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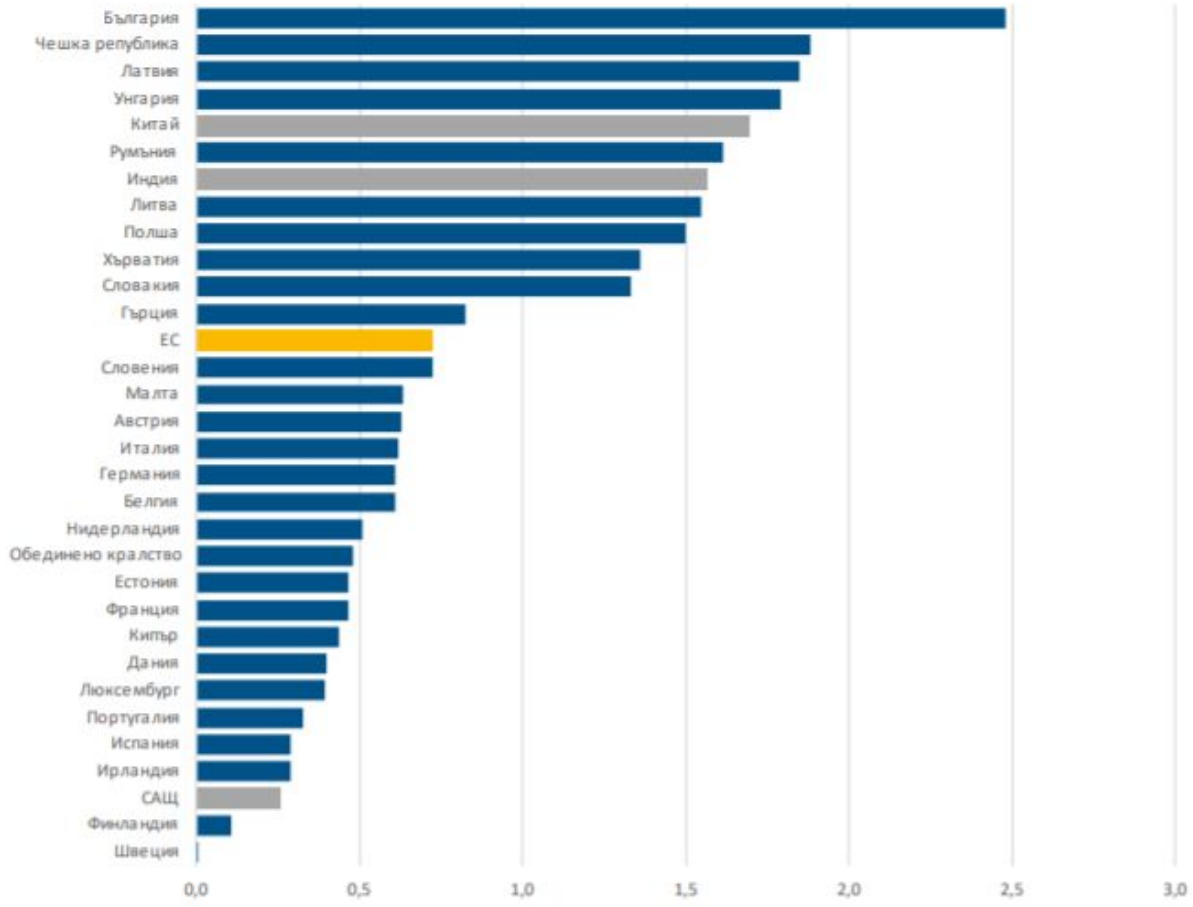
THE AMERICAN COLLEGE OF SOFIA

W.E.E. and Air Quality

Project Erasmus + 2019-1-ES01-KA202-063878
Residuos Eléctricos y Electrónicos y Calidad del Aire

Air Particles and Pollution in Sofia

Created by: Martin Palikarsky, Vyara Tsvetkova, Pavla Petrova, Gergana Valkova, Yuliya Kostadinova, Georgi Pandev, and Todor Kiurkchiev



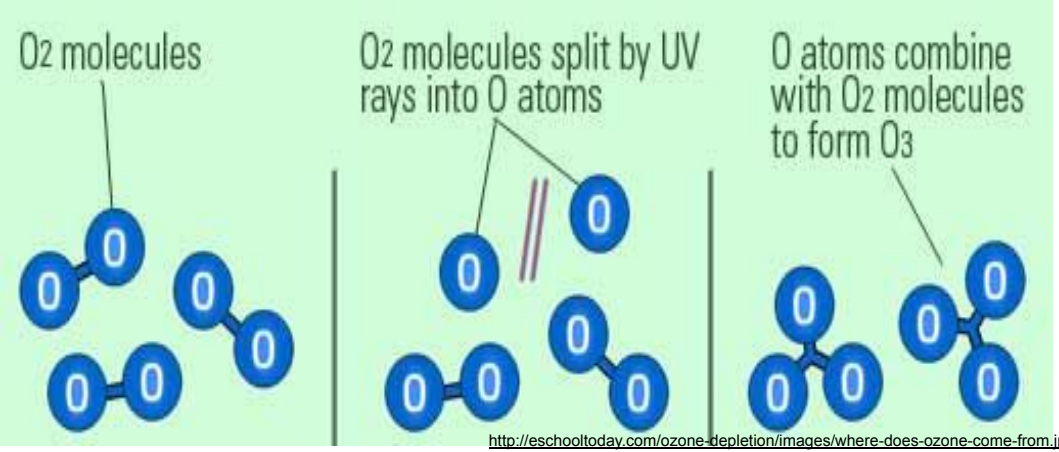
Deaths caused by the poor air quality per 100 people

https://www.eca.europa.eu/Lists/ECADocuments/SR18_23/SR_AIR_QUALITY_BG.pdf

Ozone (O_3)

Main Characteristics

- Pure ozone is pure in color
- Has a strong irritating smell
- Causes headache and nausea when inhaled
- More soluble than oxygen in water
- Boils at 161.2 K
- Melts at 80.6 K

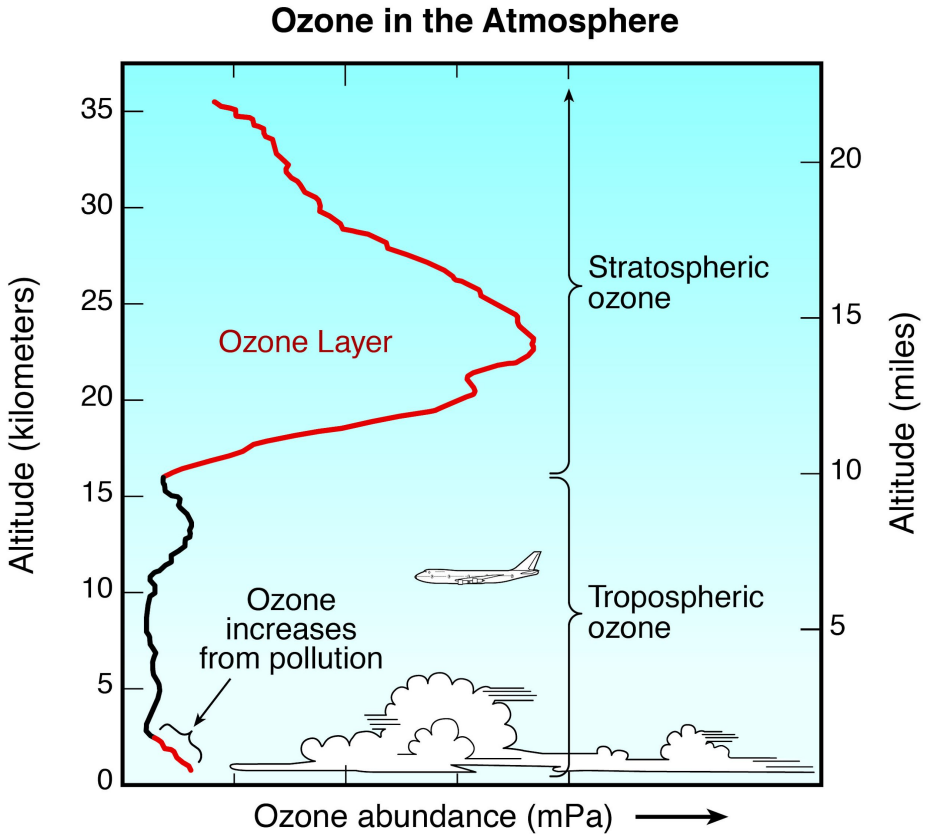


http://eschooltoday.com/ozone-depletion/images/where-does-ozone-come-from.jpg
>

Ozone (O_3)

