

POLITICAL SOLUTIONS FOR ENERGY AND INDUSTRY POLLUTION HARMING THE STARLIGHT

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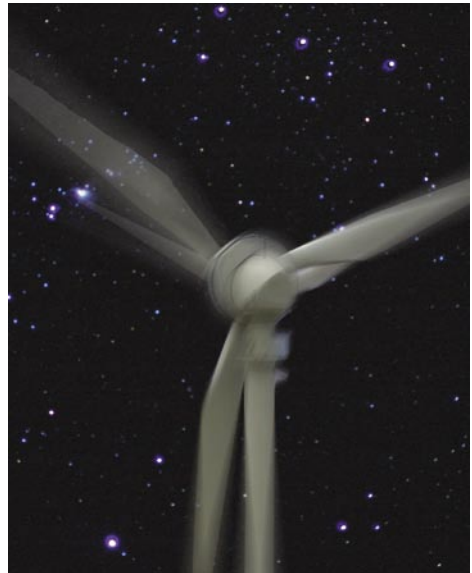
Mankind has made remarkable advances in technology since the advent of the Industrial Revolution. These developments have allowed us to achieve, at least for some segments of the world population, reduced levels of effort in our work and a greater comfort level in our common lifestyle. Many activities carried out nowadays require significantly less use of our own energy and effort compared to what was needed not even two centuries ago. Nevertheless the global price that mankind has paid is very high if we take into account the full impact of energy on ecology.

These decisions have led to the environment as one of main areas that is affected. In practically every place on Earth, diverse human activities (industry, transport, electric power generation, agriculture, leisure, wars, finances; etc.) are launching enormous quantities of dangerous contaminating gases that are distributed on the entire surface of the planet, unfailingly affecting all layers of the earth's atmosphere. The gases that contaminate the atmosphere among other effects, interrupt night and day vision of the sky.

This effect is due to the interference in the natural transmission of light, since light is an energy form and allows objects, including their details and colors, to be seen. Light takes place in natural and artificial sources. Sources of light are all objects that emit a visible light. Natural sources of light are the sun, stars, and polar auroras. Lightning flashes are also the product of electric atmospheric discharges. We can not forget that also some insects, known as fireflies, exist that emit light or shine in darkness. There are five properties which are more characteristic of light:

1. Light Propagation
2. Light Reflection
3. Light Refraction
4. Light Absorption
5. Light Diffraction

From the point of view of atmospheric contamination due to the emission of gases from industry, electricity, transport, and light pollution, directly linked with



the production of electricity, the most important properties of light to consider are:

- *Refraction of light:* It consists on deviation that luminous rays experience when crossing media of different densities. A typical well-known case is due to light rays crossing from air to water. We observe that they modify their angle of incidence as they cross the water's surface. In this occasion light is said to be refracted.
- *Absorption of light:* All bodies reflect light, for that reason they can be seen. Then, when bodies do not receive light, they can not be seen. Likewise, the color of objects depends on the type of light that they reflects. This means that if an object is red, it is because it reflects the light of that color, and the other colors are absorbed by the object. This phenomenon is known as light absorption.
- *Diffraction of light:* Another luminous phenomenon is the diffraction of light, which can also be considered as a light property. This phenomenon occurs whenever an opaque body is placed in the path of light emitted by a luminous source, separating a fraction. In 1665 the Italian scientist F. M. Grimaldi observed a ray of light coming out from a very small perforation in the window blind on which the sun was shining. In the path of this light ray, he placed a small object and observed the shade that was projected on a screen. He found that the edge of the shade was not clear but diffuse and that color bands were also formed where illuminated and dark regions were found to be alternated. Additional observations by Grimaldi led him to come to the conclusion that light “undulates” around borders of opaque obstacles illuminated by a very small source of light.



Beneficial properties of the atmosphere.

