Air pollution control

Task 1 – Types of air pollutions

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Subtask 1

- Type
    1) Major & specific pollutants
    2) Particulate matter
    3) Secondary pollutants
    4) precursors

- Emission order in EU / PL

Emission order in Poland:

CO_2 ~300Mt/a
CO ~2.5Mt/a
CH_4 ~ 2 Mt/a
SO_2&NO_x&NMVOC ~>500kt/a
NH_3 ~300kt/a
TSP ~340kt/a
Heavy mental 1-600t/a
PAHs ~150t/a
Dioxin & furans ~300 g TEQ/a

- Emission trends in EU / PL

1) Largest emission reduction:

Among Europe (2000-2017) and Poland (1990-2018), SO_x has the largest emission reduction;

Because the mainly emission resources of SO_x are power plants heating plants, when people use coal to generate electricity / heat, coal burning will release a lot of sulfide. However, in recent years, people have reduced the burning of coal, and turned to the development of cleaner energy sources, such as wind power and solar energy, as well as the use of higher-quality coal and advanced pollutants treatment equipment, so it can be seen that their emissions have been greatly reduced.

2) Smallest emission reduction:

In Europe during 2000 to 2017, its obviously that NH_3 have smallest reduction,
As we know, agriculture was responsible for more than 8% of NH_3 emissions, therefore, it is possible that the population growth in recent years has led to an increase in human demand for staple food and livestock, and therefore an increase in the use of nitrogen fertilizers, in the meantime, people changes in the handling

and management of organic manures and nitrogen fertilizers, the two influences cancel out and lead to the smallest reduction of NH_3.
In Poland during 1990-2018, PM2.5 have smallest reduction, or even the emission in 2018 unchanged from 28 years ago.
About 80% of total emission of PM2.5 is belong to the residential sector, so we can speculate that the residents' unchangeable, environmentally unfriendly lifestyle is the main reason for the high PM2.5, this includes regular use of private cars, burning coal, and wood for heat, etc.

3) SO_2, NO_x, PM2.5 - are the trends in EU and PL similar?

SO_x and NO_x have similar trends in Europe and Poland, and NO_x in Poland don't have a sharp reduction curve as Europe, one of the important reasons may be that the increase in per capita car ownership in Poland in recent years has led to an increase in its road transport emission.
As for PM2.5, Europe has a rather significant reduction than Poland, I speculate that it is because other European countries use clean energy to a greater extent, and actively use shared transportation and bicycles to reduce exhaust pollution.

- Indicate whether the concentration of this pollutant in the atmosphere is / is not regulated in the EU (averaging time, receptor); belongs / does not belong to pollutants for which WHO has established AQG

AIR QUALITY STANDARD IN EUROPE [1]

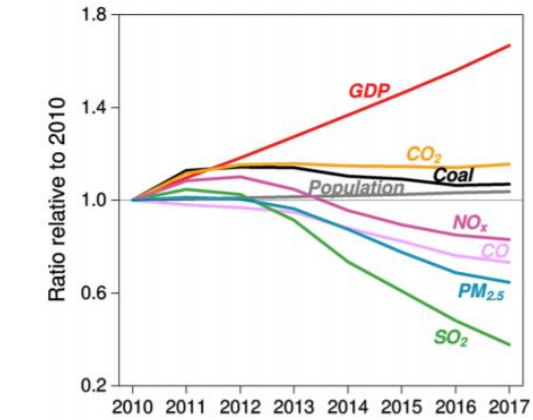
POLLUTANTS	Concentration	Averaging period	Receptor
PM2.5	25 μg/m^3	1 year	human
PM10	40 μg/m^3	1 year	human
SO_2	125 μg/m^3	24 hours	human
NO_2	40 μg/m^3	1 year	human
CO	10 μg/m^3	Maximum daily 8 hour mean	Human
O_3	120 μg/m^3	Maximum daily 8 hour mean	Human,crops,vegetation

The latest edition of WHO AQGs for ambient air pollutants was published in 2006, and included particulate matter (PM), ozone (O_3), nitrogen dioxide (NO_2) and sulfur dioxide (SO_2) [2].