Ozone in the atmosphere

- Upper layer
  - 6 to 30 miles above Earth's surface
  - Occurs naturally
  - Protective layer - absorb ultraviolet rays
  - Man-made chemicals destroy it
- Ground level
  - Formed by pollutants
  - Harmful



https://atmosphere.copernicus.eu/sites/default/files/inline-images/ozone.jpg

Ozone (O_3)

People at Risk

- People with asthma
- Children
- Older adults
- People who are active outdoors, especially outdoor workers

Health Risks

- More difficult to breathe deeply and vigorously
- Cause shortness of breath and pain when taking a deep breath
- Cause coughing and sore or scratchy throat
- Inflame and damage the airways
- Asthma, emphysema, and chronic bronchitis
- Increase the frequency of asthma attacks
- Lungs are more susceptible to infection
- Continue to damage the lungs even when the symptoms have disappeared
- Cause chronic obstructive pulmonary disease

Ozone (O_3)

How to reduce your health risk

- Be aware of ozone air quality levels, especially in the summer or when outdoor temperatures are high
- Avoid exercising or working outdoors when ozone levels are high
- If you are elderly, or have asthma or any other respiratory diseases, avoid being outdoors when ozone levels are high
- Use websites as World Air Quality that provide daily reports on air pollution

Sulfur Dioxide (SO_2)

Main Characteristics

- Colorless, bad-smelling, toxic
- Emitted by burning fossil fuels
- Diesel vehicles
- Volcanic activity
- Exists in the atmosphere in very small concentrations

https://lh3.googleusercontent.com/proxy/SkWbNQObXlyup-QHt75TNhAsG58CY6GWS6okgciNkHzf6-nUYGVH3lszS0L2qINjYNIKY9DkE6YstOK93NObm2tPlCgptGYuPSskeBvAR2j1AtPvALH-YNBn0cFI9DoGiwAeFQ

Sulfur Dioxide (SO_2)

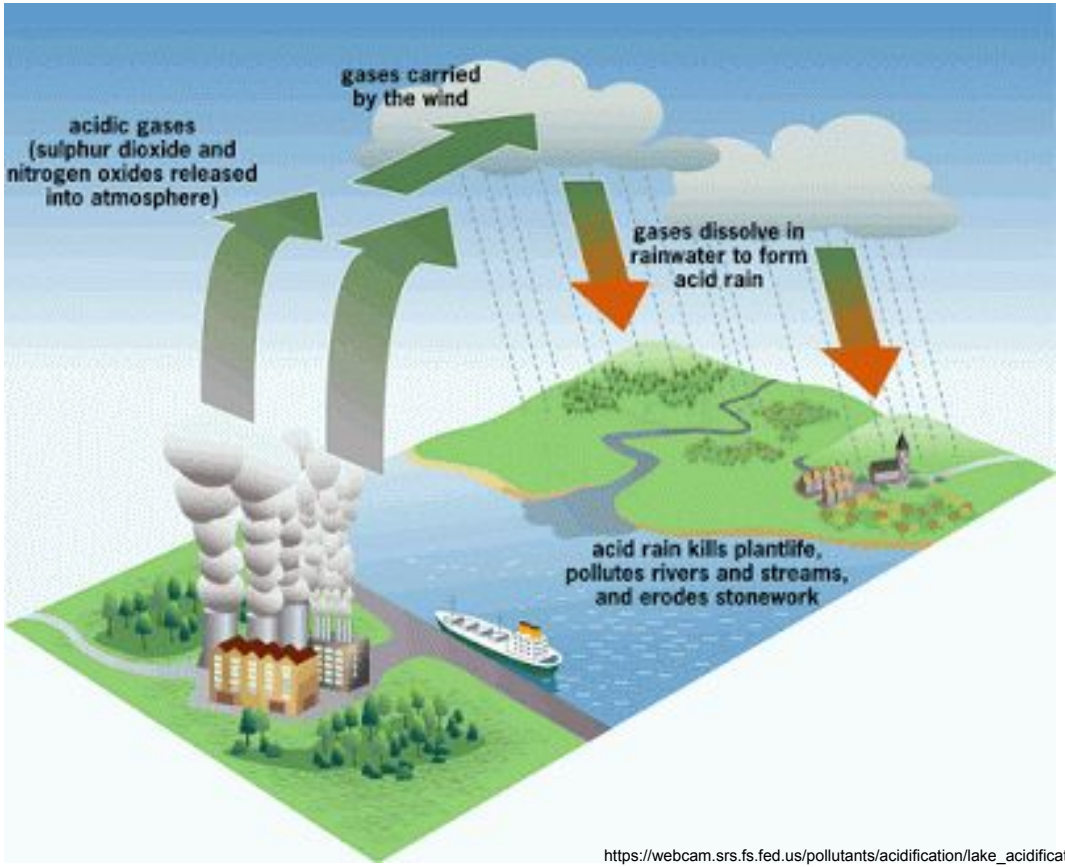
Health Effects

- Irritates skin and respiratory system
- High concentrations cause inflammation of the respiratory system
- Sulfur dioxide can deteriorate respiratory diseases and heart problems

https://images.theconversation.com/files/215647/original/file-20180419-163962-1c6rdqo.jpg?ixlib=rb-1.1.0&q=45&auto=format&w=1200&h=1200.0&fit=crop

Sulfur Dioxide (SO_2)

Effects on environment

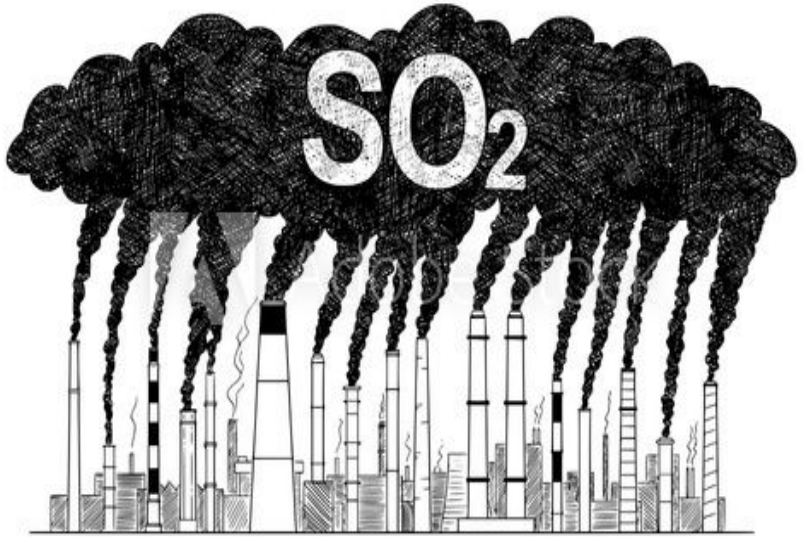


https://webcam.srs.fs.fed.us/pollutants/acidification/lake_acidification.jpg

Sulfur Dioxide (SO_2)

Presence of SO_2

- In Sofia the amounts of SO_2 are not that significant as there aren't major fossil fuel burners
- However, Bulgaria has been classified in top 20 SO_2 emitting countries in the world, the only country from the EU in this list



https://as2.ftcdn.net/jpg/02/18/37/61/500_F_218376124_QM3ARvV4zXWsJ2Jzpq8uo0Xaihw3Ok3e.jpg

Carbon Monoxide (CO)

Main Characteristics

- Colorless, odorless, and tasteless flammable gas
- Toxic to animals and humans that use hemoglobin as an oxygen carrier (when its concentration is higher than 35 ppm)
- Role in the formation of ground-level ozone
- Produced during fuel and coal burning, in chemical industry and steel production, also in small engines, stoves, lanterns, grills, fireplaces, gas ranges, or furnaces

https://mpng.pngfly.com/20180403/zqw/kisspng-ghs-hazard-pictograms-globally-harmonized-system-o-chemical-5ac4029f320b58.49908001152279516720 5.jpg

https://as2.ftcdn.net/jpg/01/83/58/47/500_F_183584703_Quyo2SgdmAjkCmFTwroNlOUA7dP8G7iX.jpg

Carbon Monoxide (CO)

