Air Pollution in Europe and the effect it has on the Heath of People

Air pollution is one of the main environmental concern of every nation.It occurs when harmful or toxic gases(or particles) are released into the air.It is harmful for both the environment and the health of people. According to the report by World Health Organization in 2014 air pollution caused the deaths of around 7 million people worldwide in 2012.WHO also states that 91% of the premature deaths occurred in low and middle income countries because of it.

Air pollution can be caused by human activities or natural pheonemenas. The main sources of Air pollution according to EEA are transports, energy producing and distributing sectors, waste management, agriculture, commercial or institutional sector and industry.Gases like ozone, particulate matter(PM) and nitrogen oxides have been known for adversely affecting the health of people in Europe.Since these pollutants are present in higher concentrations in urban areas people living there are affected more.

EU has identified the major pollutants as ozone (O3), particulate matter (PM), nitrogen oxides (NOx), sulphur dioxide (SO2), methane (CH4), ammonia (NH3) and volatile organic compounds (VOC) .Methane is produced from livestock, natural gas leakage and agriculture. VOC is produced by vehicles and power generation. Despite having reduced the emission of pollutants over the years the Air Pollution is still high when compared with the European Union (EU) and WHO (World Health Organization) standards which is affecting the health of people in Europe. Road transport is a major contributor for these pollutants especially nitrogen dioxide and particulate matter.

EU has proposed Clean Air Policy Package in 2013 to reduce the emissions of air pollutants by 2030.This policy aims at changing the social and economic patterns of a country and enforce existing rules and regulations regarding air pollution efficiently.

According to EEA (European Environment Agency) approximately 500,000

Image source - https://cdn.pixabay.com/photo/2016/10/19/12/38/industry-1752876_960_720.png

Air pollutants emission by EU over the years

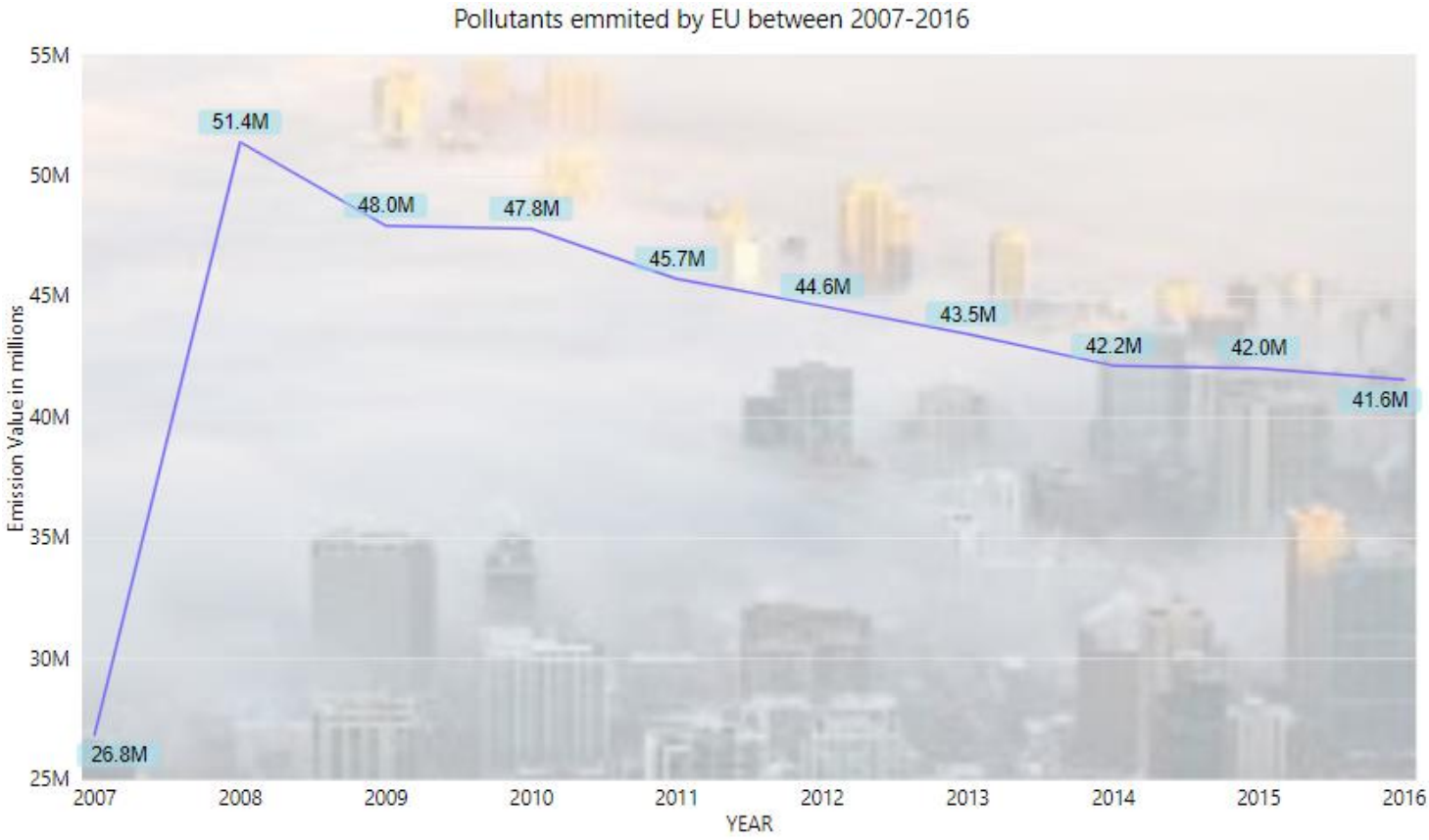

Figure 1

EU has implemented policies and launched programmes to achieve their target of reducing the emission of air pollutants into the air by 2030 as it not only damages the environment and ecosystem but it also affects health of the people.

