# Air Pollution

IS CHINA THE REAL CULPRIT?

Team 3 | MSIS 2629 | June 14, 2017
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# Table of Contents

# 1.0. Introduction

Air pollution occurs when harmful substances are introduced into Earth's atmosphere. It may cause diseases, allergies or death in humans; it may also cause harm to other living organisms such as animals and food crops and may damage the natural or built environment[1].

## 1.1. Effects of Air Pollution[2]

_Smog and soot:_

Smog occurs when emissions from combusting fossil fuels react with sunlight. Soot is made up of tiny particles of chemicals, soil, smoke, dust, or allergens, in the form of gas or solids, that are carried in the air.

_Hazardous air pollutants:_

These are either deadly or have severe health risks even in small amounts. Almost 200 are regulated by law; some of the most common are mercury, lead, dioxins, and benzene.

_Greenhouse gases:_

By trapping the earth's heat in the atmosphere, greenhouse gases lead to warmer temperatures and all the hallmarks of climate change: rising sea levels, more extreme weather, heat-related deaths.

Global warming is a term used to explain the rise in the temperature across the world over the years. Global warming occurs when carbon dioxide ($CO_2$), other air pollutants($SO_2$) and greenhouse gases collect in the atmosphere and absorb sunlight and solar radiation that have bounced off the earth's surface. Normally, this

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[1] https://en.wikipedia.org/wiki/Air_pollution

[2] https://www.nrdc.org/stories/air-pollution-everything-you-need-know

radiation would escape into space—but these pollutants, which can last for years to centuries in the atmosphere, trap the heat and cause the planet to get hotter[3].

## 2.0. About the project

This project starts by throwing some light on the absolute pollution levels in China and USA. It then gives us a better idea about who is polluting more by comparing the per capita pollution level in the two countries. Further, it describes the efforts taken by China to bring down the pollution level. We see this by considering the investments made by China in clean energy, forest growth and implementation of stricter rules and regulations for setting up new industries. It considers only these two countries because more than 40% of world's carbon emissions are created by these countries[4]

Between 2002 to 2012, as China's economy grew rapidly, bolstered by the increase in cement, steel and aluminum production, its coal consumption grew by 10.4% per year. By 2012 China was burning as much as coal the whole world together was[5].  Half of this coal was used for generating electricity and half used directly by industries. This extensive consumption of coal accounts for most of the China's increasing pollution.

Smog released into the sky by the factories is the most familiar and obvious form of air pollution. The increase in the level of $CO_2$ released from smokestacks of these factories and power plants has been a major cause of most of the climate change and global warming.

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[3] https://www.nrdc.org/stories/global-warming-101

[4] http://www.cnbc.com/2017/05/31/how-us-carbon-pollution-compares-with-the-rest-of-the-world.htm

[5] https://www.eia.gov/todayinenergy/detail.php?id=16271

Image 2.0 shows that major source of energy produced is by coal. There are several environmental impacts of coal power.
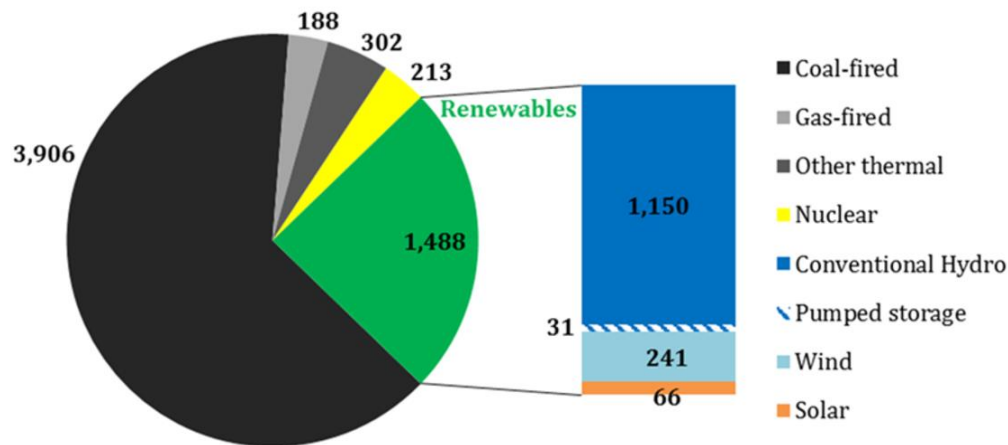


Image - 1.0 - China's Energy mix in 2016[6]

Coal plants are the nation's top source of carbon dioxide ($CO_2$) emissions, the primary cause of global warming. Burning coal is also a leading cause of smog, acid rain, and toxic air pollution. Some emissions can be significantly reduced with readily available pollution controls.

Other harmful pollutants emitted by uncontrolled coal plant include:
1. 114 pounds of lead, 4 pounds of cadmium, other toxic heavy metals, and trace amounts of uranium. Baghouses can reduce heavy metal emissions by up to 90 percent.
2. 720 tons of carbon monoxide, which causes headaches and places additional stress on people with heart disease.
3. 220 tons of hydrocarbons, volatile organic compounds (VOC), which form ozone.

[6]http://ceenews.info/en/power-statistics-china-2016-huge-growth-of-renewables-amidst-thermal-based-generation/

4. 225 pounds of arsenic, which will cause cancer in one out of 100 people who drink water containing 50 parts per billion.[7]

Climate scientists say that they are 95% sure that human influence has been the dominant cause of global warming since 1950; and the evidence for this rapid climate change is compelling.

*Sea Level Rise:*

Global sea level in the last century rose by about 8 inches and the rate in last two decades is nearly double than that of the last century.

*Global Temperature Rise:*

The planet's average surface temperature has risen by about 1.1 degree Celsius since the end of last century which is majorly driven by an increase in the $CO_2$ emissions and other human-made emissions of polluting gases.

## 2.1. Extreme Events that we can notice

Since 1950 the number of recorded high-temperature events in the United States has been increasing, while the number of recorded low-temperature events has been decreasing. The U.S. has also witnessed in increasing numbers of intense rainfall events.

## 2.2. Scientific Statement

Scientific evidence for warming of the climate system is unequivocal[8].

- Intergovernmental Panel on Climate Change

Despite the overwhelming scientific evidence that world's climate is changing, the president-elect of United States has long been skeptical about it and recently backed out of the Paris Summit because he felt that it is unfair to impose

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[7] http://www.ucsusa.org/clean-energy/coal-and-other-fossil-fuels/coal-air-pollution#.WTyk15Dyvbo

[8] https://climate.nasa.gov/evidence

strict regulation on the U.S. when developing countries like China and India are the major polluting sources.

