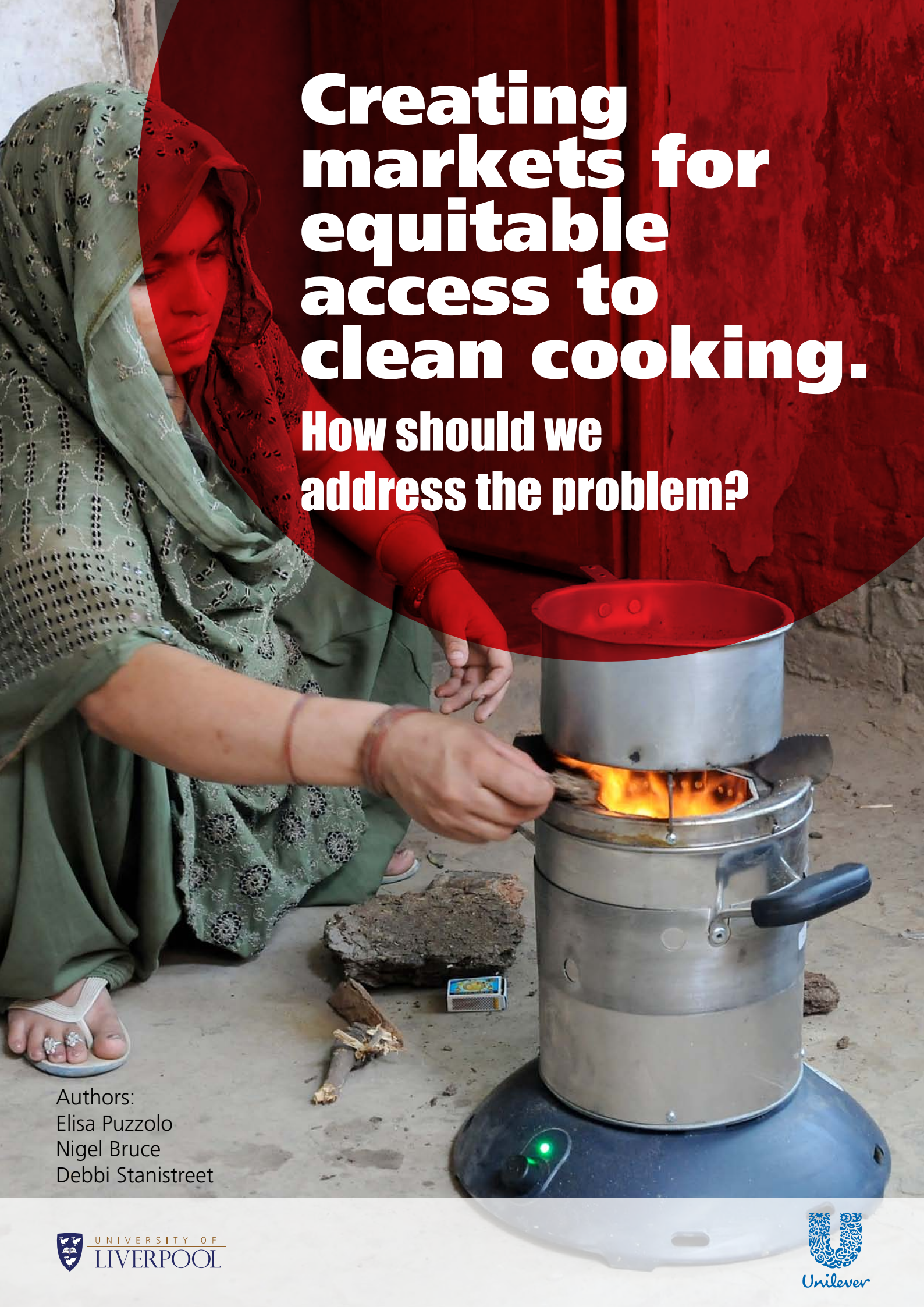
# Creating markets for equitable access to clean cooking.

## How should we address the problem?



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*Front cover image source: New Born Stove Pilot (NBSP) project implementation at SOMAARTH: Demographic, Development and Environmental Surveillance Site at Palwal, Haryana (India), The INCLEN Trust International.*

**Abbreviations:**

| | |
|---|---|
| AQG | Air Quality Guidelines |
| ALRI | Acute Lower Respiratory Infections |
| BC | Black Carbon |
| CDM | Clean Development Mechanism |
| CO | Carbon Monoxide |
| COPD | Chronic Obstructive Pulmonary Disease |
| HAP | Household Air Pollution |
| LPG | Liquefied Petroleum Gas |
| PM | Particulate Matter |
| $PM_{10}$ | Particulate Matter of a diameter of up to 10 micrometers |
| $PM_{2.5}$ | Particulate Matter of a diameter of up to 2.5 micrometers |
| UN | United Nations |
| WHO | World Health Organization |
| GHGs | Greenhouse gases |
| PAHs | Polycyclic aromatic hydrocarbons |
| GACC | Global Alliance for Clean Cookstoves |



# Executive summary

- Household air pollution from inefficient burning of solid fuels in open fires or rudimentary cookstoves is the **world's largest environmental-health threat, estimated to be responsible for almost 4 million deaths in 2010**[1].
- Women and young children, who are often carried on their mother's back during cooking, are most vulnerable to high levels of household air pollution every day.
- Open fires and simple stoves contribute to climate change through the emission of greenhouse gases (GHGs) and black carbon (BC). The harvesting of firewood in areas where forest resources are not managed sustainably also places pressure on the environment, leading to forest degradation, loss of habitat and loss of biodiversity[2].
- The **clean cookstoves and fuels sector has evolved dramatically over the last decade** and stoves with improved efficiency and reduced emissions are now commercially available in many developing country markets[3].
- Standard stove performance testing is also available and largely employed to assess stoves efficiency and emissions reduction.
- A major new initiate in the field launched in 2010 by the U.S. secretary of State Hillary Clinton and publicly supported by the actress Julia Roberts and chef Jose Andres, is the **"United Nations Global Alliance for Clean Cookstoves"**, an international public-private partnership which is encouraging the global market to sustainably address the vast cooking needs of more than 600 million households still using solid fuels in open fires and inefficient cookstoves[4].
- Successful scale up of clean cooking technologies involves multiple dimensions and implementing strategies should be planned according to the market sector targeted and should be context-specific. Top priorities set up by the Global Alliance include **enhancing demand, strengthening supply, and fostering an enabling environment**[5].
- Recent scientific advances and financial innovation are also attracting new resources and contributions from the public and private sectors, and are supported by policy drivers on energy access for the poor. An important example of this is the recent UN Secretary-General's initiative ***Sustainable Energy for All (SE4All)***, launched to mobilize global action with a target of achieving universal access to clean, modern energy by 2030 and to monitor commitments from governments and the private sector.

# Preface

This report is a contribution to the efforts to scale up effective clean cookstoves. The first section summarises the evidence of the scale of the problem, providing an overview of the health and climate change impacts associated with traditional cooking practices. It outlines the opportunities presented by the use of clean fuels and improved solid fuel stoves and then focuses specifically on the recent efforts underway globally to create a market for equitable access to improved solid fuel stoves.

The second section describes some of the main barriers and facilitators to successful scaling up of improved cookstoves. The third section reviews some of the most popular solid fuel stoves available on the African market. The report also outlines financial solutions and the role currently played by the private sector, and ends providing clear recommendations for all those who want to contribute to the expansion of the clean cookstove market.

# Household Air Pollution: the Scale of the Problem

## Overview

**Energy use is central to human activity for a range of household tasks, including cooking, boiling water, lighting and warming homes. Nearly half the world's population still rely on burning solid fuels for essential household activities.**

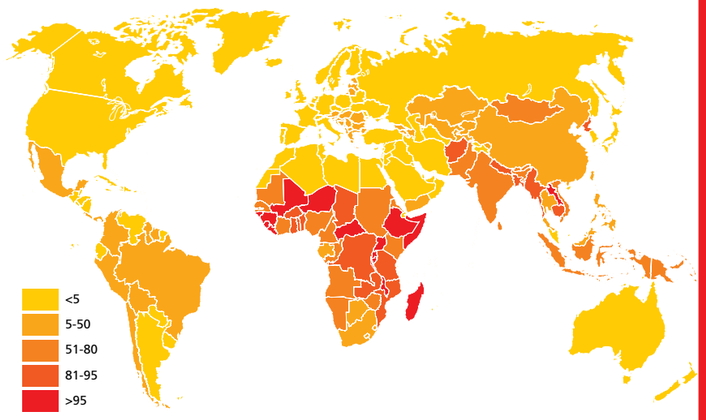
This means that almost 3 billion people (especially the poorest populations) rely on fuels and simple stoves that have changed little since prehistoric times. Dependence on polluting and inefficient fuels and appliances is both a cause and a result of poverty: people often do not have sufficient resources to afford cleaner and more efficient fuel and appliances. Energy poverty is the lack of adequate, affordable, high-quality and safely accessed modern energy services[6]. This has several negative consequences for individuals including poor health and negative impacts on the environment, but also hinders economic and social development[7] (see *Diagram 1*).

Solid fuel use is most prevalent in Sub-Saharan Africa, South East Asia and rural China, where more than 60% of households cook with solid fuels[8] (see *Figure 1*).

Using coal, burning wood, charcoal or other biomass sources on open fires or in traditional inefficient stoves generates hundreds of harmful pollutants from incomplete combustion. Household air pollution (HAP) describes the air quality within in and around the house from household sources. Exposure to very high levels of HAP causes health effects as serious as those associated with tobacco smoking (see *figure 3*). This has been documented in recent systematic reviews of health studies which demonstrate a substantive increase in risks of pneumonia in children[9], chronic obstructive pulmonary disease[10], lung cancer in adults[11], adverse pregnancy outcomes[12], and other types of cancers[13], as well as other health effects (see section on page 15).

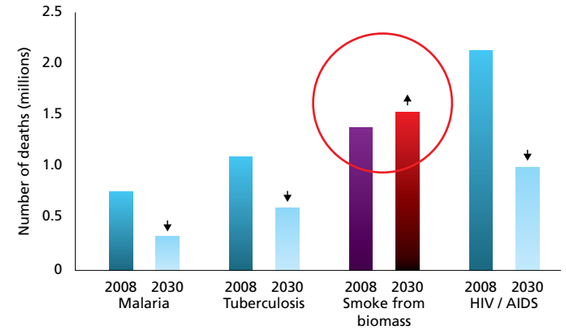


Figure 1: Percentage of population using solid fuels (data from 2010).




Source: Adapted from Bonjour et al. (2013)[8]

Figure 2. Premature annual deaths from HAP and other selected diseases (data from 2004).




Source: Adapted from IEA 2010[14]

## Fast FACTS

HOUSEHOLD AIR POLLUTION

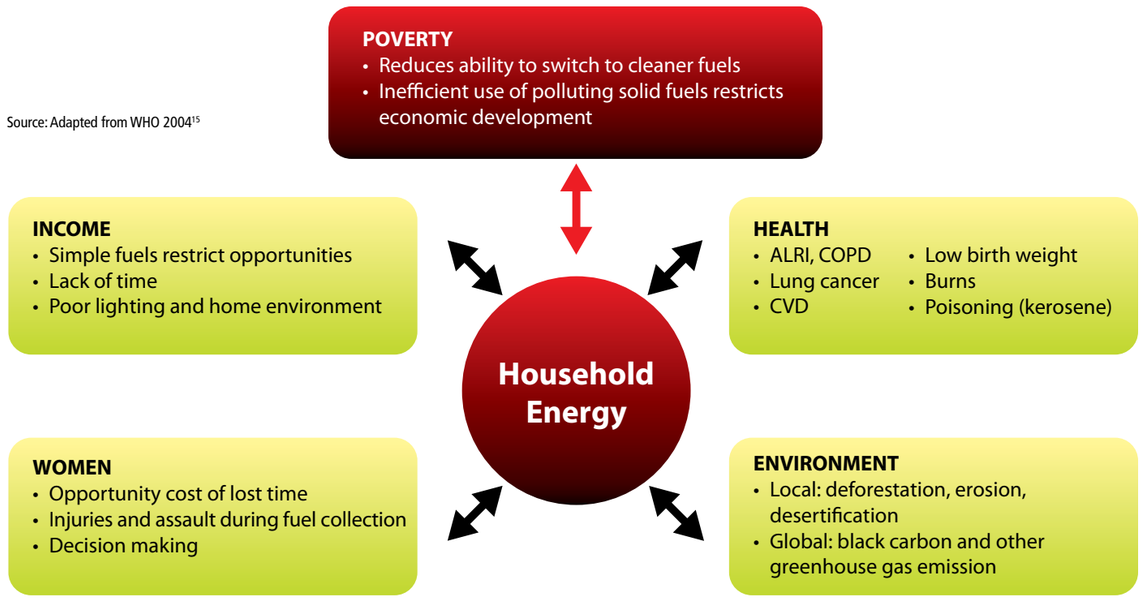
**2.8 billion people** rely on traditional use of solid fuels for cooking

**1.3 billion people** are without access to electricity

Solid fuel use is most prevalent in Africa **(646 million people)** and South East Asia **(1 billion people)**

Data from the World Health Organization for 2004 (see *Figure 2*) indicates that the number of deaths associated with cooking on traditional stoves is much higher than those associated with malaria or tuberculosis, and if current trends continue HAP will be responsible for more deaths than HIV by 2030[14]. As pointed out by some authors, these diseases justifiably capture headlines and donor dollars, but the devastating health impacts of toxic cookstove smoke merit equal attention and resources[3].

Diagram 1. The impact of household energy - WHO indoor Air Thematic Briefing 1 (2004)




Source: Adapted from WHO 2004[15]

# Effects of traditional cooking with solid fuels

## In households with limited ventilation, smoke exposure experienced by household members, particularly women and young children who spend a large proportion of their time indoors, is extremely high.

Where people habitually cook outdoors or in semi-open cooking shelters, exposure levels are lower, but still surprisingly high. Particle concentration usually exceeds guideline levels by a large margin, and can reach 50 times the level stipulated in the World Health Organisation (WHO) guidelines for clean air (annual average $PM_{2.5}$ equal to 10 µg/m$^3$)[16] (see page 14).

### Environmental impacts

Inefficient burning of solid fuels for energy does not only affect the health of millions of people but also contributes to negative environmental effects and climate change. When firewood is unsustainably harvested forest degradation and deforestation may result, with a consequent loss of habitat and biodiversity. Where wood is scarce, or populations are dense, the growth of new trees is not sufficient to match demand for fuel, resulting in deforestation, desertification, and land degradation. Apart from environmental damage, fuelwood-driven deforestation alos results in two further significant social and economic impacts: an increased burden on fuelwood collectors and farmers, and increased fuel prices[17].

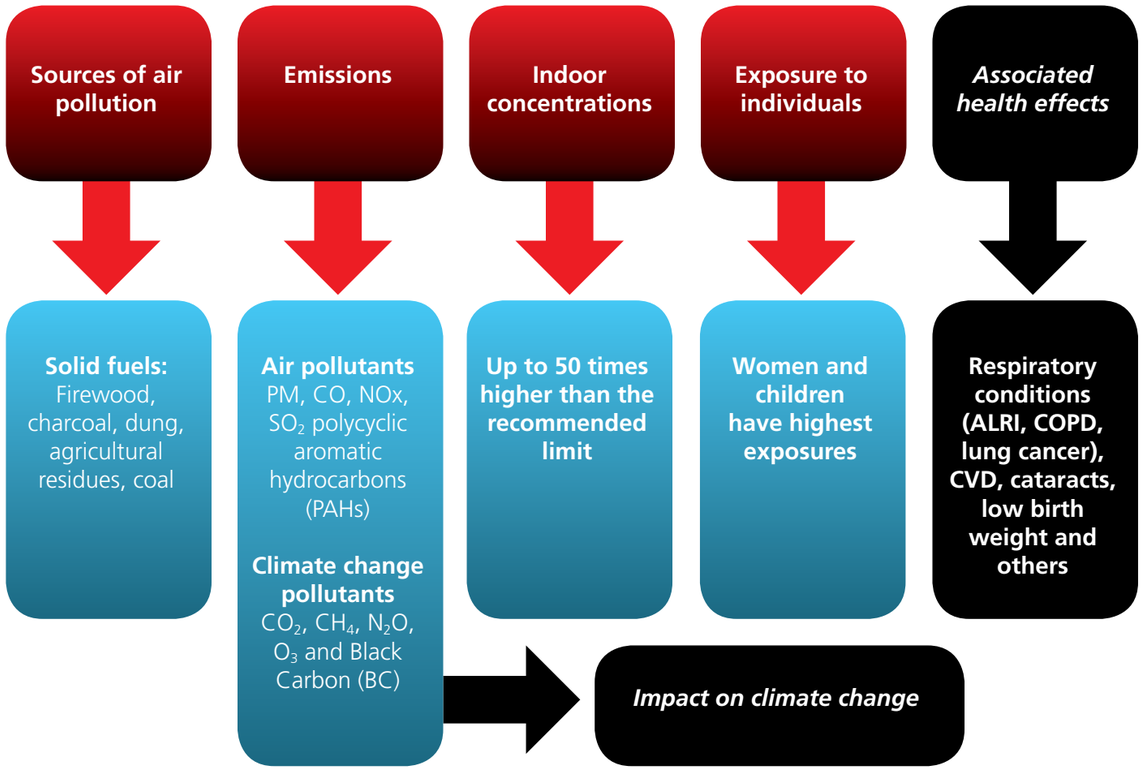
### Climate change impacts

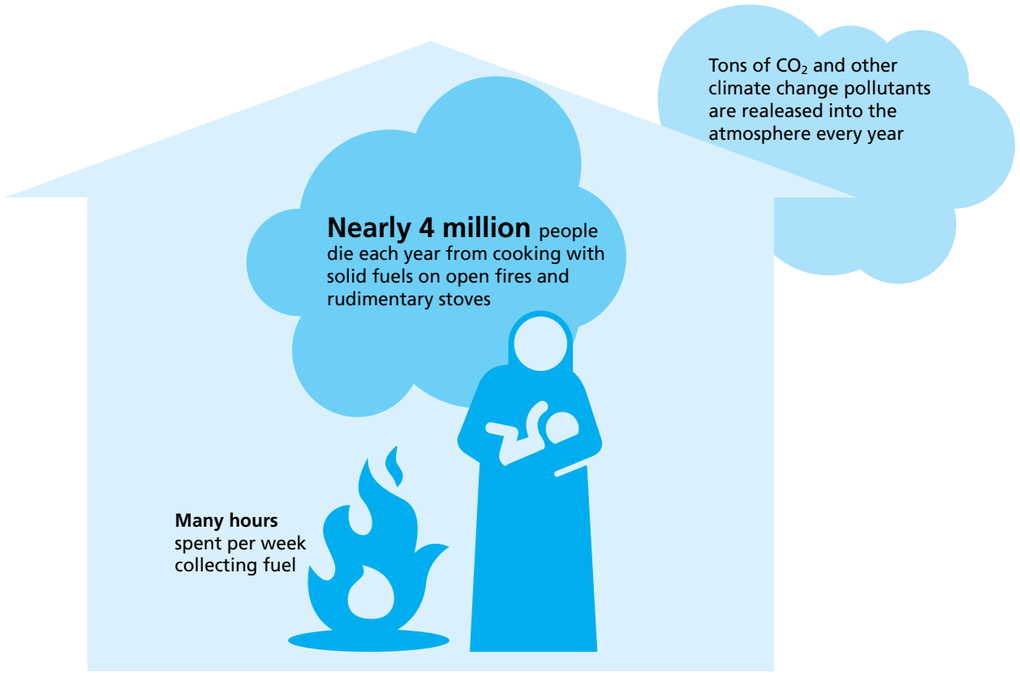
In terms of climate impact, the incomplete (or inefficient) combustion of biomass fuels releases greenhouse gases (GHGs) and other pollutants into the atmosphere, including black carbon (BC), which is estimated to contribute the equivalent of 25 to 50% of $CO_2$ warming globally[18]. $CO_2$ is the largest cause of climate change, followed by methane. Reduction of black carbon emissions through the introduction of clean cooking technologies in developing countries has recently gained momentum as a top-priority black carbon mitigation measure[19]. A reduction in emissions will therefore improve not only the health of people who cook with traditional solid fuel stoves, but will also contribute to mitigating climate change.