Figure 1 shows the total emission of pollutants (nitrogen oxide, sulphur oxides, ammonia, particulate matter 2.5 um and 10 um and volatile organic compounds) in the EU for the period of 2007 to 2016 from different sectors (Agriculture, Industrial, waste, Energy production, Road transport, Non-road transport and others).

From the figure we can see that there was sudden spike in the air pollutants emission in 2008 compared to the year 2007.The emissions in 2007 were around 26.8 million tonne and in 2008 the emission value was 51.4 million tonne.But after 2008 the value for the emissions has been decreasing gradually over the years.The year 2016 had the total emission of 41.6 million tonne which was less than all the years starting from 2008.

In 2013 Europe Commission started 'Clean Air Policy Package' for combating the problem of air pollution faced by different European countries. By adopting this package the target for 2030 by EU is to avoid at least 58,000 premature deaths and save ecosystems from the nitrogen pollutants and acidification. This package is set out to bring improvements in the health of people and ecosystems by the target year 2030.

Image source -https://get.pxhere.com/photo/air-pollution-architecture-buildings-city-cityscape-downtown-fog-mist-pollution-skyline-skyscrapers-smog-urban-area-1564103.jpg

Sectors responsible for air pollution

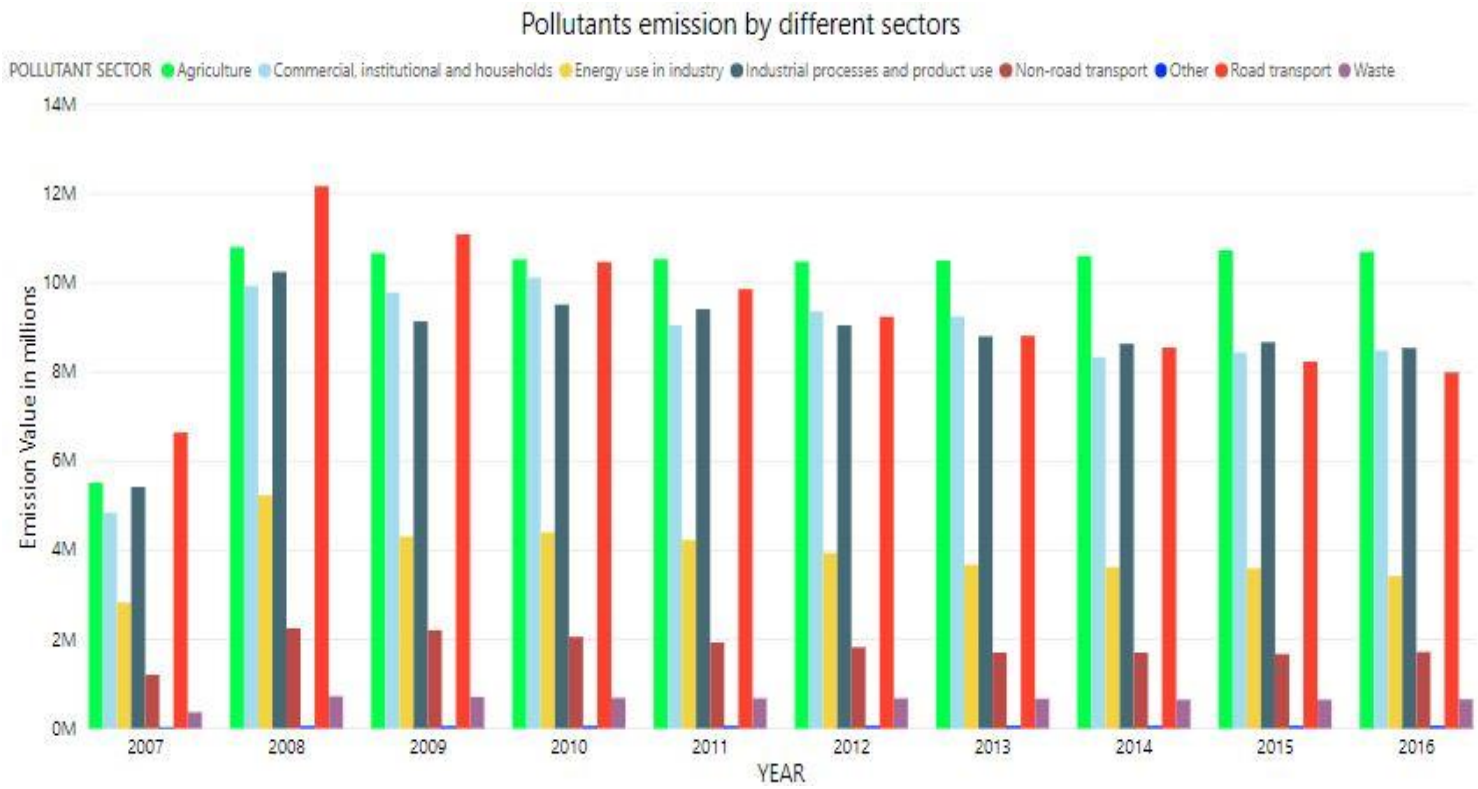

Figure 2

Figure 2 shows the emission produced each year by the eight sectors – agriculture, commercial, institutional and households, energy use in industry, industrial processes and procedure, non-road transport, road transport, other and waste. From the period 2007-2009 road transport had higher emission than any other sector while agriculture was the second highest emission producing sector. In 2010 both agriculture and road transport had nearly same emission values but from 2011-2016 agriculture overtook road transport as the highest emission producing sector.

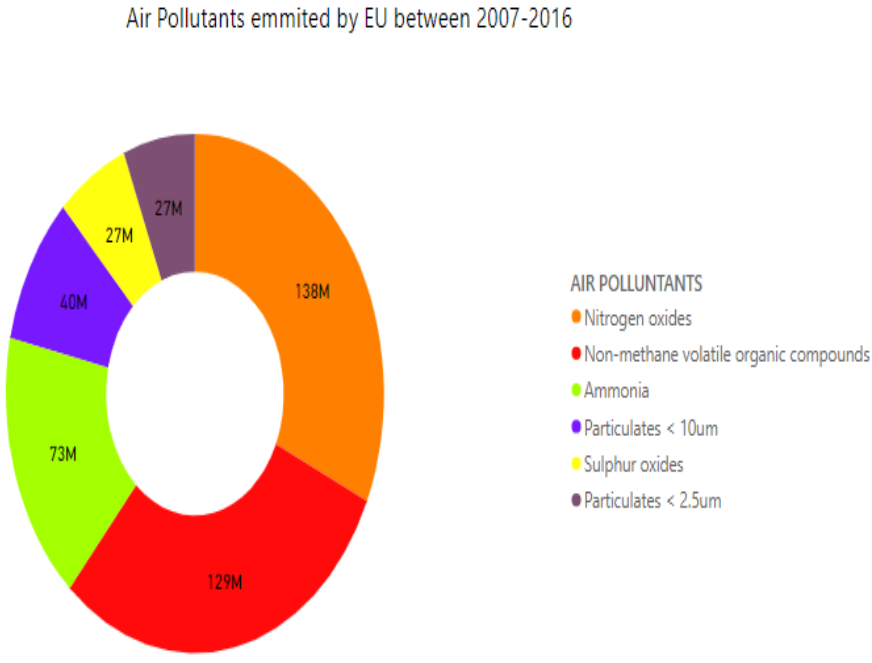

Figure 3

