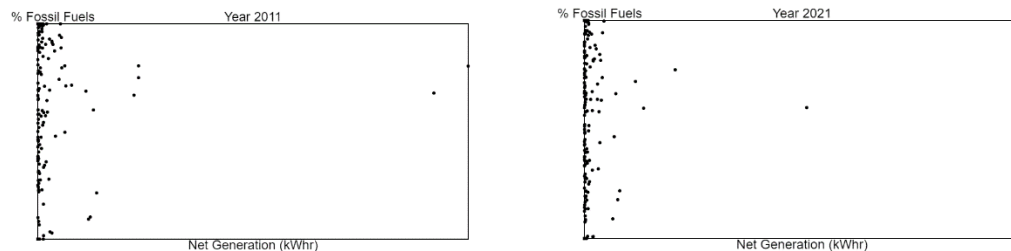
2) Percentage of electricity generated from renewable sources (percent) vs total net generation (kWhr)

3) Percentage of electricity generated from nuclear (percent) vs total net generation (kWhr)

Analysis: There is no obvious trend and it is very difficult to compare these plots because the net generation of each country changed over time. The large producers on the right-hand side of the 2021 plot may not be the same countries as in 2011 for example.

Step 2: Plot changes in proportion of each source (difference) instead of the percentage.
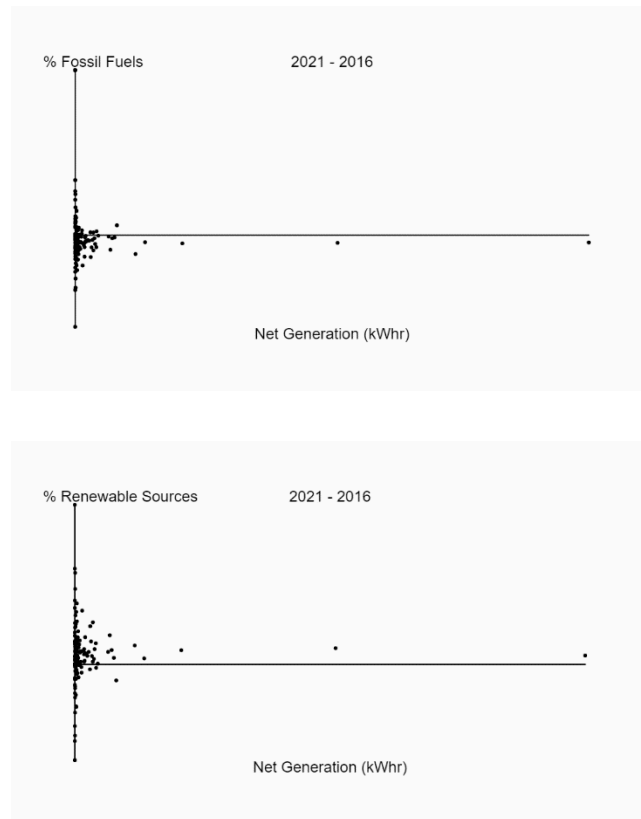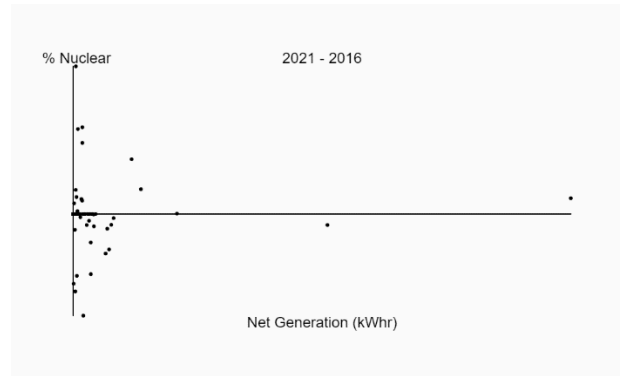
Analysis: The plots reveal some trends. For example, from 2016 to 2021 most producers increase their proportion from renewable sources and reduce the ones from fossil fuels. The countries that do the opposite are only small producers. The drawback of this plot is that only few large producers are clearly visible on the plot. This is because the large ones have significantly higher outputs than others.

