WLPGA

COOKING
FOR LIFE

THE SOCIOECONOMIC IMPACT OF SWITCHING TO LPG FOR COOKING

A report to the World LPG Association

TREVOR MORGAN, MENECON CONSULTING
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The socioeconomic impact of switching to LPG for cooking

Highlights

- Three billion people across the developing world, mainly in rural areas in sub-Saharan Africa, India and other developing Asian countries, still rely on traditional biomass, coal or kerosene for cooking on primitive stoves or open fires. This number has been rising steadily in recent years with population growth outstripping the growth in households gaining access to modern fuels like LPG.

- The socioeconomic cost of the use of these dirty fuels is enormous: exposure to indoor air pollution from cooking this way causes the premature deaths of up to four million people annually from lung cancer, cardiovascular disease, pneumonia and chronic obstructive pulmonary disease, as well as ill-health and the loss of productivity among millions more. They also damage the environment.

- Switching to LPG would improve greatly the quality of these people's lives and bring far-reaching social, economic and environmental benefits. LPG produces virtually no particulate matter and, compared with most other non-renewable fuels, low emissions of carbon monoxide. Emissions of toxic gases that can cause serious health problems if breathed in close to the point of combustion are negligible, making it highly suitable as a household cooking fuel.

- In social terms, these benefits would take the form of improved quality of life, mainly as a result of less human suffering. In economic terms, they include the reduction in health-related spending expenditure and the productivity gains that result from less illness and fewer deaths, as well as the time saved in collecting traditional fuels and cooking with them. The total economic benefits of half of all the people using solid fuels worldwide switching to LPG for cooking are estimated at around US$ 90 billion per year compared with net intervention costs of just US$ 13 billion – a benefit-cost ratio of almost seven.

- In the absence of concerted action by governments and other stakeholders, the pace of the transition to LPG and other clean cooking fuels as incomes rise will remain unacceptably slow: the International Energy Agency projects that, with no change in policy, the number of people in developing countries without access to clean cooking facilities in 2030 will be barely lower than in 2015 and the number using LPG will rise only slowly from 1.1 to 1.3 billion.

- Strong policies to drive faster take-up of clean fuels would bring enormous socioeconomic benefits. The WLPGA and the Sustainable Energy for All (SEforALL) initiative set a target in 2013 of two billion people using LPG by 2030: meeting this goal could generate around $60 billion of on-going net benefits each year in today's money.

- The goal of government policy in countries where households rely heavily on dirty fuels must be to establish a virtuous circle of growing demand, increased investment and expanded availability of LPG, by making the fuel and other clean-cooking solutions a top political priority. To achieve this, governments must put in place specific policies, cross-sectoral plans and public investments, supported by multi-stakeholder partnerships.

- Within the framework of SEforALL, the WLPGA launched in 2012 the Cooking for Life initiative – a campaign convening governments, public health officials, the energy industry and global NGOs to seek practical ways of expanding access to LPG in order to the billions of people in the developing world whose health and safety are threatened daily from cooking with solid fuels.

Summary

Three billion people across the developing world still rely on solid fuels – traditional biomass and coal – or kerosene for cooking on primitive stoves or open fires. The socioeconomic cost is enormous: exposure to indoor air pollution from cooking this way causes the premature deaths of up to four million people annually from lung cancer, cardiovascular disease, pneumonia and chronic obstructive pulmonary disease, as well as ill-health and the loss of productivity among millions more. It also entails a waste of productive time and energy, as traditional fuels usually have to be collected and transported to the home and cooking with biomass is slow. The local and global environment is also degraded, as the demand for biomass encourages deforestation, the use of animal waste degrades soil quality and burning biomass contributes to global warming and to local and regional air pollution.

Switching to LPG, which is particularly well-suited to domestic cooking, would improve greatly the quality of these people's lives and bring far-reaching social, economic and environmental benefits. Quantitative studies of the socioeconomic impact of household energy interventions in developing countries carried out in recent years suggest that the socioeconomic gains from switching to LPG are large. In the most extensive study, carried out by the World Health Organization (WHO) in 2006, in a scenario in which 50% of the people using solid fuels worldwide switch to using LPG, total economic benefits amount to roughly US$ 90 billion per year compared with net intervention costs of only US$ 13 billion (i.e. a benefit-cost ratio of 6.9). Other recent studies of national programmes demonstrate that the benefits always outweigh the costs, in most cases by a wide margin.

Over time, rising incomes will tend to boost the proportion of poor people using modern fuels such as LPG for cooking in developing countries. Yet that process will remain unacceptably slow unless governments intervene – in part because incomes are held back by the very fact that households do not have access to modern energy. The International Energy Agency projects that the number of people in developing countries without access to clean cooking facilities in 2030 will be barely lower than in 2015 in a central scenario, which assumes no change in government policy, while the number of people cooking with LPG rises slowly from 1.1 to 1.3 billion. In its Energy for All Case, in which all households gain access to modern cooking fuels by 2030, the number of people using LPG increases to 2 billion – broadly in line with the target set jointly by the WLPGA and the Sustainable Energy for All initiative in 2013. Based on the WHO analysis, meeting this goal would be expected to generate around $60 billion of on-going net benefits each year in today's money, the benefits outweighing the costs by a factor of seven to one.

These benefits provide a strong justification for decisive policy action by governments in developing countries to accelerate switching to LPG and other clean fuels and facilities. The objective must be to establish a virtuous circle of growing demand, increased investment and expanded availability of the fuel. The first step is to make LPG and other clean-cooking solutions a top political priority and put in place specific policies, cross-sectoral plans and public investments, supported by multi-stakeholder partnerships. Non-governmental organisations, international donors and lenders can assist by providing advice and funding – an essential element in achieving success.

Introduction

There is enormous potential for poor people in developing countries to switch to liquefied petroleum gas (LPG) and other modern fuels for cooking; exploiting that potential promises to improve the quality of their lives and bring major social, economic and environmental benefits – locally, regionally and globally. Three billion people across the developing world still rely on dirty fuels – traditional biomass (wood, charcoal, agricultural residues and animal waste), coal and kerosene – for cooking on primitive stoves or open fires. They have little or no access to more efficient, modern forms of energy. Unsurprisingly, traditional biomass is most commonly used in rural areas, where access to affordable modern energy is most restricted.

The consequences of poor people using solid fuels for cooking are far-reaching and dramatic. According to the most recent burden of disease estimates, exposure to indoor household air pollution (HAP) from cooking this way is responsible for up to 4.3 million premature deaths each year from pneumonia, chronic lung disease and lung cancer – equivalent to 8% of global mortality (see below). HAP also causes ill-health and the loss of productivity among millions more. The majority of the people affected are women and children, as women are usually responsible for cooking and small children often remain close to their mothers. Measured in years of healthy life lost, HAP is the single most important environmental health risk factor worldwide, more important even than lack of access to clean water and sanitation, making it the most overlooked, widespread health risk of our time.

The use of solid fuels also entails a waste of productive time and energy, as traditional fuels usually have to be collected and transported to the home. The local and global environment may also be degraded, as the demand for biomass encourages deforestation, the use of animal waste degrades soil quality and burning biomass contributes to global warming – especially if is used unsustainably. Burning solid fuels also contribute to local and regional air pollution, notably smog.

Of all the modern fuels available today, LPG, which consists mainly of propane and butane, is particularly well suited to domestic cooking and heating uses because of its clean-burning attributes and practical advantages over both solid fuels and kerosene. In particular, it is more convenient, safer and cleaner. It is also highly portable and has a high calorific value by volume and mass. Switching from solid fuels and kerosene to LPG can, therefore, bring considerable health, developmental and environmental benefits.