## 3.0. Motivation behind the project

On June 1st, 2017, President Trump announced the United States will withdraw from the Paris Climate Agreement[9]. The decision was a disruptive news for heads of state, climate activists, corporate executives, and members of the president's own staff. According to President Trump, the regulation proposed by the Paris Climate Agreement on the United States is not fair when China is the biggest pollution producer in the world[10]. Our motivation behind this project is to understand China's pollution at a granular level. We would like to assess if Trump's withdrawal from the Paris Agreement was based on China being the major pollutant is reasonable or not.

The population of the United States was 321.4 million in 2015 and China reported more than 4 times the U.S. population in 2015. With a vast population and rapid industrialization, China is bound to produce more pollution. Thus, comes the question, is it fair to compare absolute pollution level or should we utilize relative measurements and examine the data at an individual level.

## 4.0. Audience

Anyone who is concern about environment and keeps updated with regards to the recent changes in environmental regulations are our potential audience. The complexity of the visualizations has been designed keeping into consideration about

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[9] https://www.nytimes.com/2017/06/01/climate/trump-paris-climate-agreement.html

[10] https://www.whitehouse.gov/the-press-office/2017/06/01/statement-president-trump-paris-climate-accord

audience of varying skills. Looking at the visualization, exploratory as well as actionable insights can be derived.

## 5.0. Data Collection

We incorporated various data for this project.

1. State Air U.S. Department of State Air Quality Monitoring Program[11]. These are the PM2.5 data collected from 5 major Chinese cities (Beijing, Chengdu, Guangzhou, Shanghai, and Shenyang). The measurements in this dataset include the hourly value of atmospheric particulate matter (PM) that have a diameter less than 2.5 micrometers which is commonly considered as the air quality index.

2. China Total Production of Energy and Its Composition in 2016[12]. The data is provided by the National Bureau of Statistics of China. The Bureau publishes statistical yearbook which has data in various divisions such as population, energy consumption/production, and Public Health and Social Services data.

3. $CO_2$ emissions (metric tons per capita) by The World Bank[13]. The dataset provides per capita $CO_2$ emissions for various countries from 1960 to 2013.

4. Forest area (% of land area) by The World Bank[14]. The dataset provides forest area coverage for various countries from 1990 to 2015. The reason we included the dataset is to because to increase forest area coverage is one of the improvements proposed by the Chinese government in its Paris Commitment submission.

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[11] http://www.stateair.net/mobile/mission/1/index.html

[12] http://www.stats.gov.cn/tjsj/ndsj/2016/indexeh.htm

[13] http://data.worldbank.org/indicator/EN.ATM.CO2E.PC

[14] http://data.worldbank.org/indicator/AG.LND.FRST.ZS

5. Air Pollution by Hannah Ritchie and Max Roser from Our World in Data[15]. This completed report included many pollution indexes. We gathered SO2 and PM2.5 emission data per capita (tonnes per year) for the U.S. and China.

6. The volume of sulfur dioxide emissions in the U.S. from 1970 to 2014 (in 1,000 tons) by Statista[16]. The dataset included the overall SO2 emission in the U.S. from 1970 to 2014.

7. Sulphur dioxide emissions in China from 2005 to 2015 (in 1,000 tons) by Statista[17]. The dataset included the overall SO2 emission in China from 2005 to 2015.

8. Volume of particulate matter (PM2.5) emissions in the U.S. from 1990 to 2014 (in 1,000 tons) by Statista[18]. The dataset included the PM2.5 (an important air quality index) emission in the U.S. from 1990 to 2014.

## 6.0. Data Wrangling

The data wrangling section follows the order from the data collection section.

1. The PM2.5 level data included five cities and each city data was in a different .csv file. Also for each city, there were different csv's for each year (2008 onwards) For each sheet, the data started at the fourth row. We plotted the data into Jupyter Notebook to start reading from the fourth row.

```
In [1]: import pandas as pd
        import numpy as np
        %pylab inline

        Populating the interactive namespace from numpy and matplotlib

In [3]: BeijingDF1 = pd.read_csv('Beijing_2008_2.5.csv', skiprows=3, index_col=0)
```

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[15] https://ourworldindata.org/air-pollution/

[16] https://www-statista-com.libproxy.scu.edu/statistics/501303/volume-of-sulfur-dioxide-emissions-us/

[17] https://www-statista-com.libproxy.scu.edu/statistics/282680/china--sulphur-dioxide-emissions/

[18] https://www.statista.com/statistics/501298/volume-of-particulate-matter-2-5-emissions-us/

```
In [18]:  len(BeijingDF1)
          BeijingDF1.head(5)

Out[18]:  5087
```

Out[18]:

| Site | Parameter | Date (LST) | Year | Month | Day | Hour | Value | Unit | Duration | QC Name |
|------|-----------|------------|------|-------|-----|------|-------|------|----------|---------|
| Beijing | PM2.5 | 2008-04-08 15:00 | 2008 | 4 | 8 | 15 | 207 | �g/mg� | 1 Hr | Valid |
| Beijing | PM2.5 | 2008-04-08 16:00 | 2008 | 4 | 8 | 16 | 180 | �g/mg� | 1 Hr | Valid |
| Beijing | PM2.5 | 2008-04-08 17:00 | 2008 | 4 | 8 | 17 | 152 | �g/mg� | 1 Hr | Valid |
| Beijing | PM2.5 | 2008-04-08 18:00 | 2008 | 4 | 8 | 18 | 162 | �g/mg� | 1 Hr | Valid |
| Beijing | PM2.5 | 2008-04-08 19:00 | 2008 | 4 | 8 | 19 | 171 | �g/mg� | 1 Hr | Valid |

Image – 6.2

2. Data cleaning involved removing NULL/NaN values. Also, the PM2.5 Value column had negative values (-999) which were NULL values. So, we dropped all the -999 value columns. There were some columns which had same value in all columns (string values) which did not add value to our insights. So, we removed such columns (unit, Duration, QC_name). The above 2 steps were repeated to all the sheets for the five cities, and then we consolidated the data into one sheet.

```
In [20]:  BeijingDF1 = BeijingDF1[BeijingDF1.Value != -999]

In [21]:  BeijingDF1 = BeijingDF1[BeijingDF1.Value.isnull() != True]

In [22]:  BeijingDF1.drop(["QC Name","Duration", "Unit"], axis=1, inplace=True)

In [23]:  len(BeijingDF1)
          BeijingDF1.head()

Out[23]:  4821
```