Health Effects

- Symptoms of CO poisoning are:
  - Headache, dizziness, weakness
  - Chest pain, vomiting
  - Loss of balance
  - Vision problems
  - Memory problems
  - Eventual loss of consciousness
- **CO can make you pass out or kill you!**

https://www.medicalnewstoday.com/articles/171876.php#effects-

Carbon Dioxide (CO_2)

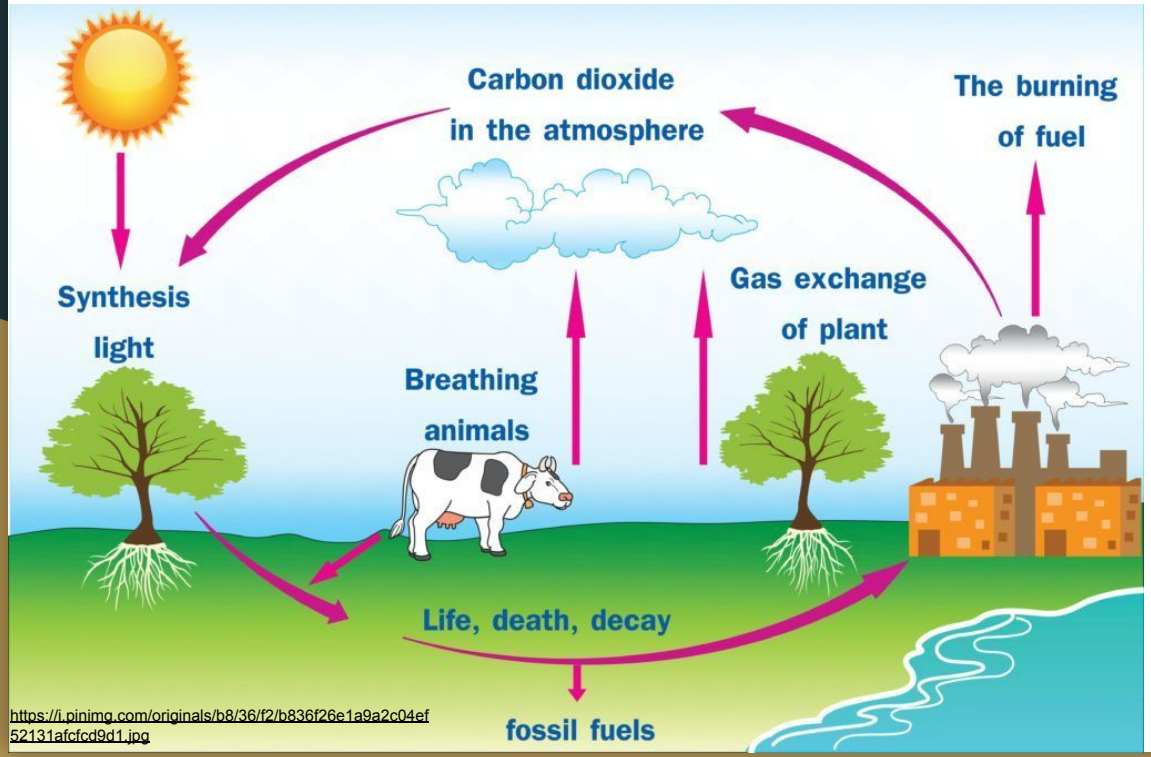
Main Characteristics

- Colourless, odorless gas formed from carbon and oxygen
- Natural part of the Earth's carbon cycle: the circulation of carbon between the atmosphere, plants, animals, soils, and oceans
- Humans exhale CO_2 and plants absorb it
- Human activity since the industrial era - led to the increased levels of CO_2 and altered the cycle
- The primary greenhouse gas emitted because of humans

https://image.shutterstock.com/image-photo/smoke-chimney-writing-co2-sky-600w-385327918.jpg

Carbon Dioxide (CO_2)

Occurrence



https://i.pinimg.com/originals/b8/36/f2/b836f26e1a9a2c04ef52131afcfcd9d1.jpg

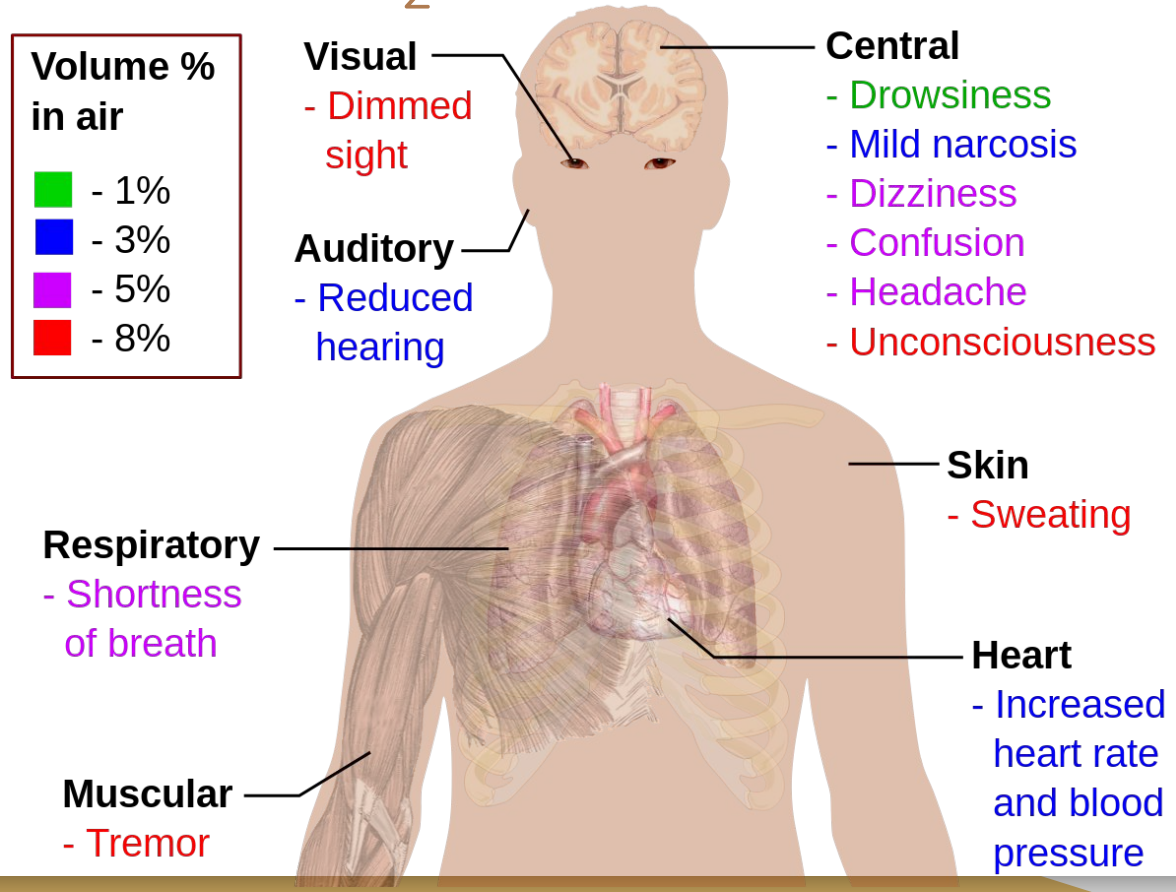
- Produced through burning fossil fuels
- Main sources of emissions globally include transport, industry, and fuel burning for electricity and heating
- Produced through natural sources

Carbon Dioxide (CO_2)

Affecting Health

- Can build up indoors if rooms are not well ventilated
- Can make people lethargic, cause headaches and difficulty concentrating, dizziness, and even nausea
- Higher concentrations (e.g. >5000 ppm over a few hours) - provoke increased heart rate, elevated blood pressure
- Indirectly through climate change and effects associated with increased pollutants (such as ozone and particle pollution)

Carbon Dioxide (CO_2)

