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CHEMISTRY TRIUMPHS

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MONTHLY NEWSLETTER

DEPARTMENT OF CHEMISTRY & ADVANCED
INSTRUMENTATION RESEARCH LABORATORY

CHEMISTRY TRIUMPHS

ON

AIR POLLUTION AND AIR QUALITY

VOLUME - I
[OCTOBER 10TH TO NOVEMBER 10TH]

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at A++ grade
valid up to July 04, 2027

Date : July 05, 2022

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Dedication Wall !!

THE FOLLOWING EDITION OF OCTOBER NEWSLETTER IS DEDICATED TO

Henry Cavendish

Henry Cavendish was a British philosopher, Scientist, Chemist and Physicist. He is best known for his DISCOVERY OF HYDROGEN or 'inflammable air', the density of air and the discovery of Earth's mass.

Born on October 10, 1731, in Nic to a family with the background of aristocrats. He died on February 24, 1810. He completed his schooling from Dr. Newcomb's Academy in Hackney, England. He went to Cambridge University in 1749 for his higher studies. Most of his work has little evidence to support his theories but all of them were experimentally proven in theory. There is no division of science that Cavendish hasn't worked upon but his work was most noted in the fields of chemistry and physics.

Sarath Guttikunda

Sarath Guttikunda has been awarded the International Award from the American Geophysical Union for his work on making the causes of air pollution more understandable. He is only the SECOND PERSON FROM INDIA to become a recipient of this award. He is a chemical engineer, atmospheric scientist, TED fellow, and founder of Urban Emissions (India). His main research interest is air quality analysis and finding ways to bridge the gap between science and policy. He was a member of India's AQI formulation committee (2014) and WHO's air quality guidelines development group (2016-2020). He has a PhD in Chemical Engineering and Environmental Policy from the University of Iowa (2002) and a B.Tech in Chemical Engineering from IIT Kharagpur (1997).

EDITORIAL

1.3 billion of our fellow Country population breathe air with particulate pollution levels well above the WHO guidelines, more than 63% are forced to breathe air worse than the national air quality standard. The statistics and data are frightening and alarming. Global Warming and Carbon Neutrality are not the matter of academics only, these are reality and a cause of concern for all. Climate change is well there and the time to act is now or never. Sustainable development Goals are already charted and defined. We need to understand and act accordingly for SDG 13.

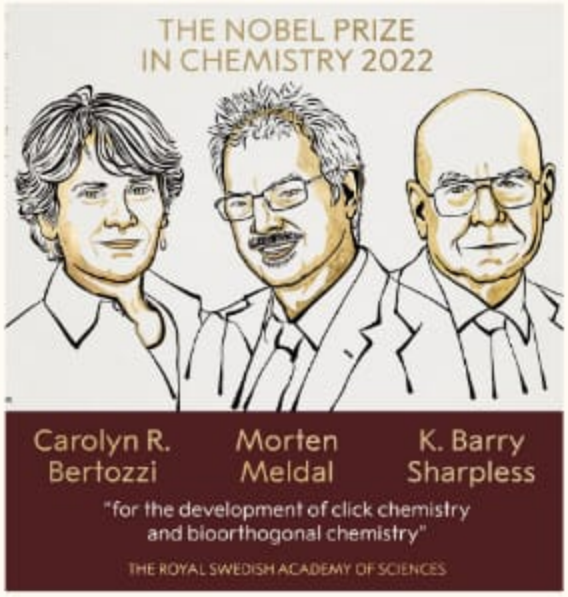
It gives us immense pride and privilege to hand over this edition of Chemistry Triumphs in your hands. We as an editorial team has compiled the information related to air quality and are bringing it for you.

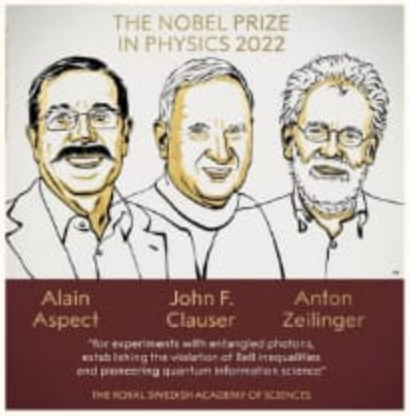
We acknowledge the support of Academic Excellence component of MPHEQIP department of higher education Bhopal for bringing in this issue, we also acknowledge the support of Principal Govt. Madhav Science College Ujjain and Head of the Department of Chemistry without whose support this endeavour might not have been possible. We are also thankful to the Faculty Department of Chemistry and PG Chemistry Class of 2021 & 2022 for their moral support.