Step 3: Try changing x axis to percentile.
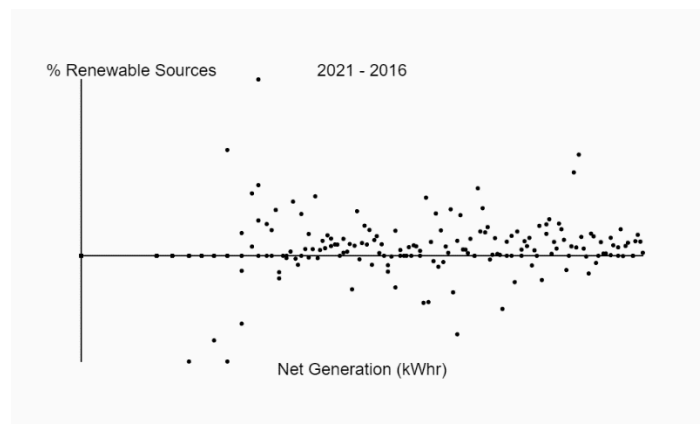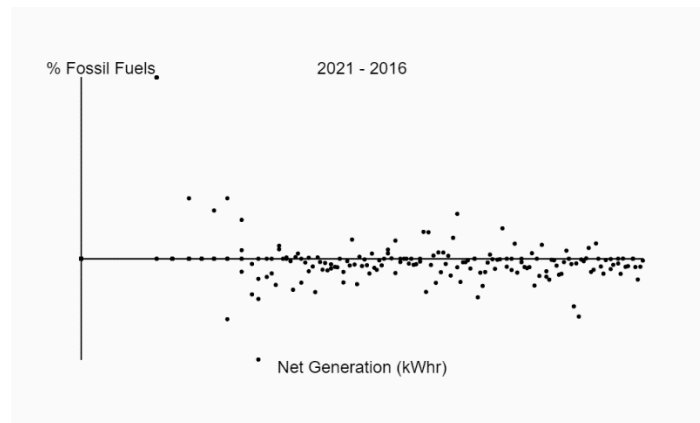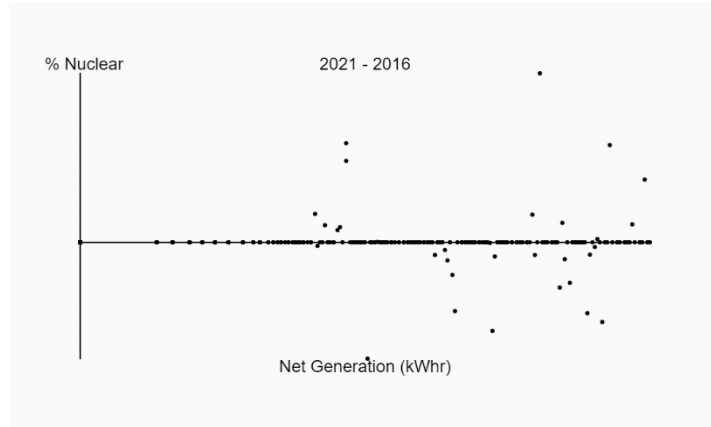
Analysis: Despite losing the kWhr scale, the behaviors of the smaller producers become more visible. Although it is easy to tell which directions most countries act, comparing multiple timeframes is still not so convenient.