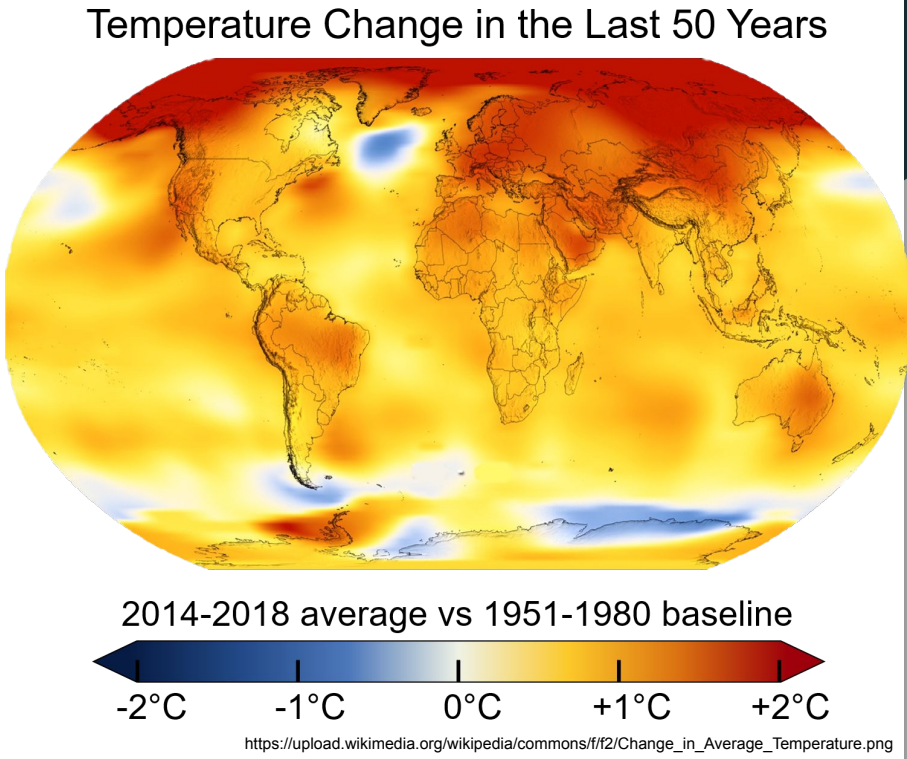


https://upload.wikimedia.org/wikipedia/commons/3/35/Main_symptoms_of_carbon_dioxide_toxicity.svg

Carbon Dioxide (CO_2)

Environmental Effects

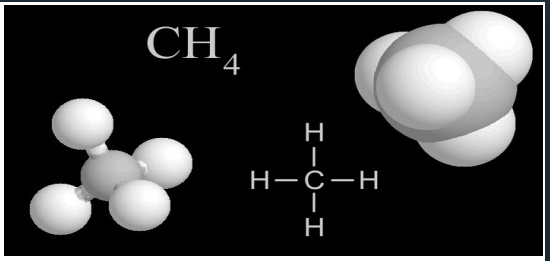
- Rising sea levels - increased likelihood of droughts and wildfires, species loss, and ecosystem damage
- CO_2 is a ‘heat-trapping’ gas as it limits heat radiation
- “Greenhouse effect” - traps more and more heat in the Earth’s atmosphere



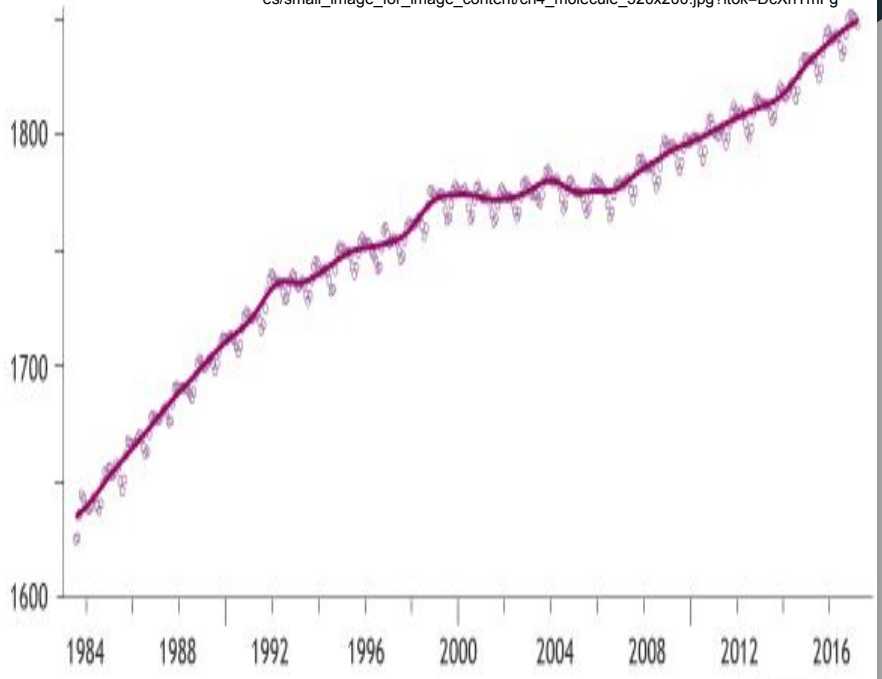
Methane (CH_4)

Main Characteristics

- Simplest hydrocarbon
- Colorless, Odorless, Flammable
- Fuel, a component of natural gas
- Greenhouse gas
- “If CO2 dictates how warm the planet will get, methane determines how fast”
- Ground level ozone



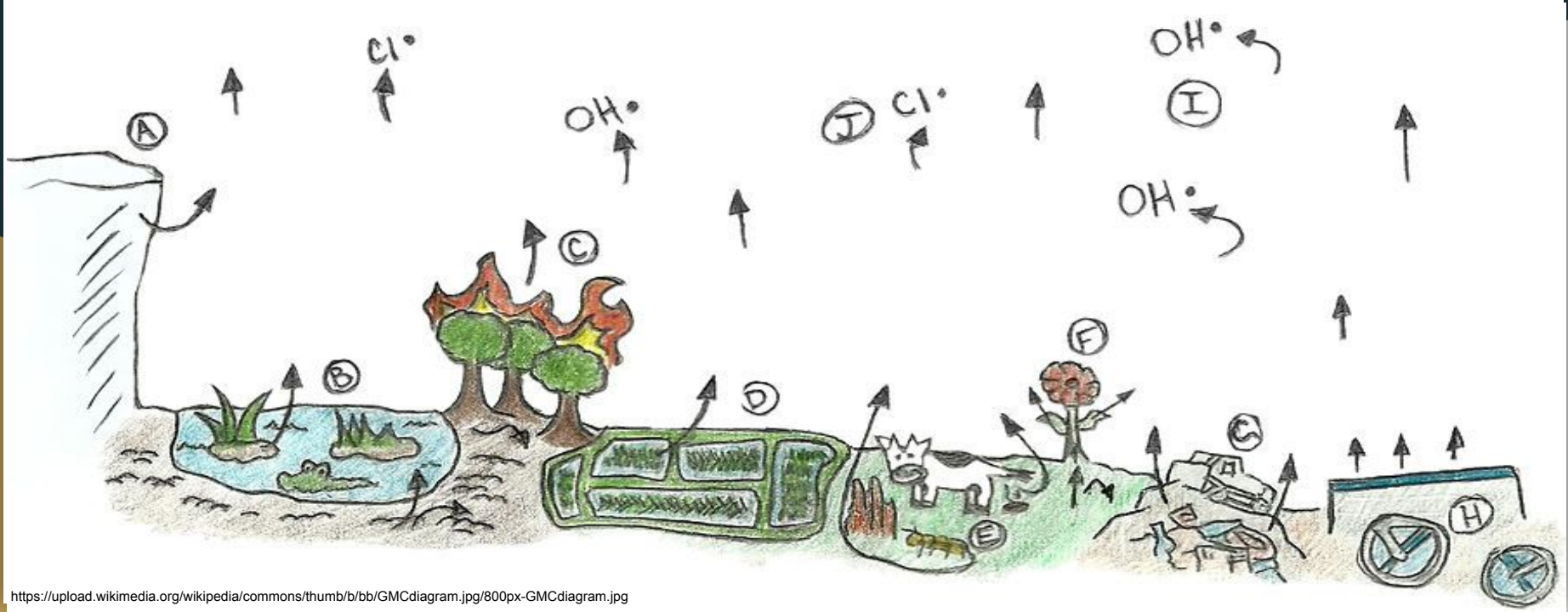
https://scied.ucar.edu/sites/default/files/styles/short_content_small_image/public/images/small_image_for_image_content/ch4_molecule_320x200.jpg?itok=DcXhTmFg



https://upload.wikimedia.org/wikipedia/commons/thumb/a/a3/Mlo_ch4_ts_obs_03437.png/300px-Mlo_ch4_ts_obs_03437.png

Methane (CH_4)

