Household air pollution accounts for 3.8 million premature deaths, particularly in low- and middle-income countries.

Black carbon is a key component of household air pollution and the second most important climate change pollutant after CO₂.

Reducing household emissions can slow near-term climate change and reduce air pollution health risks, a real win-win particularly for the world’s poorest populations.

**THE EQUATION IS SIMPLE.**

Household + Black carbon = Healthy Future.

**BREATHE LIFE**

Clean Air. Healthy Future.
**HEALTH IMPACTS**

**Household (indoor) air pollution is one of the biggest risks to health in low-income countries today.**

An estimated 3.8 million premature deaths are attributed to household air pollution, primarily due to stroke, ischaemic heart disease, chronic obstructive pulmonary disease (COPD) and pneumonia.

**Household air pollution is estimated to cause one-third of all premature deaths from COPD and over one-half of all childhood under-5 pneumonia deaths.**

**The effects of household air pollutions are highest among society’s most vulnerable groups.** Some 60% of all premature deaths from household air pollution globally are among women and children. The same groups most at risk from household air pollution also tend to have heightened risks from other factors such as smoking and poor diet, making them even more vulnerable to non-communicable diseases (NCDs).

**WHAT CREATES THESE RISKS?**

**Inefficient coal and biomass stoves**

According to a new WHO report, *Burning Opportunity: Clean Household Energy for Health, Sustainable Development, and Wellbeing of Women and Children*, nearly 3.1 billion people, or 43% of the global population, still rely on polluting fuels (i.e. biomass, coal, kerosene) and technologies for cooking - a major source of household air pollution.

Household combustion of polluting fuels releases large quantities of health-damaging pollutants, such as particulate matter (PM), carbon monoxide and volatile organic compounds. Ambient levels of PM$_{2.5}$ (fine particles smaller than 2.5 micrometres in diameter) have been shown to be as much as 100 times higher than WHO-recommended levels in households with open-burning and unvented solid fuel stoves. The burning of unprocessed coal releases a toxic mix of substances,
Household fuel combustion is a significant source of the short-lived climate pollutant black carbon. Household combustion is estimated to produce 25% of global emissions of black carbon, which is the second largest contributor to climate change after carbon dioxide (CO₂) and a major component of particulate matter. Since black carbon particles remain airborne for only a few days to a week, reducing their emissions can also slow near-term climate change as well as reducing a significant health risk.

**Kerosene**

The use of kerosene as a household fuel in unvented wick cookstoves or kerosene lamps generates high levels of carbon monoxide, nitrogen dioxide, and sulfur dioxide. Studies of kerosene used for cooking or lighting indicate that its emission impair lung function and increase risks of tuberculosis, asthma and cancer. Kerosene use also can result in burns and poisoning particularly among children. Kerosene emission of PM₂.₅ are primarily composed of black carbon making it a major concern for climate change.

**THE CONTRIBUTION TO AMBIENT AIR POLLUTION**

Household emissions are a major contributor to ambient (outdoor) air pollution. From cooking alone, household air pollution is estimated to be responsible for close to 500,000 of the 3.9 million premature deaths each year from ambient air pollution.

In addition to PM₂.₅ household coal, kerosene and biomass combustion emits significant NOₓ, Volatile Organic Compounds (VOCs) and methane. These compounds interact with other outdoor air pollutants contributing to the formation of ground level ozone, an SLCP, which can drift over many kilometres, also polluting rural areas. High ozone levels increase the risks of chronic respiratory disease, decrease crop yields and alter local weather patterns. Worldwide, some 150,000 deaths annually are attributed to ozone exposures.
As their name implies, SLCPs only remain in the atmosphere for weeks to decades, compared to CO₂, which persists for over a century. If SLCP emissions are reduced, their effects can soon be reversed, a gain for both climate and public health.

**THE HEALTH EQUITY IMPLICATIONS**

The poorest households in the world typically use the most polluting fuels, and the adoption of cleaner energy sources is closely linked to poverty reduction more generally. Fuel sources progress from the open burning of dung/crop waste, to the use of wood, charcoal, kerosene, and finally, cleaner fuels such as LPG or natural gas, biogas or ethanol, and/or electricity.