Out[23]:

| Site | Parameter | Date (LST) | Year | Month | Day | Hour | Value |
|------|-----------|------------|------|-------|-----|------|-------|
| Beijing | PM2.5 | 2008-04-08 15:00 | 2008 | 4 | 8 | 15 | 207 |
| Beijing | PM2.5 | 2008-04-08 16:00 | 2008 | 4 | 8 | 16 | 180 |
| Beijing | PM2.5 | 2008-04-08 17:00 | 2008 | 4 | 8 | 17 | 152 |
| Beijing | PM2.5 | 2008-04-08 18:00 | 2008 | 4 | 8 | 18 | 162 |
| Beijing | PM2.5 | 2008-04-08 19:00 | 2008 | 4 | 8 | 19 | 171 |

Image – 6.3

3. For each day, we had multiple values of the PM2.5 values. These values were taken at intervals of one hour. So, we did "groupby" for each day and took the mean value.

```
In [32]:  df2 = df.groupby(['Site', 'Date']).mean()

In [33]:  df2.head()

Out[33]:
```

| Site | Date | Value |
|------|------|-------|
| Beijing | 2008/10/1 | 168.000000 |
| | 2008/10/10 | 23.000000 |
| | 2008/10/11 | 33.500000 |
| | 2008/10/12 | 59.041667 |
| | 2008/10/13 | 165.458333 |

Image – 6.4

4. The Forest coverage data was in the wide format, with each row being an entry for a country across the years. But this was difficult to implement in Tableau, so we converted the wide format data to long format. We used Pandas to create a data frame for our data, and unpivot the data using Pandas.Melt().

```
In [3]:  data = pd.read_excel('Forest_China_US.xlsx')

In [4]:  data.head()

Out[4]:
```

| | Country Name | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 |
|---|--------------|------|------|------|------|------|------|------|
| 0 | China | 16.738008 | 16.949548 | 17.161088 | 17.372627 | 17.584167 | 17.795726 | 18.007286 |
| 1 | United States | 33.022308 | 33.034165 | 33.046023 | 33.057880 | 33.069737 | 33.081594 | 33.093452 |

2 rows × 27 columns

```
In [5]:  data1 = pd.melt(data, id_vars=(['Country Name']))

In [6]:  data1.columns = ['country','year','%area']

In [7]:  data1.head()

Out[7]:
```
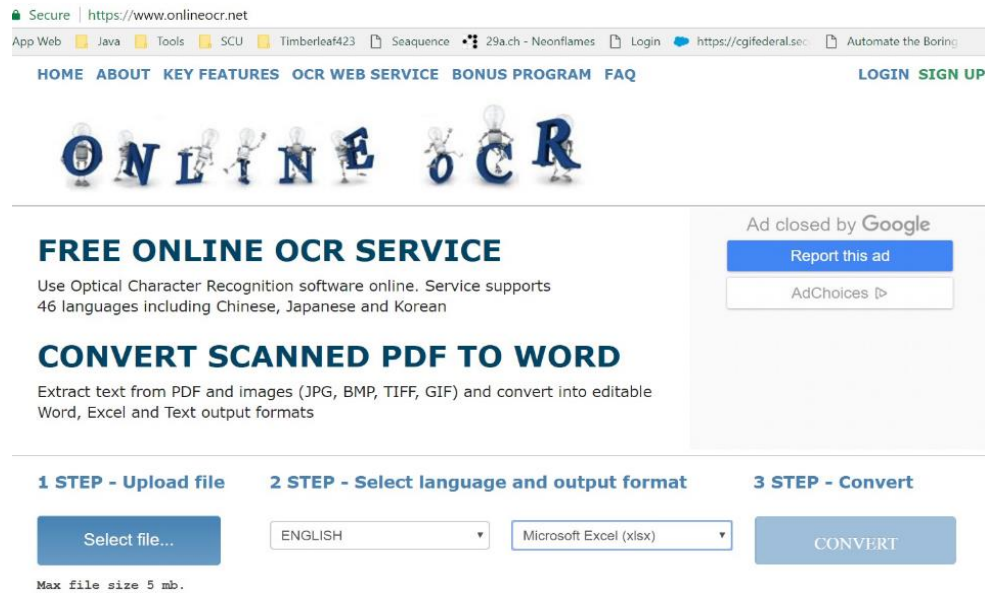
| | country | year | %area |
|---|---------|------|-------|
| 0 | China | 1990 | 16.738008 |
| 1 | United States | 1990 | 33.022308 |
| 2 | China | 1991 | 16.949548 |
| 3 | United States | 1991 | 33.034165 |
| 4 | China | 1992 | 17.161088 |

Image – 6.5

5. One of the data source was an image(jpeg). We used an online Optical Character Recognition (OCR) service to convert the image to text.[19]



Image – 6.6

[19] https://www.onlineocr.net/

# 7.0. Visualizations

## 7.1. Pollution levels of China and United States

*Claim:* Scaling up of industrialization has had direct impact on pollution in China

*Explanation:*

As we know everyone's focus is on pollution levels as it is directly affecting the climatic conditions across the globe. But, blaming China for all for this is not reasonable.

Image 7.1.0 shows, how different are the air pollution levels in China and United States.

Our focus will be $CO_2$(Carbon Dioxide), $SO_2$(Sulphur Dioxide) and PM2.5 particles which are major air pollutants. $CO_2$ is mainly released by automobiles, $SO_2$ is released by industries and PM2.5 particles come from activities that burn fossil fuels, such as traffic, smelting, and metal processing[20].

*$CO_2$:*

In the year 2005, both the countries were emitting almost similar volumes. But, United States with their strict regulations on pollution could lower this over the years. Whereas, China's rapid economic development aggravated the $CO_2$ emission over the years.

*$SO_2$:*

$SO_2$ emission has been decreasing year on year from 2005 to 2015 for both the countries. However, the gap of emission has been constant and China has never come close to United States pollution level.

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[20] http://lyberty.com/encyc/articles/PM2-5.html

*PM 2.5:*

PM 2.5 emission was constant from 2005 to 2015 for US and China and the gap between them was persistent.