Figure 3 shows the pollutants nitrogen oxide, non-methane volatile organic compounds (NMVOCs), ammonia, particulate matter (both 2.5 um and 10 um) and sulphur oxides that were emitted by the eight sectors between 2007- 2016.The emission of nitrogen oxide (138 million tonnes) and VOC (129 million tonnes) were higher compared to all the other pollutants while the emission of both particulate matter 2.5 um and 10 um (27 million tonne) was low.

um stands for the unit micro meter
1 um = 1×10^{-6} m
M stands for millions

Emissions in 2016

The table in figure 4 gives the emission value of all the pollutants (in tonnes) for each sector. Ammonia emissions are highest from the agriculture as it is produced by the decomposition of urea in animal wastes and uric acid in poultry wastes. The emission of ammonia depends on the type of livestock species, weight, age and diet. Nitrogen oxide emissions are highest from road transport because of the combustion of the fuel for running the vehicles. Volatile organic compounds emissions are higher from Industrial processes and product use sector, particulate matter (both 2.5 um and 10 um) are emitted heavily from commercial Institutional and households sector while sulphur dioxide emissions are higher from the energy use in industry.

Emission of air pollutants by sector in 2016

	Air Polluntants emission in Tonne					
Pollutant Sector	Ammonia (Tonne)	Nitrogen oxides (Tonne)	Non-methane volatile organic compounds (Tonne)	Particulates < 2.5um (Tonne)	Particulates < 10um (Tonne)	Sulphur oxides (Tonne)
Agriculture	3,611,068	492,697	882,850	48,373	315,955	646
Commercial, institutional and households	70,889	1,098,487	1,123,213	746,821	814,162	388,404
Energy use in industry	13,876	850,034	157,435	102,226	113,873	473,335
Industrial processes and product use	74,405	217,706	3,234,305	138,937	383,318	221,673
Non-road transport	269	654,854	68,476	30,960	38,179	66,194
Other	22,919	2,190	3,584	556	729	0
Road transport	53,932	2,970,219	607,897	145,988	213,885	5,139
Waste	53,871	46,617	67,189	70,741	84,350	3,921

