HEAL
Promoting environmental policy that contributes to good health

THE UNPAID HEALTH BILL

How coal power plants in Turkey make us sick

A report from the Health and Environment Alliance

A report from the Health and Environment Alliance (HEAL)

About the report

Massive investment in coal power plants is planned in Turkey. This report produced by the Health and Environment Alliance (HEAL) aims to provide an overview of the scientific evidence of how air pollution impacts health and how emissions from coal power plants in Turkey are implicated in this. It estimates that air pollution from the 19 coal-fired power plants that were in operation in 2012 caused health costs of up to 3.6 billion EUR a year. A quadrupling of coal power capacity as planned, some 80 new coal power plants, would lead to skyrocketing health costs for current and future generations. The report includes testimonies from leading health and medical experts on why they are concerned. It also develops recommendations for policy-makers and the health community on how to address the unpaid health bill and ensure that it is taken into account in future energy decisions in Turkey.

This report is based on "The Unpaid Health Bill – How coal power plants make us sick" (2013), which was written by Julia Huscher, Senior Policy Officer, HEAL; and Diana Smith, Communications Adviser, HEAL.

HEAL is a leading European not-for-profit organisation addressing how the environment affects health in the European Union (EU).

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Preface

The Turkish Medical Association (known nationally as TTB) is the organised voice of physicians in Turkey, with 80% of physicians in the country as members. The TTB is an organisation that attaches importance to social determinants of health in order to protect and promote public health and to ensure universal access to healthcare while struggling to eliminate inequalities in the field of health.

The environment is an important determinant of health in our present day. Especially since 2013, when the World Health Organization (WHO) added cancer to the list of diseases caused by exposure to air pollution, more and more attention is being given to the impact of this environmental condition on health.

Coal-fired thermal power plants are among the top contributors to air pollution in Turkey. In Europe today, because of health problems they cause and their climate change effects, there are plans to limit to the number of such plants and close them down altogether in coming decades. In Turkey, on the other hand, major investment is planned and there are attempts to create the perception that they are problem-free. Far from limitation or closure, more coal-fired thermal plants occupy an important place on the agenda in Turkey.

In spite of all the health risks involved, the Turkish government cannot detach itself from this polluted and outmoded source of energy. On the contrary, the government has made Turkey the country with the highest number of planned new thermal plants in Europe, and third highest worldwide. It is actually encouraging construction by having given permission for or financially supporting more than 80 coal-fired power plants.

There is no doubt that energy is an important need that must be met. However, knowing their polluting and hazardous nature, it is not correct to bring to the forefront coal-fired and nuclear plants while omitting alternatives such as efficient use and "renewable" energy sources. It must be recognised by all parties that public health considerations are more important than any drive for industrialisation and interests of global and national capital.

Scientific studies clearly show that, due to their polluting effects, coal-fired plants cause disorders, ill-health and even premature death, including among plant workers and people living in neighbouring areas.

According to a study conducted by the Turkish Medical Association (TTB) to investigate the health effects of Yatağan Plant, which uses coal as fuel, the share of patients receiving care in Yatağan State Hospital due to respiratory tract problems is twice as high than those receiving treatment for the same problem in hospitals at the centre of Muğla, with no power plants in the vicinity. The rate is tripled in the case of bronchitis, asthma and emphysema.

Despite the scientifically evident fact that air pollution is carcinogenic, there are no official statements and publicly available studies regarding the epidemiology of cancer cases in Turkey specifically around coal-fired power plants in the country. The Ministry of Health is hesitant to officially share any cancer maps developed so far, which would prove that the environment around some thermal plants pose a risk of lung cancer due to polluted air.

In this context, we attach great importance to the work titled "The Unpaid Health Bill – How coal power plants in Turkey make us sick" by the Health and Environment Alliance (HEAL) focusing on health problems caused by coal-fired thermal plants.

It follows the publication of the booklet "Air Pollution and Health in Turkey" prepared by HEAL with the support of the Turkish Medical Association (TTB) and four expertise associations in February 2015.

We would like to thank everyone, and in particular HEAL, together with Doctors for the Environment Turkey, Turkish Occupational Medicine Society, Turkish Respiratory Society, Turkish Society of Public Health Specialists, and Turkish Thoracic Society, who contributed to the preparation and publication of this report that we consider a significant contribution to public health.

Dr.Bayazıt İlhan
President
Central Council of Turkish Medical Association

Preface

Promoting and improving air quality has been a cornerstone of the work of the Health and Environment Alliance (HEAL) ever since its founding in 2003. Today, with our alliance of more than 70 member organisations representing health professionals, not-for-profit health insurers, doctors, nurses, cancer and asthma groups, citizens, women's groups, youth groups, environmental NGOs, scientists and public health institutes, we aim to share the latest science on how air pollution affects our health, educate the public and present to policy-makers some solutions on providing cleaner air for all.

HEAL also has a strong track record in bringing evidence and knowledge about climate change and health to the forefront of deliberations at EU and international levels as well as engaging public health and health professional communities, particularly in Europe. Information, resources and partnerships are developed in collaboration with our expert member organisations, such as the European Respiratory Society (ERS), European Lung Federation (ELF), European Federation of Allergy and Airway Diseases Patients Association (EFA) and the Collaborative on Health and Environment (CHE) in the USA.

In recent years, we have increasingly addressed questions of how energy choices are linked to our health, both in a positive and negative way. In 2013, HEAL published the report the "The Unpaid Health Bill: How coal power plants make us sick", which provided the first ever economic assessment on the health costs associated with air pollution from coal power generation. This report brought an unprecedented and continued interest from citizens, health and medical organisations and policy-makers on what coal power generation means for the health in their country, be it at local, regional or national level.

HEAL is now pleased to present the first ever estimate of the specific health costs and productivity losses associated with coal power in Turkey. These costs represent a high toll on the Turkish population, and the plans to more than quadruple the number of coal power plants in the country will massively exacerbate the situation. The new coal power plants will also contribute to an increase of carbon emissions and thus climate change at a time when many European governments are making plans to move away from coal for this very reason.

With climate change recognised to be the major public health challenge of the 21st century, over 80 new coal projects in the pipeline are an immediate and long-term health concern, not only of the Turkish people but also for citizens around the world. This size of this future investment in coal makes Turkey the third biggest global investor after China and India. From the investment side, it is too often ignored that these new coal plants would "lock in" hazardous air, mercury and carbon emissions for decades, with a threat to our health and the climate.

Around the world, more and more doctors, nurses, health experts, medical associations are speaking out against coal. They say that in order to protect people's health and the climate, coal power cannot have a future. We are pleased that the Turkish Medical Association, Doctors for the Environment Turkey, Turkish Occupational Medicine Society, Turkish Respiratory Society, Turkish Society of Public Health Specialists, and Turkish Thoracic Society, and others have added their voice to the demand to end coal power dependency. They join their compatriots in the World Federation of Public Health Associations and in the UK, Germany, Poland, Serbia and many places around the world.

HEAL hopes that this report will serve as an inspiration to many citizens and organisations in Turkey and around the world who are working to achieve good health for all.

Anne Stauffer
Deputy Director
Health and Environment Alliance (HEAL)

Executive summary

A massive investment in electricity generation from coal-power is planned in Turkey. The country has plans to increase its coal fleet by over 80 new coal-fired power plants, making it the third largest investor in coal power after China and India.

This continued reliance on coal comes at a cost that decision makers should be aware of: the unpaid health bill. This health bill is paid by individuals, national health care budgets, and by the economy at large due to productivity losses.

How is coal pollution making us sick? Coal power plants are an important contributor to air pollution in Turkey and in Europe, which European respiratory experts have called an 'invisible killer' and one of today's most important public health threats. Exposure to outdoor air pollution is linked to a number of health impacts including higher rates of respiratory and cardiovascular disease. This report developed by HEAL aims to provide:

- An overview of the scientific evidence on how air pollution impacts health and how emissions from coal power plants are implicated in this;
- The first ever economic assessment of the health costs associated with air pollution from coal power plants in Turkey;
- Testimonies from leading health advocates and medical experts on why they are concerned about coal, and;
- Recommendations for policy-makers and the health community on how to address the unpaid health bill in Turkey.

The main findings

Emissions from coal-fired power plants in Turkey contribute significantly to the burden of disease from environmental pollution. The brand-new figures published in this report show that in Turkey impacts amount to 2,876 premature deaths, 3,823 new cases of chronic bronchitis in adults, 4,311 hospital admissions and 637,643 lost working days each year. The economic costs of the health impacts from coal combustion in Turkey are estimated at 2,9 billion up to 3,6 billion EUR per year. These costs reflect the prices for the Turkish economy, and are mainly associated with respiratory and cardiovascular conditions, which are two important groups of leading chronic diseases in Turkey.

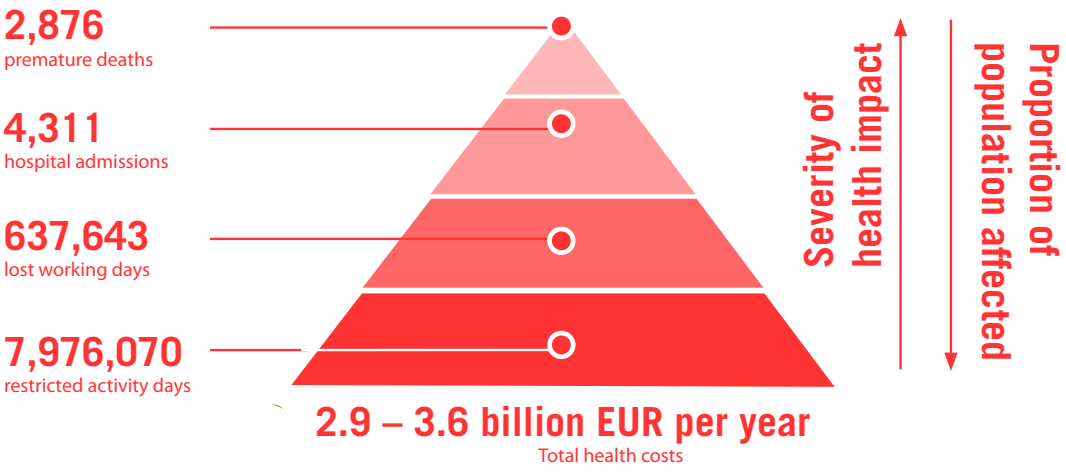


Figure 1: Health impacts associated with power sector (coal and lignite) emissions from Turkey

Top health concerns

Coal power generation adds to already poor outdoor air quality in Turkey - caused mainly by the transport sector, industrial processes, residential heating, and agriculture. Coal power plants release substantial amounts of particulate matter, sulphur dioxide, and nitrogen oxides - the latter contributing indirectly to the formation of ozone. Of these, the most worrying for health are fine particulate matter ($PM_{2.5}$) and ozone. The report estimates that 20% of the health impacts from particulate matter in Turkey is caused by coal consumption in the power sector.

Significant evidence exists on how long-term exposure to these air pollutants affects the lungs and the heart. They include chronic respiratory diseases, such as chronic bronchitis, emphysema and lung cancer, and cardiovascular diseases, such as myocardial infarctions, congestive heart failure, ischemic heart disease and heart arrhythmias. Acute effects include respiratory symptoms, such as chest tightness and coughing, as well as exacerbated asthma attacks. Children, older people and patients with an underlying condition are more susceptible to these effects.

Other hazardous substances emitted from the smokestacks of coal power plants are heavy metals, such as mercury, and persistent organic pollutants (POPs), such as dioxins and polycyclic aromatic chemicals (PAHs). These can either be breathed in or taken up indirectly via food and water. Special concern arises from the large mercury emissions from coal power plants as mercury can impair the cognitive development of children and cause irreversible damage to vital organs of the foetus.

The two-fold burden on human health: air pollution and climate change

Coal power generation is furthermore a major contributor to climate change, which was recognised by the Director-General of the WHO as the major public health challenge of the 21st century. There is no data available on the share of CO_2 emissions from coal plants in Turkey; the data for the EU-28 shows that coal in these countries contributes to approximately 20% of total greenhouse gas emissions. Evidence is growing that Turkey already experiences health impacts from climate change, and that health is particularly under threat from heat waves and water shortages in the Mediterranean region. While a phase out of coal in electricity and heat generation in Turkey is a prerequisite for preventing long term health impacts from climate change, it will also benefit people's health in the short term due to lower air pollution.

Decreasing the burning of fossil fuels, particularly coal, will bring huge public health benefits from tackling air pollution, avoiding health impacts from climate change and reducing climate change adaptation costs.