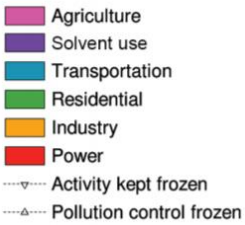
Subtask 2

Compare the emission amount and trends for your country and Poland for: CO_2, SO_2, NO_x, PM2.5, NH_3

- Resources in china: *Trends in China's anthropogenic emissions since 2010 as the consequence of clean air actions [3]*



In gross, China's gross domestic product grew by 7.6 % per year from 2010 and achieved 67 % growth by 2017; however, China's emissions flattened out from 2010 to 2013, followed by a significant decrease after 2013.



Chinese emissions are divided into six source sectors (stacked column chart): power, industry, residential, transportation, agriculture, and solvent use.

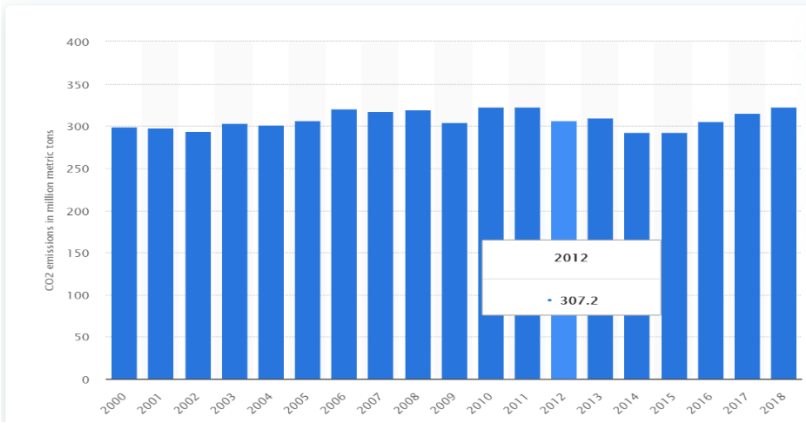
- Resources in Poland:

Submission under the UN ECE Convention on Long-range Transboundary Air Pollution and the DIRECTIVE (EU) 2016/2284 [4]
Greenhouse Gas Inventory for 1988-2017 [5]

- 1 Tg (teragram) = 1000 kt (kiloton) = 1000 Gg (gigagram)

a. CO_2

Poland: Since the turn of the century, carbon dioxide (CO_2) emissions in Poland have seen little change. Levels amounted to 322.5 million metric tons in 2018, which is an overall increase during this period. Emissions peaked in 2010 at 323 million metric tons. In 2016, Poland's energy industry accounted for 52 percent of the country's CO_2 air emissions, with most of this caused by the burning of coal. Poland is heavily reliant on coal, and in 2018 produced approximately 130 terawatt-hours of electricity, this accounted for almost 80 percent of total electricity production.



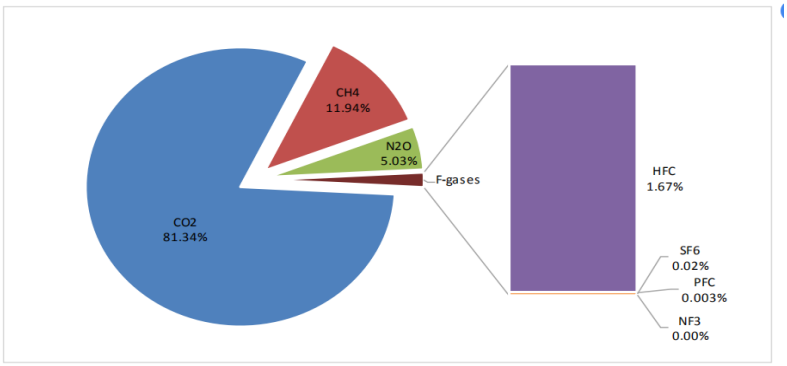
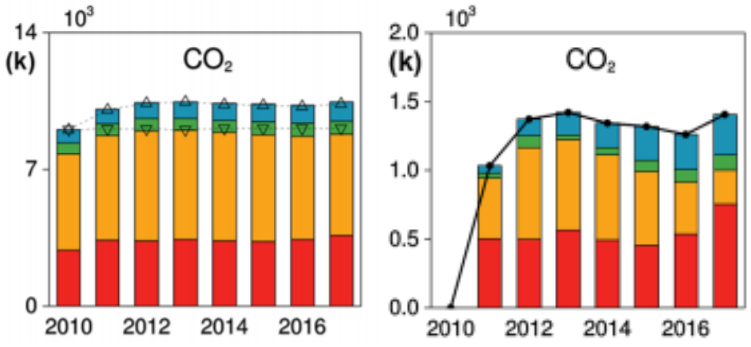