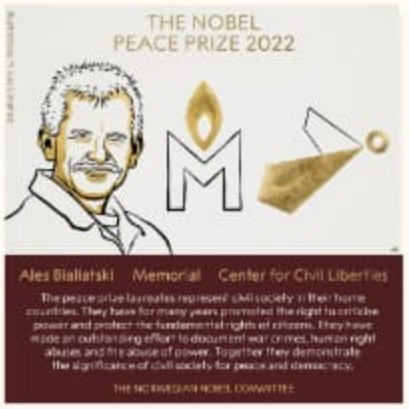
Editorial Team

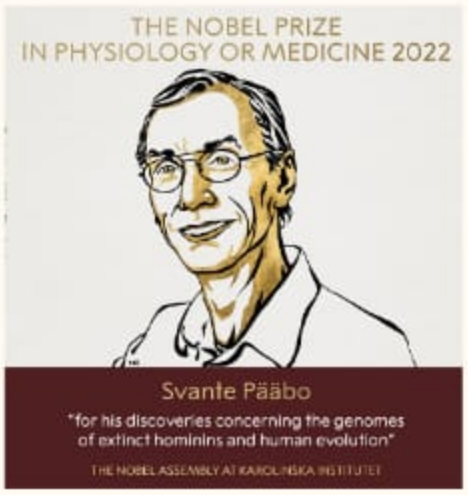
October 8th 2022

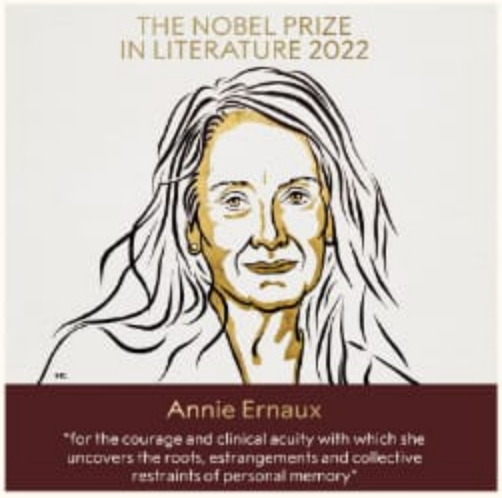
Congratulations











THIS YEAR'S NOBEL PEACE PRIZE WINNERS REMIND US THAT, EVEN IN DARK DAYS OF WAR, IN THE FACE OF INTIMIDATION AND OPPRESSION, THE COMMON HUMAN DESIRE FOR RIGHTS AND DIGNITY CANNOT BE EXTINGUISHED. WE CONGRATULATE THEM AS THEY INSPIRE US FOR A BETTER FUTURE THROUGH THEIR UNWAVERING DEDICATION.

AIR POLLUTION

Introduction

Air pollution is contamination of the indoor or outdoor environment by any chemical, physical or biological agent that modifies the natural characteristics of the atmosphere.

The following are primary pollutants, which mean they are emitted directly into the atmosphere by a particular source.

- Volatile organic compounds (VOCs) such as gases from evaporating gasoline.
- Carbon monoxide (CO), which is an odorless gas that is produced by combustion.
- NO_x, which includes nitric oxide (NO) and nitrogen dioxide (NO_2).
- Sulfur dioxide (SO_2), which is produced through the combustion of coal.
- Particulate matter (PM), which are small suspended particles.

Primary pollutants can combine with other chemicals in the atmosphere and produce secondary pollutants

- NO_x can produce nitric acid (HNO_3).
- Sulfur dioxide (SO_2) can produce sulfuric acid (H_2SO_2).
- Ozone (O_3), which is produced through chemical reactions between nitrogen dioxide, VOCs, and sunlight.

Air pollution can cause diseases, allergies and even death to humans; it can also cause harm to other living organisms such as animals and food crops, and may damage the natural environment. Growing evidences suggests that Air pollution is exposure may be associated with reduced IQ scores, impaired cognition increased risk of psychiatric disorders such as depression.

Do you know?

If the vehicles registered in Delhi are lined up one after the other, the total length would be nearly equal to the combined lengths of the two longest rivers in the world, Nile and Amazon!

How does Air Get Polluted?

The substances which contaminate the air are called air pollutants. Sometimes, such substances may come from natural sources like smoke and dust arising from forest fires or volcanic eruptions. Pollutants are also added to the atmosphere by certain human activities. The sources of air pollutants are factories, power plants, automobile exhausts and burning of firewood and dung cakes.

Source - *https://www.researchgate.net/publication/333461980_Air_Pollution*

MAIN CAUSES OF ANTHROPOGENIC AIR POLLUTION

AGRICULTURE

There are two major sources of air pollution from agriculture: livestock, which produces methane and ammonia, and the burning of agricultural waste. Methane emissions contribute to ground-level ozone, which causes asthma and other respiratory illnesses. Around 24 percent of all greenhouse gases emitted worldwide come agriculture, forestry and other land-use.

INDUSTRY

In many countries, energy production is a leading source of air pollution. Coal-burning power plants are a major contributor, while diesel generators are a growing concern in off-grid areas. Industrial processes and solvent use, in the chemical and mining industries, also pollute the air.

WASTE

Open waste burning and organic waste in landfills release harmful dioxins, furans, methane, and black carbon into the atmosphere. Globally, an estimated 40 percent of waste is openly burned. The problem is most severe in urbanizing regions and developing countries. Open burning of agricultural and municipal waste is practiced in 166 out of 193 countries.

HOUSEHOLD

The main source of household air pollution is the indoor burning of fossil fuels, wood and other biomass-based fuels to cook, heat and light homes. Around 3.8 million premature deaths are caused by indoor air pollution each year, the vast majority of them in the developing world.

TRANSPORT

The global transport sector accounts for almost one-quarter of energy-related carbon dioxide emissions and this proportion is rising. Transport emissions have been linked to nearly 400,000 premature deaths. Almost half of all deaths by air pollution from transport are caused by diesel emissions, while those living closest to major traffic arteries are up to 12 percent more likely to be diagnosed with dementia.

OTHER SOURCES

Not all air pollution comes from human activity. Volcanic eruptions, dust storms and other natural processes also cause problems. Sand and dust storms are particularly concerning. Fine particles of dust can travel thousands of miles on the back of these storms, which may also carry pathogens and harmful substances, causing acute and chronic respiratory problems.