A breath of fresh air: what needs to be done

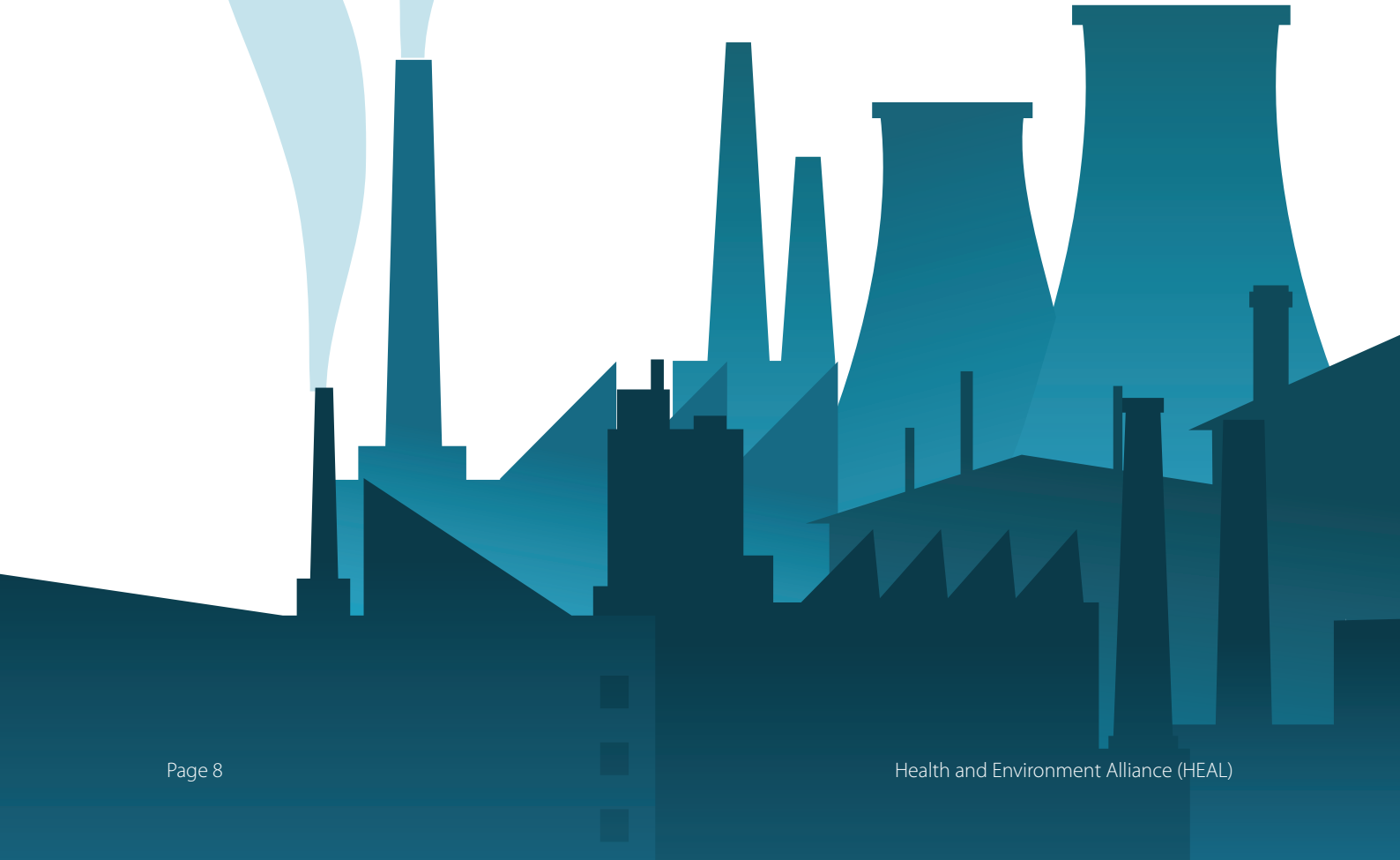
From a health perspective, building new coal power plants would work against efforts to tackle chronic disease, create substantial costs for public health and lock in hazardous emissions for decades. A large coal power plant emits several thousand tons of hazardous air pollutants every year and has an average lifetime of at least 40 years. Building new coal power plants would mean that hazardous emissions and their effects on health would continue for many years.

The external costs to health from coal power generation have been missing from the debate on the future of Turkey's energy mix. These costs should be taken into consideration in all future energy investment decisions. Conversely, claims that domestic coal represents a cheap energy source need to be urgently revised. These considerations should lead to a moratorium on the building of new coal plants in Turkey and ultimately a phase out of coal.

The role of medical professionals and public health experts in reversing Turkey's coal future

Public health experts and medical professionals can play a vital role, especially at the national and local level, in reversing this future coal scenario and ultimately making the phase out of coal a reality. They can draw on the scientific evidence presented in this report to highlight the role of coal in air quality and climate change discussions. They can also help relay the report's recommendations to policy-makers.

The engagement of public health experts will be crucial to ensure that externalities of coal - the unpaid health bill - are taken into account in future energy decisions in Turkey and elsewhere.



Coal and Health: What Is at Stake?

Air pollution and health

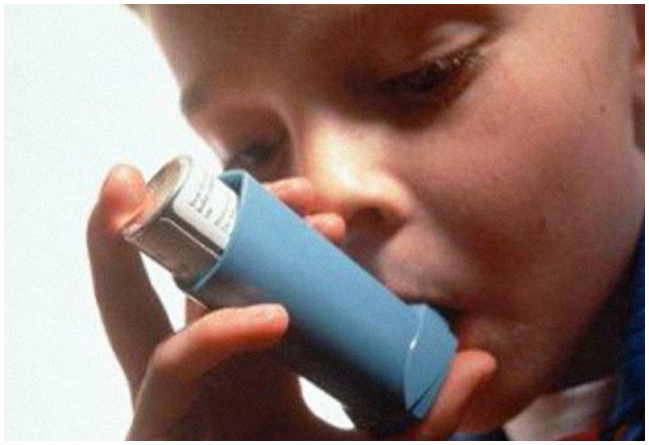
Every person is exposed to outdoor air pollution throughout their life. There is a large body of evidence on how air pollution affects health.[1] The understanding of how different sources such as transport, residential heating, agriculture, or energy generation contribute to air pollution and ill-health is steadily growing.

Air pollution is the most important environmental risk factor for the health people in Turkey and in Europe. In a recent analysis on the Global Burden of Disease commissioned by the WHO, air pollution ranked among the most important risk factors for chronic disease in the European region for the first time.[2] More than 90% of the urban population in Europe is exposed to levels of particulate matter (PM2.5) and ozone higher than those recommended by the WHO.[2] This means that almost everybody breathes in air that is considered harmful to health.[4]

In Turkey, 97.2% of the urban population is exposed to unhealthy levels of particulate matter (PM_{10}).[5] The lead city on PM_{10} pollution is Iğdır, followed by Batman and Afyon. In Ankara, average annual concentrations of PM_{10} are 58ug/m3 and in Istanbul citizens have to live with 48ug/m3 average in the year.[6] These concentrations largely exceed the recommendation of the WHO, which is an annual average of 20 ug/m3.[7]

The long-term exposure to air pollution significantly increases the risk of developing chronic cardiovascular or respiratory diseases. With the exception of a few countries, cardiovascular disease (CVD) is the leading cause of death in the EU, causing 2 million deaths per year, which accounts for approximately 40% of all deaths.[8] Public health costs related to cardiovascular diseases were estimated at 196 billion EUR a year for the EU.[9]

In Turkey, cardiovascular disease is also the leading cause of deaths, with 40% of the total deaths in 2014[10], followed by cancer. When it comes to morbidity rates, different national studies show similar but different outcomes. According to the Turkish Statistical Institute (TURKSTAT)'s 2012 study, the prevalence of the coronary heart disease is 4.1%, while a Ministry of Health report records 3.1% for the year 2011, while cerebrovascular disease prevalence are 0.9% and 1.9% in respective studies.[11]



Older people, children and patients with chronic respiratory or cardiovascular diseases experience the largest threat to their health and well-being from air pollution, as they are more susceptible to the damage done by the pollutants.

Chronic respiratory diseases constitute high health risks in Turkey, too, being the third leading cause of death. According to official statistics, 25,658 people died in 2014 due to chronic obstructive pulmonary disease (COPD), bronchiectasis (bronchial tubes are permanently and abnormally widened with accompanying infection) and asthma.[11] The Turkish Thoracic Society estimates that asthma morbidity in adults is 5-7%; while it is 13-15% in children[12], which means around 2 million children suffer from asthma in Turkey.[13] Only 500 thousand people are diagnosed with COPD, while the Ministry of Health estimates a total number of 5 million people suffering from the disease in the country.[14]

These diseases and ill-health: also impact productivity and lead to economic costs.[15] In addition, the need to take medication or to receive hospital treatment is a budgetary restraint for the people affected, as well as for health care systems. But beyond economic costs, it is the personal well-being of individuals, families and communities that should be protected from adverse environmental effects.

Given the large number of individuals affected and the high levels of asthma, chronic bronchitis, emphysema, and other chronic lung conditions as well as heart disease, and cancer, together with the high costs related to this ill-health, prevention of outdoor air pollution has to become a priority.

Air pollution resulting from coal power plants

Coal-fired power plants are an important source of air pollution from electricity generation in Turkey and in Europe. Their substantial emissions have to be considered against the backdrop of a multitude of sectors contributing to outdoor air pollution; especially transport, residential heating, and agriculture, as well as the complex dynamics and interactions of air pollutants.

Air pollutants released from smoke stacks of coal-fired power plants constitute the largest health risk for the general public in comparison to waste emissions to the water or soil. They cause both acute and chronic health effects. Communities in the proximity of coal power plants sometimes experience a much higher exposure to certain airborne pollutants. The major contribution to the air pollution, however, is transported over long distances, as shown in figure 2 on page 11. It affects a much bigger proportion of the population by increasing the background levels of ambient air pollution.

Although coal power plants are responsible only for a part of current outdoor air pollution; each coal power plant emits huge amounts of hazardous air pollutants every year and has an average lifetime of at least 40 years. Allowing new coal power plants to be built would thus lock in hazardous emissions for many years. It would also counterbalance short-term reductions in air pollutants achieved in other sectors, such as residential heating.

In Turkey, there are still considerable data gaps on the air emissions of individual coal power plants, as well as the contribution of different sectors to poor air quality. However, the information available shows that the energy sector is a major contributor to polluted air in the country. Energy use and supply (excluding transport) in Turkey is responsible for 47% of nitrogen oxide emissions (NOx), 26% of non-methane VOCs and 99% of sulphur dioxide emissions (SO2). There is no official data available for the release of particulate matter from coal power plants.[16]

Fine particles (particulate matter or PM) in the air as well as ozone are the pollutants known to cause the highest health damage. But sulphur dioxide, nitrogen oxides, methane, and ammonia are also important, since they further react in ambient air, and can contribute to higher concentrations of PM and ozone.

For both pollutants, the WHO has recently warned again that there are no safe levels (that means there is no threshold below which our health is safe).[1] This means that exposure to these pollutants should be kept as low as possible. However, the air quality standards in Turkey are much less strict than those that the WHO recommends and for some pollutants weaker than what the EU has set (see Annex 2).

LIGNITE COMBUSTION:

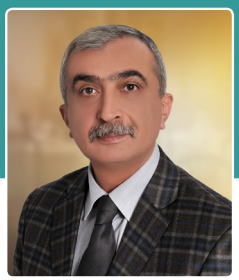
more dangerous to human health

Burning one tonne of lignite, commonly known as brown coal, will usually release less air pollution in comparison to hard coal. However, as lignite has a lower energy content than hard coal, up to three times as much lignite needs to be burned in order to generate the same amount of energy. A lignite plant with the same electrical power output as a hard coal fired plant will thus generally have more hazardous air pollution emissions, correlated also to the lower efficiency of the plant.

In Turkey, 13 existing plants use lignite, with an installed capacity of 8,238 MW (by the end of September 2014)[17].

Most coal-fired power plants in Turkey use lignite, or brown coal. The ash content of lignite and air pollutant emissions from lignite plants are considerably higher than from black coal leading to massive health and environmental problems. The most polluting lignite plants should be urgently phased out for public health, as well as the occupational health of power plant workers.

Cebrail Şimşek, MD, President
Turkish Occupational Medicine Society (İMUD)



Transboundary air pollution from coal power plants

Some air pollutants do not respect national borders. Particulate matter can travel as far as a thousand kilometres and precursors of ozone (so-called volatile organic compounds or VOCs) even beyond that. Nitrogen oxides remain in the atmosphere for about four days, however, it has been demonstrated that nitrogen oxides originating from power plants in South Africa can travel across the Indian Ocean to Australia. Mercury emissions can also reach Turkey and Europe from other parts of the world.

These facts make pollution from coal power plants a global and European and not only a national Turkish problem. Global air pollution is being tackled in the UN Convention on Long-Range Transboundary Air Pollution and its relevant protocols, which aims to reduce emissions of particulate matter, SO2, NOx, non-methane VOCs and ammonia.[18]

The WHO classification of air pollution as carcinogenic to humans (Group 1) showed that our concerns on the severity of the issue we've had and shared for years with the society, as responsible health professionals, were legitimate and sound. It is time to build a stronger alliance among the health community, environmental NGOs and democratic mass organizations, and even a louder advocacy for development of country's energy future independent of coal and other fossil fuels, prioritizing the efficient use of energy and renewable resources. It is an urgent necessity from a public health perspective, as well as it is a constitutional requirement, that the government develops its energy supply policies and supports investments in respect to this common public demand. The transboundary nature of air pollution also highlights the importance of international solidarity in support of these efforts to protect human health.

Prof. Dr. Ali Osman Karababa
President, Doctors for the Environment Turkey

The health damage caused by coal combustion is not limited to the proximity of the power plant, as the exhaust cloud from the smokestack can be transported up to several hundred kilometres and across borders, until pollutants deposit in ecosystems or in people's lungs. The height of smokestacks and wind conditions determine where pollution is transported.

LOCAL
(10km)

Coarse particulates (PM_{10}), nitrogen oxides, sulphur dioxide, acid gases, persistent organic pollutants, heavy metals, dioxins

TRANS-BOUNDARY

Sulphur dioxide, nitrogen oxides, VOCs, heavy metals, dioxins, fine particulates ($PM_{2.5}$)

GLOBAL
(>1000km)

Fine particulate matter ($PM_{2.5}$), mercury, dioxins

Figure 2: Likely scale of diffusion of direct and indirect pollutants from coal power stations

The life cycle of coal and health inequalities

Air pollution from coal power plants can disperse over a large area and across countries and even continents. But communities in the proximity of coal plants can face a particular health risk: in many cases there is also a coal mine, coal waste deposit or ash ponds which bring about further pollution and environmental impacts.

There are currently no estimates of how large these costs from the "life cycle of coal" – that is coal mining, transport, coal combustion and waste disposal are in Turkey or in Europe. For the US, researchers estimated the life cycle costs of coal power generation at up to US $ 500 billion (about 400 billion EUR).[19] These impacts included costs from land disturbance (carbon and methane), public health burden in the studied coal communities, fatalities among the public due to coal transport, emissions of air pollutants from combustion, mercury impacts, subsidies, abandoned mine lands, and climate contribution from combustion.

Limited information for Turkey shows that costs for workers' health and safety in coal mines add to the true cost of coal in Turkey.

Coal miners are often exposed to exceptionally high concentrations of pollutants leading to specific health risks. These include lung diseases such as pneumoconiosis, chronic bronchitis and obstructive lung disease, asthma, and lung cancer as well as tuberculosis and other infections. [20] Occupational dermatological disorders, eye diseases, and infections, such as tetanus, have also been observed.[21]

A major challenge in Turkey is that the official statistics about occupational diseases are not comparable and consistent with the medical literature. For instance, the Ministry of Labour and Social Security registers only 170 new cases of occupational disease, 23 permanent incapacity reports and three deaths due to occupational diseases in the coal and lignite mining sector in 2011.[22] However, workplace-based studies on respiratory diseases suggest that 20,000 out of 220,000 workers in mining sector could have pneumoconiosis and approximately 5,000 new pneumoconiosis cases may have occurred each year.[23]

In addition to chronic illnesses, insufficient occupational safety regulations and practices along with lack of proper auditing result in severe occupational injuries and disabilities, and mortality in miners. According to the Union of Chambers of Turkish Engineers and Architects (UCTEA), coal and lignite mining is sector with the highest level of occupational accidents, and the second highest level of occupational fatalities in Turkey.[24] Another study shows that Turkey has one of world's worst coal mining safety records. Between the years 2007-2012, Turkey came second after China, the biggest coal producer in the world, in terms of fatalities per million tonnes of coal produced.