Figure S.1. Percentage share of greenhouse gases in national total emission in 2017 (excluding category 4. *LULUCF*)

China: During 2010-2017, CO_2 emissions were flat, reflecting China's improved combustion efficiency and emission control, since 2013 also observed a sharp drop in particulate emissions. The improvements in combustion efficiency and oxygen blast furnace gas recycling are the largest drivers of declining CO_2 emissions



b. SO_2

Poland: Emissions of SO_2 decreased by about 78 % between 1990 and 2016. Most of the reductions were caused by the decline of the heavy industry in the late 1980s and early 1990s. In the late 1990s the emissions decreased because of the diminished share of coal (hard and brown) among fuels used for power and heat generation. The most significant decreases were in combustion processes in the Power Plants and in industries. It has resulted from the adjustment of technical specifications of the plants to meet the more stringent standards of the 2010/75/UE Directive (IED).

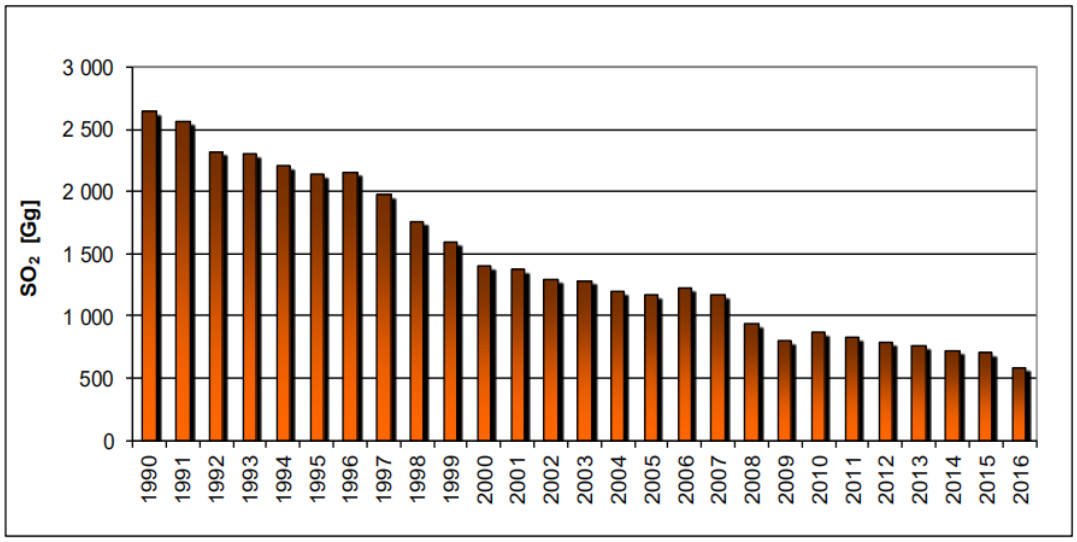
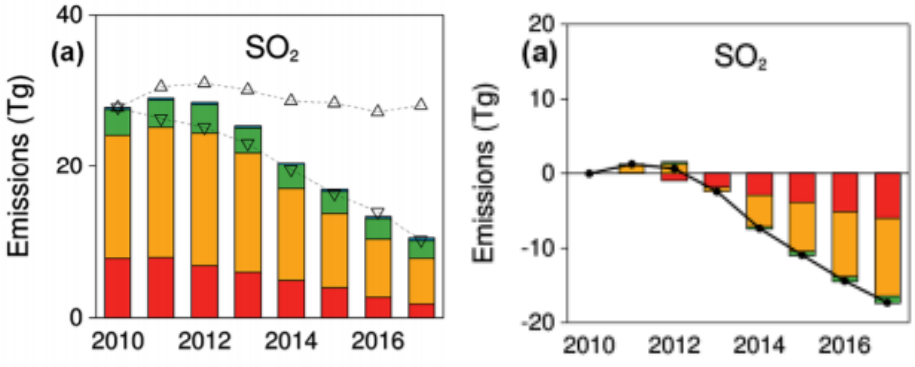


Figure 2.1.a Emissions trend of SO_2

China: For SO_2, It has declined significantly since 2013, shutting down small industrial boilers and cleaning larger ones have contributed the most to emission reductions. In particular, small coal boilers (≤ 7 MW) located in urban areas.
The reason for this is that upgrading plants with pollution control equipment in the 11th 5-Year Plan (2006–2010) significantly reduced SO_2 and particulate emissions from power plants.



c. NO_x

Poland: Emissions of NO_x decreased by over 30 % between 1990 and 2016. Similarly to Sulphur dioxide, most of the reductions were caused by the decline of the heavy industry and lower share of coal in the late 1980s and early 1990s.
At the same time there was a decrease of NO_x emissions from Public Power Plants, which has resulted from the adjustment of technical specifications of the plants to meet the more stringent standards of the 2010/75/UE Directive (IED).