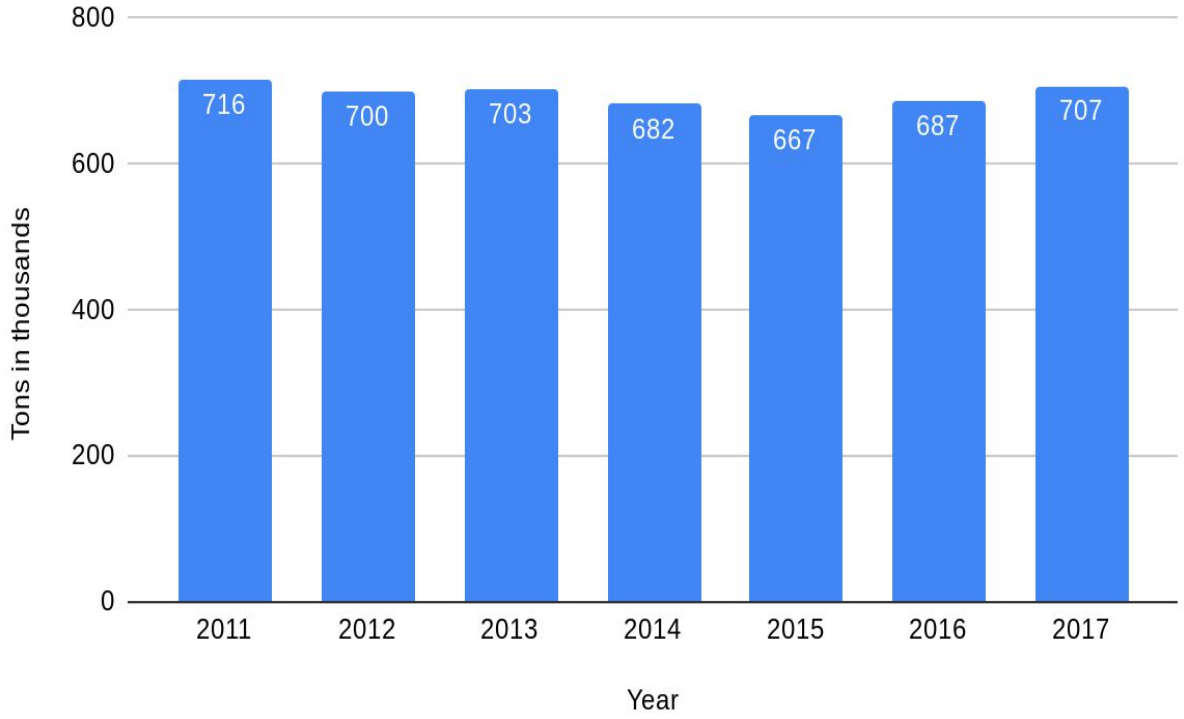
Occurrence



https://upload.wikimedia.org/wikipedia/commons/thumb/b/bb/GMCdiagram.jpg/800px-GMCdiagram.jpg

Methane (CH_4)

Statistics



"The Commission is (...) introducing limits for the first time on the amount of methane (CH4) emissions after 2030."

- Statistics for Sofia

Methane (CH_4)

Affecting Health

- Low concentrations are not harmful
- A high concentration can displace oxygen in the air leading to less oxygen to breathe and more dangerous gases like benzene
- Asthma attacks, rapid breathing, rapid heart rate, clumsiness, emotional upsets, and fatigue can result
- Headache, dizziness, vomiting, collapse, loss of coordination, and weakness

Methane (CH_4)

Affecting Climate

- Second to carbon dioxide in its importance to climate change
- Affect the abundance of other greenhouse gases, such as ozone, water vapor and carbon dioxide
- The contribution of methane emissions to global warming is 25% higher than previous estimates.

Methane (CH_4)

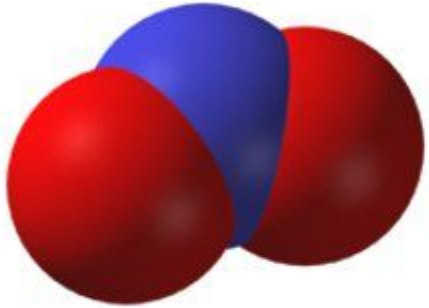
Ways to Reduce the Amount of Methane

- Agriculture: Improve soil management and animal feed quality
- Fossil fuels: Extend recovery and utilization from gas and oil production
- Waste Management: Support organic farming practices; Eat less red meat

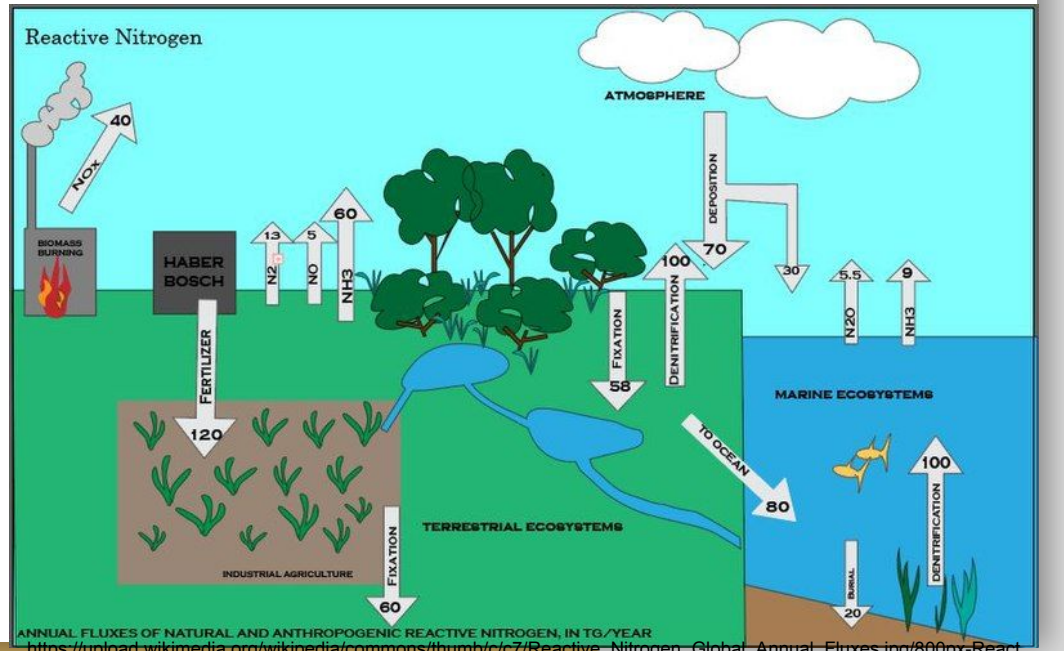
Nitrogen Dioxide (NO_2)

Main Characteristics

- Highly reactive
- Toxic by inhalation and skin absorption
- Production of fertilizers
- Part of the nitrogen cycle ⇒ we have altered in it



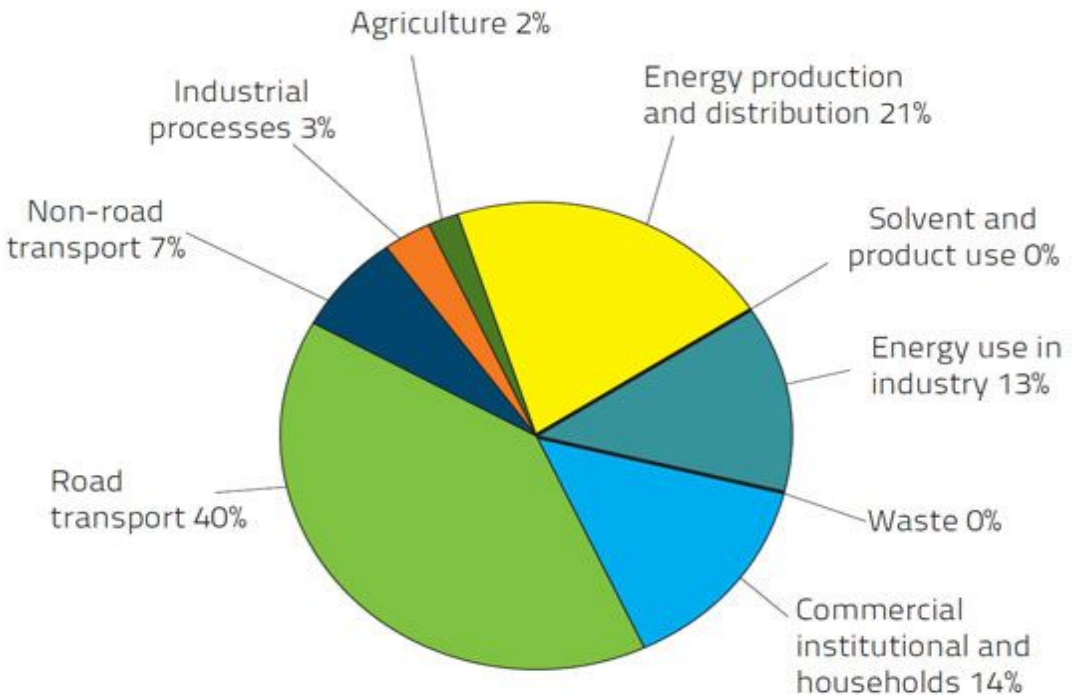
https://www.evikon.eu/includes/templates/eu.catalog/images/headers/no2.jpg



https://upload.wikimedia.org/wikipedia/commons/thumb/c/c7/Reactive_Nitrogen_Global_Annual_Fluxes.jpg/800px-Reactive_Nitrogen_Global_Annual_Fluxes.jpg

