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Impacts of pollution on our health and the planet: The case of coal power plants

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1. Introduction

Climate change is a reality that threatens the future of life on our planet. For years, nature has provided irrefutable evidence of these changes: the floods in South Asia and hurricane Harvey in Houston during the summer of 2017 are dramatic examples of the damage caused by climate change. Scientists around the world have pointed to human activity as one of the major causes. There is therefore an urgent need to take measures to keep the rise in average global temperature well below 2°C (with respect to pre-industrial levels), in accordance with the Paris Agreement. At the same time, it is essential that we deal with air pollution from greenhouse gases (GHG) and other pollutant gases such as particulate matter (PM_{10} and $PM_{2.5}$), nitrogen oxides (NO_x) and sulfur dioxide (SO_2). These have serious impacts on our health and the environment, as well as on the economy. The main sources of pollution include industrial activities, the transport and energy sector. Pollution from the latter two is primarily the result of burning fossil fuels; coal being the main polluting fossil fuel in the energy sector. Despite being the most polluting source, coal still plays a significant role in the production of electricity around the world.

The third United Nations Environmental Assembly, due to take place in December 2017, will focus on moving 'towards a pollution-free planet'. This includes air pollution, which contaminates the air we breathe, causing serious impacts on our health. Sustainable Development Goal (SDG) 3 – ensure healthy lives and promote well-being for all at all ages – includes among its targets the sustainable reduction of the number of deaths and illnesses from hazardous chemicals, and air, water and soil pollution and contamination by 2030.

This report focuses on the health and economic impacts of air pollution from the production of electricity from fossil fuels, particularly coal. First, it briefly reviews the main sources of primary energy and electricity production worldwide. It then examines air pollution due to human activity, analysing the World Health Organization (WHO) recommendations for ensuring good air quality and safeguarding human health. Thirdly, it examines emissions from burning coal and its consequences, including the impacts on health. Finally, it puts forward the case for phasing out coal and a transition to a cleaner energy model.

This analysis concludes that:

- ✓ **Transitioning towards a pollution-free planet** requires commitments to a **more sustainable energy model** based on **energy efficiency** and a greater use of **renewable sources of energy**.
- ✓ At the same time, **energy companies need to internalize the health and environment costs that result from the burning of fossil fuels** and **governments and electricity companies need to adopt commitments to gradually phase-out fossil fuels worldwide** – particularly coal, which is the most harmful. This needs to be linked to **commitments from governments to take urgent measures to reduce air pollution levels in accordance with WHO guidelines**.
- ✓ The process towards a more sustainable and low-carbon energy model must be supported by **just transition measures**.

2. Primary and secondary energy sources

Energy is produced through natural resources such as solar energy, wind, water and fossil fuels. Energy sources can be classified as renewable, which can be easily replenished; or non-renewable, which are finite. They can both be used as primary energy sources or used to produce secondary energy sources.

Primary energy is the energy extracted or captured directly from the environment. The different types of primary energy fall into two main categories: fuels and flows. The former includes nuclear fuel (uranium) and fossil fuels such as coal, crude oil and natural gas. Flows are natural processes that generate energy through movement, which can sometimes be harnessed. They include wind, solar power, tidal flows, geothermal energy and hydropower.

Most of the time these primary energy sources cannot be used directly. They need to be transformed into sources of **secondary energy** such as electricity and petroleum products (e.g. gasoil and fuel oil).

2.1. Primary energy

In 2016, the global consumption of primary energy amounted to 13,276.3 million tons of oil equivalent (toe)[1] – a growth of 1 percent from the previous year.[2] The largest contribution to this growth came from countries such as China (1.3 percent) and India (5.4 percent).[3] The United States, Russia and the European Union (EU), on the other hand, remained at similar levels to 2015.

The main types of fuel used to cover this demand were crude oil (33.3 percent), coal (28.1 percent) and natural gas (24.1 percent); followed by hydropower (6.9 percent), nuclear energy (4.4 percent) and renewable energy (3.2 percent).