*__Warrant:__* As China Roars, Pollution Reaches Deadly Extremes from NY times[21]

*__Visualization principles used__*

- Our focus is on the comparison between US and China, this illustrates how drastically different their pollution levels are.
- Different color combinations help to identify the different countries.
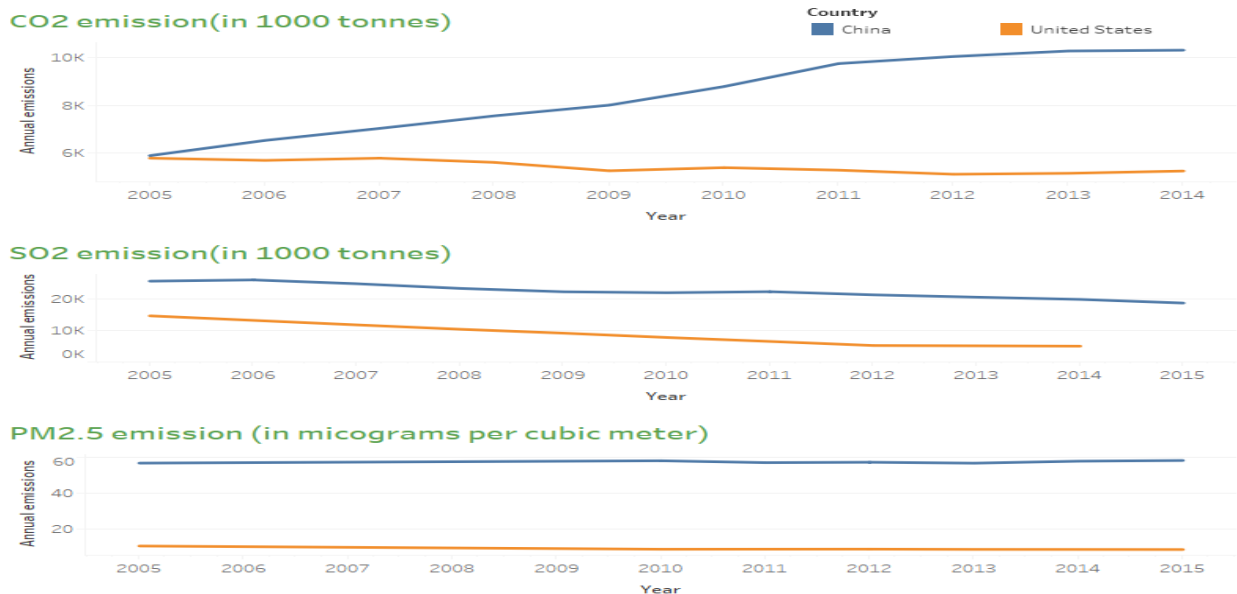- Pollution levels for last 15 years helps to identify the trend of each pollutant.



Image – 7.1.0 - Absolute Pollution levels of China and United states

[21] http://www.nytimes.com/2007/08/26/world/asia/26china.html
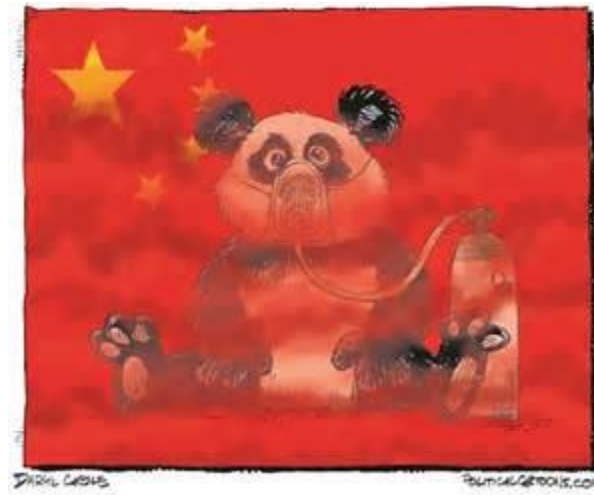
## 7.2. How safe are the 5 Chinese cities?

Image – 7.2.1

### *Explanation:*

To obtain an overview of the state of pollution in China, we visualized the air quality data for five major Chinese cities (Beijing, Chengdu, Guangzhou, Shanghai, Shenyang). We plotted the average air quality value year over year and color-filtered the ones below and above breathing hazard standard set by U.S. (hazardous when PM2.5 is above 35 µg/m3).[22] By doing so, we could visualize the pollution using air quality in these five cities.

### *Warrant:*

The proportion of safe days vs. unsafe days in the five major cities are unbalanced. Take Beijing for example, in 2013, only 18% of the whole year was

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[22] http://www.dep.state.fl.us/air/air_quality/aqi.htm