Nitrogen Dioxide (NO_2)

Occurrence

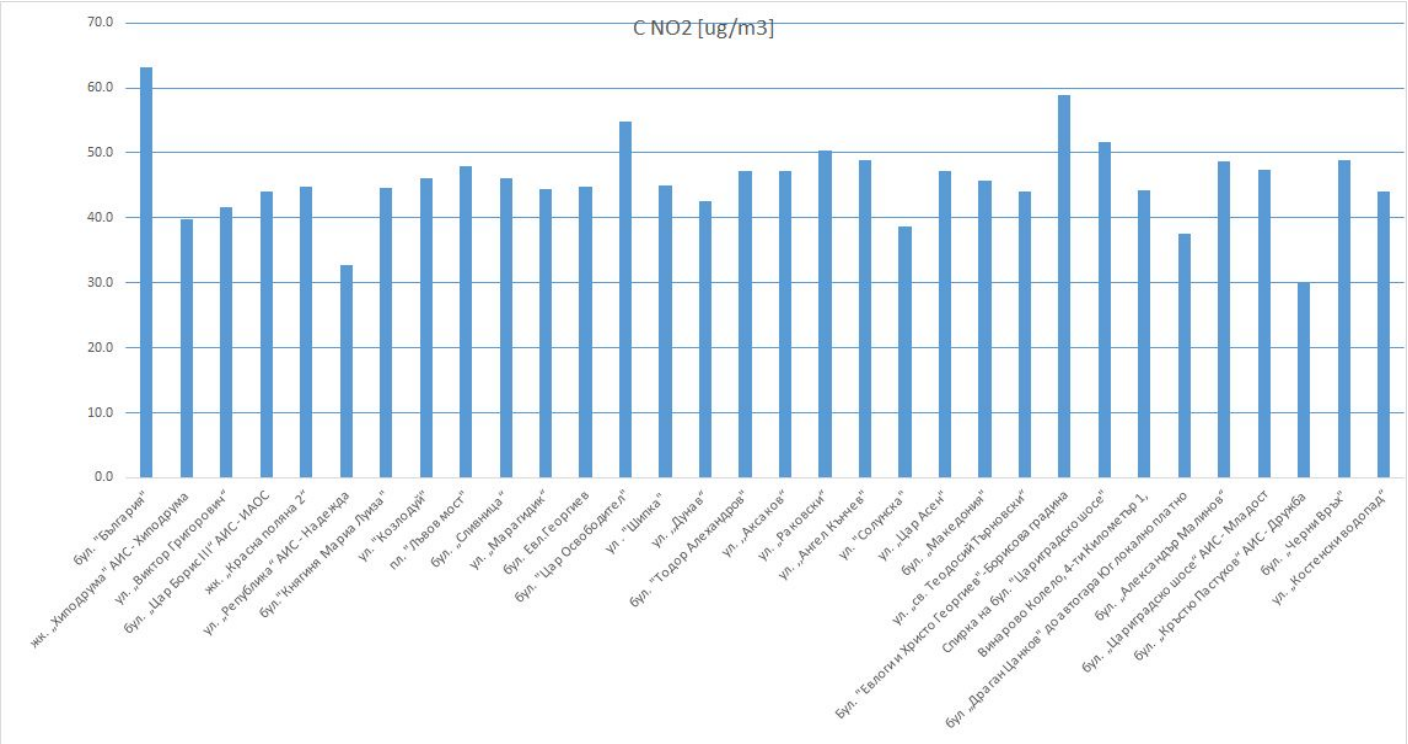


http://www.icopal-noxite.co.uk/~/media/NoxiteUK/charts/Chart-share-of-emissions-by-sector-group-2011.jpg

- 40% from road transportation
- Results from burning fossil fuels both for energy and in engines

Nitrogen Dioxide (NO_2)

Statistics



- From December, 2019
- Average for Sofia - 45.7 µg/m3

Nitrogen Dioxide (NO_2)

Affecting Health

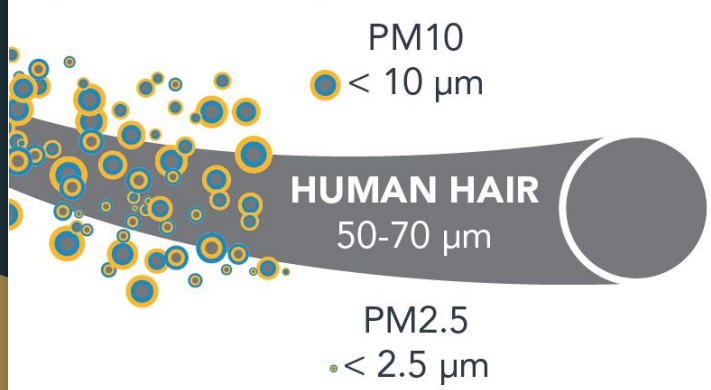
- Increased likelihood of respiratory problems
- Reduced immunity to lung infections
- Wheezing, coughing, colds, flu and bronchitis
- People with asthma and older people with heart disease are most at risk
- Can result in more frequent and more intense asthma attacks

Nitrogen Dioxide (NO_2)

Ways to reduce the amount of Nitrogen Dioxide

- Fuel switching: switch to a fuel with reduced nitrogen content like natural gas
- Use your car less: try to use bicycle instead, since most of the nitrogen dioxide in cities comes from motor vehicle exhaust

Particles PM2.5 and PM10



Main Characteristics

- Particulate matter is a mixture of aerosol particles (solid and liquid) covering a wide range of sizes and chemical compositions
- PM2.5 is particulate matter 2.5 micrometers or less in diameter, while PM10 is 10 micrometers

Particles PM2.5 and PM10

Occurrence

- Directly emitted as primary particles or form in the atmosphere from emissions of certain precursor pollutants such as SO_2, NO_2, NH_3, and NMVOCs

Particles PM2.5 and PM10

Occurrence

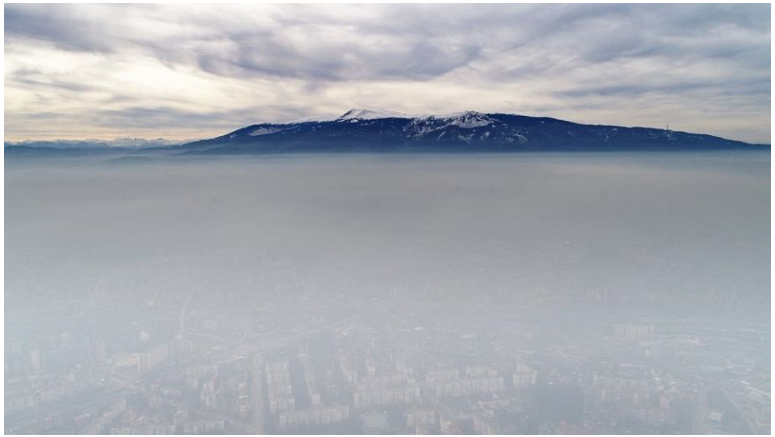
- Emitted from anthropogenic sources: burning of fossil fuels in electricity generation, transport, industry and households

- Emitted also during industrial processes and solvent use (in the chemical and mining industries) and as a product of agriculture and waste treatment