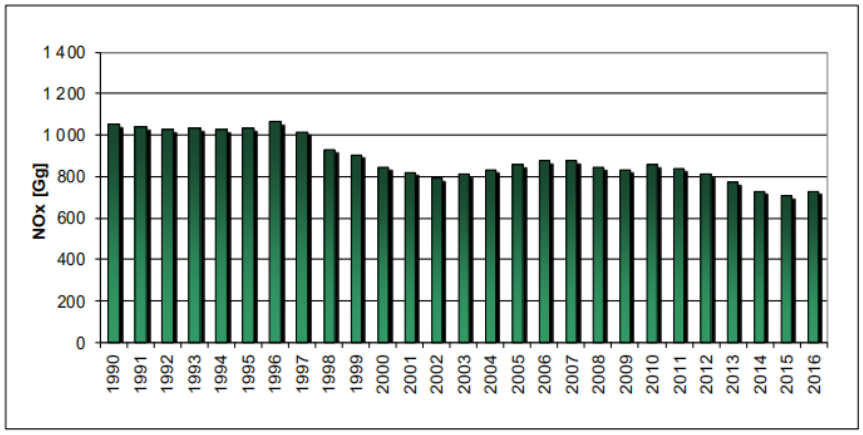


Figure 2.2.a Emissions trend of NO_x

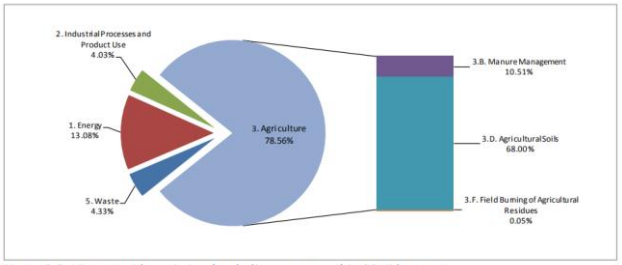
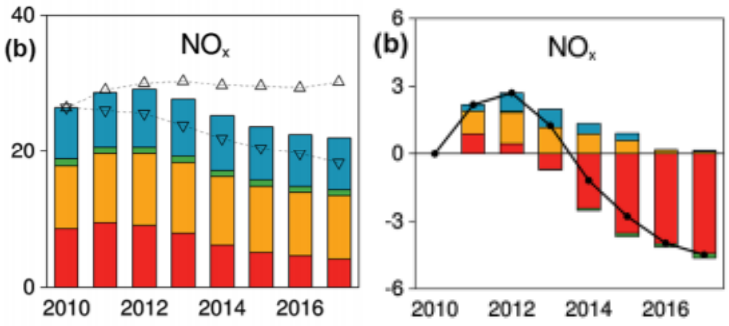


Figure S.6. Nitrous oxide emission (excluding category 4) in 2017 by sector

China: With upgraded emission standards and the spread of the ultralow emission technique, the new emission limit values have further driven down power plant emissions, which is the dominant driving force of the decrease in NO_x emissions for NO_x the power sector was the major contributor to emission reduction, then is transportation, which means that old vehicles are being replaced by newer, cleaner models subjected to tougher emission standards. China has scrapped all the old vehicles that do not meet the more stringent emission standards by the end of 2017.



d. PM2.5

Poland: From 1999 to 2016, the volume of emissions in this period remained relative stable, the higher emission before 1999, may cause by a higher volume of combusted fuels and higher use of coal in households