Step 4: Plot a histogram of 5-year changes
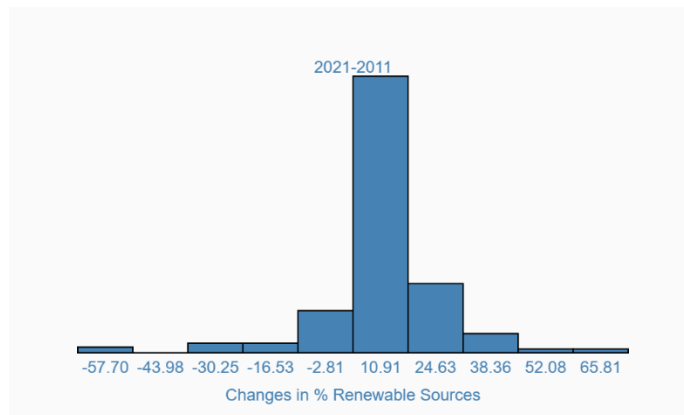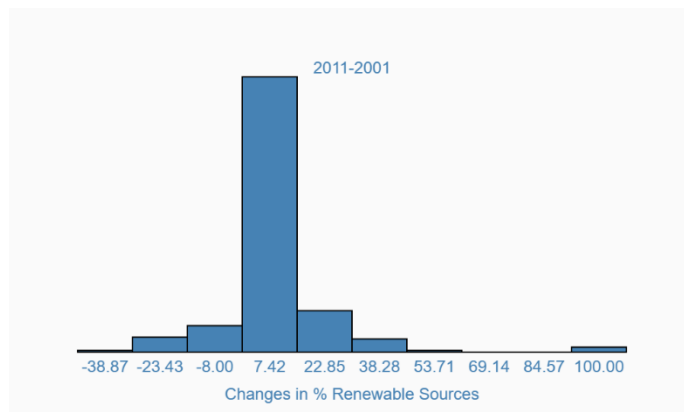
Analysis: It becomes clearer that the distribution of the change shifts to the right in 2011-2016 compared to the previous 5 years. The histogram makes the trend clearer

when comparing 2 time periods but 1 dimension will be dropped. In addition, most of the data points are at zero because many countries do not even produce electricity from that source.

Static Graphic

As a result of all the experiments, I decided to make small multiples of both the scatter plots and histograms. I placed a histogram on the y axis to eliminate the need for redundant data ink. Since the plot is small, I can show plots of many time periods together on the same canvas.

I hide the countries with no changes during the period from both the scatter plots and histograms because they are countries with no electricity generated from that particular source and they do not give any additional information about the trend.

229 countries' 10-year difference in proportion of electricity generated from 3 sources (y axis) vs net generation in percentile (x axis)
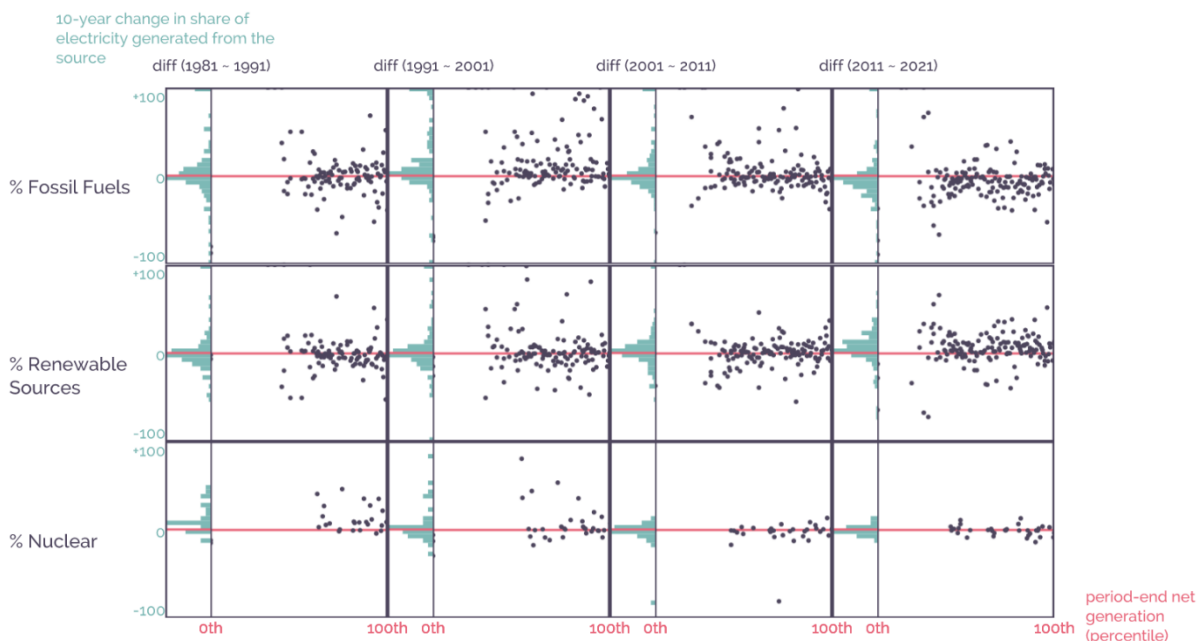
Analysis: During 1991-2001, most countries increased their proportion of fossil fuels. Only small producers had significant drops. Some countries also increased their concentration in nuclear energy during the same period.