In recognition of that critical role that access to LPG and other forms of modern energy services plays in helping developing countries alleviate poverty and achieve their development objectives, the United Nations Secretary-General launched in 2012 *Sustainable Energy for All* (SEforALL) – a global initiative to ensure universal access to modern energy services by 2030, as well as double the share of renewable energy in the global energy mix and the global rate of improvement in energy efficiency. The initiative seeks to stimulate action by governments, international development agencies, non-governmental organisations (NGOs) and the private sector in support of the UN Sustainable Development Goal 7,[1] which calls for universal access to sustainable energy by 2030, and the Paris Climate Agreement, which calls for reducing greenhouse-gas emissions to limit climate warming to below 2 degrees Celsius.[2]

Within the framework of this initiative, the World LPG Association (WLPGA) launched in 2012 the Cooking for Life initiative – a campaign to help bring LPG to the billions of people in the developing world whose health and safety are threatened daily from cooking with solid fuels and whose prospects of a better life are being held back by lack of access to modern cooking fuels.[3] The campaign convenes governments, public health officials, the energy industry

and global NGOs to seek practical ways of expand access to LPG.

In October 2013, the World LPG Association and SEforALL signed a Memorandum of Understanding committing both organisations to accelerating access to LPG for one billion more people in developing countries by 2030. A multi-stakeholder partnership was created to build on best practices and sustainable business models in order to overcome the multitude of policy, market regulation, business environment and local financing bottlenecks inhibiting the ability of governments and the private sector to meet the need for LPG.

This paper – one of several papers commissioned by the WLPGA as part of the *Cooking for Life* initiative – assesses the socioeconomic benefits of switching from traditional biomass and other fuels to LPG for cooking in developing countries based on a review of the findings of recent research and analytical work in this area. It first sets out the nature of the transition from traditional to modern fuels for cooking by households. It then considers in detail the types of impact that fuel switching can have and reviews the evidence on the magnitude of the various impacts – both costs and benefits. The paper concludes with a discussion of the implications for policy.

[1] In 2015, the United Nations adopted a set of 17 Sustainable Developments Goals for 2030, succeeding the Millennium Development Goals and including – for the first time – a specific goal (#7) for universal access to modern cooking fuels.

[2] https://www.seforall.org.

[3] https://www.wlpga.org/initiatives/cooking-for-life/.

The transition to LPG and other modern fuels

Despite important strides in economic development and rising prosperity in recent years, as well as growing awareness of the health risks of cooking with dirty fuels, an estimated 3 billion people, or 41% of the world's population, still have no access to clean cooking facilities – almost the same number as in 2000 (World Bank, 2018).[4] Most of these people rely on the use of solid biomass (Figure 1).[5] Since 2000, the number of people in low- and middle-income countries with access to clean cooking facilities has grown by 60%, but this progress has been outstripped by strong population growth, leaving around 400 million more people without clean cooking today than in 2000 (UNDESA, 2018). Furthermore, even households cooking with clean fuels may supplement them with biomass, coal or kerosene – a phenomenon known as "fuel-stacking". In addition, 1 billion people still lack access to electricity, most of them in sub-Saharan Africa and India (Word Bank, 2018).

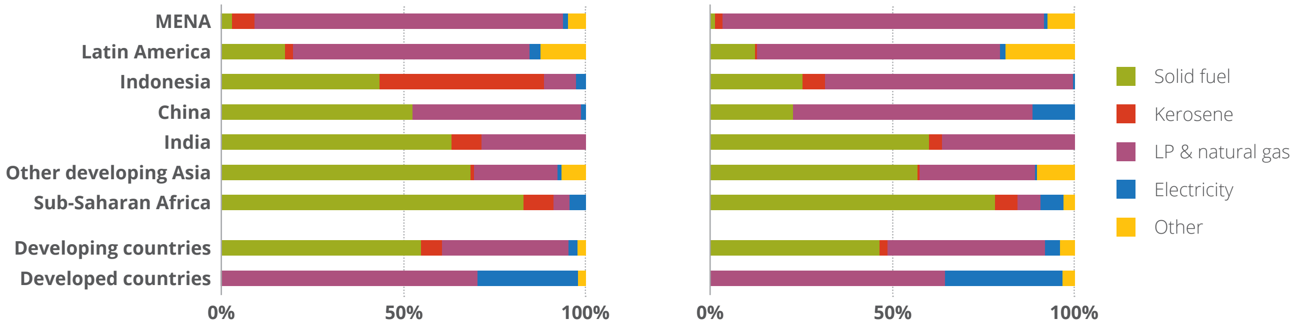
The pace of improved access to clean cooking facilities varies markedly across regions. For example, the share of people relying on solid fuels for cooking in China has dropped from 52% in 2000 to 33% today. However, progress has been very slow in sub-Saharan Africa, where population growth has outstripped progress. An estimated 84% of the population there still relies on solid biomass, coal or kerosene for cooking. Unsurprisingly, traditional biomass is most commonly used in rural areas, where the availability of affordable modern forms of energy is most limited.

A long-term transition away from solid fuels and towards modern forms of energy for cooking, including LPG, natural gas, biogas and electricity, has been underway for decades across the developing world as incomes have risen and access to modern commercial energy services has improved. In some cases, supportive government action, including direct fuel subsidies, have helped to accelerate this process. At the initial stage in this process, there is a shift from wood fuel, straw and dung to charcoal and intermediate modern fuels such as kerosene and coal, as well as the deployment of more efficient biomass stoves. As incomes rise further, the use of advanced modern fuels such as LPG, natural gas (where available in urban areas) and electricity (sometimes based on renewable technologies such as biogas and solar photovoltaic power) tends to expand.

LPG represents a vital phase in the transition to advanced modern fuel. In most countries, this transition is largely complete at per capita household incomes of more than US$ 4 000, though some richer households may persist in using solid fuels or kerosene (Kojima, 2011). At higher levels of socioeconomic development, natural gas may become available through the establishment of local distribution networks, displacing to some degree LPG. However, LPG often remains the main fuel for residential cooking (and heating) in areas remote from the natural gas grid and may be preferred by some households even where natural gas is available. In most developing countries, the distribution of natural gas to residential customers is unlikely to become widespread for many years, if ever.

The initial stage of switching from traditional fuels or kerosene to LPG in developing countries typically involves the use of a cylinder attached to a simple burner. As familiarity with LPG grows and incomes rise, the user may install a modern cooker inside the home, possibly with the gas supplied by rubber pipe from a cylinder placed outdoors or in a separate room.

FIGURE 1: SHARE OF POPULATION WITH PRIMARY RELIANCE ON VARIOUS COOKING FUELS BY REGION



Note: MENA refers to Middle East and North Africa. Solid fuel refers to solid biomass and coal. Other includes modern biomass and other renewables.
Source: IEA (2017a).

[4] Clean cooking facilities are defined here as improved biomass cookstoves, biogas systems and LPG, ethanol and solar cookstoves.

[5] There is a small discrepancy between the numbers reported by the World Bank and the IEA. The IEA estimates the total number of people lacking access to clean facilities in 2015 at 2.8 billion, compared with the more recent World Bank estimate of 2.98 billion in 2016. The IEA estimates that 2.5 billion people were using biomass, 120 million kerosene and 170 million coal in 2015.

The traditional model to describe the household transition to modern fuels is an "energy ladder" that people climb linearly as their incomes rise, swapping a traditional stove completely for a new gas one, for example. But the fuel-stacking model offers a much more realistic picture of how people actually use energy in their homes (Figure 2). Even after gaining access to LPG, members of a household might continue to cook or heat their home with an open fire or with a traditional wood-burning stove (WHO, 2016). Among the households that today continue to rely on solid fuels are many who are financially capable of paying the USD 15 to 20 a month needed to purchase LPG. The reasons for this are complex. Many factors in addition to income and the price of LPG determine use of the fuel, including availability, reliability of supply, prices of other fuels, acquisition costs of LPG cylinders and stoves, fears about safety, unfamiliarity with cooking with LPG, lack of knowledge about the harm caused by smoke from solid fuels burned in traditional stoves and cultural preferences.

A complete shift to the patterns of energy use seen in the industrialised countries cannot be achieved overnight. Many households in relatively rich developing countries continue to use large quantities of biomass, especially in rural areas because modern fuels are not available or are too expensive. In the poorest developing countries, widening access to modern fuels is limited by extreme poverty, which keeps these countries in a vicious circle of under-development. Rising incomes will tend to expand access to LPG and other modern cooking fuels, but universal access will not be achieved by 2030 on current trends.