China, the main consumer of primary energy in 2016, showed a large increase in the consumption of crude oil, natural gas, nuclear energy and renewables – replacing the United States as the largest world producer of renewable energy. However, the use of coal decreased by almost 1.4 percent. A similar trend occurred in the United States (an 8.5 percent reduction in the use of coal); while in the EU, there was an increase in the use of crude oil and natural gas and a decrease in coal, but no significant growth in the use of renewable energy. The highest increases in the consumption of crude oil and natural gas were seen in India: 8.6 percent and 9.4 percent respectively.[4]

The use of crude oil and natural gas – two of the main sources of primary energy – continues to increase. As for coal, even though it continues to play a fundamental role in the global primary energy mix, the reduction in its use[5] suggests imminent structural changes in the market, largely due to a transition towards cleaner

energy models with lower carbon emissions, as well as an increase in the competitiveness of natural gas[6] and renewable energy for electricity production.[7] In fact, even though renewables only represented 3.2 percent of the primary energy consumed in 2016, they showed the highest increase (14.4 percent), thanks to continuous scientific and technological advances. Although this is a step in the right direction, there is a need to implement more rigorous and ambitious measures worldwide to meet the objectives of the Paris Agreement.

2.2. Electricity: a secondary energy source

Electricity is an indispensable commodity and every year there is an increase in demand. As noted above, it is a secondary source of energy that can be generated from several sources of primary energy. In 2016, global electricity generation amounted to 24,816.4 TWh. The countries that produced the most electricity were China (24.8 percent), the United States (17.5 percent) and India (5.6 percent); the EU produced 13.1 percent of global electricity.[8]

Despite the rapid expansion in recent years of renewable energy sources, electricity production is still largely based on the use of fossil fuels – essentially coal and natural gas. These are also some of the main sources of air pollution. In fact, power generation is a major source of worldwide SO_2 emissions (in 2015, nearly 27 megatonnes of SO_2 were emitted by this sector – one third of the global total emissions of this pollutant). NO_x and particulate matter emissions from power generation make up a smaller but still significant contribution, amounting to 14 percent of total NO_x and 5 percent of total $PM_{2.5}$ emissions.[9] It is therefore essential to move towards a way of generating electricity which is more sustainable and respectful of the environment, based on the use of renewable energies rather than fossil fuels.

3. Air pollution

Air pollution was defined in 1979 by the United Nations Economic Commission for Europe as:
The introduction by man, directly or indirectly, of substances or energy into the air resulting in deleterious effects of such nature as to endanger human health, harm living resources and ecosystems and material property and impair or interfere with amenities and other legitimate uses of the environment.[10]

Air pollution is a direct consequence of emissions into the air of gases (carbon monoxide, carbon dioxide, nitrogen oxides and sulfur dioxide, among others), particulate matter and liquids from multiple sources, which concentrate in the atmosphere. The main sources of pollution include inefficient modes of transport, household fuel and waste burning, coal-fired power plants and industrial activities.[11]

Despite the progress made in recent decades to improve air quality, air pollution remains a major global problem. At present, it poses serious health risks, depending on the concentrations we are subjected to and the duration of exposure. Air pollution affects us in many different ways. It is related to the incidence and development of various types of diseases, and increasing morbidity and mortality,[12] as well as work days lost in affected areas. Globally, around 18,000 people die every day as a consequence of air pollution, equivalent to 6.5 million deaths a year.[13] These numbers mean that air pollution is one of the leading causes of death worldwide – more important than AIDS, tuberculosis or road traffic accidents. It also entails high economic costs. It impacts the most on people who are already ill, as well as on the most vulnerable groups such as children, the elderly and low-income families with limited access to medical care.[14]

Air pollution not only has adverse effects on human health, but also on the environment – for example, through acidification from *acid rain*. SO_2, NO_x and ammonia emissions into the atmosphere from human activity lead to the deposition of sulfuric acids, nitric acids and ammonium in ecosystems. In sensitive ecosystems, these compounds can acidify soil, affecting nutrient cycles and ecosystem services provided by forests[15] and surface waters, severely damaging the health of fish and amphibians.

The physical nature and composition of chemical air pollutants is very diverse. They can occur naturally or are produced by human activity (anthropogenic); and can be classified as either primary[16] or secondary pollutants depending on the transformation they undergo in the atmosphere.[17]

Box 1. – Main atmospheric pollutants

- **Carbon monoxide (CO)**

An odourless, colourless and tasteless gas. It is toxic and very flammable. It is produced by the incomplete combustion of organic fuels. The main anthropogenic sources are the transport sector, household devices that burn fossil fuels, the metallurgical and paper-making industry and formaldehyde-producing plants. Inhalation in small concentrations can cause mental confusion, vertigo, headaches, nausea, weakness and loss of consciousness. With prolonged or continuous exposure, the nervous system and cardiovascular system can be affected, resulting in neurological and cardiac alterations.