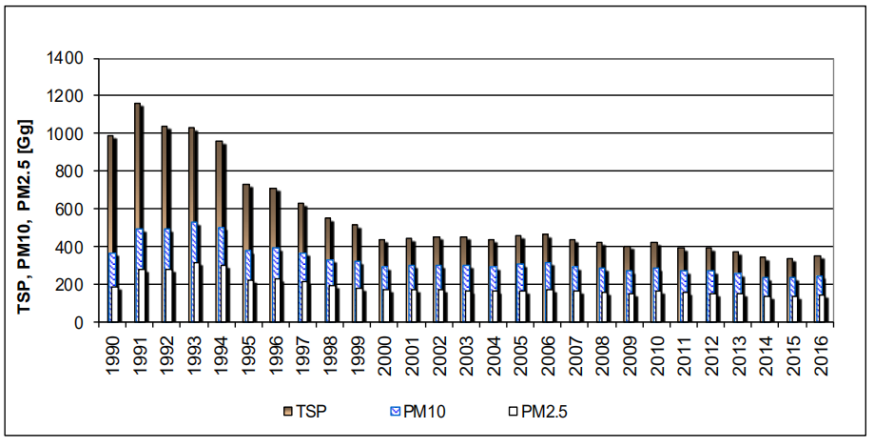
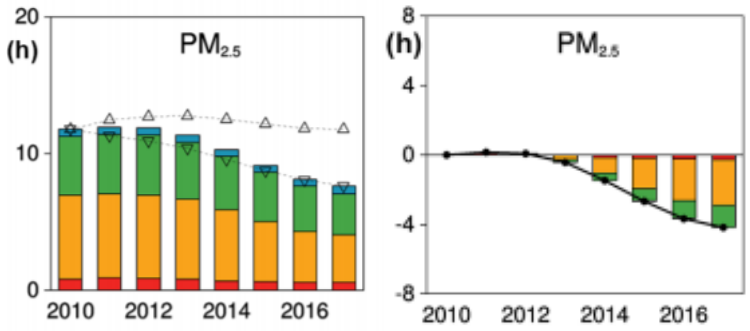


Figure 2.5.a Emissions of particulate matter

China: PM2.5 concentrations presented a relatively flat trend during 2010 and 2013, PM2.5 concentrations over China decreased by 18 % from 2013 to 2015, During 2013–2017, PM2.5 concentrations over 74 cites decreased by 35 %, the main part is the decrease of the industrial emission.



e. NH_3

Poland: The trend of ammonia emissions is influenced mainly by the agriculture sector, namely by a number of animals and volume of N fertilizers applied. The reduction in emissions since the record is not obvious, the main influence on this interannual change had the lower headage of dairy cattle and swine.