Emission Value
0 3,611,068

Figure 4

Air Pollutants emitted by EU in 2016

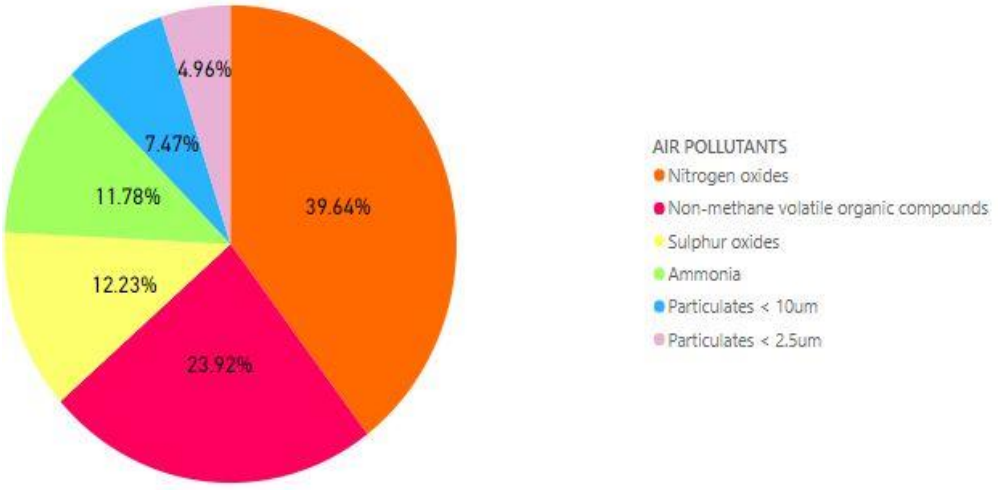

Figure 5

The pie graph in figure 5 shows the percentage of pollutants that were emitted by various sectors in 2016.Nitrogen oxides emission were highest making up 39.4% of the total pollutants emitted by the EU followed by NMVOCs at 23.92%. PM 2.5 was the lowest emitted pollutant at 4.96%.According to EEA In 2016, nitrogen oxide emissions for EU continued to fall and are now about half of their 1990 values. Introduction of the three-way catalytic converters in cars is credited for the reduction of nitrogen oxide emissions. NMVOCs emissions has also become half of the emission value of the 1990.