The IEA projects the population relying on biomass, coal and kerosene for cooking in developing countries to fall only slowly, from 2.8 billion in 2015 to just over 2.3 billion people in 2030 and 1.9 billion in 2040 in their New Policies Scenario which takes into account existing government policies and plans (IEA, 2017a). In sub-Saharan Africa, the number of people without access to modern fuels increases to over 900 million people by 2030 as population growth outstrips the impact of efforts to boost access to clean cooking facilities. The majority of those who gain access to clean cooking in urban areas do so primarily via LPG, while almost half of those who do so in rural areas opt for improved biomass cookstoves, with only 35% switching to LPG and the remainder to biogas. This demonstrates the vital importance of policies and programmes to improve the affordability and accessibility of LPG (see the last section).

FIGURE 2: HOUSEHOLD ENERGY USE IN DEVELOPING COUNTRIES BY FUEL AND LEVEL OF DEVELOPMENT

Energy service	Lower-income	Middle-income	Higher-income
COOKING	Wood, Agricultural residues, Coal, Dung	Wood, Agricultural residues, Coal, LPG / Natural gas, Kerosene, Biogas, Solar	LPG / Natural gas, Solar, Electricity, Pellets, Biogas
LIGHTING	Open fire, Candles, Kerosene	Electricity, Biogas, Solar, Kerosene, Battery torch	Biogas, LPG / Natural gas, Electricity, Solar
HEATING	Wood, Agricultural residues, Dung, Coal, Kerosene	Wood, Agricultural residues, Coal, Kerosene, LPG / Natural gas	Wood, Coal, Kerosene, Electricity, Oil, Pellets, LPG / Natural gas

Source: WHO (2016).

Types of socioeconomic impacts

Switching by households from solid and other fuels to LPG for cooking can have significant and far-reaching consequences for the lives of the people in the households in which the switch occurs, which has knock-on effects for the local community, economic activity and the environment. When switching takes place on a large scale, these socioeconomic effects are felt far beyond the local community, economy and environment. Making the switch is not without cost and some of the effects of switching may be negative, but the benefits are, in most cases, much greater, yielding important net social and economic gains.

The socioeconomic impacts of fuel switching can be categorised as costs or benefits. Most of the costs relate to the initial cost of acquiring the equipment to be able to cook with LPG namely the stove, the cylinder, the pipe and valve, and any related installation costs, as well as the cost of the fuel itself. In addition, there may be significant costs related to a programme aimed at expanding the use of LPG for cooking, which are generally borne by the government or a donor – for example, the cost of advertising, dissemination of information, education and financing/credit programmes. Maintenance costs are generally minimal. There is also a global environmental cost related to the emissions of greenhouse gases from burning LPG; however, in reality, switching to LPG is likely to lead to fewer emissions on a net basis, to the extent that it reduces the unsustainable use of traditional biomass[6] (i.e. biomass that it is not replaced once it has been harvested) and the use of coal, which is much more carbon-intensive than LPG (see below).

There are number of different social and economic benefits that result from switching from solid fuels to LPG, which accrue directly to the households that switch as well as the local, regional and global community. The most important are as follows:

- Health-related benefits, including improved quality of life as a result of less human suffering, reduced health-related expenditure as a result of less illness and the value of productivity gains resulting from less illness and fewer deaths.
- Time savings from reduced drudgery from collecting and preparing biomass for use, usually by women and children, and from more efficient and rapid cooking and heating, increasing the time available for other social and economic activities.
- Fuel savings from using a more efficient stove.
- The avoided economic cost of environmental degradation caused by the use of solid fuels, including reduced deforestation and increased agricultural productivity where agricultural residues and dung are used as fertilizer rather than fuel, as well as reduced emissions of greenhouse gases and black carbon.
- Other less tangible benefits, such as increased personal esteem, prestige and comfort levels that result from a cleaner, tidier and more modern home environment.

HEALTH-RELATED BENEFITS

Reduced pollution

Exposure to pollutants produced by burning traditional biomass and coal indoors in open fires or stoves for cooking can cause serious health problems and death, all of which can be alleviated by switching to LPG. A hearth fire or cookstove emits a mixture of soot (particulate matter, or PM), carbon monoxide, methane, carcinogenic polyaromatic hydrocarbons, volatile organic compounds and other substances, all of which are toxic to human beings in different ways and to varying degrees (WHO, 2016). Burning kerosene in simple wick lamps or cookstoves also produces significant emissions of PM, carbon monoxide, nitrogen oxides and sulphur dioxide (Ruiz *et al*., 2010).

It is difficult to differentiate and pinpoint the precise impacts of individual constituents on human health. However, a large body of epidemiological research provides strong evidence that HAP (Household Air Pollution) is a major health risk. The most common and serious health problems caused by HAP include acute lower respiratory infections, chronic obstructive pulmonary disease, lung cancer, cardiovascular disease and eye conditions such as cataracts.[7] PM is known

[6] Reduced use of biomass would also lower emissions of black carbon (soot), which contributes to global warming (see below).
[7] http://www.who.int/airpollution/household/health-impacts/diseases/en/

to be particularly harmful to human health. Once it enters the lungs, it can lead to respiratory problems, shortness of breath, bronchitis, asthma, stroke, heart attack, cancer and premature death. Generally, the smallest particles – smaller than 2.5 microns ($PM_{2.5}$) – are the more dangerous, as they are most likely to enter the lungs. The chemical composition and concentration of PM affect how dangerousness it is to human health.

Two recent studies provide detailed estimates of the number of premature deaths caused by HAP, both of which are based on data compiled periodically by the Global Burden of Disease (GBD) study – the world's leading source of detailed information on public health.[8] The most recent study by a group of GBD collaborators using data from the 2015 update of the GBD study published in a series of article in the UK *Lancet Medical Journal* and summarised by the Lancet Commission on Pollution and Health[9] found that 2.9 million people a year die prematurely from disease and illnesses caused by exposure to HAP, virtually all of them in poor developing countries (Table 1) (GBD 2015 Risk Factors Collaborators, 2016; Lancet Commission, 2018). The annual number of deaths has barely changed since 1990, mainly because population growth (World Bank/IHME, 2016). In total, HAP accounts for around 5% of all deaths worldwide. Lower respiratory infections, ischemic heart disease and chronic obstructive pulmonary disease each account for roughly one quarter of the total numbers of deaths. The study takes account only of combinations of pollution risk factors and disease for which there is convincing or probable evidence of causal association. As a result, it acknowledges that the estimate of premature deaths is likely to be an underestimate of the full burden of disease attributable to HAP.

TABLE 1: GLOBAL ESTIMATED DEATHS ATTRIBUTABLE TO HOUSEHOLD AIR POLLUTION BY REGION (MILLIONS)

WHO region	GBD Study	WHO Study
Africa	0.6	0.6
Eastern Mediterranean	0.2	0.2
Europe	0.1	0.1
Americas	0.1	0.1
Southeast Asia	1.3	1.7
Western Pacific	0.7	1.6
TOTAL	2.9	4.3

Note: The totals are less than the sum of the regions due to rounding.
Source: Lancet Commission (2018); GBD 2015 Risk Factors Collaborators (2016) ; Prüss-Ustün et al. (2016); WHO (2014).

An earlier study prepared by the World Health organisation, based on GBD data for 2012, produced a significantly higher estimate of the number of premature deaths from HAP from cooking, amounting to 4.3 million, almost all in low- and middle-income countries (Prüss-Ustin *et al*., 2016; WHO, 2014). This makes HAP the single most important environmental cause of premature death worldwide, exceeding the toll from malaria, tuberculosis and HIV/AIDS combined. HAP accounts for 7.7% of all premature deaths worldwide, causing one quarter of deaths from stroke, 17% of adult lung cancer deaths and 15% of deaths from ischaemic heart disease (WHO, 2016). It is also responsible for almost one third of all deaths from chronic obstructive pulmonary disease in low and middle incomes countries. As with the GBD Collaborators study, the largest number of deaths occurs in Southeast Asia. In India, there are an estimated 1.3 million premature deaths each year among the almost 800 million people who depend on polluting cookstoves (WHO, 2016). The main difference between the two studies concerns the Western Pacific region, where the WHO study estimates deaths at 1.6 million compared with 0.7 in the GBD Collaborators study.