The Soma Disaster in May 2014 claimed the lives of 301 workers making it one of the biggest accidents in terms of fatalities in the world's mining history.[25] In 2014, at least 347 workers died in 26 recorded accidents in Turkish hard coal and lignite mines.[26]

From a community health perspective, however, it is also important to pay attention to possible socio-economic and negative health impacts for people affected by the closure of coal power plants. While a move away from coal will definitely bring benefits for the general population, the loss of a workplace and decline in household income can lead to significant health and social impacts in former industrial areas, if no strategy for transformation exists. Adequate training systems and employment initiatives for affected communities are essential to overcome barriers to re-employment.

The need for nationwide re-employment strategies is further emphasised due to the fact that there are at least 55,500 workers in the hard coal and lignite mining sector in Turkey.[27] This number is based on estimates of direct employment in the sector. For a realistic estimate of total number of coal and lignite miners, the activities of the subcontracting companies should be taken into consideration as they have made up a larger proportion of employment since privatisation,[28] and informal employment in the sector.

Health damage from coal power plant emissions

How the inhalation of particulate matter may affect our health

Lungs

- Inflammation
- Oxidative stress
- Accelerated progression and exacerbation of COPD
- Increased respiratory symptoms
- Effected pulmonary reflexes
- Reduced lung function
- Higher lung cancer risk

Brain

- Increased cerebrovascular ischemia
- ADHD

Heart

- Altered cardiac autonomic function
- Oxidative stress
- Increased dysrhythmic susceptibility
- Altered cardiac repolarisaion
- Increased myocardial ischemia

Blood

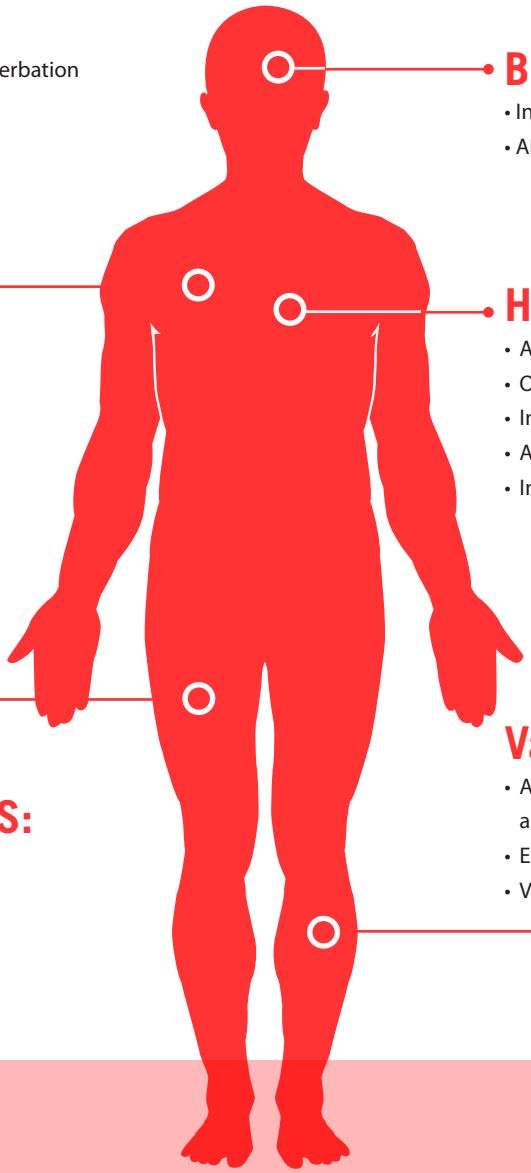
- Altered rheology
- Increased coagulability
- Translocated particles
- Peripheral thrombosis
- Reduced oxygen saturation

Vasculature

- Atherosclerosis, accelerated progression and destabilisation of plaques
- Endothelial dysfunction
- Vasoconstriction and hypertension

FURTHER IMPACTS:

- Reduced birth weight
- Pre-term birth
- Skin, bladder cancer
- Diabetes



Children, even before birth, are particularly susceptible to air pollutants. Increasing evidence shows how early-life exposure to air pollutants is contributing to higher risks of developing chronic diseases later in life, including obesity, diabetes, and hormone related cancers. Furthermore, recent studies found associations between exposure to outdoor air pollution during pregnancy and lower birth weight, as well as higher rates of preterm birth and pre-eclampsia.

Source: Adapted from APHEKOM project 2012; and Pope&Dockery 2006

Health damage from coal power plant emissions

Coal power plants release large amounts of pollutants into the air, contributing to already poor air quality in Turkey. The impacts and damage caused by air pollution on our health are well documented. In a comprehensive review of the body of evidence the WHO recently concluded that health effects can happen at lower concentrations and that the range of health impacts is larger than previously thought.[1] Air pollution not only impacts heart and lung health, it is increasingly shown to damage children's development, and even linked to diabetes.

Respiratory system

Coal fumes contribute to polluting the air with NO_x, SO_2, PM and secondary ozone,[29] which can cause or exacerbate different respiratory conditions. Ozone exposure leads to acute breathing difficulties and exacerbates conditions such as asthma and chronic obstructive pulmonary disease (COPD). Longer exposure to certain levels of fine particulates can result in COPD[30], a group of lung diseases including chronic bronchitis and emphysema, which are characterised by airways becoming narrowed, shortness of breath, and continuing decline of lung function.

In a recent systematic review and meta-analysis, it was reported that exposure to concentrations of total suspended particulates (TSM < 40 µg) higher than 200 µg/m^3 increases COPD incidence 1.33 times; and that exposure to high levels of PM increases COPD prevalence by 11%.

Fine particulates are even associated with increased mortality rates for lung cancer.[31,32] In addition, diagnosed COPD is also a risk factor for lung cancer mortality.[33]

In a recent study, the reduction of PM2.5 mass levels explained a significant fraction of the declining mortality due to lung cancer, as well as cardiovascular and neurological causes.

Asthma is a major respiratory disease and can be triggered by air pollution. In particular, ozone exposure can trigger or exacerbate asthma symptoms.[34] Particulate matter is known to aggravate asthma symptoms too[35] but it is also suspected to contribute to asthma development.[36] The European research project APHEKOM found that 15-30% of new asthma cases in children were explained by the child living close to busy roads and thus being exposed to higher local levels of air pollution. In many cases the asthma will persist throughout the person's whole life. It is estimated that there are 3.5 million asthma patients in Turkey.

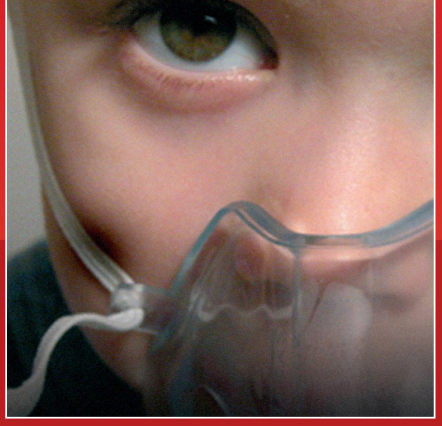
Outdoor air pollution leading environmental cause of cancer deaths

The specialised cancer agency of the WHO, the International Agency for Research on Cancer (IARC) has classified outdoor air pollution *as carcinogenic to humans* (Group 1).[38]

After thoroughly reviewing the latest available scientific literature, the world's leading experts convened by the IARC Monographs Programme concluded that there is *sufficient evidence* that exposure to outdoor air pollution causes lung cancer. They also noted a positive association between air pollution and an increased risk of bladder cancer.

Particulate matter (PM), a major component of outdoor air pollution, was evaluated separately and was also classified as carcinogenic to *humans* (Group 1).[38]

The IARC evaluation showed an increasing risk of lung cancer with increasing levels of exposure to particulate matter and air pollution. Although the composition of air pollution and levels of exposure can vary dramatically between locations, the conclusions of the Working Group apply to all regions of the world.



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Only 500.000

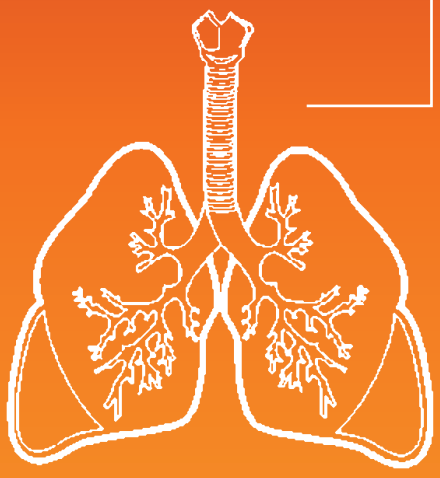
out of 5 million COPD patients in Turkey are diagnosed.

2 million

children in Turkey suffer from asthma

5-7% of adults

in Turkey have asthma



25,658 people died

in 2014 in Turkey due to chronic lower respiratory diseases.

23,642 people died

in 2104 in Turkey from cancer of the respiratory system, which is 31% of all cancer deaths.

Lung disease is a major health concern in Turkey. About 9% of National Disease Burden is composed of respiratory diseases. Cleaner air will lead to rapid health improvements. We know this because on days when air pollution has fluctuated upwards the numbers of asthma attacks, hospitalisations, and even deaths have increased.

Filiz Koşar, MD
President, Turkish Respiratory Society (TRS)

Turkish doctors and public health specialists know air pollution to be an important risk factor for health. Our Society is committed to bring the evidence on air pollution and health to the citizens and decision-makers to improve air quality. One policy change that is overdue is to include limit values for PM2.5 in the Turkish air quality legislation, and strengthen PM10 limit values to the limits recommended by the World Health Organization. Daily measurement and monitoring of PM2.5 levels must be ensured all over the country, and immediate measures must be taken to protect public health, together with effective public announcement, in severely polluted areas.

Assoc. Prof. Haluk C. Çalışır
Chair of Air Pollution Working Group,
Turkish Thoracic Society

Cardiovascular system

Air pollution's negative impact on cardiovascular health is increasingly acknowledged in the peer reviewed literature. Overall there is a clear positive correlation between air pollution and rates of major cardiovascular diseases, as well as cardiovascular mortality. The link is the strongest for particulate matter. A systematic review suggests that cardiovascular mortality rises by 12% to 14% per 10 microgram increase of fine particulate concentrations.[39]

Even short-term exposure to fine particulate matter can trigger myocardial infarctions, symptoms of ischemic (coronary) heart disease, stroke and heart arrhythmias, and cause death. Increased hospital admissions due to these conditions have been documented for periods with elevated fine particulates in ambient air.[40] Long term PM exposure increases the risk for developing a variety of cardiovascular diseases, including hypertension and atherosclerosis.[41]

Fine particles with a diameter of less than 2.5 microns are small enough to penetrate the lung tissue and enter the blood stream. A recent literature review provides evidence that these particles can cause inflammation of cardiovascular tissue as well as coagulation of the blood.[42] Exposure to air pollution can thus be linked to artery blockages, which lead to heart attacks. [43] The exact mechanisms through which air pollutants impact cardiovascular health are not yet fully understood.

40% of deaths

in Turkey are attributable to cardiovascular diseases

2.5 microns

or less is the diameter of the particles that affect cardiovascular health

12-14%

higher mortality rates have been associated with an increase of 10 microgram particle mass per cubic meter of air

151,696

people died in 2014 in Turkey from cardiovascular and circulatory system diseases.

Brain and nervous system

Air pollutants affect the arteries that nourish the brain in the same way as they affect the coronary arteries. Inflammation and oxidative stress due to short or long-term exposure to air pollution can cause ischemic stroke and other cerebrovascular disease. An ischemic stroke is triggered by low blood supply to parts of the brain. Enhanced exposure to $PM_{2.5}$ has been correlated with an increase in hospital admission rates for ischemic stroke and other cerebrovascular diseases.[44] In particular, there is strong epidemiologic evidence for a causal relationship between exposure to particulate matter and the occurrence of cerebrovascular disease (stroke and cerebral venous thrombosis) among people with diabetes.[45]

Although a small proportion of all strokes appear to be related to air pollutants, the large number of people who suffer from a stroke means that even this small risk leads to a large total health impact.[46] Stroke events in Europe were 1.1million per year in 2000, projected to rise to more than 1.5 million per year in 2025.[47]

Health impacts from heavy metals and organic pollutants

Coal burning is one of the most significant anthropogenic source of mercury emissions to the atmosphere.[48] Coal power plants are the biggest source of mercury in Europe and estimated to be so also in Turkey.[49,50] A recent study on substance flow analysis of mercury showed that 10,551 kg of mercury was emitted into the environment in Turkey from coal combustion in large coal power plants a year (88% of this mercury was released into the air).[51]

Mercury emitted to the air by coal power plants is deposited through precipitation and enters the water cycle, where it is then transformed to its organic form of methylmercury by certain bacteria. Methylmercury accumulates as it moves up the food chain and reaches the highest concentrations in long living fish species. Human exposure to the neurotoxic methylmercury is mainly derived from the consumption of contaminated fish. Increased levels of methylmercury in fish have been shown in the proximity of a coal power plant, although selenium emissions from the same source partly masked the effect in this study.[52]

Organic mercury taken up through food is notorious as a nervous system toxicant and can cause birth defects. It greatly impacts the brain development of children. This damage is neurologically irreversible, and mostly arises from exposure during early foetal development. Brain injury happens at doses much lower than previously recognised and there may be no safe level of mercury in the body of pregnant women.[53]

New evidence shows that children exposed to mercury or lead are three to five times more likely to have problems associated with Attention Deficit Hyperactivity Disorder (ADHD), including if the exposure happens before birth.[55]

There are scientific studies showing significant heavy metal exposure, which are over limit values, in residents (especially children) of highly industrialized regions in Turkey.

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MERCURY

Estimates for current levels of mercury exposure, both within and outside Europe, give rise to great concern. A recent study has estimated that about 200,000 children born in Europe each year have been exposed to critical levels of methylmercury in the womb, with associated health costs resulting from lost IQ exceeding 9 billion EUR per year for the EU-27 member states.[56]

A new United Nations treaty, the so-called Minamata Convention, aims at the phase out of human-made mercury emissions. Countries commit to implement technical measures to decrease mercury emissions from coal power plants.[57] Turkey has signed the Minamata Convention (September 2014) but not yet ratified it.