Women experience high exposure to air pollution due to their greater involvement in household activities such as cooking, sometimes with infants or children in close proximity. However, reliance on polluting fuels and technologies imposes a burden well beyond the smoke inhaled. Drudgery, injuries, safety risks and time loss are just some of the negative impacts. In the WHO *Burning Opportunity* report, an analysis of 30 countries found that girls in households that cook mainly with polluting fuels lose a significant amount of time – 15 to 30 hours each week – collecting wood or water, a higher time-loss burden than for boys. In the process of gathering fuel, sometimes with a weight 40kg or more, women and children can suffer ongoing cumulative physical strain and chronic discomfort. Women may also be at risk for threats of physical and sexual violence.

Savings in terms of avoided sickness and illness, and associated healthcare costs, are among the most immediate and direct impacts of household pollution reductions. Since illness can be catastrophic for poor families, this is also important to poverty reduction. By switching to clean energy, women and children can also suffer fewer health risks from collecting heavy loads, while also having more time to put towards other productive activities.
Household fuel combustion is a significant source of short-lived climate pollutants (SLCPs), contributing to chronic respiratory disease, decreased crop yields, and altered local weather patterns. Worldwide, they drift over many kilometres, also polluting rural areas. High ozone levels increase the risks of outdoor air pollutants, which contribute to the formation of ground level ozone, an SLCP, which can exacerbate respiratory conditions.

Design strategies are particularly important in reducing household pollution and improving ventilation. Building design measures can significantly improve stove ventilation as well as decrease the consumption of fuel. When solar power replaces diesel generators in households or health facilities, not only is pollution and black carbon emissions reduced, but there are additional health and development benefits, such as better communications, refrigeration, and access to medical services. In warmer climates, energy-efficient building designs encourage passive airflow and make use of weather-tight fittings and windows while maintaining adequate active ventilation.

At present, building and energy emissions are set to double or triple in the coming years (DALYs) annually, and a reduction of 0.5 megatonnes of black carbon, per million people, is a milestone in setting acceptable levels of PM 2.5 and carbon monoxide emissions from household appliances. Strategies to reduce household air pollution emissions include phasing out unprocessed coal and kerosene as household fuels; transitioning to clean fuels such as biogas, ethanol, and LPG, as well as more efficient biomass cookstoves, with appropriate venting. Improving household ventilation and energy design is also critical.

**Cleaner Technologies**

Dramatically increasing access to cleaner household energy fuels, such as LPG, biogas, ethanol, and electricity should be a key development priority, according to the WHO Guidelines for Indoor Air Quality – Household Fuel Combustion. Electric and electric induction stoves are often the cleanest in terms of absolute indoor emissions, although the pollution
emitted by power production is a consideration in countries dependent on dirty fuels such as coal. For solar stoves or stoves using renewable fuels such as ethanol and biogas, the climate change and SLCP benefits are even greater.

Along with reducing household air pollution, biogas production has other indirect health benefits. Methane-rich biogas can be produced from human and animal sewage and municipal waste; methane CH₄ is a greenhouse gas, and one of the most powerful SLCPs, so the climate benefits of biogas capture and combustion are very positive. Policies that encourage biogas production can also support improved sewage and waste management in households and communities, and reduce deforestation pressures.

**Discontinuing use of Dirty Fuels**

The WHO Guidelines for Indoor Air Quality – Household Fuel Combustion recommends that unprocessed coal and kerosene be discontinued altogether due to their extremely high emissions of VOCs and (in the case of coal) heavy metals as well as particulates, including black carbon. Kerosene lamps, for instance, produce as much as 270,000 tons of black carbon annually, on a worldwide level. From an overall climate mitigation standpoint, they also are an excellent policy target. It has been estimated that just one photovoltaic (PV) solar lantern or light that replaces a kerosene lamp can avert the emission of 250 kg of CO₂ emissions from a single 60 watt lightbulb equivalent.

**Advanced Combustion Low-Emission Biomass Cookstoves**

Switching from open fires or rudimentary stoves to “improved” biomass stoves can reduce black carbon and PM$_{2.5}$ emissions by a factor of 10 or greater, as well as reducing harmful CO emissions. One estimate suggested that the deployment of 150 million advanced combustion “gasifier” stoves in India would result in an annual health savings of 12,500 disability adjusted life years (DALYs) annually, and a reduction of 0.5 megatonnes of black carbon, per million population.

Even so, among the improved biomass cookstoves tested, none so far have met WHO guideline emission rate targets. Since not every ‘improved’ or ‘efficient’ stove will result in net health benefits, policymakers need to carefully assess the evidence surrounding a particular technology. Policies should support further research into cookstoves that emit fewer pollutants and are low cost.