Although women experience higher exposure to HAP than men as they are more involved in daily cooking activities, the absolute burden in both studies is larger in men due to higher background rates of disease among men. Worldwide, HAP is the second most important health risk factor for women and girls, and is responsible for more than half of the deaths from pneumonia in children aged under five years old (WHO, 2016). Pneumonia is the single biggest killer of small children, accounting for 15% of all under-five child mortality. Children are especially at risk from indoor pollution as they tend to stay close to their mothers, who are usually responsible for cooking for the entire household in developing countries.

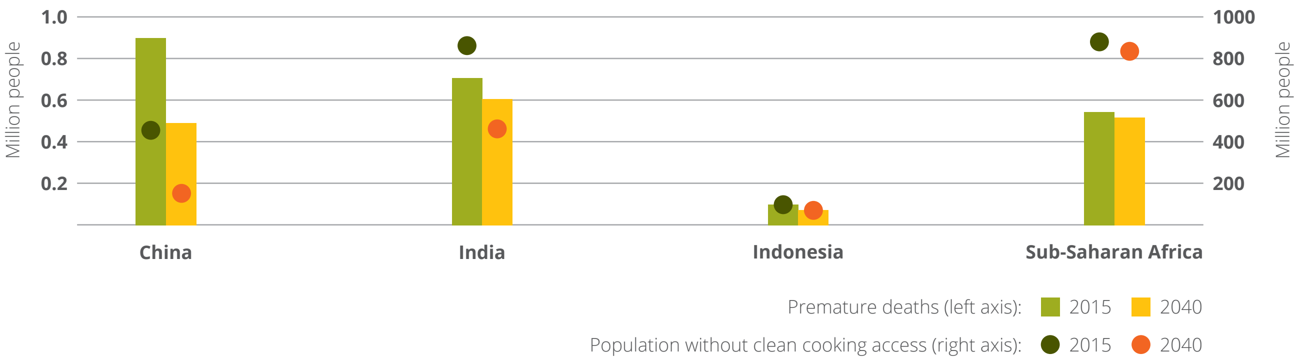
HAP also leads to non-fatal ill-health, which can be measured in Years Lived with Disability (YLD). Adding together YLD and Years of Life Lost (YLL) yields Disability Adjusted Life Years (DALYs). Based on the GBD Collaborators study estimates, 88 million DALYs were lost in 2015 due to HAP, mainly the result of respiratory illness in children. DALYs are higher when the burden of HAP on children is greater.

Switching to LPG and other clean cooking fuels such as natural gas, biogas and electricity is expected to bring down the death toll from HAP in the years to come, though only slowly without a change in policy direction. In the IEA's New Policies Scenario, emissions of $PM_{2.5}$ fall by around 15% by 2040, contributing to a decline of half a million in the number of people dying prematurely from HAP in developing countries (IEA, 2017a). China accounts for the biggest part of this reduction (Figure 3). Despite a significant projected reduction in the use of traditional cookstoves in India, Indonesia and sub-Saharan Africa, premature deaths falls much less there because of strong population growth and the continued reliance on biomass using improved stoves, which still cause HAP, albeit less than traditional stoves.

[8] The Global Burden of Disease Study, which was last updated in 2016 with data for 2015, estimates the burden of disease in 188 countries dating back to 1990. The work is led by the Institute for Health Metrics and Evaluation (IHME) at the University of Washington, with key collaborating institutions including the University of Queensland, the Harvard School of Public Health, the Johns Hopkins Bloomberg School of Public Health, the University of Tokyo, Imperial College London and the World Health Organization. The primary data can be accessed at http://www.healthdata.org/data-tools.

[9] The Commission involves more than 40 international health and environmental experts.

FIGURE 3: PREMATURE DEATHS FROM HOUSEHOLD AIR POLLUTION AND POPULATION LACKING ACCESS TO CLEAN COOKING FACILITIES



Note: The projections correspond to the New Policies Scenario of the International Energy Agency's World Energy Oulook 2017. Population without acess to clean cooking faciltiies includes those relying on traditional use of biomass, coal and kerosene.
Source: IEA (2017a).

It follows that switching from solid fuels and kerosene to cleaner cooking fuels such as LPG would bring significant health-related benefits. LPG produces virtually no particulate matter and, relative to most other non-renewable fuels, low emissions of carbon monoxide. There are negligible emissions of toxic gases that can cause serious health problems if breathed in close to the point of combustion, which makes LPG highly suitable as a household cooking fuel. In social terms, these benefits would take the form of improved quality of life as a result of less human suffering. In economic terms, they include the reduction in health-related spending expenditure and the value of the productivity gains that result from less illness and fewer deaths.

OTHER HEALTH BENEFITS

There are other significant potential health benefits from switching from traditional solid fuels and kerosene to LPG. Gathering and hauling large quantities of wood fuel can also harm health. In most rural households, women and children are responsible for collecting firewood. Wood collectors are targets for attack by criminals and wild animals, and are vulnerable to falls. In addition, carrying heavy loads over many years can be physically damaging. In Africa, women carry loads that can weigh as much as 50 kilogrammes (UNEP, 2017).

Switching from kerosene to LPG can also reduce safety hazards from accidental explosions and fires, as well as from poisoning. Using kerosene can be very dangerous, especially when handled improperly or when faulty equipment is used. Because the fuel in a kerosene stove is not sealed, it may leak and ignite when the stove is accidentally knocked over when in use. Accidents with overturned lamps or stoves, explosions of stoves due to over-filling and spilled fuel are commonplace, in some cases causing severe burns and even death; simple stoves on the floor of the home are easily knocked over by young children, especially where the home is poorly lit (Prüss-Ustin *et al*., 2016; WHO, 2016 and 2014a). In South Africa, an estimated US$ 26 million is spent annually for care of burns from kerosene cookstove incidents.[10] Kerosene-related accidents are one of the principal causes of destruction of property by fire in urban areas in developing countries. Poisoning from accidental ingestion of kerosene, which is often stored and transported in plastic water bottles, by children is also a widespread problem in developing countries. It is believed to be the primary cause of poisoning in many of them (UNICEF, 2015). On an equal use basis, the fire-safety and indoor pollution problems associated with LPG use are estimated to be only a tenth of those related to kerosene; in addition, there are no cases of poisoning with LPG.