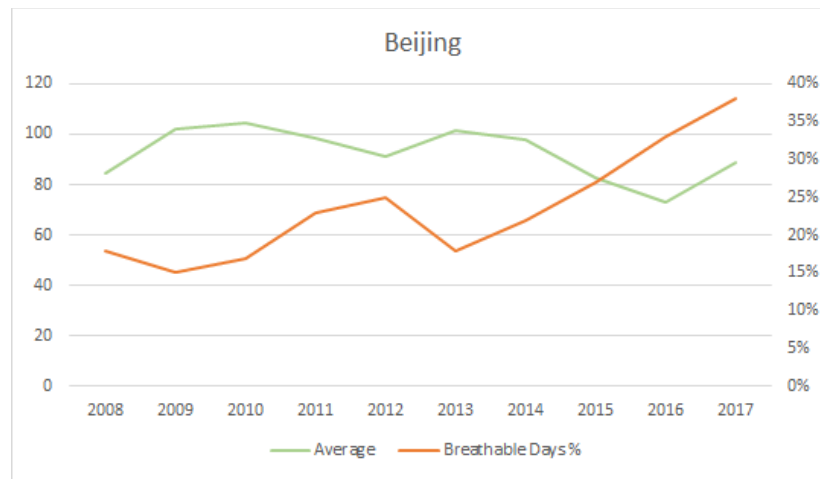breathable. According to an article by Inverse Science, a day of Beijing air can be deadlier than 40 cigarettes.[23]
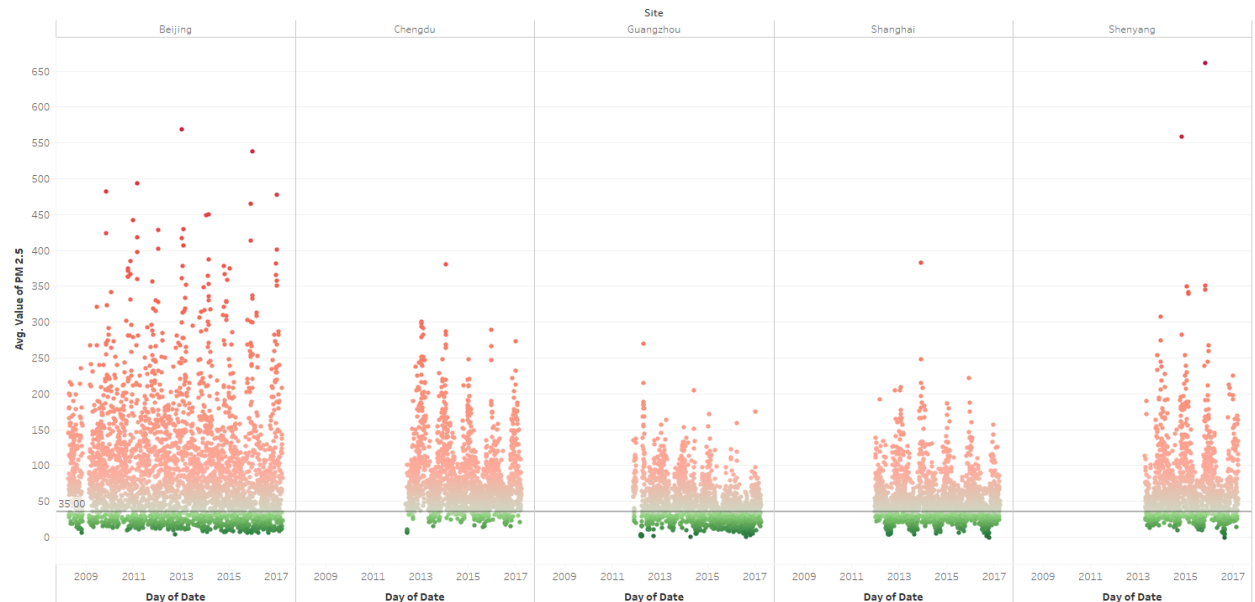


Image – 7.2.2 - Percentage of breathable days



Image – 7.2.3 – China five cities safer days

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[23] https://www.inverse.com/article/32209-air-pollution-smog-beijing-china-cigarettes-unhealthy

_Visualization principles used_

- The color differences are to give the viewer an immediate picture that the five Chinese cities are experiencing air quality way worse than the safe breathing level.

- We chose to use color green and red so that green represents safe to breathe and vice versa.

- When visualizing the data, we noticed that we need to show a more drastic color differences to convey the point of safe and dangerous. If we keep the filter using Average Value, at zero μg/m³ it will be a color not as distinct as dark green. Therefore, we decided to make the values below 35 μg/m³ a negative number by filtering using a formula (Average Value – 35). That means if the average value is less than 35, the color filter value will be a negative number, which will be represented using a darker green color.

## 7.3 Pollution levels per capita tells a different story.

_Claim_: Every American is creating five times more pollution than every Chinese.

_Explanation_:

The above graph shows how China is the largest air polluting country in the world. However, pollution should be measured in terms of the population of the country. China being the most populated country, if we compare the pollution per capita in the two countries, the story is completely different. Every American produces twice as much as $CO_2$ emissions as every Chinese does. In terms of $SO_2$ emissions the ratio is still worse and every American produces 5 times $SO_2$ emissions, as compared to per Chinese.

_**Warrant**_:  For U.S. and China, World's Biggest Climate Polluters, It's Still Business as Usual[24].

List of countries by carbon dioxide emissions per capita[25].

_**Visualization principles used**_:

- Direct comparison between US and China makes it easy to understand where the country stands.
- Different color combinations helps to identify the different countries.
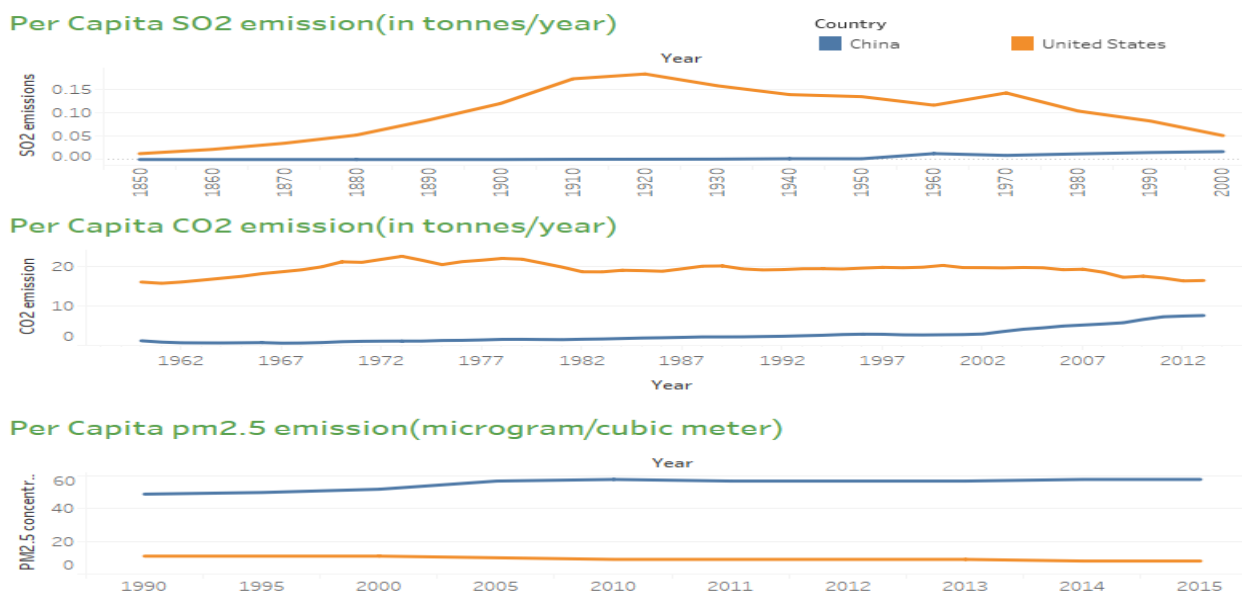- Pollution levels for more than last 50 years helps to identify the trend.