Turkey's rate of increase of GHG emissions is the highest among OECD countries, in which coal-fired power plants contribute significantly. The rapid increase of its GHG emissions puts Turkey's chance to combat climate change into jeopardy, as well as country's ability to comply with international agreements on the issue. On the other hand, environmental impacts of coal-fired power plants are not limited to massive GHG emissions. They have negative impacts on water resources' quality and quantity, due to their high water consumption; and produce high amounts of ash as waste. They also cause air pollution through emissions of carcinogenic heavy metals and radioactive particulates. These plants are one of the top emitters of PM10. Lately, PM10 concentrations have been monitored to exceed WHO standards in considerable number of cities in Turkey. Turkey is ranked first by means of levels of air pollution among OECD countries. Coal-fired power plants have negative impacts on human health due to the environmental pollution they create. Allergic reactions, asthma, COPD, and cancers are observed especially in power plant workers and residents of their immediate vicinity.

Prof. Dr. Türkan Günay
President, Turkish Society of Public Health Specialists (HASUDER)

LEAD

THE HEAVY METAL LEAD IS ALSO...

emitted by some coal power plants. Like mercury, lead damages the developing nervous system of children. In adults it can disturb the functioning of the cardiovascular system, which can lead to death, cause hypertension or anaemia.[58] It affects almost every system of the body and is directly poisonous in high concentrations. Other metals and semi-metals (which are often included in the terminology "heavy metals" in medicinal contexts) emitted by coal fired power stations include the carcinogens arsenic, beryllium and chromium.

POPs

PERSISTENT ORGANIC POLLUTANTS (POPs) SUCH AS DIOXIN DO NOT...

break down and can remain in the environment for many years. Dioxins are the most dangerous POP and are created as unintentional by-products in coal combustion, but they are only released in very small quantities. Dioxins can be transported over long distances and can cause significant harm even at very low concentrations. Some dioxins can be carcinogenic[59], mutagenic (alter genes), neurotoxic or reprotoxic (damage the nervous system or the reproductive system),[60] and at least one is known to be an endocrine disruptor (it interferes with human hormone systems).[61] Other POPs originating from coal combustion are from the group of polycyclic aromatic hydrocarbons (PAHs), some of which are carcinogenic.[62]

Climate change: A mounting health risk

Coal combustion is responsible for enormous greenhouse gas emissions, which accelerate climate change and thus contribute to a number of present and future health risks in Turkey, Europe and at the global level. Coal combustion therefore has indirect health impacts as well. In Turkey, power generation contributes to about 27% of the country's total greenhouse gas emissions in 2012. Among all fuels used in thermal power generation, coal is the most carbon-intensive energy source.[63]

Climate change is one of the biggest health challenge of our times. Recent studies underline that because of global warming, we are likely to see an increase in asthma, respiratory allergies, and airways diseases. Cancer, cardiovascular disease, stroke, heat-related disease and deaths, mental health impacts and stress-related disorders are also potential health consequences of climate change.

According to the International Panel on Climate Change (IPCC)'s Fifth Assessment Report (AR5), climate change is already observed: "Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased". Most sophisticated climate models project a change in global mean surface temperatures of between 1.5 and 4.5°C for the period of 1990-2100 (high confidence).[64]

Experience in Turkey

Over the last 25 years, changes in the climate have taken place. Temperature regimes have shifted towards warmer and hot ranges; the frequency or intensity of heat waves events has likely increased, as well as extreme precipitation events. Climate scientists project reductions in precipitation, increases in the frequency and duration of air temperatures, evaporation, heat waves and drought in Turkey and it is expected that the country will be adversely affected by climate change like many of the other countries in the Mediterranean Region.[65,66]

These changes are expected to result in health impacts due to heat stress and extreme weather events, or impacts due to prolonged allergy seasons and new allergens because of invasive plants, alterations of environmental conditions and populations of vectors, viruses, rodents, and insects, increased air pollution, and UV radiation, and impacts on food and water resources.[67,68]

The population groups that are likely to be hit hardest by climate change include the elderly, children and those already suffering from health problems. However, persons with a low socio-economic status are also at special risk. Globally the impacts of unmitigated climate change will affect the health of billions of people.

Turkey and the other 52 countries who are members of WHO have started to take steps to prepare the health sector to adapt to the threats because of climate change, but also measures to mitigate climate change, which will be beneficial for health. In 2010, they adopted the Parma Declaration and Commitment to act, which also includes actions to mitigate and adapt to climate change.[69]

In 2014, Turkey adopted a National Programme and Action Plan for Mitigating the Health Effects of Climate Change. The plan includes research and development initiatives for identification, monitoring, and mitigating health problems attributable to climate change; determination of vulnerability among different social groups; and improvement of public health infrastructure, communication and education. admissions will increase two to three times more among respiratory patients than on average.

Health Impact Cost Assessment

The unfair economics of health impacts from coal power generation

Until recently, the costs to health associated with exposure to coal fumes were not measured. They are referred to as "external costs" because they are not integrated into the price of the coal or to the price of the electricity generated from coal. This means that instead of industry paying the health bill, the population and government carry the burden.

This report is called "The Unpaid Health Bill - how coal power plants in Turkey make us sick" because although much ill health is caused by exposure to coal fumes, the companies producing this pollution do not carry the costs for the associated suffering.

In 2013, HEAL decided to commission an expert assessment of the health impacts and their costs related to exposure to polluted air from coal-fired combustion plants in Europe. The current assessment is an update of this report with new emissions data and new evidence on health effects for Turkey.

The process involves modelling the dispersion of the pollutants in the atmosphere and taking into account the size of the population that is exposed. In the EU, power plants are obliged to report their annual emissions to the EU, namely the European Pollutant Release and Transfer Register E-PRTR which makes these data publicly available. However, there is no similar pollutant registry system in Turkey.

Turkey adopted the EU Directive on Large Combustion Plants in 2010; and has recently merged it with the Regulation on Industrial Air Pollution Control.[70] However the harmonisation with the EU air quality legislation is not complete , and the Industrial Emissions Directive, which will replace the LCP Directive in the EU by 2016, has not yet been adopted. (See Annex 2).[71] According to the currently amended Regulation on Industrial Air Pollution Control, the operator should submit an annual report including total annual SO_2, NO_X and dust emissions of the power plant. However, these reports are not publicly available; thus environmental performances of coal power plants cannot be verified by the public.

Although Turkey is a party to the Convention on Long-range Transboundary Air Pollution, and not the protocols except for the EMEP, it only reports NO_x, SO_2, NMVOC, NH_3 , CO and PM_{10} emissions. It does not report $PM_{2.5}$ and heavy metal emissions, which are key to public health.

The available data leads to the conclusion that the coal power generation has already been a threat for public health in the country for decades. Turkey has the 15th biggest existing coal power fleet.[72]

The total installed capacity in operation in the country is 14,636 MW at the end of 2014; this includes 8,238.40 MW for lignite, 6,062.60 MW for imported coal, and 335 MW for domestic hard coal. [73] There are 21 coal power plants in operation that are larger than 50 MW (falling under the definition of a Large Combustion Plant of both the EU and Turkey).

Half of these large plants are between 26-57 years old, and there are concerns about the environmental performance of these plants (e.g. instalment of filters),that official monitoring results are not publicly available, and concerns about the privatisation of many plants, which will prolong the lifetime of the fleet.

RESULTS OF HEAL EXPERT ASSESSMENT

Following the expert assessment of the health impacts and costs from coal-fired combustion plants for 30 countries in Europe, in 2015 HEAL commissioned an additional assessment for Turkey, based on updated emissions data and new science on health effects of air pollution.

The starting point for the Turkish assessment is the Global Burden of Disease study, and the emissions data is taken from the Turkish government's reporting under the UN Convention on Long-Range Transboundary Air Pollution (CLRTAP). The calculation of health impacts and related costs is based on the same methodology as used by the EU Commission and the WHO. Detailed information on the methodology and data sources can be found in the technical report in Annex 1.

- The total health impacts from coal combustion plants in Turkey amount to 86,393 life years lost, or 2,876 premature deaths per year.
- Chronic health effects were calculated with 3,823 new cases of chronic bronchitis in adults every year, and 4,311 hospital admissions due to respiratory or cardiovascular conditions were additionally attributed to coal pollution in Turkey.
- Acute impacts are for example 225,384 asthma symptom days in children.
- Ill-health causes people to miss their work or at least limit their active tasks on certain days. About 637,643 lost working days out of a total of 7,976,070 restricted activity days for the working age population were associated with coal power plant emissions in Turkey.

The main findings are:

Figure 3: Health impacts and costs associated with exposure to particulate matter, from emissions from Turkish coal power plants, in Turkey.

Health Impact	Number	€ million
Deaths, adults	2,876	3,110
Life years lost, adults	86,393	2,428
Infant deaths	13	22
Chronic Bronchitis, adults	3,823	100
Bronchitis in children	27,576	8
Respiratory Hospital Admissions, all ages	2,864	3
Cardiac Hospital Admissions, all ages	1,447	2
Restricted Activity Days, all ages	7,976,070	357
Asthma symptom days, children	225,384	5
Lost working days	637,643	40
Total value (low)		2,964
Total value (high)		3,646

Which health costs are not included in this report?

The report covers respiratory and cardiovascular conditions but it does not provide for a calculation of the health costs for strokes or health impacts through the emission of mercury from coal plants; nor does it include health costs through the full life cycle of coal (for example, health costs of mining, or related socio-economic impacts).

In addition, the analysis does not include transboundary air pollution, so neither a quantification of the health damage from coal plants in the countries neighbouring Turkey, nor health costs on neighbouring countries borne from coal plants in Turkey. Data is not available for these effects, so only health costs that occur in Turkey are considered.

SHOULD COAL POWER GENERATION HAVE A FUTURE IN TURKEY?

The global coal plant pipeline and Turkey's portfolio

As of 2005 onwards, the world saw a boom in coal power generation with an increase of twice the capacity of the entire existing US coal fleet. The biggest investments are scheduled to happen in China, even though the country recently saw declines in plant utilisation rates and capacity additions. In the U.S. in the EU, coal power generation is now on a downward trend. [72]

Turkey is one of the countries on track for a huge increase in coal power generation, defying the slowdown in Europe (together with the Balkan countries and Poland). More than 80 new coal-fired power plants are in the pipeline, with a total capacity of over 65 GW. This makes it the country with the largest coal investments in the European region, and the third biggest globally, after China and India.

The three biggest projects would draw on domestic coal in their respective regions: the 3,500 MW Dinar power station, the 5,000 MW Konya Karapınar power station and the addition of up to 7,000 MW of new coal plants at the Afşin-Elbistan power complex.

At the same time, public resistance to coal power generation is growing: following six years of advocacy work by the Yaykıl villagers and environmental groups, the impact assessment process for the 1,200 MW project in Gerze, in the Black Sea region was permanently cancelled by the Ministry of Environment and Urbanization in February 2015. [74] The Hema power station in Amasra (1,320 MW), the Cenal power station in Çanakkale (1,320 MW), and the Selena power station in Hatay (900 MW) are facing delays due to legal and public challenges. [75,76]

Figure 4: The top ten countries with the largest planned coal investment

Ranking	Country	Region	Announced (MW)	Pre-permit development (MW)	Permitted (MW)	Construction (MW)	Total Pipeline (GW)
1	China	East Asia	218,310	229,960	48,060	116,610	612.94
2	India	South Asia	75,820	145,276	75,973	69,471	366.54
3	Turkey	Europe – non EU	19,084	38,784	2,537	5,035	65.44
4	Vietnam	Southeast Asia	28,020	0	16,200	17,090	61.31
5	Indonesia	Southeast Asia	15,570	10,300	1,620	5,116	32.61
6	South Africa	Africa and Middle East	4,765	3,165	0	9,828	17.76
7	South Korea	East Asia	100	0	0	14,840	14.94
8	Japan	East Asia	8,022	3,649	1,000	767	13.44
9	Bangladesh	South Asia	6,637	4,715	0	0	11.35
10	Poland	Europe - EU	5,833	335	460	3,785	10.41

Adapted from: Shearer C. et al. (2015).

Turkey's coal challenge

Turkey is the fifth biggest lignite producer in the world, with a total of 63 million tonnes produced in 2013.[77] The Turkish government intends to further exploit the country's domestic resources of lignite because they regard it as a cheap fuel contributing to national energy security, although it is the dirtiest and least efficient form of coal.

Coal is still one of the major sources of power supply in Turkey: 26% or one in four kilowatt hours of electricity generated is provided by coal power plants.[78] Lignite's contribution to total electricity generation in 2013 was 13.3%, while import coal's was 12.2% in 2013.[79] Roughly 47 million tons of lignite and 12 million tons of hard coal were burned in Turkey in the same year in power plants. The obvious lack of correlation with the electrical output data is due to the lower calorific value of lignite, requiring more fuel to be burnt.

According to the Turkish Energy Market Regulatory Authority (EPDK) (2015) existing coal power capacity utilizes 55% lignite, and 44% hard coal. Only 2.2% of the power generation capacity operates on domestic hard coal due to limited reserves of the country.[80]

Around 80 new coal power plants are currently in the pipeline in Turkey. The strategic plan of the Ministry of Energy foresees an increase in electricity generation from domestic coal to 60 billion kWh annually by 2019, almost doubling capacity in the next 4 years. According to Turkish government targets, 20% of the installed capacity will be from lignite in 2030, which requires at least 26,8 GW of lignite capacity to be built in addition to the existing 8,238.4 MW. This plan is judged as technically and financially unrealistic by energy sector experts.[81]

Regarding hard coal, proposal from the government and energy sector aim to increase the capacity of imported hard coal to about 30 GW (These are ongoing investments, or plants applied for, or plants in assessment-evaluation, or approval stages). If all of these projects are built, together with the existing plants, half of Turkey's installed capacity (i.e. 35,444 MW) would depend on imported coal.[82] This contradicts the government's claims that adding new coal capacity would increase energy security and decrease the country's dependency on energy imports.

The average life span of a coal power plant is at least 40 years. If any of the 80+ new coal power plants were built, be it lignite or hard coal plants, millions of tons of hazardous air pollution, massive health damage and greenhouse gas emissions would be locked in for decades. This unhealthy future has to be avoided.