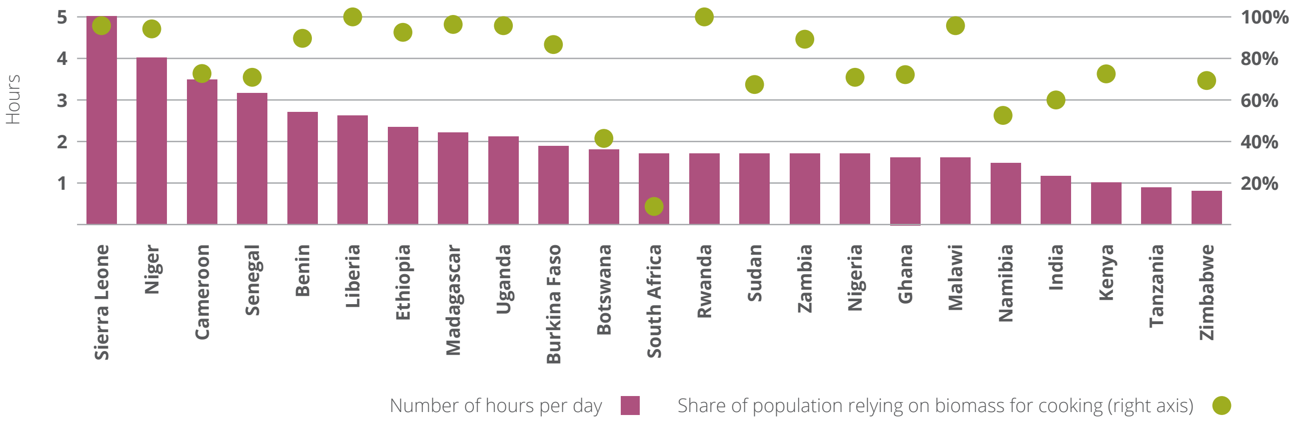
TIME SAVINGS

There can also be significant socioeconomic benefits from the time saved in not using traditional biomass by switching to LPG and other modern fuels. The principal time saving comes from eliminating the drudgery of collecting and preparing biomass for use as a cooking fuel, usually by women and children (Practical Action, 2016). LPG, which has far higher energy density than biomass, can be collected or delivered quickly to the home. Several national studies have shown that the time spent gathering fuel can be very high in the poorest countries with the greatest dependence on traditional biomass. The IEA estimates that households in developing countries dedicate an average of 1.4 hours a day collecting fuel, but that time exceeds two hours in several African countries (Figure 4). Deforestation may have increased the average time spent in recent years in many countries.

Time may also be saved in cooking with LPG, depending on the type of traditional-fuel cook stove that is being replaced. According to a laboratory study of 18 different types of cook stove in widespread use in developing countries, several biomass stoves are able to bring 5 litres of water to the boil more quickly than LPG (Aprovecho Research Center, 2011). However, only one stove with a chimney is quicker, with most of them – including the kerosene stove – far slower (Figure 5). Another study estimated savings in cooking time from switching from traditional to LPG stoves at 12% (Berkeley Air Monitoring Group, 2012). There is a little comparative data available on actual time saved by women in cooking by switching to LPG in the field. One study finds that the savings in cooking

[10] http://www.who.int/mediacentre/factsheets/fs365/en/index.html

FIGURE 4: AVERAGE NUMBER OF HOURS SPENT COLLECTING FUEL PER DAY PER HOUSEHOLD

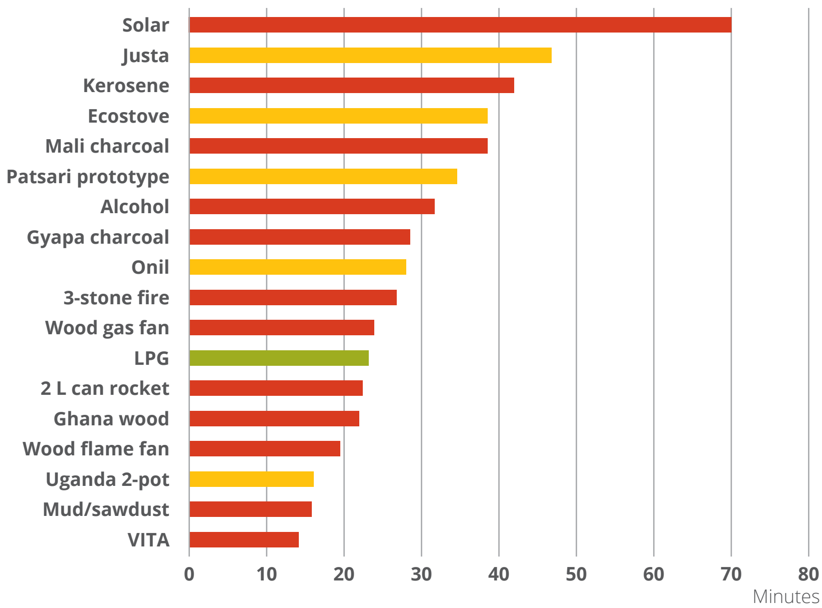


Source: IEA (2017a).

time using LPG compared with traditional fuels are much larger in real life, averaging 1.82 hours per day in Uganda (Habermehl, 2007). Studies from India suggest that savings in cooking time when switching to LPG could be substantial, exceeding those related to fuel collection (Table 2).

By eliminating the need to spend time collecting and preparing traditional biomass and reducing cooking time, switching to LPG yields a significant increase in time available for other social and economic activities, on condition that LPG cylinders are available locally and can be collected or delivered quickly. Children freed from the need to spend time collecting biomass may spend more time in school, while women may spend more time looking after and educating their children. Women may also put the additional time to directly productive use, engaging in income-generating commercial activities (WLPGA, 2014). In rural areas, these activities are likely to be related to agriculture. In Himachal Pradesh, a study found that women's participation in wage work increased noticeably as a result of an LPG adoption program: of the 53 women who bought LPG stoves, 41 were engaged in activities such as weaving and working with oil-production units, farms and orchards (UNDP, 2011). The extra income generated creates a virtuous cycle of increased spending on modern energy services, improved health, increased provision of education, increased productivity and economic and social development.

FIGURE 5: TIME TO BRING 5 LITRES OF WATER TO THE BOIL BY TYPE OF COOK STOVE



Note: Yellow bars indicate with chimney; red without.

Source: Aprovecho Research Center (2011).

Switching from kerosene to LPG can also yield time savings. Washing the pots and pans used in cooking is faster when using LPG, as it does not blacken the pots as kerosene does. In addition, less time is spent (and less cost incurred) in cleaning and repainting the kitchen as a result of the soot produced by kerosene (Chikwendu, 2011).

TABLE 2: TIME SAVED BY SWITCHING TO LPG FOR COOKING IN INDIA

Location	Original fuel/stove	Time savings (minutes per day)	
		Fuel collection	Cooking
Maharashtra, Andra Pradesh, W.Bengal, Punjab, Himachal Pradesh, Rajasthan*	Traditional biomass	17	43
	Kerosene	15	49
Karnataka, Himachal Pradesh and Odisha**	Traditional stove	NA	70
Lag Valley in Kullu Himachal Pradesh	Traditional fireplace	<360	60-120

* The time saved was calculated by subtracting the average times taken to collect firewood or cook in households that use biomass, minus the average time taken to collect fuel or cook in households using LPG.

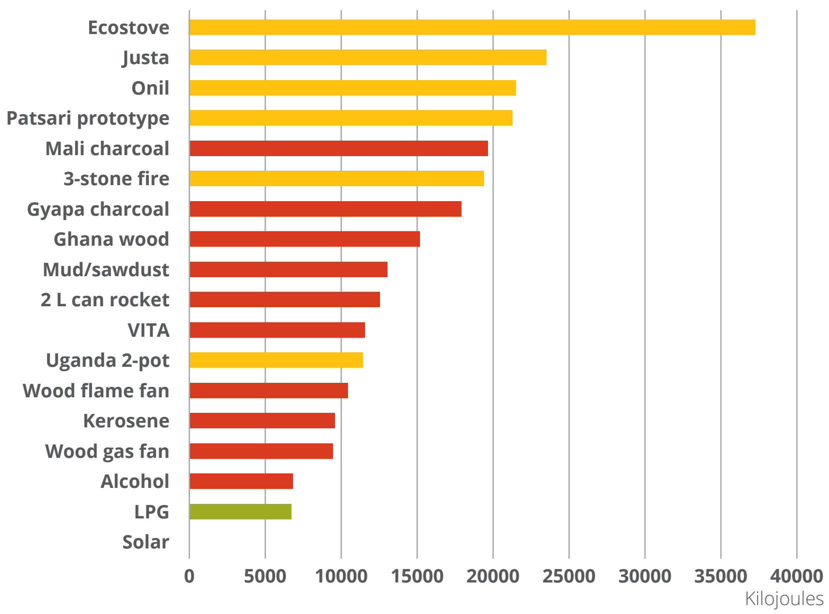
** Traditional cookstoves were replaced by LPG, biogas, electricity and/or natural gas cookstoves.

Notes: NA is not applicable.
Source: WLPGA (2014).