Image- 7.3.1 – Per capita emissions

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[24]      https://insideclimatenews.org/news/20130129/united-states-china-carbon-greenhouse-gas-emissions-renewable-energy-coal-plants-pollution-global-warming-climate

25 https://en.wikipedia.org/wiki/List_of_countries_by_carbon_dioxide_emissions_per_capita

## 7.4. China's action towards restraining pollution speaks more than Trumps speech

*Claim:* China is taking more efforts than the US to curb pollution

*Explanation:*

China contributes heavily to the global pollution, and the government is working meticulously to reduce the growing criticism over allowing the country's air to degrade to abysmal levels. China has set strict environmental regulation on existing energy usage, especially burning coal.

**More investment in clean energy:**

China's overall investment to curb pollution has been increasing. China will invest 2.5 trillion yuan ($360 billion) into renewable power projects by 2020 as the world's largest consumer of energy starts to move away from coal[26].
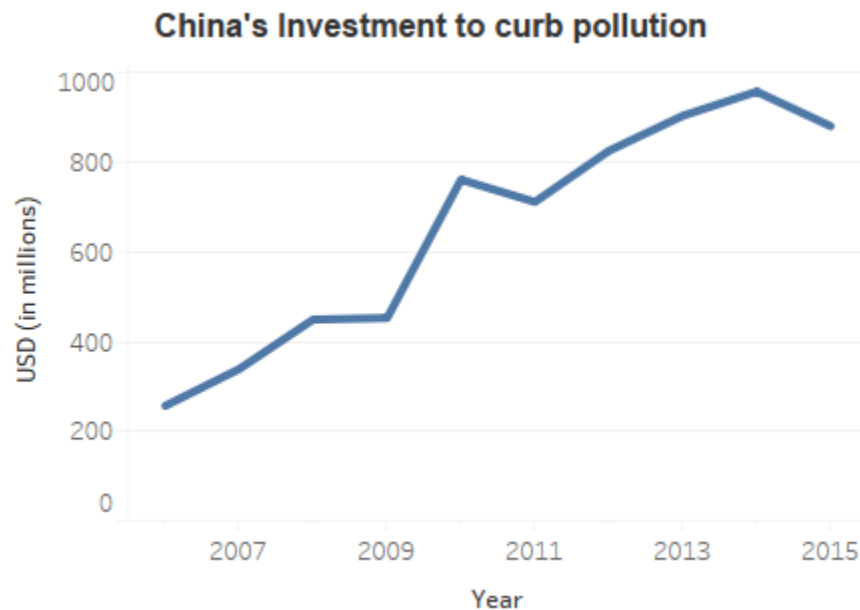


Image – 7.4.1. – China's Investment in clean energy

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[26] http://www.newsweek.com/china-invest-360-billion-green-energy-2020-reduce-pollution-538844

**Growing Forest Area:**

China's forest is crucial to ensuring soil and water conservation and climate regulation. Due to China's sheer magnitude and its rapid development, its forest has suffered in the past. The State Forestry Administration (SFA) says China is on track to meet its 2020 target for expanding the nation's forests to cover 23 percent of its landmass[27].
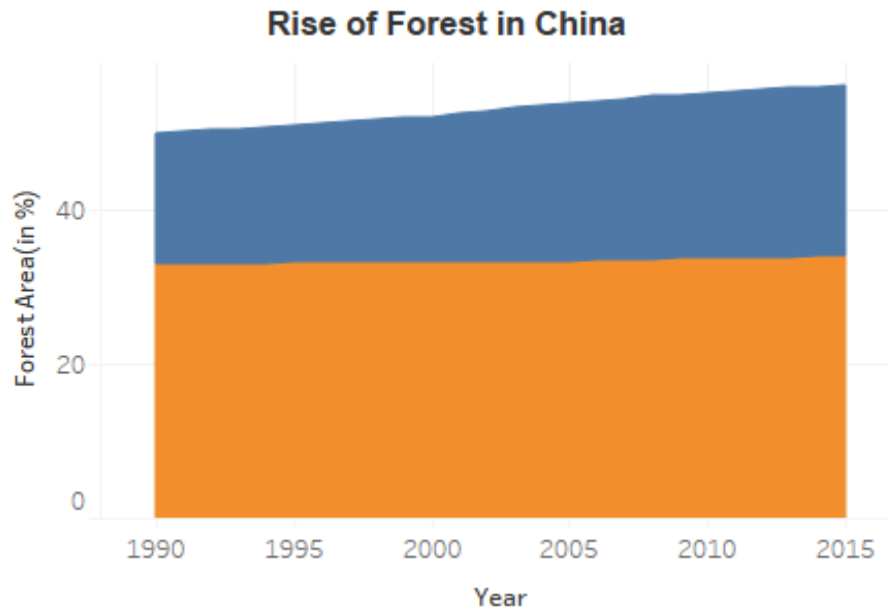


Image – 7.4.2 – Growth of Forests over years

***Warrant:*** China's efforts in curbing pollution can be reflected in the breathable days in four out of the five major cities[28].

By analysis 4 out of the 5 major cities, have improved their breathable days by reducing the PM2.5 emission.

As shown in the "China Five Cities Breathable Days" chart, except for Chengdu, the cities are showing an upward trend year over year. We can interpret

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[27] https://www.sciencedaily.com/releases/2016/03/160318181617.htm

[28] https://davos.projourno.org/see-how-many-days-a-year-chinas-air-was-unsafe-to-breathe-bef7a2e44a30

this as the warrant for China's efforts in curbing pollution has resulted into improvement in air quality and more breathable days in the major cities.
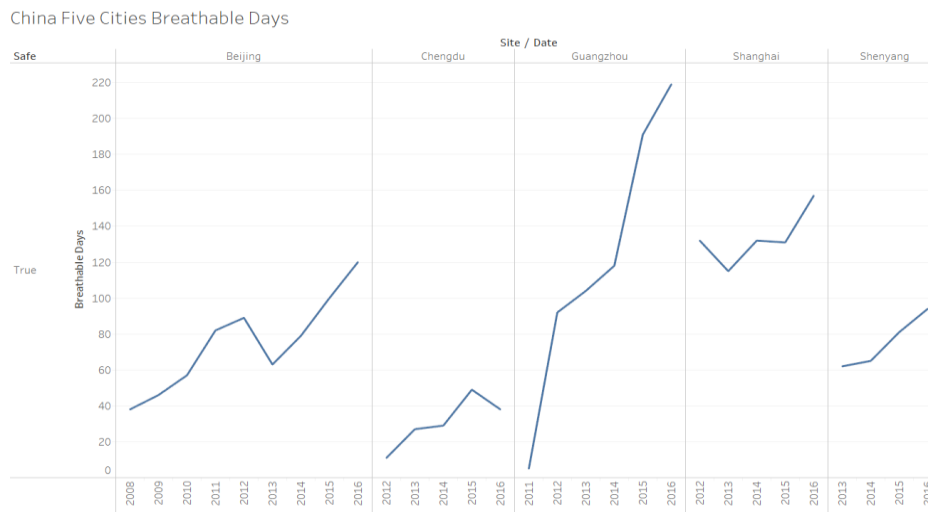