- **Carbon dioxide (CO_2)**

A colourless, odourless, slightly acidic and non-flammable gas. The main anthropogenic emissions come from the burning of fossil fuels. Thus, transport and industrial sectors are the main sources. Inhalation of high concentrations may lead to hyperventilation, loss of consciousness, tachycardia and headaches. If the exposure is prolonged or repetitive it can cause alterations in people's metabolisms.

- **Nitrogen dioxide (NO_2)**

A browny-reddish, non-flammable and toxic gas. It belongs to the family of nitrogen oxides (NO_x) and originates from the atmospheric oxidation of nitrogen monoxide (NO). It irritates and corrodes skin and the respiratory tract. Inhalation of high concentrations of this pollutant for a short period of time may lead to pulmonary edema. Prolonged exposure can affect the immune system and lungs, weakening resistance to infections and causing irreversible changes in the lung tissue. NO_2 can lead to the formation of secondary particulate matter and ozone.

- **Sulfur dioxide (SO_2)**

A colourless, non-flammable and odourous gas. It is irritating and toxic. It is produced by burning fossil materials high in sulfur content such as petroleum and coal, although it is also generated in many processes in the chemical industry. It mainly affects the mucus and lungs, causing coughing fits. Exposure to high concentrations for short periods of time can irritate the respiratory tract, cause bronchitis, asthmatic reactions, respiratory arrest and congestion in the bronchial tubes of asthmatics. Similar to NO_2, SO_2 is a precursor to the formation of secondary particulate matter.

- **PM_{10}**

Particles with an aerodynamic diameter of ≤10 µm, commonly known as coarse particles. They are made up of inorganic compounds such as silicates, aluminates and heavy metals, among others, as well as organic material associated with carbon particles. In cities, the main source is vehicle emissions or the wear of pavements, tires and brakes. In industry, the burning of fossil fuels is the main source of primary particulate matter, especially the combustion of coal. Prolonged or repetitive exposure can cause harmful effects on the respiratory system.

- **$PM_{2.5}$**

Particles with an aerodynamic diameter of ≤2.5 µm, commonly known as fine particles. They are mainly made up of secondary particles formed in the atmosphere from precursor gases – particularly NO_x, SO_2, VOC, NH_3 – through chemical processes or liquid phase reactions. They penetrate the nose and the throat, reaching the lungs. They may cause respiratory morbidity, damage to lung function and lung cancer.

- **Ozone (O_3)**

A blue gas with a very strong odour. In its natural form it appears in the upper layers of the atmosphere (stratospheric ozone), forming the layer that protects the planet from solar radiation. However, when it originates at ground level (tropospheric ozone), it is a highly toxic pollutant that affects human health and the environment. It is formed by photochemical reactions involving sunlight and precursor pollutants such as NO_x and various volatile organic compounds (VOCs). In high concentrations it can lead to asthma and respiratory problems, reduce lung function and cause lung disease.

3.1. World Health Organization air quality guidelines

WHO air quality guidelines (AQGs) are intended to support measures to achieve air quality that protects the health of people. These guidelines are based on a comprehensive set of scientific evidence relating to air pollution and its health consequences.[18]

The AQGs were published in 1987 and updated in 1997, based on the existing scientific evidence at the time and evaluated by experts. In 2005, based on subsequent studies of the effects of air pollution on health, the information on particulate matter O_3, NO_2 and SO_2 was updated, with new guideline values for each of them. However, as WHO itself states, epidemiological evidence indicates that the possibility of adverse health effects persists even when guideline values are reached. Thus, some countries may decide to adopt stricter national air quality standards, setting lower concentration values.[19] However, in reality, most air quality objectives set by national governments are more permissive than those recommended by WHO. This derives from EU Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe.[20] This shows a lack of political will to protect the population from the health effects of air pollution. The result is that, because of the more permissive values, our cities appear to have better air quality than they really do.