FUEL SAVINGS

As well as the time saved in cooking with LPG, there are potential financial and economic benefits from the lower cost of providing effective energy for cooking, to the extent that the higher efficiency outweighs the higher cost of the fuel on a gross calorific value basis. The more efficient the cookstove, the less fuel is needed. Traditional biomass may be free but time is wasted in collecting it, reducing the time available to engage in economic activities, so the efficiency of the cookstove matters. Cooking over a three-stone fire – the most basic means of cooking, which is still common in many poor rural parts of the world – generally yields only 5–20 percent overall thermal efficiency (i.e. the share of the energy content of the fuel that is transformed into useful heat); a traditional cookstove made with mud and metal is slightly more efficient. By contrast, an LPG cookstove typically has an efficiency of 50-70% depending on operating conditions.[11] With the exception of the parabolic solar cooker, LPG was by the most efficient of all the cook stoves tested in the 2011 Aprovecho study measured by the energy required to bring water to the boil (Figure 6).

FIGURE 6: ENERGY REQUIRED TO BRING 5 LITRES OF WATER TO THE BOIL AND SIMMER IT FOR 45 MINUTES BY TYPE OF COOK STOVE



Note: Yellow bars indicate with chimney; red without.
Source: Aprovecho Research Center (2011).

How big or small the fuel savings in monetary terms are in practice depends on the relative efficiency of the cook stoves, the prices of LPG and whether traditional fuels are bought commercially, which is usually the case with charcoal. If LPG is subsidised, the overall financial savings enjoyed by households may be significant, though there may be a net economic cost of switching (i.e. the cost of the subsidies to the national economy may be bigger than the financial savings to households).

AVOIDED COST OF ENVIRONMENTAL DEGRADATION

The use of traditional fuels and coal give rise to major environmental impacts, which are generally broader and larger than those associated with the use of LPG. These environmental impacts, which can be local, regional or global, carry a social and economic cost.

Local environmental benefits accrue from a switch away from biomass to cleaner fuels, as well as from the deployment of improved and more fuel-efficient stoves. The most important benefits are as follows:

- Reduced deforestation: Less use of traditional biomass means that fewer trees need to be cut down in an unsustainable fashion to meet demand for firewood or charcoal. Deforestation due to unsustainable firewood use can lead to soil erosion, desertification, and, in hilly areas, landslides. About half the wood extracted worldwide from forests is used to produce energy,

[11] See, for example, Shen et al. (2017).

mostly for cooking (FAO, 2017). It has been estimated that 30% of woodfuel harvesting is currently unsustainable (Bailis et al., 2015).

- Improved agricultural productivity: Animal dung and agricultural residues are often used as low-grade cooking fuel rather than natural soil fertilizer in poor countries. Removing these sources of nutrients interrupts the normal composting process and, in the absence of any chemical fertilizers, degrades the quality of the soil, ultimately reducing farm productivity (though some of the ash produced by the combustion of biomass may be used as fertilizer, such that not all of the nutrients are lost). Reducing the use of such fuels, therefore, helps to reduce the need to buy chemical fertilizers, boost productivity and enhance food security.

Global environmental benefits occur when greenhouse-gas emissions are reduced. The extent to which this occurs as a result of switching from solid fuels depends on the types of fuels that are replaced and the efficiency of the cook stoves in which they are used. Most biomass cook stoves are very inefficient (see above), because of the incomplete burning of the fuel and poor heat transmission, leading to excessive emissions of carbon dioxide (CO_2) and other greenhouse gases such as methane and nitrogen oxides. The use of solid fuels for cooking and heating also gives off black carbon – the sooty black ultrafine PM formed by the incomplete combustion of organic material. There is a growing body of evidence that black carbon may be the second-most important contributor to global warming after CO_2 (Ekouevi *et al*., 2014).

When biomass is produced in a sustainable manner, the CO_2 emitted in combustion are entirely offset by the CO_2 absorbed by the biomass grown to replace it. However, in reality, much of the biomass used in poor developing countries is not replaced, so net emissions are positive. Coal-based stoves, even where the efficiency is as good as that of an LPG stove, give off around 50% more CO_2; allowing for differences in stove efficiency, emissions are often twice as high. In addition, in the case of charcoal, emissions arise not only from its eventual use as a cooking fuel in the household, but also from the initial preparation of charcoal, a process which generates significant amounts of methane and other products of incomplete combustion (FAO, 2017).

OTHER BENEFITS OF SWITCHING FROM SOLID FUELS

Switching to cleaner fuels for cooking and heating brings other less tangible benefits that contribute to a better quality of life. A cleaner house due to less smoke, the prestige of owning a modern stove and its convenience are often considered important factors by users and can result in a perceived rise in their self-perception and status in the community (WHO, 2008). Household assets and amenities offer a general reflection of a household's quality of life. The transition to modern energy, of which the shift to LPG for cooking forms an important component, can facilitate development through improvement in many different areas that are important for quality of life (Barnes *et al*., 2010).

Measuring the costs and benefits of switching to LPG

ECONOMIC EVALUATIONS

While the benefits of switching to LPG for cooking are well-recognised, just how big they are and how they compared with the associated costs is less obvious. Improving access to LPG for cooking carries a financial cost – both in terms of the upfront cost to households of buying the stove and the ongoing cost of buying the fuel, as well as the administration costs of public programmes to promote the uptake of LPG. But these costs have to weighed against the wide-ranging private and social benefits described above. Measuring the impact of policy interventions to encouraging switching to modern fuels is far from straightforward, as all the different short term and longer term consequences, including investment costs, knock-on effects and feedbacks, need to be taken into account. Yet it is essential that interventions be based on a credible economic evaluation of the costs and effects of specific programmes to ensure that the choice and scale of intervention is optimised (Box 1).

BOX 1: METHODOLOGICAL APPROACHES TO ECONOMIC EVALUATION OF THE IMPACT OF SWITCHING TO LPG

Economic evaluation differs from a pure financial evaluation insofar as the former seeks to take account of non-financial impacts that may be difficult to estimate in monetary terms. Financial analysis involves assessing income, expenditure, cash flows, profit and the balance sheet at the end of a period. On the other hand, economic aims to measure the impact of an intervention on the overall economy (at the local, national, regional or global level), and considers all the uses of resources and their consequences. The results of economic evaluation can be used in a variety of ways, including for project analysis, for government policymaking, to assess the social impacts of interventions and for use by an implementing agency, such as a hospital, company or non-governmental organization (Hutton and Rehfuess, 2006).

There are two main types of economic evaluation: cost-effectiveness analysis (CEA) and cost–benefit analysis (CBA). The principal difference between them is the units in which the outcome of the intervention is measured and the scope of the analysis: CEA, which is commonly used to measure health impacts, measures the benefits of interventions to reduce indoor pollution in units such as the numbers of DALY or YLL averted. It can, therefore be used to identify how much requires to be spent on an intervention to obtain a given unit of health gain. In contrast, CBA determines the monetary value of all intervention costs and benefits to society as a whole, and hence whether the investment in the intervention yields a net gain in economic terms (i.e. whether the economic benefits of an intervention exceed its economic costs). A positive net benefit – with a benefit-cost ratio (BCR) greater than 1 – indicates that an intervention is socially and economically worthwhile. This method is usually considered more appropriate for economic evaluation of household energy interventions, though it is generally a more resource-intensive than CEA (Bruce *et al*., 2014).

CBA and CEA can be applied if primary data is available on the various impacts described above. In practice, gathering such data can be difficult. Questionnaires and participatory techniques can be used to assess and understand socioeconomic impacts. Qualitative questionnaires assess people's perceptions of impact, while quantitative questionnaires determine measurable impacts, such as time use or expenditure. Participatory methods, such as focus group discussions and ranking exercises, can be a powerful tool for assessing social and economic impacts.

