



International
Energy Agency
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Energy and Air Pollution

Executive Summary

World Energy Outlook
Special Report

INTERNATIONAL ENERGY AGENCY

The International Energy Agency (IEA), an autonomous agency, was established in November 1974. Its primary mandate was – and is – two-fold: to promote energy security amongst its member countries through collective response to physical disruptions in oil supply, and provide authoritative research and analysis on ways to ensure reliable, affordable and clean energy for its 29 member countries and beyond. The IEA carries out a comprehensive programme of energy co-operation among its member countries, each of which is obliged to hold oil stocks equivalent to 90 days of its net imports. The Agency's aims include the following objectives:

- Secure member countries' access to reliable and ample supplies of all forms of energy; in particular, through maintaining effective emergency response capabilities in case of oil supply disruptions.
- Promote sustainable energy policies that spur economic growth and environmental protection in a global context – particularly in terms of reducing greenhouse-gas emissions that contribute to climate change.
 - Improve transparency of international markets through collection and analysis of energy data.
 - Support global collaboration on energy technology to secure future energy supplies and mitigate their environmental impact, including through improved energy efficiency and development and deployment of low-carbon technologies.
 - Find solutions to global energy challenges through engagement and dialogue with non-member countries, industry, international organisations and other stakeholders.

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Air pollution is a major public health crisis, with many of its root causes and cures to be found in the energy sector. Around 6.5 million deaths are attributed each year to poor air quality, making this the world's fourth-largest threat to human health, behind high blood pressure, dietary risks and smoking. Without changes to the way that the world produces and uses energy, the ruinous toll from air pollution on human life is set to rise. That is why this *World Energy Outlook (WEO) Special Report* is dedicated, for the first time, to the links between energy, air pollution and health. It sets out in detail the scale, causes and effects of the problem and the ways in which the energy sector can contribute to a solution.

Energy production and use, mostly from unregulated, poorly regulated or inefficient fuel combustion, are the single most important man-made sources of air pollutant emissions: 85% of particulate matter and almost all of the sulfur oxides and nitrogen oxides. These three pollutants are responsible for the most widespread impacts of air pollution, either directly or once transformed into other pollutants via chemical reactions in the atmosphere. They are emitted mainly as a result of:

- **Poverty:** the wood and other solid fuels that more than 2.7 billion people use for cooking, and kerosene used for lighting (and in some countries also for cooking), create smoky environments that are associated with around 3.5 million premature deaths each year. These effects are felt mostly in developing Asia and sub-Saharan Africa, where incomplete burning of biomass accounts for more than half of emissions of particulate matter. Finer particles, whether inhaled indoors or outdoors, are particularly harmful to health as they can penetrate deep into the lungs.
- **Fossil fuel-intensive development and urbanisation:** coal and oil have powered economic growth in many countries, but their unabated combustion in power plants, industrial facilities and vehicles is the main cause of the outdoor pollution linked to around 3 million premature deaths each year. Coal is responsible for around 60% of global combustion-related sulfur dioxide emissions – a cause of respiratory illnesses and a precursor of acid rain. Fuels used for transport, first and foremost diesel, generate more than half the nitrogen oxides emitted globally, which can trigger respiratory problems and the formation of other hazardous particles and pollutants, including ozone. Cities can easily become pollution hotspots, as they concentrate people, energy use, construction activity and traffic. The impact of urban vehicle emissions is heightened by the fact that they are discharged not from the top of tall chimneys but directly into the street-level air that pedestrians breathe.

The solutions are well known, but the problem is far from being solved

Growing attention to air pollution, together with an accelerating energy transition post-COP21, puts aggregate global emissions of the main pollutants on a slowly declining trend to 2040. Fuel combustion increases steadily in our main scenario, to help meet a one-third rise in global energy demand. But global emissions of particulate matter are projected to

fall by 7%, sulfur dioxide by 20% and nitrogen oxides by 10% over the period to 2040. This de-coupling of trends is due, in roughly equal measure, to the application of air pollution control technologies and the broader global transition to cleaner energy. Pollution controls are applied with increasing rigour in the centres of rising energy demand, mostly in Asia, where air quality regulation has struggled to keep pace with rapid industrial development and urbanisation. In parallel, the broader transformation of the energy sector – boosted by the Paris climate agreement – means that more than one-third of the projected growth in energy use is met by sources that do not emit air pollutants: wind, solar, hydro and nuclear power. Another 30% comes from natural gas, which emits less air pollution than other fossil fuels or biomass.