Box 2. – WHO Guideline values

Pollutant	Guideline Values WHO [µg/m³]	Average Period
$PM_{2.5}$*	10	1 calendar year
PM_{10}	20	1 calendar year
	50	24 hours
O_3**	100	8 hours
NO_2	40	1 calendar year
	200	1 hour
SO_2***	20	24 hours

* For $PM_{2.5}$, the WHO chose a maximum concentration of 10 µg/m³ as the maximum annual mean from which health effects could be expected was within values ranging from 11 to 15 µg/m³, according to available scientific literature.

** In 2005, WHO reduced the proposed value for ozone in the latest update of its AQG, from 120 to 100 µg/m³ (maximum daily average of 8 hours) as evidence on the effects on health from epidemiological studies carried out over the years has shown that harmful effects occur with concentrations below 120 µg/m³. Nevertheless, ozone can have harmful effects on sensitive groups, such as asthmatics and the elderly, at concentrations even below this new guideline value.

*** The adoption of this low value is a precautionary measure due to the uncertainty about the causality of SO_2 on the negative impacts on health, and the difficulty in determining safe levels (below which there are no harmful effects).

4. Coal: emissions into the air and health impacts

For decades, coal has been the main source of electricity generation. According to the International Energy Agency (IEA), as of 2014, approximately 41% of the world's electricity needs were provided by coal.[21] Current global installed capacity stands at 1,965,368 MW.[22] The countries with the largest installed capacity of active coal power plants are China (922,062 MW), the United States (281,127 MW) and India (218,091 MW). The EU accounts for 157,046 MW, led by Germany, Poland and the United Kingdom with 50,826, 27,187 and 13,100 MW respectively.[23]

4.1. Emissions into the air

The production of electricity from coal is one of the main sources of CO_2 emissions. Its carbon emission factor (grams of CO_2 for every kilowatt-hour of electricity produced) depends on the type of coal burnt. It varies from 860 gCO_2/kWh of anthracite to 1,020 of lignite. Meanwhile the carbon emission factor of natural gas is 400.[24]

CO_2 and other GHG emissions into the atmosphere are responsible for trapping the heat of the sun in the lower layers of the atmosphere – which would otherwise escape into space – thereby generating global warming. The impacts of climate change include alterations to habitats or the melting of the ice caps, which can lead to the extinction of species of flora and fauna. This not only permanently alters the balance of the environment but also has profound economic and social consequences. At present, almost the entire scientific community agrees on the need to take urgent measures to stop and reverse this process.[25]

In addition, coal power plants are also responsible for important emissions of NO_x, SO_2 and particulate matter, among others, which contribute significantly to air pollution and impact severely on human health.

4.2. Health impacts

Power generation is a major source of air pollution. Coal accounts for three quarters of the energy sector's SO_2 emissions, 70 percent of its NO_x emissions and over 90 percent of its $PM_{2.5}$ emissions.[26] These pollutants have been linked to adverse health effects. Since 2005, when the latest WHO AQGs were published, multiple epidemiological and toxicological studies have provided conclusive evidence of these effects.

There have also been numerous studies on the impacts of coal emissions on health:

- In 2013, Greenpeace commissioned an air pollution modelling expert to assess the contribution of coal-fired power plants to $PM_{2.5}$ pollution in China.[37] The modelling covered over 2,000 power plants. The study attributed **9,900 premature deaths**[38] to 192 coal power plants within the Jingjinji region in 2011, with 2,000 deaths in Beijing, 1,200 in Tianjin and 6,700 in Hebei. Health impacts also included **11,110 cases of asthma, 12,100 cases of chronic bronchitis, 1,010 hospital admissions and 59,500 outpatient visits**.
- A study published in 2012,[39] on the health effects in India of coal power plants for electricity generation, attributed more than **41,000 premature deaths** in 2008 to the pollutant

Main health effects of pollutants evidenced by scientific studies

✓ Exposure to **$PM_{2.5}$** is associated with an increase in systemic inflammatory response and oxidative stress[27], as well as with variations in the biomarkers of cardiovascular inflammation such as C-reactive protein (CRP) [28] and fibrinogen.[29], [30] Long-term exposure promotes the progression of cardiovascular diseases and has been associated with an increase in total mortality – particularly, the increase in cardio-respiratory mortality[31] and mortality from lung cancer.[32] It is also related to respiratory diseases.[33]

✓ **NO_2** is a highly reactive and equally hazardous health pollutant present in the vast majority of urban and industrial areas. Prolonged exposure to NO_2 can cause damage to the respiratory system and is associated with increased symptoms of bronchitis and asthma, lung function impairment, and lung cancer.[34] Numerous epidemiological studies conducted in Europe and the rest of the world conclude that between 5 and 7 percent of lung cancer cases in ex-smokers and non-smokers may be associated with exposure to high concentrations of this pollutant.[35] It is also related to an increase in mortality.