Particles PM2.5 and PM10

Occurrence

- The Sofia field is located among mountains→closed and with bad ventilation
- Temperature inversions are formed during the winter
- Many roads with intensive traffic are parallel to the prevailing winds → The pollutants do not disperse well



Particles of PM10

Statistics

- In Sofia, the two pollutants that were most problematic in the period 2007-2011 were NO_2 and PM10
- The main sectors with a high contribution to the air pollution in Sofia were the road transport and domestic heating based on wood, coal, and some unregulated materials

Particles of PM10 Statistics

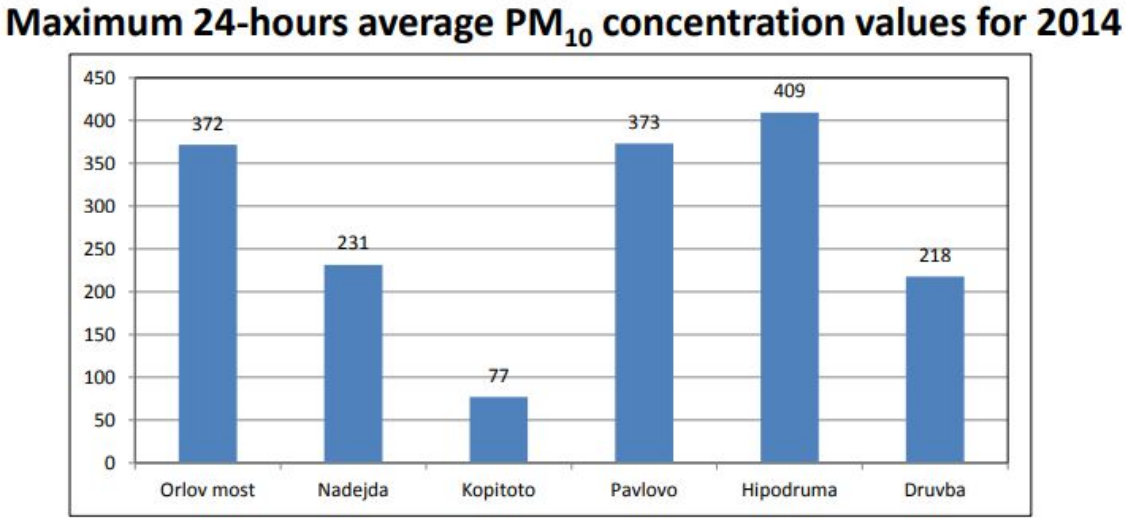
Year average PM_{10} concentration, $\mu g/m^3$

AMS	Year			
	2011	2012	2013	2014
Drujba	61.77	42.13	48.79	44.65
Pavlovo	59.41	43.66	43.04	47.73
Nadejda	69.65	44.71	41.17	41.64
Orlov most	66.09	53.84	52.43	52.96
Hipodruma	62.6	47.56	41.54	46.05
Kopitoto	22.47	19.61	16.89	16.45

Particles of PM10

Statistics

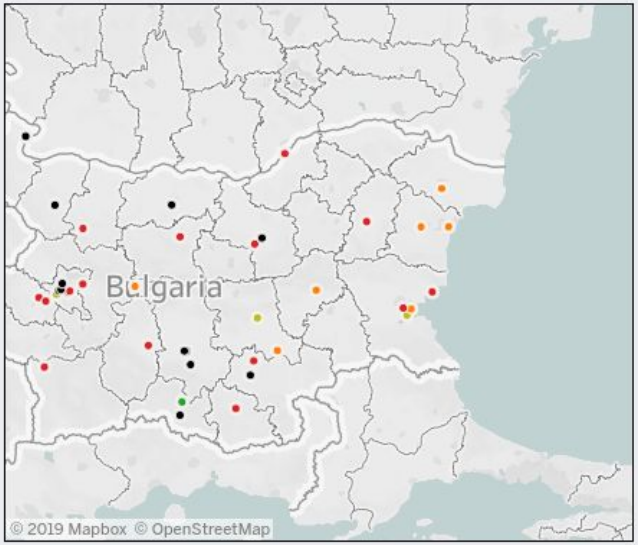
- Although the year average PM10 concentration was significantly reduced in 2014, PM10 remains a problematic pollutant for Sofia municipality.
- Problems exist in regard to the 24-hour values



Particles of PM10 Statistics

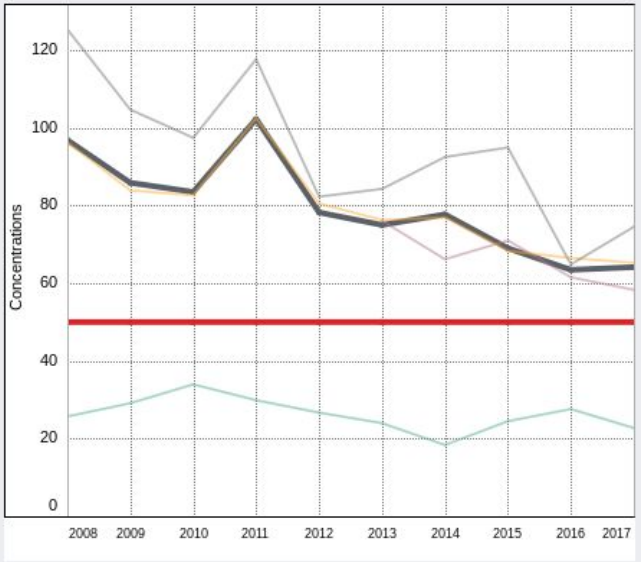
Most recent!

The PM10 percentile 90.41 concentrations in 2017 in Bulgaria compared to the EU daily limit value (50 µg/m3)



PM10 : 75.0 - µg/m3 .
PM10 : 50.0 - 75.0 µg/m3 .
PM10 : 40.0 - 50.0 µg/m3 .
PM10 : 20.0 - 40.0 µg/m3 .
PM10 : 0.0 - 20.0 µg/m3 .

The trend of PM10 percentile 90.41 concentrations in Bulgaria compared to the EU daily limit value (50 µg/m3)

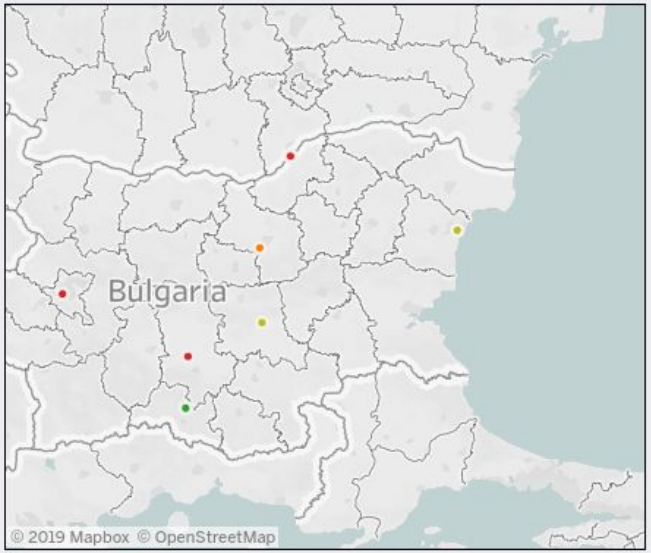


Threshold
Annual avg

Area and station type
traffic stations
background rural
background urban / suburban
other or unknown

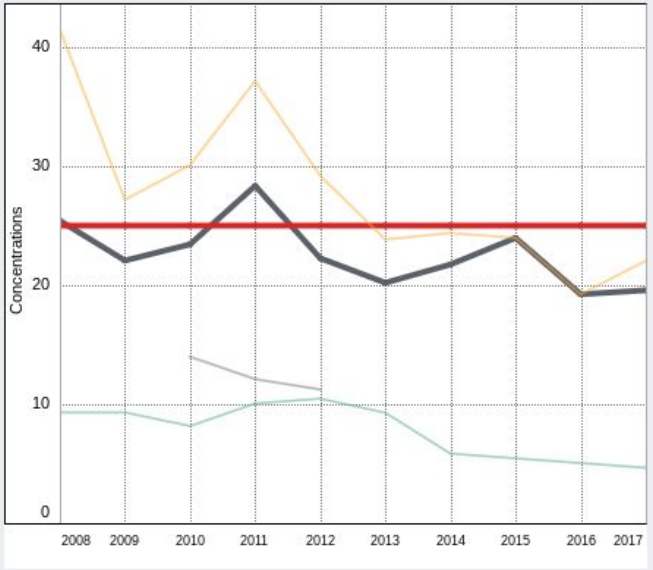
Particles of PM2.5 Statistics

The PM2.5 annual mean concentrations in 2017 in Bulgaria compared to the EU annual limit value (25 µg/m3)



PM2.5 : 25.0 - 30.0 µg/m3 .
PM2.5 : 20.0 - 25.0 µg/m3 .
PM2.5 : 10.0 - 20.0 µg/m3 .
PM2.5 : 0.0 - 10.0 µg/m3 .