Continued reductions in pollutant emissions across the industrialised world, and the onset of declines in China, are accompanied in our main scenario by modest growth in India and Southeast Asia and more rapid rises in parts of Africa. Emissions of most major pollutants are already falling in many OECD countries, and this trend continues as total energy demand falls, the growth of low-carbon alternatives accelerates and increasingly stringent combustion-control regulations take effect. In China, a strong policy focus on air quality bears fruit and the recent dip in pollutant emissions becomes a long-term trend: emissions of particulate matter are 40% lower by 2040, as energy consumption growth slows, the energy mix diversifies away from coal and strict pollution controls are enforced. In India, the air pollution outlook worsens to 2040 as energy demand rises by 150%, although tighter standards in the power and transport sectors, the replacement of traditional cooking fuels with LPG and ambitious targets for wind and solar, all help to limit the growth in pollutant emissions to around 10%. In the absence of stronger regulation, economic growth in sub-Saharan Africa (excluding South Africa) is set to be accompanied by a steady deterioration in air quality: per capita indicators for GDP and air pollutants in 2040 reach the levels of India today, even though the projected energy mix in sub-Saharan Africa is much less dependent on coal.

Despite the intensified policy efforts, regional demographic trends and rising energy use and urbanisation, especially in developing Asia, mean that the number of premature deaths attributable to outdoor air pollution continues to grow, from 3 million today to 4.5 million in 2040. Asia accounts for almost 90% of the rise in premature deaths: air pollution in many of the region's growing cities continues to be a major public health hazard and, indeed, to affect a larger share of an increasingly urban population. In China, for example, an ageing population becomes more vulnerable to the effects of air pollution on human health, even though aggregate pollutant emissions are in decline. The health impacts from household air pollution improve somewhat, but remain severe. Provision of improved cookstoves and alternatives to solid biomass means that the number of people without access to clean cooking facilities is projected to fall by almost 1 billion, to 1.8 billion; as a result, the number of premature deaths attributable each year to household pollution falls from around 3.5 million today to under 3 million in 2040.

A pragmatic, tailored alternative: a Clean Air Scenario

The IEA proposes a cost-effective strategy, based on existing technologies and proven policies, to cut pollutant emissions by more than half compared with our main scenario.

This policy path is one in which the energy sector takes determined action, co-ordinated effectively with others, to deliver a comprehensive overall improvement. This *WEO* special report identifies three key areas for government action:

1. Setting an ambitious **long-term air quality goal**, to which all stakeholders can subscribe and against which the efficacy of the various pollution mitigation options can be assessed.
2. Putting in place a **package of clean air policies for the energy sector** to achieve the long-term goal, drawing on a cost-effective mix of direct emissions controls, regulation and other measures, giving due weight to the co-benefits for other energy policy objectives.
3. Ensuring effective **monitoring, enforcement, evaluation and communication**: keeping a strategy on course requires reliable data, a continuous focus on compliance and on policy improvement, and timely and transparent public information.

The scenario builds on the success already achieved in different parts of the world in improving air quality, by municipal and regional governments (which have often played a pioneering role in developing a policy response to air pollution) and through national and international efforts. It is also mindful of some cautionary tales: for example, the large gap between test data and the higher real-world pollutant emissions from diesel vehicles, which underlines the essential nature of adequate enforcement and compliance.

The measures proposed in the Clean Air Scenario are tailored to different national and regional circumstances, and include effective action to achieve full, universal access to cleaner cooking fuels and to electricity. Given the diversity of local circumstances there can be no uniform policy prescription to improve air quality. The Clean Air Scenario rests instead on a suite of policy measures that – adapted in tailored combinations to reflect different national and regional settings – can bring about the targeted improvement in air quality. Organised in a simple A-I-R typology, these measures:

- **Avoid** pollutant emissions by providing energy services more efficiently or in a way that does not involve fuel combustion. Measures include higher efficiency standards, increased support to non-combustion renewable energy and alternatives to liquids fuels for transport, and improvements in public transport and urban planning.
- **Innovate** to reduce pollution abatement costs via technology improvements that will also reduce costs for the post-Paris energy transition.
- **Reduce** pollutant emissions to the atmosphere, via stringent emissions limits on combustion plants and vehicles, controls on industrial processes, fuel switching to less-polluting fuels and strict regulation of fuel quality.