Despite the seriousness and pervasiveness of indoor pollution caused by the use of solid fuels, only a small number of quantitative studies of the socioeconomic impact of household energy interventions in developing countries have been published in recent years. The most extensive study – and the only one with global coverage – was a cost-benefit analysis (CBA) carried out by the WHO in 2006, covering urban and rural populations at the global level and for 11 developing and middle-income regions and based on eight different scenarios of interventions to switch from solid fuels; the results are summarised in WHO (2006) and are described in detail in Hutton *et al*. (2006). Among the eight scenarios analysed, three involved switching to LPG – two of which assumed that 50% of households using solid fuels in 2005 switch by 2015 (including a pro-poor scenario in which households using the most polluting and least efficient solid fuels switch first) and one that assumed that all households switch fuels. The second is clearly not feasible, but was used to provide an indication of the hypothetical potential gains. The study involved calculating the benefit-cost ratio (BCR) as the annual average economic benefits of the intervention divided by the annual average economic net costs of the intervention, discounted over the ten-year period. Net intervention costs are calculated as absolute intervention costs minus cost savings as a result of fuel-efficiency gains. Economic benefits include reduced health expenditure due to less illness, the value of productivity gains due to less illness and death, time savings due to less time spent on both fuel collection and cooking, and reduced environmental damage at the local and global levels.

TABLE 3: BENEFIT-COST RATIOS FOR WHO LPG INTERVENTION SCENARIOS ($ RETURN PER $ INVESTED)

	50% of population reliant on traditional fuels switch to LPG				100% of population reliant on traditional fuels switch to LPG	
	Baseline		Pro-poor*		Baseline	
WHO region	Urban	Rural	Urban	Rural	Urban	Rural
Africa – D	26.5	3.7	3.3	3.2	Neg	4.4
Africa – E	Neg	6.2	12.7	6.9	Neg	10.5
Americas – B	14.3	3.8	6.9	3.7	Neg	4.7
Americas – D	Neg	1.8	0.9	3.6	Neg	2.0
E Mediterranean – B	4.9	4.2	4.9	4.3	5.0	4.2
E Mediterranean – D	Neg	2.2	16.1	2.1	Neg	2.7
Europe – B	Neg	3.0	Neg	2.9	Neg	4.1
Europe – C	Neg	3.4	Neg	3.1	Neg	6.3
SE Asia – B	Neg	2.7	0.2	3.4	Neg	3.2
SE Asia – D	2.6	1.5	1.4	1.8	Neg	1.6
W Pacific – B	27.0	21.2	68.5	14.6	Neg	Neg
WORLD**	22.3	3.2	15.1	3.7	Neg	4.0
WORLD (AVERAGE)**	6.9		6.7		33.7	

* Switching is targeted at hosueholds using the most polluting and least efficient solid fuels (first dung and crop residues, second firewood, third charcoal and finally coal).

** Excluding regions with very low mortality among both adults and children (A).

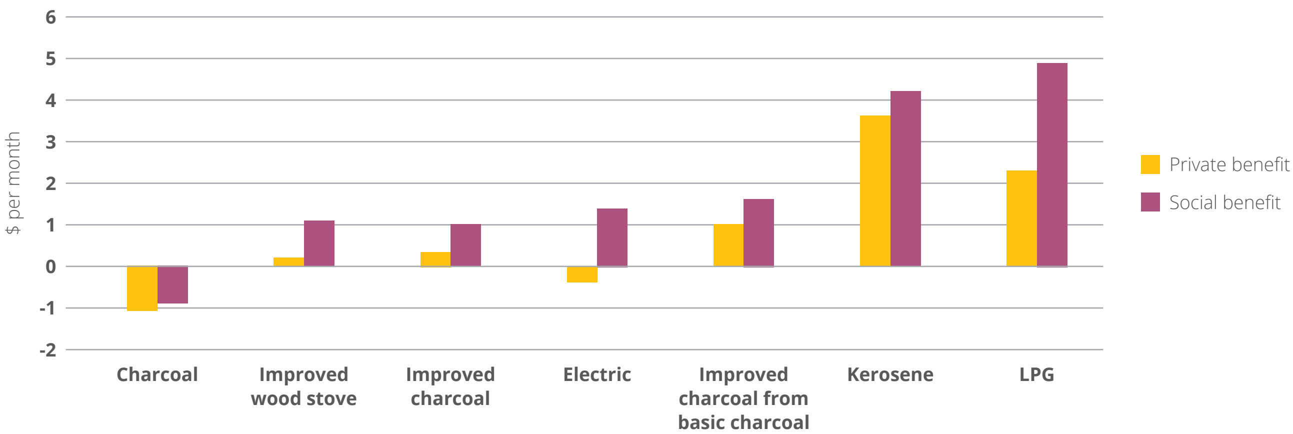
Note: Neg = negative (i.e. the intervention cost savings exceed the intervention costs). Mortality strata: A = very low child & adult; B = low child & adult; C = low child, high adult; D = high child & adult; E = high child, very high adult.

Source: Hutton et al. (2006).

The results show very favourable BCRs (i.e. well in excess of 1 – the lower limit of economic viability) for switching to LPG, as well as for the deployment of improved stoves. The benefits outweigh the costs, in most cases by a large factor, in all scenarios and regions, with the exception of the urban areas of Americas region with high mortality and the southeast Asia region with low mortality in the pro-poor scenario. On average worldwide, the benefits are around seven times greater than the costs in the two scenarios in which 50% of people using solid fuels switch to using LPG and are 34 times greater in the 100% switching scenario (Table 3). In many cases, the fuel savings for households are bigger than the upfront cost of switching (the purchase of the stove and cylinder) such that the net cost and, therefore, the benefit-cost ratio are both negative. In the scenario in which 50% of people using solid fuels switch to using LPG, total economic benefits amount to roughly US$ 90 billion per year compared with net intervention costs of only US$ 13 billion. Time savings account for 49% of the gross economic benefits, health-related productivity for 44.5%, environmental benefits for 7% and health-care savings for just 0.2%, though the breakdown varies markedly across regions. In the pro-poor scenario, the economic benefits are even higher, at US$ 102 billion, with a net intervention cost of just US$ 15 billion.

A handful of other CBA studies of the socioeconomic impact of fuel switching in households, including to LPG, have been conducted to date at the country or programme level. Most show BCRs well above 1. For example, an analysis of switching to either an improved stove or LPG in Nigeria, where 79% of the population rely on solid fuels, found BCRs of around 3 (Isihak *et al*., 2012). Another study evaluated the impact of actual programmes implemented in poor communities in Kenya and Sudan between 2004 and 2007 to reduce indoor air pollution, involving a switch to LPG (Malla *et al*., 2011). The results suggest that those programmes were justified on economic grounds with estimated internal rates of return of 429% in Kenya, where LPG and smoke hoods were introduced, and 62% in Sudan, where LPG was the only intervention. In Sudan, the BCR was 2.5 at a 10% discount rate, with the net present value amounting to US$ 227 per household. In each country, time savings constituted by far the most important benefit followed by fuel cost savings. An earlier study of switching to LPG in Columbia and Peru also yielded BCRs well above 1 (Larsen *et al*., 2008). Using a very different methodology, involving Monte Carlo simulations to incorporate uncertainty, another study found the net social benefit of switching from traditional biomass to LPG for cooking to be higher than all other options and the net private benefit to be the second highest after kerosene (Figure 7) (Jeuland and Pattanayak, 2012).

FIGURE 7: PRIVATE AND SOCIAL NET BENEFITS OF SWITCHING TO DIFFERENT COOKSTOVE OPTIONS IN DEVELOPING COUNTRIES



Note: Median values based on switching from traditional biomass cookstoves. Private benefits do not include any subsidy to the stove; social benefits inlcude black carbon accounting (CO_2, NO_2 and CH_4).
Source: : Jeuland and Pattananyak (2012).

Other cost-effectiveness analysis (CEA) studies have attempted to quantify certain aspects of household fuel switching, including productivity, health and climate change. The results vary widely as they depend on the particular outcome being evaluated, though they generally show that cooking on clean stoves including LPG is generally a cost-effective means of obtaining significant health improvements (Bruce *et al*., 2014). For example, one study quantifies the relative health and emissions impacts of different switching scenarios at the global level, concluding that LPG and kerosene stoves have unrivalled indoor air-quality benefits while their climate impacts are lower than all but the cleanest stove using traditional fuels (Greishop *et al*., 2011). Others show that the cost of improving health, measured in terms of dollars per DALY saved, through the adoption of clean cookstoves is significantly lower than for many other types of illness, such as heart and respiratory diseases (for example, Bailis *et al*., 2009).