**Solar Electrification**

Some 1.3 billion households worldwide lack access to electricity. Along with replacing kerosene lamps, solar electrification can power other household electronics or appliances, creating additional health and development benefits, such as better communications, refrigeration, and enabling more productive activities to take place after dark.
In many parts of Africa, Latin America and South-East Asia, where the grid is unreliable or non-existent, PV solar installations are becoming economically competitive with diesel generators as a source of small-scale electricity production for lights, household appliances and electronics. These same approaches also are being used to power off-grid health facilities, which suffer from critical power shortages – in surveyed sub-Saharan Africa, for instance, 26% percent of health facilities have no power at all, and only about one-third of hospitals have reliable power. Due to their large and constant energy needs, and the presence of trained staff on site, local health facilities have the potential to become community anchors for solar power generation, as this becomes even more affordable, providing a baseline of renewable electricity for community needs as well.

Household and institutional diesel generators are an important and growing source of air pollution and black carbon emissions in low-income regions – particularly Sub-Saharan Africa. So when solar power replaces diesel generators in households or health facilities, not only is health improved, but black carbon emissions are reduced – and the trajectory of future emissions growth is contained.

**Improved Housing Design**

Building design measures can significantly improve stove ventilation as well as decrease the amount of heat and power that must be used to meet other essential household energy requirements. Design strategies are particularly important in reducing household pollution and SLCP emissions from fuel-based heating systems, including black carbon, CO and NOx. More efficient building design can reduce cooling requirements, and reliance on air conditioners which use hydrofluorocarbons (HFCs). HFCs are another class of very potent SLCP – and thus significant contributor to climate change.

At present trajectories, building and energy emissions are set to double or triple in the coming decades. Yet, energy efficiencies of 50-90% have been demonstrated in new buildings as well as those making use of new retrofit technologies (IPCC, 2014).

Design measures also help to keep buildings dry, at a comfortable temperature, and to remove harmful air pollutants. In cold climates, this means creating a thermal envelope (ie. with weather-tight fittings and windows) whilst still maintaining adequate active ventilation to prevent damp and mould, and the accumulation of indoor air pollution.

In warmer climates, energy-efficient building designs encourage passive air flow, and make use of green space and reflective materials to facilitate cooling. Structural additions such as chimneys can be built in to the household to enhance ventilation.

Along with further reducing household air pollution emissions, health benefits of smart building design include a reduction in hot- and cold-related morbidity and mortality, lower rates of damp-
and mould-related illnesses, and reduced transmission of infectious disease through better ventilation, as well as reduced build-up of pollutants from construction materials and furnishings.

Smart urban design that creates compact housing clusters can also improve energy efficiencies, making “district heating” systems based on the co-generation of heat and power more feasible. ‘Trigeneration’ goes further, providing cooling through chilled water as well as heat and power. These technologies are already widely used in northern Europe.

**INITIATIVES**

In May 2015, the World Health Assembly (WHA) adopted a resolution on air pollution and health, calling for an enhanced global response to the adverse health effects of indoor and outdoor air pollution. Building on this resolution, a draft road map has been proposed for WHA69, which includes four categories: expanding the knowledge base; monitoring and reporting; global leadership and coordination; and institutional capacity strengthening. One key activity is the development of a clean household energy toolkit (CHEST), which will bring together evidence and recommendations found in WHO Guidelines for Indoor Air Quality – Household Fuel Combustion to policy-makers and health professions.

The 2014 WHO Guidelines for Indoor Air Quality – Household Fuel Combustion is an important milestone in setting acceptable levels PM$_{2.5}$ and carbon monoxide emissions from household energy sources. They set health-based emission targets for fuel and stove combinations, recommend against the household use of unprocessed coal and kerosene, and support greater access to clean fuels and optimal interim technologies. The guidelines are an important tool for effective policy and planning in energy and health.

WHO’s Health in the Green Economy series provides detailed evidence about strategies that can promote health co-benefits through more energy efficient homes, including strategies that reduce SLCP emissions as well as CO$_2$ emissions. Also forthcoming are WHO guidelines on Housing and Health, which will parovide measurable standards against which housing designs may be evaluated.

The CCAC Household Heating and Domestic Cooking Initiative is working to improve the standards and testing protocol needed to reliably evaluate emissions reductions and co-benefits from interventions to reduce black carbon, PM, and other pollutants. The initiative is in collaboration with the Global Alliance for Clean Cookstoves (GACC), aimed at expanding clean cookstove solutions in developing countries.
RESOURCES

WHO:


OTHER


Global Alliance For Clean Cookstoves: http://cleancookstoves.org/