Top 10 European countries with high air pollutants emission

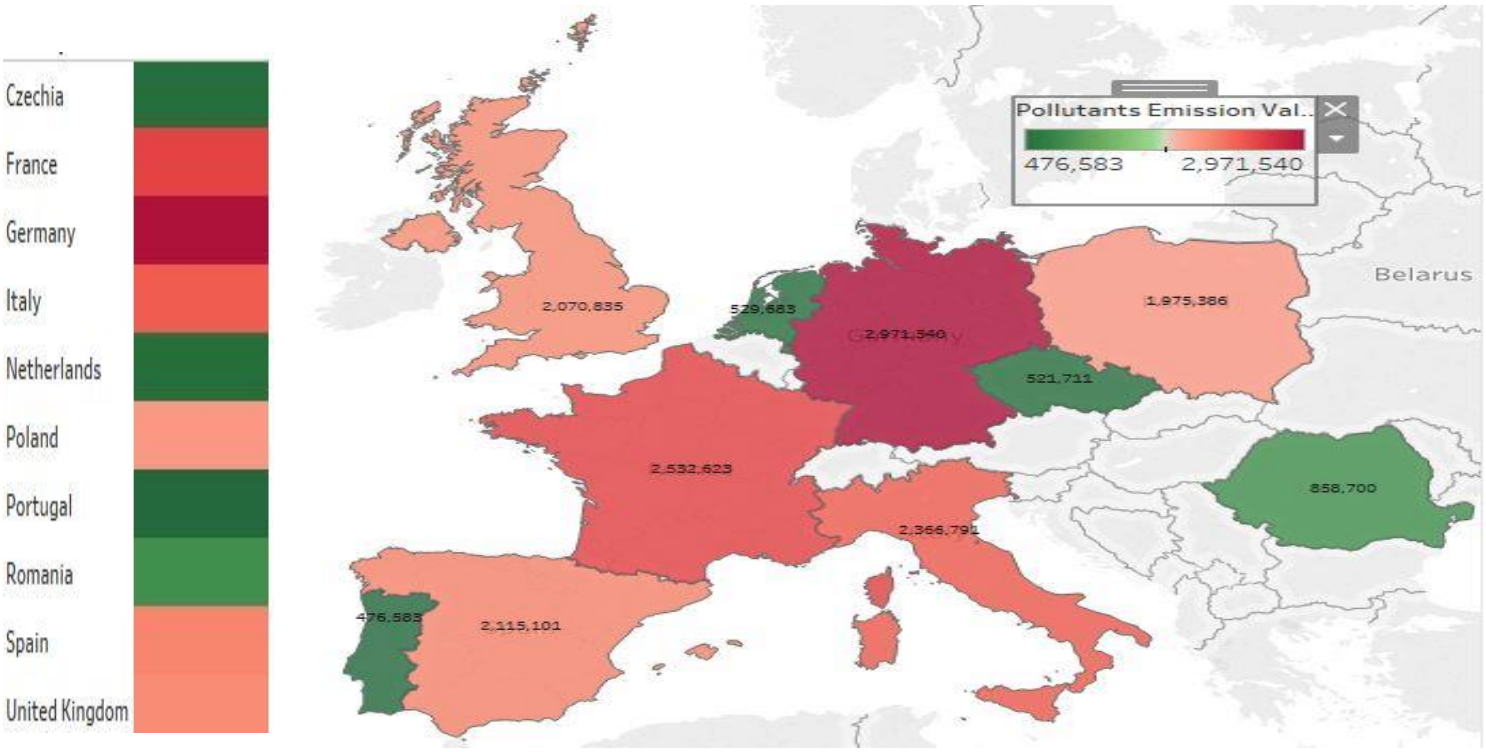

Figure 6

Top 10 countries with high pollutants emission value in 2016

Country	Emission Value in Tonne
Portugal	476583
Czechia	521711
Netherlands	529683
Romania	858700
Poland	1975386
United Kingdom	2070835
Spain	2115101
Italy	2366791
France	2532623
Germany	2971540

Figure 7

Figure 6 highlights the countries in the filled map graph that had the highest air pollutant emission values in the year 2016.The countries with highest emission are highlighted with shades of deep red while the countries with comparatively lower emissions are highlighted with the shades of dark green. The table in figure 7 shows the top 10 countries that had high emission values in ascending order of their emission values. Germany had the highest emission in 2016 compared to all the other EU countries. It had emitted about 2.9 million tonnes of air pollutants in that year. France was the second emitting around 2.5 million tonne of air pollutants. The other countries that made to the list are Italy, Spain, United Kingdom, Poland, Romania, Netherlands, Czechia and Portugal. The emission values are based on the emission of the pollutants nitrogen oxide, ammonia, NMVOCs, sulphur oxide, PM 2.5 and PM 10.

Germany has started using four strategies for dealing with air pollution that are - defining the environmental quality standards, regulations on the production, stopping the use of emission ceilings and using the best technologies available to reduce the emissions of the pollutants. Germany's project 'German Climate Action Plan 2050'aims to reduce the Greenhouse gases (GHGs) emission by 95% in 2050 and by 55% in 2030.