The terrestrial atmosphere has indispensable properties for the development of life. It protects us from the ultraviolet light of the sun, from X-rays and gamma rays, as well as from the lethal flow of very high energy particles that come from outer space. Vapor and the carbon dioxide from the atmosphere absorb the infrared radiation emitted by the surface of our planet, creating the

greenhouse effect, which maintains the temperature of the Earth in an appropriate range for the survival of all the biological different species that inhabit the planet. This way atmosphere absorbs almost all types of radiation that our eyes cannot perceive and it allows visible light to pass through, allowing us to contemplate twinkling stars at night. For more than three hundred years, all telescopes observed starlight through the transparent window of the atmosphere. However, in spite of its transparency, there are several effects that the atmosphere provokes in starlight.

Aberant effects of atmosphere on visible light coming from outer space.

Visible light is partially and unequally absorbed by the atmosphere. This effect even occurs in an astronomical observatory, usually located at altitudes over two thousand meters. We fail to receive 40% of the blue light from a star; it is either absorbed or dispersed by air molecules. Since blue is absorbed more than red, a reddening of stars occurs if compared with their colors seen from outer space. The same effect can be noticed in the evening, that is, the redness of the sun at sunset, when the light has to cross a larger layer of air. This phenomenon is known as *atmospheric extinction*.

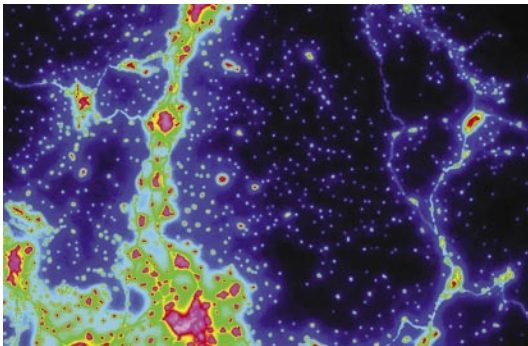


There is another effect caused by the atmosphere: *the twinkling of stars*. Frequently we notice that the stars do not seem to stay fixed, but instead lightly oscillate around their position. This effect is due to the dispersion of starlight caused by air molecules, and it happens when its light passes through the atmosphere that creates an effect of an enormous lens in movement due to atmospheric turbulences. This phenomenon occurs more frequently in stars that are near the horizon since their light has to cross over longer longitude of atmospheric layers than those that we see in the zenith.

Harmful effects on starlight, originally anthropogenic, are provoked by the emission of gases in the combustion of fossil fuels for the generation of electric power, in transport, and in some types of industrial processes.

Pollutants emitted by gases of escape of automobiles, airplanes and ships.

The automobile has made unstoppable advances in its presence in everyday life throughout the world during the last several decades, and the same happened in other means of transport (aeroplanes, ships, trains). These increases have contributed to an increase in atmospheric contamination. The main pollutants released are: carbon monoxide (CO), nitrogen oxides (NO_x), un-burnt hydrocarbons (HC), and lead composites.



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The environmental impact in the transport sector depends, in great measure, on the consumption of non-renewable fossil fuels. Emissions not only deteriorate air quality in the cities, they also contribute, in great measure, to creating global environmental problems,



such as, the global warming from the emission of GEI (CO_2 , N_2O and CH_4), acidification of medium (by emission of NO_x , SO_x and NH_3) and the formation of ozone in the troposphere from the emission of precursory ozone gases (NO_x , CH_4 and, CO).

Motors that use gasoline as fuel mainly emit carbon monoxide, nitrogen oxides, hydrocarbons and lead composites. Main diesel motors (i.e. trucks and ships) emit polluting solid particles in form of soot that results in black fumes, unburnt hydrocarbons, nitrogen oxides and sulfur dioxide coming from the sulfur contained in the fuel.

Pollutants emitted by gases of industrial boilers of electric power generation.

Energy generation, production, and energy consumption coming from fossil fuels are the main reasons for climate change, and they contribute to other problems of atmospheric contamination (acidification and contamination for ozone troposphere, air quality, etc.) They are also responsible for the consumption of a great quantity of resources.

Facilities in this sector use fuels such as coal, fuel-oil and natural gas. Production of pollutants depends in great measure on the quality of fuel and, especially on the copper sulfate combinations contained in it and of the type used in the combustion process.