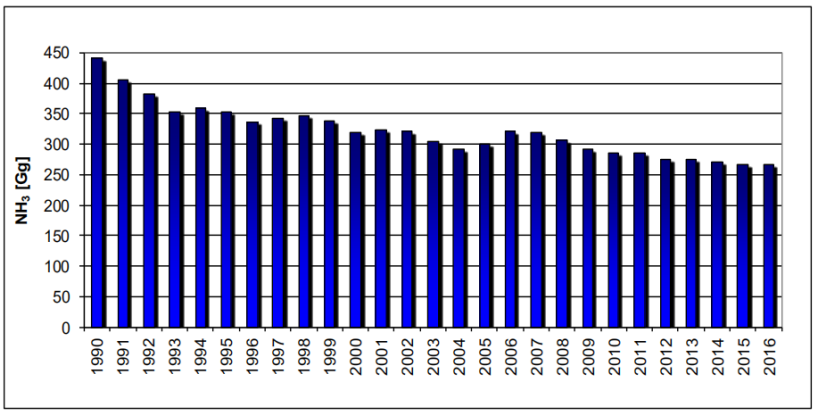


Figure 2.4.a Emissions trend of NH_3

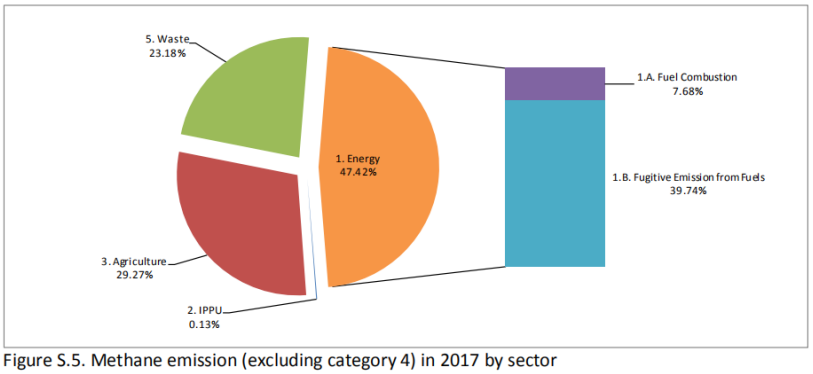
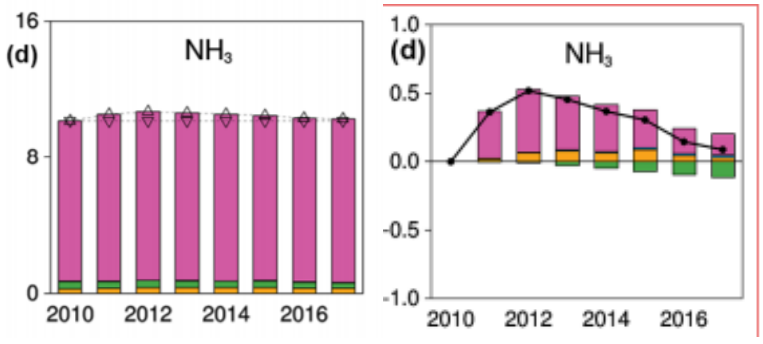


Figure S.5. Methane emission (excluding category 4) in 2017 by sector

China: The NH_3 emissions remained flat from 2010 to 2017, this trend was mainly due to the absence of effective emission control measures

The agricultural sector is the dominant source of NH_3 emissions, as it contributes to 93 % of total emissions. Agriculture has remained constant because agriculture and rural activities showed small interannual variations.



Conclusion

	Poland			China		
	2010 [Tg]	2016 [Tg]	Reduction	2010 [Tg]	2016 [Tg]	Reduction
CO_2	320	305	4.7%	9500	10800	-13.7%
SO_2	0.9	0.6	33.3%	30	16	46.7%
NO_x	0.85	0.73	14.1%	28	24	14.3%
PM2.5	0.18	0.15	16.7%	12	8	33.3%
NH_3	0.28	0.26	7.1%	10.5	10.7	-1.9%

China: From 2010 to 2017, China reduced its anthropogenic emissions by 62 % for SO_2, 17 % for NO_x, 35 % for PM2.5 according to our estimates.
Most of the emission reductions were achieved after 2013, and the index decomposition analysis confirms that emission control measures have been the dominant driver of this declining emission trend. Pollution controls on the power and industrial sectors are the most effective measures, which have contributed 56–94 % of total avoided emissions due to stringent mitigation policies, such as strengthening emission standards, eliminating outdated industrial capacity, and phasing out small high-emitting factories.
From 2010 to 2017, emissions from transport tend to remain flat, the residential sector has reduced its emissions mainly through the substitution of clean fuels, China lacked effective emission control measures on NH_3 in current policies. Besides, all cities reduce annual average PM2.5 concentrations by 18 % in 2020 compared to their 2015 levels.

Poland: Overall, all these five pollutants are decreasing from 1990 to 2016, the biggest drop is SO_2, because of the diminished share of coal (hard and brown) among fuels used for power and heat generation; The smallest decrease is CO_2, the situation is the same as China, and there have been some ups and downs in the past 20 years, because Poland, like China, is very dependent on coal, and this situation is difficult to improve in a short time, that the Bełchatów coal power plant was the biggest polluter in Europe, emitting 38.2 megatons of CO_2 equivalent. It is the largest lignite-fired power station in the world. The decline in NO_x is roughly the same in both countries, and the measures taken are similar, and the situation of NH3 is better in Poland than in China, we can see after a 10-year bottleneck in Poland, NH3 emissions began to decline slowly.
Overall, the volume of China 's pollutants emissions is about 30 to 40 times that of Poland.

Reference:

[1] https://ec.europa.eu/environment/air/quality/standards.htm
[2] http://www.euro.who.int/en/health-topics/environment-and-health/air-quality/activities/update-of-who-global-air-quality-guidelines
[3] Zheng, Bo, et al. "Trends in China's anthropogenic emissions since 2010 as the consequence of clean air actions." Atmospheric Chemistry and Physics 18.19 (2018): 14095-14111.

[4] poland's informative inventory report 2018 – KOBiZE “Submission under the UN ECE Convention on Long-range Transboundary Air Pollution and the DIRECTIVE (EU) 2016/2284”
[5] POLAND’S NATIONAL INVENTORY REPORT 2019 “Greenhouse Gas Inventory for 1988-2017”
[6]https://www.statista.com/statistics/449809/co2-emissions-poland/