✓ **SO_2** has been associated with an increase in asthma and chronic bronchitis, as well as with a decrease in lung function and bronchial inflammation. Hospital admissions for heart disease and mortality increase on days when SO_2 levels are higher.[36]

emissions of 63 coal power plants. The majority of these deaths were due to SO_2 and NO_X emissions. Although SO_2 is associated with fewer deaths per ton than $PM_{2.5}$, there are higher levels of SO_2 emissions – partly because plants have installed measures to reduce their $PM_{2.5}$ emissions (electrostatic precipitators) but do not have the necessary desulphurization techniques. NO_X is also associated with more deaths than $PM_{2.5}$ for the same reason.

- A study in Canada in 2015[40] found that the region of Alberta burns more coal than the rest of the country combined. Alberta has **700 visits to emergency units annually and 80 hospital admissions** linked to health issues (such as lung and heart problems) caused by exposure to pollution from the combustion of coal. In addition, it is also responsible for **4,800 days of asthma symptoms**, which result in absences from work and school. Annually, there are **100 premature deaths** attributed to pollutants from burning coal. In total, pollution-related illnesses cost the Canadian people around **300 million Canadian dollars every year** in health care costs.

- In 2015, a study[41] was conducted on the impact of the closure of three coal power plants in south-western Pennsylvania. Since 2012, regional estimates of mortality have been relatively high. In Allegheny County, an estimated **10 to 14 deaths per 100,000 people** every year were associated with pollution from power plants, with even higher estimates for Westmoreland and Armstrong counties (located to the east of Allegheny). According to the study, more than one third of $PM_{2.5}$ emissions could be attributed to two coal power plants in the region. When three coal power plants were closed in an area close to Pittsburgh, $PM_{2.5}$ levels decreased by about 9 percent, significantly improving the air quality in the area. This has an impact on health as, according to the study, a decrease of 10μg/m^3 in $PM_{2.5}$ concentration is associated with an approximate 0.61 year increase in life expectancy.

- A study published in June 2016 analysed the impacts of emissions from 257 coal plants in the EU in 2013.[42] It shows that more than **22,900 premature deaths** could be attributed to these emissions, as well as **21,000 hospital admissions, 11,800 cases of chronic bronchitis in adults and 51,700 cases of bronchitis in children**. In addition, it resulted in **23,502,800 restricted activity days** and **6,575,800 work days lost**. The plants that caused the most damage are in Poland, Germany, the United Kingdom, Romania, Bulgaria, Spain and the Czech Republic.

  These health impacts have associated **health costs**, known as *external costs or negative externalities*. However, these costs are not covered by the energy companies, which are responsible for the negative effects of the air pollution from their power plants. These costs are paid for by individuals and include expenses such as medicines, consultations with specialists, hospital bills and laboratory analyses. The costs associated with the health impacts of coal power plants in the EU in 2013 amounted to around **62,300 million Euros**.

- The most recent study focused on the health impacts of coal plants in Spain during 2014 – conducted by the *Instituto Internacional de Derecho y Medio Ambiente* (International Institute for Law and the Environment).[43] The study found that emissions from the 14 coal power plants in Spain (with an installed net capacity of around 9,536 MW) could be related to **709 premature deaths, 459 hospital admissions due to cardiovascular and respiratory diseases, 10,521 cases of asthma symptoms in asthmatic children, 1,233 cases of bronchitis in children** and **387 cases of chronic bronchitis in adults**. In addition, they were responsible for **747,686 restricted activity days** and **163,326 work days lost**. The **majority of deaths attributable to coal (586 out of 709) relate to $PM_{2.5}$** – mainly cardiovascular: strokes, acute myocardial infarction, hypertensive diseases, heart failure and angina pectoris;[44] and respiratory diseases: chronic lower respiratory diseases, asthma and respiratory failure. There were also a significant number of **deaths due to malignant tumour of the trachea, bronchi and lung**: 45 and 40 caused by $PM_{2.5}$ and PM_{10} respectively.