During the combustion process the sulfur contained in the fuel in form of sulfur dioxide, together with other pollutants, such as nitrogen oxides, carbon dioxide, heavy metals and a wide variety of substances is freed into the atmosphere. When it is used as fuel coal, fine abundant particles are emitted that can be transferred at long distances through upper layers of the atmosphere.

Pollutants emitted by industry.

Industrial pollution is characterized by the large quantity and diversity of pollutants produced in different stages of industrial processes. On the other hand, industrial emissions usually combine specific, easily controllable emissions, with diffuse emissions that are hard to control.

Types of pollutants produced by industrial centers basically depend on the type of production process, which technology is used and raw materials. Industrial activities that produce atmospheric pollutants are quite varied, but the main centers are in production processes used in basic or leading industries, which follow:

- Iron and steel industry. This sector produces all type of pollutants and in important quantities, the main ones being: particles, SO_x , CO , NO_x , fluorides and red fumes (iron oxides).
- Petroleum Refineries. Here SO_x , HC , CO , NO_x , ammonia, fumes and particles are most common.
- Chemical industry. The effects that take place depend on the type of process. These include: SO_2 , sulfuric, nitric and phosphoric acid clouds. Unpleasant scents are frequently generated.
- Basic aluminum industries and fluorine derivatives. They produce emissions of derived pollutants of fluorine.

Light pollution is another man-produced aspect harming starlight. It has an energy origin and accompanies the contamination produced by the electricity generation process.

Light pollution is a shining or brilliant glow in the night sky, and is produced by the diffusion of artificial light. As a result, the darkness of the night diminishes and light from stars and other emitting bodies progressively disappears. Fog and atmospheric pollution end up forming a layer of gray color that adopts the form of a luminous cloud on cities. Abundance of suspended particles (CO_2 , NO_x , SO_x , etc.) increases light dispersion, so this effect increases in areas with greater air pollution. If dispersed light comes from luminaries with a wide emission spectrum, the effect is considerable, because luminous radiations of stars with similar wavelength are no longer visible and can not be captured by observation equipments.

The main causes of light pollution are:

- a) The use of correctly designed shieldings in outdoor lighting and luminaires with the purpose of sending light where needed, avoiding its dispersion toward the sky above the horizon level.
- b) The indiscriminate use of luminaires without any shielding, a standard practice in new urban developments.
- c) The absence of control on the use of laser projectors with leisure/publicity purposes.
- d) The absence of regulation for the scheduling of the illumination of buildings of monumental interest.
- e) The preference for Mercury Vapor Lamps (MVL) in wide urban sectors, since the emission bands of this type of light is very wide. They produce strong emissions outside of the visible spectrum, especially in ultraviolet wavelengths, which are those that spread and diffuse most in the atmosphere. In addition, some of their emission lines almost coincide with those of nebulae, an effect that makes them almost invisible in urban areas.

Other harmful effects that this type of pollution produces are:

- a) Accompanying effect on electric power consumption and, therefore, fossil fuels.

Light pollution directly repercutes on electric power consumption, which in turn repercutes on the emission of gases that contaminate the atmosphere. It is important to recall that in an urban luminaire, if one draws a vertical line from the bulb to the floor, the light that is inside the cone is determined by an angle of 70° , and only this light is completely taken advantage of. The range between 70° up to 90° is a light that rather dazzles and, between 90° and 180° , it gets completely lost. Since most of these luminaires do not have shieldings that totally cover the lamp, or use refractors that disperse the light instead of concentrating it, and being their inclination not parallel to the horizon level, only 22% of the produced light,



in the best cases, is effectively useful. When shieldings are not used, the quantity of wasted energy exceeds 50% of the total light produced. If, in addition, the closing of the luminaire is made of opal methacrylate, 50% of the light produced can not reach the exterior, and the energy waste is high, approaching 80% of the total. The use of MVL's also presents negative effects with regard to energy consumption, since they need 70% more energy than High Pressure Sodium Vapor lamps and 140% more than Low Pressure Sodium Vapor lamps.

b) Ecological Effects

The emission of gases to the atmosphere (CO_2 , NO_x , SO_x , vapor, etc.) due to the combustion of fossil fuels was initially responsible for the distortion of starlight properties because of the increase of the density of air layers, of certain effects of ionization of these particles, of the modification of the ozone layer (provoked by some CFC's), and the random variations of thermodynamic variables of the atmosphere, etc. Acid rain (SO_x) helped lead to the destruction of rainforests, and of the increase of carbon dioxide (CO_2) that affects the global warming of the planet (greenhouse effect).