Source - *https://www.researchgate.net/publication/333461980_Air_Pollution*

MAJOR AIR POLLUTANTS THEIR SOURCES AND EFFECTS

Pollutant	Common Sources	Effects
1. Carbon monoxide (CO)	Automobile emissions, fires, industrial processes	Contributes to smog formation
2. Nitrogen oxides (NO and NO2)	Automobile emissions, electricity generation, industrial processes	Damage to foliage; contributes to smog formation
3. Sulfur dioxide (SO2)	Electricity generation, fossil-fuel combustion, industrial processes, automobile emissions	Major cause of haze; contributes to acid rain formation, which subsequently damages foliage, buildings, and monuments; reacts to form particulate matter
4. Ozone (O3)	Nitrogen oxides (NOx) and volatile organic compounds (VOCs) from industrial and automobile emissions, gasoline vapours, chemical solvents, and electrical utilities	Interferes with the ability of certain plants to respire, leading to increased susceptibility to other environmental stressors (e.g., disease, harsh weather)
5. Lead (Pb)	Metal processing, waste incineration, fossil-fuel combustion	Loss of biodiversity, decreased reproduction, neurological problems in vertebrates

Source- *https://www.epa.gov/criteria-air-pollutants*

ATMOSPHERIC AEROSOLS: WHAT ARE THEY, AND WHY ARE THEY SO IMPORTANT?

Aerosols are minute particles suspended in the atmosphere. When these particles are sufficiently large, we notice their presence as they scatter and absorb sunlight. Their scattering of sunlight can reduce visibility (haze) and redden sunrises and sunsets.

Aerosols interact both directly and indirectly with the Earth's radiation budget and climate. As a direct effect, the aerosols scatter sunlight directly back into space. As an indirect effect, aerosols in the lower atmosphere can modify the size of cloud particles, changing how the clouds reflect and absorb sunlight, thereby affecting the Earth's energy budget.

1. Volcanic Aerosol

Three types of aerosols significantly affect the Earth's climate. The first is the volcanic aerosol layer which forms in the stratosphere after major volcanic eruptions like Mt. Pinatubo. The dominant aerosol layer is actually formed by sulfur dioxide gas which is converted to droplets of sulfuric acid in the stratosphere over the course of a week to several months after the eruption. Winds in the stratosphere spread the aerosols until they practically cover the globe. Once formed, these aerosols stay in the stratosphere for about two years. They reflect sunlight, reducing the amount of energy reaching the lower atmosphere and the Earth's surface, cooling them.

3. Human-Made Aerosol

The third type of aerosol comes from human activities. While a large fraction of human-made aerosols come in the form of smoke from burning tropical forests, the major component comes in the form of sulfate aerosols created by the burning of coal and oil. The concentration of human-made sulfate aerosols in the atmosphere has grown rapidly since the start of the industrial revolution. At current production levels, human-made sulfate aerosols are thought to outweigh the naturally produced sulfate aerosols.

2. Desert Dust

The second type of aerosol that may have a significant effect on climate is desert dust. Pictures from weather satellites often reveal dust veils streaming out over the Atlantic Ocean from the deserts of North Africa. Fallout from these layers has been observed at various locations on the American continent. Similar veils of dust stream off deserts on the Asian continent. The particles in these dust plumes are minute grains of dirt blown from the desert surface. They are relatively large for atmospheric aerosols and would normally fall out of the atmosphere after a short flight if they were not blown to relatively high altitudes (15,000 ft. and higher) by intense dust storms. Because the dust is composed of minerals, the particles absorb sunlight as well as scatter it. Through absorption of sunlight, the dust particles warm the layer of the atmosphere where they reside. This warmer air is believed to inhibit the formation of storm clouds. Through the suppression of storm clouds and their consequent rain, the dust veil is believed to further desert expansion.

Source:https://www.nasa.gov/centers/langley/news/factsheets/Aerosols.html#:~:text=Aerosols%20are%20minute%20particles%20suspended,and%20redden%20sunrises%20and%20sunsets

TERMS OFTEN ASSOCIATED WITH AIR POLLUTION

1. SMOG

- Smog (a combination of the words "smoke" and "fog") forms when sunlight acts on a cocktail of pollutant gases such as nitrogen and sulfur oxides, unburned hydrocarbons, and carbon monoxide; that's why it's sometimes called photochemical smog (the energy in light causes the chemical reaction that makes smog).
- One of the most harmful constituents of smog is a toxic form of oxygen called ozone, which can cause serious breathing difficulties and even, sometimes, death. When smog is rich in ozone, it tends to be a blueish color; otherwise it's more likely to be brown.
- Although smog can happen in any busy city, it's a particular problem in places such as Los Angeles where the local climate (influenced by the ocean and neighbouring mountains) regularly causes what's known as a temperature inversion.
- Largely because of their traffic levels, smog afflicts many of the world's busiest cities, including Athens, Beijing, Delhi, Madrid, Mexico City, Milan, Paris, and Tokyo.