HOUSEHOLD AIR POLLUTION

Figure 3: The pathway from polluting sources to health and climate impacts



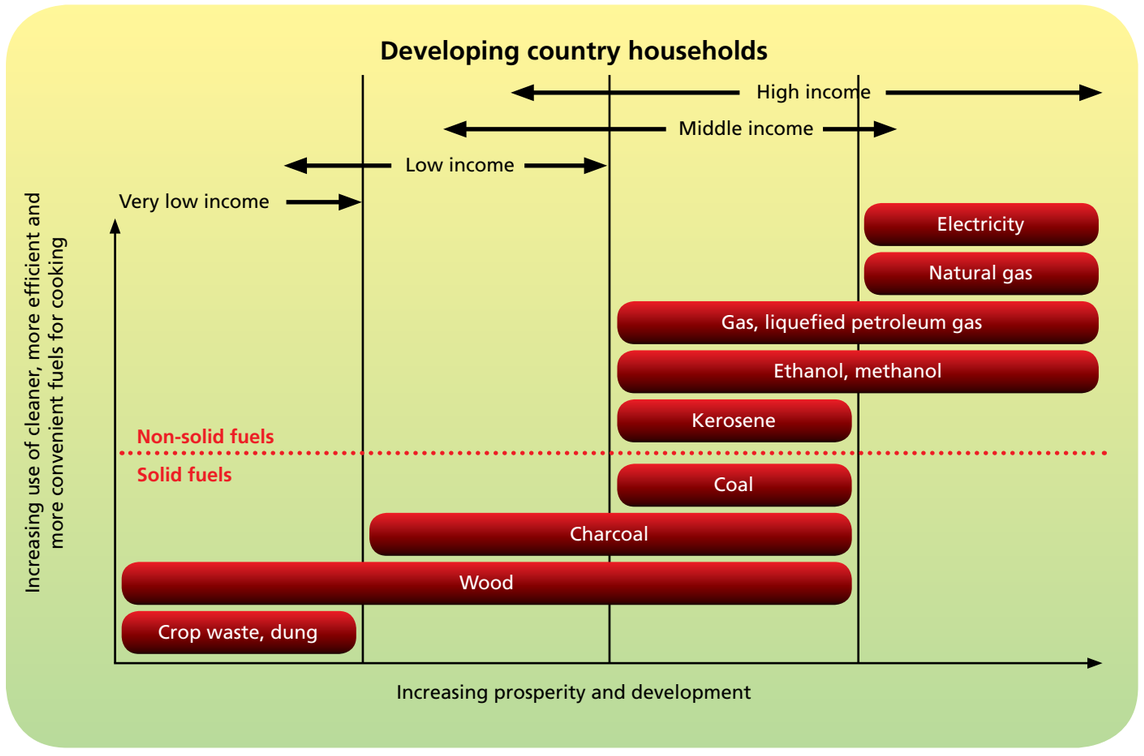
# The energy ladder

Fossil fuels – petroleum, coal, and natural gas – are the largest energy sources used by humanity[7]. Biomass (wood, agricultural residues, peat, and animal dung) accounts for a smaller percent of all energy but serves the energy needs of 42% of the world's population[8].

Household energy choice is shaped by income, fuel availability, tradition and social expectations. One of the most common concepts illustrating energy poverty is the energy ladder, where types of energy used by households can be arranged with the simplest or most traditional fuels and sources (solid fuels) at the bottom, and the more 'modern' fuels at the top of the ladder[18].

In general, when socioeconomic circumstances improve, households tend to move up the energy ladder: that is, they conduct more of their household energy activities with progressively cleaner, more efficient, and more convenient fuels (see *Figure 4*). Electricity, natural gas, liquefied petroleum gas (LPG), alcohol fuels and biogas are considered clean fuels. The ladder is also often described in terms of efficiencies, with the more efficient fuels or sources placed higher up the ladder.

Figure 4: The energy ladder




Source: Adapted by 'Fuel for Life' WHO (2006)[20]



# Positives and negatives of different energy solutions

HOUSEHOLD AIR POLLUTION

The switch to cleaner fuels and changes in appliance usage require capital investment and willingness to change. For lower income groups clean fuels are too expensive and they are economically constrained to rely on biomass fuels. In addition, the model assumes that consumers will always seek to move up the ladder, which is an assumption not fully supported by the evidence. Recent studies have shown that most households from low and middle income countries rely on more than one fuel type, depending on the type of food prepared, food availability, season, fuel cost, affordability and other factors. This phenomenon is called fuel and stove stacking[21]. The use of multiple fuels and stoves is also reported by higher income households from developing countries, as well as developed countries (e.g. coal or wood pellets for heating purposes), which means that households tend to sit on multiple rungs of the ladder simultaneously.

As the poor usually consume less energy than other higher-income households, but spend more of their income on it, reducing fuel expenditure is highly desirable. Switching from solid fuels (biomass and coal) to cleaner fuels such as LPG, biogas and alcohol fuels can offer the largest reduction in HAP if used to fulfill a majority of household energy tasks. However, in the short- to medium-term, it is unlikely that these cleaner alternatives would completely replace the existing use of solid fuels, especially for the poorer segments of society. Moreover, access to these alternatives is limited in most rural areas, and by ability to pay in many urban settings, and biomass remains the most accessible fuel. Here, cleaner-burning and more efficient stoves – provided they are adequately designed, installed and maintained – can also significantly reduce HAP. This report therefore focuses specifically on biomass improved cookstoves rather than LPG or other clean fuels, as the the first will continue to play an important part in the mix of transition fuels[22].

## Socioeconomic and urban–rural variation in solid fuel use

Clear urban–rural differences in household energy practices are apparent. In many of the poorer countries of sub-Saharan Africa and South Asia, close to 100% of rural dwellers rely nearly exclusively on gathered wood, dung, or crop waste. Biomass fuels (including charcoal) are still widespread in urban areas but often need to be purchased: this market for fuel will help drive progression toward replacement by higher quality commercial fuels, such as LPG, kerosene and electricity, at least among better-off urban groups[23].

## Traditional 3-stone fire

The most common traditional method used for cooking is the 3-stone fire. A cooking pot is placed on three stones and a fire is made in the centre of the stones under the pot. Different forms of biomass are burnt directly on open fires, leading to high concentrations in air of substances harmful to health.

## Charcoal

Charcoal is an energy-dense, light-weight, easy-to-handle fuel and is one of the preferred cooking fuels for millions of people in the developing world, especially in urban and peri-urban areas. It is less expensive than LPG or electricity in terms of both fuel and stove costs. Users usually appreciate the taste and quality that charcoal gives to slow-cooked meals, but it is less suitable for fast cooking needs.

***Fuel Efficiency:*** Traditional charcoal stove technology usually consists of a shallow and wide perforated bowl with no option to regulate the burn-rate of the fuel. Typically the pot is placed directly on the charcoal. This causes high emissions of potentially lethal carbon monoxide and wastes a significant amount of fuel. Lab testing indicates that improved charcoal stoves can reduce fuel use substantially.

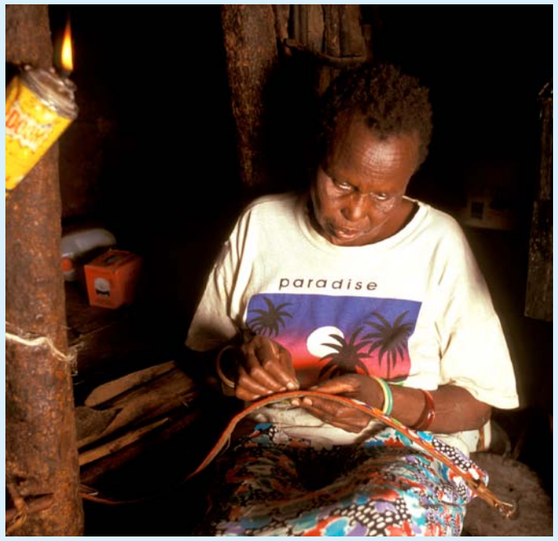
***Fuel Availability:*** Charcoal is often produced in rural areas as an income generating activity and then sold in urban markets where firewood collection is less feasible and people have more purchasing power to buy fuel. The price of charcoal is consequently linked to the size of cities, the distance to exploitable forests, and the price of the fuel required for transport. Thus, as cities expand and forests retreat, the cost of charcoal climbs upwards, often resulting in a heavy financial burden on urban households, in addition to causing environmental damage.

## Kerosene

Kerosene (also called paraffin in some countries) is a combustible liquid fuel frequently used for both cooking and lighting purposes in most developing countries worldwide. However, kerosene-burning stoves and lamps can also contribute substantially to HAP. Moreover, these cooking and lighting practices carry additional risks of burns and scalds. In addition, kerosene is commonly improperly stored in soda bottles leading to accidental poisoning of children.

***Fuel Efficiency:*** Energy efficiency depends on the technological advancement of the appliances used, which most frequently are very inefficient wick devices.

***Fuel availability:*** Kerosene can easily be transported in bulk and does not need to be transported in pressurized containers, in contrast to LPG. Thus, the logistics of distribution and retail are simpler and access to kerosene in rural and peri-urban areas is often widespread. However, use of large subsidies for kerosene has led to budgetary problems and subsidies have been abused in several countries, leading subsidized kerosene to be sold at much lower prices than gasoline or diesel and frequently diverted to the black-market for use as a transport fuel[24].




## Liquifield Petroleum Gas

Liquefied Petroleum Gas (LPG) is a gaseous fuel derived from petroleum or natural gas which burns very cleanly. It usually consists of a mixture of propane and butane for standard heating and cooking purposes.

***Fuel Efficiency:*** LPG is cost-effective, since a high proportion of its energy content is converted into heat. LPG can be up to five times more efficient than traditional fuels, resulting in less energy wasted.

***Fuel availability:*** Making LPG widely available requires considerable infrastructure for distribution and finding ways to make LPG affordable to the poor is challenging. Because of refilling costs and supply issues, LPG still remains a fuel mainly restricted to urban centres. Also, LPG use is still quite limited in most low-income countries as poor households are not able to afford refilling costs. LPG is more frequently used by middle class households and the availability of small refilling cylinders (e.g. 3kg) is favoured by users. A recent example of a successful large-scale national conversion programme has been undertaken in Indonesia, which has involved more than 40 million households converting from kerosene to LPG[25].



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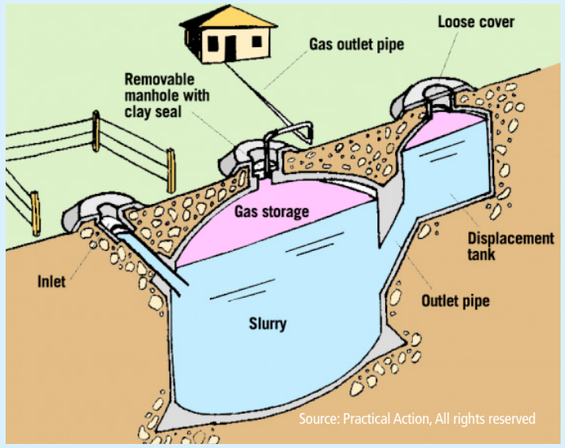
## Ethanol

Ethanol is a clean liquid bio-fuel that can be made from a variety of feedstock including sugary materials (i.e. sugar cane, molasses, sugar beet, or sweet sorghum), starchy materials (e.g. cassava potatoes, or maize) or cellulostic materials (e.g. wood, grasses, corn stover and other agricultural residues).

***Fuel Efficiency:*** When burnt in efficient alcohol stoves, ethanol is more efficient than solid fuels and kerosene, and generally comparable to LPG. Although ethanol fuel has a lower energy content by volume than kerosene, ethanol tends to combust more efficiently in a simple cookstove than kerosene does and therefore gains in efficiency what it lacks in energy. The higher ethanol quality stoves require hydrous ethanol with a maximum water content of 4-10%.

***Fuel Availability:*** Ethanol is produced in several countries, but the price of ethanol is still high, in part due to the demand created by its use as a transport fuel. Land competition with agricultural production may present a challenge in some settings, which can be minimised by setting up policy priorities and national land use programmes.


## Biogas





Biogas is a by-product of anaerobic digestion of animal (and human where used) dung in small tanks built near households, which has gained some popularity in Asiatic countries, in particular China, India and Nepal. The resulting gas can be used for multiple applications including cooking and lighting (the fuel constituent is methane), and the process retains the fertilizer value of the dung, which can be subsequently used as digester sludge.

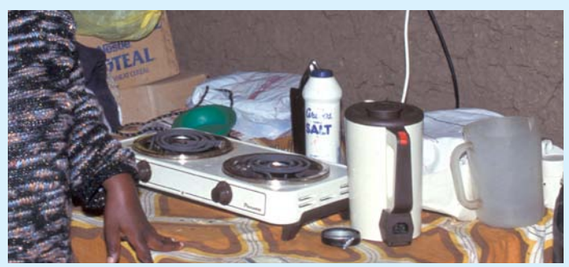
***Fuel Efficiency:*** The primary domestic uses of biogas are cooking and lighting. The efficiency of stoves depend on the gas pressure and stove design.

***Availability:*** Biogas digesters are very expensive to build (US$180-500), all require considerable financial assistance to build and require substantial management. They also cannot operate below 10ºC without specific design enhancements and require dung from at least 2 large animals, limiting potential coverage.

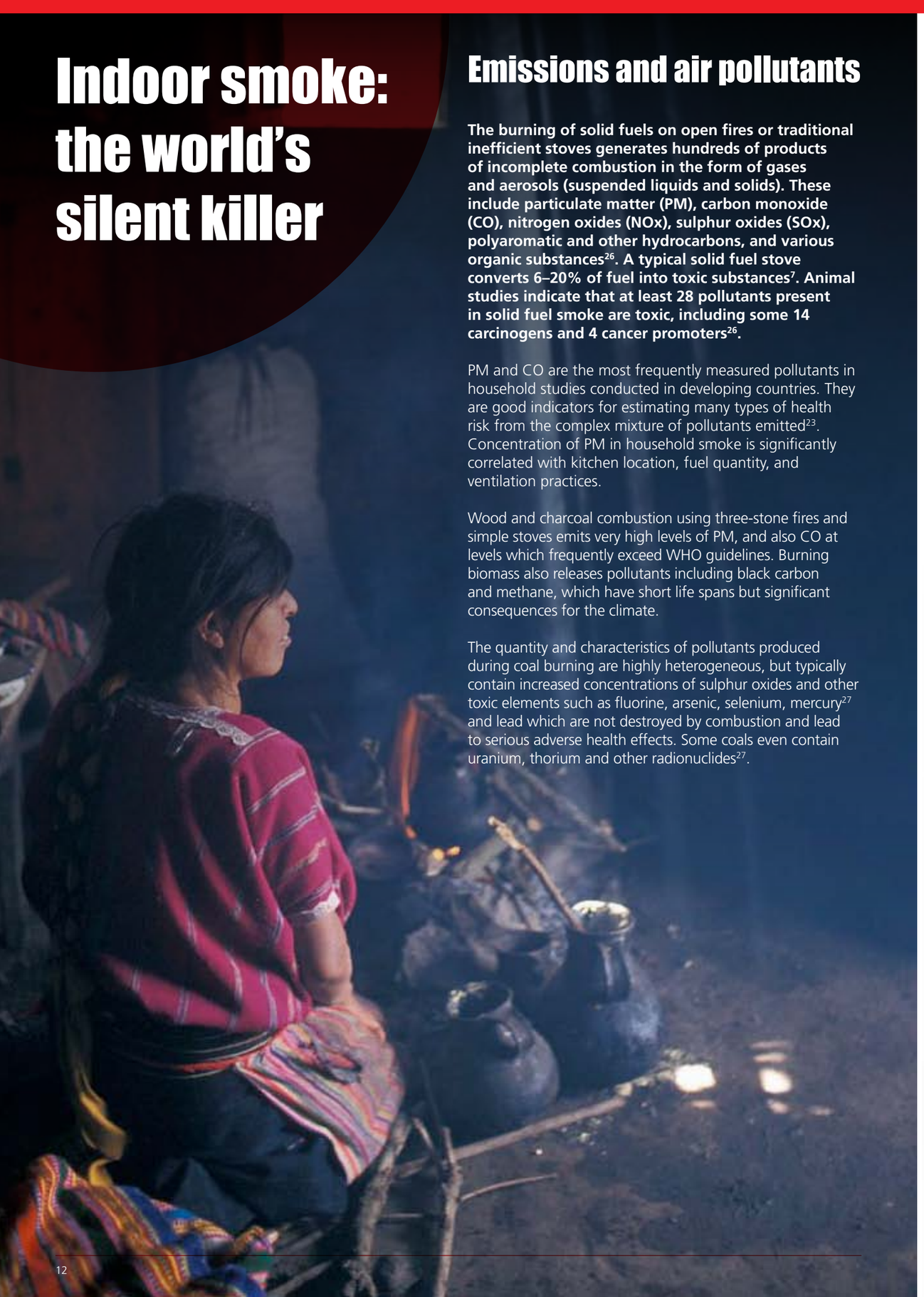
## Electricity

Electric stoves convert electrical energy into heat for cooking. Use of electric stoves is limited to areas that have access to sufficient and reliable electrical power, which often excludes rural communities. Direct use of electricity for main cooking tasks is often too expensive even to those household connected to electricity supplies.