  The **health costs** associated with the impacts of coal power plants during 2014 in Spain, together with the economic losses due to absences from work, amounted to between **880 and 1,667 million Euros**.

5. Transition to clean energy and air

Despite the impacts on health, electricity is still largely generated by the burning of fossil fuels, particularly coal. The increase in the use of coal is due to many different factors. One of them was the success of fracking in the United States; a technique of hydraulic fracturing in rocks that allows the extraction of gas and petroleum from the subsoil. These two fuels have gradually replaced coal in the United States as they can now be produced at very low prices. As a consequence, surpluses of US coal were dumped into world markets[45] causing a dramatic drop in price and a boom in coal use elsewhere.

Coal is still a profitable fuel for electricity companies because most of them continue to use old plants, without the investments necessary to comply with requirements for reducing emissions. The running costs of an existing installation are much lower than the costs of investing in new renewable capacity.

Furthermore, coal burning in many countries has been subsidized for many years,[46] which has discouraged and slowed down the conversion to renewables.

In Europe, the low price of CO_2 emission allowances are not having the intended deterrent effect and have failed to encourage electricity companies to opt for cleaner production methods. On the contrary, they choose to continue emitting GHGs that cause global warming and trade in emission allowances.

The most important reason for the continued use of coal is that the external costs associated with its burning are not internalized, which distorts comparisons of profitability between different technologies for producing electricity. All costs associated with their use should be adequately internalized; they should include not only the investment and operational cost, but also the costs associated with negative externalities. The vast majority of environmental and human health impacts associated with conventional technologies such as coal burning are not monetized, so they are not reflected in cost structures. Renewable technologies, on the other hand, do not entail the same external costs as fossil fuels because, if they are correctly implemented, their environmental impact is very low.

The increase in electricity demand, together with the need to reduce GHG emissions and air pollution levels, has prompted the focus on renewables in the energy sector. However, as they are by nature intermittent energy sources, they require the support of Electrical Energy Storage (EES)[47] technologies. EES can not only alleviate this problem, but can also cover peaks in demand, improve the quality and reliability of supply, and facilitate the management of the electricity grid. In recent years, the EES sector has grown enormously, leading to notable improvements in the characteristics of existing storage systems as well as a sharp increase in the number of new technologies available.

Modern technological advances in the EES sector are leading to a rapid and important reduction in the price of electricity generated from renewable sources: in 2016, the global installed capacity of renewables registered its greatest annual increase, with around 161 GW of capacity added. Total capacity reached 2,017 GW, an increase of almost 9 percent compared to 2015, the majority of which (1,096 GW) was generated by hydropower. Wind and solar energy accounts for 487 GW and 303 GW respectively. Solar photovoltaic energy showed the largest growth in capacity in 2016, with an increase of 75 GW. Lower increases were recorded for wind (55 GW) and hydropower (25 GW). The countries that contribute the most to installed capacity for renewables are China and the United States, with 564 and 225 GW respectively; while the EU accounts for 428 GW.[48] In total, renewable energy can supply almost 25 percent of the world's electricity.[49]

A recent study by the Carbon Tracker Initiative compares the costs of different renewable and non-renewable technologies through a levelized cost of electricity (LCOE) analysis to evaluate their profitability across three different scenarios. It shows that “renewable power generation costs are already lower on average worldwide than those of fossil fuels, and clean energy plants will become even more cost-competitive by 2020”.[50]

In light of the lower costs of renewables and technological advances, achieving a clean energy future and cleaner air by 2050 now seems feasible.

6. Conclusions

In the past, economic development has been based on an increasing use of fossil fuels (mainly coal, oil and natural gas) for generating energy, which has led to an increase in emissions of GHGs and other pollutants responsible for climate change, as well as air pollution and the negative consequences both on human health and the environment that this entails.