Effect of air pollutants on the health of people

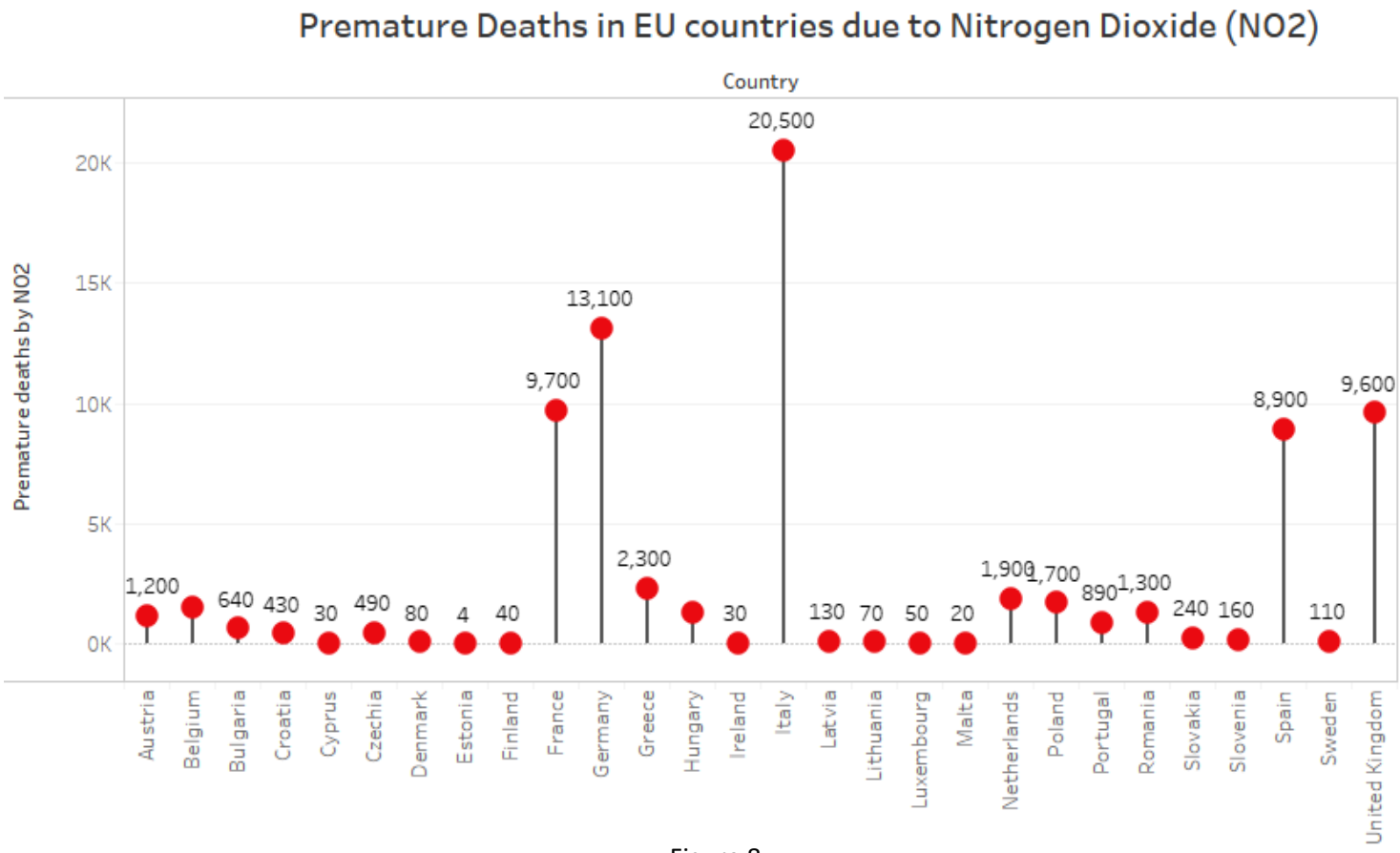

Figure 8

NO2 (Nitrogen dioxide) is a group of highly reactive gases from nitrogen oxides. It is primarily produced by the combustion of fuels and emitted from transports, power plants and other fuel burning industries. This pollutant can affect people that have existing respiratory problems like asthma as it can enter the respiratory system through air. Longer exposure to high level of NO2 is also attributed to developing asthma in people. Since NO2 is highly reactive sometimes it can react with other chemicals in the atmosphere and cause acid rain. It can also cause visibility problem by making the air in the atmosphere hazy and they also cause nutrient pollution in the coastal river areas.

Figure 8 shows the number of premature deaths that has happened in different European countries in the year 2015 due to the emission of N02 by various sectors. Italy has the highest number of premature deaths at 20,500.The other countries with higher number of deaths are Germany, France, United Kingdom and Spain. These countries are also one of the top 10 countries that had high pollutant emission. Countries with higher emissions have more number of premature deaths as the concentration level of pollutants is high in those countries. Malta has the lowest number of deaths at 20 and it is also one of the countries with low emission of air pollutants in EU.