Electric stoves are smokeless at the point of use and do not produce any emissions within a household, though electricity generation does contribute to emissions that impact ambient air quality.



# Indoor smoke: the world's silent killer



## Emissions and air pollutants

**The burning of solid fuels on open fires or traditional inefficient stoves generates hundreds of products of incomplete combustion in the form of gases and aerosols (suspended liquids and solids). These include particulate matter (PM), carbon monoxide (CO), nitrogen oxides (NOx), sulphur oxides (SOx), polyaromatic and other hydrocarbons, and various organic substances[26]. A typical solid fuel stove converts 6–20% of fuel into toxic substances[7]. Animal studies indicate that at least 28 pollutants present in solid fuel smoke are toxic, including some 14 carcinogens and 4 cancer promoters[26].**

PM and CO are the most frequently measured pollutants in household studies conducted in developing countries. They are good indicators for estimating many types of health risk from the complex mixture of pollutants emitted[23]. Concentration of PM in household smoke is significantly correlated with kitchen location, fuel quantity, and ventilation practices.

Wood and charcoal combustion using three-stone fires and simple stoves emits very high levels of PM, and also CO at levels which frequently exceed WHO guidelines. Burning biomass also releases pollutants including black carbon and methane, which have short life spans but significant consequences for the climate.

The quantity and characteristics of pollutants produced during coal burning are highly heterogeneous, but typically contain increased concentrations of sulphur oxides and other toxic elements such as fluorine, arsenic, selenium, mercury[27] and lead which are not destroyed by combustion and lead to serious adverse health effects. Some coals even contain uranium, thorium and other radionuclides[27].



# How the damage is done?



**There are several mechanisms through which PM, CO and other pollutants may adversely affect the respiratory and cardiovascular systems as well as immunologic and inflammatory responses.**

## Particulate matter (PM)

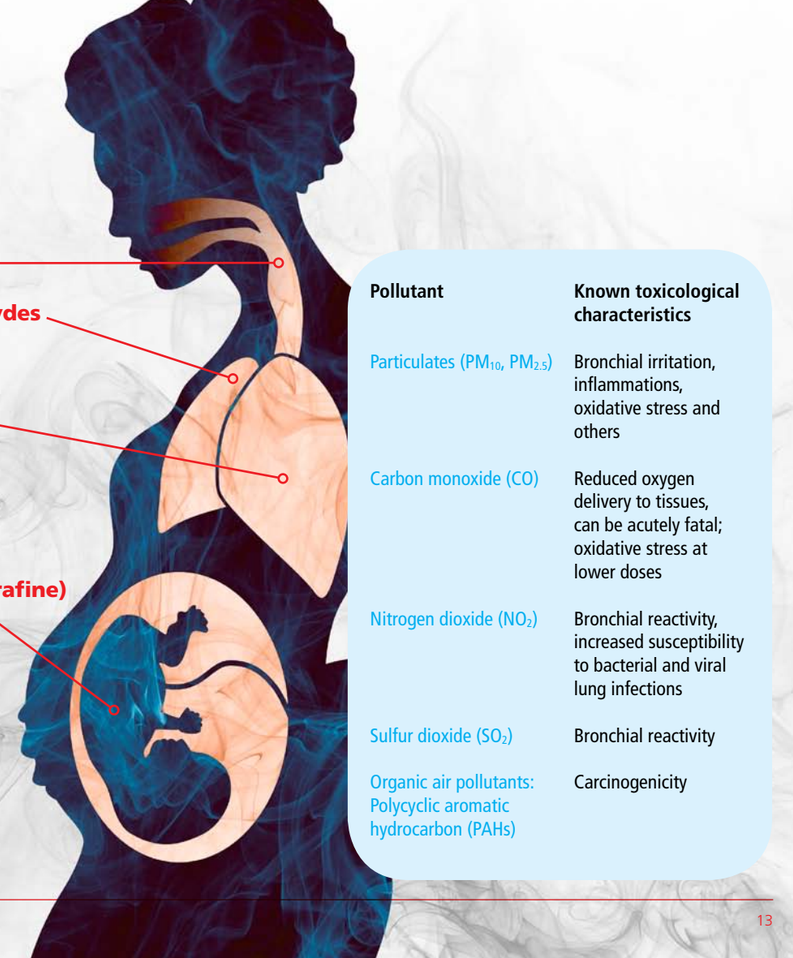
**Particles are generally classified according to their aerodynamic properties.**

- **$PM_{10}$** ($PM$ with a diameter of up to 10μm) is the most common annual measure used in urban ambient air assessments;
- **$PM_{2.5}$** (fine particles with diameter up to 2.5μm) is generally considered the best pollutant to measure for studies of health effects from combustion-generated pollutant mixtures in developing countries, as it is likely to have the greatest impact on respiratory health (see *Figure 5*). $PM_{2.5}$ is filtered only to a limited extent by the naso-oropharangeal region and can penetrate deep into the bronchial and alveolar regions[23].
- **Ultrafine particles** (with diameter less than 100nm) can be absorbed into the bloodstream and may cause systemic effects (that is extending throughout the body, via the circulatory system) including cardiovascular disease, impacts upon the growing fetus, and eye disease (cataract).

## Carbon monoxide (CO)

**CO is a colorless, odorless, and tasteless gas.** Exposure to carbon monoxide reduces the blood's ability to carry oxygen. Exposure is particularly dangerous to unborn babies, infants and people with anaemia or a history of heart disease[23]. CO concentrations are also used as a proxy for $PM_{2.5}$. CO is easier to measure than $PM_{2.5}$ making population-based personal exposure assessment feasible for children and babies.

Figure 5: Deposition of air pollutants within the human body




| Pollutant | Known toxicological characteristics |
|---|---|
| Particulates ($PM_{10}$, $PM_{2.5}$) | Bronchial irritation, inflammations, oxidative stress and others |
| Carbon monoxide (CO) | Reduced oxygen delivery to tissues, can be acutely fatal; oxidative stress at lower doses |
| Nitrogen dioxide ($NO_2$) | Bronchial reactivity, increased susceptibility to bacterial and viral lung infections |
| Sulfur dioxide ($SO_2$) | Bronchial reactivity |
| Organic air pollutants: Polycyclic aromatic hydrocarbon (PAHs) | Carcinogenicity |

# Exposure to household fuel combustion products

## Levels of pollution in homes using biomass fuel

Typically, the concentrations of pollutants in homes using open fires or traditional stoves are extremely high. These levels exceed the pollutant-specific annual World Health Organization Air Quality Guidelines[16], often by one or two orders of magnitude (10-100 times).

24-hr kitchen concentrations of $PM_{2.5}$ from wood fires usually range from 100 µg/m³ in homes using chimney stoves in good condition to 1000 µg/m³ in homes using open fires.

## World Health Organisation (WHO) Air Quality Guidelines (AQG)

WHO air quality guidelines report levels of both short-term (24-hour) and long-term (annual) exposure to PM which are considered 'safe', i.e. those associated with no or minimal health risk.

In addition, three interim targets (IT) have been set up to provide assistance for countries when gauging progress in the difficult process of steadily reducing population exposure to PM[16].

| | $PM_{10}$ (µg/m³) | | $PM_{2.5}$ (µg/m³) | |
|---|---|---|---|---|
| | **Annual** | **24 hours** | **Annual** | **24 hours** |
| WHO interim target 1 (IT-1) | 70 | 150 | 35 | 75 |
| WHO interim target 2 (IT-2) | 50 | 100 | 25 | 50 |
| WHO interim target 3 (IT-3) | 30 | 75 | 15 | 37.5 |
| **WHO air quality guidelines (AQG)** | **20** | **50** | **10** | **25** |

The extent of exposure to household air pollution due to combustion of solid fuel is determined by several parameters, in particular fuel type, stove type, ventilation and consumer behaviour.

Family members have different levels of exposure depending on the time they spend in different polluted parts of the home and the extent to which they do the cooking, or are kept close to the fire during cooking, as in the case of small children.

**Personal exposure** is determined by two components: (a) the level of exposure in and around the home; (b) the length of time for which each person in the home is exposed to that level. We know that typically women, girls and young children (until they can walk), are often exposed for at least 3–5 hours a day, often more. In cold settings and in some communities, exposure will be for a much longer period each day.

## Climate impacts of solid fuel stoves

Burning solid fuels in open fires and traditional stoves also releases several climate change pollutants, including carbon dioxide, black carbon, methane, and ozone precursors (such as carbon monoxide)[2].

Black carbon (BC) is a fine particulate matter, resulting from incomplete combustion of fossil fuels and biomass fuels, and contributes significantly to global warming[28]. In South Asia, where half of the BC comes from cookstoves, BC also disrupts the monsoon season and accelerates the melting of the Himalayayan-Tibetan glaciers[2,29].

A recent field test study of BC from stoves reports that BC can be substantially reduced by the most effective improved solid fuel cook stoves (50-90%)[30]. These findings indicate the opportunity to both slow climate change and protect health by promoting clean cooking devices and fuels which substantially reduce both particulate matter and other health-damaging pollutants that have the greatest impact on health.



# Household Air Pollution: Effects on health

HOUSEHOLD AIR POLLUTION

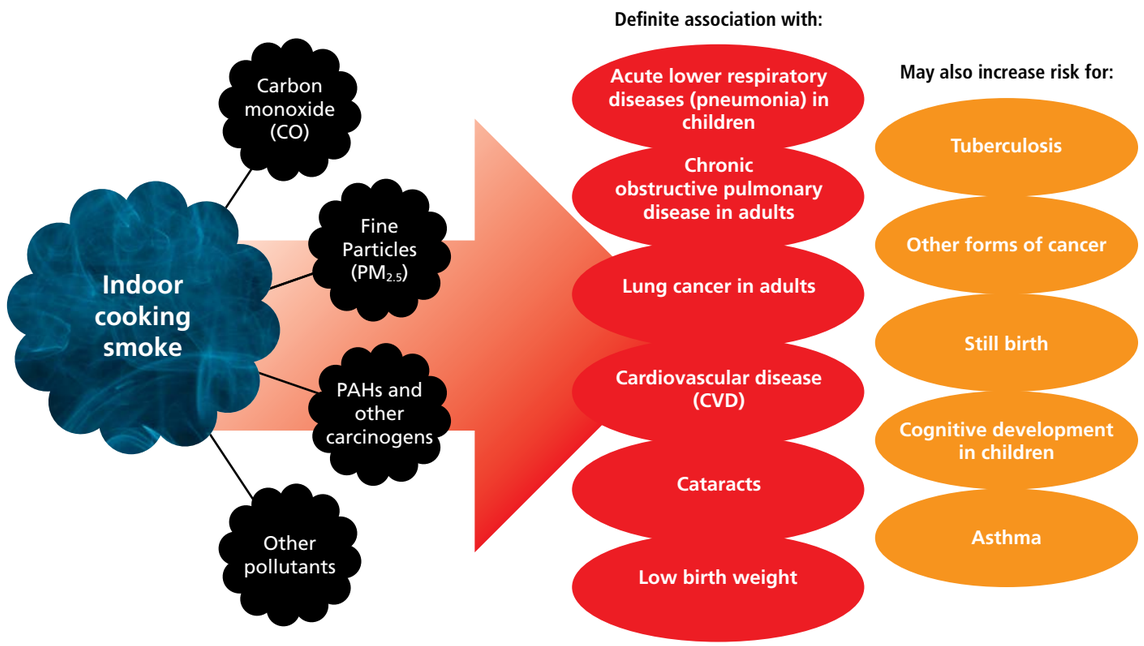
## Exposure to Household Air Pollution (HAP) is a recognised risk factor for several diseases.

According to the new global burden of disease estimates published in the Lancet 2012, HAP from cooking with solid fuels was estimated to have caused almost 4 million deaths in 2010 (range: 2,6 to 4,3 million)[1]. This latest estimate is nearly double the previous number published by WHO for the year 2004[14], mainly due to the addition of cardiovascular diseases as an outcome (as evidence for a link with this disease is now stronger)[31]. Further, many more individuals suffer from disabilities related to acute and chronic respiratory conditions, cataracts.

The link between diseases caused by solid fuel use in the home for cooking and/or heating has been demonstrated by a substantial number of studies conducted over the years, which have been compiled in systematic reviews.

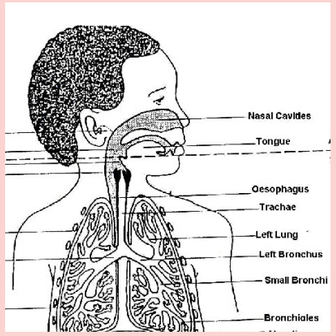
These studies have found that HAP exposure is associated with a wide range of child and adult health outcomes (see *Figure* 6). Strong evidence is reported for conditions such as ALRI (i.e. pneumonia) and low birth weight in children as well as COPD, lung cancer and cataract in adults (and especially among women). Strong evidence for cardiovascular diseases comes mainly from studies of other sources of combustion pollution, namely outdoor air pollution, second-hand and active smoking. Multiple studies have also shown somewhat weaker relationships with other conditions such as tuberculosis, still birth and pre-term birth, other cancers, and asthma.

Figure 6: Health impacts of household air pollution

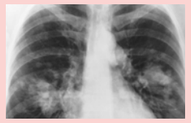


## Child Acute Lower Respiratory Infections (ALRI)

ALRI in children consists mainly of pneumonia and acute bronchiolitis. Pneumonia is still the leading cause of mortality in children younger than 5 years. In 2010 about 1.4 million young children died from this infection[32], and up to 13% of roughly 155 million episodes are severe enough to warrant hospital admission[33]. Diarrhoea and malaria follow pneumonia, and were responsible for 800 000 and 563 000 deaths respectively in 2010[32]. The incidence and mortality from ALRI are generally highest in those countries and regions where solid fuel use is greatest. These respiratory-tract infections are caused by a mixture of viral and bacterial pathogens and are particularly common in low birth weight children and children exposed to poor nutritional conditions, household air pollution, poverty, overcrowded living conditions etc. Pneumonia not only has an immediate effect during childhood, but can also lead to impaired lung function years later in adulthood[34].




## Lung Cancer



Increase in cancer risk is largely caused by the specific chemicals found in combustion emissions of both coal and biomass. Coal smoke is a powerful carcinogen and lung cancer from exposure to coal smoke in countries making use of coal for domestic activities, including cooking and heating, is a common illness. In studies conducted in China, the relative risk for lung cancer in women over 30 years of age was found to be nearly two times greater than in women not exposed, and also moderately higher in exposed men[11]. More recently, evidence also confirms an increase in risk for lung cancer from exposure to biomass smoke[35].

## Chronic Obstructive Pulmonary Disease (COPD)

*Picture source: Wikipedia - James Heilman, MD*

COPD describes a collection of lung diseases including chronic bronchitis, emphysema and chronic obstructive airways disease. People with COPD have difficulties breathing, primarily due to the narrowing of their airways. Typical symptoms of COPD include: increasing breathlessness when active, a persistent cough with phlegm, frequent chest infections etc. Globally, tobacco smoking is considered to be the most important risk factor for COPD, but household air pollution from solid fuel use is likely to play a significant role among the large population of non-smoking women in developing countries[36]. Recent studies have identified that the relative risk for COPD in women over 30 years of age is three times greater than in women non-exposed and nearly two times greater in exposed men over 30 years of age[10].

## Cardiovascular diseases (CVD)

Outdoor air pollution and smoking (both active and second-hand), are strongly linked to cardiovascular disease, so it is not surprising to expect links between HAP and this disease outcome. However, this association has not yet been studied very extensively in developing countries. Only two recent epidemiological studies conducted in China and Bangladesh have investigated the risk of completed CVD outcomes associated with solid fuel use[37, 38], which provide evidence that is consistent with the risk expected from other sources of combustion pollution.