However, the global energy sector is now in transition. In the twenty-first century, an energy model based on the burning of fossil fuels can no longer be the basis of economic development; it must be respectful of the environment and compatible with improvements in the quality of life. Therefore, one of the main challenges today in the fight against climate change and air pollution is the 'decoupling' of fossil fuels and economic growth. For this, we must commit to a **more sustainable energy model** based on **energy efficiency** (such as improvements in building insulation or lighting systems) and on a greater use of **renewable sources of energy**. More investment is needed to increase electricity production from renewable sources; scientific and technological developments make this type of generation increasingly competitive in comparison to more conventional technologies. Even though they are intermittent sources – directly dependent on meteorology and day-night cycles – the rapid advances in EES technologies will increasingly minimize this problem, making it possible to increase the contribution of renewable sources to the electricity system.

At the same time, it is necessary for **energy companies to internalize the external costs associated with the generation of electricity produced through the burning of fossil fuels** and for **governments and electricity companies to adopt commitments to gradually phase-out fossil fuels worldwide** – starting with the most harmful: coal. The phasing out of coal offers, without doubt, a unique opportunity to reduce pollutant emissions and to mitigate climate change. In addition, improvements in air quality would lead to improvements in human health, avoiding the premature death of thousands of people every year. This needs to be linked to the **commitment from governments to take urgent measures to reduce air pollution levels in accordance with WHO guidelines**. Civil society can play a key role in this, pressuring governments to adopt and implement these commitments.

The transition towards a more sustainable and low-carbon energy model must be supported by **just transition measures**. Both governments and companies should begin a systematic process of dismantling the fossil industry, while ensuring new employment opportunities for all affected workers. At the same time, greater use of indigenous renewable energy sources would lead to less dependence on energy from abroad and favour the creation of local jobs.

All individuals are entitled to live in an environment adequate for their health and well-being.[51] Political decisions adopted in the short, medium and long term must be compatible with commitments to fight against climate change and to achieve a pollution-free planet. They must also be directed towards achieving economic growth that is sustainable and respectful of human health and the environment, without damaging the well-being of present and future generations.

Authors

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Endnotes:

1 Tonne(s) of oil equivalent is a normalized unit of energy. By convention it is equivalent to the approximate amount of energy that can be extracted from one tonne of crude oil. Source: Eurostat.
2 BP, BP Statistical Review of World Energy, June 2017, p. 9. Available online at: http://www.bp.com/content/dam/bp/en/corporate/pdf/energy-economics/statistical-review-2017/bp-statistical-review-of-world-energy-2017-full-report.pdf
3 Ibid, p. 3.
4 Ibid.
5 Coal was the only source of primary energy which saw a reduction in its contribution to energy consumption from 2015 (-1.4%). Source: own figures based on data from BP, Statistical Review of World Energy – underpinning data, Download available at: http://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy/downloads.html
6 It must be highlighted that although natural gas is gaining in importance in the global energy scenario, there are many environmental and climatic risks associated with its use. This fuel, composed of 90 to 95% methane (CH_4), is found in the subsoil under pressurized conditions. Therefore, during its extraction, there is a very high risk of leakage into the atmosphere. Depending on the amount released, these leaks can have a strong impact on climate change, since CH_4 has a global warming potential 72 times greater than CO_2 in the first 20 years, and 25 times greater in 100 years.
7 BP, BP Statistical, op. cit., p. 5.
8 Ibid. p. 46.
9 International Energy Agency (IEA), *Energy and Air Pollution*, World Energy Outlook Special Report (2016), p. 43. Available at: http://www.iea.org/publications/freepublications/publication/WorldEnergyOutlookSpecialReport2016EnergyandAirPollution.pdf.
10 1979 Convention on long-range transboundary air pollution, done at Geneva on 13 November 1979.
11 WHO, *WHO releases country estimates on air pollution exposure and health impacts*. URL: http://www.who.int/mediacentre/news/releases/2016/air-pollution-estimates/en/
12 Morbidity is defined as the proportion of people who become ill at a given place and time. Mortality, in turn, is the statistics on deaths in a given population.
13 IEA, ***Energy***, op. cit., p. 3
14 Source: WHO. More information at: http://www.who.int/phe/health_topics/outdoorair/databases/health_impacts/en/
15 Source: United States Department of Agriculture, USDA.
16 They are discharged directly into the atmosphere from sources, whether natural or anthropogenic, without having undergone any previous transformation.
17 They are formed as a consequence of the chemical and photochemical transformation and reaction of primary pollutants in the atmosphere.
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19 Ibid.
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