2. ACID RAIN

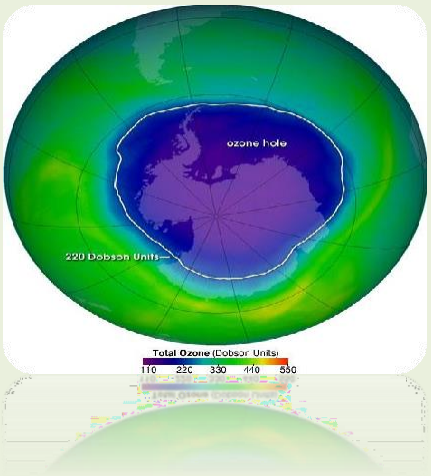
- When rain falls through polluted air, it can pick up some of the pollution and turn more acidic—producing what's known as acid rain.
- Pure water is neither acidic nor alkaline but completely neutral (we say it has an acidity level or pH of 7.0). Ordinary rainwater is a little bit more acidic than this with about the same acidity as bananas (roughly pH 5.5), but if rain falls through sulfur dioxide pollution it can turn much more acidic (with a pH of 4.5 or lower, which is the same acidity as orange or lemon juice).
- Acid rain has caused major problems in lakes throughout North America and Europe. It also causes the death of forests, reduces the fertility of soil, and damages buildings by eating away stonework (the marble on the US Capitol in Washington, DC has been eroded by acid-rain, for example). One of the biggest difficulties in tackling acid rain is that it can happen over very long distances.

Source- *https://www.researchgate.net/publication/333461980_Air_Pollution*

3. GLOBAL WARMING

Every time you ride in a car, turn on the lights, switch on your TV, take a shower, microwave a meal, or use energy that's come from burning a fossil fuel such as oil, coal, or natural gas, you're almost certainly adding to the problem of global warming and climate change: unless it's been produced in some environmentally friendly way, the energy you're using has most likely released carbon dioxide gas into the air. While it's not an obvious pollutant, carbon dioxide has gradually built up in the atmosphere, along with other chemicals known as greenhouse gases. Together, these gases act a bit like a blanket surrounding our planet that is slowly making the mean global temperature rise, causing the climate (the long-term pattern of our weather) to change, and producing a variety of different effects on the natural world, including rising sea levels.

4. OZONE HOLE



Global warming is a really dramatic effect of air pollution produced by humans, but that doesn't mean it's an insoluble problem. People have already managed to solve another huge air pollution problem that affected the whole world: the damage to a part of the atmosphere called the ozone layer. At ground level, ozone is an air pollutant—but the ozone that exists in the stratosphere (high up in the atmosphere), is exactly the opposite: it's a perfectly natural chemical that protects us like sunscreen, blocking out some of the Sun's harmful ultraviolet radiation. During the 20th century, people started using large quantities of chemicals called chlorofluorocarbons (CFCs), because they worked very well as cooling chemicals in refrigerators and propellant gases in aerosol cans. In 1974, scientists Mario Molina and Sherwood Rowland suggested that chlorofluorocarbons attacked and destroyed the ozone layer, producing holes that would allow dangerous ultraviolet light to stream through. In the 1980s, huge "ozone holes" started to appear over Antarctica, prompting many countries to unite and sign an international agreement called the Montreal Protocol, which rapidly phased out the use of CFCs. As a result, the ozone layer—though still damaged— is expected to recover by the end of the 21st century.

Source- *https://www.researchgate.net/publication/333461980_Air_Pollution*

Current Issue

- **‘Air pollution cuts India’s average life expectancy by 5 years’**

Worsening air pollution is robbing a decade of the life expectancy of those living in Delhi, the world’s most polluted city and India’s capital, according to a new analysis by the University of Chicago. Indians, on average, are losing about five years**.**

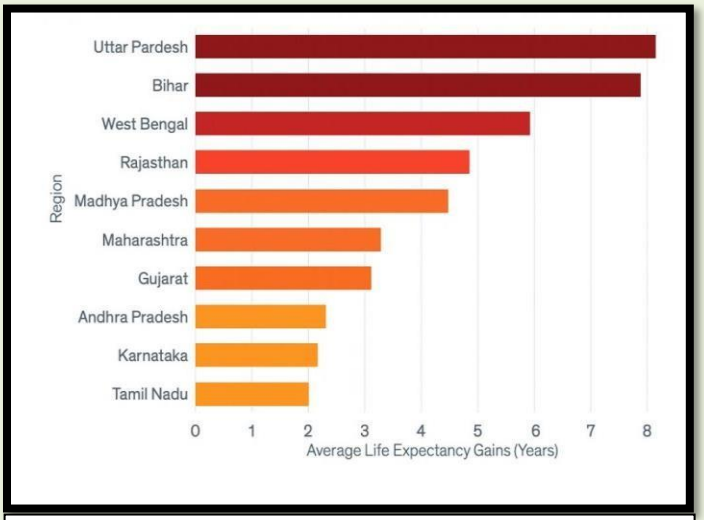
In comparison, 1.8 years of life are lost due to child and maternal malnutrition, while smoking robs nearly two years of life expectancy in India.

The report noted that the country’s entire population — all 1.3 billion — breathe air with particulate pollution level well above the WHO guideline. Also, more than 63 per cent breathe air worse than the national air quality standard of 40 µg/m^3.