Data from Greenpeace estimate that, if we continue the growing rate of global energy consumption to 2020, only considering emissions of SO_2 and CO_2 in coal thermal plants and, obtaining a savings between 30% to 50% of its estimated consumption, emissions of between 2.3 and 3.8 millions of tons of SO_2 and between 39 and 64 millions of tons of CO_2 could be prevented from entering the atmosphere.

c) Economic Effects

The consumption of wasted energy is an expense which is difficult to justify. Electric power is excessively expensive because, among other causes, we undersell it in excess.

d) Effects on road safety and citizens.

The excess of illumination and shining areas hinder the vision of drivers and therefore produce a decrease in road safety. Therefore, lights that are not properly covered or that have shining refractors, such as poorly adjusted projectors, installed near highways, represent risk factors which can not be ignored.

Main solutions against atmospheric deterioration that harms starlight

Solutions that we should look for must be global and should be undertaken from all involved areas covering different collectives. These solutions should be comprehensive and global, understood in items focused toward two important dimensions: collective and singular.

The first has a lot to do with world politicians. The second pays closer attention to the daily activity by each one of us in the social and family environments that we spend time in. By way of orientation the following ones should be on the political agenda:

Global politics

Promotion of a common educational policy, reflecting a cultural and psychological order that re-orientes the attitude of citizens with the objective of adopting an active and committed role in their day-to-day responsibilities. Participation in the following activities which need to be carried out:

General policies:

- Avoid those activities and products that generate CFC emissions.
- Reduce consumption of fossil fuels.
- Look for and use alternative sources of energy.



Industrial Policies in R+D+i:

- Improve the quality of fuels and machinery efficiency.
- Promote the design of non-polluting industrial systems and equipments, or that produce a minimum degree of emissions.
- Improve systems of collective transport. Guarantee that they are efficient with regard to pollutant emissions.
- Promote the search for alternative sources of energy.
- Encourage the design, production and installation of effective outdoor lighting.

Regional policies:

- Redesign urban planning policies in all territories.
- Encourage the use of resources by changing consumption habits.
- Promote the observation of regulations and promotion of new attitudes by local population.

Private area policies:

- Avoid actions which waste energy by introducing a severe sanctioning system.
- Learn to save electricity, water, paper, fuels, etc.
- Keep automobiles and machinery in good condition to stop the emission of pollutants.
- When necessary, use air conditioning systems sensibly.

Table 1: Policies to improve the quality of starlight related with energy consumption by means of improving atmospheric air.

Concepts under study	Procedures	Attitudes
Composition and properties of the atmosphere.	Carry out experiences guided to the study of air and its interaction with light.	Valuation of regulation which guarantee quality and security in meteorological and astronomical testing laboratories.
Stratification of atmosphere layers.	Collection, representation and interpretation of relative meteorological data in relation with pollutants and starlight.	Promoting international networking of work groups.
Problems of atmosphere.	Interpretation of meteorological maps of interferences of solar light properties.	Develop political awareness in the maintenance of good quality air.
Atmospheric weather. Determining factors: (Pressure, Temperature, atmospheric humidity.)	Design and Construction of simple devices for detection and measurement of light interferences in the atmosphere	Awareness campaigns stressing the importance of the modification of air components and the effect it has on starlight atmospheric phenomenon and living beings.
Meteorological phenomena. (Winds, Clouds, Aqueous Meteors.)		
Weather Maps		
Supply and properties of nitrogen.		
Supply and properties of oxygen.		
Supply and interactions with other gases and particles.		
Atmospheric thermodynamics.		