In line with its energy supply strategy, the Turkish government continues to subsidise coal investments, disregarding the social, environmental and health costs from coal power generation. A recent study of the International Institute for Sustainable Development, which compares subsidies to coal and renewable energy provided by the Turkish government, found that there were significant subsidies to coal in Turkey to a value of US$ 730 million in 2013, including direct transfers to the hard coal industry, subsidies to exploration of coal resources, and rehabilitation of power stations. However, if health and environment related externalities are included in assesment of energy costs, electricity generations from wind and solar is already cheaper than coal generation for Turkey.[81]

Why a move away from coal is important for the climate and our health

Runaway climate change, which could already be triggered by 2 degrees Celsius of global temperature rise and which would cause immeasurable impacts on human health, must be avoided. Therefore, global greenhouse gas emissions have to decline steeply over the next decades.[83]

Anything other than a substantial reduction in the amount of coal consumed for power generation would move this target out of reach, even if technology was to be applied in all new and most of the existing plants to reduce CO_2emissions.[84]

Although being party to both the UNFCCC and the Kyoto Protocol, to date Turkey did not commit to any reduction target for its greenhouse gas emissions in international climate change negotiations.[85] However, being part of G20, a member of OECD, a candidate for EU membership and a member of WHO Europe, it is not diplomatically and economically realistic for the country to postpone taking a substantial responsibility in global combat against climate change.

The huge public health benefits that arise from decreasing the burning of fossil fuels such as coal can substantially mitigate costs of greenhouse gas reductions. Putting it the other way around, mitigating climate change saves enormous costs in air pollution control as well as in climate change adaptation. Importantly, the health benefits already occur at a short and medium time scale.

In February 2015, the over 100 associations of the World Federation of Public Health Associations (WFPHA) adopted the Kolkata Call to Action, the strongest yet to emerge from the global public health community.[86] The WFPHA points to the contribution of fossil fuels and coal in particular to climate change as well as to detrimental impacts on the health and wellbeing of local communities. They therefore advocate for a rapid phase-out of coal to limit further global warming and prevent illnesses and deaths associated with air pollution and a transition to renewable energy.

At national level, doctors and other health experts are also adding their voice in the debates on climate change and energy. In the UK, the British Medical Association voted in favour of an end to its investments in fossil fuels in June 2014. In Serbia, more than 50 experts came together in October 2014 to discuss coal and health and have issued a statement to move away from coal. The German Medical Association is also looking into the health benefits and risks of energy transition. And in Poland, the health community advocates for considering health in future decisions on energy.[87]

In Turkey, medical professionals have a long record of speaking out against air pollution, particularly against health impacts of coal power plants.[88] In October 2014, five Turkish medical organisations, led by the Turkish Medical Association (TTB), stated their concerns about coal power plants, highlighting that these plants have a significant impact on the health of the Turkish population. They call on the Turkish government not to go ahead with the building of new plants, make binding the use of best available techniques for existing plants and start the phase out of coal plants.[89] Since November 2014, TTB and specialty associations who are active in public health issues, together with environmental NGOs, regularly meet and consult each other on the increasing coal threat the Turkish population faces.

POLICY RECOMMENDATIONS

TO MEDICAL PROFESSIONALS AND PUBLIC HEALTH EXPERTS:

The time is right for advocacy on the health damage from coal. Based on the established scientific evidence about the health risks from coal combustion, doctors and health organisations can increase their engagement in debates about Turkey's future energy supply.

THEY SHOULD >>>>>

- Highlight to Turkish decision makers that the health impacts and external costs of coal have to be taken into account in energy decisions. From a health perspective, building new coal power plants is detrimental to efforts of tackling chronic disease and creates high costs.
- Advocate for the establishment of clearly defined, transparent, official consultation processes within energy and environmental policy and strategy development mechanisms at the national level.
- Advocate for improved transparency and access to environmental information and public participation in energy/environmental decision mechanisms at all levels.
- Become involved in the debates on higher air quality standards nationally that are harmonized with the WHO recommendations for improved public health.
- Become involved in the debates for more ambitious climate action nationally and at the international level.
- Raise awareness on the health risks from coal power in local consultation processes (such as environmental impact assessment of coal projects and development of regional/provincial environmental plans) and help to ensure the enforcement of better pollution control for existing coal in order to protect public health.

TO THE TURKISH GOVERNMENT AND PUBLIC AUTHORITIES:

The government needs to increase efforts to reduce outdoor air pollution from coal power plants, in the interest of their citizens' health but also of their neighbouring countries, and as a contribution to the global efforts to combat climate change.

DECISION-MAKERS SHOULD >>>>>

- End all exemptions from the highest pollution control standards for existing coal plants.
- Increase efforts to harmonise air quality and emissions legislation with EU frameworks, and tackle monitoring and data gaps.
- Develop accessible and transparent decision-making processes for national energy deliberations and for individual energy projects for the health and medical community and other civil society actors, in conjunction with improved public access to information. It is key that the ministry of health is involved and consulted with in all these decision-processes.
- End all direct and indirect subsidies and tax exemptions for coal power generation.
- Investigate - particularly the Ministry of Health - the win-wins for health and the climate from not building the 80+ new coal-fired power plants.
- Introduce a moratorium on the construction of new coal power plants.
- Develop a national phase-out plan for coal in power generation, building on a health and external cost impact assessment for existing and new coal plans. It is key that the Ministry of Health is involved and consulted with in all these decision-processes.

TO INTERNATIONAL ACTORS:

The planned massive investment in coal power would put Turkey on the wrong track for health protection and tackling climate change. International actors, including the United Nations, the EU, the World Bank, together with other international development agencies and bilateral donors, should promote an energy future for Turkey which does not rely on coal power generation, as part of the sustainable development of the country.

THEY SHOULD >>

- End all international lending for the building of new coal plants that would contribute to an increase in coal capacity.
- Insist on Turkey's full compliance with international agreements and conventions on health, environment and climate change to which the country is a party, and to foster the inclusion of Turkey into those international agreements currently not endorsed.
- Encourage improved sustainability, transparency and governance criteria in energy projects of Turkey.

ANNEX 1

TECHNICAL REPORT, METHOD FOR THE HEALTH IMPACT ASSESSMENT

Estimating Air Pollution Impacts on Health for Turkey –

by Mike Holland

Introduction

Previous research by the European Environment Agency (EEA)[90, 91] has highlighted the impacts of industrial emissions of air pollutants on health. This work has been supplemented by HEAL (2013), considering emissions from coal fired power plants.

The 2011 report from the EEA provided estimates of health damage per tonne emission for the air pollutants NH_3, NO_x, $PM_{2.5}$, SO_2 and VOCs, for most European countries.[90] Data were used to quantify the damage from individual industrial facilities in a number of European countries, those that reported emissions to the EEA through the European-Pollutant Release and Transfer Register (E-PRTR). Although damage per tonne figures were given for Turkey in the appendices to the report, no Turkish facilities were included in the analysis in the main body of the report as they do not report to the E-PRTR.

The second EEA report[91] provided updated damage per tonne estimates, though not for Turkey. Turkey was not included because it was omitted from the revised pollutant transfer matrix on which calculations were made. In addition to updating the damage numbers to account for changes in the EMEP dispersion model and associated baseline emission scenarios, the updated results also accounted for improvements to the health impact assessment drawing on the recommendations of WHO under the HRAPIE Project (Health Response to Air Pollution in Europe: WHO 2013) [92], updated incidence data for various health effects taking better account of national conditions (Holland, 2014a) and updated valuations (Holland, 2014b) [93].

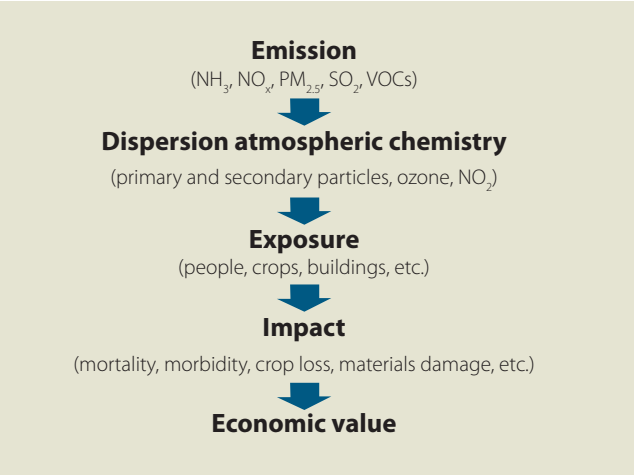
It would be possible to take the earlier dispersion modelling, used in the 2011 report, and apply the updated functions and valuations to generate new damage per tonne estimates. However, the position of Turkey at the very edge of the modelling domain introduces additional issues, unknown sensitivity to the methodological changes to the dispersion modelling and the extent to which impacts in neighbouring countries are fully accounted for.

Recognising these issues, an alternative approach is applied here, taking as the starting point the results of the Global Burden of Disease (GBD) study, which provides estimates of mortality in all countries of the world from various causes, including exposure to air pollution[94].

Methods

As just noted, the GBD study is used here as the starting point for analysis. GBD estimates a total mortality impact in Turkey equivalent to 28,000 deaths and 722,000 lost years of life. The GBD analysis, like the studies by EEA and Holland follows the impact pathway approach, tracking emissions from source to exposure of the population and subsequent health impact.[95]

Figure 1a. Impact Pathway Approach, tracing the consequences of pollutant release from emission to impact and economic value.



The general form of the equation for the calculation of impacts is:

Impact = Pollution level x Stock at risk x Response function

From analysis using the updated ALPHA-Riskpoll model of Holland (2014b) that applies the full set of HRAPIE functions, incidence data and valuations it is then possible to quantify the morbidity impacts and convert to an economic equivalent, simply by scaling against the morbidity impact. The economic values from Holland (2014b) were developed to reflect preferences in the EU, which are a function of income levels. These can be adjusted to reflect Turkish conditions (Turkish public preference for resource allocation) using methods described by OECD (2012)[96] that introduce a factor 0.487 to the analysis. A price year of 2005 is adopted, as this is still the year used to price abatement technologies in European analysis.

Emission estimates are taken from two sources, Turkey's latest (2014) submission under the Convention on Long Range Transboundary Air Pollution[97] covering emissions for the year 2012, and a bottom-up analysis by L. Myllyvirta of Greenpeace (personal communication), using data for individual power plant reported by the Ministry of Environment and Forestry under the Air Quality Twinning Project between German and Turkish authorities. Emissions data are shown in Table 1. The coal and lignite share of power sector emissions is not provided directly by the CLRTAP return, but has been estimated from the Greenpeace work, which indicates that 86% of power sector SO_2 emissions are from the use of coal and lignite, and 57% of NOx emissions; the residual emissions are from use of fuel oil and natural gas. There are clear differences between the CLRTAP and Greenpeace estimates for the power sector: CLRTAP shows much higher SO_2 emissions but lower NO_x and PM_{10} emissions. The official (CLRTAP) PM_{10} emission estimates seem very low indeed, relative to the other data shown. For this reason, both the CLRTAP and Greenpeace estimates are used to calculate effects.

Table 1. Emissions data for Turkey. CLRTAP data are for 2012. Units: tonnes/year.

SOURCE	SECTOR	NO_x	PM_{10}	SO_2	NH_3	VOCs
CLRTAP	National total	1,117,327	728,830	2,652,705	1,079,462	562,714
CLRTAP	Public electricity, heat	269,797	7,653	1,362,109		
CLRTAP	Public electricity, heat sector, coal, lignite	154,324	7,653	1,168,690		
Greenpeace	Power sector, coal, lignite	255,767	54,890	760,052		

Emissions of ammonia and non-methane volatile organic compounds (NMVOCs) are included in this table because they contribute to particle formation. However, emissions of these pollutants from the energy sector are low, here assumed negligible.

Before attributing damage to each pollutant and the public power sector, there are four issues to consider:

1. Conversion of the mass of PM10 to the PM2.5 metric used in the EEA modeling. This is simply done using the following relationship from EEA (2014) 91: PM2.5 = 0.65xPM10.

2. The relative potency of emissions with respect to their health impacts mediated through particulate exposure. Comparison of results for the pollutants from EEA (2014) in South Eastern European countries (Albania, Bosnia and Herzegovina, Bulgaria, Cyprus, Greece, TFYR Macedonia, Moldova, Romania, and Serbia and Montenegro) more generally gives the following results for damage caused by NOx and SO2 emissions relative to PM2.5 (NH3 and VOC emissions are also included, to account for their role in PM formation):

Table 2. Health damage from NH_3, NO_x, SO_2 and VOC emissions in SE Europe relative to $PM_{2.5}$.

	NH_3:$PM_{2.5}$	NO_x:$PM_{2.5}$	SO_2:$PM_{2.5}$	VOC:$PM_{2.5}$
Average	36%	13%	28%	3%
Minimum	18%	5%	15%	1%
Maximum	46%	20%	36%	4%

3. How much of the damage occurring within Turkey is attributable to pollutants released within the country, and how much to pollutants released from neighbouring countries? This can be inferred from data for other large countries that are covered by the EMEP transfer matrices (Table 3), assuming broadly similar emission rates in surrounding countries. To interpret the table, if a pollutant scored 100%, all impacts associated with that pollutant would occur in the country where emissions originate. If a pollutant scored 0%, all impacts would occur outside the country of origin. The highest score is 76% on average, for $PM_{2.5}$. That this pollutant scores highest is not surprising, as it is the only pollutant for which impacts are linked to the pollutant in the state in which it is emitted. All of the other pollutants need to react to form particles in the atmosphere before they register an impact (the analysis excludes impacts of ozone and NO_2). Next comes ammonia and then SO_2, which are both more reactive with respect to particle formation than NO_x and NMVOCs.

Table 3. % PM-health related impact from emission of each pollutant that occurs within the emitting country (highlighted 'mean' row used for analysis).

DATA SOURCE	NO_x	$PM_{2.5}$	SO_2	NH_3	NMVOC
Greece	33%	86%	65%	81%	54%
Ukraine	42%	79%	49%	69%	28%
Germany	41%	76%	57%	59%	32%
Romania	48%	71%	52%	57%	28%
Bulgaria	35%	66%	43%	57%	23%
Poland	33%	72%	45%	53%	26%
UK	36%	87%	65%	69%	30%
France	36%	73%	45%	58%	25%
Mean	**38%**	**76%**	**53%**	**63%**	**31%**
Minimum	**33%**	**66%**	**43%**	**53%**	**23%**
Maximum	**48%**	**87%**	**65%**	**81%**	**54%**

4. How damaging different sources are, relative to each other. For example, a particle emitted at ground level within a city centre is more likely to be breathed in than a particle emitted from a tall chimney in a rural area. Information from the Eurodelta II study, cited by EEA (2014) suggests that emissions from the power sector will give a lower level of exposure than average emissions, by factors of 0.78 for NO_x, 0.50 for $PM_{2.5}$ and 0.87 for SO_2.

Results

Total impacts associated with exposure to fine particles in Turkey are shown in Table 4. The result for deaths and life years lost for adults (alternative estimates of the same impact) are taken from the Global Burden of Disease estimates and concern exposure to particulate matter only (both primary and secondary particles). The other impacts are calculated pro rata against these from analysis of morbidity impacts of particulate exposure, using the Alpha-Riskpoll model.