The role of clean cooking facilities as a cost-effective measure to tackle climate change is gaining increasing attention. Various studies show that controlling both short-lived climate pollutants and long-lived greenhouse gases from cooking can increase the chances of meeting the goal under the Paris Agreement of limiting global temperature rise to below 2° C, notably by reducing emissions of black carbon. A World Bank study emphasizes the importance of introducing clean-burning biomass cookstoves and substituting traditional cookstoves with those that use LPG to mitigate climate change, as well as improve indoor air quality (World Bank/ICCI, 2013). The global potential for greenhouse gas (GHG) emission reductions from improved cookstove projects has been estimated at around 1 gigatonne of carbon dioxide (CO_2) per year (Lee *et al*., 2013).

ESTIMATING THE NET BENEFIT OF A BILLION PEOPLE SWITCHING TO LPG BY 2030

LPG will continue to play a central role in the quest for universal access to modern energy for cooking alongside other fuels and technologies, including advanced cook stoves for biomass and other solid fuels, electricity, natural gas in urban areas (where available) and biogas. How quickly this will occur is uncertain, depending to a large degree on efforts by the public authorities and other stakeholders to intervene to speed up the process. In its New Policies Scenario, the IEA projects the number of people with access to modern fuels for cooking in developing countries to increase by 690 million between 2015 and 2030, with a little over 200 million of them choosing LPG (IEA, 2017a). By 2030, a total of 1.3 billion people are using LPG for cooking, compared with around 1.1 billion today. In its Energy for All Case, in which all households gain access to modern cooking fuels by 2030 (in line with the UN Sustainable Development Goal #7) more than three-and-a-half times more people in developing countries gain access to modern cooking fuels relative to the New Policies Scenario, representing an additional 2.3 billion people. Of these, 750 million opt for LPG, taking the total number using LPG to just over 2 billion. This is broadly in line with the WLPGA/SEforALL goal of one billion people switching to LPG by 2030.

What would be the value of the socioeconomic benefits of meeting that one billion target? The results of the 2006 CBA carried out by the WHO can be used to provide an indication, even though the assumptions about the numbers switching and the timeframe are not the same. In the scenario that assumes that 50% of people relying on solid fuels in 2005 (which equates to around 1.4 billion people) switch to LPG by 2015, the total benefits total US$ 90 billion per year and net intervention costs US$ 13 billion per year, yielding an overall net present value benefit of US$ 77 billion per year and a benefit-cost ratio of almost seven to one. Scaling down the net benefit to 1 billion people and adjusting for inflation over the period since the WHO study was carried out yields a net present value of around $60 billion per year in 2018 dollars. This includes the welfare benefits of deaths avoided: the IEA estimates that premature deaths caused by HAP would fall by 1.8 million by 2030 in the Energy All Case compared with 2015 (IEA, 2017a).

Implications for policy

Over time, rising incomes will tend to boost the proportion of poor people using modern fuels such as LPG for cooking in developing countries. Yet that process will remain unacceptably slow unless governments intervene – in part because incomes are held back by the very fact that households do not have access to modern energy. At present, progress in expanding access to LPG and other clean cooking fuels falls well short of that required for universal access to be achieved by 2030 (World bank, 2018; IEA, 2017a). The enormous potential socioeconomic benefits – to households themselves, but also to the broader community – of universal access provide a strong justification for decisive policy action. The upfront financial costs involved in making this happen on a large scale are not trivial, but are small compared with the benefits that would accrue and are tiny compared with overall energy investment needs.[12]

The government in every developing country has a crucial part to play in establishing an enabling environment for the private sector to facilitate the expanded use of LPG by households through a variety of actions both within and outside the LPG sector. Non-governmental organisations and international donors can assist by providing advice and financial resources. The objective must be to establish a virtuous circle of growing demand, increased investment and expanded availability of the fuel. The compatibility of policies to boost switching to LPG with other policies, including structural and regulatory reforms and policies concerning health, education, infrastructure and financing, is critical to their success. The first step is to make LPG and other clean-cooking solutions a top political priority and put in place specific policies, cross-sectoral plans and public investments, supported by multi-stakeholder partnerships (UNDESA, 2018; Lancet Commission, 2018). Those that have already taken laudable steps toward national plans must accelerate their implementation (World Bank, 2018).

At the level of implementation, how well actual programmes are integrated into broader urban and rural energy development plans will influence how effective they are in encouraging the use and availability of LPG. In rural areas, co-ordination with, and the participation of, local organisations can be of vital importance; co-operatives, non-governmental organisations and local community organisations can be highly effective vehicles for supporting the establishment of local systems for energy distribution and delivery, as they understand local needs and can play a key role in communicating these needs to government, donors and external development agencies (WHO, 2014b; World Bank/WLPGA, 2002).,

Within the LPG sector, support can take various forms, including measures to make the general regulatory and business environment more favourable to investment in distribution infrastructure (including making it clear to investors what laws, regulations and standards apply) and programmes to make LPG more affordable and to provide assistance in setting up micro-credit or micro-finance programmes. Policies and regulations need to be accompanied by effective monitoring and enforcement to ensure fair competition and that efficiency

[12] The IEA estimates that the total purchase cost of LPG cookstoves in its New Policies Scenario, in which the number of people using the fuel for cooking rises by 200 million, amounts to around USD 12 billion over 2016-2030, or USD 800 million per year (IEA, 2017a). This is equal to a mere 0.04% of the projected average total energy-sector investment needs over 2016-2040 (IEA, 2017b).

gains are passed on to consumers in the form of lower prices. Adequate funding is essential. The authorities need to seek out innovative financing mechanisms and leverage private and international sources of funding. For example, the Indian government has launched a scheme to encourage wealthy households to give up voluntarily the subsidy they enjoy on LPG so it can be redirected to poor households.[13] At present, the bulk of funding for clean cooking programmes comes from international donors and domestic public sources, though the role of private lending is growing (SEforALL/CPI/World Bank, 2017).

Outside the sector, the government needs to ensure that the transport infrastructure is built to enable the fuel to be delivered to local communities, including roads that can cope with heavy trucks and adequate port facilities. Effective policymaking calls for strong leadership on tackling household energy poverty and addressing apathy and resistance to change on the part of public institutions and households, good inter-institutional coordination, education and training and access to resources by the authorities as well as households.

It may make sense to first target households whose income is sufficiently high to start using LPG without subsidies and who already live in areas with LPG marketers, because these households are best placed to switch entirely to LPG and sustain its use (Kojima, 2011). Most of these households are likely to be in urban or peri-urban areas. Increasing use of LPG in the community will tend to lead others to consider switching to the fuel too through demonstration effects. But attention also needs to be given to encouraging the distribution of LPG in more remote rural areas, where the use of dirty traditional fuels and the problems of indoor pollution are most prevalent.

Raising awareness of the true cost of solid fuel use and the benefits of switching to LPG is a critical part of the solution. This makes it all the more important that donors and governments understand the scale of the socioeconomic prize. Analysis of costs and benefits not only shows the potential efficiency of the interventions, but also who is likely to incur the costs and who enjoys the benefits of the interventions. The UN Sustainable Energy for All initiative (SE4All) has already had a big impact in raising global awareness of energy poverty and the urgent need to increase modern energy access, as well as stimulating real action to advance the transition to modern energy in the developing world. But the slow progress of the last few years demonstrates very clearly the need for much stronger action for universal access to clean cooking fuels to become a reality.

[13] http://www.givitup.in/

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WLPGA

WLPGA
182, avenue Charles de Gaulle
92200 Neuilly-sur-Seine, France
Tel: +33 1 78 99 13 30

association@wlpga.org
www.wlpga.org