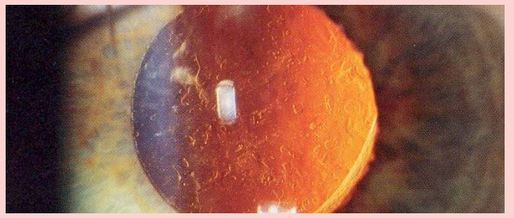
*Picture source: Wikipedia - Bryan Brandenburg http://bryanbrandenburg.net/wikpedia-heart-3d//*



HOUSEHOLD AIR POLLUTION

## Cataracts

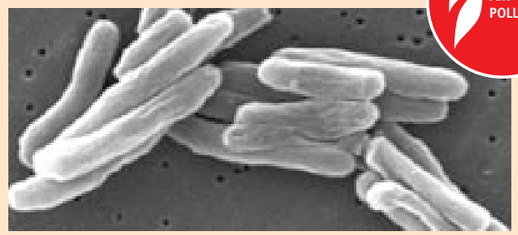
Severe lens opacification, also know as cataracts, is one of the leading causes of blindness in the developing world. Epidemiological studies from Nepal and India have confirmed the association between cataracts or blindness with women cooking using biomass fuels in traditional stoves[39, 40]. Smoke induces oxidative stress and depletes important compounds, which provide antioxidant protection against cataract formation[44].



*Picture source: Wikipedia - Rakesh Ahuja, MD*

## Adverse pregnancy outcome

Chronic and elevated biomass smoke exposure during pregnancy has been associated with a number of adverse pregnancy outcomes, including low birth weight and stillbirth[12]. Multiple studies also confirm the association linking low birth weight with exposure to environmental tobacco smoke and ambient air pollution.



## Tuberculosis

Tuberculosis was responsible for 1.4 million deaths and almost 9 million new cases worldwide in 2011[42]. Although much remains unknown about the disease transmission and activation, nearly two billion people have latent infections. There is increasingly strong evidence for an association between HAP and tuberculosis. A recent systematic review exploring this association reinforces this finding[43], although the exact mechanisms are uncertain and any causal relationship needs to be assessed.

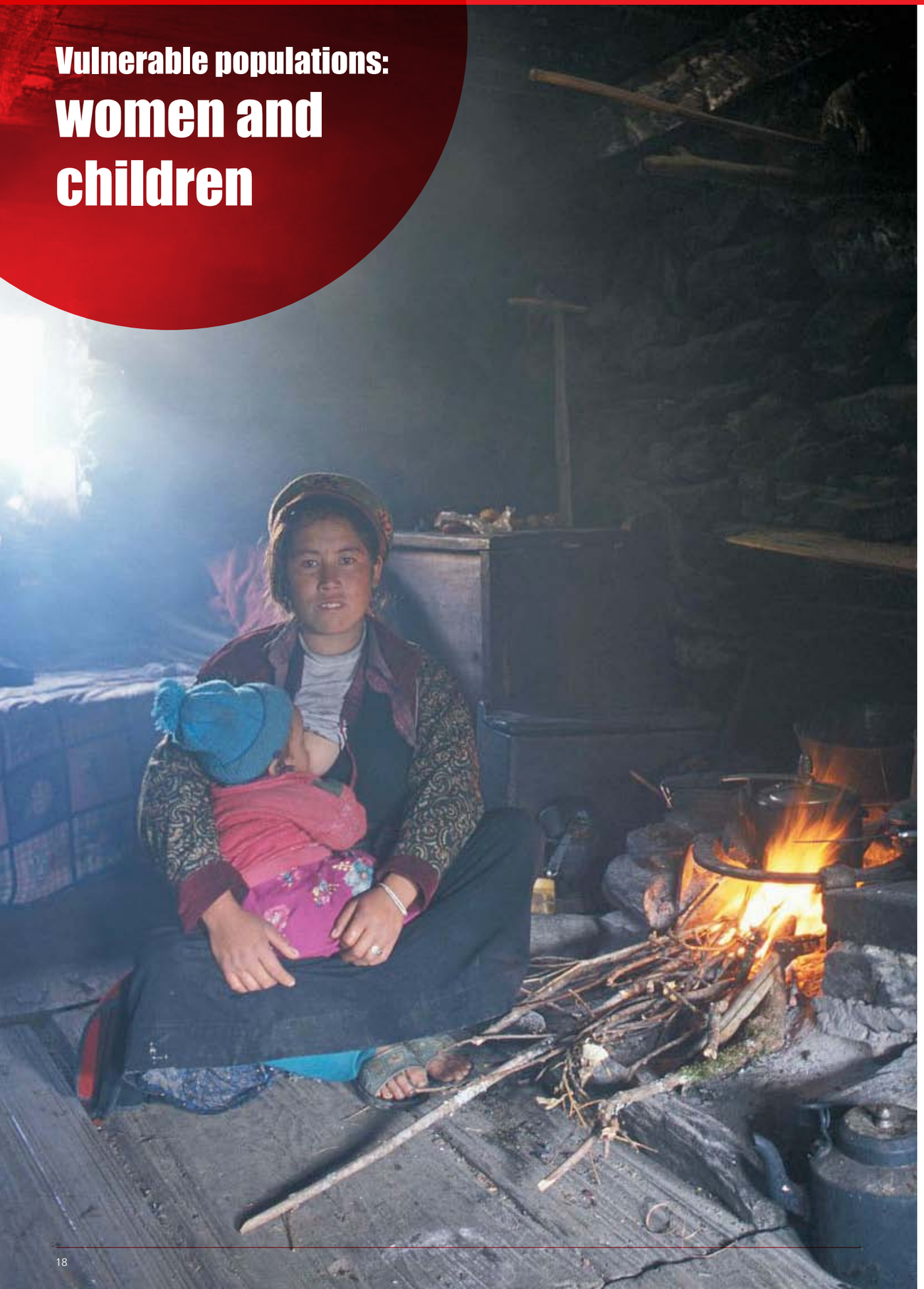
## Cognitive development

Children's cognitive neurodevelopment is also affected by indoor smoke. Recent evidence demonstrates that chronic exposure to carbon monoxide in utero (CO levels <13 ppm) impacts the neurodevelopment of the fetus. When pregnant women are chronically exposed to high level of CO, inverse associations between CO exposure and child neuropsychological performance is reported[44]. Other pollutants in HAP have also been shown to impair cognitive developments, so there is a growing body of evidence that suggest that HAP exposure – especially during pregnancy – could impair cognitive development, although the exact mechanism of these effects are yet to be established.

## Burns and poisoning

The combustion of household fuels used for cooking, heating, and lighting often results in burns and scalds. In the combustion of fuels at home, most burn injuries are caused by a hot liquid (scalds), a hot solid (contact burns), or a flame (flame burns).
***Kerosene***, used most commonly for lighting, also causes many burns and fires in homes when lamps and stoves are knocked over. Children are a high risk group for burn injuries and deaths because of a combination of limited awareness of fire dangers, impulsiveness, curiosity, and imitation of adult behaviour[45]. Some of the fuels are also poisonous. Ingestion of kerosene is a common example of poisoning, especially among children.

# Vulnerable populations: women and children





HOUSEHOLD AIR POLLUTION

## Women and children from developing countries, who spend most of their time at home, are at a high risk of exposure to household smoke.

Women are primarily involved in cooking, and it is they who usually bear the brunt of collection and harvesting of firewood. Women and their daughters can spend 20 or more hours per week on long, exhausting walks in dangerous and isolated areas in order to collect fuel[3]. When they leave their communities to do so, they are at increased risk of falls, assaults and gender-based violence. In conflict areas, where armed conflicts make exposure to rape and other physical assaults a daily threat, women and girls often pay a high price for using fuels that need collecting[3].

Back problems are also often a consequence of carrying heavy loads of firewood and bending over the fire for long period during cooking[46]. Fuel gathering also largely impacts on women's time. Hours spent during collection may prevent women from using their time for other activities in the house, such as helping children in school, visiting the elderly or the sick in the community, and prevents women from being involved in income generating activities[3].

**Pregnant women** are particularly at risk. Carbon monoxide reduces oxygen delivery to key organs of the developing fetus, impacting on the brain formation, the cardiovascular system, heart, lungs etc.

**Young children** – especially before they can walk – are highly exposed to harmful pollutants as they spend most of their time with (or close to) their mothers. Also, the impact of exposure to any air pollutant is usually greater than for an adult since:

- They inhale more pollutants per kilogram of body weight than adults
- Exposure increases the risk of infections
- Their airways are narrower, and irritation can result in proportionately greater airway obstruction

# How do cleaner cookstoves change lives?



HOUSEHOLD AIR POLLUTION

## Healthy cooking starts with the stove. Cleaner, safer and more efficient stoves can improve the livelihoods of poor households in a myriad of ways.

Improved stoves (see page 43 for definition) can bring a range of benefits. They can reduce smoke inhalation, some quite substantially, and in a few studies - for example in China and Guatemala - stoves have been shown to result in useful health benefits. Where fuel is collected, the time saved from less fuel gathering can be translated into multiple activities that women can do at home and for their families[3]. Where fuel is purchased, there are savings from reduced consumption which can be used for beneficial purposes. Cookstove projects can also benefit men, provide employment opportunities for both women and men in making and selling new stoves, and contribute to technology transfer.

Interventions to reduce exposure to household air pollution can be classified broadly as:

- those acting to change the primary household fuel
- those promoting improved solid fuel stoves
- those improving the living environment and
- those modifying user behavior[47].




*Source: Text adapted from GACC (2012)[3]*

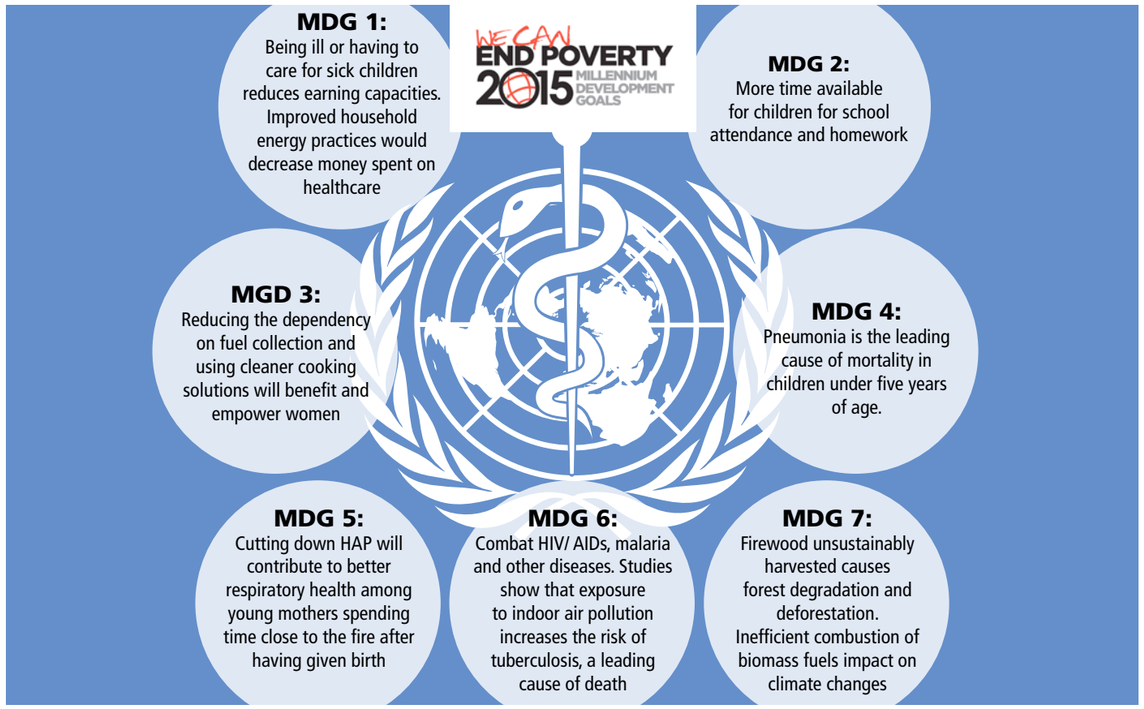
# What is being done?

Although the last 30 years have seen a variety of efforts aimed at improving household energy, ranging from small scale NGO-led projects to the vast Chinese National Improved Stoves Programme[48], most have been directed at saving fuel and reducing deforestation rather than protecting health.

In recent years, as evidence on the harmful health impacts of household air pollution has been demonstrated and climate change has become prominent on the global agenda, there has been a resurgence of interest in cleaner and more fuel-efficient stoves as a way of simultaneously improving health, reducing climate change pollutants, generating environmental benefits, and contributing to social and economic development.

The increase in political will and attention has been translated into a number of Alliances and global initiatives which can be game-changing opportunities to speed up the large-scale adoption of cleaner cooking technologies, in order to achieve the Millennium Development Goals (MDGs). Links between household energy and its contribution to achieving the MGDs are summarised in *Figure 7*. These initiatives are expected to lay the basis for expanding opportunities to develop markets and improve access, for example through more responsive governments and other relevant institutions, finance solutions etc.

Figure 7: Contribution of improved household energy practices to the Millennium Development Goals





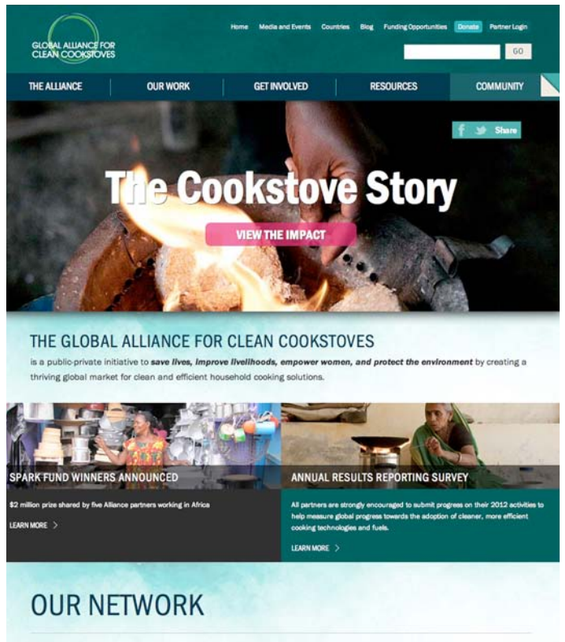

# The Global Alliance for Clean Cookstoves

HOUSEHOLD AIR POLLUTION

GLOBAL ALLIANCE FOR CLEAN COOKSTOVES

In 2010, a major new development initiative was launched by the U.S. Secretary of State Hilary Clinton, along with several leading international public figures and private companies: the **"Global Alliance for Clean Cookstoves"**. The Alliance, as it is commonly known, is currently playing a key role to "catalyse a thriving global market for clean cooking solutions"[4].


*http://www.state.gov/s/partnerships/cleancookstoves/*




*http://www.cleancookstoves.org*

At the end of 2011, the UN Secretary-General launched the **Sustainable Energy for All** (SE4ALL) Initiative, with ambitious targets for universal access to electricity and modern cooking energy systems by 2030[5]. Access to Energy was not originally included among the Millennium Development Goals set up by the global community in 2000, but household energy is inextricably linked to most of these goals and improvements in access to cleaner energy can undoubtedly make multiple contributions to the MDGs. With less than 1,000 days left to meet the Millennium Development Goal targets, the process of establishing new development goals beyond 2015 is taking place.

The post-2015 agenda will reflect new development challenges following on the "Rio+20" conference, where the importance of climate change and access to energy is likely to appear among the future Sustainable Development Goals.

# GLOBAL ALLIANCE FOR CLEAN COOKSTOVES

The three-year-old Global Alliance for Clean Cookstoves (GACC), is a $250m public-private partnership launched in 2010 and led by the United Nations Foundation (www.cleancookstoves.org). Designed to save lives, improve livelihoods and mitigate climate changes, the Alliance is committed to enabling **100 million households to adopt clean and efficient cookstoves and fuels by 2020.**

This ambitious goal has mobilised support from a wide range of private, public, and non-profit stakeholders[49]. Over 690 worldwide partners, including 57 Governments, private companies, carbon project developers and multilateral organisations have joined the Alliance (see *Figure 8*). National and multi-national business companies, alongside small enterprises, are actively promoting cleaner cooking technologies to the developing world. Companies involved include Philips, Deloitte, Morgan Stanley, Nexant and Novazymes just to mention a few[4].

Figure 8: Partners of the Global Alliance for Clean cookstoves


*Source: Adapted from www.cleancookstoves.org*

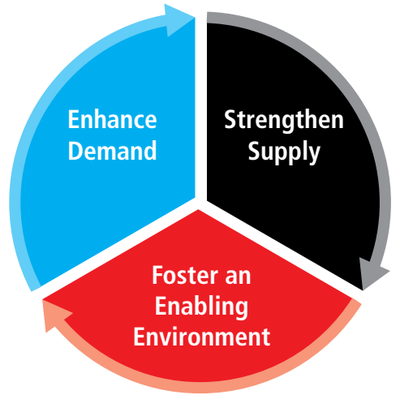


HOUSEHOLD AIR POLLUTION

The Global Alliance is the most concerted effort yet to co-ordinate the world's many clean-stove projects and programmes, from arranging financing sources through to establishing quality-control standards (see *Figure 9*). The organization does not sell cookstoves but works with manufacturers, distributors and others to develop markets for a range of stove types; it also plans to broker micro-financing to help poor households afford improved cookstoves[3].