If the WHO guidelines are met in the 10 most populous states of the country, life expectancy can improve significantly, the report noted:

- Uttar Pradesh will gain more than eight years on its life expectancy
- Bihar will gain more than seven years
- West Bengal will gain nearly six years
- Rajasthan, Maharashtra and Madhya Pradesh will gain around five years
- Gujarat will gain a little over three years
- Andhra Pradesh, Karnataka and Tamil Nadu will gain some two years

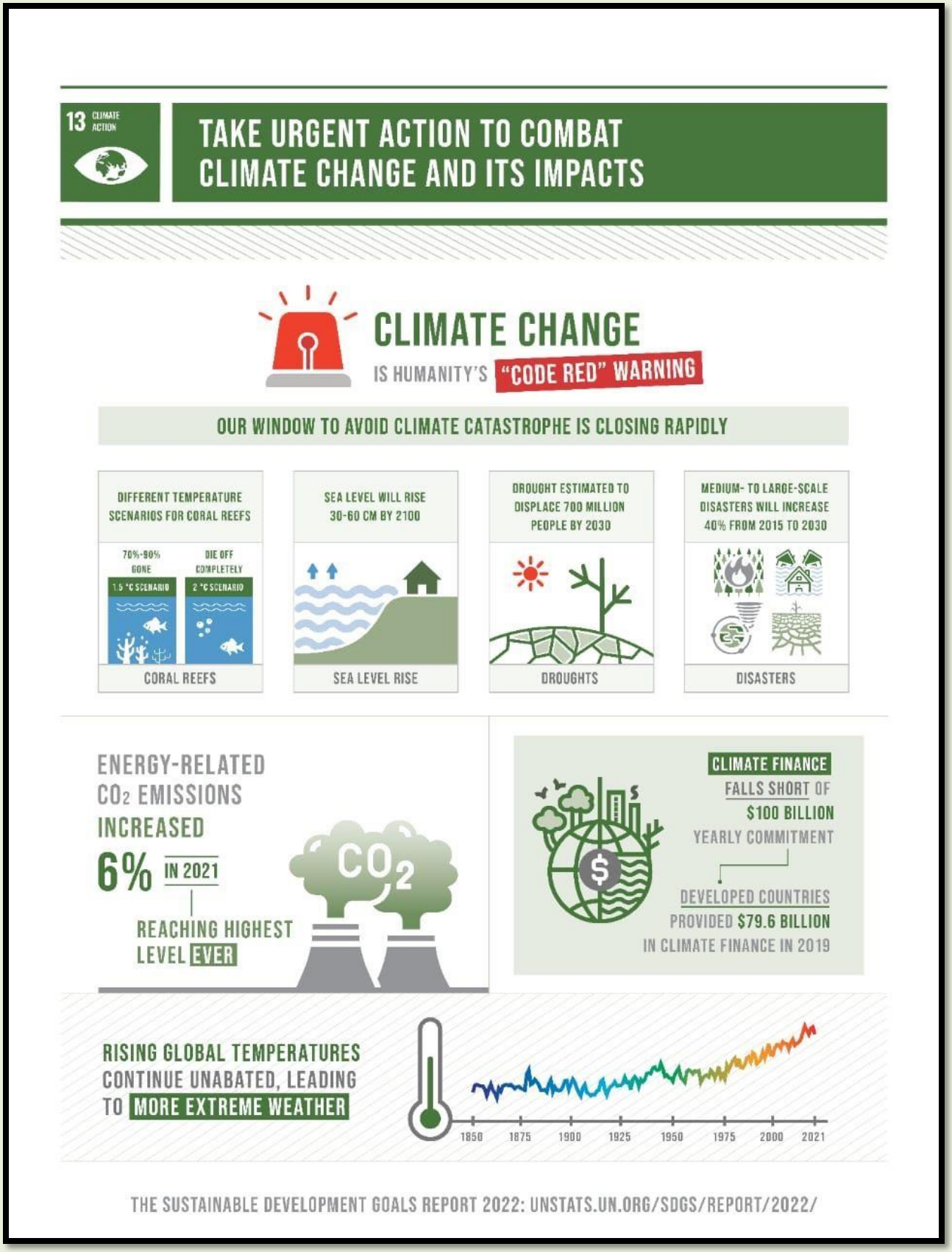
In 2019 the government launched the National Clean Air Programme (NCAP) which set a non-binding goal to reduce particulate pollution by 20 to 30 per cent as compared to the 2017 levels, by 2024. If these targets are met, health can improve remarkably.



Potential Gain in Life Expectancy from Reducing PM2.5 to the WHO Guideline in the 10 Most Populous States of India.

Source- *https://www.downtoearth.org.in/news/air/-air-pollution-cuts-india-s-average-life-expectancy-by-5-years--83290*