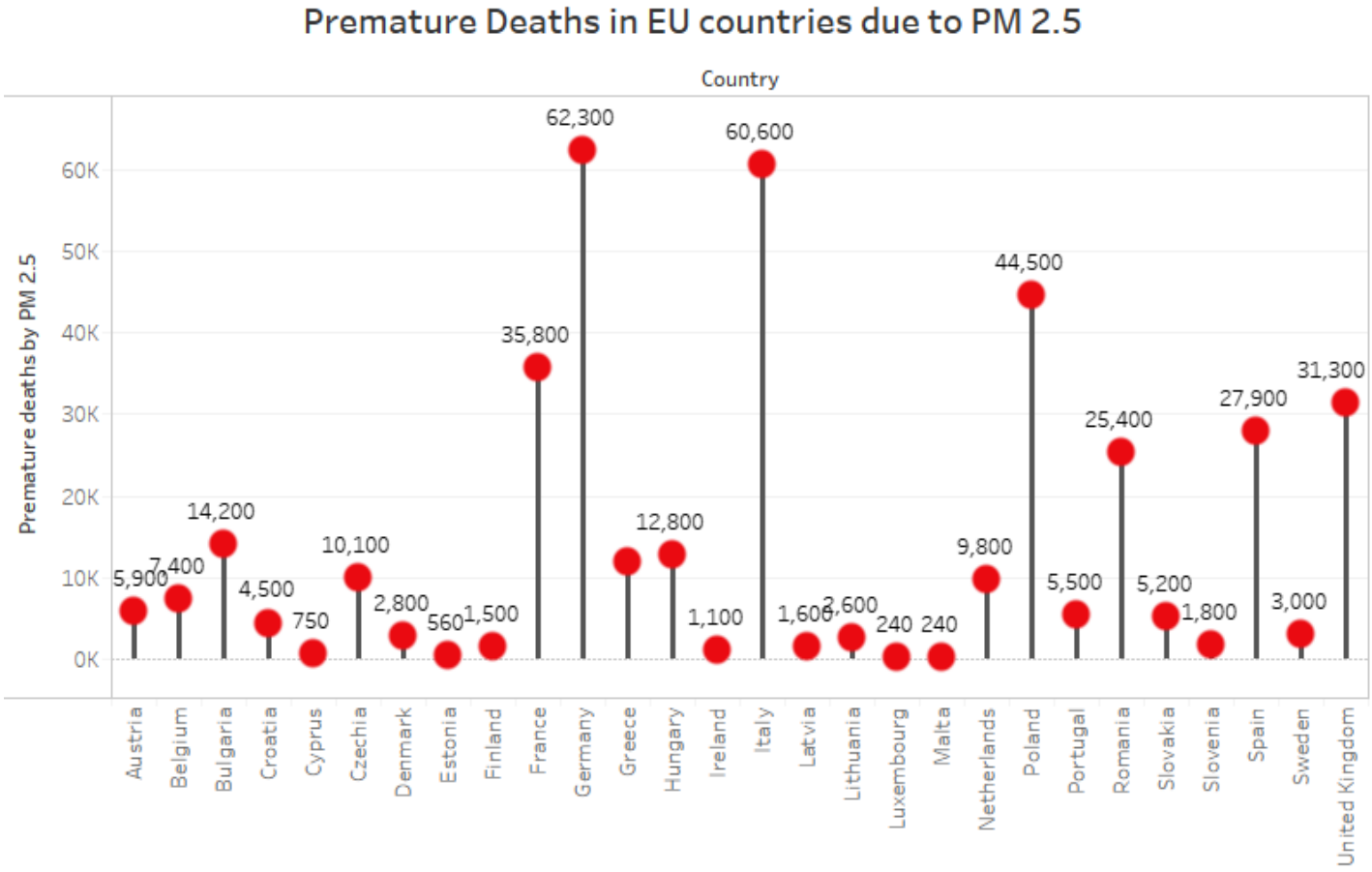

Figure 9

Particulate matter (PM) is also called as particle pollution. Particle pollution consists of PM 10 and PM 2.5.PM 10 are fine inhalable particles having a diameter of 10 micro - meter (um) or smaller. PM 2.5 are fine inhalable particles having a diameter of 2.5 um or smaller. These particles can be of different shapes and sizes and they are either emitted from places like fields, construction sites and smokes or formed by complex reaction of sulphur dioxide and nitrogen oxide in the atmosphere. Since these particles are so small they end up getting into lungs or bloodstream posing risk to the health of a person. These particles can aggravate the health of people that are suffering from respiratory diseases like asthma and bronchitis.

Figure 9 shows the number of premature deaths that has happened in different European countries in the year 2015 due to PM 2.5. Germany has the highest number of premature deaths which is 62,300 in the year 2015. The other countries that have higher number of premature deaths are Italy, Poland and France. These countries are also one of the top 10 countries with higher pollutants emission. Malta and Luxembourg both have lowest number of premature deaths and they also have the lowest pollution emission values. The premature deaths in a country correlate with the air pollutants emitted by that country, higher the emission higher is the number of premature deaths.

The diameter of average human hair is around 70 um which is approximately 30 times of PM 2.5 that's how small a PM 2.5 particle is.
Death of a person before reaching an expected age is defined as premature