Figure 9: A three-pronged strategy has been developed to spur the clean cookstove & fuel markets

- Understand and motivate the user as a customer
- Reach the last mile
- Finance the purchase of clean cookstoves and fuels
- Develop better cookstove technologies and a broader menu of options




- Finance clean cookstoves and fuels at scale
- Access carbon finance
- Build an inclusive value chain for clean cookstoves and fuels
- Gather better market intelligence
- Ensure access for vulnerable populations (humanitarian)

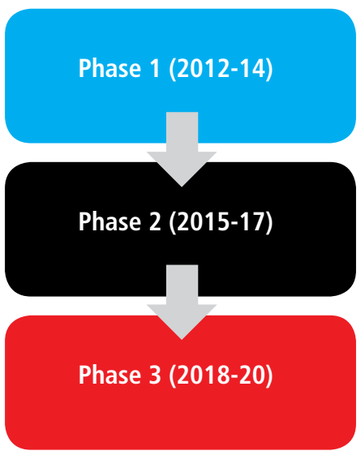
GLOBAL ALLIANCE FOR CLEAN COOKSTOVES

- Promote international standards and rigorous testing protocols, locally and globally
- Champion the sector to build awareness
- Further document the evidence base (health, climate and gender)
- Engage national and local stakeholders
- Develop credible monitoring and evaluation systems

*Source: Alliance Business Plan – October 2012[4]*

The first two years have seen the Alliance convening experts to help develop a forward-looking plan for overcoming the many barriers that have restricted progress in the past (see *Figure 10*). In its third year, the initiative is ramping up in six priority countries: Bangladesh, China, Ghana, Kenya, Nigeria and Uganda, aiming to favour private investment into the sector, and advancing priority research[2]. An early important success was the publication of an International Organisation for Standardisation (ISO) supported International Working Agreement: *"Guidelines for evaluating cookstove performance"*[49], which serves as an international framework for evaluating stoves against specific indicators covering fuel efficiency, emissions (for health impacts) and safety (see page 43 for details). While these guidelines and the associated regional testing centres under development are starting to provide an incentive for stove developers, many countries have already set up new ambitious national programmes and targets to adopt cleaner cooking solutions. Ethiopia and Nigeria for example, have set national goals of reaching 9,000,000 and 10,000,000 households respectively[3].

Figure 10: The Alliance will utilize a three-phased approach to achieve its goals




**Launch global and regional efforts to rapidly grow the sector**

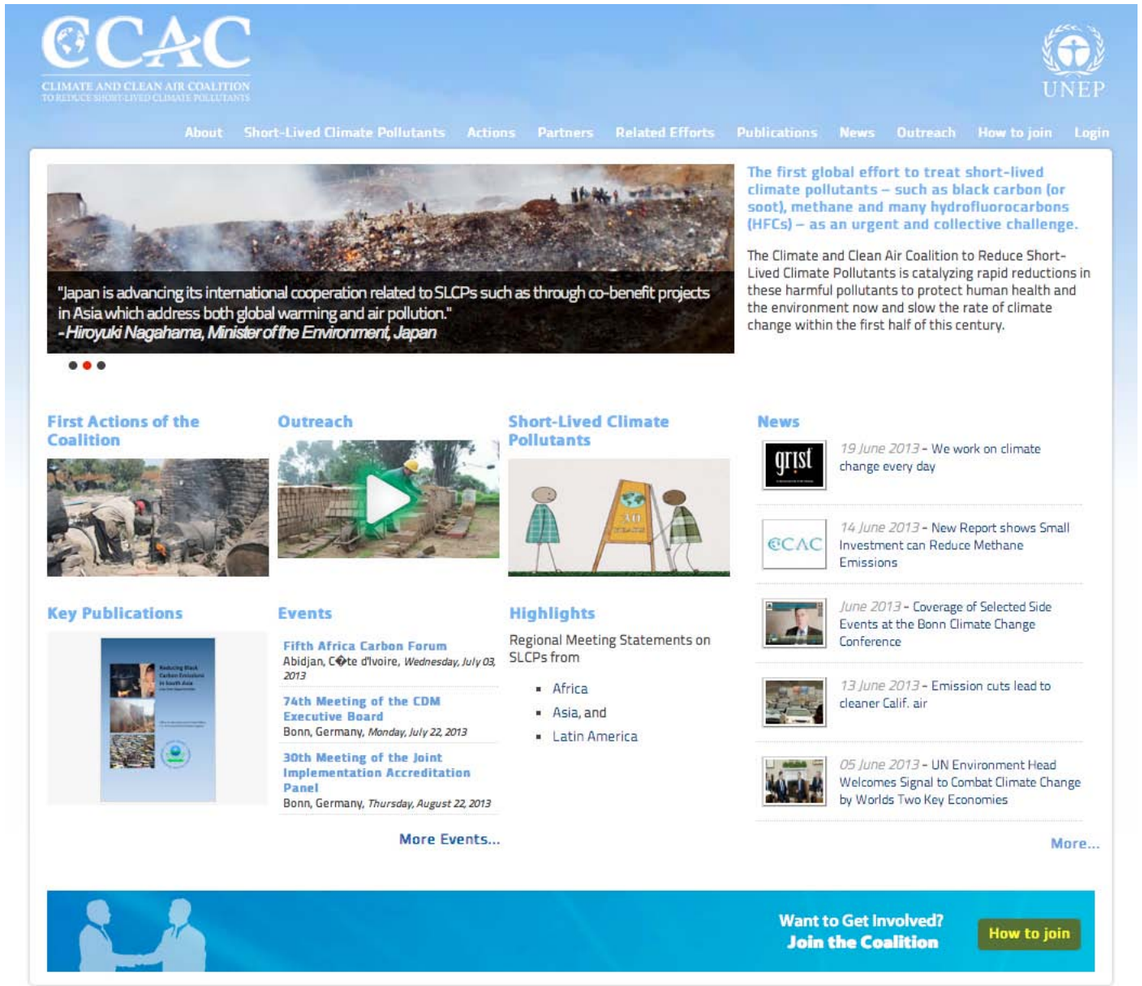
**Drive investments, innovation, and operations to scale**

**Establish a thriving and sustainable global market for clean cookstoves and fuels**

*Source: Alliance Business Plan – October 2012[4]*

# The Climate and Clean Air Coalition

The Climate and Clean Air Coalition (CCAC) (http://unep.org/ccac/) was launched in 2012 by a number of country partners and the United Nations Environment Programme with the intention of scaling-up international actions to reduce short-lived climate pollutants (including BC, methane and other greenhouse gases), which are many of the same components most damaging to health[50]. This international initiative provides an additional opportunity to promote clean cooking solutions, benefiting both climate and health.



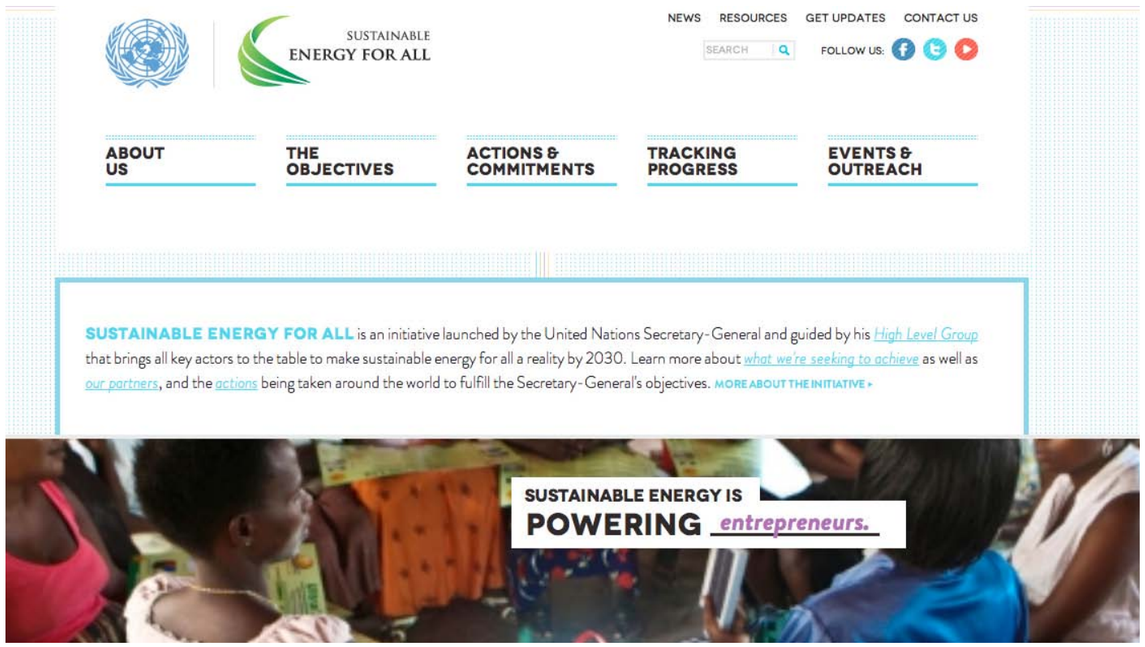

*Source: http://unep.org/ccac/*



# Sustainable Energy For All Initiative: making sustainable energy for all a reality by 2030

The SE4ALL initiative launched by the UN Secretary-General in September 2011 brings together governments, businesses and civil society groups in an unprecedented effort to transform the world's energy systems by 2030 (http://www.sustainableenergyforall.org).
Three inter-linked objectives have been set up: progress in achieving one can help with progress toward the others.


The initiative is mobilising action from all key stakeholders: governments, the private sector and civil society partners globally. The Steering Group is co-led by the World Bank/ESMAP and the International Energy Agency and comprises multiple partners.




*Source: http://www.sustainableenergyforall.org/*

# Scaling Up Of Improved Solid Fuel Stoves: Enablers & Barriers

## Until recently, progress with the implementation of policies and interventions for improving access to clean and safe household energy has been very slow in the majority of the most affected countries.

Some successful experiences do exist on a large scale, such as those in China, Brazil and Indonesia[51]. However, the reason many other programmes, large and small, have not been successful in the past is attributable to several aspects, including: the stove itself, the failure to understand consumer tastes and cooking habits, the lack of appropriate promotion strategies to increase awareness and benefits of clean cooking, short-term and target-driven programmes with limited supply chains and poor post-acquisition support for users, appropriate financing for businesses and consumers, and most frequently, a combination of a number of these issues[3,51].

These barriers are now better understood and the sector is experiencing renewed interest. Furthermore, recent international policy drivers, scientific advances, financial innovation and more involvement of the private sector has contributed to raising the sector's profile, enabling new approaches to encourage the large-scale and sustainable adoption of cleaner cooking solutions[3].





# A global self-sustaining clean-stove market: the role of the Global Alliance for Clean Cookstoves

## The Global Alliance for Clean Cookstoves (the 'Alliance') is contributing significantly to the establishment of a global market for clean cookstoves based on innovative business models.

These models are helping manufacturers to expand beyond local and artisanal cookstove production, in order to offer standardized and high-quality improved cookstoves at a price and scale that can be accessible to the poorest communities[52]. Supporting this kind of market enabling activity is contributing to increased sales and adoption of clean stoves. The creation of a common fund to support national domestic businesses and entrepreneurs is an example of this effort. Thus, in 2013, the Alliance has granted funding through the $2 million Spark Fund to five manufacturing companies across Kenya, Uganda and Ghana[49], that have demonstrated a strong track record of results in their domestic markets.

### Guidelines and Standards

The Alliance is also driving and expanding standards for cookstoves and fuels, so that consumers can know they are buying a quality product[49]. Tiered performance standards for the sector have been initiated through the **ISO International Workshop Agreement on Clean and Efficient Cookstoves**, which took place in February 2012. These standards enable promotion and monitoring of stoves that contribute towards international targets for efficient and improved stoves (see section 3, page 43). Although the challenge to design accessible and affordable stoves that women like and want to use and that reduce fuel use and emissions enough to achieve today's policy goals still exists[53], the establishment of international standards is an important step in ensuring the production of higher-quality products with reduced emissions and increased consumer satisfaction.

### Building partnerships

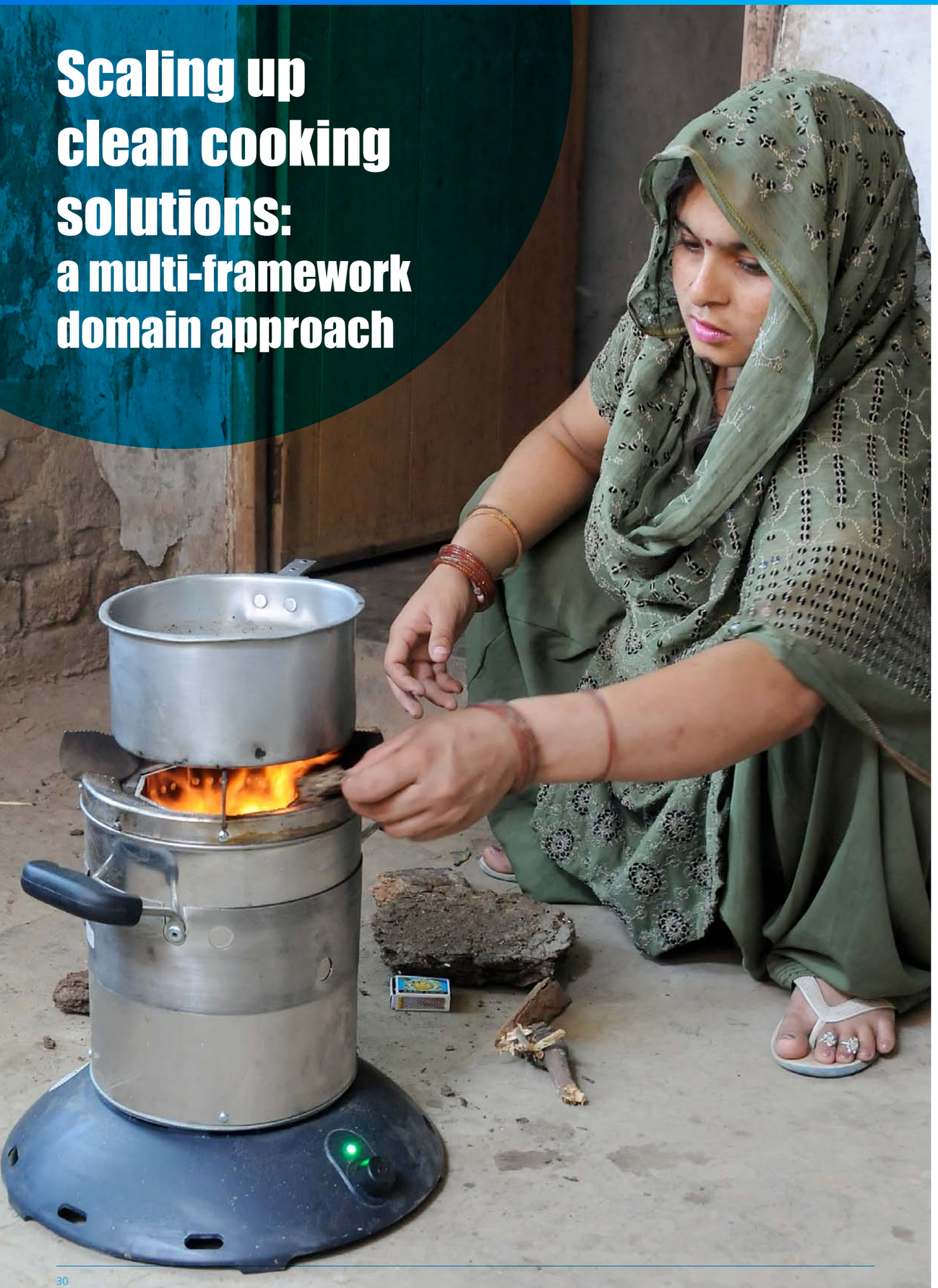
The Alliance, as detailed in the report "Igniting Change" (2012)[3], is also increasing the number of organizations engaged in the clean cookstove market and brokering new partnerships with carbon financers, technological innovators and public and private investors[3]. In addition, commercial players who are experienced in marketing and sales have the chance to contribute significantly to market expansion[52]. As reported by Zeriffi (2011): "Consumers at the base of the economic pyramid are being viewed by the private sector as viable consumers, with the right to the same range of goods and services as those farther up the economic ladder. This evolution in how consumers are viewed by the sector has led to a more thoughtful, innovative, and interdisciplinary approach to promoting modern, aspirational cooking solutions than has occurred in the past"[52].

**Reaching universal adoption is now possible**

- Availability of new cookstove models significantly reducing exposure to smoke
- Design and production of new technologies for measuring and tracking emissions
- Consumers at the base of the pyramid now also considered as key
- Innovative financing tools to promote equitable access
- Rise of local stove manufacturers and innovative business models
- Advent of public-private partnership that can contribute to market expansion

*Source: Adapted from 'Igniting Change", GACC (2012)[3]*

# Scaling up clean cooking solutions: a multi-framework domain approach





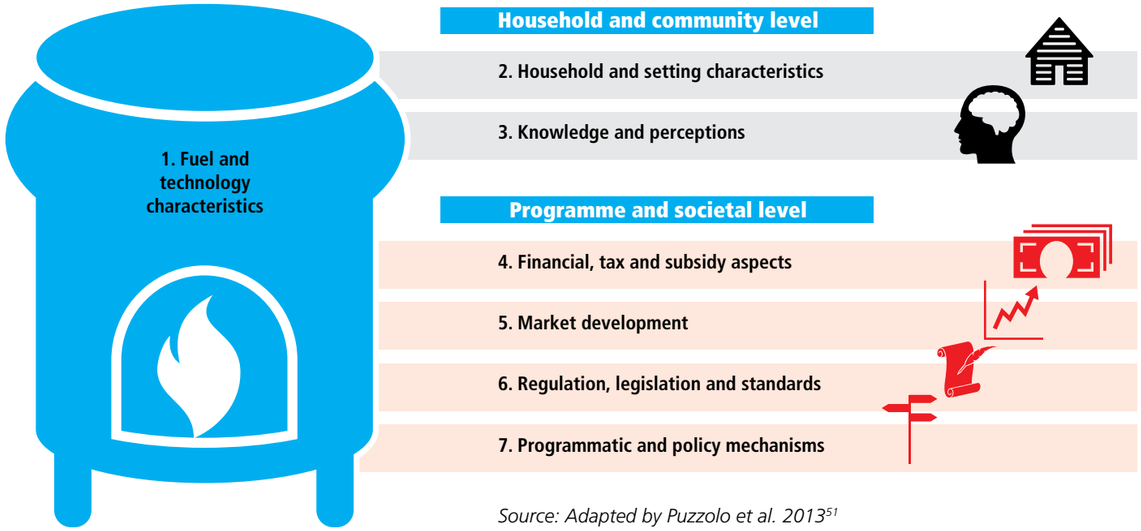
BARRIERS AND FACILITATORS

## Implementation of programmes targeting cookstove consumers is a complex issue and successful scale up involves multiple approaches

Based on a recent systematic review of barriers and enablers influencing the adoption of cleaner household cooking technologies[51], a wide range of factors across seven domains was identified to be important for uptake (see *Figure 11*). The review drew on over 50 studies on ICS conducted across Sub-Saharan Africa, Asia and Latin-America, providing robust findings and offering a comprehensive view of what is required for effective scale up.