In 2011-2021, the trend became the opposite. Most countries reduced their proportion of fossil fuels and increased that of renewable sources. The countries that greatly reduce their proportion of renewable sources are all small producers. There are very small changes in nuclear energy in this period.

In conclusion, it can be inferred that the world is becoming more concerned about the environment and the safety of nuclear energy compared to in the past.

Interactive Graphic

229 countries' proportion of electricity generated from 3 sources vs net generation

Use the slide bar to select a time period for the data

[Slider: 1980 — 1991 — 2010 — 2021]

Change in %
Renewable
Sources

+100

0

-100

0th

100th

Period-End Net Generation (percentile)

Greenland(24.44,75.00)

Mode: Difference Mode
x-axis: Percentile
Lock Timeframe: Off

Keyboard Commands:

Press S to switch between Fossil Fuels, Renewable Sources,
and Nuclear
Press D to switch between difference mode and normal mode
Press L to lock the distance between 2 sliders (difference
mode only)
Press P to switch between percentile and level for x axis

Greenland	1991	diff	2010
% Fossil Fuels:	100.00	-75.00	25.00
% Renewable Sources:	0.00	+75.00	75.00
% Nuclear:	0.00	0.00	0.00
2010 net generation: 24.44 percentile			

Hover the mouse over a data point to show its information

The interactive graphic's design is based on the same logic as the static one. However, instead of showing multiple plots, the interactive graphic will show only 1 plot and adjust the plot as users adjust the settings.

There are 2 modes in the graphic: Difference and Normal. Difference mode displays y axis as the difference between the source's share between the selected years. Normal mode shows y axis as the percentage of electricity generated from the source within 1 selected year.

The functionalities of the graphic are as follows.

1) Mode Selection

   ○ Press D key to switch between Difference mode and Normal mode.

2) Time Period Selection:

   ○ In difference mode, a slide bar can be used to select 2 years for calculating the difference. In normal mode, the slide bar will only have 1 slider for selecting a year to be displayed.

   ○ In difference mode, press L key to lock or unlock the time length between 2 sliders. When the time frame is locked, both the sliders will move together as the users drag one of them.

3) Series Selection

  ○ Press S key to switch between 3 data sets: % Fossil Fuels, % Renewable Sources, and % Nuclear.

  ○ Press P key to switch between percentile and level for x axis.

4) Detailed Information Display

  ○ Hover the mouse over a data point on the scatter plot to display its information.

Conclusion

The first question "How would a country allocate its electricity generation over 3 sources over time?" can be answered from both the static and interactive graphics. Both shows that there is a global trend for electricity generation and the trend changes over time. The second question, "Do large-size and small-size producers have different trends?", is answered as well. Smaller-size producers tends to have more tendency to act opposed the global trend.