Table 4. Impacts associated with exposure to PM in Turkey.

DATA SOURCE	IMPACTS	€ MILLION
Deaths, adults *	28,014	30,288
Life years lost, adults *	722,346	20,299
Infant deaths	112	181
Chronic Bronchitis, adults	31,966	834
Bronchitis in children	230,566	66
Respiratory Hospital Admissions, all ages	23,948	26
Cardiac Hospital Admissions, all ages	12,103	13
Restricted Activity Days, all ages	66,689,294	2,988
Asthma symptom days, children	1,884,477	39
Lost working days	5,331,441	338
Total value (low)		24,784
Total value (high)		34,773

Note: * 'life years lost' and 'deaths' are not additive, as they are different expressions of the same impact, effects on adult mortality

The next step in the analysis is to calculate the fraction of impacts occurring in Turkey that are associated with emissions from sources within Turkey. This is calculated by multiplying emissions by:

1. The factor 0.65 to convert PM_{10} to $PM_{2.5}$
2. The factors shown in Table 2 to account for the potency of emissions relative to $PM_{2.5}$
3. The factors shown in Table 3 to account for differences in 'leakage' of emissions beyond national borders.

Taken together, these factors indicate that 60% of the impact described Table 4 is attributable to emissions within Turkey.

Table 5. Impacts associated with exposure to PM derived from Turkish emissions, in Turkey.

DATA SOURCE	IMPACTS	€ MILLION
Deaths, adults	16,727	18,085
Life years lost, adults	431,301	12,120
Infant deaths	67	108
Chronic Bronchitis, adults	19,086	498
Bronchitis in children	137,667	39
Respiratory Hospital Admissions, all ages	14,299	15
Cardiac Hospital Admissions, all ages	7,226	8
Restricted Activity Days, all ages	39,819,107	1,784
Asthma symptom days, children	1,125,191	23
Lost working days	3,183,318	202
Total value (low)		14,798
Total value (high)		20,763

Accounting for the emissions from the power sector, and adding an extra factor to account for the differential impact of the power sector compared to average emissions sources, indicates that 17% of the impacts associated with particles generated from within Turkey on the Turkish population are attributable to coal consumption. Results are shown in Table 6.

Table 6. Impacts associated with exposure to PM derived from Turkish emissions from coal consumption in the power sector, in Turkey, based on CLRTAP data.

DATA SOURCE	IMPACTS	€ MILLION
Deaths, adults	2,876	3,110
Life years lost, adults	86,393	2,428
Infant deaths	13	22
Chronic Bronchitis, adults	3,823	100
Bronchitis in children	27,576	8
Respiratory Hospital Admissions, all ages	2,864	3
Cardiac Hospital Admissions, all ages	1,447	2
Restricted Activity Days, all ages	7,976,070	357
Asthma symptom days, children	225,384	5
Lost working days	637,643	40
Total value (low)		2,964
Total value (high)		3,646

Taking the alternative estimates of power station emissions generated by Greenpeace produces estimates that are approximately 50% larger.

ANNEX 2

HEALTH RISKS FROM VARIOUS POLLUTANTS, POLLUTANT GUIDELINE VALUES FOR AMBIENT AIR AND EMISSION LIMIT VALUES FOR COAL POWER PLANTS

POLLUTANT	RELATED HEALTH RISKS	GUIDELINE AND LIMIT VALUES[98]
Carbon dioxide (CO_2)	Indirect health impacts from climate change	
High volume hazardous air pollutants		
Sulphur dioxide (SO_2)	Can affect respiratory system and lung functions, aggravation of asthma and chronic bronchitis, makes people more prone to infections of the respiratory tract; irritation of eyes; cardiac disease aggravated ; ischemic stroke risk	**Ambient Air** WHO AQ Guidelines: 20 µg/m³ (day), 500 µg/m³ (10min) Directive 2008/50/EC: 350 µg/m³ (1 hour), 125 µg/m³ (24 hours) Turkish AQAC (06/06/2008-26898)[99] 150 µg/m³ (year), 250 µg/m³ (day) (95% /year), 900 µg/m³ (hour) Not defined (10min) **LCP Emissions to Air** EU Directive 2001/80/EC: 400 mg/m³ (old plants),, 200 mg/m³ (new plants) Turkish IAPC (06/06/2008-26898)[100]: Old Plants 2000 mg/Nm³ (50 MW ≤ Thermal power < 100 MW 2000-400 mg/Nm³ (100 MW ≤ Thermal power < 500 MW (linear decrease) 400 mg/Nm³ (Thermal power ≥ 500 MW) New Plants 850 mg/Nm³ (50 MW ≤ Thermal power < 100 MW) 200 mg/Nm³ (Thermal power ≥ 100 MW)
Nitrous oxides (NO	Asthma development (suspected), asthma exacerbation, chronic obstructive pulmonary disease, stunted lung development; cardiac arrhythmias, ischemic stroke. Reacts with VOCs in sunlight to form ground-level ozone	**Ambient Air** WHO AQ Guidelines: NO_2: 40 µg/m³ (year), NO_2: 200 µg/m³ (1h) Directive 2008/50/EC for NO_2: 200 µg/m³ (1 hour), 40 µg/m³ (1 year)

High volume hazardous air pollutants		
Nitrous oxides (NO_x);	Asthma development (suspected), asthma exacerbation, chronic obstructive pulmonary disease, stunted lung development; cardiac arrhythmias, ischemic stroke. Reacts with VOCs in sunlight to form ground-level ozone	Turkish AQAC (06/06/2008-26898) NO_2: 300 µg/m³ (day) (95% /year), 60 µg/m³ (year) **LCP Emissions to Air** EU Directive 2001/80/EC: NOx: 500 mg/m³ (old plants), NOx: 200 mg/m³ (new plants) Turkish IAPC (06/06/2008-26898): NO_2 and NO: Old Plants 600 mg/Nm³ (50 MW ≤ Thermal power < 500 MW) 200 mg/Nm³ (Thermal power ≥ 500 MW) New Plants 400 mg/Nm³ (50 MW ≤ Thermal power < 100 MW) 200 mg/Nm³ (Thermal power ≥ 100 MW)
Particulate matter: coarse particulates (PM_{10}), fine particulates ($PM_{2.5}$)	Respiratory: asthma development (suspected), asthma exacerbation, chronic obstructive pulmonary disease, stunted lung development ($PM_{2.5}$), lung cancer; Cardiovascular: cardiac arrhythmias, acute myocardial infarction, congestive heart failure ($PM_{2.5}$). Nervous system: ischemic stroke.	**Ambient Air** WHO AQ Guidelines: $PM_{2.5}$: 10 µg/m³ (year) , PM_{10}: 20 µg/m³ (year) EU Directive 2008/50/EC: $PM_{2.5}$ (target): 25 µg/m³ (year) , PM_{10} (limit): 50 µg/m³ (day), not to exceed on >35 days Turkish HKDKYY (06/06/2008-26898) PM_{10}: (with tolerance down to zero in 2019); 90 µg/m³ (24 hour), 56 µg/m³ (yearly) $PM_{2.5}$: Limit or target not defined **LCP Emissions to Air** EU Directive 2001/80/EC: Total dust (monthly): 50 mg/m³ (old plants), 30 mg/m³ (new plants) Turkish SKHKKY (06/06/2008-26898): Total dust: 150 mg/Nm³ (50 MW ≥ Thermal power) 100 mg/Nm³ (50 MW ≤ Thermal power) New Plants 50 mg/Nm³ (50 MW ≤ Thermal power < 100 MW) 30 mg/Nm³ (Thermal power ≥100 MW) Existing plants 100 mg/Nm³ (50 MW ≤ Thermal power <500 MW) 50 mg/Nm³ (Thermal power ≥ 500 MW)
High volume hazardous air pollutants		
Ammonia (NH_3)	Respiratory irritation, can cause skin and eye burns. Precursor of secondary particulates.	**Ambient Air** WHO AQ Guidelines: 270 µg/m³ (day)
Hydrogen Chloride and Fluoride (HCl, HF)	Acute irritation to skin, eyes, nose, throat, breathing passages.	Turkish SKHKKY (06/06/2008-26898) HCl (within the impact area of the plant): 150 µg/m³ (day), 60 µg/m³ (year) HF: 30 µg/m³ (hour), 5 µg/m³ (day)

Organic pollutants		
Dioxins and furans (e.g.,2,3,7,8-tetrachlorodibenzo-dioxin , short TCDD)	Probable carcinogen (stomach cancer); affect reproductive, endocrine and immune systems. Dioxins accumulate in the food chain.	**Ambient Air** WHO AQ Guidelines value: TCDD 70 pg/kg weight/month tolerable intake (provisional)
Polycyclic Aromatic Hydrocarbons (PAHs): e.g., Benzo-a-anthracene, Benzo-a-pyrene	Probable carcinogens; may have adverse effects on the liver, kidney, and testes; may damage sperm cells and impair reproduction. PAHs can be attached to small particulate matter and deposit in the lungs.	**Ambient Air** No WHO guideline value, to be kept as low as possible EU Directive 2004/107/EC: benzo-a-pyrene: 1ng/m^3 (air) Turkish AQAC (06/06/2008-26898): benzo-a-pyrene: Target Values by 1 January 2020 1ng/m^3
Non-Methane Volatile Organic Compounds (VOCs)		
Aromatic hydrocarbons: e.g. benzene, xylene, ethylbenzene, toluene	Irritation of the skin, eyes, nose, throat; difficulty in breathing; impaired function of the lungs; delayed response to visual stimulus; impaired memory; stomach discomfort; effects to the liver and kidneys; may cause adverse effects to the nervous system. Benzene is a strong carcinogen.	**Ambient Air** WHO AQ Guidelines values: Benzene: no safe levels can be determined; toluene: 0.26 mg/m^3; formaldehydes: 0.1 mg/m^3 (30min) EU Directive 2008/50/EC: Benzene: 5 µg/m^3 (year) Turkish HKDKYY (06/06/2008-26898) Benzene: 5 µg/m^3 (year) Toluene: No limit values defined Formaldehydes: No limit values defined
Aldehydes including formaldehyde	Probable carcinogen (lung and nasopharyngeal cancer); eye, nose, throat irritation; respiratory symptoms	
Heavy metals		
Mercury (Hg), in food as Methylmercury	Damage to brain, nervous system, kidneys and liver; neurological and developmental birth defects.	**Ambient Air** WHO AQ Guidelines value: 3.2 µg/kg weight/week tolerable intake EU: no emission limit values
Lead (Pb)	Damages nervous system of children; may adversely affect learning, memory and behaviour; may damage kidneys, cause cardiovascular disease, anemia.	**Ambient Air** WHO AQ Guidelines value: 0.5 µg/m^3 EU Directive 2008/50/EC: 0,5 µg/m^3 Turkish HKDKYY (06/06/2008-26898) 0,5 µg/m^3, 1 µg/m^3 [101]
Antimony (Sb), Arsenic (As), Beryllium (Be), Cadmium (Cd), Chromium (Cr), Nickel (Ni), Selenium (Se), Manganese (Mn)	Carcinogens (lung, bladder, kidney, skin cancers); may adversely affect nervous, cardiovascular, dermal, respiratory and immune systems. The International Agency for Research on Cancer classifies arsenic and its compounds as group 1 carcinogens.	**Ambient Air** WHO AQ Guidelines: As: no safe level established Cd 5 ng/m^3 air EU Directive 2004/107/EC: As 6ng/m^3; Cd 5ng/m^3; Ni 20ng/m^3 (ambient air) Turkish HKDKYY (06/06/2008-26898) As, Cd, Ni: No existing limit values Target Values by 1 January 2020: As: 6 ng/m^3, Cd: 5 ng/m^3, Ni: 20 ng/m^3
Radioisotopes		
Radium (Ra)	Carcinogen (lung and bone cancers); bronchopneumonia, anemia, brain abscess	
Uranium (Ur)	Carcinogen (lungs and lymphatic system); kidney disease	

REFERENCES

[1] WHO (2013): Review of evidence on health aspects of air pollution – REVIHAAP project: final technical report; World Health Organization, Regional Office for Europe: http://www.euro.who.int/en/health-topics/environment-and-health/air-quality/publications/2013/review-of-evidence-on-health-aspects-of-air-pollution-revihaap-project-final-technical-report [accessed 21 April 2015]

[2] Lim, SS, Vos, T, Flaxman AD, et al. (2012). A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990—2010: a systematic analysis for the Global Burden of Disease Study 2010. The Lancet, 380 (9859): 2224-2260. http://www.thelancet.com/journals/lancet/article/PIIS0140-6736%2812%2961766-8/fulltext

[3] European Environment Agency (2014): Air Quality in Europe – 2014 report: http://www.eea.europa.eu/publications/air-quality-in-europe-2014 [accessed 21 April 2015]

[4] However, there is a great difference in the levels of air pollution between different European countries. For example, the effect of fine particles in ambient air leads to an average loss of life per person of three months in Finland, 16 months in the German Ruhr area, and 18 months in a region in Hungary. The wider equity gap in air quality in Europe should be closed quickly. See: Brunekreef B, Annesi-Maesano I, Ayres JG, Forastiere F, Forsberg B, Künzli N, Pekkanen J and Sigsgaard T (2012): Ten principles for clean air. European Respiratory Journal, 2012, 39(3):525-528; doi: 10.1183/09031936.00001112 http://erj. ersjournals.com/content/39/3/525?cited-by=yes&legid=erj;39/3/525#

[5] EEA (2014b). Air pollution fact sheet 2014: Turkey. http://www.eea.europa.eu/themes/air/air-pollution-country-fact-sheets [accessed February 2015]

[6] World Health Organisation-WHO (2014). Ambient (outdoor) air pollution in cities database 2014. http://www.who.int/phe/health_topics/outdoorair/databases/cities/en/ [accessed February 2015]

[7] (121) WHO (2006). WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide; Global update 2005; Summary of risk assessment. World Health Organization, Geneva. http://whqlibdoc.who.int/hq/2006/WHO_SDE_PHE_OEH_06.02_eng.pdf [accessed February 2015]

[8] (13) European Commission DG Health and Food Safety (2015). Public Health web site. http://ec.europa.eu/health/major_chronic_diseases/diseases/cardiovascular/index_en.htm [accessed April 2015]

[9] (14) European Heart Network and European Society of Cardiology (2012): European Cardiovascular Disease Statistics 2012. http://www.ehnheart.org/cvd-statistics.html [accessed April 2015]

[10] Turkish Statistical Institute (2015) Causes of Death Statistics, 2014. http://www.turkstat.gov.tr/PreHaberBultenleri.do?id=18855 [accessed April 2015]

[11] Şahan, C, Sözmen, K, Ünal B (2014), Kalp Damar Hastalıkları Morbiditesi, in Türkiye Sağlık Raporu 2014 (Turkey's Health Report 2014), Halk Sağlığı Uzmanları Derneği (Turkish Society of Public Health Specialists) – HASUDER, 2014: 220-228.