Domains identified include: (1) Fuel and technology characteristics, (2) Households and settings, (3) Knowledge and perceptions, (4) Financial, tax and subsidy aspects, (5) Market development, (6) Regulation, legislation and standards, (7) Programmatic and policy mechanisms. As shown in *Figure 11*, all domains are inter-related, with some operating primarily at household and community level (i.e. associated with users, their culture, socio-economic status, geographical location) and others operating primarily at programmatic and societal level.

Figure 11: Seven domains of factors influencing uptake of cleaner household energy




*Source: Adapted by Puzzolo et al. 2013[51]*

# Factors influencing the uptake of improved solid fuel stoves

Uptake of improved cookstoves is influenced by multiple factors across the seven domains. All the factors can be influential and are context-specific. The assessment of all factors should be conducted for individual settings during the planning and implementation of any dissemination approach.

A total of 31 factors across the seven domains were identified as influencing the uptake of improved solid fuel stoves. Rather than presenting these factors as discrete facilitators and barriers, it is suggested that these can most usefully be seen as operating on a spectrum, so that when present or satisfactory they are enabling, and vice-versa[51]. For example, while fuel saving is highly appreciated by users and therefore enabling (especially in areas where it is paid for), and stoves that do not save fuel are more likely to be abandoned and this negatively impacts on uptake. The provision of after-sales support makes repairs and maintenance easier, and this is valued by users. Conversely, the lack of this service means that stoves requiring maintenance or repair may fall into disuse. These are just a few examples illustrating how factors operate. The nature of the available evidence identified through the systematic review does not support formal prioritisation of domains or factors within them, but the main aspects that need to be considered in any effort to scale up are summarised in the following diagram reported on pages 32 - 33. Additional considerations will be also presented in section 3 of this report.

# Factors and aspects to be considered for successful scaling up of ICS

BARRIERS AND FACILITATORS

## 1. Fuel and technology characteristics

A. **Design to meet users' needs**
- Ability to cook main dishes and to use traditional pots
- Safe technology, easy to use, easy to clean and durable.

B. **Fuel and costs savings** from less fuel gathering and/or fuel purchasing due to higher stove efficiency.

C. **Time savings** for faster cooking speed or less fuel gathering for collectors.

## 2. Household and setting characteristics

A. **Household characteristics impacting on adoption include:**
- Socio-economic status
- Education
- Demographics
- House ownership and structure.

B. **Multiple stove and fuel use** may favour adoption of a new stoveor cleaner fuel but also may impair its exclusive use.

C. **Geography and climate:** cold and rainy settings require appropriate stove technologies.

## 3. Knowledge and perceptions

A. **Stove should provide smoke reduction with consequent:**
- Health benefits
- Cleaner home environment.

B. **Ability to prepare main dishes to the same taste.**

C. **Aesthetic / design appeal.**

D. **Social influence:** success with early adopters.

## 4. Financial, tax and subsidy aspects

A. **Initial stove cost is often a barrier:** financial solutions may help consumers and increase demand.

B. **Payments modalities** such as instalments, loans or microcredit facilitate adoption.

C. **Adequate upfront capital and financial support (.e.g loans) for setting up stove businesses is critical.**

## 5. Market development

A. **Demand is influenced by marketing strategies and social networks:** live demonstration and success with early adopters are usually the most effective ways.

B. **Functional and efficient supply chains for stove and stove components are critical for scale up.**

C. **Business development can be achieved through multiple approaches** (e.g. marketing multiple products, having different prices, identyfing appropiate distribution channels, etc).

## 6. Regulation, legislation and standards

A. **Certification** of stoves can help ensure adherence to design specifications for fuel efficiency and emissions.

B. **Stove labels have been** successfully used to guarantee construction standards.

C. **Enforcement of standards can be achieved through mechanisms such as** procurement of materials from designated suppliers, exclusive use of accredited manufacturers and penalties in case of non-compliance with standards.

## 7. Programmatic and policy mechanisms

A. **Co-ordination** and regular interaction required **between key stakeholders.**

B. **Community involvement** (in particular women) for the identification of suitable stove designs and promotional campaigns.

C. **Ensure high-quality stove construction and installation.**

D. **Provide hands-on-training to consumers.**

E. **Ensure post-acquisition support** for maintenance and repair.

F. Plan for **monitoring and evaluation.**

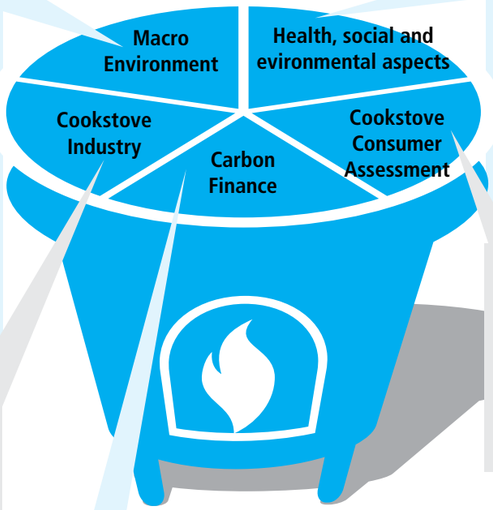
# The Sector Mapping Approach

A first step in planning for more effective adoption at any scale is to carry out market and needs assessments, followed by demand generation, and ensuring high quality and adequate supply can be met.

As promoted by the Global Alliance during initial country assessments, a first step should consist of sector mapping across key dimensions as illustated in the example below (see *Figure 12*). This initial approach can be used to gain a deeper understanding of the market potential and needs in each selected setting and includes: exploring the market players, selecting the consumers to be targeted, understanding their needs and identifying all possible barriers to success. This initial stage should then be supported by wider considerations for planning and implentations, in light of the evidence emergining from the domains and factors relevant to upscale previously discussed.

Figure 12: The cookstove 'Sector Mapping Approach' used by the Global Alliance for Clean Cookstoves

- **Social:** What are the country demographics & population distribution across regions?
- **Political:** How stable is government & what political risks will any program face?
- **Economic:** How much money do our potential customers have & what is the economic cycle?
- **Technological:** How sophisticated is the infrastructure & what is the plan for progress?
- **Environmental:** How do ecological conditions impact the success of cookstove programmes?




- How do people cook and what fuels are used in the region?
- What is the current HAP exposure profile of our target market?
- What are the other impacts caused by the use of poor cooking stoves?
- How does the impact of cookstoves stack up against other health & social prorities?

- What is the profile of the target population?
- How can the customer population be segmented / categorized?
- How big is each customer segment, what are the specific needs and characteristics?

- What cooking devices are currently used within the region?
- Who are the main players active in the cookstove sector?
- What are the opportunities / threats for current & future cookstove programmes?
- How commercially attractive is the sector & what are likely to be some of the industry changes?
- How have stakeholders approached the sector and what are their likely future policy priorities?

- What carbon financing options exist for the country?
- What structures exist which can be leveraged for future carbon financing components?
- Which entities are likely to fill the required roles in the carbon finance operating model?

GLOBAL ALLIANCE FOR CLEAN COOKSTOVES

*Source: Adapted by GACC (2012b)*[53]





# Consumer segments in the market

Understanding and targeting different consumer segments of the market is a first step to any commercial and non-commercial effort to scale up improved cookstoves.

The basic consumer segmentation for the cookstove sector includes the distinction between solid fuel collectors or purchasers, and how this applies to low and middle / high income users. It is also very important to take into account rural versus urban locations, as well as households living in suburbs or at the periphery of big cities (often referred to as peri-urban households), who may have different needs and economic potential. In most settings it is also necessary to make a distinction between firewood vs. charcoal users, as charcoal is almost always purchased in contrast to wood which is often collected, and where purchased firewood is generally cheaper than charcoal.

*Diagrams 2* and *3* are taken from the "India Cookstoves and Fuels Market Assessment" report[54] commissioned by the Alliance and shows a detailed analysis of what characteristics and challenges are faced by the eight consumer segments identified for this country. In other countries some of the segments can be grouped and the overall number could be reduced to four or five, but the key message is that for each of them a detailed analysis is required. Authors used multiple sources to define segments including the National Census Data for 2011 (based on 235 million households which provided answers on fuel use) and other official data.[54]

Also, drivers for willingness to pay vary according to different target audiences, as suggested in *Diagram 3*, and this has to be taken into account during a market analysis and consequent implementation.

# Diagram 2: The 8 key Indian consumer segments

| | Primary Characteristics | Challenges |
|---|---|---|
| **Very low income solid fuel collectors** | • Limited interest and ability to pay for stove<br>• Demographic profile likely skewed towards low education, marginalized populations<br>• Likely to use more open fires than enclosed stoves | • Requires subsidy approaches due to lack of disposable income<br>• Requires higher investment in awareness and consumer behaviour<br>• Need to convince them of "aspirational" value of stove as well as time savings value |
| **Low and mid-high income solid fuel collectors** | • Can afford improved solutions and for higher income group, additional financing not needed<br>• Have higher education and awareness levels<br>• May not appreciate opportunity cost of fuel collection as much | • Distribution challenges in reaching rural population<br>• Identifying which marketing message works best (i.e. opportunity cost? health?) |
| **Rural very low income solid fuel purchasers** | • Live in areas of biomass scarcity so collection not an option<br>• Consumers may partly collect and partly purchase based on seasonal availability and income fluctuation | • Under a lot of income pressure, so may not be an attractive segment to target<br>• Would require financing / subsidy approaches for enhanced and higher end biomass solutions<br>• Hard to reach with modern fuel options |
| **Urban very low income solid fuel purchasers** | • Primarily slum dwellers with limited access to modern fuel solutions and likely have low education<br>• High levels of fuel purchasing behaviour despite very low incomes | • Require financing options (i.e. targeted subsidies or cash transfers), but move to modern fuels might be possible<br>• Need to consider crowding / space issues, portability and property rights as a key part of appropriate technologies |
| **Rural low and mid-high income solid fuel purchasers** | • Has some disposable income and already pays for fuel so can be a key segment to target<br>• Higher levels of education likely<br>• Appropriate segment for biogas, LPG conversion (if in peri-urban areas) and enhanced to advanced biomass solutions | • Market can be quite fragmented across country – need to identify effective distribution strategies<br>• Need to identify message that will resonate most strongly with the consumers |
| **Urban low and mid-high income solid fuel purchasers** | • High levels of fuel purchasing behaviour despite lower incomes for majority of this segment<br>• Cultural factors likely leading to continued use of solid fuels<br>• Education and awareness is likely to be higher, particularly among mid-high income segment | • Focus on consumer education and commercial models for the mid-high income segment<br>• Need to consider crowding / space issues, portability and property rights as a key part of appropriate technologies |
| **Rural modern energy users** | • Majority of the segment can afford fuels and cooking solutions<br>• Many, possibly most, do fuel stacking (i.e. using solid fuels for secondary cooking needs)<br>• Has already changed cooking behaviour so likely easier to reach and lower burden of persuasion | • Convincing consumers to change their *secondary* stove away from an unimproved chulha can be difficult<br>• Understanding and being able to manage government policy changes in LPG and kerosene |
| **Urban modern energy users** | • Majority of the segment can afford improved cooking solutions<br>• There is likely a lot of fuel stacking in this segment as well as an opportunity to move kerosene users towards cleaner and safer solutions | • Identifying key message that resonates with the consumers<br>• Understanding and being able to manage government policy changes in LPG and kerosene |

Note: this assessment was conducted in February 2013. The poverty line is inr 26 ($0,4) / day for rural india and inr 32 ($0,5) / day for urban india. the bottom 40% of rural households and bottom 20% of urban households fall into this category (overall ~34% of india falls into this category);this category (overall ~34% of india falls into this category). Source used: dalberg consumer segmentation database; nsso 2004/2006 and 2009/2010 database; census 2011; planning commission of India.







# Diagram 3: Consumers' willingness to pay varies depending on the consumer segment: an example from India


| "Willingness to pay" drivers | Likely target audience |
|---|---|
| Economic savings: monetary savings due to decreased need for fuel (greater efficiency) lower cost of fuel (due to fuel switching) or more durable stove (limited replacement costs) | • Solid fuel purchasers (primarily male as the economic decision maker)<br>• Educated consumers<br>• Commercial / institutional buyers |
| Time savings: recouped time from time not spent collecting fuel or from decreasing long cooking times (through more efficient stoves) | • Higher income / educated rural consumers (with opportunities for alternative livelihood)<br>• Solid fuel collectors (primarily female who have the most time burden from cooking) |
| Health concerns: key issues include ensuring healthier children and mitigating chronic health issues such as eye irritation, difficulty breathing etc | • Female consumers (as primary caretakers of the house and children)<br>• Donor agencies and "mission-driven" institutional purchasers |
| Cleanliness: improving the look and overall cleanliness of the kitchen, utensils and home | • Female consumers (as primary cooks and presence in the kitchen) |
| Aspirational technology: improving the look and overall cleanliness of the kitchen, utensils and home | • Female consumers (as primary cooks and presence in the kitchen) |

Note: this is based on expert interviews; Dalberg consulting analysis; GACC stakeholder consultations

# Generating demand

The decision to acquire an improved cookstove (whatever market segment consumers are part of) is significantly enhanced or impaired by positive or negative experiences of neighbours or relatives who have adopted the stove. As illustrated in *Figure 13*, 'word of mouth' is a powerful influence within communities acting for or against adoption depending on the perceptions and experiences communicated.

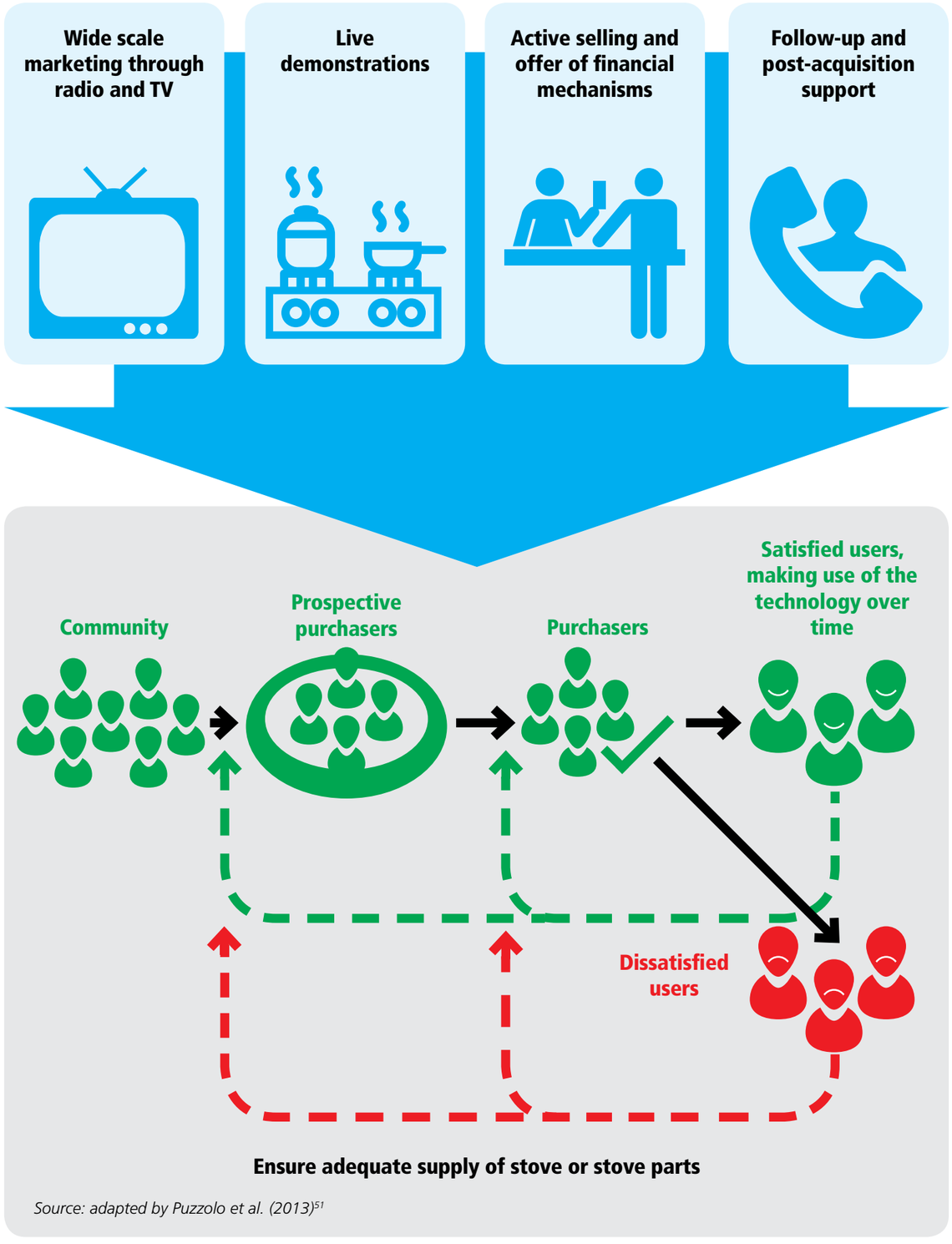
In summary, findings from the systematic review of improved solid fuel stoves uptake[51], which are echoed by a number of marketing reports[55-56] have identified that:

- Direct contact with individual users and live demonstrations of the new technology are successful strategies to increase demand; wide scale marketing through TV and radio is not sufficient on its own to increase awareness and generate demand.
- Opinion leaders within a community are important for initial acquisition, but sustainable use is ultimately determined by a combination of benefits, including fuel / time savings and overall user satisfaction.
- Early adopters among different consumer segments need to be identified and should be targeted to facilitate market penetration.
- Increase consumer choice and offer financial mechanisms to overcome liquidity constraints.
- Ensure adequate supply of stoves or stove parts (e.g. through the use of already established supply chains).
- Initial user training and post-acquisition support is critical for increasing consumer satisfaction and encouraging sustained use of the technology.
- Marketing campaigns should not exclude men, who have substantial decision-making power at household level in most low and middle income settings.