Image – 7.4.4 – China five cities breathable days

## 7.5. China setting benchmark for coal plant to reduce emission

*Claim*: If current U.S. regulatory trends continue, by 2020, every coal plant operating in the United States would be illegal to operate in China[29].

### *Explanation*:

In response to the rising pollution levels, China since 2014 has taken a startling approach to curbing the pollution. Starting 2014 China has implemented standards for conventional air pollutants that are much stricter than the US standards. Until now, the new regulation has focused on conventional pollutants, as they are of major concern, but the "next round of regulatory tightening will target carbon dioxide."[30]

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[29]https://www.americanprogress.org/issues/green/reports/2017/05/15/432141/everything-think-know-coal-china-wrong/

[30]https://www.americanprogress.org/issues/green/reports/2017/05/15/432141/everything-think-know-coal-china-wrong/

_**Warrant**_: By 2020, every Chinese coal plant will be more efficient than every US coal plant[31].
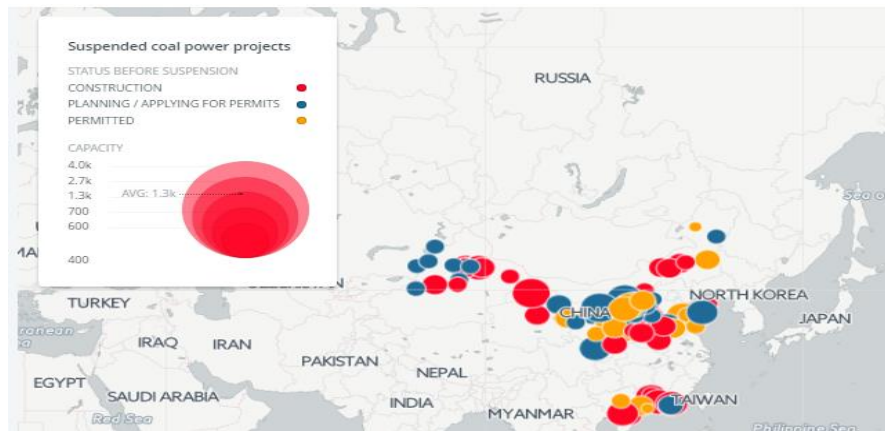


Image – 7.5.2 – Suspended Coal projects

_**Visualization Principles Used**_:

Comparison of current and new pollution standards for each gas is conveyed effectively using different color-coded bar graphs.
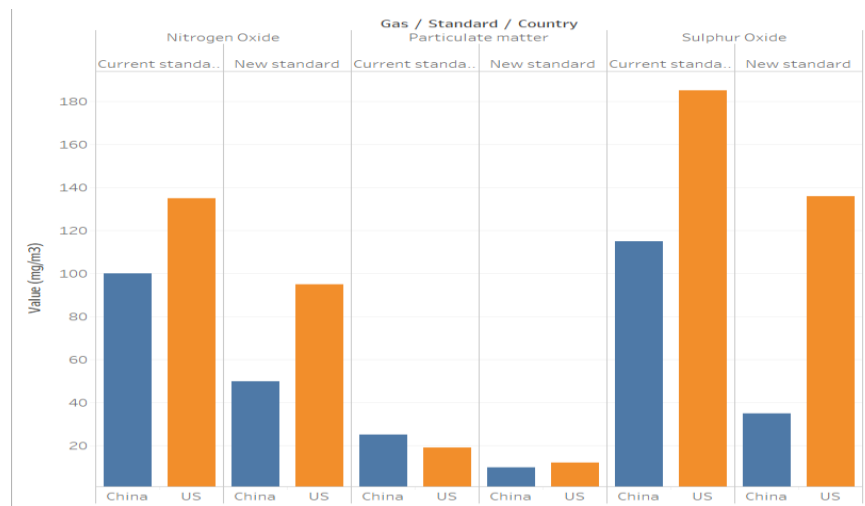


Image – 7.5.1 – Emission standards

31 https://www.vox.com/energy-and-environment/2017/5/15/15634538/china-coal-cleaner

Earlier this year Beijing ordered the suspension of more than 100 planned and under-construction coal plants in order to comply with the cap in its Five Year Plan. This strict regulation has helped China to reduce a lot of pollution due to the burning of coal.

## 7.6. China is aggressively moving towards clean energy production to meets its energy demands.

*Claim* - China is investing more in renewable energy sources than US.

### *Explanation:*

As of 2017, China is set to take a leap ahead of the United States and become a world leader in the production of clean energy.  Reuters reported that China's National Energy Administration (NEA) had announced in the next three years alone, China will invest $361 billion in renewable power generation[32]. By ramping up clean energy production, China is not only building on solar power but also embracing other technologies such as the wind, hydro and bio. China has set ambitious targets for developing its renewable energy resources with a major push of laws, policies, and incentives in the last few years. The wind power sector is illustrative of China's accomplishments, as installed wind power capacity has gone from 0.567 GW in 2003 to 91 GW in 2013; China surpassed the United States in 2010 with over 41 GW of installed wind power capacity[33].

The air pollution caused in part by the burning of coal for electric power has become a major public policy focus in China and it recognizes that developing its domestic renewable energy industry and building its manufacturing capacity will help meet its energy demands while putting a stop to pollution.

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[32]https://www.forbes.com/sites/edfenergyexchange/2017/01/06/china-is-going-all-in-on-clean-energy-as-the-u-s-waffles-how-is-that-making-america-great-again/#3fffb68061c1

[33] http://nationalaglawcenter.org/wp-content/uploads/assets/crs/R41748.pdf

_**Warrant**_ - Global renewable energy investment trends 2017[34]

China is Leaving the U.S. Behind on Clean Energy Investment[35.]