Infographic: Climate Action

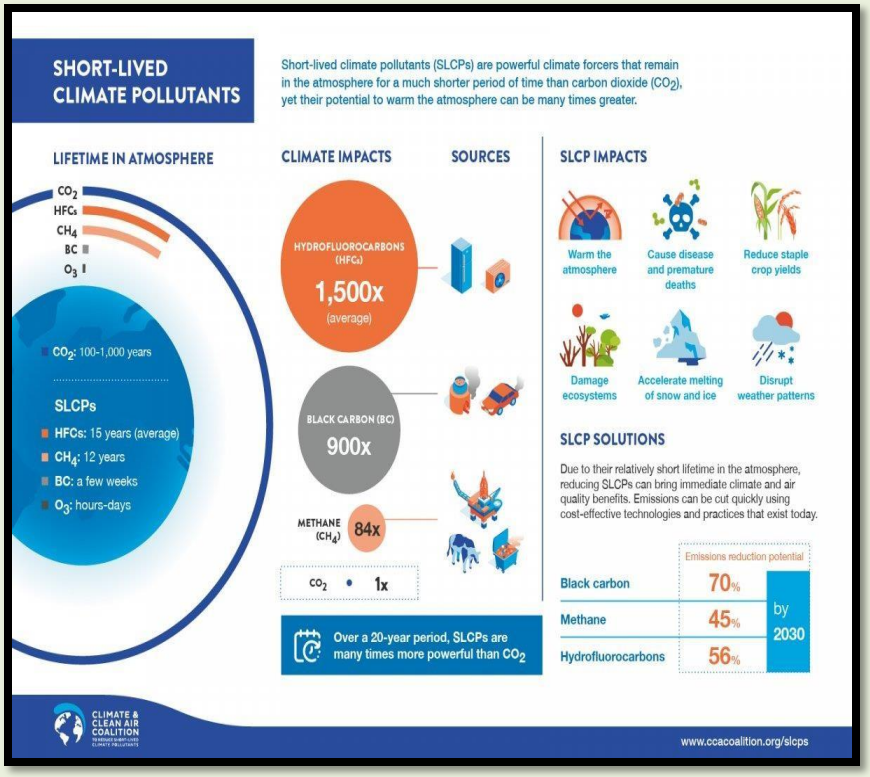


Source- *https://www.un.org/sustainabledevelopment/climate-change/*

Short-Lived Climate Pollutants (SLCPs)

Short-lived climate pollutants are powerful climate forcers that remain in the atmosphere for a much shorter period of time than carbon dioxide (CO2), yet their potential to warm the atmosphere can be many times greater. Certain short-lived climate pollutants are also dangerous air pollutants that have harmful effects for people, ecosystems and agricultural productivity.

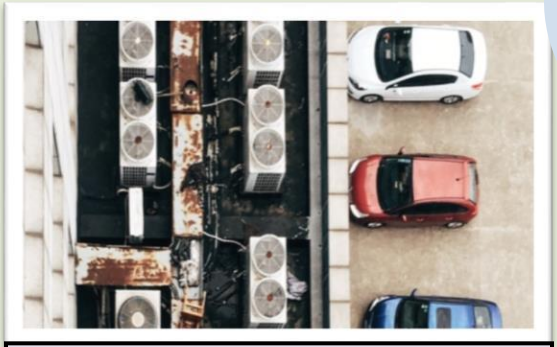
The short-lived climate pollutants **black carbon, methane, tropospheric ozone,** and **hydrofluorocarbons** are the most important contributors to the man-made global greenhouse effect after carbon dioxide, responsible for up to 45% of current global warming.



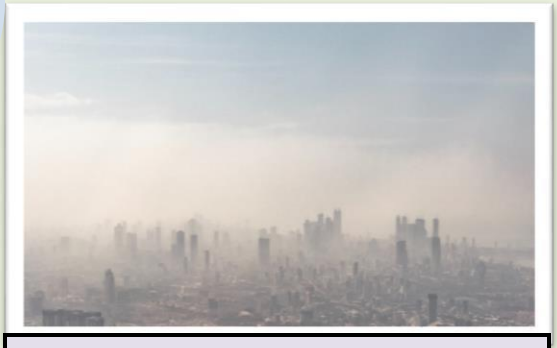
BLACK CARBON

METHANE

Major Contributors of man-made global greenhouse effect



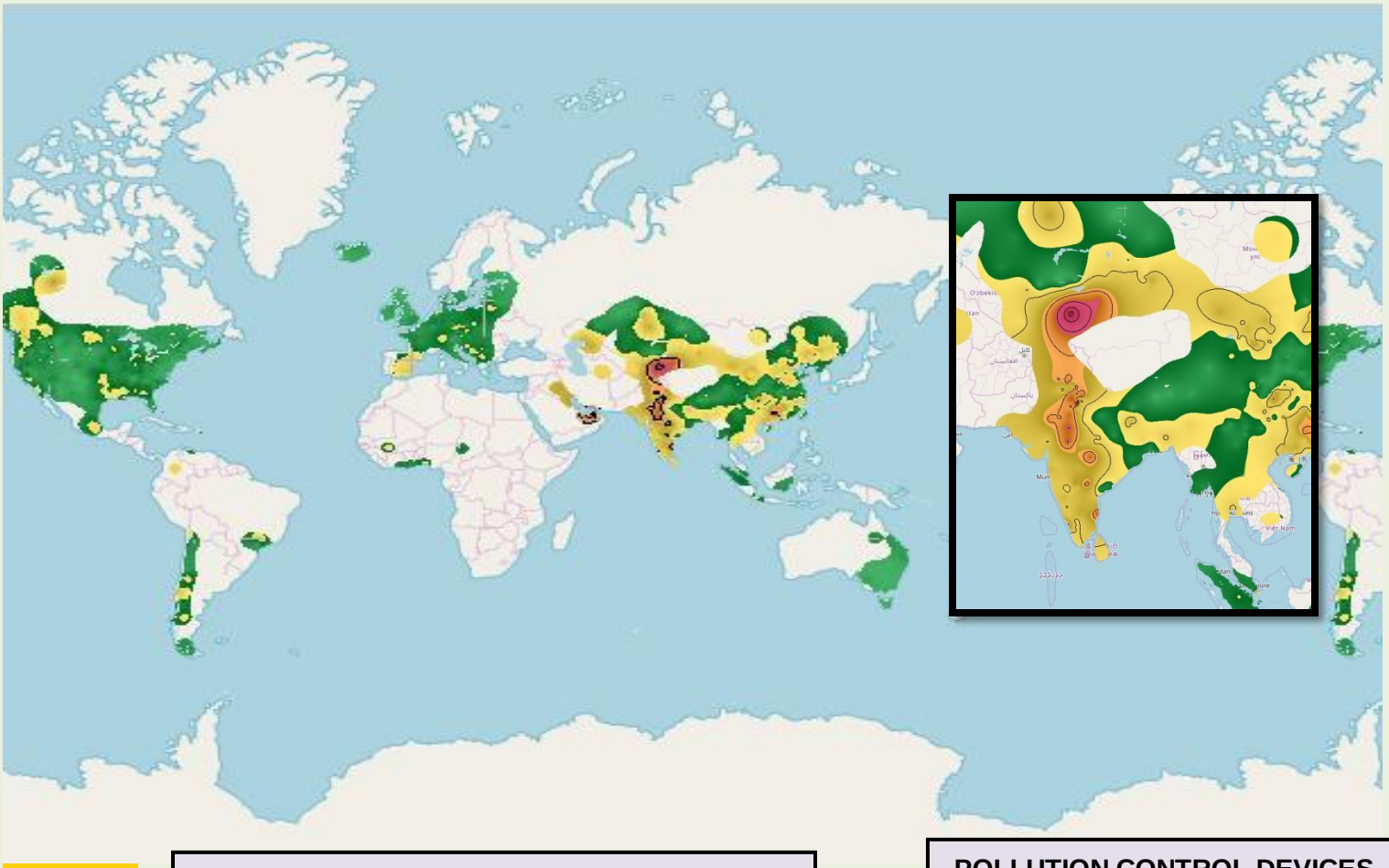
HYDROFLUOROCARBONS (HFCS)