## Figure 13: Demand creation for improved solid fuel stoves

BARRIERS AND FACILITATORS




*Source: adapted by Puzzolo et al. (2013)[51]*

# CONCLUSIONS

In conclusion, the availability of effective improved stoves on the market (as described in the following section) is not sufficient to guarantee adoption and associated benefits to health and other aspects of people's lives, particularly if the technology is not affordable, desired, used and maintained over time.

Past experience with improved stoves suggests that achieving these goals is challenging, although there are also examples of more successful adoption and sustained use. The critical nature of this issue is brought into focus by the fact that those suffering the greatest burdens of adverse consequences on health, time, personal safety, and the local environment are generally also the poorest, facing demands on very limited resources. This presents additional challenges for ensuring equity of access to these fuels and technologies.

A wide range of factors across the multiple domains identified in the foregoing discussion need to be taken into account for successful scaling up. Not acknowledging these factors will increase the likelihood of failure. Market and needs assessment are a first step in planning for more effective adoption, which should be followed by demand creation, ensuring adequate supply, setting up post-acquisition support and planning for monitoring and evaluation. The latter should be conducted at different stages of a dissemination campaign, as this could help in identifying unexpected problems and wider barriers to larger-scale dissemination and sustained technology use at an early stage.





# Improved Solid Fuel Stoves: Technology Aspects and Market Availability

Over the last 30-40 years, stove designs have primarily sought to increase fuel efficiency, paying less attention to health and climate implications. Recent technical insights have supported the development of new stove designs which are capable of reducing exposure to emissions sufficiently to impact on long-term health risks.

Fuel savings and improved stove efficiency alone are not sufficient to define a stove as 'clean' (refer to *Box 1* for definition). Commonly called 'improved stoves' generally reach variable levels of emission reductions (usually 30-70%) and usually have higher precision manufacturing, insulation, robust metals which last longer at higher temperatures, and air control mechanisms.

Recently, efforts have been made to develop standards for cookstoves and cooking solutions with the International Organization for Standardization (ISO)[49] (the world largest developer of voluntary International Standards), supported by regional testing centres (see *Box 1*). Promoting international standards is important for comparing performance, emissions and safety, in order to drive innovation. Stoves must be carefully designed and tested to verify performance (see *Box 2*). Designers and manufacturers now need to focus on improving the performance and quality of their cookstove products, and producing multiple stove designs to accommodate a variety of cooking practices and fuels, according to different levels of affordability.





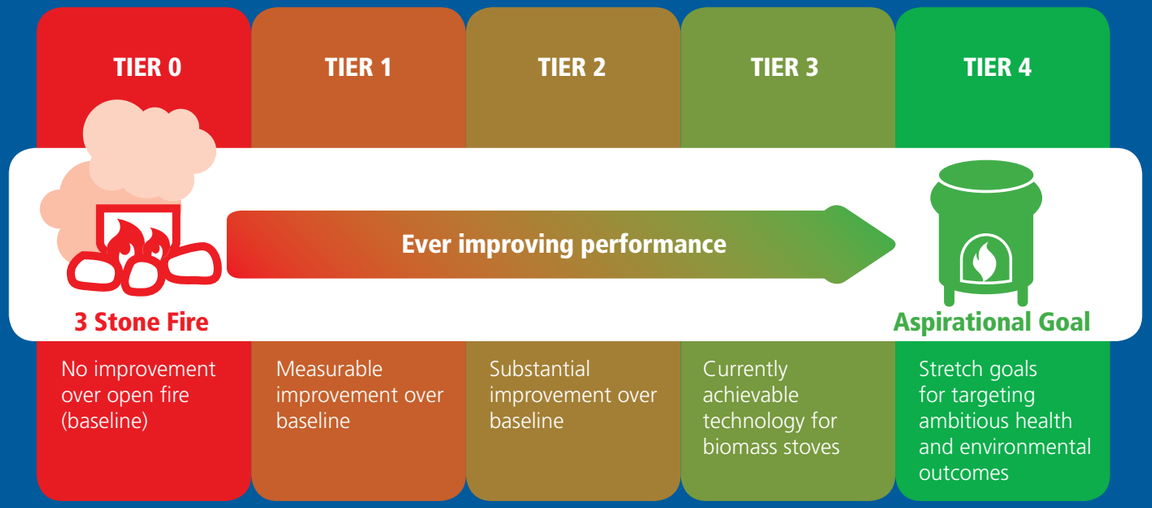
ISO IWA

Box 1 - International standards for cookstoves (ISO process)

The first ISO International Workshop Agreement (IWA) on Clean and Efficient Cookstoves took place in 2012[49]. The standards provide tiered categories (Tier 0 to Tier 4) of performance across four dimensions:

- Fuel use (i.e. Is the stove efficient?)
- Total emissions (i.e. How much pollution is emitted by the stove?)
- Indoor emissions (i.e. Does the stove reduce indoor pollutant concentrations with a chimney or without?)
- Safety (i.e. Does the stove reduce the risk of burns, poisoning and other injuries?)

Additional aspects, such as stove durability, field-relevant testing and climate emissions[4] are also expected to be incorporated in the ISO process. IWA does not currently cover risk of poisoning from liquid fuels.




*Source: Adapted from http://www.cleancookstoves.org/resources_files/measuring-progress-during-phase-I.pdf*

**According to ISO standards, the aspirational goal for a "clean" stove includes:**

- **45% thermal efficiency reduction (at high power) over baseline**
- **Reduced indoor emissions:**
  - **CO: 0.40g/min (as compared to baseline emissions of CO: 0.97g/min)**
  - **PM2.5: 2mg/min (as compared to baseline emissions of PM2.5: 40mg/min)**

**In an average kitchen these levels would lead to HAP concentrations equivalent to WHO annual average IT-1 for PM2.5, and the 24-hr air quality guideline for CO.**

# Stove Performance

The ***performance*** of a stove includes measurement of key features:

- Fuel use is the measure of how efficiently the stove is able to transfer heat into the pot[57].
- Thermal efficiency is a combination of both combustion efficiency and heat transfer to the cooking pot[58].

Measures that help to maximize heat transfer to the cooking pot include the use of pot skirts and metallic bodies[62]. Although thermal efficiency is seen as the most effective way of determining stove performance, thermal efficiency can be achieved at the expense of combustion efficiency, meaning that more thermally efficient stoves do not necessarily reduce polluting emissions. Stove performance testing is therefore crucial when assessing a variety of performance indicators including emissions, thermal and fuel efficiency, cooking time and ease of use[59].

## Some core design aspects of a good cooking stove:

- Good quality combustion
- Reduced (verified) emissions
- Low specific energy consumption at high power
- Easy power regulation - suitable turn-down ratio
- No unintended flame extinguishing at low power, even in wind
- No very hot outer parts
- Easy placing and removal of pots without getting burnt
- Easy filling of fuel - even when hot
- Stable on a variety of surfaces
- Suitable for accommodating different pot-shapes
- Should be easy to ignite and preferably not require a separate starting fuel
- It should also be easy to light in a wind
- Maximum power sufficient for cooking meals in pots of the largest common size
- No danger of fires or spillage even if mishandled
- Durable - life span of several years



# A global self-sustaining stove market: the role of the Global Alliance for Clean Cookstoves

STOVE TECHNOLOGY

Testing of stoves for efficiency and emissions is very important in order to identify which technology works best and to help ensure that stoves being disseminated are truly significant improvements over traditional cooking methods. As discussed in Box 2, there are three main stove performance tests commonly used, which follow two different approaches: laboratory versus field-based testing.

BOX 2 - How stove efficiency and fuel reduction is measured

- **Water boiling Tests** (WBT) are used to determine the boiling time for a specified volume of water. It measures the thermal efficiency of the stove and the specific fuel consumption at both maximum and minimum power. This test is used to evaluate stoves in laboratory (controlled) settings and is useful for stove design purposes and comparing different stoves using a common protocol[59]. However, indicators of stove performance derived from the WBT are usually not good predictors of actual fuel use[60].

- **Controlled Cooking Tests** (CCT) assess stove performance based on preparation of common foods cooked by local people in semi-controlled settings. This test measures the mass of food and fuel used taking into account the time needed to cook a typical meal[59]. CCTs are designed to check whether the new replacement stoves perform well in the same cooking task.

- **Kitchen Performance Tests** (KPT) assess real-time stove performance in households under actual daily use[59]. This is a field-based effectiveness test, which is more accurate at determining the real fuel and emission reductions which can be obtained at home. It is the only way to provide an indication of changes achieved by an intervention in a population setting. However, these tests are more difficult to conduct because of variation in the field and logistic issues.

- Laboratory testing is the first step in establishing the performance of any new cooking device. Laboratory testing should be based on standardized testing methods, which allow for comparison of different stoves promoted around the world.

- Field-based testing assesses more realistic estimates of fuel savings and reduction in emissions during household daily use. Field tests offer a measure of real stove performance, which is influenced by initial stove installation, maintenance and user's operation.

*Source: Advanced Cookstoves Laboratory by Dan Bihn. All rights reserved.*

# Main Category of Stove Technologies

Stove designs include a wide variety of styles, materials, construction techniques and performances. Stoves range from very simple to well-engineered and sophisticated technologies. According to the new ISO standards (Tier 0 to 4)[49], stoves can be classified as follows (see also *Figure 14*):

**Simple improved stoves (ISO tier 0 – 1):**
typically enclosed and with some improvement to combustion (e.g. basic biomass portable stoves). Emissions have been tested in laboratory and field settings. Performance varies greatly depending on design and condition, with some stoves delivering little or no reduction in emissions and exposure, while others can halve indoor exposure where chimneys are fitted and the stove is kept in good condition. Processed fuels are not required.

**Intermediate stove technologies (ISO tier 1 – 2):**
use improved combustion chambers (e.g. rocket stoves, highly improved charcoal stoves, natural draft gasifier). Emissions have been tested in both laboratory and field settings. Performance varies widely between models, settings and accessories. Fuel must be cut into smaller pieces, but processed fuels are not usually required. Those stoves that have well-maintained chimneys will further reduce indoor smoke exposures.

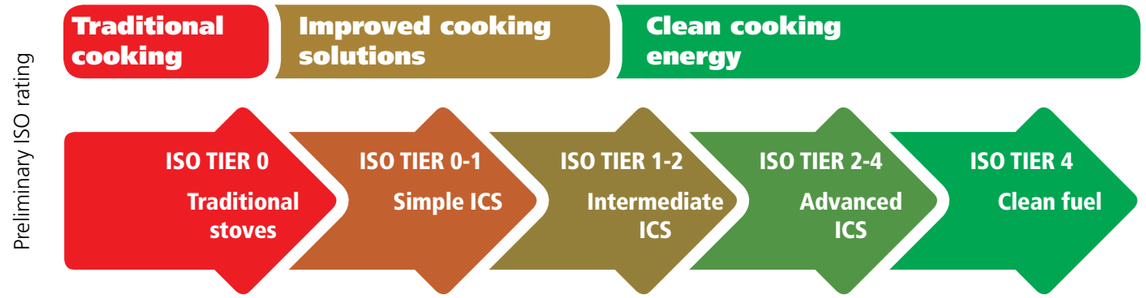
**Advanced biomass stoves (ISO tier 2 – 4):**
use forced ventilation with or without secondary combustion (gasification) (e.g. fan-assisted biomass stoves, forced draft gasifiers). Stoves fitted with fans require low-wattage electric power, and batteries permit stove use even with intermittent electricity supply. Some newer models generate power independently from heat (thermoelectric generation).

**Stoves making use of clean cooking fuels (ISO tier 4):**
these are non-biomass stoves relying on different forms of gas or liquid fuels (i.e. LPG, biogas, ethanol) or electricity





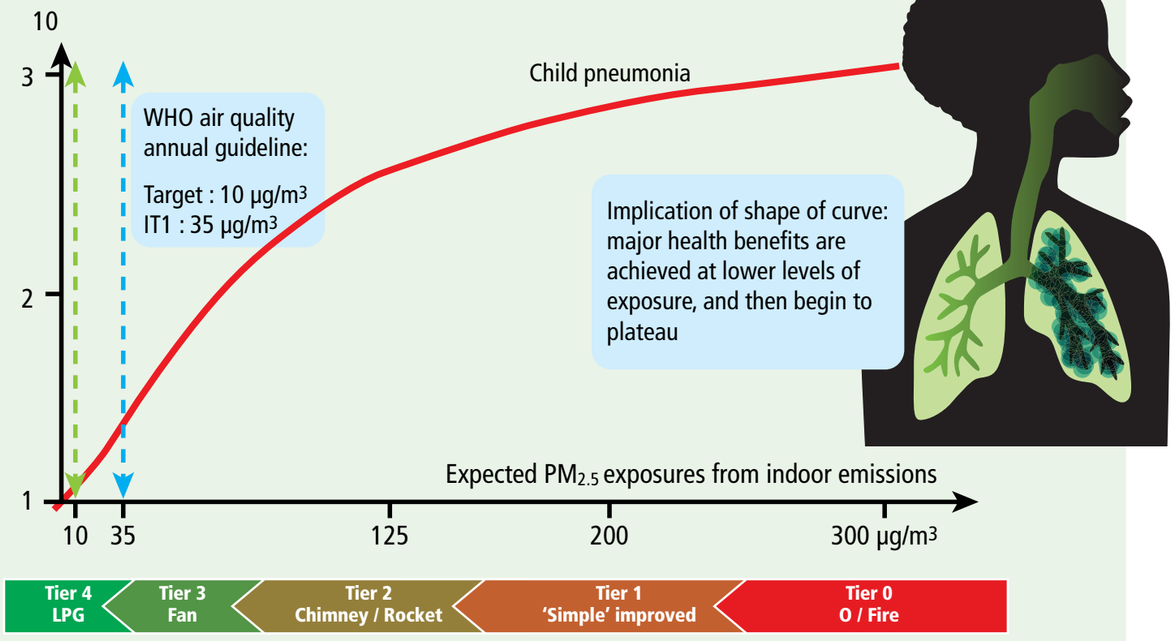
Figure 14: Main improved and clean stove categories according to the ISO tier standards




*Source: Adapted by PCIA and GACC (2012)[61]*

Example: Exposure-response relationship

For a disease such as childhood ALRI, reduction in exposure to emissions is not linearly correlated to reduction in health outcomes (i.e. 50% reduction in cooking smoke does not translate into a 50% reduction of respiratory diseases[2]. To prevent the great majority of cases caused by HAP exposure, the WHO air quality target of 10µg/m³ $PM_{2.5}$ annual mean should be met (green arrow) or at least the initial WHO interim target 1 (IT1: 35µg/m³ $PM_{2.5}$) (blue arrow) should be pursued.



# Some Examples of Solid Biomass Stoves Available on the Market

STOVE TECHNOLOGY

There are a variety of stove models available on the market. Most models have been designed to be tailored to specific cooking needs which depend on geographical settings and traditions.

The list of stoves reported below includes selected examples of commonly used stove models commercially available in East African Countries that have been tested in controlled lab-based conditions[62]. Data are directly comparable across the listed stoves and fully reported online at: http://ehs.sph.berkeley.edu/krsmith/publications/2012/jetter_2012_supp.pdf.

| | | | STOVE CHARACTERISTICS | | | | | EFFICIENCY (COMPARED TO 3-STONE)* | EMISSIONS* | | MANUFACTUING |
|---|---|---|---|---|---|---|---|---|---|---|---|
| FUEL | STOVE | | TYPE | FUEL TYPE | COMBUSTION CHAMBER MATERIAL | OTHER DESIGN FEATURES | ISO IWA TIER | HIGH POWER THERMAL EFFICIENCY (%) | CO (HIGH POWER) | PM (HIGH POWER) | APPROXIMATE RETAIL COST |
| WOOD | Envirofit G-3300 |  | rocket | wood | metal | metal ring to improve combustion; metal skirt (add on); ceramic base for insulation | 2 | 39.4 (%) | 0.558 (g/min) | 52.6 (mg/min) | US $31 (base) |
| | Philips Natural Draft Stove (HD4008) |  | natural draft gasifier | wood /biomass | stainless steel | coated steel (base), galvanized steel (upper body) | 2-3 | 34.4 (%) | 0.39 (g/min) | 53.8 (mg/min) | US $31 |
| | Philips Power Stove (HD4012) |  | forced draft gasifier | wood /biomass | thin ceramic tiles | requires a source of electricity to recharge the battery and/or power the fan | 3 | 38.4 (%) | 0.102 (g/min) | 6.3 (mg/min) | US $89 |
| CHARCOAL | Envirofit CH-2200** |  | highly efficient improved stove | charcoal | metal | small metal stove | 2 | N/A | N/A | N/A | US $19 |
| | Envirofit CH-5200** |  | | charcoal | metal | same as CH-2200 stove, extra support to accommodate larger pots | 2 | N/A | N/A | N/A | > US $19 |
| | Jiko (ceramic) |  | simple non traditional | charcoal | ceramic | metal-clad ceramic stove (with variations used in many countries in Africa | 0-1 | 25.3 (%) | 0.624 | 22.6 | < US $4 |
| | KCJ (Kenya Ceramic Jiko) Standard Stove. |  | simple non traditional | charcoal | metal | metal-clad ceramic stove (disseminated by the organization Practical Action) | 0-1 | 32.3 (%) | 0.406 | 18.3 | US $6-10 |



* Emission and performance data by Jetter et al. 2012 (U.S. Environmental Protection Agency) avaialbe online at: http://ehs.sph.berkeley.edu/krsmith/publications/2012/jetter_2012_supp.pdf
** Stoves not included in the comparisons test by Jetter et al. 2012. Emission and performance data conducted by the Colorado State University avaialbe at: http://www.envirofit.org/products/?sub=cookstoves

# Stove Production and Marketing

Adopting cleaner cooking stoves requires an initial investment for the consumer. Stove technology costs varies significantly, from a few dollars for the simplest mud and clay improved stoves, to more than US $90 for more advanced combustions stoves.