With only a 7% increase in total energy investment over the period to 2040, the Clean Air Scenario produces a sharp improvement in health compared with our main scenario: premature deaths from outdoor air pollution are 1.7 million lower in 2040 and, from household pollution, 1.6 million lower. Investment in the Clean Air Scenario includes an extra \$2.3 trillion in advanced pollution control technologies (two-thirds of this to comply with higher vehicle emissions standards) and \$2.5 trillion in a more rapid transformation of the energy sector. The resultant benefits are many times more valuable. In 2040, global emissions of sulfur dioxide and nitrogen oxides are more than 50% lower, while emissions of particulate matter fall by almost three-quarters. These reductions are largest in developing countries. As a result, the share of India's population exposed to air with a high concentration of fine particles (higher than the least stringent of the World Health Organisation's interim targets) falls to less than 20% in 2040 from more than 60% today; in China, this figure shrinks below one-quarter (from well over half), and in Indonesia and South Africa it falls almost to zero. Access to clean cooking for all is instrumental in securing life-saving reductions in particulate emissions. The extra impetus to the energy transition means that global energy demand is nearly 15% lower in 2040 than in our main scenario, thanks to improvements in energy efficiency, while the use of renewables (except biomass) increases more quickly. Of the energy that is combusted, three-quarters is subject to advanced pollution controls by 2040, compared with around 45% today.

Well-designed air quality strategies will have major co-benefits for other policy goals: the Clean Air Scenario provides for an early peak in carbon dioxide emissions, a central objective of the Paris climate change agreement. Air pollution policy cannot be viewed in isolation: it is closely linked not only to policies for energy, but also to those dealing with climate, transport, trade, agriculture, biodiversity and other issues. Reducing pollutant emissions improves water and soil quality, crop yields and, in turn, food security. Improving air quality, via improved efficiency and increased deployment of renewables, goes hand-in-hand with the broader energy sector transformation agreed at COP21. Tackling household air pollution, via the provision of modern energy for cooking and lighting, promotes sustainable development goals dealing with poverty, education and gender equality. Policy makers have to co-ordinate their actions to take into account the potential impacts of action in one area on others and the benefits and disadvantages of the interactions. Measures to address climate change could, for example, lead in some instances to more air pollution: an isolated focus on reducing carbon dioxide emissions by encouraging the use of wood stoves, diesel cars or biofuels, could increase human exposure to fine particles. Similarly, an exclusive focus on direct emissions controls, rather than the package of measures proposed in the Clean Air Scenario, could result in increased commitments to high-carbon energy infrastructure, such as coal-fired power plants. A solution to the world's pressing air pollution problem is within reach, but it must be grasped in a way that avoids impeding progress in other domains. Integrated policy approaches are essential and will continue to be promoted by the IEA as it strengthens its role as a global hub for clean and efficient energy: a Clean Air Scenario will bring much more than clean air.

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Typeset in France by IEA, June 2016

Cover design: IEA, photo credits: GraphicObsession

IEA/OECD possible corrigenda on:
www.oecd.org/about/publishing/corrigenda.htm

Energy and Air Pollution

- Around 6.5 million premature deaths each year can be attributed to air pollution.
- Energy production and use are by far the largest man-made sources of air pollutants.
- Technologies to tackle air pollution are well known.

Clean air is vital for good health. Yet despite growing recognition of this imperative, the problem of air pollution is far from solved in many countries, and the global health impacts risk intensifying in the decades to come.

The scale of the public health crisis caused by air pollution and the importance of the energy sector to its resolution are the reasons why the IEA is focusing on this critical topic for the first time.

Based on new data for pollutant emissions in 2015 and projections to 2040, this special report, the latest in the *World Energy Outlook* series, provides a global outlook for energy and air pollution as well as detailed profiles of key countries and regions: the United States, Mexico, the European Union, the People's Republic of China, India, Southeast Asia and Africa.

In a Clean Air Scenario, the report proposes a pragmatic and attainable strategy to reconcile the world's energy requirements with its need for cleaner air. Alongside the multiple benefits to human health, this strategy shows that resolving the world's air pollution problem can go hand-in-hand with progress towards other environmental and development goals.

World Energy Outlook Special Report

For more information, and the free download of the report, please visit www.worldenergyoutlook.org/airpollution