TROPOSPHERIC OZONE

Source - *https://www.ccacoalition.org/en/content/short-lived-climate-pollutants-slcps*

GET YOUR REAL-TIME AIR QUALITY MAPS NOW: http://berkeleyearth.org/air-quality-real-time-map/



DO YOU KNOW

AIR POLLUTION MEASURING INSTRUMENTS

RESPIRABLE DUST SAMPLER

MULTI-PARAMETER ANALYZER

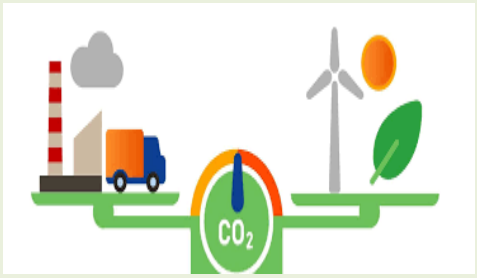
POLLUTION CONTROL DEVICES

JUST Google IT

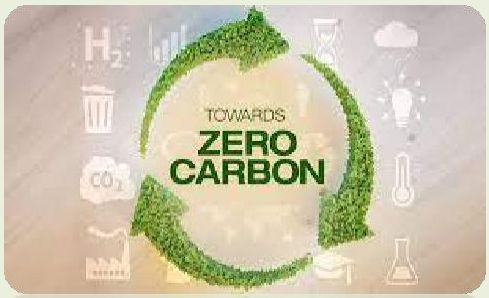
- Gravity Settling Chambers
- Mechanical Collectors
- Cyclones
- Wet Scrubbers
- Venturi Scrubbers
- Impingement Plate Scrubbers
- Spray Tower Scrubbers
- Electrostatic Precipitators
- Fabric Filters
- Carbon Sequestration