Also within a given class or design of stoves, prices can vary considerably (e.g. rocket stoves). Variations usually depend on raw material used, labour and manufacturing margin. Devices that reach the lower level of emissions (i.e. ISO tier 3 - 4 – see *Figure 12*) are usually those within the higher price range. Taxes, distribution costs and local transport also increase costs. Economies of scale in production, local manufacturing and wider dissemination should favour stove affordability. However, as illustrated in the following section, there are a number of available financing solutions which can also help to reduce the financial challenge posed to the poorer households.

# Financing Solutions for Initial Stove Cost

Affordability issues can be overcome through a number of financial solutions and schemes tailored to customers' needs.

Although households who pay for biomass fuel can generally cover the cost of a more efficient cookstove by fuel savings alone within a few months from initial acquisition, financing can make technologies more easily available to the less well off, the key target of this market.

Direct financing options include credit options through loans or payment in instalments, to reduce upfront costs for consumers. Third party financing is widely used and includes micro-financing and carbon financing sources (see below), which can be used by either enterprise or consumers. The range of options is summarised in *Figure 15*.

Figure 15: Overview of financing options






## Direct Finance and Microcredit

A range of organizations, such as credit unions, credit cooperatives, self-help groups and microfinance institutions (MFIs) can contribute to help consumers to pay for their new stove in instalments spread across several months[3]. Evidence suggests these solutions can be effective in encouraging stove purchase and uptake[51]. However, to date, few MFIs offer loan products for clean cookstoves, and more institutions should be encouraged to do so[3]. Funds from donors and governments include corporate and institutional financing; selling stoves in bulk to a corporation who will resell to the consumer at or below cost.

## Carbon Finance

One area of more recent innovation in financing cleaner cooking solutions is the use of carbon credits[52]. Carbon finance plays an important role in reducing the cost of quality stoves to the consumer and is the main source of stove subsidy currently used by manufacturers and distributors.

There are two types of carbon markets: (i) compliance (or regulatory) and (ii) voluntary. Compliance or regulatory markets, also known as the **Clean Development Mechanism** (CDM) is the largest and most elaborate carbon market. Within the CDM, projects which reduce greenhouse gas emissions in developing countries can generate carbon credits (i.e. Certified Emission Reductions, CERs) which can be purchased by countries and organisations to fulfil their emission reduction commitments under the Kyoto protocol and the European Emissions Trading Scheme[63]. Voluntary markets also generate carbon credits (i.e. Voluntary Emission Reduction, VERs), which are exchanged by a variety of organizations without regulation, because these are not recognised under the Kyoto protocol[63]. In both markets, the amount of credits generated is calculated by estimating the avoided emissions from the combustion of fuels for water boiling, for example. Challenges and concerns related to carbon finance do exist and there is considerable room for improvement in how offset methodologies should account for the improved cookstoves[64].

# Getting the Product Right:
## What Matters to Users

STOVE TECHNOLOGY

As already discussed in the second section of this report, there are a number of aspects that users value that will encourage them to purchase a cleaner cooking technology and, importantly, continue to use it over time. Although there is little published research comparing and understanding in-depth user views on different cookstoves models, the following points emerge as key evidence-based findings[51]:

- Stoves should be culturally and/or locally appropriate; inappropriate stove design hampers use leading to stove modification by users or reversion to traditional stoves
- Stoves should meet users' needs in terms of cooking most of the traditional daily meals at least as quickly as the traditional stove, achieving favoured taste, and using available fuels and familiar pots
- Fuel saving is a critical factor as it impacts on both household expenditure (where fuel is purchased) and collection time (most commonly involving women and children) where fuel is gathered
- Stoves which reduce cooking time are also highly valued by users, but the opportunity-cost associated with time savings varies across rural-urban settings. In rural areas with more abundant labour, especially where education levels are low, time savings associated with reduced fuelwood collection or cooking time are much less valued
- Smoke reduction is generally appreciated because it is associated with better health for women and their children, and favours a cleaner home and cleaner cooking vessels
- Aesthetic features, convenience, safety, durability, ability to provide warmth and portability in cold and rainy settings are also valued
- The aesthetic appeal and modernity of a stove are valued and contribute to the increased symbolic value of a stove, hence improved social status.

# Public-private Partnership: the Way Forward

A mix of public and private investment is a sensible way forward to promote the dissemination of cleaner cooking stoves at scale in the developing world.

Several stakeholders, including government agencies, civil society organizations, academics, international donors and private foundations, are now contributing to revitalise the sector and make the wide-scale adoption of cleaner cooking technologies possible. This is being achieved through engagement in different parts of the technology value chain (technology development, manufacture, commercialization, and dissemination)[65] and by the creation of public-private partnerships.

Accelerating access to energy and cleaner cooking technology is far too complex an issue to be tackled by a single organisation alone. Commercially oriented solutions should be complemented by governments and donors, who can contribute to the creation of supportive policies and regulatory environments that favour more equitable clean energy access[52]. There are several examples showing how the private sector is successfully operating alongside public organisations, with the private sector leading on stove production and distribution costs (fully covered by the stove price) and the public sector providing programmatic activities, consistent policy supporting investment, and governmental mobilisation[65].

# The Role of Unilever and the Private Sector

Private companies such as Unilever have much to offer to the household energy sector. The benefits of improved cooking stoves are well aligned with the objectives of the Unilever Sustainable Living Plan, i.e. **improving the health and well-being of 1 billion people by 2020.**

By leveraging the marketing capacity and equity of Unilever brands much can be done by the company to contribute to building a sustainable market for improved cook stoves.

Activities should focus on developing technologies and resources which are reliable, affordable, socially acceptable, environmentally sound, and of proven effectiveness for health and other attributes in everyday use. In African countries such as Uganda or Kenya, the cookstove market is greatly expanding. In Kenya for example, availability of Improved Cookstoves is much greater than in the rest of East Africa[53], and a new manufacturing cookstove plant has recently been opened in Nairobi by Envirofit. This is an important step forward in bringing a larger range of products closer to consumers, as well as offering new job opportunities to local people. Unilever is also contributing to make these technologies known and more accessible to urban charcoal users in Nairobi, working across the entire value chain.

The possibility of engaging with carbon financers directly is also important, rather than with brokers who charge for the service. Such a partnership would make these technologies more affordable for consumers. Successful commercial and socially responsible models to promote clean cooking do exist. Cambodia, for example, has disseminated more than 2,000,000 cookstoves to the domestic market, through the creation of a network of companies and manufacturers across the country.

For global companies like Unilever with extensive reach into developing markets and distributing fast moving consumer goods to households, adding cleaner cookstoves as a new product line can open up new opportunities for mass distribution. Millions of people, including in particular children and women, stand to benefit from clean, efficient and safe household energy technologies and fuels, creating a positive and equitable social impact whilst contributing to sustainable energy use in the longer term.


*Source: http://www.unileverusa.com/sustainable-living/uslp/index.aspx*

# The Royco Jiko

## The Partnership

Over the past two years, Unilever, Shell Foundation and Envirofit, have embarked on a partnership in Kenya. The aim has been to combine the skills of the three organisations to offer consumers the best possible cookstove: a balance of fuel efficiency, reduction in HAP, cost and durability. Each partner brings something different to the table. Unilever provides branding and marketing expertise as well as a broad and extensive distribution network. Envirofit is a social enterprise that designs and manufactures clean cookstoves. They provide the technology and R&D, as well as the manufacturing capability. Globally Envirofit have sold more than half a million stoves over the past 5 years, gaining invaluable experience in the carbon market. The Shell Foundation has invested substantial time and resources into the problem of HAP, bringing a wealth of knowledge as well as extensive experience scaling social enterprises. To begin with, Unilever has chosen to sell the Envirofit CH2200 charcoal stove under Unilever's Royco brand. The stove has entered the market as "The Royco Jiko", with the word jiko being synonymous with charcoal stove in Kenya.

The Royco Brand is a range of meal makers; ready mixed, natural seasoning that can be added to a variety of dishes to enhance flavour. Royco is a local jewel for Unilever's Kenyan business. The brand stands for healthy living and great taste. The brand is perceived as understanding the hardships consumers go through and is trusted by women, who generally take sole responsibility for cooking in Kenyan households. Providing consumers with high quality products at the right price is central to the brand strategy, making the Royco Jiko a good brand fit. Royco meal makers (Mchuzi Mix) has approximately 80% market share in Kenya.



## The Sales Model

Thus far, the partnership has sold over 2000 stoves in Kenya, testing a variety of distribution channels. Door to door sales have proved successful but using this approach at scale is commercially challenging. Kiosks and small stores are an effective sales method, but alone do not have the reach necessary for commercial success. The pilot phase indicates that an integrated, cross-channel approach is needed, utilising the learnings from each channel to enhance the activation of the other channels.

The pilot phase has shown the importance of consumer education in promoting the purchase of these stoves. The traditional clay alternative is 3-4 times cheaper than the Royco Jiko. However, the upfront cost is offset with the opportunity for substantial ongoing fuel savings as the Royco Jiko is far more efficient than the traditional clay stove. The ongoing saving is the most powerful marketing tool as it is tangible, putting cash directly back into consumers' pockets. The health benefits are appreciated but the concern is not so much the long term effect of HAP but the day to day issue of smoke in the home causing watering eyes and coughing, especially for children. Conveying all of this information to consumers and asking them to pay a price considerably higher than they are used to for a jiko requires a great deal of education. Marketing expertise is therefore critical to sales success.

The next stage of this partnership is to combine the familiarity and intimacy of a door to door sales agent or local store owner, with the scale of mainstream retail. The plan is to enter modern trade (supermarkets) by the end of 2013, initially testing the model in a small number of stores most relevant to our target consumer. Sales agents will interact with consumers, explaining the benefits and demonstrating the cooking ability of the stove on the busiest shopping days of the week, as well as allowing them to touch and feel the stove themselves. The sales agents will be women who have used the Royco Jiko themselves. The rationale behind this is twofold. The negative effects of traditional stoves disproportionately affect women (due to traditional household roles). Thus, their credibility as converted users is unparalleled. This approach also allows us to gain valuable feedback on marketing messages, first impression on the stove and also living with it as the teams will be in store for at least 3 months. Further, there is a genuine interest in women's empowerment within Unilever and the Royco Jiko offers a practical way to contribute. In line with this, Unilever is also speaking to Women's Groups to explore the potential of selling through this avenue, creating entrepreneurs and providing business skills in the process. The other channel is door to door sales using an existing service (such as Living Goods) and adding the stove to their basket of goods. This makes sense from a cost and scalability perspective as well as ensuring that we utilise an expert organisation, rather than trying to build our own door to door sales force. These options are also aligned with our commitment to empowering women.

## Challenges

Unilever is making headway with the partnership and the future looks promising. However, as with anything new, there have been challenges. The market itself is immature and constantly evolving and there is no definitive model with regards to how such a partnership should work, or how the market should be tackled. The team brings together different cultures from a geographic and organisational perspective and objectives, whilst broadly aligned, do have nuanced differences. However, whilst combining objectives and cultures is not always simple, it does provide an opportunity to generate real synergies as all involved learn from the other members of the team and we can ultimately achieve a higher quality output.

Carbon credits are set to be part of the business model, which adds some complexity. This is a new type of business model for Unilever meaning traditional thinking has to shift. Relevant information from consumers must also be collected and audited on an ongoing basis which provides a logistical challenge. However, Envirofit have devised an innovative solution with one of their partners, allowing us to utilise simple mobile technology to collect the data. Going forward, paper-based forms will not be required, significantly decreasing risk, whilst adding some powerful data analysis tools.

The product is new for Unilever but also for consumers and, as mentioned previously, education will be key. Therefore training people to be able to spread that message and train others is critical. Sales agents and Women's Groups will be important here as word of mouth has proven to be essential in increasing consumer understanding in the benefits provided by the improved stoves. The improvement is so drastic that some potential users simply do not believe the claims at first. The voice of converted stove users will therefore have an important role to play.

The product is also new for many of Unilever's retailers and channel partners and devising training and support will also be crucial in helping them communicate effectively to consumers in store. There are challenges but the variety of experiences and specialities within the team has helped overcome these, proving the value of such a diverse partnership when bringing such products to market at scale.

## Why are Unilever involved?

One might ask, why are Unilever even involved? Primarily, because Unilever believes it is the right thing to do from both a people and planet perspective, whilst also making commercial sense. Millions are dying every year from a preventable problem that is also ravishing the earth through deforestation and greenhouse gas emissions - this is simply not acceptable. The Unilever Sustainable Living Plan (USLP) is a business strategy, not a nod to Corporate Social Responsibility, and aims at doubling the size of our business whilst halving our environmental impact. The problem of unsustainable consumption in growing markets is real, often fuelled by (frequently illegal) deforestation and Unilever's involvement makes both social and economic sense. For any consumer goods company and energy availability and security is crucial to our future existence. This is an opportunity for Unilever to activate responsible capitalism and back the intentions set out in the USLP with action, showing Unilever is not afraid to lead from the front and pioneer a partnership that bridges our experience gap in new and different markets.

## The Vision

The vision for the Royco Jiko project is to have multi-channel distribution, with the ability to reach not just mainstream consumers but also the poorer, more remote consumers who will benefit the most. Gender empowerment will be part of that approach with female entrepreneurs trained and supported by the programme. Supermarkets will be fundamental in driving trial and awareness at scale but there are many people who do not shop in supermarkets, meaning kiosks and door to door sales will also play a role. We are looking to leverage the expertise Unilever has in certain channels, as well as exploring new ones that make sense for the company in a wider context. At scale, the Royco Jiko will encompass a portfolio of stoves, with relevant products for different market segments. In practice, this will involve stoves of varying complexity at different price points and will unlikely be limited to just charcoal stoves. At scale, fuel will also play a part: it offers the chance to give the consumer better quality at a similar or lower price, can contribute to our environmental objective, and also adds to the business model. A credit facility to aid consumers with the initial outlay of purchasing the stove is something we are also exploring.

Unilever see the Royco Jiko as taking consumers on an energy journey toward cleaner fuels such as LPG. The extension of the brand into stoves is a pioneering move by all involved and opens the door for other such partnership innovation. Work is also underway to explore the viability of a variety of solar products utilising similar partnership models.

# CONCLUSIONS

Improving domestic cooking is a recognised priority worldwide and the stove market is currently at a point of rapid change and expansion. Stove designs that allow for both improved efficiency and cleaner combustion, to address the multiple challenges to health, environment and climate caused by inefficient burning of solid fuels, are now increasingly available on the market.

The recent development of international standards and certification contributes to ensuring higher levels of stove performance and accelerates industrial and semi-industrial solutions. Success in large-scale dissemination of improved and cleaner stoves requires attention to be paid to all to all elements of the technology value chain and the consumers' needs.

## Recommendations for the Private Sector

1. Promote in-country production of quality technologies that have certified and recognised health and climate benefits.

2. Encourage promotion of clean fuels alongside improved solid fuels stoves where supply chains are well enough developed to support their distribution.

3. Support public-private partnerships between local, national and global stakeholders. These can (i) help achieve a balance between market innovation and public sector action on regulation/standards, (ii) influence policy to encourage investment and (iii) facilitate financing to ensure markets operate on a more equitable basis.

4. Ensure efficient and reliable supply chains through partnerships that have existing distribution capabilities, such as fast-moving consumer goods companies.

5. Assess potential markets and customer need using customer segmentation. Link the marketing of products with (i) financial services according to need, and (ii) after sales support, particularly in rural areas.

6. Consider community led approaches to distribution in rural areas, such as direct demonstrations and approaches used by 'Living Goods', drama representation and others. Where possible, partner with brands (e.g cooking products and foods) in adjacent sectors to increase familiarity and trust in the product.

7. Promote a variety of payment options in both urban and rural areas, and build on the success of disruptive business models (e.g. the Ashden Award winner Toyola stoves 'Free 1 month stove trial' are an example of this model)[66].

8. Ensure well-structured investments in monitoring and evaluation.



## Expanding access to cleaner fuels

Access by poorer and rural communities to modern, clean fuels (among which LPG is the most widely available) is currently limited by relatively high prices, low demand and unreliable supply. The benefits in terms of low emissions, speed, controllability and convenience are substantial however, and parallel efforts need to be made to overcome these barriers.

Although LPG prices and reliable delivery pose a challenge in many countries, the multiple benefits brought by the transition to clean fuels should be pursued. Rapid large-scale uptake of LPG is possible as illustrated by the Indonesian experience, where more than 40 million kerosene-using homes switched to LPG in 2011. Similarly, a recent national policy in Ghana has been enacted to support transition from biomass to LPG in rural areas. These examples show that attitudes towards promotion and adoption of LPG / clean fuels are moving forward.

## Further Information and Contact Details

This report summarises research findings for improved and cleaner solid fuel stoves to be promoted in countries lacking clean household energy.

For further information on Unilever's involvement and engagement in the promotion of cooking technologies, please contact:

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