The trend of PM2.5 annual mean concentrations in Bulgaria compared to the EU annual limit value (25 µg/m3)

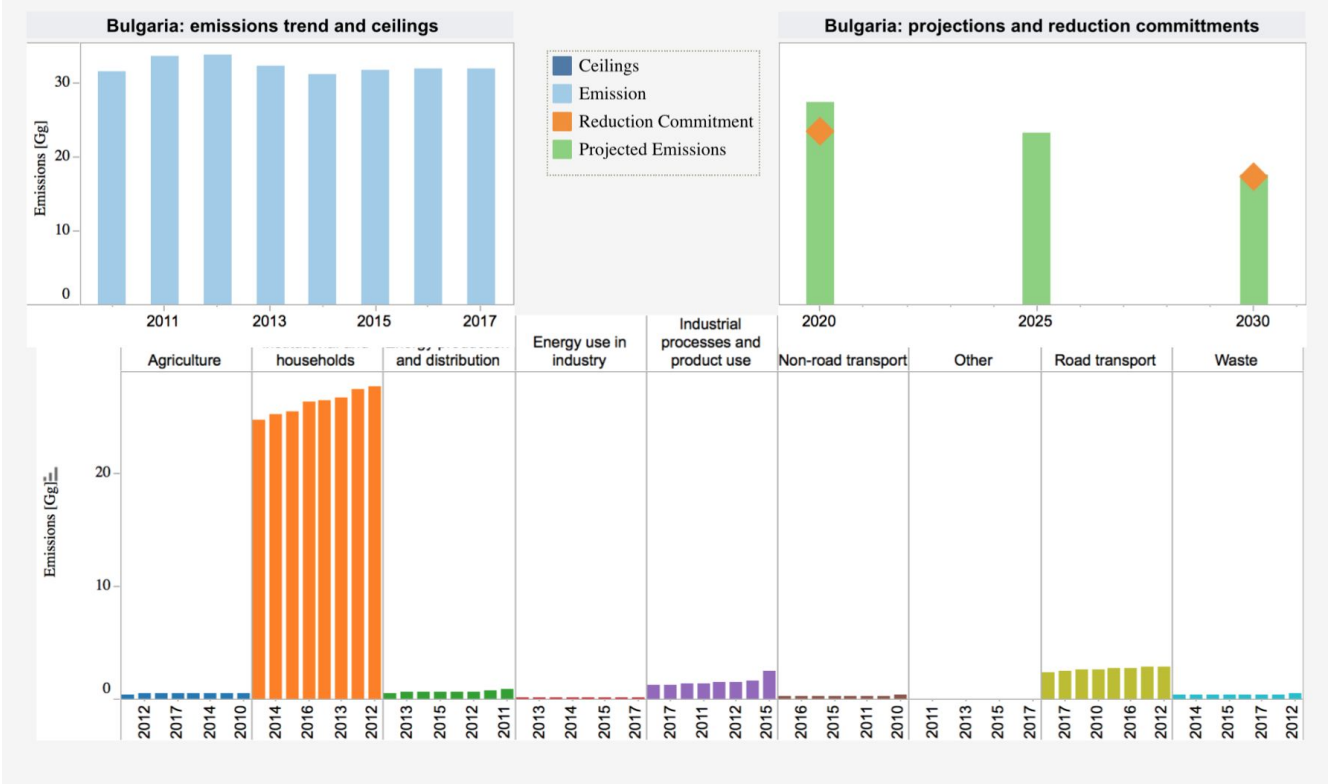


Threshold
Annual avg

Area and station type

traffic stations
background rural
background urban / suburban

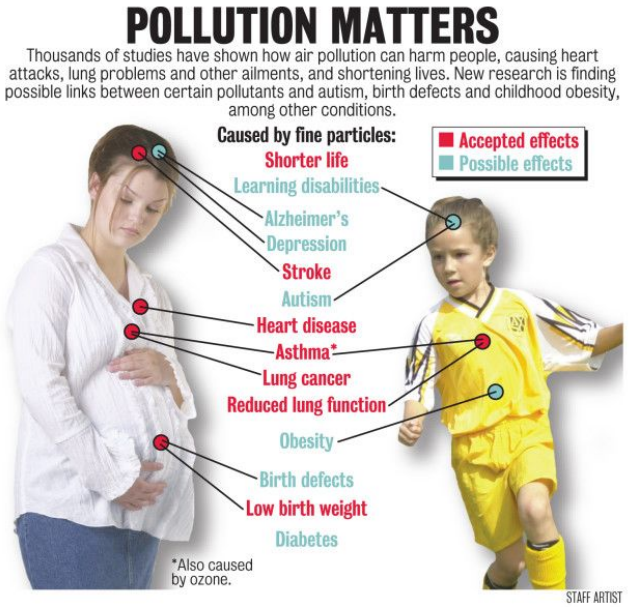
Particles of PM2.5 Statistics



Particles PM2.5 and PM10

Affecting Health

- Causes or aggravates cardiovascular and lung diseases, heart attacks and arrhythmias
- Affects the central nervous system and the reproductive system, can cause cancer
- One outcome of exposure to PM can be premature death



Particles of PM2.5 Affecting Health

- The health effects of air pollution can also be quantified as premature deaths
- Premature deaths are deaths that occur before a person reaches an expected age
- Premature deaths are preventable if their cause can be eliminated

Particles of PM2.5 Affecting Health

- The table shows premature deaths attributable to PM2.5 in 2016

Country	Population (x1000)	Annual mean (PM2.5)	Premature deaths (PM2.5)	Annual mean (NO2)	Sum of Premature deaths NO2)	Somo35 (O3)	Sum of Premature deaths (O3)
Bulgaria	7,154	22.3	13,100	18.8	1,100	3,347	280
Bulgaria	7,154	22.34	13,100	18.78	1,100	3,346.78	280
EU-28	506,028	12.93	374,000	16.29	68,000	3,547.19	14,000
Total	538,014	14.42	412,000	16.28	71,000	3,811.00	15,100

Particles PM2.5 and PM10 Affecting Health

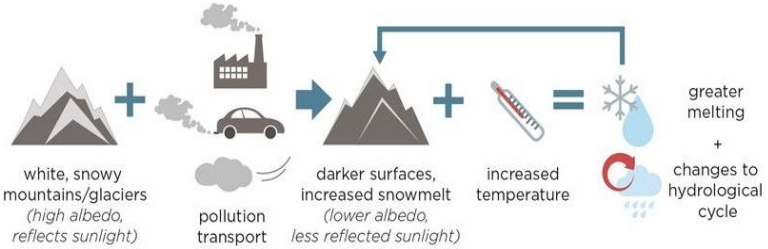
- The table shows the percentage of urban population exposed to concentrations above EU standards for selected air pollutants

		2013	2014	2015	2016	2017
O3	percentile 93.15	0.0	0.0	0.0	0.0	0.0
NO2	annual mean	0.5	0.0	0.2	6.9	0.5
BaP	annual mean	34.2	25.4	34.7	33.7	28.4
PM10	percentile 90.41	91.3	96.9	78.9	90.7	75.7
PM2.5	annual mean			77.2	0.0	

Particles PM2.5 and PM10

Affecting Climate

- Act as a greenhouse gas
- Mainly cooling the earth's climate, although certain types of PM contribute to atmospheric warming



- PM can also alter rainfall patterns and affect the surface albedo properties of snow

Particles PM2.5 and PM10 Affecting Climate

- Pollution affects climate and climate affects pollution

Particles PM2.5 and PM10
How to reduce pollution?

- The government should encourage the use of public transport through initiatives like the green tickets
- Social support should be given to people to go back to central heating and gasification
- Changes in the legislation are necessary in order to force citizens to use newer cars

Thank you!

Gracias!

Благодаря!

Ευχαριστώ!

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