[12] Turkish Thoracic Society (2015) http://www.toraks.org.tr/halk/Default.aspx?p=astim [official website] [accessed 5 April 2015)

[13] Turkish Thoracic Society (2014). Türkiye'de 2 milyon çocuk astımlı! (2 million children suffer from asthma in Turkey). Press conference on 7 May 2014, Istanbul. http://www.medimagazin.com.tr/ana-sayfa/guncel/tr-turkiyede-2-milyon-cocuk-astimli-1-11-58421.html [accessed 5 April 2015)

[14] Ministry of Health Public Health Institute of Turkey (2014). Türkiye Kronik Hava Yolu Hastalıkları Önleme ve Kontrol Programı (2014-2017) (GARD Turkey Chronic Respiratory Disease (Asthma and COPD) Prevention and Control Program). Ankara. p:27. http://gard.org.tr/kontrol-programi/69-t%C3%BCrkiye-kronik-hava-yolu-hastal%C4%B1klar%C4%B1-%C3%B6nleme-ve-kontrol-program%C4%B1-2014-2017.html [accessed March 2015]

[15] The European Commission estimates that for the EU-28 air pollution led to health cost of 330 – 940 billion EUR in 2010 alone (3-9% of EU GDP). EU Commission impact assessment 2013: http://ec.europa.eu/environment/air/clean_air_policy.htm [accessed 21 April 2015]

[16] European Environment Agency (2014): Turkey air pollution country fact sheet: http://www.eea.europa.eu/themes/air/air-pollution-country-fact-sheets-2014/turkey-air-pollutant-emissions-country-factsheet/view [accessed 21 April 2015]

[17] Ministry of Energy and Natural Resources Department of Strategic Development (2014) Dünya ve Ülkemiz Enerji ve Tabii Kaynaklar Görünümü 01 Ekim 2014 itibariyle. http://www.enerji.gov.tr/Resources/Sites/1/Pages/Sayi_06/Sayi_06.html#p=2 [accessed April 2015]

[18] Geneva Convention on Long-Range Transboundary Air Pollution: http://www.unece.org/fr/env/lrtap/lrtap_h1.html [accessed 21 April 2015]

[19] Epstein, Paul R. et al (2011) : Full cost accounting for the life cycle of coal. Annals of the New York Academy of Sciences, 1219 (2011), p. 73-9 http://www.chgeharvard.org/sites/default/files/epstein_full%20cost%20of%20coal.pdf [accessed 21 April 2015]

[20] Attfield, MD., Petsonk, EL., Wagner, GR (2011). Coal Workers' Lung Diseases, in 10. Respiratory System, David, Alois,Wagner, Gregory R., Editor, Encyclopedia of Occupational Health and Safety, Jeanne Mager Stellman, Editor-in-Chief. International Labor Organization, Geneva.

[21] Türkiye`de İşyerlerinde İş Sağlığı ve Güvenliği Koşullarının İyileştirilmesi Projesi - TR0702.20-01/001. KOBİ'ler için İş Sağlığı ve Güvenliği Yönetim Rehberi: Risk Değerlendirmesi, İSG Performans İzleme ve Sağlık Tehlikeleri,MADEN SEKTÖRÜ: Kömür.

[22] TR Ministry of Labour and Social Security (2013). Maden İşletmelerinde İş Sağlığı Ve Güvenliği 2012 Programlı Teftişleri Sonuç Raporu [2012 Programmed Auditing Report on Occupational Health and Safety at Mining Enterprises]. Ankara. P: 84.

[23] Cimrin, A, and Erdut, Z (2007) General aspect of pneumoconiosis in Turkey, in Indian Journal of Occupational and Environmental Medicine. 2007 May-Aug; 11(2): 50–55.

[24] Makine Mühendisleri Odası (2014), İşçi Sağlığı ve İş Güvenliği, Report. Fifth Extended Version.Publication:MMO/617.

[25] Kaymaz T, Kızılca, İ, (2014) Kömür Madeni İşletmelerinde Verimlilik ve İş Güvenliği. Assessment note, The Economic Policy Research Foundation of Turkey – TEPAV. N201423.

[26] Dev-Maden Sendikası (2015) 2014'te 361 maden işçisi iş cinayetlerinde öldü. Press Release: 5 January 2015. http://www.sendika.org/2015/01/disk-dev-maden-sen-2014te-361-maden-iscisi-oldu/ [accessed 10 April 2015]

[27] TKI. (2013). Coal Sector Report (Lignite). Turkish Coal Enterprises. Retrieved from http://www.tki.gov.tr/Dosyalar/ Dosya/Sekt%C3%B6r%20Raporu%20 2013.pdf

[28] Acar, S, Kitson, L, Bridle R. (2015) Subsidies to Coal and Renewable Energy in Turkey. The International Institute for Sustainable Development. http://www.iisd.org/gsi/subsidies-coal-and-renewable-energy-turkey. [accessed 10 April 2015]

[29] Ground-level ozone is produced when NO_2 reacts with fugitive organic substances, so called volatile organic compounds (VOCs), which is catalysed by sunlight and heat. VOCs are also released by coal power plants, as well as from other sources such as traffic.

[30] Sunyer J (2001): Urban air pollution and chronic obstructive pulmonary disease: a review. European Respiratory Journal, 2001, 17(5):1024-1033. http://erj.ersjournals.com/content/17/5/1024.full [accessed 12 February 2013]

[31] Krewski D, Jerrett M, Burnett RT, et al. (2009): Extended follow-up and spatial analysis of the American Cancer Society study linking particulate air pollution and mortality. Research Report (Health Effects Institute), 2009 May, (140):5-114; discussion 115-36. http://www.ncbi.nlm.nih.gov/pubmed/19627030

[32] Pope CA 3rd, Burnett RT, Thun MJ, et al. (2002): Lung cancer, cardiopulmonary mortality, and long-term exposure to fine particulate air pollution. Journal of the American Medical Association, 2002 Mar 6, 287(9):1132-41. http://www.ncbi.nlm.nih. gov/pubmed/11879110

[33] Young RP, Hopkins RJ, Christmas T, et al. (2009): COPD prevalence is increased in lung cancer, independent of age, sex and smoking history. European Respiratory Journal, 2009, 34:380–386. http://erj.ersjournals.com/content/34/2/380.full [accessed 12 February 2013]

[34] Gala I, Tobias A, Banegas JR, Aranguez E (2003): Short-term effects of air pollution on daily asthma emergency room admissions. European Respiratory Journal 2003; 22:802-808; http://erj.ersjournals.com/content/22/5/802.full. pdf+html?sid=3327d02f-e124-4be7-a47b-35064c63edff [accessed 12 February 2013] as well as Sousa SI, Alvim-Ferraz MC, Martins FG (2013): Health effects of ozone focusing on childhood asthma: What is now known - a review from an epidemiological point of view. Chemosphere, 2013 February ;90(7):2051-8. doi: 10.1016/j.chemosphere.2012.10.063.

[35] WHO (2011): Fact Sheet 3.3. Exposure to Air Pollution (Particulate Matter) in Outdoor Air. World Health Organization Regional Office for Europe, Copenhagen, Denmark. http://www.euro.who.int/

[36] European Federation of Allergy and Airways Diseases Patients Associations (without date): Asthma. http://www.efanet.org/ asthma/ [official website] [accessed 12 February 2013]

[37] Aphekom (2012): Summary report of the Aphekom project 2008-2011. http://www.aphekom.org/c/document_library/get_file?uuid=5532fafa-921f-4ab1-9ed9 c0148f7da36a&groupId=10347 [accessed 12 February 2013]. Pope III CA and Dockery DW. (2006). Health Effects of Fine Particulate Air Pollution: Lines that Connect, Journal of the Air & Waste Management Association, 56:6, 709-742, DOI: 10.1080/10473289.2006.10464485.

[38] IARC (2013): Outdoor air pollution a leading environmental cause of cancer deaths. World Health Organization International Agency for Research on Cancer: http://www.iarc.fr/en/media-centre/iarcnews/pdf/pr221_E.pdf [accessed 21 April 2015]

[39] Chen H, Goldberg MS, Villeneuve PJ (2008): A systematic review of the relation between long-term exposure to ambient air pollution and chronic diseases. Reviews on Environmental Health, 2008 October-December, 23(4):243-97. [accessed 12 February 2013]

[40] Peters A, Liu E, Verrier RL, et al. (2000): Air pollution and incidence of cardiac arrhythmia. Epidemiology, 2000, 11(1):11–17; Peters A, Dockery DW, Muller JE, et al. (2001): Increased particulate air pollution and the triggering of myocardial infarction. Circulation, 2001, 103(23):2810–2815. http://circ.ahajournals.org/content/103/23/2810.full [accessed 13 February 2013]; Simkhovich BZ, Kleinman MT, Kloner RA (2009): Particulate air pollution and coronary heart disease. Current Opinion in Cardiology, 2009 November, 24(6):604-9. [accessed 12 February 2013]

[41] Brook RD (2007): Is air pollution a cause of cardiovascular disease? Updated review and controversies. Reviews on Environmental Health, 2007 April-June, 22(2):115-37. [accessed 12 February 2013]

[42] Anderson JO, Thundiyil JG, Stolbach A (2012): Clearing the air: a review of the effects of particulate matter air pollution on human health. Journal of Medical Toxicology, 2012 June, 8(2):166-75. doi: 10.1007/s13181-011-0203-1. [accessed 12 February 2013]

[43] Lockwood et al. (2009) op. cit.

[44] Lockwood et al. (2009), op. cit.; Ischemic stroke occurs as a result of an obstruction within a blood vessel supplying blood to the brain. It accounts for 87 percent of all stroke cases. http://www.strokeassociation.org/STROKEORG/AboutStroke/Types-of-Stroke_UCM_308531_ SubHomePage.jsp [accessed 12 February 2013]

[45] Franchini M and Mannucci PM (2011): Thrombogenicity and cardiovascular effects of ambient air pollution. Blood. 2011 September 1; 118(9):2405-12; O'Donnell MJ, Fang J, Mittleman MA, et al. (2011): Fine Particulate Air Pollution (PM2.5) and the Risk of Acute Ischemic Stroke. Epidemiology, 2011 May, 22(3):422–431. [accessed 12 February 2013]

[46] Lockwood et al. (2009), op. cit.

[47] In the EU, plus Norway, Switzerland and Iceland; Truelsen T, Piechowski-Jóźwiak B, Bonita R, et al. (2006): Stroke incidence and prevalence in Europe: a review of available data. European Journal of Neurology 2006, 13:581–598, http://onlinelibrary.wiley.com/doi/10.1111/j.1468-1331.2006.01138.x/pdf [accessed 12 February 2013]

[48] UNEP, 2013. Global Mercury Assessment 2013: Sources, Emissions, Releases and Environmental Transport. UNEP Chemicals Branch, Geneva, Switzerland.

[49] Task Force on Hemispheric Transport of Air Pollution acting within the framework of the Convention on Long-range Transboundary Air Pollution (2010). Hemispheric Transport of Air Pollution 2010 Part B: Mercury. Air Pollution Studies No. 18. Editors: Nicola Pirrone and Terry Keating. UNITED NATIONS. New York and Geneva. http://www.htap.org/publications/2010_report/2010_Final_Report/HTAP%202010%20Part%20B%20110408.pdf

[50] Civancik D1, Yetis U. (2015) Substance flow analysis of mercury in Turkey for policy decision support. Environ Sci Pollut Res Int. 2015 Jan 6. Ahmet Demirak, Ahmet Balci, Ömer Dalman, Mehmet Tüfekçi (2005) Chemical Investigation of Water Resources Around the Yatagan Thermal Power Plant of Turkey, in Water, Air, and Soil Pollution, March 2005, Volume 162, Issue 1-4, pp 171-181.

[51] Civancik D1, Yetis U. (2015) Substance flow analysis of mercury in Turkey for policy decision support. Environmental Science and Pollution Research. Published online: 6 January 2015. http://link.springer.com/article/10.1007/s11356-014-3996-z. [accessed 19 April 2015]

[52] Sackett DK, Aday DD, Rice JA, et al. (2010): Does proximity to coal-fired power plants influence fish tissue mercury? Ecotoxicology. 2010 November, 19(8):1601-11. http://www.ncbi.nlm.nih.gov/pubmed/20848188 [accessed 12 February 2013]

[53] Grandjean P, Weihe P, White RF, et al. (1997): Cognitive deficit in 7-year-old children with prenatal exposure to methylmercury. Neurotoxicology and Teratology, 1997, 19:417–428; Bellanger M, Pichery C, Aerts D, et al. (2013): Economic benefits of methylmercury exposure control in Europe: Monetary value of neurotoxicity prevention. Environmental Health, 2013, 12:3, published online 7 January 2013 http://www.ehjournal. net/content/12/1/3/abstract [accessed 12 February 2013]

[54] Boucher O, Jacobson SW, Plusquellec P, et al. (2012): Prenatal Methylmercury, Postnatal Lead Exposure, and Evidence of Attention Deficit/Hyperactivity Disorder among Inuit Children in Arctic Québec. Environmental Health Perspectives, 2012, 120:1456–1461. http://ehp.niehs.nih.gov/2012/10/1204976/ [accessed 12 February 2013]

[55] Sagiv SK, Thurston SW, Bellinger DC, et al. (2012): Prenatal exposure to mercury and fish consumption during pregnancy and attention-deficit/hyperactivity disorder-related behavior in children. Archives of Pediatrics & Adolescent Medicine, 2012 December, 166(12):1123-31. doi: 10.1001/archpediatrics.2012.1286 [accessed 12 February 2013]

[56] Bellanger et al 2013, cited op.