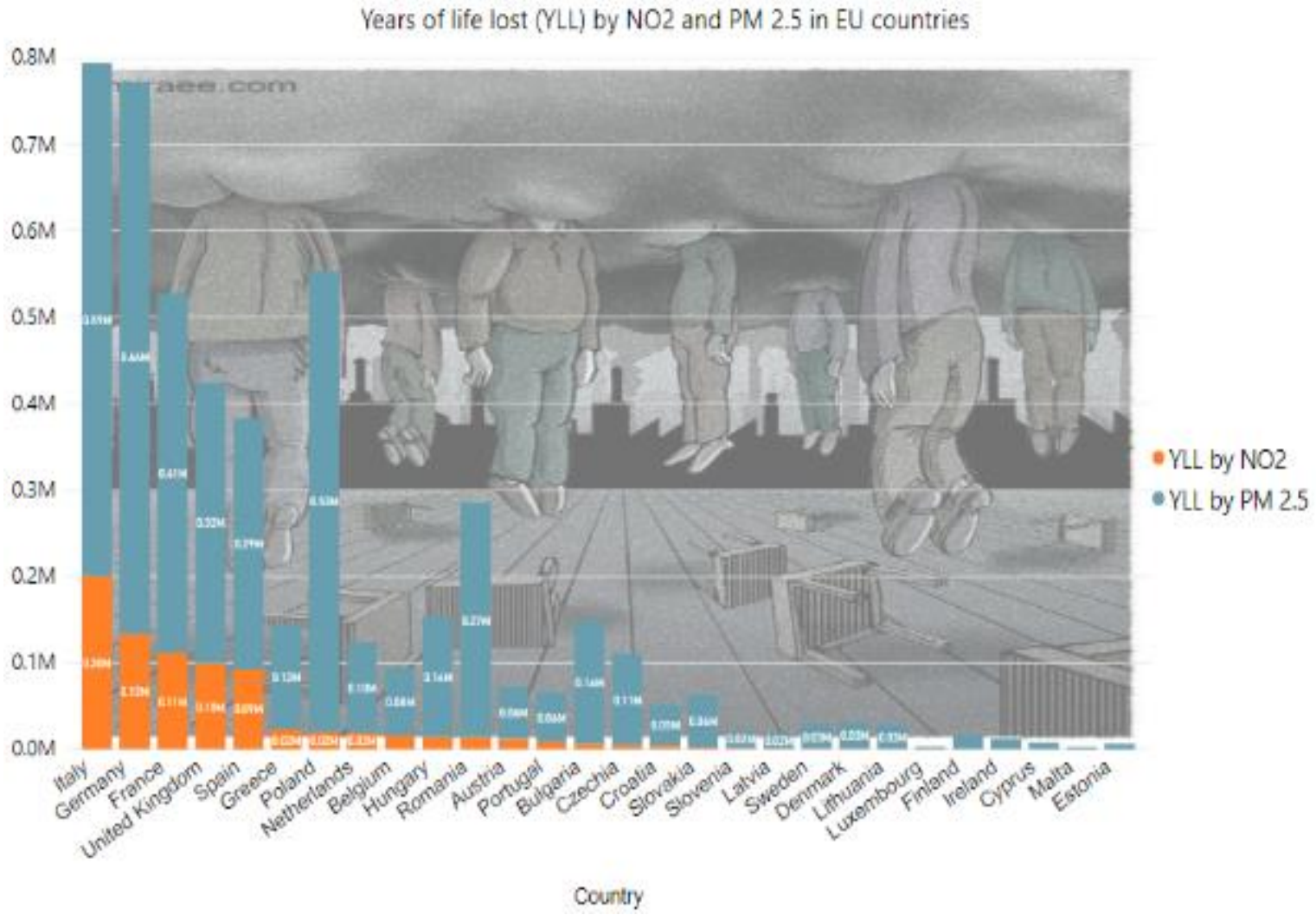

Figure 10

The years of the potential life lost because of a premature death is defined as Years of life lost (YLL).It is estimate of the average of no. of years a person would have lived without dying prematurely. It gives more weightage to the death of young people as compared to the death of older people.

Figure 10 shows a stacked column chart that shows the YLL caused by both PM 2.5 and NO2 (nitrogen dioxide) for all the countries in EU. Italy experiences highest YLL while Germany comes as second. Malta experiences the lowest YLL and Luxembourg is the second lowest. YLL by PM2.5 is higher in all the countries as compared to YLL caused by NO2. This shows that PM 2.5 contributes more to YLL then NO2. Countries that have higher population and higher emissions (like Germany) seems to experience more YLL then compared to countries with low population and lower emissions (like Malta).

Barcelona Institute for Global Health conducted a study that showed that exposure to PM less than 10 um and 2.5 um every year takes away 125,000 year of life (YLL) from children in Europe.

Image source - https://upload.wikimedia.org/wikipedia/commons/5/59/Air_pollution_by_Ali_Miraee.jpg

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Appendix

i) Figure 1
Data Source: Eurostat (http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_air_emis&lang=en)
Date: 08-05-2019
Visual: Line Chart
Reason: Data is temporal as the total emission values of EU is shown for each year (from the year 2007 to 2016) and to compare the emissions of each year line chart is a good option.
Software: Power BI

ii) Figure 2
Data Source: Eurostat (http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_air_emis&lang=en)
Date: 08-05-2019
Visual: Clustered column Chart
Reason: To compare multiple sectors for the same year or for different years clustered column chart is the best option. For example agriculture can be compared with road transport for the same year and it can be compared with agriculture sector for different years.
Software: Power BI

iii) Figure 3
Data Source: Eurostat (http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_air_emis&lang=en)
Date: 08-05-2019
Visual: Donut Chart
Reason: This chart is good for comparing the emission of different pollutants for the same time period (2007 - 2016). This helps in identifying the largest emitted pollutant in 10 years.
Software: Power BI

iv) Figure 4
Data Source: Eurostat (http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_air_emis&lang=en)
Date: 08-05-2019
Visual: Highlight Table
Reason: This chart helps in seeing the emission of each pollutant from each sector and identify which sector has the highest emission of a particular pollutant. The shading in the highlights table help in realizing if the values are low or high. Deep Red indicates a high emission value while dark grey indicates lower emission value.
Software: Tableau

v) Figure 5
Data Source: Eurostat (http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_air_emis&lang=en)
Date: 08-05-2019
Visual: Pie Chart
Reason: To compare the emission of all the pollutants for the year 2016 and figure out which pollutant had high emission and which one had low emission in that year.
Software: Power BI

vi) Figure 6
Data Source: Eurostat (http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_air_emis&lang=en)
Date: 08-05-2019
Visual: Filled map and highlight table
Reason: Maps are used for visualizing the top 10 countries with high emissions in 2016.The highlight table is provided on the left side of the map for identifying the countries based on colour.
Software: Tableau

vii) Figure 7
Data Source: Eurostat (http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_air_emis&lang=en)
Date: 08-05-2019
Visual: Matrix using Top n
Reason: The matrix table gives the name of the top 10 countries having high emission with their emission value (in tonne).To get the name of 10 countries from all the EU countries Top N function of Power BI was used.
Software: Power BI

viii) Figure 8
Data Source: Air quality in Europe 2018 report (https://www.eea.europa.eu/publications/air-quality-in-europe-2018)
Date: 29-10-2018
Visual: Lollipop chart
Reason: This chart compares the number of premature deaths caused by NO2 in different European countries for the year 2015.
Software: Tableau

ix) Figure 9
Data Source: Air quality in Europe 2018 report (https://www.eea.europa.eu/publications/air-quality-in-europe-2018)
Date: 29-10-2018
Visual: Lollipop chart
Reason: This chart compares the number of premature deaths caused by PM 2.5 in different European countries for the year 2015.
Software: Tableau

x) Figure 10
Data Source: Air quality in Europe 2018 report (https://www.eea.europa.eu/publications/air-quality-in-europe-2018)
Date: 29-10-2018
Visual: Stacked column chart
Reason: This chart helps in comparing the years of life lost (YLL) in different European countries by both NO2 and PM 2.5 for the year 2015.
Software: Power BI