_**Visualization Principles Used**_: Line chart used to compare the trend over the same period for more than one group.



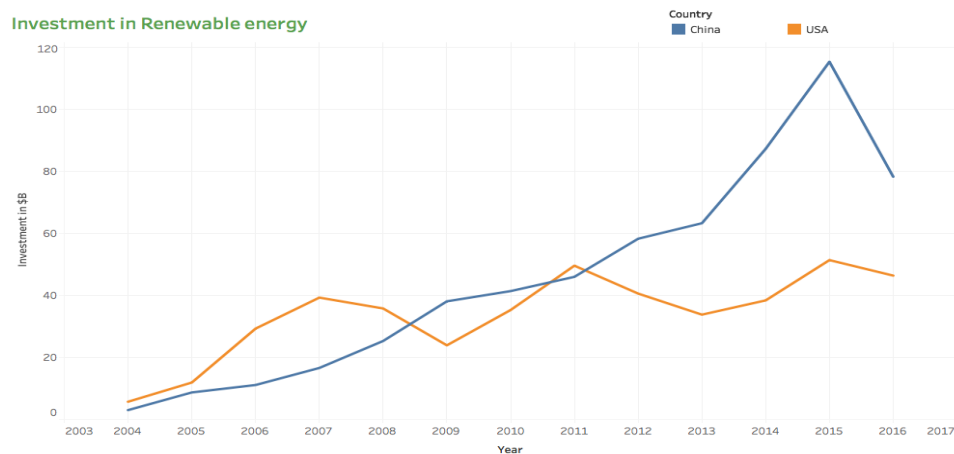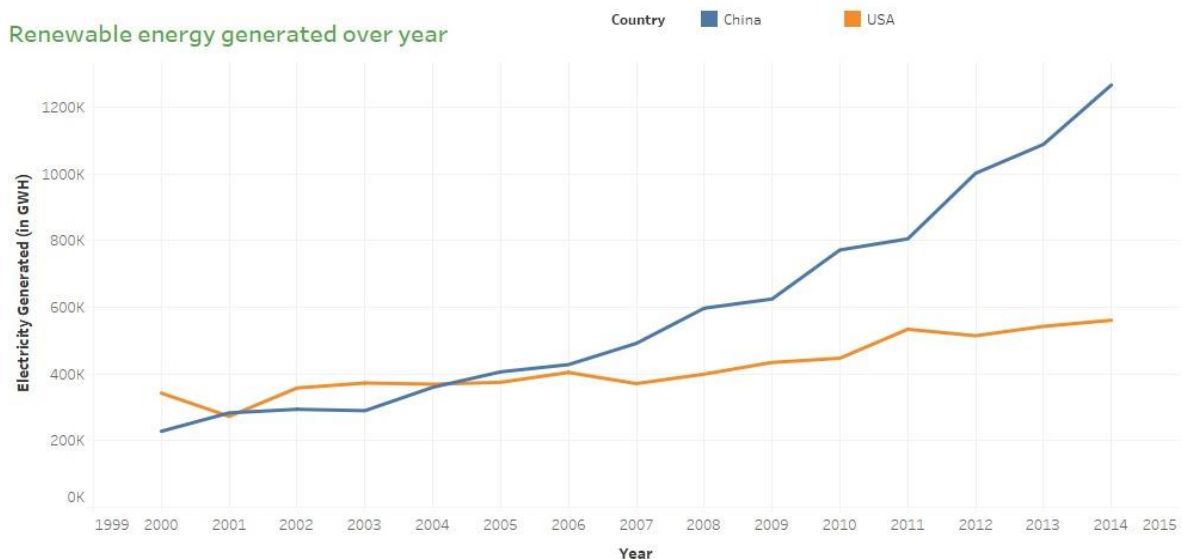Image – 7.6.1 – Investment in renewable energy



Image – 7.6.2 – Renewable energy generated

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[34] http://resourceirena.irena.org/gateway/dashboard/?topic=6&subTopic=11

[35] http://www.wri.org/blog/2017/01/china-leaving-us-behind-clean-energy-investment

## 8.0. Challenges

1.  **Finding the data for Chinese pollution** - Most of the pollution related data for China is confidential. Chinese government data is very difficult to find and not available publicly. We had to search a lot about data on different websites, and this took a lot of time. There was no single dataset which satisfied our claims. We had to read a lot of articles and find data from multiple sources. This includes Pollution levels, forest coverage, renewable energy source, investment data etc.

2.  **Deciding/Changing the Claim** – Initially, our claim was about bad pollution levels in China, but after we researched and studied the trend over the years, we had to change the claim. This took a lot of time to understand and interpret our claim

3.  **Deciding the scope of the project** - Since pollution is the vast topic and dependent on multiple parameters, we found it tough where to start the research. Also, we had to read a lot about "Paris climate summit" and try to understand the blame game.

## 9.0. Critique

1.  Due to the limitation in data and time, this project was developed using limited data points. The data given by US and Chinese sources had discrepancies and were not coherent.

3.  Our project deals with disparate data and topics and we realized that this aspect is a major shortcoming, because it was difficult to find a strong correlation between the fact that China is the largest polluter in the world as well as doing much more than other countries to curb pollution. This statement might look like a paradox, but that's the fact.

4. The dashboard that we prepared for the audience provides an exploration of data. But we would like to create a 2.0 of this dashboard that also has some predictive capabilities.

5. Being a beginner in Tableau, we were not able to create beautiful charts for our dashboard. We would love to improve upon that aspect.

## 10.0. Conclusion

There is a difference in opinion within the Trump administration, who believe that it was unfair to impose strict regulations on United States, while the developing countries like China and India are the major pollution source.

From the comparative analysis of pollution per capita, we are in a strong position to say that China, even having a large population, when compared to US, is polluting less. More ever, Chinese government is taking numerous measures to stabilize the situation. Creation of new emission standards, increasing investments in clean energy and clean power generation, increasing the growth in forest area suggests that China is taking aggressive actions to address pollution and global warming.

So, we can clearly refute the statement of Trump and his administration, our analysis shows that a single American is polluting more than a Chinese. Finally, we believe that the whole world should collaborate to fight pollution. US and China should work hand in hand to curb pollution and China should not be solely blame as the "real culprit" of pollution.