[57] http://www.mercuryconvention.org/ [accessed 21 April 2015]

[58] IPCS (1995): Inorganic lead. World Health Organization, International Program on Chemical Safety. Environmental Health Criteria 165. World Health Organization, Geneva. http://www.inchem.org/documents/ehc/ehc/ehc165.htm ; WHO (2010): Exposure to Lead: A Major Public Health Concern. WHO Factsheet Preventing Disease Through Healthy Environments. World Health Organization, Geneva. http://www.who.int/ipcs/features/lead..pdf

[59] The WHO International Agency for Research on Cancer (IARC) recognizes only 2,3,7,8-tetrachlorodibenzo-para-dioxin as carcinogenic. Monograph: http://monographs.iarc.fr/ENG/Monographs/vol69/volume69.pdf [accessed 12 February 2013]

[60] WHO (2010): Preventing Disease Through Healthy Environments. Exposure to Dioxins And Dioxin-like Substances – A Major Public Health Concern. World Health Organization, Geneva. http://www.who.int/ipcs/features/dioxins.pdf [accessed 12 February 2013]

[61] Vandenberg LN, Colborn T, Hayes TB, et al. (2012): Hormones and Endocrine Disrupting Chemicals: Low Dose Effects and Non-Monotonic Dose Responses. Endocrine Reviews, 2012 June, 33(3):378 doi:10.1210/er.2011-1050 http://edrv. endojournals.org/content/early/2012/03/14/er.2011-1050.full.pdf+html [accessed 12 February 2013]

[62] WHO (2003): Guidelines for Drinking Water Quality. Polynuclear Aromatic Hydrocarbons. World Health Organization, Geneva. http://www.who.int/water_sanitation_health/dwq/chemicals/pahsum.pdf [accessed 12 February 2013]

[63] http://www.eia.gov/tools/faqs/faq.cfm?id=74&t=11

[64] IPCC, 2013: Summary for Policymakers. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S. K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[65] http://www.hidropolitikakademi.org/tr/turkiyede-gozlenen-ve-model-kestirimi-iklim-degisikligi-ve-degiskenligi-uzerine-kisa-bir-degerlendirme-2.html

[66] Türkeş, M (2014) Türkiye'de Gözlenen Ve Model Kestirimi İklim Değişikliği ve Değişkenliği Üzerine Kisa Bir Değerlendirme. vhttp://Www.Hidropolitikakademi.Org/Tr/Turkiyede-Gozlenen-Ve-Model-Kestirimi-İklim-Degisikligi-Ve-Degiskenligi-Uzerine-Kisa-Bir-Degerlendirme-2.Html [Accessed April 2015]

[67] World Health Organization and World Meteorological Organization (2012) Atlas of Health and Climate. WMO-No. 1098. Geneva, Switzerland.

[68] Tekeli, I. et al. (2010) Türkiye Açısından Dünyada İklim Değişikliği. Türkiye Bilimler Akademisi Raporları Dizisi. Sayı:22. Ankara.

[69] World Health Organization Europe (2010): Parma Declaration on Environment and Health: http://www.euro.who.int/en/health-topics/noncommunicable-diseases/cancer/publications/2010/parma-declaration-on-environment-and-health [accessed 21 April 2015]

[70] Ministry of Environment and Urbanization (2014) Regulation on Industrial Air Pollution Control [Sanayi Kaynaklı Hava Kirliliğinin Kontrolü Yönetmeliği]. Official Gazette Date and Issue: 03/07/2009-27277. Amendment on Official Gazette Date: 20/12/2014-29211.

[71] TEPAV (2015) Turkey's Compliance with the Industrial Emissions Directive - A Legislation Gap Analysis and its Possible Costs on the Turkish Energy Sector. http://www.tepav.org.tr/upload/files/haber/1427475571-5.Turkey___s_Compliance_with_the_Industrial_Emissions_Directive.pdf

[72] Shearer, C, Ghio, N, Myllyvirta, L, and Nace T (2015) Boom and Bust - Tracking The Global Coal Plant Pipeline. CoalSwarm and Sierra Club. http://endcoal.org/the-worldwide-coal-boom-goes-bust/ [accessed 16 April 2015]

[73] TR Energy Market Regulatory Authority [EPDK] (2015). License Database. http://lisans.epdk.org.tr/epvys-web/faces/pages/lisans/elektrikUretim/elektrikUretimOzetSorgula.xhtml [accessed 6 April 2015]

[74] http://www.bianet.org/bianet/toplum/162774-gerzeliler-kazandi-termik-santral-yapilamayacak; http://www.sourcewatch.org/index.php/Gerze_power_station

[75] http://www.bianet.org/english/environment/156258-amasra-residents-protest-coal-on-land-sea; http://www.hurriyetdailynews.com/istanbul-airport-contractor-gets-new-setback-on-coal-plant-project.aspx?pageID=238&nID=74853&NewsCatID=340; http://www.sourcewatch.org/index.php/Selena_power_station

[76] http://www.bto.org.tr/news.php?i=4153, http://www.bto.org.tr/news.php?i=4374/; http://www.bto.org.tr/news.php?i=4197

[77] World Coal Association (2014) Coal Facts 2014. http://www.worldcoal.org/resources/coal-statistics/ [accessed April 2015].

[78] Ministry of Energy and Natural Resources (2014). General Energy Balance Sheet 2013.

[79] TR Energy Market Regulatory Authority [EPDK] (2015). License Database. http://lisans.epdk.org.tr/epvys-web/faces/pages/lisans/elektrikUretim/elektrikUretimOzetSorgula.xhtml [accessed 6 April 2015]

[80] Turkish Ministry of Energy and Natural Resources (2014) Blue Book [Mavi Kitap].

[81] This amount includes direct transfers transfers to the hard coal industry, subsidies to exploration of resources, rehabilitation of power stations and coal aid to poor families. The Institute also identified further subsidies including investment guarantees and tax exemptions which were not quantified. IISD concludes that health related externalities continue to be left out of considerations of energy costs and that electricity generations from wind and solar is already cheaper than coal generation. See: Acar, S, Kitson, L, Bridle R. (2015) Subsidies to Coal and Renewable Energy in Turkey. The International Institute for Sustainable Development. http://www.iisd.org/gsi/subsidies-coal-and-renewable-energy-turkey. [accessed 10 April 2015]

[82] Editors: Basa, N, Pamir N. (2014) Proceedings of Energy and Law Syposium [Enerji ve Hukuk Sempozyumu Sonuç Bildirgesi Temel Saptamalar ve Sorunlar Çözüm Önerileri]. Union of Turkish Bar Associations. Ankara.

[83] EU Roadmap for a low-carbon economy in 2050: http://ec.europa.eu/clima/policies/roadmap/index_en.htm [accessed 21 April 2015]

[84] The EU and other industrialised countries of G7 have pledged to reduce their GHG emissions to 80% compared to 1990 to stay below the 2 degrees threshold. See: All decarbonisation scenarios for the EU 2050 Energy Roadmap, which is based on five different scenarios for the transition to a low carbon energy system by 2050, include a substantial decrease in the share of coal in the energy mix; of the order of halve the current share or even less. Carbon Capture and Storage plays an important role in at least two of these scenarios.

[85] The government's strategy to reduce CO_2 emissions from coal combustion includes improving the efficiency of the existing plants and using clean coal technologies. There are no strategies or planned actions for a phase out of coal. See: T.R. Ministry of Environment and Forestry (2010) National Climate Change Strategy Document 2010-2020. Ankara. http://www.dsi.gov.tr/docs/iklim-degisikligi/national_climate_change_strategy.pdf?sfvrsn=2; T.R. Ministry of Environment and Forestry (2011) National Climate Change Action Plan 2010-2023. Ankara. http://www.dsi.gov.tr/docs/iklim-degisikligi/%C4%B1depeng.pdf?sfvrsn=2

[86] World Federation of Public Health Associations (2014): Kolkata Call to Action: http://www.wfpha.org/policy-advocacy/declarations-en [accessed 21 April 2015]

[87] See: http://env-health.org/policies/climate-and-energy/

[88] Some selected publications of Turkish medical organisations and public health specialists on health impacts of coal power plants: http://www.ttb.org.tr/kutuphane/yatagan-rpr.pdf; http://www.tema.org.tr/folders/14966/categorial1docs/83/TERMIK%20SANTRAL%20RAPOR%20A5%20BASKI.pdf; Gürsoy, U. (2004). Enerjide Toplumsal Maliyet ve Temiz ve Yenilenebilir Enerji Kaynakları, Türk Tabipleri Birliği Yayınları Ankara; Pala, K. (2014). Kömürlü Termik Santrallerin Sağlık Etkileri, Türk Tabipleri Birliği Bursa Tabip Odası, Bursa.; Çağlayan, Ç. (2014). Türkiye'de Hava Kirliliği in Türkiye Sağlık Raporu 2014 [Turkey's Health Report 2014]. Ertem, M, and Çan, G), Halk Sağlığı Uzmanları Derneği], Ankara.

[89] Turkish Medical Association, et al (2014). Kömürlü termik santraller çevreye ve sağlığa zararlıdır [Press Release]. http://www.ttb.org.tr/index.php/Haberler/komurlu-4871.html

[90] EEA (2011) Revealing the costs of air pollution from industrial facilities in Europe. European Environment Agency, Technical Report 15/2011. http://www.eea.europa.eu/media/publications/cost-of-air-pollution, accessed 3/4/2015.

[91] EEA (2014) Cost of air pollution from European Industrial Facilities 2008-12. European Environment Agency. http://www.eea.europa.eu/publications/costs-of-air-pollution-2008-2012, accessed 2/4/2015.

[92] WHO (2013) HRAPIE: Health risks of air pollution in Europe – HRAPIE project Recommendations for concentration–response functions for cost–benefit analysis of particulate matter, ozone and nitrogen dioxide. World Health Organization, Regional Office for Europe, Bonn, Germany. http://www.euro.who.int/en/health-topics/environment-and-health/air-quality/publications/2013/health-risks-of-air-pollution-in-europe-hrapie-project-recommendations-for-concentrationresponse-functions-for-costbenefit-analysis-of-particulate-matter,-ozone-and-nitrogen-dioxide

[93] Holland, M. (2014a) Cost-benefit analysis of final policy scenarios for the EU Clean Air Package. Corresponding to IIASA TSAP report no.11. Report to European Commission DG Environment. March 2014. http://ec.europa.eu/environment/air/pdf/review/TSAP%20CBA%20corresponding%20to%20IIASA11%20v2.pdf; Holland, M. (2014b) Implementation of the HRAPIE Recommendations for European Air Pollution CBA work. Report to European Commission DG Environment. January 2014. http://ec.europa.eu/environment/air/pdf/review/CBA%20HRAPIE%20implement.pdf

[94] Global Burden of Disease: http://ghdx.healthdata.org/global-burden-disease-study-2010-gbd-2010-data-downloads

[95] ExternE (1995) Volume 2: methodology. ExternE: Externalities of Energy. http://www.externe.info/externe_d7/?q=node/37.
OECD (2012) Mortality Risk Valuation in Environment, Health and Transport Policies. OECD, Paris.

[96] OECD (2012) Mortality Risk Valuation in Environment, Health and Transport Policies. OECD, Paris.

[97] http://www.eea.europa.eu/data-and-maps/data/national-emissions-reported-to-the-convention-on-long-range-transboundary-air-pollution-lrtap-convention-8

[98] The guideline values listed here refer to ambient outdoor air and are derived from the WHO 2000 Air Quality Guidelines for Europe as well as the 2005 WHO Air quality Guidelines Global Update. The WHO gives recommendations for concentration limits that should not be exceeded, based on a review of the scientific evidence on health effects. The limit values for SO2, NOx and PM are in contrast set for the exhaust air from coal power stations and thus have a different order of magnitude. They were taken from the Large Combustion Plants Directive 2001/80/EC which will be substituted by Directive 2010/75/EC from January 2016 on. Other limit or target values are concerning ambient air and have been taken from Directive 2008/50/EC and Directive 2004/107/EC on ambient air.

[99] Turkish Air Quality Assessment and Control Regulation (AQAC), RG (Official Gazette): 06/06/2008-26898; amended RG: 5/5/2009-27219)

[100] Turkish Regulation on Industrial Air Pollution Control (IAPC), RG (Official Gazette): 03/07/2009-27277; amended RG: 20/12/2014-29211)

[101] In "regions" and "sub-regions" where there are special industrial sources of Pb emissions, and have been contaminated for a long period of time due to industrial activities. These regions and sub-regions are to be identified by the Provincial Directorates of Ministry of Environment, not to be away from the special sources more than 1000 meters.

Health and Environment Alliance (HEAL)

The Health and Environment Alliance (HEAL) is a leading European not-for-profit organisation addressing how the environment affects health in the European Union (EU). We demonstrate how policy changes can help protect health and enhance people's quality of life.

With the support of more than 70 member organisations, representing health professionals, not-for-profit health insurers, patients, citizens, women, youth and environmental experts, HEAL brings independent expertise and evidence from the health community to different decision-making processes. Members include international and Europe-wide organisations, as well as national and local groups.

Turkish Medical Association

The Turkish Medical Association (known nationally as TTB) is the organised voice of physicians in Turkey, with 80% of physicians in the country as members. Under Constitutional guarantee, the Association has the status of public organization on the basis of the Law no. 6023. The main source of income for the Association is membership fees, without any funds received from the government.

Doctors for the Environment Turkey

Founded in 1998, this organisation aims to bring together medical doctors in order to make ecological awareness an effective power in society and improve information exchange and cooperation. They report on the impacts of environmental problems and disturbance of ecological balance on human and ecosystem health; identify measures to protect health, and aim to raise awareness of medical doctors on environmental and ecological issue.

Turkish Occupational Medicine Society (İMUD)

This is a speciality association that brings together experts on occupational - vocational diseases, in order to contribute to workers' health from a social responsibility perspective. İMUD works at the national and international levels to provide training and research, define national standards on occupational diseases, as well as on diagnosis, treatment, care and rehabilitation of patients, contribute to development of national policies in order to provide effective protection of occupational health and improved treatment of vocational diseases.

Turkish Respiratory Society (TÜSAD)

Founded in Istanbul in 1970. In 1975, it was granted the status of a public benefit organisation. With its about 2750 members, TÜSAD is a member of GARD and co-founder of Turkish Respiratory Diseases BOARD.

Turkish Society of Public Health Specialists

The organisation works to protect and improve health in Turkey, as well as capacity building for public health specialists. The environmental working group of HASUDER aims to reach both the general public and public health specialists through reports, scientific meetings and public statements on global and local environmental problems and associated health impacts.

Turkish Thoracic Society

This speciality association aims to improve national lung health, highlighting the importance of basic human needs, economic and social security for all, use of easily monitored eco-technologies which are compatible with nature, and use of renewable energy resources. TTD advocates a shift from "sustainable development" to a "sustainable future and life" as the solution of all ecological problems we are facing, including air pollution.

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HEAL
Promoting environmental policy that contributes to good health

A report from the Health and Environment Alliance