Source- https://www.researchgate.net/publication/333461980_Air_Pollution

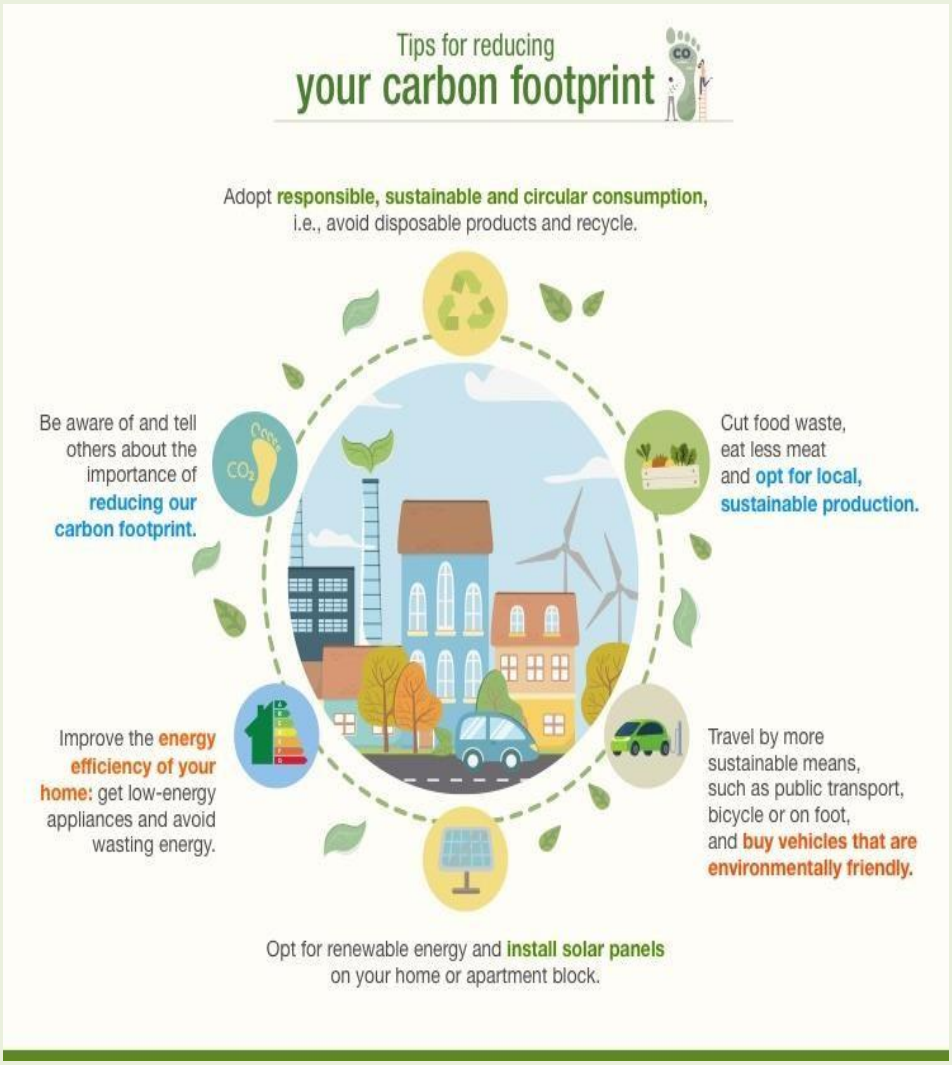
Carbon Neutrality



Carbon neutrality means having a balance between emitting carbon and absorbing carbon from the atmosphere in carbon sinks. Removing carbon oxide from the atmosphere and then storing it is known as carbon sequestration. In order to achieve net zero emissions, all worldwide greenhouse gas (GHG) emissions will have to be counterbalanced by carbon sequestration.



The carbon stored in natural sinks such as forests is released into the atmosphere through forest fires, changes in land use or logging. This is why it is essential to reduce carbon emissions in order to reach climate neutrality.



CARBON OFFSETTING

One way to reduce emissions and to pursue carbon neutrality is to offset emissions made in one sector by reducing them somewhere else. This can be done through investment in **renewable energy, energy efficiency** or other clean, low-carbon technologies. The EU's **emissions trading system (ETS)** is an example of a carbon offsetting system.

Another example of an initiative to reduce emissions is the **carbon border adjustment mechanism**, which would apply carbon prices on imported goods from less climate ambitious countries.

Source- *https://www.europarl.europa.eu/news/en/headlines/society/*

https://www.iberdrola.com/sustainability/what-is-carbon-neutrality

LINKAGES WITH SUSTAINABLE DEVELOPMENT GOALS

THE AIR (PREVENTION AND CONTROL OF POLLUTION) ACT, 1981

Salient Features

- The Act makes provisions for the establishing of Central Pollution Control Board (CPCB) at the apex level and State Pollution Control Boards at the state level.
- The CPCB advises the Central Government on any matter concerning the improvement of the quality of the air and prevention, control and abatement of air pollution. It also helps to plan and cause to be executed a nation-wide programme for the prevention, control and abatement of air pollution. It provides technical assistance to and guidance to the State Pollution Control Board. It also lays down the down standards for the quality of air.
- The SPCBs plan a comprehensive programme for prevention, control and abatement of air pollution and to secure the execution thereof.
- They also advise the State Government on any matter concerning prevention, control and abatement of air pollution.
- Kindly note that according to this act, the “air pollutant” means any solid, liquid or gaseous substance (including noise) present in the atmosphere in such concentration as may be or tend to be injurious to human beings or other living creatures or plants or property or environment.
- This act provides that the State Government may, after consultation with the State Board, by notification declare any area or areas within the State a as air pollution control areas. The state government is also powered to make any alternations in the area pollution control areas such as merging the areas. If the state government, after consultation with the State Board, is of opinion that the use of any fuel or burning of any non-fuel material other than an approved fuel, in any air pollution control area or part thereof, may cause or is likely to cause air pollution, it may, by notification, prohibit the use of such fuel in such area.

World Health Organization

Our Planet Our Health

Clean our air, water & food

#HealthierTomorrow

WHAT ARE THE SOURCES OF AIR POLLUTION?

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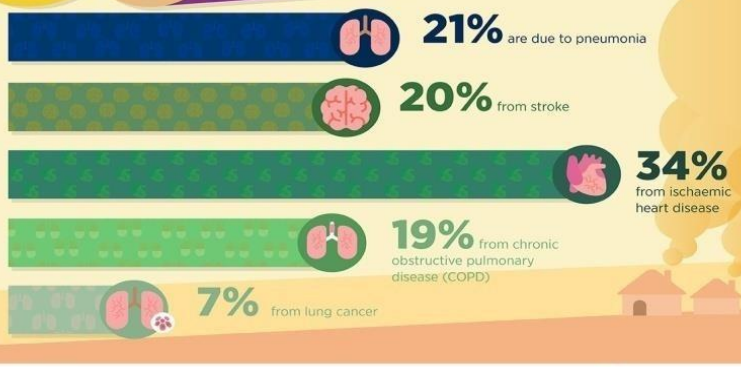
DEATHS LINKED TO OUTDOOR AND HOUSEHOLD AIR POLLUTION

7 million people die prematurely every year from air pollution – both household and outdoor.
Among these deaths:



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SOLUTIONS

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Declaration:

The literature, data and photographs presented in this newsletter is from various secondary sources. The sole purpose of this newsletter is the dissemination of the information related to Chemistry and more importantly to spread awareness about the recent issues related to Chemistry.

Feedback for the newsletter would be appreciated

https://docs.google.com/forms/d/e/1FAIpQLSdx1x1w5ZYzpevuI4DPk3w_7TJCVkmIRSiyqZ3ZRt_HgopAJg/viewform